Respiratory Indications for Polysomnography in Children: An Evidence-Based Review

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Objective: This comprehensive evidence-based review provides a systematic analysis of the literature regarding the validity, reliability, and clinical utility of polysomnography for characterization of breathing during sleep in children. Findings will serve as the foundation for development of practice parameters regarding respiratory indications for polysomnography in children.

Methods: A task force of content experts performed a systematic review of the relevant literature and graded the evidence using a standardized grading system. Over 240 evidentiary papers were reviewed, summarized and graded. The analysis addressed the operating characteristics of polysomnography as a diagnostic procedure in children, and identified strengths and limitations of polysomnography for evaluation of respiratory function during sleep.

Results: The analysis documents strong face validity and content validity, moderately strong convergent validity when comparing respiratory findings with a variety of relevant independent measures, moderate-to-strong test-retest validity, and limited data supporting discriminant validity for characterizing breathing during sleep in children. The analysis documents moderate-to-strong test-retest reliability and interscorer reliability based on limited data. The data indicate particularly strong clinical utility in children with suspected sleep related breathing disorders and obesity, evolving metabolic syndrome, neurological, neurodevelopmental, or genetic disorders, and children with craniofacial syndromes. Specific consideration was given to potential clinical utility of polysomnography prior to adenotonsillectomy for confirmation of obstructive sleep apnea syndrome. The most relevant findings include: (1) recognition that the clinical history and examination are often poor predictors of respiratory polygraphic findings, (2) preoperative polysomnography is helpful in predicting risk for perioperative complications, and (3) preoperative polysomnography is often helpful in predicting persistence of obstructive sleep apnea syndrome in a substantial minority of patients after adenotonsillectomy. No prospective studies were identified that address whether clinical outcome following adenotonsillectomy for treatment of obstructive sleep apnea is improved in association with routine performance of polysomnography before surgery in otherwise healthy children. A small but clinically useful group of papers confirm the clinical utility of polysomnography for initiation and titration of positive airway pressure support, but there are no papers that address optimal timing of repeat studies in children receiving chronic positive airway pressure support.

Conclusions: Pediatric polysomnography shows validity, reliability, and clinical utility that is commensurate with most other routinely employed diagnostic clinical tools or procedures. Findings from this evidence-based review indicate that the "gold standard" for diagnosis of sleep related breathing disorders in children is not polysomnography alone, but rather the skillful integration of clinical and polygraphic findings by a knowledgeable sleep specialist. Future developments will provide more sophisticated methods for data collection and analysis, but integration of polysomnographic findings with the clinical evaluation will represent the fundamental diagnostic challenge for the sleep specialist.

Keywords: Polysomnography, pediatric, indications, clinical utility, sleep related breathing disorders, obstructive sleep apnea syndrome

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1.0 INTRODUCTION

Evaluation of children with suspected sleep disorders begins with and is based primarily on a thorough history. In appropriate cases the diagnostic process includes performance of polysomnography (PSG), most commonly for characterization of breathing during sleep. Less commonly, PSG is performed for characterization of certain movements or behaviors during sleep, or evaluation of suspected narcolepsy. Because PSG is a relatively expensive procedure requiring significant time and health care resources, understanding the strengths, limitations, and clinical utility of PSG is necessary to ensure optimal utilization.

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The purpose of this paper is to summarize information in the medical literature about respiratory indications for PSG in children. The specific objectives are: (1) to provide a systematic and comprehensive review of the relevant medical literature regarding respiratory indications for PSG in children; (2) to grade the strength of evidence contained in the literature using a standardized grading system; (3) to summarize information regarding the validity and reliability, clinical utility, and when available, outcomes associated with use of PSG in children with suspected respiratory disturbance during sleep; and (4) to discuss the strengths and limitations of current knowledge about the utility of PSG in children.

Findings from this paper will provide the foundation for development of evidence-based practice parameters regarding respiratory indications for PSG in children by the Standards of Practice Committee (SPC) of the American Academy of Sleep Medicine (AASM). The decision was reached to produce three review papers; this paper will focus on respiratory indications,

and a second paper will be devoted to non-respiratory indications for PSG in children. A third paper will focus on potential indications for PSG in children with attention deficit hyperactivity disorder (ADHD) and autistic spectrum disorders (ASD). It is beyond the scope of this review to evaluate standards for how to perform PSG, equipment for PSG in children, methods for scoring respiratory events during sleep in children, or economic cost and cost-benefit analyses of PSG in children. Unattended testing outside the sleep laboratory in children has been used predominantly in research settings, and there is a paucity of research comparing it to traditional in-laboratory attended PSG or other objective clinical outcomes. For this reason, the task force did not address validity, reliability, or clinical utility of unattended testing outside the sleep laboratory in children.

2.0 BACKGROUND

2.1 Rationale

The dramatic growth of pediatric sleep medicine over the past three decades is well documented (see Figure 1).[1,2] Examples of changes that involve PSG include advances in digital recording techniques, improvements in signal acquisition and processing and recognition that child-friendly approaches may improve the quality of physiological measurements and clinical utility. Improved education of physicians, other healthcare providers, and the general public has led to greater recognition of the impact of untreated sleep related breathing disorders (SRBD) in children on cognition, behavior, growth, and cardiovascular health.[3-9] Availability of sleep facilities with well-trained pediatric sleep technologists and sleep medicine physicians has improved, but access to pediatric PSG remains suboptimal in some geographic areas.

Standardized operational definitions of respiratory events during sleep,[10] and diagnostic criteria for pediatric SRBD,[11] have contributed to consistency in the evaluation and management of SRBD in children. Adenotonsillectomy (AT) remains the primary treatment for clinically significant obstructive sleep apnea syndrome (OSAS),[12] but therapeutic interventions such as positive airway pressure (PAP) and surgical procedures other than AT are viable options for certain children with OSAS. In concert with these changes, there has been robust growth in the peer-reviewed medical literature regarding pediatric PSG, as shown in Figure 1. This expansion of the literature creates an opportunity for systematic and comprehensive review and evidence grading of the literature, and this paper is part of a commitment by the AASM to develop evidence-based practice parameters regarding the clinical practice of sleep medicine.

2.2 Summary of Earlier Guidelines and Recommendations

Several professional organizations have produced clinical guidelines or practice parameters regarding indications for PSG in children. Earlier publications included expected limitations associated with a less mature literature and less sophisticated sleep technology, and many recommendations were primarily consensus-based rather than evidence-based.

In 1996 the American Thoracic Society (ATS) produced a set of consensus-based recommendations with regard to respiratory indications for PSG in children, as well as guidelines for performing PSG, scoring and reporting data from PSG studies,

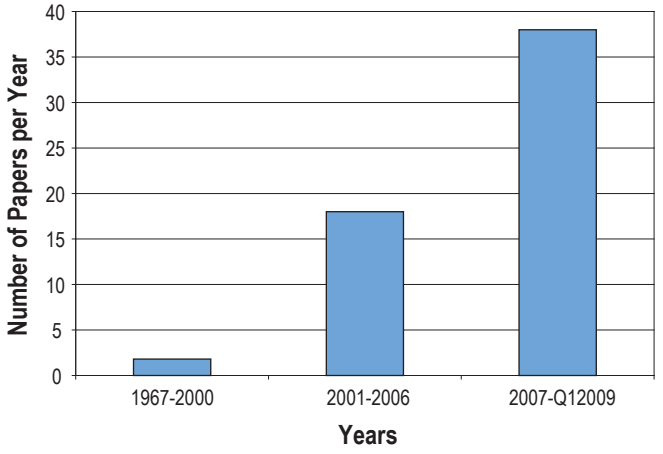

Figure 1—Growth rate of peer reviewed publications regarding pediatric PSG.

and identification of areas where knowledge was lacking.[13] For a number of years, this publication served as a primary resource for sleep specialists involved with evaluation of respiratory sleep disorders in children.

The ATS paper on standards and indications for cardiopulmonary sleep studies in children included the following primary conclusions:

> 1) polysomnography is recommended to differentiate benign or primary snoring, i.e., snoring not associated with apnea, hypoventilation, or evidence of cardiovascular or central nervous system effects, for which treatment is rarely indicated, from pathologic snoring (OSA), i.e., snoring associated with either partial or complete airway obstruction, hypoxemia, and sleep disruption. A history of loud snoring alone has not been shown consistently to have sufficient diagnostic sensitivity upon which to base a recommendation for surgery, whether adenotonsillectomy, uvulopalatopharyngoplasty (UPPP), or tracheostomy, and 2) polysomnography is indicated for evaluating the child with disturbed sleep patterns, excessive daytime sleepiness, cor pulmonale, failure to thrive, or polycythemia unexplained by other factors or conditions, especially if the child also snores.[13]

The ATS guidelines included the recommendation that PSG can be deferred in children with clinically significant airway obstruction in order to expedite therapy such as surgical intervention. The guidelines also reviewed factors that may increase risk for perioperative complications following upper airway surgery. There was discussion of laryngomalacia, bronchopulmonary dysplasia (BPD), cystic fibrosis (CF), neuromuscular disorders, asthma, obesity, sickle cell disease, certain craniofacial abnormalities, infants with apnea and bradycardia, and timing of repeat PSG after surgical intervention. The ATS guidelines discussed use of PSG to facilitate treatment of OSAS with PAP support, and use of PSG followed by the multiple sleep latency test (MSLT) as part of the evaluation of suspected narcolepsy in children. The ATS guidelines provided a "risk stratification" approach for determination of the clinical utility of PSG in children, but the largely consensus-based process and paucity of larger studies with optimal study design represented limitations.

Box 1—AAP Guidelines regarding diagnosis and management of OSA in children[12]

AAP Guidelines for Childhood OSA

1. All children should be screened for snoring.
2. Complex high-risk patients should be referred to a specialist.
3. Patients with cardiorespiratory failure cannot await elective evaluation.
4. Diagnostic evaluation is useful in discriminating between primary snoring and OSA, the gold standard being polysomnography.
5. Adenotonsillectomy is the first line of treatment for most children, and continuous positive airway pressure is an option for those who are not candidates for surgery or do not respond to surgery.
6. High-risk patients should be monitored as inpatients postoperatively.
7. Patients should be reevaluated postoperatively to determine whether additional treatment is required.

The AASM (formerly known as the American Sleep Disorders Association) produced comprehensive practice parameters for clinical indications for PSG and related procedures in 1997.[14] These practice parameters included respiratory and non-respiratory indications for PSG, and the process was evidence-based, but recommendations were focused on adult patients. Except for sections on parasomnias and nocturnal seizures, indications for pediatric patients were not addressed. The AASM updated these adult-focused practice parameters in 2005.[15]

The American Academy of Pediatrics (AAP) published a clinical practice guideline in 2002 on diagnosis and management of childhood OSAS (see Box 1).[12] This guideline was primarily evidence-based and was intended for primary care providers. The guideline focused on uncomplicated childhood OSAS, defined as otherwise healthy children with OSAS associated with adenotonsillar hypertrophy (ATH) and/or obesity, being treated in the primary care setting. The AAP guideline specifically excluded infants younger than 1 year, patients with central apnea or hypoventilation syndromes, and patients with OSAS associated with other medical disorders, including but not limited to Down syndrome, craniofacial anomalies, neuromuscular disease (including cerebral palsy), chronic lung disease, sickle cell disease, metabolic disease, or laryngomalacia.

The AAP guidelines include an algorithm to summarize recommendations. When clinical evaluation suggests OSAS, PSG is recognized in the guideline as the "gold standard" for diagnostic evaluation, but other screening studies such as audiovisual taping, overnight pulse oximetry, nap studies, and unattended home studies are listed as alternatives to PSG. If these screening studies are negative, referral for PSG is recommended.[12] The accompanying Technical Report[16] describes the procedures involved in developing the AAP guidelines and acknowledges the paucity of methodologically strong cohort studies or randomized, controlled trials in pediatric OSAS. Most studies cited were clinical series and cross-sectional studies.

Standardized clinical diagnostic criteria for SRBD in children are presented in the International Classification of Sleep Disorders, 2nd edition, (ICSD-2) published by the AASM in 2005.[11] Polygraphic diagnostic criteria are provided for pediatric OSAS, primary sleep apnea of infancy, and congenital central alveolar hypoventilation syndrome. However, the polysomnographic diagnostic criteria for pediatric OSAS are not explicitly stated other than the requirement that one or more scorable respiratory events per hour are present. ICSD-2 diagnostic criteria include arterial oxygen desaturations in association with the apneic episodes, hypercapnia during sleep, and "markedly negative esophageal pressure swings," but there is no delineation of level of negative pressure swing required.[11]

The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology, and Specifications[10] was developed using a comprehensive literature review and analysis, and a standardized consensus process to produce a definitive resource for sleep specialists. This publication provides explicit rules for scoring respiratory events, sleep stages, arousals, and other aspects of pediatric PSG. The AASM sleep scoring manual lists respiratory rules for children including technical considerations, and scoring rules for apnea, hypopnea, respiratory effort related arousal (RERA), hypoventilation and periodic breathing.

A recurring theme in these publications is the observation that clinical history and physical examination often cannot reliably distinguish between primary snoring and OSAS in children. This observation suggests that optimal practice requires performance of a comprehensive PSG to establish a definitive diagnosis of OSAS in children. This practice would establish PSG as the *de facto* "gold standard" for the diagnosis of OSAS in children. It is challenging to prove that PSG is a fully validated and reliable diagnostic procedure for characterization of respiratory function during sleep in children. For example, definitive pathological cut-offs for frequency of respiratory events or arterial oxygen desaturation are difficult to establish in children, and there are reports that document clinical improvement following AT in children with presumed OSAS who did not meet the certain polysomnographic diagnostic criteria for OSAS.[17] Even more challenging is the issue of whether comprehensive PSG is *routinely* indicated prior to or following AT, and whether performance of PSG is associated with improved outcome.

2.3 Establishment of the Task Force

The Indications for Polysomnography in Children task force was established in 2007 by the AASM SPC and approved by the AASM Board of Directors. The task force was asked to: (1) provide a systematic and comprehensive review of the relevant medical literature regarding respiratory indications for PSG in children; (2) grade the strength of evidence contained in the literature using a standardized grading system; (3) summarize information regarding the validity and reliability, clinical utility, and when available, outcomes associated with use of PSG in children with suspected respiratory disturbance during sleep; and (4) summarize and discuss the strengths and limitations of current knowledge about the clinical utility of PSG in children.

The task force was created to address respiratory and non-respiratory indications for PSG in children. The composition of the task force includes individuals who are content experts in respiratory and non-respiratory areas of pediatric sleep medicine, with clinical and research experience in pediatric PSG. Of the 8 task force members, 4 are pediatric pulmonary medicine specialists, 3 are neurologists with clinical neurophysiology training (2 are child neurologists and 1 is an adult neurologist with extensive pediatric experience), and 1 is a pediatric neuropsychologist and sleep specialist. All task force members completed AASM conflict of interest forms and were found to have

Table 1—Definitions of reliability and validity

Type of Reliability or Validity	Definition	Polysomnography Example
Test-retest reliability	Stability of a measurement across time	Consistency of PSG data on 2 consecutive nights
Interrater reliability	Consistency of a measurement when used by multiple raters	Agreement between 2 people scoring the same PSG
Intrarater reliability	Consistency of a measurement when used by the same rater	Agreement between 2 scorings of the same PSG by the same person
Types of Construct Validity: (test-retest, convergent, discriminant)	Extent to which explanatory concepts account for performance on the test	
Test-retest validity (or responsiveness)	Change in the expected direction on 2 administrations of a test following a manipulation that is expected to have an impact on the measure	Reduction in the PSG-determined AHI following adenotonsillectomy
Convergent validity	Measures that should be related are in reality related	Positive correlation between oxygen saturation by oximetry and ABG
Discriminant validity	Measures that should not be related are in reality not related	Absence of significant correlation between PLM index and apnea/hypopnea index
Face validity	Agreement by experts or examinees that the test looks like it is measuring what it intends to measure	Agreement between experts that measuring airflow at the nose and mouth is a reasonable assessment of breathing during sleep Agreement between questionnaire data assessing clinical symptoms of OSA and OSA determined by PSG
Content validity	Agreement that the test samples the phenomena about which conclusions will be drawn	Agreement between experts that sleep stages can be determined by using EEG, EOG, and EMG during PSG
Criterion (predictive) validity	Agreement between the test and a direct measure of the behavior or characteristic	Increased signal amplitude on snore sensor when patient has audible snoring Consistent subjective report of sleeping when awakened from a specific sleep stage

no potential conflicts. Three SPC members were identified to serve as liaisons to the task force, and these individuals participated actively in telephone conferences and in person meetings of the task force.

2.4 Assessment of a De Facto "Gold Standard" Diagnostic Test

Assessment of clinical utility and indications for performing a diagnostic test is often challenging, particularly when the diagnostic test is viewed as a *de facto* "gold standard." The ideal approach to establishing the clinical utility of a diagnostic test is assessment of whether patient outcome is improved in association with performance of the test. As with many other diagnostic tests, there are no published studies that explicitly address this issue with regard to diagnostic PSG in children. A second approach involves assessment of the operating characteristics of the diagnostic test in an effort to document validity, reliability, and clinical utility. Examples include identification of the diagnostic sensitivity, diagnostic specificity, positive predictive value (PPV), and negative predictive value (NPV), in comparison with an independent measurement of the condition. However, there are limitations associated with this strategy when the test is viewed as the "gold standard" for defining the presence and severity of a condition. With regard to OSAS, explicit diagnostic criteria listed in the International Classification of Sleep Disorders, 2nd Edition,[11] include PSG respiratory findings that must be present to confirm a diagnosis of OSAS. Thus, determination of the clinical utility of PSG for diagnosis of OSAS involves "incorporation bias" since polygraphic diagnostic criteria are incorporated into diagnostic criteria.

Validation of a diagnostic test often involves establishment of different types of validity and reliability. A diagnostic test is said to have **face validity** when the measurement "looks like" it has intrinsic value for the measurement of the phenomenon in question.[18,19] For example, measurement of airflow at the nose and mouth during sleep has face validity for assessment of breathing during sleep. However, the validity of measuring airflow is limited by the consistency and accuracy of the measurement tool used to register airflow. Table 1 provides definitions of reliability and validity, and examples that involve PSG findings to illustrate these definitions.

The validity and reliability of techniques used for collecting and processing data influence the clinical utility of the diagnostic procedure. PSG is not a unitary procedure but rather a collection of simultaneously recorded physiological signals, with strengths and limitations associated with each parameter. A recurring challenge in this project is comparison of clinical utility of PSG across studies performed using different methods for measurement of respiratory parameters. This issue is important because the evolution of PSG includes several advances in registration of airflow, respiratory effort, measurement of arterial oxyhemoglobin saturation, and cortical (EEG) and subcortical arousals. Also, a variety of newer techniques are being investi-

Box 2—Literature search criteria

Inclusion Criteria:

- English language
- Human subjects
- Greater than or equal to 10 subjects for OSAS or CSA papers, and greater than or equal to 5 subjects for other respiratory papers
- Less than 18 years of age

Search Dates: 1966 through March 27, 2009

gated that involve more sophisticated characterization of cortical or subcortical arousals using respiratory cycle related EEG changes (RCREC), cyclic alternating pattern (CAP), pulse transit time (PTT), and peripheral arterial tonometry (PAT). These examples highlight the challenges of assessing clinical utility, given the continuous evolution of techniques and methods encompassed by PSG.

For this project the task force viewed clinical utility as a multidimensional concept, and the following attributes were considered to define clinical utility: the diagnostic test (PSG) must (1) have acceptable validity and reliability in the clinical populations of interest, (2) be useful for diagnosis and management decisions, and results should inform clinical decision-making, (3) be applied when effective therapies are available (results can influence outcome only when effective treatment is available), and (4) be interpreted by clinicians with necessary skills to use results in a meaningful way and to recognize false signals (artifact).

3.0 METHODS

3.1 Overview

The SPC liaisons and the task force developed a list of specific questions or issues to be addressed in this review. This resulted in creation of Population, Intervention, Comparison, and Outcome (PICO) tables, which were used to guide the task force and to focus the review process on clinically relevant issues. The PICO tables for this project are available on the AASM website directory (www.aasmnet.org). In preparation for this project, the task force reviewed previous AASM publications and papers produced by other organizations relevant to this topic. The task force developed a literature search strategy, established methods for selection of relevant papers, developed procedures for extracting data and grading the strength of evidence of selected papers, and generated successive drafts of this review paper. Liaisons from the SPC interacted frequently with the task force throughout this process, and comments were generated by the SPC at several key stages of this process. The task force, SPC liaisons, and AASM support staff held monthly telephone conference calls and three in-person meetings.

3.2 Literature Search Strategy

The task force divided the project into three broad sections and developed searches that correspond to topical categories. The SRBD section includes evaluation of studies that provide data regarding validity or reliability of PSG for characterization of breathing during sleep in children, clinical utility of PSG in children with risk factors for SRBD (a "risk stratification" strategy), clinical utility of PSG prior to AT or other surgical procedures, and clinical utility of PSG for assessment of infants less than 12 months of age with suspected SRBD. The Other Chronic Respiratory Disorders section includes clinical utility of PSG in children with chronic obstructive pulmonary disease and chronic restrictive lung disease. The final section on clinical utility of PSG for therapeutic intervention includes evaluation of PSG to initiate positive airway pressure (PAP) in children with SRBD, and other potential therapeutic applications.

The task force developed search terms and search strategies suitable for queries of the medical literature using Medline. Explicit inclusion and exclusion criteria, search dates, and other search limitations were established to guide selection of relevant citations (summarized in Box 2). A full listing of search terms is provided on the AASM website (www.aasmnet.org). Following performance of the literature search, a master list of candidate papers was assembled. Task force members reviewed all candidate citations by title and abstract to identify papers that met inclusion criteria and to exclude papers with exclusionary features. At least 2 task force members reviewed each citation to determine acceptance, and the task force chair provided final resolution when task force members differed in their recommendation. Accepted papers were allocated to the appropriate section or sections of the review paper. A second pathway for consideration of candidate papers involved the process known as "pearling." Pearling involves identification of relevant papers by examination of the references cited in papers deemed to be relevant or through a task force member's personal knowledge of a paper. Pearling identifies relevant papers that were not identified through the formal Medline search process. Papers identified through pearling were evaluated by at least 2 task force members in the same fashion as other papers. A summary of literature search results is provided in Section 4.1.

3.3 Data Extraction and Evidence Grading Process

Data extraction and evidence grading forms were developed to provide a standardized approach for summarizing relevant data and grading the strength of evidence. The process of data extraction and evidence grading followed a 2-step process, similar to that used in other recent AASM evidence-based review projects. Each paper was assigned for primary and secondary review. Because of the large number of papers identified, with the approval of the SPC and the AASM Board of Directors, the task force identified a group of sleep specialists to serve as primary reviewers to perform the initial data extraction and initial evidence grading for accepted papers. In preparation for performing these functions, all primary reviewers were oriented to the AASM evidence-based review process and to the objectives of this project. The task force chair and AASM support personnel conducted a series of training sessions via teleconference that included the approach to analysis of papers, completion of the data extraction form, and determination of level of evidence. Prior to beginning work on this project, all primary reviewers participated in reviewing, extracting, and grading evidence using a training set of papers, and their performance was evaluated by the task force chair to insure competency. Primary reviewers completed AASM conflict of interest forms and were provided with nominal financial remuneration by the AASM in recognition of their time and effort. All papers were then re-

viewed by at least 1, and often 2 or more, task force members. Papers were reviewed and graded with respect to the operating characteristics of PSG, which differed in some cases from the primary objectives of the paper. Task force members were charged with reviewing and modifying responses on the data extraction and evidence grading forms. When significant discrepancies occurred with evidence grading between primary and secondary reviewers, the task force chair reviewed and resolved these differences.

Table 2—Levels of evidence

Level	Description
1	Evidence provided by a **prospective** study in a **broad spectrum** of persons with the suspected condition, using a **reference (gold) standard** for case definition, where test is applied in a **blinded fashion**, and enabling the assessment of appropriate test of diagnostic accuracy. All persons undergoing the diagnostic test have the presence or absence of the disease determined. Level 1 studies are judged to have a low risk of bias.
2	Evidence provided by a **prospective** study of a **narrow spectrum** of persons with the suspected condition, or a **well-designed retrospective** study of a **broad spectrum** of persons with an established condition (by **"gold standard"**) compared to a **broad spectrum of controls**, where test is applied in a **blinded** evaluation, and enabling the assessment of appropriate tests of diagnostic accuracy. Level 2 studies are judged to have a moderate risk of bias.
3	Evidence provided by a **retrospective** study where either person with the established condition or controls are of a **narrow spectrum**, and where **the reference standard, if not objective, is applied by someone other than the person that performed (interpreted) the test**. Level 3 studies are judged to have a moderate to high risk of bias.
4	Any study design where **test is not applied in an independent evaluation** or evidence is provided by expert opinion alone or in **descriptive case series without controls**. There is **no blinding or there may be inadequate blinding**. The **spectrum of persons tested may be broad or narrow**. Level 4 studies are judged to have a very high risk of bias.

The data extraction and evidence grading form for this project is available for review on the AASM website (www.aasmnet.org). The form includes description of study design, assessment of potential sources of bias or systemic error including sample sizes, degree of blinding, referral sources, funding sources, and whether the study included a broad or narrow spectrum of subjects relative to the topic of interest. A study was considered to have a broad spectrum when the range of eligible subjects included mild through severe disease plus subjects presumed to have no disease (normal controls). A study was considered to have a narrow spectrum when the range of eligible subjects was limited to those with signs or symptoms of the disease or a restricted subgroup of those with the disease, and limited or no representation of subjects without disease (normal controls).

Assessment of evidence level was challenging for several reasons. Because this project involved evaluation of validity, reliability, and clinical utility of a diagnostic procedure rather than evaluation of therapeutic trials, the task force elected to use a classification of evidence that differed from the previous AASM system. The task force evaluated a number of evidence grading systems and performed pilots of the candidate systems using a subset of papers selected for this project. After assessment, and with approval from the SPC, the task force elected to use an evidence grading system developed by the American Academy of Neurology (AAN) for assessment of clinical utility of diagnostic tests.[20] The system involves 4 tiers of evidence, with Level 1 studies judged to have a low risk of bias and Level 4 studies judged to have a very high risk of bias. A lower level of evidence does not indicate a flawed study but refers to weaker scientific evidence and greater potential bias. Weaker levels of evidence indicate the need to integrate greater clinical judgment when applying the results to clinical decision making. The task force's assessment of data takes into account not only the levels of evidence in relevant papers, but also the number of papers identified, the magnitude and direction of various findings, and whether papers demonstrate convergent or divergent conclusions. Table 2 describes the essential features of the evidence grading system used by the task force.

After completion of the review, data extraction and evidence grading for each paper, key data were entered into an Evidence Table to summarize findings. The Evidence Table is provided on the AASM website (www.aasmnet.org).

4.0 RESULTS

4.1 Overview of Results

Approximately 3500 candidate papers were identified and screened, and 243 papers were selected for inclusion. Papers were allocated by topic, and a number of papers were relevant to more than one topic or category. Presentation of results is organized into 3 main sections: sleep related breathing disorders (SRBD), other chronic respiratory disorders, and clinical utility of PSG for therapeutic intervention.

4.2 Sleep Related Breathing Disorders

The SRBD section is composed of 4 subsections: (1) studies that assess validity and/or reliability of PSG for characterization of breathing in children, (2) clinical utility of PSG in children with risk factors for SRBD, (3) clinical utility of PSG prior to adenotonsillectomy or other surgical procedures, and (4) clinical utility of PSG for assessment of infants less than 12 months of age with suspected SRBD.

4.2.1 Studies that assess validity or reliability of PSG in children

The task force's objective was to evaluate data that address the validity or reliability of PSG in children. This objective is important because establishment of validity and reliability is requisite in order to assess the clinical utility of a diagnostic test. Establishing validity of a "gold standard" diagnostic test is challenging, particularly given that PSG is a collection of simultaneously recorded physiological measures, each with its own technical strengths and limitations. Few studies have been performed with the primary objective to assess validity or reliability of PSG in children or adults. For this reason, the task force also evaluated papers that provide useful information about validity or reliability indirectly. This strategy involved comparison of

PSG respiratory findings with other independent measures that are relevant to assessment of SRBD in children to assess the construct validity of PSG. The task force also identified studies that compare PSG findings before and after therapeutic interventions such as AT, and studies that include control groups without intervention, which allows assessment of the stability of PSG respiratory measures over time. The movement of PSG respiratory parameters in the expected direction after surgery supports the face validity and reliability of PSG for measurement of breathing during sleep. Table 3 summarizes the evidence with respect to number of papers, level of evidence, and direction and strength of support for the validity and reliability of PSG.

4.2.1.1 Correlation of PSG findings with independent measures

4.2.1.1.1 History of snoring and other nocturnal symptoms

Our search regarding the association between elements of the clinical history and PSG respiratory findings identified 35 articles. Two papers provided Level 1 evidence,[21,22] 4 Level 2 evidence,[17,23-25] and the remaining reports provided Level 3 (n = 11)[26-36] or 4 (n = 18)[37-54] evidence.

Brouillette et al.[26] (Level 3) reported results from a detailed investigator-parent interview and questionnaire in 23 children with adenotonsillar hypertrophy with PSG confirmed OSAS and 46 controls. Based on their results, a mathematical equation was developed to yield an OSA score. In this population, an OSA score > 3.5 correctly identified 22/23 of the children with OSA and a score of < −1.0 correctly identified all the normal subjects. The investigators concluded that an OSA score > 3.5 was diagnostic of OSA, a score < −1 indicated no OSA, and children with intermediate scores require PSG. These findings provide evidence that supports the validity of PSG when compared with a structured history. Carroll et al.[27] (Level 3) applied the Brouillette scoring system to 83 referred children and found the OSA score misclassified 1 in 4 subjects. The investigators concluded that in an unselected population of snoring children, the OSA score was not able to reliably distinguish between primary snoring and OSA. Although the symptoms of snoring, difficulty breathing, noisy breathing, and observed apnea are more frequent in children with OSA than children without OSA, the sensitivity and specificity for these historical findings compared with PSG is relatively poor in unselected populations.[21,23,27,29-31,33,35,36,39,41,45,47-49,53]

The Tucson Children's Assessment of Sleep Apnea Study (Goodwin et al.,[23] Level 2) examined the relationship between parasomnias and OSAS. Investigators reported a significantly increased prevalence of parasomnias, including enuresis, in children with OSAS based on PSG studies, but this was not a consistently discriminating finding.[23] Goldstein et al. reported on a large cohort of children with clinically suspected OSAS. All underwent PSG, and only 27 of 56 had PSG-proven OSA using a diagnostic cut-off of RDI > 5, or > 10% of the night with oxygen saturation values < 90%. These 27 children and half of those with a normal PSG underwent adenotonsillectomy with a follow-up clinic visit at 6 months. Clinical symptoms were significantly improved in all who underwent surgery, but little difference was noted in those who had not been treated (Level 2, Goldstein et al.[17]).

In summary, our search identified a number of papers that address the potential association between various elements of the clinical history and respiratory PSG findings. In general, findings provide limited and inconsistent evidence to support the validity of PSG for evaluation of suspected SRBD when using the clinical history as an independent comparison measure. One interpretation of these data is that the clinical history is not sufficiently accurate, reliable, or stable to represent a meaningful comparison with the objective physiological measurements encompassed by PSG.

4.2.1.1.2 Audio or video recordings

Our search regarding the correlation of audio or video recordings with PSG findings in children identified 4 articles. Two provide Level 2 evidence,[17,55] while 2 provide Level 3 evidence.[56,57] Lamm et al.[55] (Level 2) studied 29 children referred for evaluation of OSAS using a prospective, blinded design. All subjects underwent PSG, and findings were compared with the interpretations of 15-min audiotapes. The sensitivity and specificity of the audiotapes in predicting polygraphically confirmed OSAS was 71% and 80%, respectively. Even though the authors concluded that home audiotapes are not sufficiently specific to reliably distinguish snoring from OSAS, these findings provide a moderate level of support for the validity of PSG in this population when using home audiotapes as an independent measure.

In a similar study, Goldstein et al.[17] (Level 2) evaluated 59 children with a clinical diagnosis of OSAS made by review of symptoms, radiographs, audiotape recording of breathing during sleep, and physical examination. All subjects underwent PSG, and OSAS was confirmed in 48%. Analysis of the relationship between PSG findings and the pre-PSG audiotape rating of severe, moderate, or negative, revealed a sensitivity of 88%, specificity of 52%, PPV of 62%, and a NPV of 83% for obstructive sounds compared with PSG findings. The authors concluded that although in-lab audio taping is not specific enough to distinguish between children with normal PSG findings and those with OSAS, it is an inexpensive, convenient method of confirming the parents' description of the child's nighttime breathing difficulties. As with the study of Lamm et al., these findings provide a moderate level of support for the validity of PSG in this population when using home audiotapes as an independent measure.

Sivan et al.[56] (Level 3) included a 30-min videotape of their study subjects' head and torso, taken while exhibiting symptoms of OSAS during sleep. Findings were similar to Lamm et al. and Goldstein et al., in that the sensitivity for predicting OSAS was high (94%) but the specificity was only 68% for identifying normals. PSG studies did not include EEG monitoring, so hypopneas terminating in arousals would not have been included in the AHI, potentially affecting the accuracy of their comparison.

Only 1 study compared audiovisual recordings in the home with laboratory PSG. Jacob et al.[57] (Level 3) compared findings from 21 children with ATH in a prospective, blinded study. The investigators showed excellent correlation between audiovisual recordings and PSG findings. However, their analysis did not compare interpretation of the isolated audiovisual tape with PSG, but rather the entire home recording montage which included cardiorespiratory parameters as well.

Table 3—Summary of evidence regarding validity or reliability of PSG for characterization of SRBD in children

Independent Measures	No. of Papers/Level of Evidence	Type of Reliability or Validity	Direction of Support	Strength of Support*
History of snoring or other nocturnal sx	Level 1: 2 Level 2: 4 Level 3: 11 Level 4: 18	Convergent validity	Inconsistent	Limited and inconsistent
Audio or video recordings	Level 1: 0 Level 2: 2 Level 3: 2 Level 4: 0	Convergent validity Discriminant validity	Supportive	Limited but consistent
Questionnaires	Level 1: 0 Level 2: 2 Level 3: 3 Level 4: 4	Convergent validity Face validity	Inconsistent	Limited and inconsistent
Measures of sleepiness: Subjective	Level 1: 1 Level 2: 3 Level 3: 4 Level 4: 3	Convergent validity	Inconsistent	Limited and inconsistent
Measures of sleepiness: Objective	Level 1: 0 Level 2: 2 Level 3: 1 Level 4: 2	Convergent validity	Supportive	Limited but consistent
Physical examination	Level 1: 0 Level 2: 2 Level 3: 3 Level 4: 6	Convergent validity	Inconsistent	Limited and inconsistent
Radiographic evaluation	Level 1: 0 Level 2: 1 Level 3: 2 Level 4: 1	Convergent validity	Supportive	Limited but consistent
Neurocognitive or psychological evaluation	Level 1: 0 Level 2: 5 Level 3: 7 Level 4: 8	Convergent	Inconsistent	Moderate but inconsistent (due to the complexity of neuropsychological assessment)
Serial or ambulatory BP	Level 1: 0 Level 2: 5 Level 3: 5 Level 4: 2	Convergent	Supportive	Moderate
QOL measures	Level 1: 0 Level 2: 2 Level 3: 3 Level 4: 3	Test-retest validity Convergent validity	Inconsistent	Limited and inconsistent
Therapeutic intervention studies for test-retest validity	Level 1: 0 Level 2: 10 Level 3: 14 Level 4: 21	Test-retest validity Convergent validity Criterion validity Discriminant validity	Supportive	Moderate to strong and consistent
Other measures	Level 1: 0 Level 2: 6 Level 3: 4 Level 4: 3	Convergent validity	Inconsistent	Inconsistent and limited
Test-retest reliability and scoring reliability	Level 1: 1 Level 2: 1 Level 3: 2 Level 4: 2	Test-retest reliability Interscorer reliability	Supportive	Limited but consistent

*General criteria for grading strength of support: **Strong**—at least one Level 1 paper; if other levels of evidence are also present, findings are consistent (in same direction). **Moderate**—at least two Level 2 papers with consistent results or findings. **Limited**—at least two Level 3 or 4 papers; may show some degree of variability or consistency. **Minimal**—Little or no support, highly inconsistent support, or no data in literature to support.

In summary, our search identified several papers that address correlation of audio or video tape assessments with respiratory PSG findings as a method for supporting the validity of PSG for evaluation of suspected OSA in children.

4.2.1.1.3 Questionnaires

The task force searched the literature regarding the association between pediatric sleep questionnaire (SQ) results and PSG respiratory findings. The search identified 9 articles, including 2 with Level 2 evidence,[23,58] 3 with Level 3 evidence,[26,59,60] and 4 with Level 4 evidence.[39,46,49,53]

A large community-based prospective cohort population study with Level 2 evidence by Goodwin et al.[23] in children 6-11 years of age used parent-completed questionnaires and PSG performed at home. Investigators reported significantly higher likelihood of parasomnias and learning problems in children with polygraphically confirmed OSAS. This study used comprehensive unattended home PSG. Although not performed to assess the validity of PSG through comparison with questionnaires, this large study provides evidence that PSG respiratory measurements are correlated positively with reports of parasomnias and learning problems identified by parent-completed questionnaires.

Verbally administered sleep questionnaires regarding breathing problems during sleep showed generally good correlation with PSG findings in a large prospective single-blind randomized controlled Level 2 study by Chau et al. of 108 children (ages 0-18 y) who snored.[58] The sensitivity of the questionnaire was 0.65, the specificity 0.82, the PPV 0.65, and the NPV 0.816 for predicting polygraphically confirmed OSAS in children referred for snoring. The SQ showed a generally good ability to rule out OSAS but had only limited ability to correctly identify polygraphically confirmed OSAS cases.

A Level 3 study by Brouillette et al.[26] found that results from a validated questionnaire misclassified about 1 of 4 children using PSG as the diagnostic standard, and an expanded pediatric sleep questionnaire which the investigators developed and validated could not discriminate primary snorers from OSAS, failing to identify PSG-confirmed OSAS in one-third of children referred for suspected OSAS. This study was limited because of its retrospective design, narrow spectrum of subjects, and absence of controls. A Level 3 study by Chervin et al.[59] found scores on a validated pediatric sleep questionnaire did not correlate well with respiratory PSG data. There was insufficient reliability to predict whether individual patients would or would not have evidence of OSAS on PSG.

A small uncontrolled Level 3 study by Villa et al.[60] found that PSG showed generally good correlation with clinical scores derived from a pediatric sleep questionnaire. Questionnaire results improved in tandem with improvements in the PSG following OSAS treatment, suggesting that the questionnaire provided support for the validity of PSG and PSG improvements following intervention. A Level 4 study by Rosen et al.[46] involving a retrospective case-control study design with 326 children (ages 1-12 y) referred for habitual snoring and suspected OSAS found that sleep questionnaire data did not correlate well with respiratory PSG findings. These findings are similar to several other Level 4 studies.[39,49,53]

In summary, our search identified a limited number of papers (most with Level 3 or 4 evidence and 2 papers with Level 2 evidence) that address the association between pediatric sleep questionnaire results and PSG respiratory findings among children with suspected OSAS. Some sleep questionnaires had a generally good correlation with PSG results, but most questionnaires do not provide strong evidence to support the validity of PSG respiratory measurements. This observation does not necessarily indicate poor validation of PSG, but instead, it may suggest that currently available pediatric sleep questionnaires are not able to discriminate between children with primary snoring versus OSAS, nor gauge the severity of OSAS as determined by PSG.

4.2.1.1.4 Measures of sleepiness

4.2.1.1.4.1 Subjective measures

Our literature search regarding correlation of PSG findings with subjective measures of sleepiness identified a total of 11 articles. One paper provided Level 1[22] evidence regarding correlation of PSG findings with subjective measures of sleepiness, 3 papers provided Level 2 evidence,[17,24,61] 4 papers provided Level 3 evidence,[30,31,35,36] and 3 papers provided Level 4 evidence.[37,50,62]

A large prospective, blinded case-control study by Chervin et al.[22] assessed children referred for clinically indicated AT and control subjects with PSG including esophageal pressure monitoring, MSLT, and a validated SQ. This Level 1 study demonstrated that sleepiness subscores on the questionnaire correlated inversely with mean sleep latency on MSLT and positively with AI, AHI, and RDI on PSG.

In a Level 2 study Goldstein et al.[17] assessed subjective sleepiness before and after AT in children with clinically diagnosed OSAS. Findings suggested that postoperative improvement in the sleepiness score was greatest for the children having PSG-defined OSAS, but some improvement was evident for children with negative PSG findings.

A Level 2 study by Goodwin et al.[24] found that snoring, excessive sleepiness, and learning problems were associated with abnormal RDI. The study was limited by the fact that characterization of learning problems was based on a single question-item as assessed by parents, but findings support an association between abnormal RDI on PSG, snoring, and daytime sleepiness.

A Level 2 study by Melendres et al.[61] reported that children with PSG-defined OSAS demonstrated greater degrees of sleepiness on the Epworth Sleepiness Scale (ESS) than control subjects who did not report symptoms of OSAS. A limitation was lack of PSG for the control group.

A Level 3 case control study by Xu et al.[36] assessed children with suspected OSAS using PSG, history, physical examination, and lateral neck radiographs. The study was limited by the narrow spectrum of the population studied and use of AHI > 5 for determination of OSAS. However, findings support an association between subjective sleepiness (intrusive naps), ATH, and PSG-defined OSAS. A Level 3 case series by Wang et al.[35] reported that clinical symptoms of OSAS, including subjective sleepiness, were poor predictors of PSG-defined OSAS.

In a Level 3 study, Pagel et al.[31] screened children recruited from a child psychiatry clinic for daytime sleepiness using a

questionnaire and performed PSG for children endorsing this symptom. While the study identified a high rate of OSAS among children endorsing sleepiness, sleepiness alone did not distinguish which children had PSG-confirmed OSAS from those without OSAS. A relatively large but unblinded Level 3 study by Nieminen et al.,[30] assessing snoring children with questionnaires and limited PSG, identified a high prevalence of OSAS as defined by AHI > 1. Findings suggested that the presence of subjective sleepiness did not reliably distinguish primary snoring from OSAS.

Montgomery-Downs et al.[62] assessed children with questionnaires that included parental reports of daytime behaviors including sleepiness, and PSG. Subjects with snoring plus daytime problem behaviors including sleepiness had a stronger association with PSG-confirmed OSAS compared with subjects with snoring alone. Reports of falling asleep while watching television were more predictive of OSAS for older children than preschoolers. This study provided Level 4 evidence.

A case series with Level 4 evidence reported by Greenfeld et al.[37] reported low prevalence of subjective sleepiness among infants with OSAS and ATH. A Level 4 study by Sisk et al.[50] assessed children with achondroplasia and identified a high prevalence of PSG-defined OSAS. The presence of subjective daytime sleepiness or irritability did not distinguish between subjects with OSAS and those without.

In summary, our search identified a limited number of papers that address correlation of PSG findings with subjective measures of sleepiness. Most but not all papers support an association between subjective sleepiness and abnormal PSG or MSLT parameters; however, the presence of subjective sleepiness alone does not accurately predict the presence of PSG-defined OSAS. Findings provide support and validation for the role of PSG in children to determine whether subjectively reported sleepiness is related to the presence of underlying OSAS.

4.2.1.1.4.2 Objective measures

Our search regarding the association between PSG findings and objective measures of sleepiness identified 5 articles. Two papers provided Level 2[25,63] evidence correlating PSG findings with objective measures of sleepiness, 1 paper provided Level 3[64] evidence, and 2 papers provided Level 4[38,65] evidence.

A large Level 2 case-control study by Wing et al.[25] assessed obese children and age-matched normal weight children with PSG and MSLT. Although obese children demonstrated significantly higher rates of upper airway obstruction during sleep than non-obese children, the mean sleep latency (MSL) on MSLT did not distinguish between obese and non-obese children or between children with and without mild OSAS.

A large prospective study with Level 2 evidence by Chervin et al.[63] compared children referred for clinically indicated AT with control subjects, using PSG and MSLT performed preoperatively and one year postoperatively. The baseline MSLT demonstrated greater sleepiness for children undergoing AT compared to control subjects at baseline, and MSLT-defined sleepiness was associated with higher measures of OSAS, including AHI, RDI, and obstructive apnea index (OAI). At reassessment one year postoperatively, MSL values improved for those subjects with PSG-defined OSAS, but not for children who underwent AT in the absence of OSAS. Improvement of MSL values following treatment was predicted by improvement in AHI, RDI, and other measures of OSAS severity.

A prospective cohort study with Level 3 evidence by Gozal et al.[64] assessed sleepiness in children with PSG-defined OSAS (OAI > 2), children with primary snoring (OAI ≤ 2), and asymptomatic controls. MSL values were mildly but significantly reduced for children with OSAS compared to children with primary snoring and controls. In addition, the MSLT demonstrated sleepiness more frequently in children with suspected OSAS than did questionnaire results. The study was limited by the exclusion of hypopneas from PSG scoring and analysis.

A Level 4 prospective cohort study by Gozal et al.[65] compared snoring children with and without obesity. MSL values were significantly lower for obese children despite comparable severity of OSAS in the non-obese subjects. MSL values demonstrated linear correlations with AHI, RDI, and body mass index (BMI). Among children demonstrating sleepiness on MSLT, fewer than half had been subjectively rated as sleepy by their parent. Limitations were the narrow spectrum of patients and lack of blinding. A small case series with Level 4 evidence by Guilleminault, et al.[38] assessed 5 children with upper airway resistance syndrome using PSG and MSLT before and after AT. Short MSL values were observed in all children preoperatively and in none postoperatively.

In summary, our search identified a small number of papers that correlate PSG respiratory findings with objective measures of sleepiness. These papers support consistent but often weak associations between abnormal respiratory PSG parameters and MSLT-defined sleepiness among children with OSAS. These findings provide some limited support for the validity of PSG respiratory measures for characterization of OSAS in children. These findings also suggest that objective sleepiness is less often present and less severe in children with OSAS compared with adults. Several studies suggest that the MSLT may be more sensitive than subjective ratings of sleepiness in children with OSAS. Findings provide support for the use of PSG for evaluation of suspected OSAS in sleepy children and for a potential role of the MSLT in assessing children with OSAS for sleepiness that may be underestimated by subjective screening measures.

4.2.1.1.5 Physical examination

Our search identified 11 papers (2 Level 2,[17,25] 3 Level 3,[35,36,66] and 6 Level 4[37,52,53,67-69]) that provide evidence to address validity of PSG for characterization of SRBD in children in comparison to physical examination. This strategy is based on the premise that certain physical findings are known to represent significant risk factors for OSAS in children, and a thorough physical examination is part of the standard clinical evaluation. However, we recognize that the presence of physical findings such as ATH does not define OSAS and that some children with OSAS do not have abnormal physical findings.

Xu et al.[36] developed a clinical score including mouth breathing and tonsillar hypertrophy and found a high correlation with polygraphically confirmed OSAS. The clinical score also included parental observations, physician evaluation, and radiographic evaluation (Level 3 evidence). Goldstein et al.[17] also developed a clinical score that included history, physical examination, voice recording, tape recording of breathing, and radiographic evaluation. Investigators reported that many children

with a positive clinical assessment experienced improvement after AT. However, this was true even when the PSG was interpreted as normal (Level 2 evidence). Wang et al.[3515] concluded that tonsil size and weight are poor predictors of PSG-defined OSAS (Level 3 evidence). The presence of mouth-breathing, which suggests adenoidal hypertrophy and/or rhinosinusitis, was a consistent feature in children at risk for OSAS (including Weatherly et al., Level 4).[17,36,53] Dental malocclusion may be associated with polygraphically confirmed OSAS (Villa et al.,[52] Level 4 evidence).

Our search identified 2 papers (Shatz,[66] Level 3, and Greenfeld et al.,[37] Level 4) that support an association between ATH in infants and PSG findings when there is clinical concern for OSAS.

Overweight status or obesity is a physical examination finding often associated with OSAS in adults. This physical attribute is explored specifically as a risk factor for OSAS in section 4.2.2.1. Obesity in association with Prader-Willi syndrome is examined in 7 papers in section 4.2.2.9.1.2. Wing et al.[25] showed with Level 2 evidence that the presence of obesity alone had a variable PPV for polygraphically defined OSAS (15.2% to 78.3%), but there was a much higher PPV when children were both overweight and had tonsillar hypertrophy. In contrast, a large study by Lam et al.[67] demonstrated that degree of obesity (BMI Z-score) and tonsil size have only a mild correlation with severity of PSG defined OSAS (Level 4 evidence). Tauman et al.[68] reported no correlation between the presence of obesity and metabolic abnormalities (e.g., insulin resistance), and presence or severity of sleep disordered breathing (Level 4 evidence).

Children with craniofacial abnormalities are known to have elevated risk for OSAS. Papers that examine the association of craniofacial abnormalities with PSG respiratory findings are discussed in section 4.2.2.9.2.

A Level 4 study by Zhang et al.[69] compared polygraphic measurements in 37 children with ATH with OSAS and without OSAS. When using an apnea index greater than 1 to define OSAS, 20 subjects had OSAS, 17 subjects did not have OSAS, and the AHI was significantly higher in subjects with OSAS than those without. These findings would support convergent validity of PSG because subjects with OSAS had more frequent hypopneas as well as apneas. The study is limited by the absence of any independent measurement of OSAS severity other than PSG.

In summary, our search identified several papers that examine the association between physical examination and PSG findings. The strength of association between physical examination findings and PSG findings is variable. This is consistent with the observation that PSG is a physiological measurement of breathing during sleep, whereas the physical examination is focused on anatomic structures during wakefulness. Physical findings provide only limited independent validation of PSG for characterization of SRBD in children and cannot take the place of PSG for diagnosis of OSAS.

4.2.1.1.6 Radiographic and endoscopic evaluation

A variety of radiographic studies have been used clinically to characterize the degree of upper airway obstruction in children. We evaluated the literature to probe whether radiographic imaging findings provide independent support for validity of PSG in characterizing SRBD. Our search identified 4 papers—1 with Level 2,[17] 2 with Level 3,[36,70] and 1 with Level 4 evidence.[71] Xu et al.[36] (Level 3) demonstrated that the presence of upper airway narrowing on lateral neck x-ray and/or mouth breathing had the highest sensitivity (90.3%) among several measures in identifying children with polygraphically confirmed OSAS. Jain et al.[71] (Level 4) and Brooks et al.[70] (Level 3) reported that relative adenoid size had a significant correlation with degree of polygraphically determined OSAS in children. Other investigators (Goldstein et al.,[17] Level 2) have included lateral neck x-rays as part of their clinical screening with variable correlation with PSG findings.

Various types of naso-oro-pharyngeal endoscopy have been used to visualize upper airway anatomy. We identified 3 papers[72-74] with Level 3 or 4 evidence that showed variable correlation with PSG findings. Gozal and Burnside[72] (Level 3) demonstrated that upper airway cross-sectional area as measured by acoustic pharyngometry predicts with high sensitivity (90.9%) and specificity (88.4%) children who met PSG diagnostic criteria for OSAS.

In summary, our search yielded a relatively small number of papers that provide consistently positive associations between independent assessments with radiographic or endoscopic methods for imaging the upper airway and PSG findings in children with suspected OSAS. In aggregate, these studies provide a moderate degree of support for the validity of PSG. An inclusion bias is likely in these studies because the subjects who underwent radiographic studies were suspected of having OSAS on the basis of the history or physical examination. We identified no studies that included a broad spectrum of patients, including subjects not suspected of having OSAS.

4.2.1.1.7 Neurocognitive or psychological assessments

Our search regarding the relationship between neuropsychological functioning and PSG findings in children with suspected SRBD identified 20 articles. Five papers provided Level 2 evidence,[61,63,75-77] 7 provided Level 3 evidence,[59,78-83] and 8 provided Level 4 evidence.[38,84-90]

A cross-sectional study by Melendres et al.[61] with Level 2 evidence involving 108 children (age 2-17 y) with suspected SRBD evaluated the relationship between PSG, ESS scores, and the Conners Abbreviated Symptoms Questionnaire for hyperactivity. Seventy-two normal control children completed the ESS and Conners questionnaires, but PSG was not performed. Fifty-eight percent of the patients who underwent PSG had primary snoring, and the remainder had varying degrees of OSAS. Subjects with primary snoring and OSAS had higher ESS scores and higher Conners scores than control subjects. There was no difference in ADHD symptoms between children with primary snoring and those with PSG-confirmed OSAS. The authors concluded that even the mildest forms of SRBD (i.e., primary snoring) in children appear to affect neuropsychological functioning.

In an early Level 4 study by Guilleminault et al.[38] involving 25 snoring children (age 2-14 y) without frank obstructive apnea, investigators performed multiple measures including PSG, clinical examination, and soft tissue x-rays of the neck. The MSLT and multiple administrations of the Wilkinson Addition

Test (WAT) were performed in a subset of 5 patients. All children had repeat evaluation after tonsillectomy and/or adenoidectomy. Three months after surgery, WAT results demonstrated a 35% increase in the number of problems tabulated and 48% increase in number of problems solved correctly. Prior to surgery, performance on the WAT deteriorated throughout multiple test administrations, but after surgery there were no significant differences between the first and last test administration.

A Level 2 study by O'Brien et al.[75] compared PSG with several neuropsychological measures in 87 children (age 5-7 y) with primary snoring (AHI < 5), and in 31 controls who had normal PSG (AHI < 1). Children with primary snoring performed worse than normal controls on measures related to attention, social problems, anxiety/depression symptoms, overall cognitive function, language ability, and visuospatial ability.

A Level 2 study by Chervin et al.[63] compared 78 children age 5-12 years scheduled for AT (the majority with suspected SRBD) with 27 control children referred for other surgical care. Children in both groups underwent PSG, MSLT, and neurobehavioral evaluation with a variety of instruments prior to surgery and 1 year later. Children in the AT group were more hyperactive (Conners score), inattentive (cognitive testing), and sleepy (MSLT) than normal controls. They were also more likely to meet diagnostic criteria for ADHD. Cognitive and behavioral measures improved in both groups in the 1-year follow-up evaluation; however, children in the AT group continued to have more hyperactivity and lower scores on measures of attention than normal controls. The study was limited in that it excluded children whose surgeons required PSG for clinical purposes and because children in the AT group were younger than those in the control group.

In a Level 3 study utilizing the same sample, Chervin et al.[59] compared PSG data with data from the SRBD scale of the Pediatric Sleep Questionnaire (PSQ) and the neuropsychological and behavioral measures described previously. A high baseline score on the SRBD scale was associated with a 3-fold risk of OSAS on PSG and with a 2-fold risk of residual OSAS when administered again 1 year later. Compared to PSG data, the SRBD scale was more closely correlated with hyperactivity, both at baseline and 1-year follow-up, suggesting that that the SRBD scale of the PSQ may predict OSAS-related neurobehavioral morbidity and its response to AT as well as or better than PSG. The authors concluded that the SRBD scale is useful for research but not accurate enough to make patient care decisions on an individual basis. This study was limited in that it excluded children whose surgeons required PSG for clinical purposes and because children in the AT group were younger than those in the control group.

In the same cohort of children from the Chervin et al.[59] study, Dillon et al.[76] evaluated the frequency of mental disorders in children undergoing AT. In this Level 2 study, the PSQ and a structured psychiatric interview were administered in 79 children (38 without OSAS, 40 with OSAS; mean age 8.1 ± 1.8 y) undergoing AT and 27 control children (mean age 9.3 ± 2.0 y) being evaluated for other surgery. PSG and structured psychiatric interviews were performed preoperatively and postoperatively. Among children undergoing AT, those with PSG-confirmed OSAS did not differ from children who had no OSAS with regard to psychiatric symptom severity, ADHD diagnosis, or presence of at least one disruptive behavior; however, these symptoms were higher in the AT groups vs. controls. PSG evidence of OSAS did not predict improvement in behavioral measures at follow-up. These findings suggest that the AHI is not a significant predictor of the presence of psychiatric disorders or behavioral disturbance in children.

In a Level 2 study using the same cohort of children, Giordani et al.[77] performed comprehensive neuropsychological evaluation in multiple domains including higher cognitive functions, psychomotor functions, and behavior. Similar to the findings of Dillon et al.,[76] children undergoing AT had lower performance on these measures than controls. Lower performance was found on measures related to visual spatial ability, arithmetic academic achievement, one test of visual delayed recall, and short-term attention/working memory. Interestingly, children undergoing AT who did *not* have PSG-confirmed OSAS demonstrated *more* neurobehavioral symptoms than children with PSG-confirmed OSAS. This study showed that although children with ATH are more likely than controls to have neuropsychological and behavioral symptoms, PSG-confirmed OSAS alone is not a significant risk for these symptoms.

In a Level 4 study[84] Archbold et al. utilized a subset of 12 children (age 8-11.9 y) from the AT group described above. The investigators evaluated executive function (working memory, attention, and mental flexibility) in mild OSAS (AHI ≥ 1 and < 10) prior to AT. All children included in this study underwent PSG, MSLT, and multiple neuropsychological measures. Children with mild OSAS on PSG demonstrated significant impairment of sustained attention and vigilance. Low mental flexibility scores were correlated with increased percentage of stage 1 sleep and higher AHI values.

In a Level 3 study designed to evaluate whether the APOE ε4 allele is associated with increased neuropsychological morbidity in children with OSAS, Gozal et al.[78] performed PSG, administered the Differential Ability Scales and NEPSY, and obtained blood tests for APOE ε4 testing in 258 habitually snoring children (age 5-7 y), compared with 87 age-matched control children who did not snore and who had normal PSG. Conclusions regarding correlations between neuropsychological findings and PSG findings are somewhat limited because test scores were not described or correlated with OSAS severity. Whereas none of the normal controls had ≥ 2 abnormal neuropsychological tests, 14.2% of snoring children without OSAS and 49% of snoring children with OSAS had ≥ 2 abnormal neuropsychological tests. If snoring is viewed on a continuum with OSAS, convergent validity of PSG for confirmation of OSAS is demonstrated by this study because increasing percentages of children had ≥ 2 abnormal neuropsychological tests in non-snoring vs. snoring vs. snoring with OSAS.

In a Level 3 study by Emancipator et al.[79] involving home PSG, 835 children age 8-11 underwent home PSG and cognitive testing (Peabody Picture Vocabulary Test-Revised, Kaufman Assessment Battery for Children, and the Continuous Performance Test). After correcting for socioeconomic status, there were no significant differences in cognitive functioning in children with OSAS compared to children without OSAS. Weak associations were found between cognitive measures, oxygen saturation measures, AHI, and OAI. In a subgroup of children

who were preterm, there were stronger associations between PSG-confirmed OSAS and cognitive deficits.

In a Level 3 case-controlled study by Montgomery-Downs et al.[80] of 19 socioeconomically at-risk children enrolled in a preschool enrichment program, PSG and cognitive testing (Differential Ability Scales) were obtained before and 3-6 months after AT. Scores on cognitive testing and PSG results were compared with a matched group of children without OSAS. AHI improved to approximately 1 in the children who underwent AT. Performance on cognitive testing also improved significantly but was still lower (although not statistically significant) than that of socioeconomically matched controls. The study was limited in that control subjects underwent testing only once; therefore, the relative contributions of participation in the enrichment program, test practice effects, and AT on cognitive test performance could not be determined.

In a Level 3 study by Crabtree et al.[81] involving 85 children with a history of snoring and suspected OSAS (age 8-12 y; 44 obese, 41 non-obese), depression symptoms were compared with a group of 35 asymptomatic controls. Seventy-two of the children in the OSAS group underwent PSG. Controls were not studied with PSG. Children with suspected OSAS had lower quality of life scores and more depressive symptoms than controls. Obese and non-obese snorers did not differ from each other in depressive symptoms, but AHI values were higher in the obese children.

Tran et al.[85] administered the Child Behavior Checklist (CBCL) and a quality of life measure (OSA-18) to 42 children (age 2.5-11.5 y) with PSG-confirmed OSAS before and 3 months after AT, compared to 41 non-snoring control children (age 2.1-14 y) undergoing unrelated elective surgery. This Level 4 study was limited because children with OSAS were selected from a waiting list for AT, normal controls did not undergo PSG, and children with OSAS did not undergo PSG after surgery. CBCL total problem T- scores and OSA-18 scores were higher in the OSAS group vs. the control group, and scores improved postoperatively.

Two papers with Level 4 evidence by Mitchell et al.[86,87] report findings prior to and following AT using the Behavior Assessment System for Children (BASC), an inventory to evaluate changes in emotional, behavioral, social, and adaptive functioning. Subjects ranged in age from 2.5-14.9 y, and all had AHI $\geq$ 5 on preoperative PSG (mean AHI = 16.2/h; range 5.0-88/h). Postoperative PSG was not performed. The 2005 study reported behavioral impairment preoperatively, ranging from mild to severe, in 37% of children with OSAS.[86] Following AT, significant improvements were observed in depression, hyperactivity, atypicality, somatization, and aggression. In the 2006 study, BASC data from 23 children were obtained prior to AT, within 6 months of AT, and again 9-18 months following AT.[87] The 6-month data again demonstrated improvement in aggression, hyperactivity, depression, and somatization.

In a Level 4 study, Mitchell and Kelly[88] performed PSG and administered the BASC to 17 children with mild SRBD (mean AHI 3.1; range 1.7-4.7) and 23 children with OSAS (mean AHI 25.3, range 10-48) before and after AT. The study was limited because there was no control group, the sample size was small, and there was insufficient blinding. No data on sleep architecture or PSG findings after AT were presented. Children with mild SRBD did not differ significantly from those with OSAS on any of the BASC subscales, and both groups demonstrated improvement following AT. Findings showed no relationship between severity of SRBD on PSG and parental report of behavioral problems in children undergoing AT.

A Level 3 study by O'Brien et al.[82] involving first graders compared 35 subjects with OSAS and 35 closely matched controls using the Conners Parent Rating Scale, Child Behavior Checklist, Differential Abilities Scales (DAS), and the Developmental Neuropsychological Assessment (NEPSY). All children underwent PSG. Children with PSG-confirmed OSAS had lower scores on general conceptual ability, nonverbal test performance, attention/executive function, visual attention, and phonological processing. Severity of OSAS was ranked, and although the relationship between OSAS rank and cognitive-behavioral function was not described, there was a negative correlation between arousal index and the General Conceptual Ability score on the DAS. In contrast to several other studies, children with OSAS did not differ from controls on the Conners and CBCL, possibly due to the close matching with additional demographic variables including maternal smoking, age, gender, ethnicity, and socioeconomic status.

In a Level 3 study designed to determine the relative importance of sleep, intelligence, neuropsychological function, and ADHD scores in predicting academic achievement, Mayes et al.[83] performed PSG, neuropsychological testing, and assessment of academic achievement in children in grades K-5. Children with major medical and neurological conditions were excluded, but children with ADHD, learning disability, and anxiety were included. Eighty-seven children (21%) had AHI $\geq$ 1, and 5 (1.2%) had AHI $\geq$ 5. In the logistic regression analysis, the best predictors of academic performance were Full Scale IQ, the Digit Span subtest, and the Development Test of Visual-Motor Integration score. None of the objective or subjective sleep related measures, including snoring, were significant predictors. This study does not support convergent validity of neuropsychological function with PSG respiratory measures including AHI, mean oxygen saturation during sleep, oxygen saturation nadir, snoring severity, or arousal index.

A Level 4 study by Owens et al.[89] was designed to evaluate the relative contributions of a variety of clinical attributes, sleep duration, and comorbid sleep disorders to adverse behavioral outcomes in children referred for evaluation of SRBD. Subjects were evaluated with PSG, growth parameters, the CBCL, and parent-reported sleep duration. Children were divided into 3 weight groups based on BMI percentile. The study was limited due to lack of a control group, and all subjects were referred for symptoms suggestive of OSAS. Weight group was closely associated with poor behavioral outcomes, in particular internalizing problems, more than any traditional polygraphic measure of SRBD severity. Shorter mean sleep duration was associated with externalizing concerns, and comorbid insomnia was the most significant predictor of CBCL scores in these children. In this population, which included a strong referral bias since all children had clinical symptoms suggestive of OSAS, there was little correlation between adverse behavioral outcomes and any of the PSG respiratory measures used to denote OSAS severity.

In a Level 4 study designed to investigate emotional disturbances in children with adenotonsillar hypertrophy and OSAS,

Kurnatowski, et al.[90] performed PSG in a large sample of Polish children in 2 age groups (6-9 y and 10-13 y). One hundred twenty-one children with ATH had OSAS confirmed by PSG and were compared with 104 healthy control children who had normal PSG and no ATH. The study was limited by use of thermistors rather than pressure transducers for registration of airflow and the absence of BMI data. Emotional functioning was evaluated with the Children's Depression Inventory, the State-Trait Anxiety Inventory for Children, and an emotional instability scale. Children with OSAS had mean obstructive AHI of 4.9 (range 1-29). Younger children with OSAS and ATH had more emotional instability than normal controls, but scores on the depression and anxiety measures did not differ between groups. There were no differences in emotional instability, depression, or anxiety in the older children with OSAS and ATH vs. normal controls.

In summary, our search identified 20 studies that address the construct validity of PSG for the evaluation of SRBD utilizing measures of neuropsychological, behavioral, and emotional functioning as the convergent construct. The magnitude of association and the nature of the relationship between these measures and sleep disordered breathing during PSG varied across studies, but when studies are considered as an aggregate, children with SRBD appear to function at lower levels than children without SRBD. The presence of ADHD appears to be a moderating factor in several studies. In a number of studies the absence of a statistically significant association between neuropsychological function or behavior disorders and respiratory PSG findings may reflect complex interrelated factors such as duration of disease, genetic factors, sociocultural influences, and timing of exposure to SRBD in children. It is also possible that current methods for characterization of respiratory disturbance may not reflect subtle alterations in sleep microarchitecture, which may be better predictors of neurobehavioral outcomes. Finally, interpretation of performance on neuropsychological or behavioral instruments may be complicated by the phenomena of practice effects and regression to the mean. Despite limitations, these studies lend moderate support for the construct validity of PSG and suggest that even mild SRBD may be associated with impairments in behavior and neuropsychological functioning.

4.2.1.1.8 Serial or ambulatory BP measurements

The task force searched the literature to address whether independent measurements of blood pressure (BP) provide evidence to support the validity of respiratory PSG findings for characterizing SRBD in children. This strategy was based upon the known moderate to strong association between BP values and the presence and severity of OSAS in adults,[91-95] and the emerging scientific literature supporting a similar relationship in children. Our search found 12 articles[32,96-106] that address this issue. We graded 5 as Level 2 evidence,[96-99,102] 5 Level 3,[32,100,101,103,105] and 2 Level 4.[104,106]

Two Level 2 studies[98,99] correlated casual, or serial, systemic arterial BP measurements in children with suspected OSAS with OSAS severity on PSG. A blinded prospective Level 2 study by Bixler et al.[98] reported that an AHI ≥ 5 in a broad spectrum of children 5-12 years of age was an *independent* risk factor for elevated BP among 700 randomly selected elementary schoolchildren. Investigators also found that AHI during NREM sleep (but not REM sleep) was significantly associated with elevated BP values.

Another large prospective population-based Level 2 study by Enright et al.[99] involving 239 white and Hispanic schoolchildren (ages 6-11 y, 51% Hispanic, 12% obese) reported casual evening BP before unattended comprehensive home PSG. Investigators reported that the AHI was independently associated with elevated evening BP only when obstructive respiratory events were associated with ≥ 2% oxyhemoglobin desaturation.

Serial BP measurements were compared with PSG results in 1 Level 2[102] and 2 Level 4[104,106] studies. In a Level 2 study by Redline et al.,[102] systolic and diastolic BP at 10 pm, 7 am, and 1 pm among 270 adolescents (mean age 13.6 ± 0.7 y) was significantly higher in a group of subjects with OSAS (AHI ≥ 5, P = 0.0015). Secondary analyses showed even after adjusting for sex and BMI percentile, adolescents with OSAS had elevated BP levels. In a Level 4 study, Marcus et al.[106] reported higher diastolic BP values in 41 children with PSG-confirmed OSAS compared with 26 children with primary snoring. Diastolic BP values increased with the apnea index (AI). Thirty-two percent of the children with OSAS and 19% of the primary snorers had BP > 95th percentile during sleep versus 2% to 5% in the general pediatric population. Kohyama et al.[104] (Level 4) found children with an AHI ≥ 10 on overnight PSG had significantly higher systolic and diastolic BP values during wakefulness and REM sleep compared to children with AHI < 10. Using multiple linear regression, both of these Level 4 studies found that nocturnal BP was independently predicted by AI or AHI.

Ambulatory BP monitoring (ABPM) was used to study the relationships between OSAS and BP in 5 studies, including 1 paper with Level 2[96] evidence and 3 with Level 3[100,101,105] evidence. Recording overnight PSG and ABPM in 190 Hong Kong children (age 6-13 y), Li et al.[105] reported in a Level 3 study that nighttime diastolic BP values were significantly higher in children with primary snoring than non-snoring controls even after adjusting for age, sex, and BMI. They found significant dose-response trends for the proportion of subjects with nighttime systolic and diastolic HTN. In a Level 3 study, Leung et al.[100] compared PSG results with 24-h ABPM in 96 snoring Chinese children (mean age 9.4 years, 41% obese). HTN was 3.2 times as common in children with an AHI ≥ 5 than those with an AHI < 5. Children with AHI > 5 had significantly higher systolic BP awake and asleep. The desaturation index (DI) independently predicted the sleep diastolic BP elevation. BP values were positively associated with log AHI, log desaturation index, and arousal index. This study was limited by a relatively narrow spectrum of subjects and use of thermal sensors to measure airflow. Another Level 3 study by Li et al.[101] compared ABPM results to PSG findings among 306 children recruited from 13 randomly selected Hong Kong schools. Children with AHI > 1 had higher BP values than normal controls during sleep and wakefulness. BP values increased with the severity of OSAS, and children with AHI > 5 were 3.9 times more likely to have nocturnal systolic hypertension and 3.3 times more likely to have diastolic hypertension. The strongest PSG correlation with BP values was the DI. Multiple linear regression analy-

sis revealed a significant association between DI and AHI with daytime and nocturnal BP, respectively, independent of obesity.

A prospective case-control Level 2 study by Amin et al.[96] found obstructive AHI was a significant predictor of both diurnal and nocturnal systolic, diastolic, and mean BP values using activity-adjusted 24-h ABPM. They also found significant differences in the morning BP surge, even in children with AHI < 5 compared with controls, and increases in BP surge, BP load, and in 24-h ambulatory blood pressure in subjects with AHI > 5.

A Level 3 study by Amin et al.[103] compared 24-h ABPM with PSG found children with OSAS compared with those with primary snoring had significantly greater mean BP variability during wakefulness and sleep, higher night-to-day systolic BP, and smaller nocturnal dipping of mean BP. Variability in the mean arterial pressure awake could be predicted by DI, BMI, and arousal indexes, and BP variability asleep by AHI and BMI. Nocturnal BP dipping was predicted by the DI. Diastolic BP awake was significantly different between the groups and correlated negatively with the AHI.

Obesity can be a confounding factor for elevated BP, risk of HTN, and OSAS severity among children who snore or have SRBD. A large longitudinal community-based Level 2 study of adolescents by Redline et al.[102] found a significant association between SRBD (AHI ≥ 5) and systolic and diastolic BP, even after adjusting for BMI. A Level 3 study by Leung et al.[100] reported that the prevalence of HTN was 6.7 times higher (OR 6.7, 95% CI 1.0-44.3) among obese children with an AHI > 5 compared to obese children with an AHI < 5. A Level 3 study by Reade et al.[32] reported a higher incidence of HTN (68% vs. 30%) and obesity (75% vs. 52%) in patients with and without OSAS. OSAS was defined as an AI > 1 or an oxyhemoglobin saturation < 90% associated with obstructive apnea. Multiple regression analysis showed that HI and BMI scores were significant independent predictors of systolic and diastolic BP scores. HI had significant correlation with the degree of HTN in obese patients, which they could not attribute to the degree of obesity. An earlier Level 4 study by Marcus et al.[106] found the degree of BP elevation was related to the severity of OSA on PSG and the degree of obesity.

Two papers with Level 2[96,97] evidence reported findings regarding the correlation between postoperative AHI and remission of HTN or elevated BP in children with OSAS. A prospective Level 2 study by Apostolidou et al.[97] evaluated whether cardiovascular factors including BP would be affected by AT in 58 children with OSAS (mean age 6.2 ± 2.6 y) and 17 controls (6.5 ± 2 y). Subjects were considered to have OSAS when ATH, snoring > 3 nights per week, and AHI > 1 on baseline PSG were present. Control subjects had AT performed for treatment of recurrent infections. Systolic and diastolic BP measures were similar before surgery for all 3 groups: those who had AT for OSAS with postoperative AHI ≤ 1 after AT (n = 13), those with OSAS who had postoperative AHI > 1 (n = 45), and 17 controls who had AT done for other reasons. Investigators found the postoperative diastolic BP was lower in patients with OSAS who had surgical "cure" (defined as a postoperative AHI < 1), compared with controls and OSAS patients with residual disease following surgery (AHI > 1). The group of children with a postoperative AHI > 1 had a significant increase in their systolic BP index ($P < 0.05$), especially in the non-obese children. These findings support the validity of PSG for identifying SRBD through comparison with independent measurement of BP, a parameter know to be associated with increased cardiovascular risk.

A prospective longitudinal Level 2 study by Amin et al.[96] examined outcome following AT, including serial BP measurements and left ventricular wall thickness and mass. Subjects were studied with PSG and BP measurements before AT, and 6 and 12 months after AT. There were significant increases in BP in children who had recurrence of SRBD at 1 year, including an independent association of AHI at 1 year with systolic and diastolic BP. Statistical modeling demonstrated that AHI was a significant predictor of systolic ($P = 0.03$) and diastolic ($P = 0.0004$) BP one year following AT.

In summary, findings from eleven papers provide moderate-to-strong evidence for convergent (construct) validity of PSG respiratory measures using various BP measurement techniques as an independent measurement. AHI and DI correlated positively with BP measurements in children independent of obesity. An AHI ≥ 5 in school age children was an *independent* risk factor for elevated systolic and diastolic BP, even after adjusting for various confounding factors including BMI**.** Level 2 evidence supports an AHI ≥ 5 per hour as the threshold for OSAS severity associated with clinically significant elevations of BP values in children. The positive association between left ventricular remodeling and 24-h blood pressure monitoring highlights the relationship between PSG respiratory findings and increasing cardiovascular morbidity.

4.2.1.1.9 Quality of life measures

Health-related quality-of-life (HRQOL) measures are validated questionnaires completed by the subject or caregiver that identify the quality-of-life (QOL) impact of a medical disorder on different domains of a patient's life. Generic QOL instruments are often used to compare outcomes across groups of subjects with different diseases.[107-110] Studies evaluating QOL in children with suspected or confirmed SRBD have used either a generic health-related QOL instrument such as the Child Health Questionnaire (CHQ),[111] or a disease-specific QOL tool developed to evaluate children with SRBD such as the OSA-18[112] or the OSD-6.[113] Pediatric otolaryngologists have developed OSA-specific QOL surveys to assess outcome following AT.[112-114]

The task force posed 2 questions to assess whether QOL measurements provide independent validation of PSG for characterization of SRBD in children: (1) do caregiver-rated QOL scores correlate with the severity of SRBD on PSG? (2) does improvement in QOL measures following AT for treatment of SRBD correlate with resolution of SRBD on PSG? Our search identified 8 studies that evaluated the correlation between QOL scores and PSG findings in children with SRBD. We graded 2 as Level 2,[115,116] 3 as Level 3,[81,117,118] and 3 as Level 4.[112,119,120]

Four studies correlated QOL and preoperative PSG findings in children or adolescents with suspected SRBD. A Level 2 study by Rosen et al.[116] compared PSG findings with the Child Health Questionnaire in 326 children (5-12 y) referred for suspected SRBD. Investigators reported that: (1) children with AHI ≥ 10 were 2.7 times more likely to have reduced overall physical health status and 2.2 times more likely to report bodily pain; (2) children with AHI between 5 and 10/h were 3.8 times

more likely to have reduced overall physical health status; and (3) even mild SRBD in children was associated with daytime neurocognitive and behavioral dysfunction. This study was limited by a narrow spectrum of subjects and absence of blinding.

A Level 3 study by Crabtree et al.[81] used the Pediatric Quality of Life Inventory, Version 4.0 to compare 85 children (ages 8-12 y) with primary snoring, OSAS, and normal controls. Children with OSAS, regardless of severity based on AHI, had more impairment in HRQOL than normal controls. No significant differences in HRQOL were identified between subjects with primary snoring, mild OSAS, or moderate to severe OSAS based on PSG findings.

A Level 4 study by Franco et al.[112] identified significant correlations between caregiver scores on the OSA-18 QOL instrument and the RDI (r = 0.43). Sleep disturbance and caregiver concerns had the highest associations with RDI (R = 0.45 and 0.47, respectively). The relationship between the OSA-18 summary score and RDI (R = 0.43) was not strong but was statistically significant even after adjusting for BMI, adenoid size, and age. Only tonsil size was identified as a significant confounding factor in multivariate analysis. A regression model predicted 25% variability in RDI levels (P = 0.007). Although this study was prospective, it was limited by the use of nap cardiorespiratory studies rather than comprehensive overnight PSG. A Level 4 study by Carno et al.[119] found no significant correlation between respiratory PSG findings and either parent- or patient-reported QOL measures in a group of children referred for suspected SRBD. They also found no significant differences between QOL measures in primary snorers and those with AHI ≥ 2, or between those with and without OSAS (defined either as AI ≥ 1 or AHI ≥ 2, or AHI ≥ 5).

Four other studies compared PSG respiratory findings and QOL before and after AT: 1 provided Level 2 evidence,[115] 2 provided Level 3 evidence,[117,118] and 1 provided Level 4 evidence.[120] A prospective cohort Level 2 study by Mitchell et al. compared subjective OSA-18 surveys to objective PSG data before and 3-6 months after AT in 79 children (mean age 6.3 y) with OSAS.[115] The mean AHI before surgery was 27.5, (AHI 3.5 after surgery; P < 0.001), but only 73% of children with a preoperative AHI > 10 had remission of OSAS following AT. Despite this, QOL scores showed significant improvement after surgery (P < 0.001). The authors concluded that correlations between improvements in QOL and AHI before surgery were fair (r = 0.28) and after surgery even poorer (r = 0.16).

Two other QOL studies by Mitchell et al.[117,118] (both graded as Level 3 evidence) found caregivers of 30 obese children with moderate-to-severe OSAS (mean AHI 30 before surgery) and 29 children with severe OSAS (mean AHI 64) uniformly reported "robust" or "great" improvement in QOL following AT even though the mean postoperative AHI was 12-14/h, indicating residual SRBD. Another retrospective Level 4 study by Constantin et al.[120] compared short- and long-term improvements in QOL among children with SRBD who did and did not undergo AT. They found QOL scores improved in 74% of the children with SRBD who underwent AT compared with 10% who did not have AT (P < 0.001, OR 25.1, 95% CI 8.8-71.8). The children who did not undergo AT tended to have mild to no OSAS (AHI 1.5 ± 3.7). Findings are of limited value because QOL data were available for only 35% of the cohort.

In summary, results from generic and disease-specific QOL instruments show generally low, and rarely moderate, correlation with objective respiratory PSG data in children or adolescents with primary snoring and OSAS. QOL scores could not differentiate primary snorers from those who had OSAS on PSG. QOL scores most often could not differentiate mild from severe OSAS. QOL scores showed improvement even when postoperative PSG showed mild to even severe residual OSAS (e.g., AHI 12-14). However, caregiver reports of persistent snoring or sleep disturbance following AT were likely to be associated with residual OSAS on postoperative PSG. Such discrepancies between QOL measures and PSG respiratory findings may reflect the different types of measurements between a physiological study (PSG) and the issues probed by QOL instruments. These findings indicate that in general QOL measures alone do not provide significant independent validation of PSG respiratory measures.

4.2.1.1.10 Therapeutic intervention studies that provide evidence of test-retest validity

Therapeutic intervention studies offer an opportunity to evaluate test-retest validity when PSG is performed on the same group of subjects before and after an intervention known to improve respiratory function during sleep. When the test values change in the expected direction following the intervention, test-retest validity is demonstrated. Our search identified 23 studies in which PSG was performed before and after AT, 8 studies with PSG before and after other surgical procedures, 11 studies with PSG before and after nonsurgical intervention such as orthodontic treatment, and 3 studies with PSG before and after mixed surgical and nonsurgical interventions. In the group of AT surgical studies, 5 provided Level 2[63,76,96,97,121] evidence, 9 provided Level 3[30,59,66,80,122-126] evidence, and 9 provided Level 4[43,71,88,127-132] evidence. In the other surgical group, 1 study provided Level 3[133] evidence and 7 provided Level 4[134-140] evidence. In the group of nonsurgical interventions, 4 provided Level 2[141-144] evidence, 4 provided Level 3[60,145-147] evidence, and 3 provided Level 4[52,148,149] evidence. One study in the mixed treatment group was Level 2,[150] and 2 were Level 4.[151,152]

Surgical intervention studies: Adenotonsillectomy

In a Level 2 study, Chervin et al.[63] evaluated 78 children (mean age 8.1 ± 1.8) with PSG prior to AT, with 77/78 undergoing repeat PSG 1 year later. PSG was also performed on a control group of 27 children (mean age 9.3 ± 2.0 y) who were seen for unrelated surgical care, with 23/27 reevaluated in 1 year. At baseline, children in the pre-AT group had significantly higher mean apnea index, AHI, RDI, and percent of sleep time spent with end-tidal CO_2 > 50 mm Hg, and lower minimum oxygen saturation compared to controls. At the 1-year follow-up, children in the control group did not differ significantly from children who had undergone AT on any PSG measures. Improvement in the expected direction by the AT group, as well as the finding that PSG measures following AT did not differ from PSG measures in control children provides test-retest validity for PSG.

In the same cohort of children, frequency of mental disorders in children undergoing AT was evaluated in a Level 2 study by Dillon et al.[76] PSG, the Pediatric Sleep Questionnaire, and struc-

tured psychiatric interview in 78 children (38 without OSAS, 40 with OSAS; mean age 8.1 ± 1.8 y) undergoing AT and 27 control children (mean age 9.3 ± 2.0 y) undergoing evaluation for other surgery. PSG and structured psychiatric interviews were performed pre- and postoperatively. The postoperative AI improved in the expected direction, which supports test-retest validity of PSG for characterization of SRBD.

In a Level 2 study, Apostolidou et al.[97] performed pre- and postoperative PSG, and obtained fasting C-reactive protein levels, serum glucose, and blood pressure in a group of 58 children with SRBD and 17 controls were undergoing AT for recurrent tonsillitis or otitis. The postoperative PSG was performed at 2-14 months. The purpose of the study was to assess changes in CRP, circulating intercellular adhesion molecule-1 (cICAM-1), insulin, and blood pressure levels after AT for SRBD. Following surgery, AHI decreased significantly in children with SRBD but not in controls. Children were grouped into controls, AHI ≤ 1 postoperatively, and AHI > 1 postoperatively. A significant reduction in BP in the group of children with normalization of AHI postoperatively provides convergent validity for PSG, and the reduction in AHI postoperatively in children with SRBD compared to controls undergoing AT for tonsillitis or otitis provides test-retest validity for PSG measurements of respiratory function.

In a Level 2 study by Gozal et al.,[121] designed to better understand the role of OSAS in the pathogenesis of several cardiovascular risk factors, 62 children were evaluated with PSG and a number of metabolic and systemic inflammatory measurements before and 6-12 months after AT. The significant decrease in obstructive AHI in both obese and non-obese subjects following AT supports test-retest validity of PSG.

In a study with Level 2 evidence, Amin et al.[96] performed 4 PSGs (preoperative, 6 weeks postoperative, 6 months postoperative, and 1 year postoperative) on a group of 40 children age 7-13 with SRBD who were scheduled to undergo AT. PSGs at the same intervals were performed on 30 normal controls who did not undergo surgery. BMI and systolic/diastolic BP were measured at the time of each PSG. The purpose of the study was to evaluate risk of recurrence of SRBD following AT in obese vs. non-obese children. A normal AHI was defined as ≤ 3, and thus some children with mild but clinically significant SRBD may have been included as normal controls. Both obese and non-obese children demonstrated improvement in AHI following AT. At 6-week and 1-year follow-up (but not at 6 months postoperatively), obese children were more likely that non-obese children to have AHI > 3, and the BMI regression slope (an indicator of weight gain velocity) was a significant predictor of recurrence of SDB over time. There was no significant correlation between the 6-week and 1-year postoperative AHI. African American race, mean BMI across the 4 PSGs, and BMI slope were the strongest predictors of AHI > 3 at the 1-year follow up. Systolic BP at 1 year was significantly higher than at baseline in children with AHI > 3 at 1 year in comparison to children who did not experience recurrence of SDB. The significant increase in systolic BP in children with AHI ≥ 3 at 1 year and the recurrence of SDB in children with more rapid weight gain following AT provide construct validity for PSG. The improvement in the AHI postoperatively provides support for test-retest validity of PSG.

Further support for test-retest validity of PSG was demonstrated in Level 3 and 4 surgical outcome studies. Some of these studies also support other types of validity including convergent validity, discriminant validity, and criterion validity. Test-retest validity is demonstrated by improvement in SRBD postoperatively (Level 3: Mitchell and Kelly,[122] Chervin et al.,[59] Shatz et al.,[66] Gozal et al.,[125] Nieminen et al.,[30] Tunkel et al.,[123] Tauman et al.,[124] Montgomery-Downs et al.,[80] Walker et al.[126]; Level 4: Gozal et al.,[127] Shine et al.,[128] O'Brien et al.,[129] Mitchell and Kelly,[88] de la Chaux et al.,[130] Helfaer et al.,[131] Pavone et al.,[43] Sullivan et al.,[132] and Jain et al.[71]).

Combined treatment studies:

In a Level 2 study designed to determine the presence of subclinical cardiac abnormalities in childhood OSA before and after treatment, Chan et al.[150] analyzed PSG and echocardiograms in 101 children age 6-13 years with high-risk symptoms vs. a control group of randomly chosen low-risk children. Convergent validity for PSG-determined AHI cutoffs of normal (AHI < 1) vs. mild (AHI 1-5) and moderate-to-severe (AHI > 5) is demonstrated in that children with AHI > 5 had more cardiac abnormalities vs. the other 2 groups. Test-retest validity is demonstrated in that cardiac function improved in the expected direction only in the children who had improvement in AHI following treatment of OSAS with either AT or topical nasal steroid therapy.

Two Level 4 studies (Uong et al.[151] and Scholle and Zwacka[152]) demonstrated improvement in sleep disordered breathing following treatment with AT and/or CPAP, supporting test-retest validity of PSG in children.

Other surgical interventions:

Review of the literature also included other surgical interventions for SRBD including cervicomedullary decompression in children with achondroplasia (Mogayzel et al.[133]), mandibular distraction for micrognathia (Mitsukawa et al.[134]), mandibular distraction with an internal curvilinear device (Miller et al.[135]), distraction osteogenesis in children with Pierre Robin sequence (Monasterio et al.[136]), supraglottoplasty for laryngotracheomalacia (Zafereo et al.[137]), pharyngeal flap surgery (Morita et al.[138]), and bariatric surgery (Kalra et al.[139,140]). Each study demonstrated improvement in the expected direction postoperatively and provided Level 3 (Mogayzel et al.) or 4 evidence (all other studies).

Nonsurgical interventions:

In a Level 2 placebo-controlled study of fluticasone, Brouillette et al.[141] performed PSG before and 6 weeks after treatment in 25 children age 1-10 years. Test-retest validity for PSG is demonstrated by findings of significant improvement in AHI in the treatment group but an increase in AHI in the placebo group.

In a Level 2 randomized crossover study designed to evaluate the effectiveness of intranasal budesonide for treatment of mild OSAS (defined as obstructive AI > 1/h or obstructive AHI of > 2/h but ≤ 7/h with nadir oxygen saturation value < 92%, or in the presence of AHI ≤ 2, a respiratory arousal index > 2 and nadir oxygen saturation > 85%), Kheirandish-Gozal et al.[142] performed PSG and obtained lateral neck radiographs to evaluate the adenoidal/nasopharyngeal ratio at baseline, fol-

lowing 6 weeks of treatment with either placebo or budesonide, then again after the crossover portion of the study. The study is limited in that only 69% of children completed both phases of the study. Convergent validity for the PSG-determined AHI is demonstrated in that the adenoidal/nasopharyngeal ratio was significantly reduced in the treatment group, and this improvement was associated with improvement in PSG respiratory parameters. Test-retest validity of the PSG-determined AHI is demonstrated in that obstructive AHI, respiratory arousal index, SpO_2 nadir, percent stage 4 sleep, and percent REM sleep improved in the expected direction following treatment, but these values were unchanged or worse in the control group. A Level 2 study by Goldbart et al.[144] demonstrated test-retest validity of PSG-determined AHI following treatment with montelukast therapy. The obstructive AHI decreased significantly in association with treatment, whereas the obstructive AHI showed a mild increase in control subjects. Two studies[146,147] with Level 3 evidence also demonstrated test-retest validity of respiratory PSG parameters using nonsurgical interventions.

A Level 3 study by Villa et al.[60] evaluating the effectiveness of rapid maxillary expansion demonstrated continuing improvement in the AHI and arousal index with 3 consecutive PSGs during over a 12-month period. A Level 3 study by Groswasser et al.[145] showed that modest improvement occurred following placement of a nasoesophageal probe in a group of infants with OSAS, supporting test-retest validity of PSG in infants and toddlers. Other nonsurgical intervention studies include use of an oral jaw-positioning appliance (correcting malocclusion without mandibular advancement, Villa et al.,[52] Level 4), an orthodontic appliance for children with Pierre Robin sequence (Buchenau,[143] Level 2), enzyme replacement therapy for mucopolysaccharidosis type I (Kakkis,[148] Level 4), and growth hormone in children with Prader-Willi syndrome (Miller et al.,[149] Level 4). In each of these studies, treatment demonstrated improvement in sleep disordered breathing, supporting test-retest validity of PSG.

In summary, our search identified 45 interventional studies that address test-retest validity of PSG. All studies provided data that support test-retest validity of PSG. The interventional studies often differed regarding definitions of apnea and hypopnea. Although in some circumstances this would be considered a measurement weakness, it also provides an opportunity to evaluate convergent validity when studies with similar designs use different operational definitions for the same construct. In the pre- and post-AT studies, for example, convergent validity for the measurement of SRBD with PSG was demonstrated by the observation that multiple face-valid yet slightly different definitions of SRBD yielded similar results. Although many of the papers have methodological limitations resulting from selection bias and lack of control groups, the overall consistency of results provides moderate to strong evidence for test-retest validity of PSG for characterization of SRBD in children.

4.2.1.1.11 Other measures

The task force identified studies that assess the validity of PSG for characterization of SRBD through correlations with other independent measures in addition to those discussed above. Identified studies used surrogates of end-organ dysfunction in SRBD such as hormone levels, inflammatory markers, markers of cardiovascular dysfunction, and biochemical markers of neurocognitive dysfunction.

Our search regarding other measures for providing construct, face, or convergent validity for SRBD identified 13 papers. Six provided Level 2 evidence,[9,102,150,153-155] 4 provided Level 3[28,78,125,156] evidence, and 3 papers provided Level 4 evidence.[68,127,157]

In several studies, certain hormone levels show correlations with PSG respiratory measures for SRBD and provide support for validity of the PSG. In a Level 2 study Redline et al.[102] evaluated the association between SRBD and metabolic syndrome in a large number of adolescents (age 13-16 y) using modified adult criteria for metabolic syndrome. Logistic regression found that adolescents with PSG confirmed SRBD had a 7-fold increased odds of metabolic syndrome compared to those without SRBD, even with adjustment for sex, age, race, and preterm status. This study provides evidence of convergent validity of PSG in adolescents because markers of metabolic syndrome correlate with PSG respiratory measures. In a Level 4 study, Tauman et al.[157] evaluated 130 consecutively referred children (39% obese) with PSG and measurements of leptin, adiponectin, resistin, glucose, insulin, and CRP. Lower adiponectin levels were identified in obese children and were inversely correlated with BMI z scores but not with log AHI. The log leptin concentrations were higher in obese children, correlated with BMI z scores, and were lower in children with lower AHI (< 1/h) and in children with an oxygen saturation nadir $\geq 90\%$. These results suggest that circulating adipokines are a function of ponderal index rather than an effect of SRBD on insulin resistance. These findings do not provide independent support for validity of PSG in assessment of breathing. In a Level 4 study by Tauman et al.,[68] snoring children with dyslipidemia and insulin resistance were evaluated with various biochemical assessments and PSG. The investigators found no consistent association between PSG respiratory measures and metabolic derangements.

Inflammation is thought to play a role in SRBD in adults and children, and several investigators have evaluated the association between various inflammatory markers and PSG respiratory parameters. We identified 2 studies that evaluated different inflammatory markers from the airway as predictors of SRBD compared to PSG. In a Level 2 study, Verhulst et al.[153] evaluated exhaled nitric breath oxide (eNo) as a marker of inflammation in overweight children (without asthma and atopy, but with PSG-confirmed SRBD) compared to normal children. eNo was significantly higher in overweight children with snoring and SRBD. eNo was not higher in overweight children with normal PSG. In a Level 3 study, Goldbart et al.[28] studied exhaled breath condensates (EBC) from 50/56 children with SRBD and compared results with 12 non-snoring children. Children with SRBD showed a statistically significant increase in EBC for inflammatory markers (leukotrienes) in a dose-dependent fashion, but these results were confounded by higher BMI in those with SRBD. The EBC did not differ significantly over different time points, up to 6 months. EBC and eNo are nonspecific markers of inflammation and may be elevated in individuals with other pulmonary disorders. These results suggest that inflammatory markers provide support for validity of PSG for assessment of SRBD in children.

One Level 2 and 1 Level 4 paper assessed the correlation between altered systemic inflammatory markers in SRBD and PSG findings. In the Level 2 study by Li et al.,[154] systemic inflammatory markers such as IL-6, IL-8, CRP, and TNF-α were compared to PSG finding before and after treatment of SRBD in 11-year-old children. Levels of IL-6 and IL-8 were significantly elevated in children with PSG confirmed OSA (OAI > 1/h) and IL-6 correlated with OAI index in a dose-dependent fashion. IL-8 values decreased following treatment for 2-3 months, suggesting that the inflammation decreased. CRP was increased and was positively associated with OAI. The CRP decreased significantly in 16 treated children post treatment. In a Level 4 study Gozal et al.,[127] **e**valuated IL-6 and anti-inflammatory IL-10 levels in young children (age 4-9 y). Investigators showed that children with SRBD had increased IL-6 and lower IL-10 levels. These studies indicate that certain inflammatory markers are abnormal in children with PSG-confirmed SRBD compared to controls and that these values improve significantly after treatment. These findings provide evidence to support construct validity for PSG in children with SRBD.

Similar to adults, there is growing evidence that cardiovascular dysfunction occurs in children with PSG confirmed SRBD. A Level 2 study by Chan et al.[150] evaluated children with various degrees of SRBD using echocardiography and PSG pre- and post-treatment with intranasal steroids and surgery. Convergent validity for PSG-determined AHI cutoffs of normal (AHI < 1), mild (AHI 1-5), and moderate to severe (AHI > 5) were found. Children with AHI > 5 had more cardiac abnormalities and improvement was documented following treatment. A Level 2 study by Ugur et al.[9] using Doppler imaging for cardiac imaging evaluated both systolic and diastolic dysfunction in children with PSG-confirmed SRBD and showed that changes in cardiac velocities are detectable even in mild SRBD. These studies provide convergent validity for PSG for evaluation of SRBD in children.

Several investigators have evaluated endothelial dysfunction as a marker for cardiovascular dysfunction in children. One paper with Level 3 evidence by Gozal et al.,[125] showed that 12 of 34 children with very severe PSG-confirmed SRBD, including hypoxemia and hypercapnia, had changes in reperfusion kinetics and soluble CD40 ligand as markers of endothelial dysfunction. There was an improvement following AT. Although based on relatively small studies, these correlations provide support for convergent validity for PSG in children with endothelial dysfunction associated with SRBD.

SRBD in children is associated with changes in neurocognitive function. Three studies with varying levels of evidence have evaluated PSG parameters compared to different biochemical markers associated with neurocognitive dysfunction. A Level 3 study by Gozal et al.,[78] evaluated genetic determinants of susceptibility for neurocognitive deficits using apolipoprotein E (APOE ε4). In subjects with SRBD, 16 of 146 children were found to have APOE ε4, and those with lower neurocognitive testing scores had APOE ε4. The study showed that children with PSG-confirmed SRBD had lower neurocognitive scores on ≥ 2 measures, which supports the validity of PSG. In a Level 2 study, Hill et al.,[155] performed an elegant exploratory study evaluating cerebral blood flow velocity and differences in children with mild PSG-confirmed SRBD without hypoxemia, including neuropsychological testing. No relationship was found between changes in cerebral blood flow velocity with PSG respiratory parameters, indicating that CBFV does not provide support for validity for PSG for mild SRBD. A Level 3 study by Khadra et al.[156] investigated the relationship between regional cerebral oxygenation and cognition in children with SRBD. Results suggest that increasing mean arterial pressure, age, oxygen saturation, and REM sleep augment cerebral oxygenation, while SRBD, male sex, arousal index, and NREM sleep diminish cerebral oxygenation. The investigators proposed a model that may help explain the sources of variability in cognitive function in children with SRBD. The study has limited application here because of the limited PSG data provided.

In summary, our search identified several measurements that are independent of PSG and other parameters discussed above that have theoretical or proven value as surrogate markers of SRBD. These independent measures provide low to moderate strength of evidence to support construct and convergent validity for PSG.

4.2.1.2 Test-retest reliability and scoring reliability

Reliability testing evaluates the consistency and stability of a measurement across time or determines the accuracy of a measurement when used by multiple raters. Reliability is necessary (although not sufficient) for determining the validity of a test, and reliability of a test sets the upper limit for validity. In PSG, both interscorer reliability and test-retest reliability are clinically relevant.

Our search identified one study specifically designed to evaluate interscorer reliability in pediatric PSG, and a second study (discussed below) also reported data on agreement between 2 independent scorers. In a Level 1 study, interrater and intrarater reliability of PSG respiratory scoring and other aspects of scoring in infants were evaluated in a detailed fashion by The Collaborative Home Infant Monitoring Evaluation (CHIME) Steering Committee.[158] The investigators used the appropriate statistical reliability measure (κ, with a 95% confidence interval) and demonstrated agreement in respiratory scoring ranged from 0.67 to 0.83, indicating substantial to excellent agreement. Investigators also demonstrated excellent intrarater reliability among 4 scorers for respiratory measures, with κ values from 0.79 to 0.95. Although scorers showed suboptimal agreement with regard to EEG, EOG, and body movement, investigators demonstrated improvement through uniform training and establishment of more explicit scoring rules for use in infants evaluated with PSG.

Our search regarding test-retest reliability identified 4 studies designed specifically to evaluate test-retest reliability in pediatric PSG performed for the evaluation of SRBD and 2 additional studies in which at least one group of children underwent repeat PSG without any therapeutic intervention between studies. One study provided Level 1 evidence,[158] 1 provided Level 2 evidence,[159] 2 provided Level 3 evidence,[30,160] and 2 provided Level 4 evidence.[161,162]

In a Level 2 study by Rebuffat et al.,[159] consecutive nights of PSG were performed in 19 infants (median chronological age 11 weeks, range 5-36 weeks) to evaluate night-to-night variability in PSG findings. Eleven of 19 subjects underwent 3 nights of PSG, and 8 of 19 underwent 2 consecutive nights of PSG. Eight infants had history of evaluation for an ap-

parent life-threatening event (ALTE), and the other 11 were randomly selected from a group of healthy infants whose parents had enrolled the infants for participation in sleep related research. There were no significant differences on any scored parameters in the control infants or ALTE infants between nights. Findings demonstrated consistency of PSG measures from night to night. All recordings were scored by 2 independent scorers, with an overall interscorer agreement of 93%, indicating excellent interrater reliability. This study supports both test-retest reliability and interscorer reliability for PSG in infants.

In a Level 3 study by Katz et al.,[160] 2 nights of PSG were performed in 30 snoring children with ATH (mean age 4.1 ± 2 y) separated by 7-27 days. The investigators evaluated the consistency of multiple sleep and respiratory variables. Intraclass correlation coefficients were computed on natural logarithm transformations of the data, and difference scores were computed. There were no significant differences between apnea index, AHI, percentage of time in supine vs. non-supine position, SpO_2 nadir, %TST with SpO_2 < 92%, end-tidal pCO_2 peak, or %TST with end-tidal pCO_2 > 50 mm Hg. Subjects were also rated as having primary snoring or OSAS, and further divided into categories of mild, moderate, or severe. Evaluation of 2 children who changed category demonstrated a characteristic regression to the mean effect, with one changing from mild to moderate and the other changing from severe to moderate. Results support test-retest reliability of PSG in a clinical sample of children undergoing evaluation for SRBD.

In a Level 4 study, Li et al.[161] performed 2 consecutive PSGs in 44 obese children and 43 normal controls matched on age and sex (mean age 11.21 y, SD 2.21 y). An OAI ≥ 1 on either night was considered diagnostic of SRBD, and primary snoring was defined as report of snoring for > 4 nights/week. The study was limited in that criteria for scoring hypopnea were not described, and no reliability coefficients were reported on any of the PSG variables. There were no significant differences in time spent supine vs. nonsupine on night 1 vs. night 2. The AHI and oxygen desaturation and hypopnea indices were reduced on the second night in patients with SRBD but were unchanged in the primary snorers. In the normal subjects the hypopnea index, CAI, and AHI were slightly increased on night 2, presumably due to the increase in percentage of REM sleep. The authors concluded that the first night PSG would have correctly identified 84% of cases, and reported that the cases missed by the first night study had only borderline SRBD. This study supports test-retest reliability of PSG for children with and without SRBD.

In a Level 3 study Nieminen et al.[30] evaluated 58 snoring children (age 3-10 y) with two 6-channel PSGs separated by 6 months. A group of 30 nonsnoring children underwent the 6-channel PSG once and served as controls. The study is limited in that there was no EEG recording. There was no significant difference (i.e., no spontaneous improvement and no indication of an increase in severity) in the mean AHI over the 6-month period. This supports test-retest reliability for PSG in snoring children.

In a Level 4 study, Abreu e Silva et al.[162] studied 3 subgroups of infants with possible risk factors for sudden infant death syndrome (SIDS) compared with 11 normal controls. PSG was performed for 3-4 hours after the last evening feeding. A "symptoms" subgroup of 33 infants (16 recovering from acute bronchiolitis, 5 with upper respiratory tract infection, 7 with congenital laryngeal stridor, and 5 with recurrent vomiting due to congenital hypertropic pyloric stenosis) underwent 59 recordings, a second subgroup of 24 siblings of infants with SIDS underwent 50 recordings, and a subgroup of 29 "near miss" for SIDS infants underwent 77 recordings. The normal control infants were studied on 31 occasions. The study was limited because while descriptive data were reported on the percentages of children in each subgroup who had respiratory events, no significance testing or test-retest reliability coefficients were reported. Due to insufficient data, it is indeterminate if test-retest reliability of abbreviated (3-4 h) PSG is supported by this study.

In summary, our search identified 6 papers that address the issue of test-retest reliability for PSG in infants and children, 2 of which reported interscorer reliability data. Findings provide good to excellent support for test-retest reliability for respiratory PSG parameters.

4.2.1.3 Daytime nap PSG compared with full night PSG

Nap PSG is an appealing alternative to overnight PSG for the evaluation of SRBD in children because it is potentially less expensive and more convenient. Our search comparing daytime nap studies with overnight PSG identified 3 articles, all with Level 4 evidence.[163-165]

A retrospective study by Saeed et al.[163] of 143 children (age 5.6 ± 3.1 y) with suspected OSA included performance of a 1-h nap and overnight PSG. Nap sleep was induced with chloral hydrate in the majority of patients. The study demonstrated that no individual nap parameter had both good sensitivity and specificity for predicting abnormal nocturnal PSG findings. Approximately half of the subjects with a normal nap PSG went on to have an abnormal overnight PSG, and 77% with an abnormal nap PSG had an abnormal overnight PSG. Twenty-three percent with an abnormal nap study had a normal overnight study. Snoring was the most sensitive parameter (86%), predicting an abnormal overnight study, but was also the least specific. The presence of gasping and retractions had a specificity of 100% but variable sensitivity. The study was limited by a narrow spectrum of subjects because only children with normal or mildly abnormal nap studies were included. Findings suggest that when certain nap study parameters are abnormal, the chance of confirming OSAS may be high; however, a normal daytime nap study does not reliably exclude OSAS when compared with nocturnal PSG in symptomatic children.

In a Level 4 study by Marcus et al.,[164] 1-h nap and overnight PSG studies obtained 26 ± 4 days apart were compared in a population of 40 children (age 5.4 ± 0.8 y) referred for evaluation of SRBD. Nap sleep was induced with chloral hydrate in the majority of children. Nap vs. overnight PSG was abnormal in 70% and 95% of subjects, respectively. Nap PSGs significantly underestimated duration of longest obstructive apnea, highest $PetCO_2$, and lowest SaO_2. Nap PSG demonstrated a sensitivity of 74% and specificity of 100% in predicting abnormalities on overnight PSG. Excluding subjects with OSAS who were

sedated with chloral hydrate did not change outcomes. This study was limited because neither nap PSG nor overnight PSG included EEG, there was no control group of normal children, and the degree of blinding is uncertain. Despite these limitations, findings suggest that in children with suspected SRBD, nap PSG is not as sensitive as overnight PSG for characterization of breathing during sleep.

In a related study with Level 4 evidence by Marcus et al.[165] involving 53 children with Down syndrome (mean age 7.4 ± 1.2 y), 16 consecutively enrolled children underwent both nap PSG (1-2 h) and overnight PSG, and 37 underwent nap PSG only. These children were compared with 8 asymptomatic normal control children who underwent overnight PSG only. Nap PSG was abnormal in 77% of children. In the subset of children who underwent both overnight PSG and nap PSG, 12/16 children had abnormal nap PSG findings, whereas all 16 had abnormal overnight PSG. These children were also included in the previously cited study of 40 children.[164] Nap PSG significantly underestimated the lowest oxygen saturation and highest $PetCO_2$. Findings suggest that nap PSG is not as sensitive as overnight PSG for identification of SRBD in children with Down syndrome.

In summary, findings provide very limited support for the potential role of nap PSG as a screening method or a diagnostic procedure in children with suspected SRBD. Even when sedation with chloral hydrate is used during nap studies, nap PSG is not as sensitive as overnight PSG in identifying SRBD. Nap studies tend to underestimate the severity of SRBD when compared to overnight PSG.

4.2.1.4 Nocturnal home oximetry compared with PSG

Several studies have evaluated the potential clinical utility of nocturnal home oximetry for diagnosis of OSAS in children. The task force reviewed 3 papers[166-168] that compare diagnostic utility of home oximetry with PSG in children. In summary, home oximetry findings may be relatively specific for OSAS in certain settings when positive, but findings are insensitive and no studies provided support that home oximetry alone offers an acceptable degree of diagnostic accuracy to replace PSG. The task force did not perform formal data extraction and evidence grading of these papers because oximetry is a component of full PSG, and thus findings cannot be used to support or not support the validity of full PSG. Findings are presented because they illustrate the limitations of home oximetry as a screening or diagnostic tool for diagnosis of OSAS in children.

4.2.2 Clinical utility of PSG in children with risk factors for SRBD

The objective of this section is to present findings that address the clinical utility of PSG for evaluation of suspected SRBD in children. The task force reviewed and summarized the literature with respect to a series of clinical attributes that are thought to represent varying levels of risk for SRBD. This approach is designed to evaluate clinical utility through a "risk stratification" strategy in order to support optimal clinical decision making regarding indications for PSG in children.

4.2.2.1 Obesity

The prevalence of obesity in the United States has doubled in the last 2 decades in younger children and tripled in adolescents.[169-173] The task force identified 34 papers that address the potential clinical utility of PSG in obese or overweight children with suspected SRBD. We identified 7 sub-questions regarding the clinical utility of PSG for evaluation of suspected SRBD in obese children.

Are SRBDs more common in obese or overweight children than normal weight children?

Nine studies addressed whether SRBD is more common in obese children, including 1 Level 1,[174] 1 Level 2,[25] 2 Level 3,[175,176] and 5 Level 4 studies.[39,140,177-179] The literature provides strong supportive evidence that SRBDs are significantly more common in obese or overweight children compared with non-obese children matched for age and gender. A Level 1 study by Xu et al. reported that 60% of 37 obese children and none of 37 normal weight children without ATH had SRBD based on PSG.[174] A Level 2 study by Wing et al. reported that 33% of 46 obese children (10.8 ± 2.3 y) had an RDI ≥ 5 and 26% had an OAI ≥ 1, whereas only 4.5% of normal weight controls had RDI ≥ 5 and 2.3% an OAI ≥ 1.[25] A Level 3 study by Chay et al. reported that 35% of obese children (4-12 y) had an OAHI ≥ 1 compared with 16% of normal weight children referred for snoring.[175] In a Level 3 study, Beebe et al. reported that 13% of 60 overweight older children (10 to 16.9 y) had an AHI > 5 and 50% had an AHI > 1, whereas none of the normal weight controls had an AHI > 5 and only 14% had an AHI > 1.[176] Four other studies examined the prevalence of SRBD in obese children, and investigators reported that 18% to 61% of obese children met diagnostic criteria for SRBD.[39,177-179] In a Level 4 retrospective case series by Kalra et al.[140] involving primarily older adolescents with morbid obesity who had bariatric surgery, OSAS was present preoperatively in 55% of subjects.

Is the severity of SRBD worse among obese compared with non-obese children?

Our search identified 7 papers relevant to this question. A Level 2 study by Wing et al. reported that the RDI averaged 9.3 ± 18.7 vs. 2.0 ± 1.5 and the OAI 3.4 ± 10.7 vs. 0.3 ± 0.8 in obese vs. non-obese children.[25] A Level 1 study by Xu et al.[174] found a positive correlation between BMI z score and AHI ($r = 0.535$, $P < 0.001$) and an inverse correlation between the BMI z score and the nadir SpO_2 ($r = -0.507$, $P < 0.001$). The degree of central obesity correlated with the AHI and nadir SpO_2 ($P < 0.001$ for both) among 198 obese (BMI z > 1.96) Chinese children. The adjusted odds ratio (OR) for finding OSAS on PSG in an obese child was 18.7. A Level 3 study by Redline et al. reported that obese children were much more likely to have an AHI > 10 (28%) than an AHI < 5 (7%) on ambulatory PSG.[180] Two Level 4 [68,178] studies also found AHI values were significantly higher in obese compared with age- and gender-matched non-obese controls, even after adjusting for other confounding factors. One Level 2 study by Goodwin et al.[24] identified *no* correlation between obesity and frequency of clinical symptoms of OSAS, RDI values, or oxyhemoglobin desaturation using comprehensive ambulatory PSG.[35] Two Level 4 studies reported that when SRBD was present in obese children or adolescents, the severity was often mild.[39,178] In summary, SRBD tends to be more severe in obese compared with non-obese children, although this was not a uniform finding across studies.

Are obese children with PSG confirmed SRBD objectively sleepier than non-obese children with equally severe SRBD?

Four papers (1 Level 2,[25] 1 Level 3,[64] 2 Level 4[65,178]) reported evidence that pathologically short MSL values are observed on MSLT in children with SRBD, more often in the more obese patients, and in subjects with higher AI and lower oxyhemoglobin desaturation. A Level 4 study by Gozal et al. reported that average MSL values were significantly shorter among 50 obese (12.9 ± 0.9 min) compared to 50 non-obese (17.9 ± 0.7 min) children with similar level of severity of SRBD.[65] Forty-four percent of the obese children had MSL ≤ 12 min, compared with only 10% of the non-obese subjects. A earlier Level 3 study by Gozal found MSL values of 20.0 ± 7.1 min in 54 children with OSA, 23.7 ± 3.1 min in 14 with primary snoring, and 23.7 ± 3.0 min in 24 controls.[64] A Level 4 study by Marcus et al.[178] also reported MSL values (12 ± 5 min) among 18 obese children (age 10 ± 5 y) with PSG-confirmed SRBD, which is significantly lower than age-appropriate norms. However, the investigators found no significant correlation between sleepiness and AI, nadir SpO_2, sleep efficiency, hypoventilation as a percent of TST, or number of arousals from sleep. MSL correlated with the %IBW ($r = -0.50$, $P < 0.05$). A Level 2 study by Wing et al. found no group differences in MSL values between 46 obese (15.5 ± 3.4 min) and 44 non-obese (14.7 ± 4.2 min) children with SRBD.[25]

Does tonsillar hypertrophy increase the likelihood that an obese child or adolescent will have PSG-confirmed SRBD?

Five studies (1 Level 1,[174] 1 Level 2,[25] 1 Level 3,[175] and 2 Level 4[67,179]) address whether tonsillar hypertrophy (TH), or adenoidal hypertrophy (AH) increase the risk that an obese or overweight child will have SRBD based on PSG. A level 2 study by Wing et al. reported that the adjusted OR for identifying OSAS on PSG with 2+ or greater TH was 12.7, whereas an elevated BMI increased the OR only 1.2 times.[25] In this study, TH and/or a narrow velopharyngeal space in obese children was highly predictive that OSAS would be confirmed on PSGs (83% PPV, 79% NPV, sensitivity 39%, specificity 97%). A Level 1 study by Xu et al.[174] reported that obesity, TH, and AH were independent risk factors for OSAS. Obesity alone increased the adjusted OR of OSAS (AHI > 5 or OAI > 1) on PSG 18.7 times (95% CI 5.3-52.6, $P < 0.001$), TH 5.2 (95% CI 1.3-28.2, $P = 0.042$), and AH 3.1 (95% CI 1.4-15.2, $P = 0.004$). AHI values were lowest in normal weight children without ATH and highest in obese children with ATH. OSAS was significantly related to ATH, TH, and obesity in a regression model. A Level 3 study by Chay et al.[175] showed that TH increased the risk of an obese child having OSAS on PSG 6.9 times, and AH 3.5 times when compared with non-obese children. With increasing obesity, the risk was 8.2 times higher for those with TH but not those with AH. Among morbidly obese adolescents with mild SRBD on PSG, tonsillar size correlated with AHI ($P = 0.07$), DI ($P = 0.04$), and mean SpO_2 ($P = 0.01$). A Level 4 study by McKenzie et al.[179] of 158 obese British children (age 2-16 y) found OSAS was more likely to be identified in obese children with TH. Another Level 4 study by Lam et al. of 482 Chinese children (median age 6 y) found BMI z score and 4+ TH correlated with log-transformed AHI even after adjusting for other confounding factors.[67] These results provide strong evidence that TH increases the risk that obese children will have PSG-confirmed SRBD compared with non-obese children.

Is SRBD less likely to resolve in obese children following AT compared with non-obese children, suggesting the potential indication for repeat PSG?

Seven studies (2 Level 2,[96,181] 2 Level 3,[122,124] and 3 Level 4[128,129,182]) addressed whether obese children are less likely to be cured by AT compared with non-obese children. In a Level 2 study by Amin et al.,[96] obesity and gain velocity in BMI conferred independent risk for recurrence of SRBD after AT based on serial PSG studies. A Level 3 study by Mitchell and Kelly[122] reported that SRBD (AHI ≥ 2, moderate ≥ 5, severe ≥ 15) was more likely to persist following AT in obese vs. non-obese children. Following AT, 76% of the obese vs. 28% of non-obese children had persistent OSAS (severe in 15% of obese and 0% in non-obese). The OR for persistent OSAS after AT in obese compared with non-obese children was 6.25 (95% CI 1.8-12.9, $P = 0.001$). The investigators found that BMI and preoperative AHI correlated significantly with persistent OSAS ($P < 0.001$). A Level 3 study by Tauman et al. found obese children were far less likely to have complete resolution of their OSAS by AT.[124] The frequency of subjects with AHI ≤ 1 after surgery was significantly lower in obese subjects ($P < 0.05$). Moreover, they showed complete normalization of SDB on PSG occurs in only 25% of pediatric patients following AT; 46% had a postoperative AHI between 1 and 5/h TST, and 29% had an AHI ≥ 5.

Three studies with Level 4 evidence found AT often failed to "cure" OSAS in obese children. Shine et al.[128] reported that 56% of 19 morbidly obese children (median age 78 ± 53.3 months, median BMI z scores 2.84 ± 0.94) had sufficient residual OSAS to warrant CPAP therapy following AT. O'Brien et al.[129] reported that SRBD resolved following AT in 45% of obese children (without a significant increase in BMI), compared with 78% of the non-obese obese children ($P = 0.011$). The OR for persistent OSAS in obese compared to non-obese children was 4.2 (95% CI 1.5-11.9 $P = 0.005$). Morton et al.[182] reported that obese children were nearly 4 times more likely to have a postoperative RDI ≥ 5 (adjusted OR 3.98; 95% CI 1.05, 15.08) compared with non-obese children. Costa and Mitchell[183] pooled data from 110 children (mean age 8.4 y; mean BMI 29.7) in a meta-analysis of the 4 studies previously cited.[122,128,129,182] The interval from AT to postoperative PSG was 4.8 months (range 3-5.7). Mean pre- and postoperative AHIs were 29.4 and 10.3, respectively, and nadirs SpO_2 were 78.4% and 85.7%, respectively. Forty-nine percent of the obese children had a postoperative AHI < 5, 25% < 2, and 12% < 1. Based on this analysis, AT improved but did not resolve OSAS in the majority of obese children.

A Level 2 study by Apostolidou et al.[181] reported that the percentage of children "cured" by AT did not differ (23% of the obese and 25% of the non-obese had an AHI < 1 following surgery), even after correcting for obesity, preoperative AHI, and degree of ATH.

Is obesity in children or adolescents an independent risk factor for SRBD?

Seven papers (1 Level 1,[174] 2 Level 2,[25,184] 3 Level 3,[70,180,185] and 1 Level 4[46]) identified obesity as an independent risk fac-

tor SRBD. One Level 3 paper reported that obesity was not an independent risk factor for OSA.[36]

A prospective Level 2 study by Wing et al. reported that 26% of 46 obese children (age 10.8 ± 2.3 y, mean BMI 27.4 ± 5.1) had OAI ≥ 1 vs. 2% of 44 normal weight children (11.7 ± 2.1 y).[25] In a Level 3 study by Brooks et al.,[70] obesity was the only predictor of number of respiratory events per hour, and percent ideal body weight was a major predictor of lowest oxyhemoglobin saturation during nocturnal PSG. A Level 1 study by Xu et al.[174] found ATH increased the likelihood of an AHI > 5 or an OAI > 1 on a PSG in obese children (BMI z score > 1.96); obesity alone increased the adjusted OR 1.9 times. A Level 2 study by Stepanski et al.[184] found obesity emerged as a significant predictor of OSAS in children 8 years or older. A Level 3 study, Redline et al.[180] reported obese children (BMI > 28) were 4.6 times more likely to have an AHI ≥ 10 and 6.1 times more likely to have an AHI > 5 than non-obese children after adjusting for race. The risk for identifying OSAS on PSG increased 12% for every increment in BMI of 1 kg/m^2 beyond the mean BMI for age and sex; furthermore, the effect of obesity on the risk for moderate SRBD (OR 4.6) was half that of adults (OR 10 to 12 in adults). A cross-sectional Level 4 study of 326 children by Rosen et al.[46] reported the prevalence of obesity in children with snoring or trouble sleeping was 28% (n = 326), or twice the prevalence of obesity in the general pediatric population at that time.[186]

In a Level 3 study by Kohler et al., BMI was a significant but weak predictor of obstructive AHI.[185] In a Level 3 study by Xu et al. involving a clinical series of subjects referred for evaluation of suspected SRBD, obesity was not an independent risk factor for OSAS.[36]

What are the relationships between systemic hypertension (HTN), metabolic syndrome (MS), insulin resistance, dyslipidemia, fatty liver disease (FLD), proteinuria, and SRBD in obese children or adolescents?

Three studies examined the relationships between obesity, SRBD, and HTN in children. A Level 3 study by Reade et al.[32] reported that OSAS was present in 54% of obese and 29% of non-obese subjects referred for suspected SRBD. Sixty-eight percent of the obese and only 30% of the non-obese had HTN by awake office BP measurement. HTN predicted higher AHI and HI in obese patients, and an elevated HI predicted diastolic HTN in older children. In a Level 3 study by Leung et al.,[100] 67% of obese children with an AHI > 5 had systemic HTN compared with 23% with an AHI < 5. Obesity increased the OR of systemic HTN 6.7 times (95% CI 1.04-44.29). The BMI z score was a significant predictor for systolic HTN awake and asleep, and diastolic HTN asleep.

Two studies examined the relationship between obesity, SRBD, and MS in children. A Level 2 study by Redline et al.[102] reported that adolescents with SRBD had a 6.5-fold higher risk for MS compared with those without SRBD (59% of children with SRBD had MS, 16% without SRBD), even after adjusting for sex, age, race, and preterm status. A Level 3 study by Verhulst et al.[187] found that minimum SpO_2 was a weak predictor (OR 0.9) for MS among 104 overweight older children (mean age 11.1 ± 2.6 y).

A Level 3 paper by Kheirandish-Gozal et al.[188] evaluated the relationship between FLD and SRBD, and reported that 32% of 142 overweight or obese children had FLD, and 42 (91%) of these children had OSAS on PSG. In contrast, only 3 children (< 1%) among the 376 non-obese subjects had FLD, even though 248 (66%) had OSAS on PSG. Insulin resistance and hyperlipidemia were also more common in children with FLD. FLD was improved after treatment of OSAS in 32 of 42 obese children (P < 0.0001).

Four studies evaluated relationships between obesity, SRBD, proteinuria, insulin resistance, and dyslipidemia. Most of these papers reported negative or inconsistent findings. However, one Level 4 study by de la Eva et al.[177] reported that the severity of OSAS correlated with fasting insulin levels, independent of BMI and age, in 62 morbidly obese children (mean age 10.9 ± 3.1 y, BMI 31.2 ± 7.0 kg/m^2), and another Level 3 study correlated the severity of SRBD independently with log AUC glucose, HDL cholesterol, log cholesterol, and log triglyceride levels among 104 overweight older children (mean age 11.1 ± 2.6 y).[187] In a Level 4 study by Tauman et al.,[68] insulin resistance and hyperlipidemia among 116 snoring children and 19 controls (mean age 8.9 ± 3.5 y, 59% boys, 52% obese) was determined primarily by the degree of body adiposity, not the degree of SRBD. In a Level 4 study, Verhulst et al.[173] found no correlation between SRBD severity and proteinuria among 94 overweight or obese children (mean age 11.0 ± 2.5 y).

A Level 2 case-control study by Gozal et al.[121] evaluated fasting glucose, insulin, C-reactive protein, apolipoprotein B, and serum lipid concentrations before and 6-12 months following AT in 62 children with OSAS (37 obese, mean age 7.4 ± 2.6 y). Investigators found no changes in BMI, fasting glucose, or insulin, but significant improvements in lipid profiles, C-reactive protein, and apolipoprotein B levels among the obese children following AT. AT among the non-obese children was associated with mild but significant increases in BMI z scores, significant increases in HDL and reciprocal decreases in LDL, and reductions in plasma C-reactive protein and apolipoprotein B levels.

In summary, multiple groups of investigators report that obesity in children correlates with the presence and severity of SRBD on PSG. However, the effect of obesity on the risk for SRBD in children is probably not as strong as that observed in adults. There is relatively strong evidence that obese children 8 years or older are at significant risk for obstructive SRBD. The presence of even a modest degree of TH and/or narrow velopharyngeal space potentiates the risk of SRBD in obese children. Obese children are more likely to have residual OSAS following AT compared with non-obese children, which suggests the need for careful clinical follow-up and possibly repeat PSG after surgery. OSAS in obese children is associated with increased risk for hypertension, metabolic syndrome, and FLD. Based upon the available literature, PSG has significant clinical utility for the diagnosis and management of SRBD in obese children and adolescents and for following clinical course after therapeutic intervention. Additional data will be helpful in refining our understanding of when repeat PSG is indicated and in achieving greater ability to stratify risk for SRBD through identification of clinical risk factors.

4.2.2.2 Prematurity

Our search regarding prematurity as a risk factor for PSG confirmed SRBD identified 4 articles. Two papers provided Level 3 evidence,[79,189] and 2 provided Level 4 evidence.[37,190]

In a Level 3 retrospective, population-based study of 383 children born prematurely, Hibbs et al.[189] reported a high prevalence rate of 7.3% for OSAS at 8 to 11 years of age. Mild maternal pre-eclampsia and single parent household represented the most robust risk factors within the cohort studied (odds ratios 7.17 and 3.72, respectively). Although the study was limited by use of portable cardiorespiratory studies, the mean AHI for these studies correlated well with laboratory-based PSGs that were performed for 55 subjects.

In a Level 3 study, Emancipator et al.[79] studied sleep and cognition in 835 former term and preterm children drawn from the same Cleveland Children's Sleep and Health Study cohort. Associations between SRBD and lower cognitive and achievement measures were stronger in children born prematurely compared to those born near term. The study was limited by use of unattended cardiorespiratory sleep studies rather than full PSG.

A Level 4 study by Paul et al.[190] found that central and mixed apneas were more frequent than obstructive apneas among 29 preterm children whose desaturation or bradycardia during sleep had not responded to treatment with aminophylline. The study was limited by lack of a control group and use of 2-h nap studies.

A case series providing Level 4 evidence by Greenfeld et al.[37] reported PSG and clinical findings in 29 consecutive children less than 18 months of age with OSAS on PSG. Although many (24%) of these subjects were born prematurely, no other findings referable to prematurity were reported. The study was limited because the PSG criteria used for the diagnosis of OSAS were not stated.

In summary, we identified 4 papers that address the association between PSG respiratory findings and prematurity. Two papers suggest an association between prematurity and abnormal respiratory PSG parameters, and one study stratified risk factors for OSAS among children born prematurely. One study demonstrated good correlation between ambulatory cardiorespiratory studies and in-laboratory PSG in children born prematurely. These findings provide support for the role of PSG in identification and classification of SRBD in children born prematurely, and findings suggest that prematurity may be an independent risk factor for SRBD.

4.2.2.3 Race/Ethnicity

Our search regarding papers that address race/ethnicity as a risk factor for PSG confirmed SRBD identified 6 articles. Three papers provided Level 2,[23,24,184] 1 provided Level 3,[180] and 2 provided Level 4 evidence.[46,182]

A Level 2 prospective cohort study by Goodwin et al.[24] used structured questionnaires and home PSG to assess sleep among 239 Hispanic and Caucasian children. The investigators reported that snoring, excessive sleepiness, and learning problems were associated with abnormal PSG parameters (RDI $\geq$ 5 or RDI > 1 for events associated with 3% desaturation from baseline) and that these associations did not vary with ethnicity. A subsequent Level 2 study reported by Goodwin et al.[23] assessing 480 children from the same TUCASA study cohort reported that PSG-defined OSAS was associated with increased risk for parasomnias and that the association did not vary with ethnicity. Both studies were limited by the use of unattended portable PSG and potential self-selection bias within the population studied.

In a cohort of 198 consecutively referred children evaluated for suspected SRBD, Stepanski et al.[184] reported in a Level 2 study that sleep architecture and prevalence of PSG confirmed SRBD were identical among African American, Latino, and Caucasian children; however, African American children demonstrated more severe oxygen desaturation following obstructive events compared with children from other ethnic groups. ECG abnormalities were reported during PSG for 8 African American children, all of whom had SRBD, compared with no children from other ethnic groups.

In a Level 4 observational study with 577 children reported by Morton et al.,[182] subjects with SRBD who had previously undergone AT were followed long term. Black ethnicity was the most robust predictor of residual OSAS, exceeding the risks associated with obesity or positive family history. A Level 3 report by Redline et al.[180] assessing children from the same Cleveland Family Study cohort, found that the presence of moderate SRBD was correlated with both African American race and obesity. Both of these studies were limited by unattended ambulatory PSG studies and use of adult criteria for the diagnosis of OSAS.

A large Level 4 case series by Rosen[46] described the clinical and PSG characteristics of 326 otherwise healthy children referred for evaluation of suspected SRBD. African American children were 3 times as likely to be diagnosed as having OSAS compared with Hispanic and Caucasian children. The retrospective nature of the study and lack of a control group represent limitations of the study.

In summary, our search identified a limited number of papers that address correlation of PSG findings with race and ethnicity. Most but not all papers support an association between African American race/ethnicity, increased risk for SRBD, and higher risk for residual OSAS following AT.

4.2.2.4 Family history of SRBD

Our search regarding correlation of PSG findings with family history of SRBD identified 2 articles, 1 each with Level 3[180] and Level 4 evidence.[191]

A large case-control study by Redline et al.[180] (Level 3) compared children from families with a history of PSG-confirmed OSAS with children from neighborhood control families. A significantly higher prevalence of OSAS (AHI > 10) was identified for the children with a family history of OSAS compared to children in the control group. The study was limited by use of portable studies rather than full PSG and by a high threshold criterion for determination of the presence of OSAS. A case series by Ovchinsky et al.[191] reported a high prevalence for symptoms suggestive of OSAS among first-degree relatives of children with PSG-confirmed OSAS (RDI > 5 or SaO_2 nadir < 92% during a nap PSG). This study was limited by lack of a control group and by the fact that the self-selected nature of survey respondents could represent a bias.

In summary, our search correlating PSG findings with family history of SRBD identified 2 papers that suggest that children

with a family history of SRBD are at increased risk for SRBD. Data in this area are too limited to support an indication for PSG based solely on a positive family history, but it is possible that family history of SRBD represents a significant modifier for the expression of SRBD or severity of respiratory disturbance associated with SRBD in children.

4.2.2.5 Allergic rhinitis or recurrent sinusitis

Our search regarding the association between rhinitis or recurrent sinusitis yielded limited evidence. In a Level 3 study by Redline[180] using limited channel PSG and adult definitions for OSAS (RDI > 10/h), children with self-reported sinus problems or hay fever had a 5-fold increased likelihood of SRBD independent of lower respiratory problems such as asthma. A Level 4 study by Morton et al.,[182] a longitudinal genetic epidemiological cohort study that addressed allergies as a risk factor of sleep disordered breathing, showed an association between children with self- or parent-reported positive skin test for allergens (pollen, dust, and mold) and SRBD (AHI > 5) using limited, in-home cardiorespiratory monitoring only. A Level 4 study by McColley[192] also showed that children with habitual snoring and confirmed SRBD on PSG have increased prevalence of atopy using multi-allergen radio-allergosorbent testing compared to the general population.

These studies provide limited evidence that allergic rhinitis is independently associated with PSG-confirmed SRBD in children. However, the magnitude of association and the relationships between other comorbid conditions and SRBD have not been fully addressed.

4.2.2.6 Systemic hypertension

Systemic hypertension in children is known to be associated with SRBD with or without obesity. We identified 6 articles that address the potential clinical utility of PSG for evaluation of hypertension in children. Using prospective data from 2 Level 2 studies, several investigators[98,99] showed that SRBD is an independent predictor of hypertension, particularly when the AHI is > 5. Convergent validity of PSG-determined SRBD was demonstrated by the correlation between the AHI and blood pressure, independent of obesity (Level 3 evidence).[101] Using a longitudinal cohort, Redline[102] demonstrated that adolescents with SRBD have a higher prevalence of metabolic syndrome. They hypothesized that sleep disordered breathing may contribute to metabolic dysfunction beyond the effect of overweight alone and specifically, oxygen desaturation on PSG is associated with metabolic dysfunction (Level 2 evidence). Reade et al.[32] demonstrated that the hypopnea index had a significant correlation with the degree of hypertension in obese children, which could not be attributed solely to the degree of obesity. The findings support the hypothesis that PSG-confirmed OSAS may be a mechanism for hypertension in certain obese children (Level 3 evidence). Amin et al.[193] demonstrated that hypertension and ventricular remodeling are associated with increasing severity of SRBD in children and that there may be cardiovascular alterations at levels of respiratory disturbance that in the past have been thought to be mild (Level 3 evidence).

In summary, we identified a limited number of papers that demonstrate consistent findings to support the clinical utility of PSG for identification of SRBD in children with systemic hypertension, in association with and independent of obesity.

4.2.2.7 Unexplained pulmonary hypertension

Our search identified no articles that provide data regarding an association between unexplained pulmonary hypertension and SRBD or the clinical utility of PSG in children with unexplained pulmonary hypertension.

4.2.2.8 Other risk factors and special populations

4.2.2.8.1 Chromosomal and neurogenetic disorders

4.2.2.8.1.1 Down Syndrome

Children with Down syndrome are at significant risk for SRBD due to craniofacial anomalies such as midfacial hypoplasia and glossoptosis, as well as hypotonia, increased secretions, tracheal anomalies, obesity, and hypothyroidism. Our search for papers that address the clinical utility of PSG for evaluation of SRBD in Down syndrome identified 5 articles, all of which provided Level 4 evidence.[49,165,194-196] Together, the publications spanned the age range from infancy to adulthood. All studies were limited in that they were not population-based; some studies were uncontrolled or used older technology (such as thermistor assessment of airflow or nap PSG). Nevertheless, studies were uniform in showing a high prevalence of OSAS in Down syndrome, with OSAS occurring in at least half the patients evaluated in each study. Two studies used parental questionnaires in conjunction with PSG and demonstrated a poor correlation between parental impressions of sleep problems and PSG results,[49,165] indicating that the clinical history is a poor predictor of OSAS in this population, and that PSG is a more reliable diagnostic measure. These findings support the use of PSG as a diagnostic procedure in children with Down syndrome. We found no papers that specifically address optimal timing for performance of PSG in this population, but several papers reported significant SRBD by 4 years of age.

4.2.2.8.1.2 Prader-Willi Syndrome

Children with Prader-Willi syndrome have ventilatory abnormalities during sleep, including abnormal ventilatory responses, and they are at increased risk for SRBD due to hypotonia. Our search for studies that address the clinical utility of PSG in children with Prader-Willi syndrome identified 7 papers, 1 with Level 3 (Festen et al.)[197] and the others with Level 4 evidence.[43,149,198-201] Three studies[197-199] used limited PSG data as nested cohort studies within multicenter growth hormone trials of infants and children with Prader-Willi syndrome. Findings suggest that PSG is clinically useful in infants and children with Prader-Willi syndrome in order to characterize the severity of SRBD. Two retrospective clinical series[200,201] in children also support the clinical utility of PSG in these children, including a high prevalence of SRBD, even in the absence of sleep complaints. The prevalence of SRBD in this population could not be linked to any specific marker such as BMI, type of genetic abnormality, use of growth hormone supplementation, or age.[201] One study[199] evaluated the association between cognitive function and sleep in children with Prader-Willi and found that improved sleep was associated with improved performance, but the study did not support that SRBD resulted in worse behavior problems in this group; however, the sample size was small.

One study,[43] based on a case series with Level 4 evidence, provided information about children with Prader-Willi syndrome who underwent PSG pre- and post-AT for OSAS. Although the study was limited because of limited respiratory channels on PSG, findings provided support for the clinical utility of PSG in patients with AT, including improvement in respiratory parameters in the expected direction after surgery. Of the 5 selected patients, 4 had postoperative complications suggesting that children with Prader-Willi syndrome are at increased risk for postoperative complications. Some of the children were treated with growth hormone, which confounds the issue of SRBD in this population. There are limited data about postoperative complications following surgery in this group.

In summary, several studies support the clinical utility of PSG for identifying SRBD in infants and children with Prader-Willi syndrome. Since there are no clinical variables that are predictive of the severity of SRBD in Prader-Willi syndrome, and given the relatively high risk for SRBD, it is likely that routine evaluation of children with Prader-Willi syndrome with PSG is warranted. However, the optimal timing and frequency of PSG in these children has not been established. The potential clinical utility of PSG in children with Prader-Willi syndrome receiving growth hormone treatment is addressed in section 4.4.8.

4.2.2.8.1.3 Rett Syndrome

Our search identified 1 article[202] with Level 4 evidence that demonstrated that unless there is a clinical concern for SRBD, the diagnostic yield associated with PSG is low in Rett syndrome patients. Episodic hyperventilation followed by apnea is a common awake phenomenon in this population.

4.2.2.8.2 Disorders with craniofacial anomalies

A number of case reports and case series have documented the presence of OSAS in children with craniofacial anomalies. However, there have been very few systematic studies, and the few larger studies that have been performed were limited because they were not population-based. As with other studies involving SRBD in children, several papers were limited because the investigators did not use standardized PSG techniques or scoring techniques, or the investigators provided only limited details regarding techniques. A total of 13 papers were identified. One paper provided Level 2 evidence, 1 provided Level 3 evidence, and the remainder had Level 4 evidence.

4.2.2.8.2.1 Pierre Robin sequence

Six studies were identified in children with Pierre Robin sequence, of which 1 was Level 2[143] and the remaining articles were Level 4.[73,136,203-205] In a Level 2 study, Buchenau et al.[143] performed cardiorespiratory studies in infants with Pierre Robin sequence. The primary aim of this study was to evaluate the use of an intra-oral appliance, and thus only infants with an AHI $\geq$ 3 were included. However, the authors note that 16 of 21 (76%) of infants met this criterion. Data presented on the 11 subjects who participated in the trial showed a mean AHI of 13.8, suggesting that infants with Pierre Robin sequence have mild-to-moderate OSAS. The 5 Level 4 studies were all limited in that they included only symptomatic children, and therefore cannot be used to estimate prevalence. In addition, 3 of these studies comprised mainly children with Pierre Robin sequence, but also included children with other syndromes or with isolated cleft palates. Overall, these studies suggest that significant OSAS is often present in infants with Pierre Robin sequence, and PSG is clinically useful in evaluating breathing in this population. However, population-based studies are needed to determine the true prevalence of OSAS in Pierre Robin sequence.

4.2.2.8.2.2 Achondroplasia

A large, Level 3 study[133] of 88 children with achondroplasia showed a high prevalence (48%) of respiratory PSG abnormalities including primarily hypoxemia, but also OSAS and central sleep apnea. A Level 4 study by Sisk et al.[50] reported PSG in 28 of 95 subjects with achondroplasia and similarly showed a high prevalence of SRBD; however, this study was very limited because selection criteria for PSG. PSG techniques and detailed PSG results were not reported. In summary, these studies suggest a high prevalence of SRBD in children with achondroplasia. The presence and severity of SRBD may not be predicted by history, which suggests an important role for PSG in characterizing breathing abnormalities in children with achondroplasia.

4.2.2.8.2.3 Craniofacial Dysostosis (Apert, Crouzon, and Pfeiffer syndromes)

In a Level 4 study, Gonsalez et al.[206] performed PSG in 13 patients with syndromic craniofacial dysostosis who were found on routine MRI testing to have evidence of hindbrain herniation. OSAS was identified in 10 of the 11 children who did not have tracheostomies. A high clinical suspicion of SRBD based on parental history had a good PPV for the presence of SDB on PSG in this patient population (all 7 patients with a positive history had positive PSG). However, a low clinical suspicion of SRBD based on parental assessment of symptoms had a poor NPV for PSG-diagnosed SRBD. This study suggests that children with craniofacial dysostosis have a high prevalence of OSAS that may be missed on history. Another Level 4 study by Pijpers et al.[44] showed a high prevalence of OSAS on PSG in children with craniofacial dysostoses, but only 10 of the 72 children in the study underwent PSG.

4.2.2.8.2.4 Pharyngeal flap surgery for velopharyngeal incompetence

Pharyngeal flap surgery is performed to correct velopharyngeal incompetence, particularly in patients who have had cleft palate repair. OSAS is a known complication of this procedure. Three Level 4 studies included performance of PSG before and after surgery for velopharyngeal incompetence.[138,207,208] Sirois et al.[207] performed PSG in a convenience sample of 41 children before and after pharyngeal flap surgery. Only 1 subject had an abnormal PSG preoperatively. Morita et al.[138] studied 16 children, and found that the AHI (using adult scoring criteria) was < 5/h in all subjects preoperatively. Liao et al.[208] evaluated 10 patients. Using adult scoring criteria, all subjects had normal PSG findings preoperatively. Thus, these studies suggest that children with velopharyngeal incompetence tend to have normal PSG preoperatively, and that, therefore, routine PSG preoperatively is not useful. In contrast, obstructive apnea occurs relatively frequently following pharyngeal flap surgery. Section 4.4.3 provides discussion of PSG following surgery.

In summary, multiple studies suggest a high prevalence of SRBD in children with craniofacial anomalies, and that PSG has clinical utility in detection of respiratory abnormalities that are clinically unsuspected. However, population-based studies are needed to improve understanding of when PSG can be most helpful and how often repeat PSG may be clinically useful. Asymptomatic children with velopharyngeal incompetence are unlikely to benefit from routine preoperative PSG but may benefit from PSG following pharyngeal flap surgery to ensure that the surgery has not resulted in OSAS. This conclusion cannot be extrapolated to patients with velopharyngeal incompetence associated with craniofacial syndromes other than isolated repaired cleft palate.

4.2.2.8.3 Sickle cell disease

The task force evaluated the clinical utility of PSG in children with sickle cell disease (SCD) and suspected SRBD. The primary question considered was whether SRBDs occur with greater frequency or severity in children with SCD compared with unaffected children and whether PSG is useful for characterization. It is well documented that individuals with SCD often experience hypoxemia during wakefulness and sleep, and thus, low baseline values on oximetry or abnormal desaturation during sleep are not unexpected. Several studies confirm this finding.[209,210] The task force identified 6 studies that address the potential clinical utility of PSG for characterization of SRBD in children with SCD (often with coexisting hypoxemia). One paper provided Level 2 evidence,[210] and the others provided Level 4 evidence.[209,211-214]

In a prospective Level 2 study involving SCD patients (most of whom were referred for suspected SRBD), Samuels et al.[210] reported that 18 of 53 subjects (36%) had OSAS; 16% had episodic hypoxemia ($SaO_2 \leq 80\%$) and/or baseline $SaO_2 < 95.8\%$. Postoperative PSG was performed on 15 of the 18 patients with OSAS. All subjects demonstrated improvement in symptoms and a reduction or abolition of episodic hypoxemia.

In a Level 4 study, Needleman et al.[211] reported that only 5 of 20 SCD patients (ages 7-21 y) had any obstructive events associated with desaturations. The median RDI was 1.4, and 6% of the total sleep time was spent snoring. No correlation was found between the number of obstructive apneas and mean oxygen saturation during sleep ($r = 0.012$, $P = 0.95$). The investigators concluded that nocturnal oxygen desaturation (NOD) was common in SCD and upper airway obstruction did not appear to play an important role in the pathogenesis of NOD.

In a Level 4 study by Brooks et al.,[212] there were *no* significant differences in AHI or SpO_2 nadir between children with mild SCD disease (AHI 1.3 ± 0.8/h, nadir SpO_2 84.6% ± 4.0%) and severe disease (AHI 1.1 ± 1.4/h, nadir SpO_2 84.9% ± 6.8%).

In a Level 4 retrospective review by Spivey et al.[213] the investigators reported that NOD without SRBD was identified in 55% of the 20 subjects (mean nighttime SpO_2 88.9%), while SRBD was present in 7 (35%) [RDI 14.3, AI 3.4, average nighttime SpO_2 89.3%]. All subjects had previously demonstrated waking $SpO_2 \leq 94\%$ in the clinic. The authors concluded that: (1) patients with SCD who have a baseline daytime saturation of ≤ 94% are likely to have nocturnal desaturations but not necessarily OSAS; (2) neither daytime nor nighttime pulse oximetry values alone predict which subjects will have OSAS on PSG; and (3) SCD children whose baseline saturation during the day is ≤ 94% are likely to have PSG respiratory abnormalities. Based on these data, the authors concluded that in children with SCD and daytime $SpO_2 \leq 94\%$, concomitant OSAS will be present in approximately one-third. Limitations of this study include its retrospective design and referral bias.

Two studies documented the presence of SRBD in children with SCD. In a Level 4 study by Kaleyias et al.,[209] the investigators reported an AHI ≥ 1 in 12 (63%) of 19 SCD children referred for suspected OSAS. In a Level 4 study by Souza et al.,[214] overnight PSG was performed in 50 adolescents with clinically stable SCD. Subjects were divided into 2 groups based on mean SpO_2 during REM sleep ($SpO_2 \leq 93\%$ and $SpO_2 > 93\%$). Subjects in the lower oxygen saturation group had significantly higher RDI values, lower oxygen nadir values, and greater TST with oxygen saturation less than 90%. Because of various limitations in study design and sources of bias, these studies cannot be used to identify the precise incidence of SRBD among children with SCD.

Other issues regarding clinical utility of PSG in children with SCD

Children with SCD may be at increased risk for OSAS due to ATH. ATH is thought to occur commonly in SCD because of compensatory lymphoid hyperplasia of the adenoids and tonsils following splenic infarction and/or repeated infections.[215-218] One study reported that 55% of 85 children with SCD (mean age 9.3 ± 3.9 y) had ATH compared to 11% to 13% in pediatric populations with other underlying diseases.[219] AT should be approached with caution in children with SCD because of greater risk for complications, including vaso-occlusive events.[220,221] AT often, but not always, improves nocturnal SpO_2 values in children with SCD.[222]

Beginning in the 1980s, scattered case reports appeared linking OSAS due to ATH in children with SCD and more frequent vaso-occlusive painful crises.[218,223-226] A recent study suggests the relationship between OSAS and more frequent painful crises in SCD is weak.[212] One study suggests that NOD rather than obstructive SRBD is likely to be a predisposing factor for painful crises in SCD.[227] In a Level 4 study, Brooks et al.[212] reported no relationship between the number of painful crises and sleep apnea severity based on PSG findings. A recent study by Kirkham et al.[228] also suggests that NOD and not OSAS is more likely to predispose SCD patients to central nervous system events. The dips observed on overnight pulse oximetry that were suggestive of obstructive SRBD did not predict central nervous system events, and performance of AT did not prevent them.

In summary, the precise incidence of OSAS in children with SCD is not known, and there is inconsistency in the literature about whether SRBDs occur more commonly in this population. Although children with SCD often experience NOD, it is not clear that they are more likely to have OSAS than children without SCD. However, children with SCD and OSAS appear to have more severe NOD compared with SCD subjects without OSAS. The task force recognizes a number of limitations in the literature in this area, and it is likely that future investigations will provide greater clarity regarding the clinical utility of and indications for PSG in children with SCD. Prospective and well-designed studies are needed to investigate the inci-

dence of OSAS in children with SCD, including evaluation of various clinical subgroups and age groups, in order to identify relative risk. Pulse oximetry may not provide an accurate measurement of SpO_2 values in SCD, and oximetry alone is probably not useful as a screening method for OSAS in children with SCD.

4.2.2.8.4. Neurological disorders

The task force identified 24 papers that address the potential clinical utility of PSG for characterization of SRBD in children with neurological disorders. One paper provided Level 1 evidence,[21] 4 provided Level 3 evidence,[229-232] and 19 provided Level 4 evidence.[233-250]

In a Level 1 study, Masters et al.[21] investigated a variety of neurologically abnormal children to determine whether or not OSAS is more common or severe compared with neurologically normal children. The 16 neurologically abnormal children (median age 30 months) had a variety of conditions and clinical symptoms, and PSG findings were prospectively compared with 40 neurologically normal children who were referred for suspected OSAS. A pediatric pulmonary specialist rated the clinical severity of OSAS using a 37-item checklist, which generated a clinical score. The neurologically abnormal children had more severe respiratory PSG abnormalities (OAI 2.6 vs. 0.95, P = 0.0009) and lower SpO_2 nadir values. A significant correlation was noted between the clinical severity scores and PSG values (r = 0.057) for the neurologically abnormal children. Using the final clinical diagnosis as the reference standard, the authors reported that among the neurologically abnormal children, sensitivity of the PSG for identification of OSAS was 50% and specificity was 82%. However, these results are of limited usefulness because clinical scores were unreliable among the neurologically normal children, investigators were not blinded, and the sample of neurologically abnormal children was relatively small and diverse.

Neuromuscular disorders (NMD)

Many NMD are associated with SRBD, and respiratory abnormalities occur due to a variety of underlying factors including primary weakness of the diaphragm and other muscles of respiration, bulbar weakness, restrictive lung disease, impaired central respiratory control, recurrent infection, impaired cough, malnutrition, and obesity.[251] Sleep related hypoventilation can precede waking symptoms or progressive respiratory failure by months or years in patients with NMD. Nocturnal positive pressure ventilation (NPPV) via nasal or oronasal mask has been used in an effort to improve quality of life and longevity, and avoid or delay the need for tracheostomy or ventilator support.

Duchenne Muscular Dystrophy (DMD)

Six studies were identified that examined SRBD in patients with DMD. In a Level 4 study, Suresh et al.[233] reported a bimodal presentation of SRBD, with OSAS in the first decade of life, followed by sleep related hypoventilation in the second. Ten (31%) of 32 DMD patients referred for suspected SRBD had OSAS on overnight PSG (median age 8 y, mean OAHI 12, median nadir SpO_2 87%). Fifteen (47%) were normal (median age 10 y, median nadir SpO_2 94%), and 11 (32%) had sleep related hypoventilation (median age 13 y, mean AHI 13, median nadir SpO_2 90%).

In a Level 3 study by Khan et al.,[229] which involved 8-channel ambulatory PSG, investigators found a strong association between age, number of years wheelchair-bound, and severity of nocturnal oxygen desaturations (NOD) in 21 wheelchair-bound "asymptomatic" DMD patients compared to 12 age-matched normal male controls. Sixty-two percent of the DMD subjects had NOD < 90% (0% in controls). Apneas (60% obstructive, 40% central) were observed in 12 DMD patients, typically during REM sleep.

In a Level 4 study by Smith et al.,[234] which involved 14 patients with DMD (mean age 18.3 y; mean vital capacity 1.24 L), SRBD was present in all subjects despite their lack of sleep related symptoms and normal daytime blood gas tensions. The mean AHI was 9.6. Nine patients had NOD > 5%. Sleep related hypoventilation in DMD was predicted by a vital capacity < 2 liters, loss of ambulation, and scoliosis.

Additionally, Level 4 studies of SRBD in DMD found that: (1) the occurrence of central apneas and severe NOD occurred primarily or exclusively during REM sleep in wheelchair-bound adolescents (Smith et al., Barbe et al., and Manni et al.)[234-236]; (2) sleep related hypercapnia and hypoxemia during REM sleep were typically the first abnormalities in PSGs of patients with DMD; 3) AHI correlated with daytime PaO_2, and AHI in REM sleep with age[235]; 4) central apneas are associated with far greater decreases in SpO_2 values compared to controls and correlated with reduced VC[234,236];and 5) the development of baseline nocturnal hypoxemia during NREM sleep in DMD was associated with a high risk for death within 2 years, most often due to respiratory failure or cardiomyopathy (Kerr et al.).[237]

In 2004 the American Thoracic Society (ATS) produced an expert consensus statement on the respiratory care of the patient with DMD.[252] This resource provides recommendations that address the need for multidisciplinary care including a review of sleep quality and symptoms of sleep disordered breathing at every patient encounter. The ATS statement indicated that the timing of PSG to detect sleep hypoventilation or upper airway obstruction has not been determined in patients with DMD. Annual PSG with continuous pCO_2 monitoring was recommended when available beginning when the patient becomes wheelchair dependent or when clinically indicated. The statement also recommends at least annual monitoring of gas exchange when noninvasive ventilation is being employed in DMD patients.

Cerebral Palsy

Cerebral palsy (CP) is associated with increased risk for a variety of sleep problems and disorders,[253] and SRBD is a significant contributor to morbidity and mortality in CP.[254] Our search identified 2 studies[238,239] (with Level 4 evidence) that evaluated the clinical utility of PSG in children with CP. A Level 4 study by Kotagal et al.[238] reported PSG findings in 9 children with CP (mean age 37 months) evaluated because of noisy breathing and disturbed nocturnal sleep. All had spastic quadriparesis, severe developmental delay, and epilepsy treated with medications. Five of the 9 children with CP had OSAS (mean RDI 5.4 vs. 2.2 in controls, P < 0.01). OSAS was attributed to ATH in 4 and tracheal stenosis and micrognathia in 1. Respiratory events included both obstructive and central apneas, and hypopneas.

Additionally, paradoxical chest wall motion during REM sleep leading to NOD was observed in 4 (noted in 1 of the controls). Body position changes during sleep occurred far less frequently among the children with CP (0.3/h vs. 6.6/h in controls), and children with spastic quadriparesis failed to change body position when desaturations to 70% occurred. Epileptiform discharges on EEG were associated with apnea in 1 CP patient. Only 2 subjects had post-treatment PSG (one following tracheostomy, the other after AT), and both showed improvemen

A Level 4 study by Cohen et al.[239] reported pre- and postoperative PSG findings in 18 patients (ages 9 months to 17.5 y) with CP and OSAS who underwent AT. The authors performed a variety of alternative upper airway surgeries to control obstructive SRBD while avoiding tracheostomy. Changes from preoperative to postoperative PSG included AI 3.6 to 0.7, RDI 7.0 to 1.4, and SpO_2 nadir from 73.7% to 88.2%. Fifteen (83%) of the patients were tracheostomy-free after a mean follow-up time of 30 months; however, 2 children ultimately required tracheostomy. A variety of ENT procedures were employed to address problems in this population, and the authors emphasized that different strategies can be used to avoid tracheostomy and that close monitoring is required in the perioperative period.

Hsiao et al.[255] identified significant improvements in quality of life (QOL), especially sleep disturbance (P = 0.005), daytime functioning (P = 0.03) and caregiver concern (P = 0.03) in 51 children with CP treated for OSAS with AT or CPAP compared with no treatment.[255] Although PSG data were not reported, this study highlights the improvements experienced by children with CP following identification and effective treatment of OSAS.

Meningomyelocele, Spina Bifida, and/or Chiari Malformation

Chiari malformations (CM) are often associated with varying combinations of spina bifida (SB), meningomyelocele (MM), bilateral abductor vocal cord paralysis, and sudden unexplained death in sleep. Our search found 4 studies that examined SRBD in children with these disorders including 1 Level 3[230] and 3 Level 4[240-242] studies.

In a Level 3 study**,** Dauvilliers et al.[230] evaluated SRBD in 46 patients with CM (20 children, 26 adults; 40 with CM type 1, 6 with type 2). SRBD was present in 60% (obstructive 35%, central 25%) of the children with CM. The CAI was best predicted by age, presence of CM2, and vocal cord paralysis.

A Level 4 study by Waters et al.[240] reported SRBD (moderate-to-severe in 20%, mildly abnormal in 42%, and normal in 37%) in 83 Australian children with MM. The likelihood ratio was 11.6 times higher for finding moderate-to-severe SDB if the child with MM had abnormalities on PFTs, 9.2 times more likely among those with spinal cord lesions involving thoracic regions, 3.5 fold higher if the child had undergone a previous posterior fossa decompression, and 3-fold greater in those with CM2 (as opposed to milder CM1) malformations.

In a Level 4 study by Kirk et al.,[241] 73 children with MM and moderate-to-severe SDB were evaluated. 41% had OSAS (mean OAHI 17), 34% CA (CAHI 16.6), 16% central sleep related hypoventilation (peak $etCO_2$ 67 ± 11 mm Hg), and 8% sleep-exacerbated restrictive lung disease, which caused nocturnal hypoxemia with apnea or hypercapnia (nadir SpO_2 67% ± 14%). OSAS persisted in 71% of the 14 MM subjects who underwent AT, while CPAP was effective in 18 of 22 patients. The treatment approach for CA or central hypoventilation was stepwise, starting with supplemental oxygen (with or without methylxanthines) and adding NPPV when needed. None required tracheostomy or diaphragm pacing. Twelve patients underwent posterior fossa decompression, but impact on outcome was not assessed.

In another Level 4 study, Murray et al.[242] reported that SRBD was characterized by severe central apnea and bradypnea in 3 children (ages 3, 9, and 13 years) with CM1. Breathing normalized following urgent posterior fossa decompression.

Other Neuromuscular Disorders

Four studies evaluated suspected SRBD in patients with a variety of other neuromuscular disorders including myotonic dystrophy,[243] spinal muscular atrophies,[231] mucopolysaccharidoses (MPS),[244] and ataxia-telangiectasis.[232] In a Level 4 study, Quera Salva et al.[243] prospectively recorded PSG followed by MSLT in 21 patients (mean age 15 ± 3 y), first diagnosed with myotonic dystrophy at mean age of 12 ± 2.9 years. 76% experienced fatigue and 52% had excessive sleepiness. Sleep was fragmented (mean 17 ± 7 arousals/h), and respiratory abnormalities were present in 6 of 21 subjects.

In a Level 3 study, Mellies et al.[231] reported that sleep architecture and daytime symptoms were significantly worse in 10 of 15 patients with different types of spinal muscular atrophy (SMA) who had NOD on overnight PSG. Treating NOD in these symptomatic SMA patients resulted in increased NREM 3 sleep, a trend toward more REM sleep, a mean fall in the nocturnal heart rate, and sleep architecture "normalization" to resemble the reference group.

Children or adolescents with mucopolysaccharidoses (MPS) are at risk for OSAS. In a Level 4 study, Santamaria et al.[244] compared overnight PSG, nasal endoscopy, and upper airway CT scans in 5 children (median age 6.9 years) to 6 adults (median age 25) with various types of MPS. They found OSAS (mean AI 10.4 and AHI 14.7) in all 5 children with MPS, but in only one adult (mean AI 2.3 and AHI 7.4). Nasal endoscopy demonstrated adenoidal hypertrophy in all subjects.

McGrath-Morrow et al.[232] reported in a Level 3 study that 11 wheelchair-bound adolescents with ataxia-telangiectasis had sleep related hypercapnia. The median age of the subjects was 16 (13-20) years, and the median FVC was 44%. The most significant abnormality was mildly elevated $ETpCO_2$ (mean peak $ETpCO_2$ 53 torr) in 4; $ETpCO_2$ in 2 was ≥ 50 torr for > 50% of the TST.

Epilepsy

Our search found 1 Level 4 study on epilepsy and 4 Level 4 studies on vagal nerve stimulation (VNS) in patients with epilepsy. Based on parental history, SRBD is often present in children with epilepsy.[256,257]

In a Level 4 study, Kaleyias et al.[245] retrospectively analyzed 40 children with epilepsy. SRBD was identified in 42.5% (20% OSA [AHI > 1], 8% UARS, and 13% obstructive hypoventilation); snoring was present in 83% of the group. Children with epilepsy and OSAS compared to children with uncomplicated moderate OSA controls had significantly higher BMI (29 vs. 21.5, P = 0.01) and were more often obese (BMI > 95th percentile 62% vs. 18%, P = 0.048). Children with epilepsy had

significantly longer sleep latency (51 vs. 16 min, P = 0.05), higher arousal index (49 vs 21, P = 0.012), and significantly lower nadir SpO_2 (86% vs. 90%, P = 0.001) despite having a lower mean AHI (3.4) compared to those with uncomplicated moderate OSA (6.9, P = 0.001).

VNS is documented in Level 4 studies to be associated with OSAS and other SRBDs in children with epilepsy. Nagarajan et al.[246] reported respiratory effort and tidal volume decreased in 7 of 8 children when the VNS activated, causing an increase in the respiratory rate in 6 and a decrease in 1. None of these changes had an obvious clinical impact on sleep. Hsieh et al.[247] reported that 8 of 9 children had OSAS following VNS placement. One child had severe OSA and apneas occurred regularly and consistently with VNS activation; when retested with the stimulator off, the sleep apnea was completely resolved. CPAP therapy suppressed the effects of VNS when the VNS device was activated again. Khurana et al.[248] reported that OSAS was present in 4 and subsequently developed in another 4 of 26 children in whom a VNS stimulator was implanted. OSAS symptoms improved among these children after AT or CPAP treatment.

Zaaimi et al.[249] noted the amplitude of respiratory effort decreased when the VNS activated among all 10 children studied with PSG. The effect was most pronounced within the first 15 seconds (maximal decrease of 47% ± 17%). They found that: (1) the respiratory effort amplitude reduction was present in 7 children only during the first 15 sec of VNS activation, and throughout the 30-sec activation in 3; (2) a rebound increase in amplitude was seen in 4 following cessation of the VNS stimulation; (3) the respiratory frequency increased during VNS activation in all 10 children; (4) the SpO_2 fell > 1% in 50% of the observed periods of stimulation in 3 children, beginning about 10 sec after VNS; (5) the effects of VNS activation upon amplitude of respiratory effort signal was more pronounced during NREM sleep compared with REM sleep; and (6) reducing the VNS stimulation current suppressed the effect of VNS on respiration.

Neurological disorders, OSAS, therapeutic effect of AT, and risk for postoperative complications

Two studies with Level 4 evidence evaluated whether children with neurological comorbidities were likely to have more postoperative complications, more severe preoperative PSG, or worse response to AT or other upper airway surgery for OSAS.[54,250] Biavati et al.[250] evaluated the risk factors predictive of postoperative complications in 355 children undergoing AT for OSAS. They found the odds ratio (OR) for postoperative respiratory complications was 6.8 times higher in children with CP (95% CI 0.97-47.2) and 5.2 times higher in children with epilepsy (95% CI 1.2-22.6). Preoperative PSG was performed in only 23 (6%) of the children, but when abnormal, PSG had a 63% predictive value for a complicated postoperative course while a normal preoperative PSG (other than snoring) predicted an uncomplicated postoperative course. Wiet et al.[54] evaluated effectiveness of various upper airway surgeries for OSAS in 48 children (mean age 7.5 y). Most subjects were obese (58%), and 7 (15%) had neurological conditions (Down syndrome in 5 and cerebral palsy in 2). Preoperative mean AHI was higher (33.7 vs 27 ± 11) and postoperative AHI lower (4 ± 1 vs 9 ± 2) among the 20 morbidly obese children compared to the five with Trisomy 21.

4.2.3 Clinical utility of PSG prior to adenotonsillectomy

A common clinical indication for PSG in children is to determine whether OSAS is present, and hence, whether the patient would benefit from AT. AT is considered a first-line treatment for children with OSAS.[12,16] The issue of whether PSG has clinical utility prior to AT is relevant for a number of reasons:

1. AT is a surgical intervention associated with risk of hemorrhage, infection, upper airway compromise, and pain, and thus parents and otolaryngologists prefer to proceed with AT only when necessary and to not perform AT when the degree of respiratory disturbance during sleep is minimal or absent.
2. The economic cost of AT is significant, and there may be cost advantages associated with a trial of medical management rather than proceeding directly to surgery in certain patients.
3. Routine clinical assessment may be unreliable regarding whether significant OSAS is present. Examples include an unreliable history from the parents or caregivers or discrepancies between different caregivers' history.
4. Patients with some chronic medical conditions may have higher than usual risk for complications. Examples of these conditions include coagulopathy, sickle cell disease, HIV infection, history of respiratory compromise or anesthesia complications, and congenital heart disease.
5. Patients with severe OSAS may have a significantly higher risk of perioperative problems including respiratory compromise, and identification of these patients prior to surgery may improve outcome.
6. Children with central sleep apnea (suspected or unsuspected) in addition to obstructive sleep apnea, may be at higher risk for perioperative complications.
7. Children with a high likelihood of residual upper airway obstruction after AT, in whom there may be consideration of treatment with CPAP, may benefit from documentation of pre- and postoperative respiratory findings on PSG.
8. High levels of parental anxiety or indecision about whether to proceed with surgical intervention may delay or prevent optimal decision-making. Additional physiological data from PSG may be helpful to parents as they consider the potential risks and benefits of AT.

Assessment of the clinical utility of PSG prior to AT is challenging because PSG is considered by many sleep specialists to be the gold standard for the diagnosis of OSAS,[12] and it is difficult to know what standard to use to determine the utility of PSG as a diagnostic tool for OSAS preoperatively. Many ENT specialists do not routinely request comprehensive nocturnal PSG in children with suspected OSA prior to AT,[258,259] while some request PSG selectively and others request PSG routinely before AT.[221]

The task force's search identified 30 papers that address one or more aspects of clinical utility of PSG prior to AT. The majority of the studies identified and reviewed provided Level 3 or 4 evidence, and there were no Level 1 and only 2 Level 2 papers. The majority of studies were not designed primarily to assess the clinical utility of PSG prior to AT but to provide data to address clinical utility indirectly. In addition, some investigators used adult scoring or diagnostic criteria, such as requiring that obstructive apneas last ≥ 10 seconds, or considered stud-

ies abnormal only if the AHI was > 5. This made comparison between studies difficult. Most studies reported the AHI as the primary outcome parameter, with limited details on other aspects of PSG such as arterial oxygen saturation, pCO_2 levels, or sleep architecture. Some studies, particularly those in the surgical literature, did not provide details on PSG methods. The task force's literature search and review did not differentiate between studies involving traditional surgical tonsillectomy and studies using alternate techniques such as tonsillotomy or subcapsular tonsillectomy. Several papers presented in this section are also presented and discussed in other sections of this review. With the above acknowledgements, the task force developed a series of questions in order to organize the review with regard to the clinical utility of PSG in children prior to AT.

1. Does the preoperative PSG correlate with symptoms of OSAS or physical findings?

This issue is addressed more thoroughly in section 4.2.1.1 (Correlation of PSG findings with independent measures), including the clinical history of snoring and other nocturnal symptoms, audio or video recordings, questionnaires, and physical examination findings. The task force identified 1 Level 2,[17] 3 Level 3,[30,35,66] and 2 Level 4[38,53] papers that address this question. In a Level 2 study, Goldstein et al.[17] used a clinical score (based on symptoms, physical examination, lateral neck x-ray, echocardiogram, and audiotape) to assess the effects of AT in children with either positive or negative PSG. The symptom score improved postoperatively in children with abnormal PSG, but also in children with negative PSG; there was only a slight improvement in score in those children with a negative PSG who did not undergo AT. The authors concluded that clinical evaluation may be more useful than PSG in diagnosing SRBD. However, this study was significantly limited by: (1) the use of an abbreviated cardiorespiratory montage, (2) measurement of airflow with a loose-fitting nasal mask or a thermistor, (3) the decision to use AHI ≥ 5 as the abnormal cut-off value, and (4) a 23% attrition rate, which may have biased the results.

In a Level 3 study by Shatz et al. involving infants with symptoms of OSAS and adenoidal hypertrophy, the degree of adenoidal obstruction of the nasopharynx on x-ray did not correlate with the severity of OSAS as determined by the AHI on PSG.[66] Postoperatively, there was significant improvement in respiratory PSG parameters as well as with clinical symptoms and growth velocity. Thus, PSG showed face validity in this cohort of infants with adenoidal hypertrophy and clinically suspected SRBD, and findings suggested that PSG could be more useful prior to surgery than some other clinical parameters, such as adenoidal size.

In another Level 3 study, Nieminen et al.[30] evaluated 58 children with suspected OSAS. Subjects found to have OSAS on PSG had a significant postoperative improvement in PSG respiratory parameters and clinical symptoms. Preoperative symptoms alone did not predict the presence of OSAS on PSG, and the authors speculated that PSG should therefore be performed preoperatively in order to confirm the diagnosis before surgery.

In a paper by Weatherly et al.[53] with Level 4 evidence, the investigators evaluated 34 children diagnosed clinically by an otolaryngologist with SRBD. The clinical criteria for diagnosis were not specified. The authors reported a poor correlation between clinical assessment and PSG findings when using an OAI > 1 or AHI > 5 as criteria for OSAS. There was a better correlation when the investigators included respiratory effort related arousals (RERAs), measured with esophageal catheters, in the definition of OSAS.

In a study with Level 3 evidence, Wang et al.[35] evaluated 82 children with symptoms of OSAS. The overall predictive accuracy of clinical suspicion of OSAS was only 30% (using adult PSG criteria), indicating that clinical history was a poor predictor of polygraphically confirmed OSAS.

A Level 4 study by Guilleminault et al.[38] evaluated a clinical cohort of 25 children who presented with symptoms of OSAS but had no apnea on PSG. Based on tachypnea, esophageal pressure swings and arrhythmias, subjects were classified as having the upper airway resistance syndrome (UARS). Postoperative improvements were reported in 5 subjects, including improvement in respiratory PSG findings, growth, MSLT findings, and cognitive assessments. This study suggests that conventional PSG may fail to identify the diagnosis of SRBD in children. Several limitations are present, including small sample size, lack of formal statistical analyses or P values for most of the reported outcomes, and use of outdated PSG methods in this older study. Esophageal manometry is rarely performed clinically, and may be difficult for children to tolerate.[260] Current PSG methods, including nasal pressure measurements and pCO_2 measurements, may make esophageal manometry unnecessary.

In summary, several studies show that symptoms, physical examination and certain laboratory tests are poor predictors of respiratory PSG findings in children for whom AT is being considered. This observation supports the clinical utility of PSG prior to AT in order to confirm the diagnosis of OSAS and to provide objective characterization of severity of respiratory disturbance during sleep.

2. Do PSG respiratory parameters improve postoperatively?

A change in frequency or severity of obstructive respiratory events in the expected direction following surgical intervention would provide test-retest validity for PSG for characterization of SRBD. This topic is explored in detail in section 4.2.1.1.10. Several studies, including 3 level 2 studies,[63,115,181] have shown an improvement in PSG parameters after AT in patients with clinically suspected OSAS, indicating that PSG is a valid diagnostic test for OSAS.[30,54,71,123,124,126,129-131] In addition, several Level 3 and 2 Level 2 studies showed that changes in the PSG postoperatively were associated with changes in neurocognitive or behavioral factors,[63,80] quality of life,[115,123] and growth.[66]

3. Does PSG have clinical utility prior to AT for assessment of perioperative risk?

Our search regarding the clinical utility of PSG for assessment of perioperative risk related to AT in children with SRBD identified 11 papers. A recent paper by Sanders[261] with Level 2 evidence demonstrated that children with OSAS based on preoperative PSG experienced more frequent postoperative respiratory complications than non-OSAS children (5.7 complications vs. 2.9, P < 0.001). Supraglottic obstruction, breath holding, and oxygen desaturation on anesthetic induction and emergence were the most common complications. Children

with SRBD were more likely to have a Cormack-Lehane score ≥ 2, suggesting difficulty with visualization of the airway at the time of intubation (P = 0.05). Increased severity of OSAS, low weight, and young age were correlated with an increased rate of complications. Medical intervention was necessary in more children with OSAS during recovery and emergence than in the non-OSAS group (17 of 61 OSAS vs. 1 of 21 controls, P < 0.05). The RDI score at which the increased rate of complications became statistically significant was different for different complications. With an RDI ≥ 30, an OSAS patient was more likely to have laryngospasm or desaturation < 85% on emergence (P < 0.05). With an RDI ≥ 20, an OSAS patient was more likely to have breath holding on induction (P = 0.001). With an RDI ≥ 5, an OSAS patient was more likely to require additional morphine in the recovery room (P = 0.005).

A relatively large study by Wilson et al.[262] showed that a preoperative obstructive AHI ≥ 5/h was associated with increased risk (odds ratio 7.2) for postoperative respiratory complications. The investigators also found that a preoperative SpO_2 nadir ≤ 80% was associated with increased risk (odds ratio 6.4) for postoperative respiratory complications (Level 3 evidence). McColley et al.[263] showed similar findings; 23% of children undergoing AT for OSA had severe postoperative respiratory complications. Multiple logistic regression analyses revealed the most significant risk factors for respiratory compromise after surgery were age below 3 years and an obstructive AHI > 10 (Level 4 evidence).

Rosen et al.[264] identified an increased risk of immediate postoperative respiratory compromise in children with "high-risk" PSG findings (defined as an RDI > 40 and SpO_2 nadir < 70%) (Level 4 evidence). A large study with level 4 evidence by Ye[265] with 321 otherwise healthy children demonstrated the most important predictors of postsurgical respiratory morbidity were young age, obesity, and initial severity of OSAS. Of the 321 children diagnosed by OSAS by preoperative PSG, 11.2% had postoperative respiratory complications necessitating medical intervention. The highest complication rate among all the studies was reported to be 60% (Level 4 evidence).[266] Overall, children with more severe OSAS documented on a preoperative PSG, as well as younger children and those with comorbid medical conditions, appear to experience increased risk of perioperative complications.

Two papers with Level 4 evidence showed that PSG studies with normal respiratory findings are highly predictive of an uncomplicated postoperative course.[131,250] Helfaer et al.[131] suggested that otherwise healthy children with mild OSAS (mean OI 5) did well on the night of surgery and did not need intensive postoperative monitoring. Two small retrospective studies[42,267] with Level 4 evidence suggested that because the overall complication rate from AT is low, knowing the severity of respiratory disturbance during sleep is not necessary, including in children < 3 years. This conclusion is not shared by the other groups of investigators, as discussed above.

In a specific population of children with scoliosis who could not perform pulmonary function testing to assess ventilation, PSG could not predict the need for prolonged postoperative mechanical ventilation (Level 4 evidence).[268]

In summary, the literature provides significant documentation to support the clinical utility of preoperative PSG to predict the likelihood of perioperative respiratory compromise in children with OSAS. Findings also suggest that a preoperative PSG with evidence of mild or minimal respiratory disturbance during sleep is associated with very low risk for perioperative complications.

4. Is PSG useful in determining which children will have residual OSAS postoperatively, and hence require additional treatment such as CPAP?

Eight studies of children with ATH and/or obesity were identified. Wiet et al.[54] (Level 4 evidence) performed PSG before and after upper airway surgery in a heterogeneous group of children, 73% of whom had medical conditions such as obesity, Down syndrome, or cerebral palsy. They found that the AHI (using adult scoring criteria) decreased significantly postoperatively. Nevertheless, the postoperative AHI remained elevated postoperatively in both the otherwise healthy children (n = 13, AHI decreased from 23 ± 6 to 6 ± 2) and in those with underlying medical conditions. Thus, PSG was useful in determining which children need further treatment postoperatively.

A Level 4 study repeated PSG following AT in 69 children.[129] Of note, only 27% of the cohort participated in the follow-up PSG; thus, it is possible that a selective group underwent re-evaluation. A further caveat is that the time between AT and postoperative PSG was long (1.7 ± 1.4 y); thus, some of the postoperative findings may have been due to intercurrent changes, such as weight gain or adenoidal regrowth. This study showed that the majority of children had an improvement in the RDI following AT. Obese children were less likely to have postoperative resolution of their OSAS than non-obese subjects. However, a significant minority of subjects in both weight groups had persistent OSAS postoperatively. Subjects with the highest RDI were not more likely to have persistent OSAS postoperatively compared to subjects with the lowest RDI; however, continuous analyses were not performed. Although this study may suggest that preoperative PSG is not helpful in determining which patients are at risk for persistent OSAS postoperatively, the conclusions should be viewed in light of the limitations of the study.

In a Level 3 study Tauman et al.[124] studied 110 children before and after AT. Although there was a significant decrease in the AHI postoperatively, the study showed a high rate of postoperative OSAS. A high preoperative AHI, in addition to degree of obesity, was a predictor of elevated AHI postoperatively. This study was limited by lack of description of the study sample and design, and the long and variable time between PSGs (1-15 months), during which subjects may have gained weight or developed new risk factors for OSAS. Also, this study involved a predominantly obese population, and may not be applicable to a non-obese population.

In a Level 2 study of 79 children, the mean group AHI decreased postoperatively from 27.5 to 3.9/h.[115] The higher the preoperative AHI, the more likely the patient was to have a persistently abnormal PSG after AT.

Apostolidou et al.[181] (Level 2 evidence) evaluated 48 non-obese and 22 obese children before and after AT. They found that approximately three quarters of subjects continued to have an AHI ≥ 1 postoperatively. However, only 8%-10% of obese and non-obese children with a preoperative AHI ≥ 5 had a postoperative AHI ≥ 5, i.e., the majority of patients had a large

clinical improvement postoperatively. Limitations to this study included the fact that the time between pre- and postoperative PSG was as long as 14 months; thus, some children may have experienced adenoidal regrowth in the interim. In addition, thermistors were used as the only measure of airflow.

Jain and Sahni[71] (Level 4 evidence) reported improvement in PSG respiratory parameters following AT. Discrepancies between this study and others in the literature may be due to the use of adult rather than pediatric scoring in the Jain study. In a Level 4 study by de la Chaux et al.[130] all 20 children undergoing adenoidectomy or tonsillectomy improved to an AHI < 5. Montgomery-Downs et al.[80] (Level 3 evidence) found that, as a group, OSAS resolved postoperatively in the preschoolers studied.

Three Level 3 or 4 studies showed persistence of OSAS postoperatively in children with achondroplasia[133] or in mixed groups of children with complex medical conditions.[54,126]

In summary, the preponderance of studies, including a few Level 2 studies using pediatric scoring criteria, showed that OSAS improved dramatically postoperatively, but that a substantial minority of children experience residual OSAS. The AHI tended to predict those children with persistent OSAS after AT. This would support the utility of both preoperative PSG to determine high risk patients, and/or postoperative PSG to determine the need for further treatment. However, the task force did not identify any prospective studies that specifically address whether clinical outcome following AT is improved in association with routine performance of PSG prior to AT in otherwise healthy children. There are data that support improvement in outcome through use of preoperative PSG to help the clinician identify children at higher than usual risk for perioperative complications.

4.2.4 Clinical utility of PSG for assessment of infants less than 12 months of age with suspected SRBD or related conditions

In this section the task force focused on SRBDs and related conditions that typically present during infancy. The literature search was developed to identify papers that address the clinical utility of PSG for assessment of primary sleep apnea of infancy, congenital central hypoventilation syndrome, suspected SRBD and gastroesophageal reflux (GER) disease, apparent life threatening events (ALTEs), laryngotracheomalacia, and assessment of risk of sudden infant death syndrome (SIDS). There is topical overlap between some papers discussed in this section and those covered in other sections.

A Level 2 study by Simakajornboon et al.[269] employed a prospective, blinded, controlled crossover design and demonstrated with full PSG that otherwise healthy premature infants at or near term and almost ready for hospital discharge experience frequent, unsuspected adverse cardiorespiratory events, including apnea and bradycardia. Findings also support that administration of low-flow supplemental oxygen improves respiratory stability in several ways, and PSG was helpful in confirming this improvement. PSG confirmed that supplemental oxygen was associated with changes in sleep architecture by increasing quiet sleep density and decreasing active sleep density.

Three articles with Level 4 evidence provided support for the clinical utility of daytime nap PSG[270,271] or nocturnal PSG[162] in infants born either preterm or at term, for differentiation between normal and abnormal breathing, and cardiorespiratory differences of heart rate and blood pressure, and sleep position.

Our search regarding clinical utility of PSG for assessment of infants less than 12 months of age with suspected SRBD identified 1 article[33] with Level 3 evidence. The investigators evaluated 17 infants younger than 10 months of age with suspected airway anomalies who presented with stridor or stertor. The infants were diagnosed with a variety of conditions including seizures, gastroesophageal reflux, and upper airway obstruction. The investigators indicated that use of a limited number of channels rather than full PSG led to the incorrect diagnoses in some cases. The presence of observed apneas and stertor was correlated with SRBD on PSG. The investigators concluded that full PSG provides the physiological data for proper diagnosis and that limited cardiorespiratory studies can be misleading in this population.

Another paper[272] with Level 2 evidence evaluated 14 infants with cyanotic breath holding spells, and all subjects were found to have PSG abnormalities consistent with SRBD. Esophageal pressure monitoring was used. The caregivers of the 19 infants reported a variety of sleep complaints and several physical examination findings were documented. However, no specific findings were predictive of an abnormal PSG. Four infants had an AHI < 1, and the SRBD would not have been detected without esophageal pressure monitoring. This is a small exploratory study but findings suggest that infants who present with cyanotic breath holding spells may benefit from PSG to evaluate for SRBD.

4.2.4.1 Suspected primary sleep apnea of infancy

We found no articles in the peer-reviewed literature that address specifically the clinical utility of PSG for establishing a diagnosis of primary sleep apnea of infancy. The term "primary sleep apnea of infancy" is used in the ICSD-2 as a replacement for variety of previously used terms.[11] There is recognition that "apnea of prematurity" and "apnea of infancy" represent different forms of the disorder, and there is discussion in the ICSD that apnea in the premature newborn often occurs due to developmental instability of respiratory control, or as a sign of a variety of medical or neurological causes in premature or term infants. It is likely that most infants with this entity are diagnosed based on the clinical history and observations in the nursery setting rather than based on PSG. Clinically, these infants experience recurrent apneas with or without bradycardia, and respiratory events often include central as well as obstructive or mixed events. A variety of potential etiologies or comorbid conditions exist including prematurity, gastroesophageal reflux (GER) or other medical disorders, and neurological disorders. Although PSG may be employed selectively depending upon clinician practice patterns and PSG availability, specific PSG diagnostic criteria are not provided in the ICSD and there is a paucity of evidence upon which to base recommendations.[11]

Our search identified 1 paper[273] with Level 4 evidence that evaluated 17 infants between 3-37 weeks of age for apnea of infancy or apparent life threatening events associated with suspected regurgitation. PSG with esophageal pH monitoring was performed in all cases. Several etiologies were identified including GER and seizures. There were no consistent relationships noted between seizures, GER episodes and apnea of

infancy. The diagnostic yield of PSG with or without esophageal pH probe for suspected primary sleep apnea of infancy has not been determined, although it is likely that PSG may provide useful physiological data in certain circumstances.

A paper with Level 4 evidence by Paul et al.[190] evaluated 29 pre-term infants born at 25-35 weeks gestation (mean gestational age 28 weeks) who were 33 ± 2.4 weeks gestation at the time of PSG. PSGs were compared 1 day before anti-reflux therapy and 2 days after beginning therapy. Investigators reported that the frequency of apneas decreased with treatment and etiology of the apneas was presumed to be related to GER. However, this study is limited by the absence of pH probe monitoring. Findings suggest that PSG may be helpful in evaluation of recurrent apneas in premature infants but the precise diagnostic yield for determination of etiology of apnea is not known.

4.2.4.2 Suspected congenital central hypoventilation syndrome

Congenital central hypoventilation syndrome (CCHS) is a genetic disorder due to a heterozygous mutation in the paired-like homeobox 2b (PHOX2b) gene on chromosome 4p12.[274-279] Virtually all CCHS patients (> 97%) have PHOX2b gene mutations.[276,280] Our search identified 2 papers that address the potential clinical utility of PSG for evaluation of suspected CCHS (1 with Level 2[281] and 1 with Level 4[282] evidence).

In a Level 4 paper by Weese-Mayer et al.,[282] the investigators recorded PSG with end-tidal and transcutaneous pCO_2 in 32 infants with CCHS. The investigators performed ventilatory challenges by withdrawing supplemental oxygen or mechanical ventilation. Infants with CCHS manifested hypoventilation during quiet (NREM) sleep and they did not increase their respiratory rate in the face of hypercapnia or hypoxemia. Hypoventilation was also present during active (REM) sleep, but less severe than that observed during NREM sleep. Thirty-eight percent of infants also had hypoventilation when awake.[282]

One paper regarding late-onset forms of CCHS was identified that report sufficient PSG data to meet inclusion criteria.[281] Huang et al.[281] (Level 2 evidence) prospectively studied breathing during wake, NREM, and REM sleep in 9 PHOX2b-gene confirmed patients with late onset CCHS (age 13 ± 7 y) and compared them to baseline PSG data from age- and gender-matched controls. The investigators allowed the subjects to fall asleep on their usual home ventilator settings. Subjects were briefly disconnected from the ventilator and the ventilatory challenge was terminated when the $ETpCO_2$ rose > 55 torr for > 5 min or > 60 torr for any duration, or the patient aroused. Arousal in the face of hypercapnia and hypoxia occurred in 46% of REM vs. 38% of NREM trials (not significant). Central apneas were observed in 42% of the trials. In all cases, the central apnea occurred at the beginning of a ventilator disconnect. The duration of central apnea was 25 ± 19 sec (range 38 to 54 sec). The minute ventilation fell precipitously during NREM and REM sleep.

In a clinical series by Trochet et al.[283] a review of 25 patients with late onset CCHS and 15 parents who had a child with CCHS and proved to be a carrier of the PHOX2b gene mutation were reported. Twenty-one of the patients required assisted ventilation, but only when sleeping. Among the 15 parents of infants with PHOX2b-gene confirmed CCHS, most were asymptomatic and one developed sleep apnea at age 40 years treated with CPAP. The authors recommended that asymptomatic carriers of the PHOX2b gene mutation should be periodically evaluated and counseled on the increased risk of sleep related hypoventilation developing with general anesthesia, sedation, or respiratory infections.

In summary, there are limited data that address the clinical utility of PSG for the diagnosis of CCHS. Further investigations may clarify the clinical utility and timing of PSG in suspected CCHS, the role of PSG in assessment of "asymptomatic" carriers of the PHOX2b mutation, and when periodic reevaluation may be necessary.

4.2.4.3 Suspected SRBD and gastroesophageal reflux

The potential relationship between gastroesophageal reflux and SRBD in infants is not fully understood. Our search regarding the clinical utility of PSG, including the simultaneous recording of lower esophageal pH monitoring, in infants with suspected gastroesophageal reflux and SRBD identified 7 papers, 1 with Level 2,[284] 2 with Level 3[145,285] and 4 with Level 4[47,273,286,287] evidence.

A Level 2 study by Sacre and Vandenplas[284] evaluated whether GER may be a factor in the pathogenesis of apnea in certain infants, including a group of subjects with an ALTE, a control group, infants with GER, and a group with respiratory dysfunction. GER was evaluated using 24-h esophageal pH monitoring; full PSG was performed, and a double blind study design was used. In those subjects with respiratory dysfunction, GER was detected in 75%; conversely, in subjects with GER, respiratory dysfunction was present in 45%. In subjects with respiratory dysfunction, if GER was treated effectively then respiratory dysfunction resolved in 92%. If GER was resistant to treatment, then respiratory dysfunction persisted in 81%. Findings support that PSG combined with esophageal pH monitoring is clinically useful in characterizing respiratory abnormalities and GER, including assessment of response to intervention. However, findings did not show any causal relationship between prolonged apnea and GER.

A Level 4 study by Harris et al.[287] included 102 infants referred for suspected apnea, GER, or seizures. Infants with a history of apnea frequently had GER episodes, but these episodes did not correlate with respiratory events. Two studies[47,273] included fewer subjects but demonstrated similar findings. A study by Arad-Cohen[285] (Level 3) that included infants referred with apnea or an ALTE also demonstrated that episodes of apnea were seldom associated with GER; however, in those instances when apnea and reflux were associated, the predominant sequence of events was obstructive apnea followed by reflux. Position does not seem to influence the presence of reflux-related respiratory events.[286]

A Level 3 study by Groswasser et al.[145] evaluated the effect of an esophageal pH probe on the frequency of apneas in 35 full term infants suspected to have OSAS. Two consecutive PSGs were performed in random order (with and without the pH probe). In the infants who were found to have repeated apneas, the presence of the probe was associated with significant decreases in both obstructive and central apneas in 21 of 25 subjects. The investigators suggested that the probe could oppose

mucosal adhesion forces, separate the tongue from the posterior pharyngeal wall, decrease the collapsibility of the pharynx, or increase swallowing frequency resulting in a higher tone of the pharynx dilating muscles. Thus, evaluation of suspected SRBD and GER using PSG with an esophageal pH probe may alter respiratory dynamics.

The diagnostic yield and clinical utility of lower esophageal pH monitoring during overnight PSG in infants is not resolved because of limitations in the literature. These limitations include a paucity of studies, the lack of studies with a broad spectrum of subjects and sufficient number of subjects, probable referral bias, and technical issues related to measurement of acidic and non-acidic reflux during PSG.

4.2.4.4 Apparent life-threatening events

Evaluation of the infant who experiences an apparent life threatening event (ALTE) is challenging for the clinician. The task force searched for papers that assess the potential clinical utility of PSG in infants with a history of ALTE. Thirteen papers were identified including 1 with Level 1 evidence,[288] 5 with Level 2,[159,284,289-291] 4 with Level 3,[285,292-294] and 3 with Level 4 evidence.[47,162,273]

A Level 1 study by Hoppenbrouwers[288] and the CHIME study group evaluated sleep in 201 pre-term infants and 198 term infants between 33 and 58 weeks post-menstrual age. Extreme premature infants were not included as they could not be adequately matched. Cross-sectional hospital-based nocturnal PSG data were available for the preterm infants and the term infants and consisted of 51 infants with ALTE, 59 siblings of babies who died of SIDS, and 88 healthy term infants. There were no differences found in sleep parameters (quiet sleep, active sleep, and indeterminate sleep) between the ALTE and healthy control group, but the siblings of SIDS victims had less quiet sleep, suggesting a delay in maturation of the sleep architecture; however, respiratory parameters were not reported. Preterm infants did not have a delay in sleep architecture unless the gestational age was early or there was associated comorbidity.

A Level 2 study by Harrington et al.[289] evaluated cardiorespiratory control in 10 infants with ALTE compared to 12 controls using overnight PSG and using head-up tilt testing to evaluate heart rate and blood pressure variability. They reported that 5 of 10 infants with ALTE had > 2 obstructive apneas/h and showed a reduced heart rate response; 3 of 5 showed marked hypotension, rather than increased BP. These infants had altered heart rate and BP variability as well as altered arousal response in REM. These findings suggest that a subset of ALTE infants have abnormal cardiovascular autonomic control and decreased arousability in REM, which may be a possible explanation for the etiology of the ALTE. Clinical history could not distinguish the infants with ALTE versus controls, but the PSG parameters and the autonomic testing were able to differentiate infants with ALTE versus ALTE with OSAS. Another Level 2 study by Horemuzova et al.[290] compared PSG results in 40 infants with ALTE with 40 age-matched controls. Infants with ALTE had higher phase angle changes (indicating greater thoracoabdominal asynchrony and inspiratory effort) as well as more hypoxemic episodes (oxygen saturation < 90% for ≥ 5 sec) compared to normal infants. The sleep architecture was comparable between groups. One Level 2 study by Rebuffat et al.[159] evaluated PSG on 2 consecutive nights in 8 infants with ALTE compared to 11 healthy controls. Investigators reported no differences in respiratory events across the 2 nights, suggesting that one night of monitoring would be sufficient to identify PSG related differences in the ALTE group; however, because of the very small sample size, no conclusions are possible regarding differences in respiratory findings between the 2 groups.

A Level 2 study by Sacre and Vandenplas[284] evaluated whether GER may be a factor in the pathogenesis of apnea in certain infants, including a group of subjects with an ALTE. GER was evaluated using 24-h esophageal pH monitoring; full PSG was performed, and a double blind study design was used. In those subjects with respiratory dysfunction, GER was detected in 75%; conversely, in subjects with GER, respiratory dysfunction was present in 45%. In subjects with respiratory dysfunction, if GER was treated effectively then respiratory dysfunction resolved in 92%. If GER was resistant to treatment, then respiratory dysfunction persisted in 81%. Findings support that PSG combined with esophageal pH monitoring is clinically useful in characterizing respiratory abnormalities and GER, including assessment of response to intervention. However, findings do not show any causal relationship between prolonged apnea and GER.

Other investigators have attempted to evaluate sleep in patients with ALTE. In a Level 4 study, Rosen et al.[47] reported a variety of overnight PSG findings from 26 infants with ALTE, including EEG abnormalities or patterns of uncertain diagnostic significance, GER episodes, and abnormal respiratory events such as central, mixed, and obstructive apneas. Thirteen infants had subsequent ALTEs during the period of follow-up, and PSG abnormalities were not predictive of recurrence. A Level 3 study by Kahn et al.[294] evaluated infants with ALTE with a clinical history, PSG, and other studies. Details regarding the precise PSG abnormalities, as well as timing and duration of the PSG are not provided. A Level 4 case series by Tirosh et al.[273] reported PSG and esophageal pH studies in a group of 17 infants with apnea or ALTE along with suspected regurgitation due to GER. Although this report emphasized the occurrence of GER in this population, results did not confirm a consistent relationship between GER episodes, apnea and ALTE. A study by Arad-Cohen et al.[285] (Level 3 evidence) that included infants referred with apnea or ALTE also demonstrated that episodes of apnea, if associated with reflux, were obstructive or mixed, and followed by reflux rather than preceded by it. A study with Level 4 evidence by Abreu e Silva et al.[162] evaluated a small number of healthy term infants compared to siblings of SIDS victims and infants who presented with ALTEs. The investigators reported that PSG could identify abnormal breathing in some subjects, but there were no specific PSG findings that distinguished the groups of infants.

Taken together, these studies suggest that GER, as well as subtle or nonspecific abnormalities may be identified on PSG in this population, but it was not possible to estimate the diagnostic yield of PSG based on these results. Altered cardiovascular control is most likely present, but routine clinical PSG parameters do not measure this. It is possible that PSG may be clinically useful in selected populations, particularly when there is clinical concern for upper airway obstruction or other forms of SRBD. In general the prognosis for recurrence of ALTE could

not be predicted based on PSG findings, and a significant proportion of infants who experience an ALTE have a normal PSG.

The question has been raised about whether the presence of an ALTE is a risk factor for SRBD in children. A small study with Level 3 evidence by Guilleminault et al.,[292] followed 5 infants with ALTEs to determine if there was an increased risk for SRBD over time. PSG was inadequate to predict which infants would develop SRBD. This was studied more systematically in a larger group in a Level 3 study by Guilleminault and Stoohs.[293] The investigators followed 25 infants with ALTE prospectively who developed more florid symptoms of SRBD and compared them to other infants who presented with ALTE but did not have subsequent difficulty. Index cases presented more frequently with a positive family history of OSAS and an early report of snoring or noisy breathing, suggesting that a subset of those who present with ALTE may be at risk for SRBD in the first 5 years of life. On PSG, there were no differences in the number of respiratory events in the ALTE groups, but the esophageal pressure nadir was different in the group that continued to be symptomatic, suggesting that increased upper airway resistance played a role. Guilleminault et al.[291] (Level 2 evidence) also reported that 57.4% of 346 infants with an ALTE presentation and OSAS had facial dysmorphism (small chin, low placed palate, overall small upper airway) that was noticeably different compared to controls at 6 months of age.

In summary, there is some evidence to suggest that infants who experience an ALTE are at increased risk for SRBD in association with facial dysmorphology, or other risk factors such as family history of SRBD. However, determination of the clinical utility of PSG in this population requires more evaluation.

4.2.4.5 Laryngotracheomalacia and suspected SRBD

Laryngomalacia is a relatively common cause of partial upper airway obstruction in infants. Our search for papers that address the clinical utility of PSG for assessment of infants with laryngomalacia and suspected SRBD identified only one paper. In a Level 4 study, Zafereo et al.[137] retrospectively analyzed PSG data in 10 infants who had surgical treatment for moderate laryngomalacia. PSG performed prior to surgery and approximately 4 months after supraglottoplasty revealed significant improvement in AHI (mean 12.2 to 4.2/h) and minimum oxygen saturation (79% to 87%). There was no control group, and the large range in subject age (1-9 months) and time interval between PSG recordings (2-29 weeks) represent limitations in this study. From this single paper it is not possible to confirm the clinical utility of PSG in this population of infants, but findings suggest that PSG may have clinical utility in evaluating SRBD before and after surgical intervention, particularly if there is clinical concern for moderate to severe respiratory disturbance.

4.2.2.6 Assessing risk of sudden infant death syndrome (SIDS)

Our search identified 7 papers that address the potential clinical utility of PSG for assessment of risk for SIDS. All papers were case-control studies with Level 3 evidence.

Kahn et al.[295] evaluated polygraphic findings of 11 infants who subsequently died due to SIDS in comparison to 22 matched control infants to investigate the possibility that PSG variables might help predict risk factors for SIDS. PSG parameters were identical in cases versus controls for most variables, except that the SIDS victims had longer apneas, and more obstructive and mixed apneic events compared to matched controls. This was further expanded to include PSG findings of 30 infants who died from SIDS and 60 age-matched controls by Kahn et al.[296] The investigators found that future SIDS victims had fewer body movements and more obstructive and mixed apneas per hour compared to controls. The differences between groups for both datasets were small, with large heterogeneity. This same study was expanded further to 40 infants by Kato et al.[297] compared to 607 healthy infants to identify if any PSG parameters could predict risk of SIDS. The investigators found that males between 9-19 weeks of age had higher rates of SRBD compared to controls, but 25% of future SIDS infants had no obstructive events. This suggests that PSG evidence of SRBD does not predict which infants will die due to SIDS.

Kato et al.[298] compared 16 future SIDS victims to 16 age-matched controls to evaluate differences in both cortical and subcortical arousals. Minor differences in arousal characteristics were found during the night between future SIDS victims and controls. Another level 3 article by Sawaguchi et al.[34] also evaluated PSG findings from 27 SIDS victims compared with infants who died of other causes (12). The investigators reported that duration of apneas was an important factor, followed by frequency of central apneas. However, few details related to these events were provided. More detailed analyses of PSG findings were conducted including heart rate spectral analyses in another Level 3 study by Franco et al.[299] to determine whether victims of SIDS had distinguishing features. PSG recordings from a small group of infants who subsequently died of SIDS had evidence of altered heart rate power spectral analysis compared to controls, suggesting a potential role of abnormal autonomic cardiac response in the etiology of SIDS. Another study by Franco et al.[300] evaluated Q-T intervals in these SIDS victims to determine if any difference compared to controls could be used to define infants at risk for SIDS and no definitive evidence was found.

In summary, although a variety of PSG findings have been reported in subjects who later died due to SIDS, PSG does not provide sufficiently distinctive or predictive findings to support a routine clinical indication for PSG to determine risk of death due to SIDS. This is an area of active investigation and future work involving more sophisticated recording techniques may lead to greater clinical utility of PSG.

4.3 Other Chronic Respiratory Disorders

4.3.1 Clinical utility of PSG in children with chronic obstructive lung disease

4.3.1.1 Asthma

Many clinicians have suspected that children with asthma are at increased risk for OSAS. However, very few studies have specifically evaluated the clinical utility of PSG in children with asthma to evaluate for OSAS. In a Level 3 study by Redline et al.[180] that was limited by the use of 4-channel ambulatory PSG and adult definitions of OSAS, children with a physician-diag-

nosed history of asthma had a 3.83 adjusted odds ratio (95%CI: 1.39-10.55) of OSAS on PSG. Contrary to expectations, a Level 4 retrospective study by Ramagopal et al.[301] of 236 subjects found that a parent or guardian report of asthma was associated with decreased odds of OSAS on PSG. However, this study was limited by its retrospective nature and use of questionnaire data to determine the diagnosis of asthma. Because of the limited data available, no conclusions can be made regarding whether PSG is routinely indicated in children with asthma. However, clinical screening for signs and symptoms of OSAS in children with asthma, particularly those with suboptimal control or those with multiple risk factors for OSAS, appears warranted.

4.3.1.2 Cystic fibrosis

Our search identified 2 articles with Level 4 evidence that addressed the clinical utility of PSG to identify respiratory abnormalities during sleep in children and young adults with cystic fibrosis (CF). Villa et al.[302] demonstrated that infants with ongoing respiratory tract inflammation had desaturations during sleep (Level 4 evidence). Gozal et al.[303] demonstrated that PSG can be used to initiate and titrate noninvasive ventilation (NIV) in adolescent and young adult CF patients with SRBD. Several other papers were identified that involved use of PSG in adults with CF but these were not reviewed or graded for strength of evidence.

In summary, our search identified a very limited number of articles that suggest clinical utility of PSG as part of a diagnostic and therapeutic algorithm for identifying and managing CF patients with SRBD.

4.3.1.3 Bronchopulmonary dysplasia

The task force identified no papers that met inclusion criteria that address the clinical utility of PSG for diagnosis of SRBD in infants or young children with bronchopulmonary dysplasia (BPD). Given that infants with BPD often have significant medical or neurodevelopmental comorbidities that may confer a higher risk for SRBD, clinical screening for signs or symptoms of SRBD is warranted.

4.3.2 Clinical utility of PSG in children with chronic restrictive lung disease

4.3.2.1 Kyphoscoliosis and other chest wall abnormalities

The task force identified 2 papers that address the clinical utility of PSG for assessment of breathing during sleep in children with kyphoscoliosis and other chest wall abnormalities. Yuan et al.[268] reported a retrospective chart review with Level 4 evidence involving 110 children who had undergone either a nap PSG study (n = 73) or overnight PSG (n = 39) as part of their preoperative assessment prior to scoliosis repair. The investigators performed PSG in order to identify children at elevated risk of prolonged postoperative ventilation. Preoperatively, patients had normal gas exchange on PSG. The mean AHI for the group requiring postoperative mechanical ventilation was 3.4 ± 7.7, compared to 1.3 ± 4.4 in the group not requiring ventilation; the difference was not significant. No PSG respiratory findings correlated with duration of postoperative mechanical ventilation. The relatively small number of subjects who underwent comprehensive nocturnal PSG as compared to nap studies, and changes in medical management during the 10-year period of the chart review limit the ability of this study to identify the predictive value of PSG in this population.

A Level 4 study by Kirk et al.[241] reported treatment of SRBD in children with myelomeningocele and PSG-proven SRBD. This paper includes a subgroup of children with scoliosis (42 of 73 subjects). There is no comparison of PSG findings from this subgroup to those with no scoliosis, but 4 distinct types of SRBD were described including what the authors proposed as "sleep-exacerbated restrictive lung disease." Four children with scoliosis had no significant apnea, hypopnea, or central hypoventilation on PSG, but had moderate hypoxemia with tachypnea during sleep. These children responded well to supplemental oxygen with (n = 2) or without (n = 2) noninvasive positive pressure ventilation. One child underwent scoliosis repair, and her postoperative PSG showed significant improvement.[241]

In summary, there are very limited data regarding the clinical utility of PSG in evaluation of children with kyphoscoliosis. The 2 papers identified show limited evidence to support clinical utility of PSG in identifying SRBD in this population, but there is no evidence that supports the routine performance of PSG prior to surgical intervention.

4.3.2.2 Restrictive parenchymal lung disease, including diaphragmatic hernia

The task force identified no papers that met inclusion criteria that address the clinical utility of PSG for diagnosis of SRBD in infants or children with restrictive lung disease, including diaphragmatic hernia.

4.3.2.3 Neuromuscular weakness and progressive respiratory insufficiency

The clinical utility of PSG in children with neuromuscular weakness and progressive respiratory insufficiency is discussed in section 4.2.2.9.4 (Clinical utility of PSG in neurological disorders).

4.4 Clinical utility of PSG for therapeutic intervention

4.4.1 PSG for positive airway pressure (PAP) titration

The Positive Airway Pressure Titration Task Force of the AASM recently published guidelines for manual titration of positive airway pressure (PAP) in patients with OSAS.[304] A literature search was performed, and the task force reviewed titration protocols from 51 accredited sleep laboratories. The task force concluded that there was wide variation in practice and recommendations were provided for conducting PAP titration using PSG in adults and children. There was acknowledgement of the paucity of literature involving PAP titration in children.[304]

Our primary search regarding the clinical utility of PSG for titration of PAP in children identified 7 papers. Downey et al.[305] (Level 3) described the use of PAP in 9 children under 2 years of age with OSAS. Only 6 subjects underwent laboratory PAP titration, but the authors described their protocol for titration using PSG. A baseline PAP of 5 cm H_2O was used followed by increases by 2 cm H_2O increments to abolish "snoring and OSA." Additional pressure changes in 1 cm H_2O increments were made to achieve best possible patient comfort. This protocol is similar to that described by Uong et al.[151] more recently

in a Level 4 paper that reported on 46 children using PAP for treatment of OSAS (age > 7 y). The purpose of this report was to describe adherence to therapy in this age group, but there was a brief description of how optimal PAP pressures were determined. Baseline pressure was set at 5 cm H_2O and increased in 2 cm H_2O increments to "improve gas exchange and normalize AHI." A different protocol is described by McNamara et al.[204] (Level 4) in their description of CPAP use in infants. They performed titration studies in the sleep laboratory and used a baseline pressure setting of 3.7 cm H_2O with incremental changes of only 0.3 cm H_2O until there were no identified apneas and the carbon dioxide levels were normalized. A Level 2 case-control study by Nakra et al.[306] reported the effect of PAP on metabolic parameters in children with OSAS. This paper included a brief description of PAP titration during PSG (goal was reduction of AHI to less than 1). The remaining papers, although referring to PSG studies to follow PAP requirements, do not include any details as to how titration studies were conducted.[241,307,308] One paper reported using "auto-titrating" CPAP studies in 5 children, but no details were provided.[307]

In summary, several investigators have described how PSG is used to assist with determination of optimal PAP settings in children. Published reports suggest there is significant regional variation in practice patterns, and there is general acceptance of PSG as a useful procedure for PAP titration in children.

The task force also identified 5 studies that evaluated or described the clinical utility of introducing, titrating and reassessing nocturnal intermittent positive pressure ventilation (NIPPV) in children with SRBD and neuromuscular disorders (NMD). We graded 1 as Level 3 evidence[231] and 4 as Level 4.[233,307-309]

A prospective Level 4 longitudinal cohort study by Mellies et al.[309] evaluated the long-term impact of NIPPV on sleep, SRBD, and respiratory function in 30 children and adolescents (12.3 ± 4.1 y) with various inherited progressive NMD treated for ventilatory insufficiency (n = 14) or symptomatic SRBD (n = 16). NIPPV normalized nocturnal gas exchange in all patients and diurnal gas exchange in patients with ventilatory insufficiency. NIPPV improved RDI, arousals from sleep, nocturnal heart rate, and sleep architecture. Withdrawal of NIV for 3 nights in 10 previously stable patients resulted in prompt deterioration of SRBD and gas exchange back to baseline, which was reversed by resumption of NIPPV.

A Level 4 study by Young et al.[308] reviewed medical records and obtained clinical data from the year prior to starting NIPPV. PSG was used to initiate and titrate NIPPV. Six of the 14 patients had serial PSG which showed a decrease in RDI (P = 0.013), and decrease in RDI in REM sleep (P = 0.009) but no change in SpO_2, pCO_2, percent REM sleep, or sleep efficiency over a mean of 30 (6-84) months. Daytime sleepiness (P = 0.003), headache (P = 0.046), hospitalization rates (P = 0.002), and health care costs (P = 0.003) all decreased with NIPPV. QOL remained stable after NIPPV, despite disease progression.

One Level 3 and 1 Level 4 studies reported clinical utility of NIPPV in NMD, including use of PSG to assist with initiation and titration of treatment. NIPPV significantly improved sleep related hypoventilation, eliminated apneas and hypopneas, normalized sleep architecture and reduced sleep/wake symptoms in 10 of 15 SMA patients with sleep related hypoventilation (Mellies et al.,[231] Level 3). Significant improvement in PSG-documented AHI (mean difference = 11.31, 95% CI = 5.91-16.70, P = 0.001) was reported in 11 DMD patients (mean age 13 y, median FVC 27% predicted) treated with NIV (Suresh et al.,[233] Level 4).

Adjustments in settings for NIPPV are often needed over time in patients with NMD. A retrospective Level 4 chart review by Tan et al.[307] of 61 sleep studies recorded over a 12-month period in 45 children with NMD (median age 8.3 y, 27 boys) reported that 66% needed modifications in their sleep related respiratory support. An increase in the respiratory support setting was needed in 39%, a decrease in 10%, discontinuation in 3%, and 13% failed discontinuation.

In summary, 5 studies document evidence of the clinical utility of PSG to assist with initiation and titration of NIPPV in patients with NMD. Repeat sleep studies were often needed to adjust PPV settings or change treatment modalities.

4.4.2 Repeat PSG in children on chronic PAP support

The task force identified 1 paper that addresses the clinical utility of repeat PSG in children on chronic PAP support. In a Level 4 study, Tan et al.[307] performed a retrospective review of sleep studies performed over a 12-month period to identify whether clinical factors could predict the need for a PAP pressure change. The authors reported data from 61 PSGs in 45 children using PAP for treatment of OSAS; pressure changes were required in 66% and the investigators were unable to identify clinical predictors for these pressure change requirements. The authors concluded that PSG provides important information for optimizing long term management with PAP.

4.4.3 PSG following adenotonsillectomy or other procedures to assess response to intervention

Rapid maxillary expansion (RME) is a relatively new therapy for the treatment of OSAS in children with a constricted maxilla (high-arched palate) and a cross-bite. In 1 Level 3[60] and 1 Level 4[310] study, OSAS on PSG was shown to improve after RME. However, significant residual disease remained. Thus, PSG was useful in determining whether additional treatment was necessary. It is reasonable to consider PSG after maximum treatment results are obtained from RME, particularly if ATH is present.

Oral Appliances

Few studies have examined oral appliances in children. Villa et al.,[52] in a Level 4 study, showed a significant decrease (mean of 7.6 ± 4.6 to 2.6 ± 2.2) but not normalization of AHI in patients treated with oral appliances. Buchenau et al.[143] (Level 2 evidence) used PSG to show the efficacy of a specific intra-oral device in the treatment of infants with Pierre Robin syndrome. These studies support the clinical utility of PSG in characterizing respiratory parameters following treatment interventions.

Pharyngeal flap surgery for velopharyngeal incompetence

Pharyngeal flap surgery is performed to correct velopharyngeal incompetence, particularly in patients who have had cleft palate repairs. OSAS is a known complication of this procedure. Three Level 4[138,207,208] studies performed PSG before and after surgery for velopharyngeal incompetence.

Sirois et al.[207] performed PSG in a convenience sample of 41 children before and after pharyngeal flap surgery. Only 1 subject had an abnormal PSG preoperatively; surgery was cancelled in

that individual. Of the remaining subjects, 35% had abnormal PSGs immediately (1-15 days postoperatively). The authors describe both central and obstructive apnea, but do not give details. PSG was repeated in 10 of the 14 subjects with abnormal postoperative PSG over a widely varying time frame (1 month to 2 years) and resolution of SRBD was documented in most cases. This study was limited in that not all subjects undergoing pharyngeal flap were included and, thus, there may have been some selection bias; adult scoring standards were used for the PSG; airflow was monitored with thermistry only; oximetry data was excluded due to poor signals in a substantial number of cases; it was unclear what degree of central apnea was considered pathological, and the time between surgery and PSG was relatively prolonged.

Morita et al.[138] studied 16 children prior to flap surgery. The AHI (using adult scoring criteria) was < 5 in all subjects preoperatively. The AHI increased to 10 ± 7 one week postoperatively (n = 5), but, on average, was only slightly elevated 3 ± 3 two weeks postoperatively (n = 12). The main limitation of this study is that postoperative studies were performed in only a subset of children and selection bias may have been present.

Liao et al.[208] evaluated 10 patients with PSG before and after Furlow palatoplasty, an alternative treatment for velopharyngeal incompetence that is thought to cause less airway obstruction than pharyngeal flap surgery. Using adult scoring criteria, all subjects had normal PSG findings preoperatively, and had a very mild increase in the AHI one week postoperatively, that improved further postoperatively. Thus, this small study suggests that clinically important OSAS does not occur following Furlow palatoplasty and that postoperative PSG is not required.

In general, these studies support the use of PSG following pharyngeal flap surgery but do not support the routine use of PSG preoperatively.

Supraglottoplasty

Two Level 4 studies used PSG to evaluate efficacy of supraglottoplasty in infants with severe laryngomalacia.[137,311]

Other procedures

One Level 4 study indicated that PSG was useful in assessing the response to surgical procedures such as AT or posterior fossa decompression in children with myelomeningocele; in most cases, SRBD did not resolve postoperatively.[241] One Level 4 study showed that 6 infants with micrognathia who underwent mandibular distraction had improvements in OSAS postoperatively on PSG, although no details were provided.[135]

4.4.4 Consideration of decannulation of tracheostomy

Our search identified 1 paper[312] with Level 3 evidence that demonstrated PSG is a useful supplement to airway endoscopy in the evaluation of readiness for decannulation in children with long-term tracheostomy.

4.4.5 PSG for management of mechanical ventilator settings or weaning from ventilator support

Our search regarding papers that address the clinical utility of PSG for management of patients who require mechanical ventilation or weaning of mechanical ventilator support identified 1 paper. A Level 4 study by Tan et al.[307] reported findings from a retrospective chart review of children who required mechanical respiratory support over a 1-year period. No clinical features were able to predict which subjects would require changes in pressure support. In this study PSG was not used to adjust settings, nor did every child have a complete PSG. In summary, we found no evidence to support or not support the clinical use of PSG for management of ventilator settings in children.

4.4.6 Titration of supplemental oxygen

Our search regarding papers that address the clinical utility of PSG for titration of supplemental oxygen for treatment of sleep related hypoxia in children identified no papers. This paucity of published data may reflect the common clinical practice of using overnight oximetry to assist with supplemental oxygen titration, or empirical clinical decisions using caregiver observations.

4.4.7 PSG in relation to use or discontinuation of infant apnea monitors

Our search identified 1 article[47] with Level 4 evidence that demonstrated how PSG can be used to evaluate infants who present with an ALTE who are monitored at home with an infant apnea monitor following the event. Using overnight PSG, Rosen et al.[47] studied 26 infants who had presented with an ALTE and found subtle or nonspecific findings such as questionable EEG abnormalities in 9 infants, prolonged central apneas in one infant, and increased frequency of mixed and obstructive apneas in 5 infants. Of the 11 infants who underwent simultaneous pH monitoring, 7 had at least 1 reflux episode but the episodes were not accompanied by apnea or bradycardia. Of the 26 infants, 24 were monitored at home with event-recording monitors. Over time, 21 of the infants (81%) had subsequent episodes (13 infants required stimulation, 7 infants required cardiopulmonary resuscitation), 2 infants were diagnosed with a seizure disorder, and 2 infants died.

In summary, although nonspecific abnormalities may be present on PSG in infants being monitored with infant apnea monitors, the task force identified no papers that provide specific guidance regarding PSG as a predictor for the use or successful discontinuation of infant apnea monitors, or which provide data that are predictive of recurrent apnea or death.

4.4.8 PSG for assessment and monitoring of children with Prader-Willi syndrome being considered for or receiving growth hormone supplementation

Reports of sudden death in children with Prader-Willi syndrome (PWS) who are receiving growth hormone supplementation have raised the issue of whether clinicians should monitor for physiological abnormalities during sleep that may predict risk for SRBD or sudden death in this population. We identified 3 papers that address this issue.

A study with Level 2 evidence by Haqq et al.,[313] using a double-blind, randomized, placebo-controlled, crossover design evaluated 12 children with PWS with PSG performed before and after growth hormone administration. The investigators reported increased apneas and hypopneas in PWS subjects compared to normal children. After administration of GH, there was a trend toward a decreased number of apneas and hypopneas, but these changes did not reach statistical significance.

A study with Level 3 evidence by Festen et al.[197] was part of a prospective, multicenter, randomized, controlled trial involv-

ing GH supplementation in 53 children with PWS. PSG was added to the protocol after the investigators began the initial trial. PSG respiratory parameters before and 6 months after GH administration showed that the slightly increased AHI post-GH administration was related to central apneas; there was no increase in AHI 6 months after GH. A Level 4 study by Miller et al.[149] reported data regarding 25 subjects with PWS who had PSG performed at baseline and 6 weeks after GH therapy. The patients were not GH naïve, and only 16 of 25 were children. Only changes in AHI were reported and diagnostic criteria used for OSAS were not defined. One child died who had nonspecific abnormalities on PSG.

In summary, our search identified a small number of papers that provide very limited data regarding the potential clinical utility for PSG in children with PWS who are being considered for or who are receiving GH supplementation. The findings do not provide sufficient support for the routine use of PSG to predict risk of death or to monitor for development of significant cardiorespiratory abnormalities in this population. Additional studies with larger numbers of subjects and longitudinal data are needed to develop a more complete profile of risk for sudden death in this population. This profile will most likely require integration of clinical factors and PSG findings.

5.0 DISCUSSION

This comprehensive evidence-based review provides a systematic analysis of the literature regarding the validity, reliability, and clinical utility of PSG for characterization of breathing during sleep in children. The review involved a standardized process for identification of relevant papers and assessment of the strength of evidence. The analysis addresses the operating characteristics of PSG as a diagnostic procedure and identifies the strengths and limitations of PSG. The review documents the most extensive collection of data on this topic to date and serves as the primary basis for evidence-based practice parameters.

The assessment of clinical utility for a diagnostic procedure begins by evaluating the validity and reliability of the procedure. In aggregate, our analysis documents strong face validity and content validity, moderately strong convergent validity when comparing respiratory PSG findings with a variety of relevant independent measures, moderate-to-strong test-retest validity, and limited data supporting discriminant validity for characterizing breathing in children. The analysis documents moderate-to-strong test-retest reliability and interscorer reliability based on limited data. Throughout this process the task force recognized the many challenges associated with establishing validity and reliability of PSG in children. There is a continued need for well-designed, well-powered studies that evaluate the operating characteristics of PSG in a broad range of populations using more recently standardized methods for signal acquisition and scoring.

The task force addressed the clinical utility of PSG in children by evaluating published literature regarding diagnostic yield and other aspects of test performance in various clinical groups thought to be at risk for SRBD. The data indicate particularly strong clinical utility in children with obesity, evolving metabolic syndrome, neurological, neurodevelopmental, or genetic disorders (for example, Down syndrome and Prader-Willi syndrome), and children with craniofacial syndromes and clinical features of SRBD. The task force gave specific consideration to evaluation of clinical utility of PSG prior to AT for confirmation of OSA, and for assessment of perioperative risk. The most relevant findings included: (1) recognition that the clinical history and physical examination are often poor predictors of respiratory PSG findings; (2) preoperative PSG is helpful in predicting risk of perioperative complications; and (3) preoperative PSG is often helpful in predicting persistence of OSA in a substantial minority of patients after AT. The latter issue is important because it may help identify children who require further treatment. However, the task force did not identify any prospective studies that specifically address whether clinical outcome following AT for treatment of OSA in children is improved in association with *routine* performance of PSG before surgery in otherwise healthy children.

The analysis of clinical utility of PSG in infants less than 12 months of age with suspected SRBD revealed very limited data, and the task force recognizes this as an important area for future investigation. Given the disappointing paucity of higher quality data regarding infants, current practice should continue to incorporate a thorough clinical evaluation of infants, consideration of referral to appropriate pediatric specialists, and selective use of PSG based on the clinical judgment of the sleep specialist and other involved clinicians. The task force identified very limited data regarding clinical utility of PSG for evaluation of children with chronic respiratory disorders such as chronic obstructive or restrictive lung disease, and suspected SRBD. Lastly, the task force assessed the literature regarding the clinical utility of PSG for therapeutic purposes including PAP titration, repeat PSG following AT or other surgical procedures, consideration of changes in mechanical ventilator management, decannulation of tracheostomy, and other uses. A small but clinically useful group of papers confirmed the utility of PSG for initiation and titration of PAP support in children, and a few papers demonstrated the usefulness of PSG following AT or other surgical procedures to improve airway patency. However, the data do not address the optimal timing for repeat studies, or whether ultimate clinical outcome is enhanced through the routine performance of PSG following all surgical procedures in children with various levels of severity of SRBD.

The task force identified few or no papers that address several other relevant issues. First, there were no papers that explicitly address whether the diagnostic yield for PSG is different based on which type of clinician (primary care provider, a general versus a pediatric sleep specialist, or a related specialist such as an otolaryngologist) referred the patient for PSG. Most papers report findings from studies performed in academic or tertiary care centers, indicating that subjects were evaluated by one or more specialists, and that some degree of selection or referral bias was likely. Second, the task force notes that the pediatric sleep literature lags behind the adult sleep literature in a number of regards, and this limits our ability to draw firm conclusions about the utility of PSG in some situations. Third, as in the adult sleep field, there are marked variations in the techniques used for performing, scoring, and interpreting pediatric PSG in papers published 5-30 years ago, with a significant trend for improvement in standardization over the past 5 years. It is likely that standardized methods for performing and interpreting PSG are even more crucial in pediatric PSG compared with adults,

and maintaining high technical standards will be important in order to achieve optimal diagnostic yield and clinical utility. Fourth, because of the paucity of data regarding ambulatory PSG (with full or abbreviated montages) in children, the task force elected to not evaluate the clinical utility of ambulatory PSG. Future reviews on this topic will almost certainly address many of these issues, and the task force was impressed by recent increases in the quantity and quality of papers published in this field.

Based on assessment and integration of findings from over 240 evidentiary papers, it is the consensus of the task force that, when viewed collectively and when giving greater weight to papers with higher levels of evidence, pediatric PSG shows validity, reliability and clinical utility that is commensurate with most other routinely employed diagnostic clinical tools or procedures. It is apparent that the "gold standard" for diagnosis of SRBD in children is not PSG alone, but rather the skillful integration of clinical and PSG findings by a knowledgeable sleep specialist. Like many other diagnostic tools, PSG represents an extension of the clinical evaluation, and it provides valuable physiological data regarding many aspects of respiratory function during sleep in children. Future developments will provide more sophisticated methods for data collection and analysis, but integration of PSG findings with the clinical evaluation will represent the fundamental diagnostic challenge for the sleep specialist.

6.0 SUMMARY AND FUTURE DIRECTIONS

A significant number of challenges exist with regard to improving the clinical utility and cost effectiveness of PSG in children with suspected SRBD. Despite the recent increase in number of publications, the pediatric literature lags behind the adult literature, and there is continued need for well-designed, well-powered studies that evaluate the operating characteristics of PSG in a broad range of populations. As with adults, standardized methods for measuring and scoring respiratory parameters during sleep and improved characterization of cortical and subcortical arousals are likely to improve the diagnostic accuracy and reliability of PSG in children.

The most pressing need for future studies involves investigation of special populations including children with obesity and other important risk factors for cardiovascular disease, neurodevelopmental and neuromuscular disorders, sickle cell disease, and certain craniofacial syndromes. Studies of children with metabolic syndrome and children with overt or evolving hypertension are needed, and the clinical utility of PSG in infants less than 12 months of age is not well understood. Whether PSG is routinely indicated prior to AT is not fully resolved, but it is clear that preoperative PSG is useful in identification of children at increased risk for perioperative complications. Postoperative PSG is helpful in assessment of response to AT and determination of whether addition treatment is necessary for residual OSAS. Additional studies are needed to evaluate how and in what circumstances PSG results are predictive of clinical outcomes and treatment response in children. The feasibility and clinical utility of ambulatory PSG in children will require additional investigation, and it is possible that certain subgroups are good candidates for unattended testing outside the sleep laboratory. Finally, creative, developmentally appropriate and family-friendly approaches to PSG are likely to enhance the quality of data obtained and to minimize disruption to the child and parents' life.

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List of abbreviations

AASM	American Academy of Sleep Medicine
ABPM	Ambulatory blood pressure monitoring
ADHD	Attention deficit hyperactivity disorder
AH	Adenoidal hypertrophy
AHI	Apnea-hypopnea index
AI	Apnea index
ALTE	Apparent life threatening event
ASD	Autistic spectrum disorder
AT	Adenotonsillectomy
BASC	Behavior assessment system for children
BMI	Body mass index
BP	Blood pressure
BPD	Bronchopulmonary dysplasia
CAI	Central apnea index
CAP	Cyclic alternating pattern
CBCL	Child behavior checklist
CCHS	Congenital central hypoventilation syndrome
CF	Cystic fibrosis
CI	Confidence interval
CPAP	Continuous positive airway pressure
DI	Desaturation index
DMD	Duchenne muscular dystrophy
EEG	Electroencephalograph(y)
ECG	Electrocardiogram
EMG	Electromyograph(y)
FLD	Fatty liver disease
GER	Gastroesophageal reflux
HRQOL	Health-related quality of life
ICSD	International Classification of Sleep Disorders
LO-CHS	Late-onset congenital hypoventilation syndrome
MRI	Magnetic resonance imaging
MSL	Mean sleep latency
MSLT	Multiple sleep latency test
NIPPV	Nocturnal intermittent positive pressure ventilation
NOD	Nocturnal oxygen desaturation
NMD	Neuromuscular disorders
NPV	Negative predictive value
NREM	Non-rapid eye movement
OAHI	Obstructive apnea hypopnea index
OAI	Obstructive apnea index
OR	Odds ratio
OSAS	Obstructive sleep apnea syndrome
PAP	Positive airway pressure
PPV	Positive predictive value
PSG	Polysomnography
PTT	Pulse transit time
PWS	Prader-Willi syndrome
QOL	Quality of life
RCREC	Respiratory cycle-related EEG change
RDI	Respiratory disturbance index
REM	Rapid eye movement
RERA	Respiratory effort-related arousal
RME	Rapid maxillary expansion
SCD	Sickle cell disease
SIDS	Sudden infant death syndrome
SPC	Standards of Practice Committee
SQ	Sleep questionnaire
SRBD	Sleep related breathing disorders
TH	Tonsillar hypertrophy
TST	Total sleep time
UARS	Upper airway resistance syndrome
VNS	Vagal nerve stimulation
WAT	Wilkinson Addition Test

PEDS Evidence Table

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.1.1.1 History of snoring and other nocturnal symptoms												
21	Masters (1999)	1	This study compared clinical symptoms with PSG findings. Could sx predict PSG findings? The majority of children were neurologically normal, however 16 children were neurologically abnormal.	Clinical series, observational Blinding absent; This paper attempted to identify a relationship between the clinical and PSG characteristics of neurologically normal and abnormal children with OSA.	Eligible: 56 Completed study: 56 16 neurologically abnormal % males:61	Cases: median 35 months (2- 60) Wide spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Other, specify Clinical history classification devised by authors, with maximum clinical score of 37 reflecting various symptoms including snoring, witnessed apneas, EDS, restlessness, behavioural abnormality, neurodevelopmental delay, ALTE, respiratory failure related to UAO, cardiac or growth abnormalities	Diagnosis reached using PSG criteria	Yes / yes	Comprehensive PSG / not specified / nocturnal	1) Findings suggest that for neurologically normal children there is a poor correlation between findings on PSG and the clinical rating scale used by these authors to determine severity of obstructive sleep apnea. It is not clear, however, that the clinical rating score used had been validated or correlated in any way with actual pathophysiology of disease. 2) PSG findings were generally worse in this small group of neurologically abnormal children with a diverse group of diagnoses, although individual PSG characteristics of patients were not reported. Agree about the rating score. Overall a vague study. The neurologically abnormal kids covered a wide spectrum (everything from CP to epilepsy to muscular dystrophy to prader-willi). Not sure how clinically useful this can be to lump them all together.
22	Chervin (2006)	1	PSG, MSLT and Pediatric Sleep Questionnaire Sleepiness Subscale (PSQ-SS) were performed on 103 children aged 5-12 yrs (77 case subjects scheduled for AT; 26 controls scheduled for unrelated surgical care). Study objective was to compare validated measure of subjective childhood sleepiness (PSQ-SS) to objective measures of sleepiness (MSLT) and examine by PSG (standard and investigational measures) what measures of SDB predict subjective sleepiness.	Case control study Blinded study	Eligible: 77 Completed study: 77 % males: 57 (total group) # controls: 26 % males: 57 (total group)	Cases: 8.4 +/- 1.9 yrs. (5-12.9 yrs) Mean age and range is for entire group; no designation of case and control values. Narrow spectrum	Academic center and community referral Strategy not specified Government funded	Behavioral scales MSL on MSLT	Other diagnostic criteria developed by authors ENT clinically determined indications for AT	Yes / Yes	Comprehensive PSG and MSLT PSG duration = overnight Timing of PSG:Nocturnal	1) Subjective sleepiness (as measured by PSQ-SS) is a frequent problem among children with suspected SDB. 2) Subjective sleepiness (PSQ-SS) reflects MSLT results to a limited extent. 3) Standard PSG measures of SDB predict subjective sleepiness, but respiratory cycle-related EEG changes may offer additional clinical utility.
17	Goldstein (2004)	2	41 children underwent PSG : 21 were initially PSG + as defined by RDI>5. The 20 pts who were PSG-were randomized to T&A or nonsurgery. Repeat PSG and 32 item clinical assessment was done on all 41 children after intervention and results compared. The goal of this study was to determine if patients with a clinical assessment of OSA but negative PSG had improvement in their clinical assessment score after T&A compared to children who did not undergo surgery	Prospective cohort study Blinded study	Eligible:78 Completed study: 41 % males: 50% (more females with –PSG randomized to T&A)	Cases: 5.8 (+/- 2.6) to 7 (3.6) Narrow spectrum	Academic center Random selection Government funded	Multiple comparators: Clinical assessment Score :Thiry two items which were differentially weighted by specificity of symptoms to OSA (as determined by authors previous data review.) Highest possible score was 164, children with >40 were considered to have OSA, <20 asymptomatic , and between 20-40 mild symptoms of upper airway obstruction	PSG criteria and Other diagnostic criteria developed by authors	No / Yes	No sleep stage scoring – only respiratory parameters were used. Used RDI >5 as definition of OSALimited sleep study (describe parameters) PSG duration = Not specified Timing of PSG:Not specified	In children with clinically determined OSA, negative PSG, without evaluation of UARS may not be sensitive in picking up children who may improve clinically with T&A. Findings suggest overnight PSG should be considered after T&A for treatment of OSA, and also may be considered if high clinical suspicion with initial negative PSG Lateral neck x-rays to assess adenoidal size were included as part of the clinical score. But the positive predictive value of the clinical score for predicting a positive PSG was only 48%.
23	Goodwin (2004)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). Sleep habits questionnaire (SHQ) assessed for presence of sleepwalking, sleeptalking, sleepterrors, eneuresis as well as measures of snoring, EDS, witnessed apneas, insomnia and learning problems. Likelihood of having a parasomnia was correlated with evidence of SDB.	Prospective cohort Blinding not applicable	Completed study: 480 % males:50	Cases: 6-8y 52.9% 9-11 47.1% Narrow spectrum	Patients recruited from school system Self-selected groups Government funded	Parental observations	PSG criteria	Yes / Yes	Ambulatory (unattended) sleep study PSG duration = 487 minutes Timing = nocturnal	1) Unattended home PSG appears to identify a large number of patients with SDB (24%) in a non-clinically referred population, suggesting possible usefulness as a screening tool 2) Study suggests that PSG might be useful in diagnosing SDB in patients with parasomnias (specifically sleepwalking, sleep talking and eneuresis)
24	Goodwin (2003)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). BMI, snoring, EDS, witnessed apneas, insomnia and "learning problems" were compared among the group using different cutoffs of RDI and oxygen desaturations to define SDB	Prospective cohort study Blinding not applicable	Eligible: Completed study 239 % males:55.2 # controls:depends on cutoff RDI +/- desats	Cases: 6-11 yrs old 55% 6-8 44.8% 9-11 not further broken down Narrow spectrum	Recruited through school district Self-selected groups Government funded	Parental observations	PSG criteria	Yes / yes	Ambulatory (unattended) sleep study PSG duration =490 minutes Timing of PSG:Nocturnal	Abnormalities on overnight, unattended PSG in a large study population of children appear to correlate with symptoms of snoring, excessive daytime sleepiness and learning problems as assessed by parental answers on questionnaire
25	Wing (2003)	2	46 obese children from academic clinic (>=120% ideal body weight) were compared with age and gender-matched control children from the local schools for prevalence of OSA; pts with known clinical conditions (e.g., Down's, Prader Willi, neuromuscular dz, laryngomalacia, upper airway surgery) were excluded; One ENT evaluated the nasoropharyngeal anatomy and graded tonsil size, adenoidal size, turbinate size, and velopharngeal isthmus. Protocol: 2 consecutive nights of PSG; after second PSG, MSLT the next day; there was at least one night of PSG on all children (3 ss did not get 2 nights)	Case control study Blinded study (E-mail communication with the author indicated that the PSG interpretation was done in a blinded fashion; the ENT eval was also effectively blinded since it was done prior to the PSG)	Eligible: 46 Completed study: % males: 72% # controls: 44 % males: 66%	Cases: 10.8 (2.3) Controls: 11.7 (2.1) Wide spectrum	Academic center and local schools Random selection Non-US funding agency	Physical examination Included measurements of tonsils, adenoids, turbinates, and velopharyngeal isthmus.	PSG criteria	Yes E-mail communication with the primary author indicates that they used R & K Were respiratory scoring methods clearly defined? Yes Comments: Used duration criterion of >2 breaths for obstructive events and >20" for CA or any duration with >4% drop in oxy sat	Comprehensive PSG 1. C3-A2 2. C4-A1 3. ROC-A1 4. LOC-A2 5. Submental EMG 6. Intercostal EMG 7. Snore channel 8. EKG 9. RAT-LAT (single leg EMG over both AT's) 10. Airflow via thermistors 11. Thoracic belt 12. Abdominal belt 13. Sum of thoracic and abdominal movement 14. Position sensor 15. Pulse oximeter 16. ET-CO2 via nasal cannula PSG duration = c. 542 minutes Timing of PSG: Nocturnal	1. The presence of tonsillar enlargement (size of > 2/4) and/or narrower velopharyngeal space in obese children can help triage obese children for PSG since there is a high PPV and high specificity for diagnosing OSA in this group 2. The presence of obesity alone has a variable PPV for OSA ranging from 15.2% to 78.3%, depending on the definition of OSA (OAI>=1—PPV=26.1%; AHI>=5—PPV=32.6%); 3. The absence of obesity had a NPV of 97.7% (OAI>=1) and 95.5% (AHI>=5) 4. PSG is more likely to show respiratory abnormalities in obese children than in non-obese children

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
26	Brouillette (1984)	3	This study was designed to test a questionnaire developed by the authors to determine if it is able to discriminate between children referred for suspected OSA (due to adenotonsillar hypertrophy) who need no further follow up versus those who require PSG evaluation. The investigators enrolled 23 children with PSG-diagnosed OSA and 46 matched controls (2 for each OSA subject). All subjects completed a sleep questionnaire and an OSA score was derived that allowed classification of OSA and control groups. This OSA score was then used in a new group of 23 subjects - who were referred for suspected OSA - to determine how well the questionnaire predicted which of the newly-referred children likely had a diagnosis of OSA.	Clinical series Blinding not specified	Eligible: 23 OSA; 23 possible OSA subsequently referred; Completed study: 23 OSA; 23 possible OSA % males: 16/23 (69.5%) OSA 17/23 (74%) possible OSA subsequently referred # controls:unknown number of controls eligible as controls were matched to OSA % males: Figure not stated but OSA matched to 2 controls of same sex therefore there were 32/46 (69.5%) male	Cases: OSA: 3.8±2.4 yrs (range 1-10yrs) Possible OSA 5.3±3.6 yrs (range unknwn) Controls:4.0±2.3 yrs (range 1-10yrs) Patient Spectrum =Narrow The first part of the study was a narrow spectrum (OSA and controls); the second part included children suspected of having OSA so that the predictive value of the questionnaire could be tested	Academic center and community referral Expert assigned or selected groups Expert assigned as well as self-selected groups Privately funded (non-pharmaceutical)	Parental observations	Diagnosis reached using other diagnostic criteria developed by authors Comment: Dx of OSA made initially by PSG using abnormal tcPO2 or PzO2, and clinically significant morbidities (cor pulmonale, FTT etc).	No / No: Comments: Reader referred to previous citations by the investigators. Dx of OSA made initially by PSG using abnormal tcPo2 or PzO2, and clinically significant morbidities (cor pulmonale, FTT etc)	Parameters: Heart rate, ECG, tcPO2, PaCO2, oral and nasal airflow, thorax, abdomen Limited sleep study (describe parameters) PSG duration = not stated Timing of PSG:Daytime naps following sleep deprivation	*- findings suggestive of a questionnaire-generated OSA score that may be useful to help clinicians decide which children with adenotonsillar hypertrophy (and without other medical comorbidities) should undergo PSG. - Definition of OSA used in this old but key paper..very much affected their conclusions, as the Definition required some clinically reported symptoms..rather than an objective diagnosis being made and then comparing to symptoms.
27	Carroll (1995)	3	This is a retrospective study of 83 children who were referred for PSG. For each child, a clinical history (OSA score) was obtained and a PSG was performed. The study objective was to determine whether primary snoring (PS) could be distinguished from OSA by clinical history (OSA score) alone.	Clinical series Blinded study	Eligible: 83 Completed study: 83 % males: 58	Cases: PS: 5.6+/-3.4 years; OSA: 4.3+/- 2.4 years; Range: 5.4 months-14.8 years Narrow spectrum	Academic center and community referral Expert assigned or selected groups American Lung Association Research Grant	Parental observations: Obstructive Sleep Apnea Score	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration not stated Timing of PSG: Nocturnal	1) The authors conclude that PS in children cannot be reliably distinguished from OSA by clinical history alone. 2) PSG is indicated in children, with symptoms suggestive of OSA, to accurately diagnose OSA, in order to avoid unnecessary surgery or other intervention in children with PS.
28	Goldbart (2006)	3	PSGs and exhaled breath condensate testing for leuokotrienes and prostaglandins from 50 snoring children were compared with PSGs and EBC from 12 non-snoring children . Collected EBC samples from 50 of 56 snoring children and 12 non-snoring controls over a 4 month period, assayed these for cys-LT levels, The primary objective of this study was to determine if there are difference in inflammatory markers (eicosenoids such as leukotrienes and progstaglandins) in children with and without sleep disordered breathing MGD: paper could be used to 1) alternative method for diagnosing pediatric OSA; 2) validity (need to identify pediatric OSA) for PSG in children with suspected OSA	Case control study Blinding not specified	Eligible: Completed study: 50 % males: 58 # controls:12 % males: 58	Cases: 9.6 +/- 2.9 (mild SDB) and 10.3 +/- °.7 (SDB, AHI>5) Controls: 7.1 +/- 1.6 Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Parental observations	Diagnosis reached using PSG criteria R & K for EEG, AASM Task Force for arousals Hypopneas scored: 50% drop in nasal flow for 2 breaths with > 4% desat or arousal.	Yes / Yes	Comprehensive PSG But refer for protocol to 2005 paper PSG duration = Not stated Timing of PSG: Nocturnal	1) In children aged 6-16 referred for PSG for habitual snoring (reported by parents >3 nights per week), 29 had an AHI<5, and 21 had an AHI >.5. 2) Children with SDB showed a statistically significant increase in exhaled breath condensate for inflammatory markers (leukotrienes) in a dose-dependent fashion, although this was confounded by higher BMI in SDB group. Results suggest this may have some clinical utility in assessing snoring patients.
29	Kaditis (2004)	3	Describe the clinical factors associated with sleep disorder breathing in 1-6,7-12, 13-18 yo patients	Prospective cohort Blinding absent	Eligible:103 Completed study:70 % males: 47 # controls:none	Cases:9.8 ±2 Controls:none Patient Spectrum not applicable	Community referral Random selection Funding not specified	Multiple comparators, specify: Questionaire administered to parents and teacher assessing frequency of clinical factors	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = not specified Timing of PSG:Nocturnal	The incidence of OSA based on PSG, in a limited subset of children, who snore more than 1 night a week 4.3% of children. Children with a history of taTA had a snoring incidence of 6.1%. Cigarette smoke exposure, a history of paternal snoring, and chronic nasal obstruction and LRTI were at highest incidence for habitual snoring.
30	Niemenen (2000)	3	This study looked at 58 snoring children with symptoms of SDB who underwent two PSGs 6 months apart. Thirty healthy children also underwent a single PSG as a control	Prospective cohort Blinding not specified	Eligible: 78 Completed study: 58 % males: 53 # controls: 30 % males: 57	Cases: 5.8 +/- 1.8 (2.4-10.5) Controls: 7.1 +/- 1.8 (4.3-10.9) Narrow spectrum	Community referral Expert assigned or selected Funding not specified	This study used a questionnaire to determine severity of symptoms of OSA, and an OSA scoring system developed by Brouillette but not further described	PSG criteria	No (no EEG) / Yes (but not "standard" and technology poor)	No EEG or EOG was used, so no sleep stage scoring was done Duration not specified Timing was nocturnal	1)This study suggest that clinical symptoms alone are inadequate in differentiating primary snoring from obstructive sleep apnea, and that PSG is required. 2)This study suggests that an AHI of >2 on PSG may be an indication for T&A, with improvement in symptoms and PSG findings postoperatively 3) I n patients with primary snoring, short term f/u (6 months) with PSG does not appear warranted as symptoms did not worsen in this study in those patients Strain gauge, no CO2 monitoring, No nasal pressure so accuracy of test deficient ****No sleep stage scoring/EEG monitoring was done in this study
31	Pagel (2004)	3	Cohort was identified from within a pediatric psychiatry clinic. Patients who answered affirmatively to one of four indicators of daytime sleepiness (waking unrefreshed, sleepiness during the day, teacher or other adult reporting daytime sleepiness, or hard to wake up in the morning) were offered further evaluation with full Sleep Medicine evaluation and PSG. Patients with prior T&A and trisomy 21 were excluded. There is no mention of how many patients failed to complete the evaluation after meeting initial eligibility. PSG results are then discussed, and correlations with psychiatric diagnoses, tonsillar size, and questionnaire responses are made.	Prospective cohort Blinding not applicable	Eligible: not stated Completed study: 45 % males: 66% # controls: 29 % males: 58%	Cases: range 3-16 30 children had AD/HD Narrow spectrum	Academic center Self-selected groups Funding source not specified	Questionnaire: Psychiatric diagnoses correlates (ADHD) and size of tonsils	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Not specified this does not state specifically that the PSG was nocturnal, but reference is made to "AASM-accredited sleep lab clinical pediatric protocol."—probably safe to assume these were nocturnal full PSGs.	Among pediatric psychiatry clinic patients, a clinical history of suggesting daytime sleepiness may be associated with a high pre-test probability of PSG showing a significant degree of sleep disordered breathing. The questionnaire was otherwise unhelpful for identifying those with OSA. This suggests that PSG is indicated for the further evaluation of patients in this population. In particular, pediatric patients with ADHD and daytime sleepiness appear to be at highest risk. ADHD children with tonsillar hypertrophy and daytime sleepiness are more likely to have OSA.
32	Reade (2004)	3	Records from 130 pediatric patients were reviewed. Excluded those with renal failure, transplantation, mental retardation, NMD, DM, chronic lung disease, congenital heart disease, sickle cell, or antihypertensive therapy, left 90 patients. Patients had originally been referred by their primary physicians for a polysomnogram for various reasons. Patients with medical comorbidities were excluded. 90 patients were included in the study. Polysomnographic data is reviewed, and is correlated with presence of obesity and hypertension.	Clinical series, observational study, case reports Blinding not specified	Eligible:90 Completed study: 90 % males:64%	Cases: 10.7 yrs range 4.2-18.8 Narrow spectrum	Community referral Referred by PCP for sleep study because of their clinical presentation Expert assigned or selected groups Funding not specified	Hypertension	Hypopnea defined as a 20-50% reduction in airflow with a minimum duration of 10 and associated with a desaturation of 3% or greater or a 3 sec EEG arousal.	Yes	Comprehensive PSG Oronasal airflow, etC02 PSG duration = "overnight" Timing of PSG: Nocturnal	In obese pediatric patients, the hypopnea index and arousal index are physiologically significant predictors of cardiovascular risk posed by obstructive sleep apnea. Obesity and hypertension in pediatric patients should prompt a careful evaluation for sleep disorders. Obesity is a risk factor for OSA especially in older children; hypertension in a child warrants consideration of obstructed SDB. Only elevated hypopnea index was a predictor of diastolic hypertension in children with SDB.
33	Rimell (1998)	3	17 children (under 10 months of age), with airway problems, underwent full PSG to evaluate the usefulness of obtaining a PSG for the evaluation of stridor or stertor.	Clinical series Blinding not applicable	Eligible: 17 Completed study: 17 % males: not specified	Cases: range 2-8 months Controls: NA Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Physical examination	PSG criteria	Yes / Yes	Comprehensive PSG	1) Full PSG provides physiological data that complement anatomical data obtained via endoscopy and is a useful tool for evaluating the significance of airway disorders in infants. 2) Performing 4- or 6-channel studies is less than adequate and significant problems are often missed. 3) The presence of observed apneas plus stertor in an infant appears to be correlated with the presence of sleep-disordered breathing during PSG.
34	Sawaguchi (2002)	3	From a large (27,000 infants) cohort of infants studied in a sleep lab over 20 years, 38 infants died suddenly 3-12 weeks after the sleep recording. 27 were considered to be SIDS victims, and characteristics of these children were examined, including frequency and duration of sleep apneas, characteristics of brain stem changes consistent with gliosis, and epidemiological data on sleep position. These data were compared to findings in 12 infants who died of other causes.	Clinical series Blinded study; This study was done to determine if there were autopsy findings in SIDS victims that correlated with sleep apnea or sleep position	Eligible: 27 Completed study: 26 % males: 61 # controls: 12 % males: 66	Cases: 3-40 weeks Controls: 4-24 weeks (died of other various causes – cardiac, infected pulmonary dysplasia, septic shock, prolonged hypoxemia, prolonged seizure) Narrow spectrum	Academic center Self-selected groups Government funded	Autopsy results of infants brainsterns	PSG criteria and other criteria: Diagnosis of SIDS made when infant died unexpectedly and no other cause found.	Yes / Yes Apneas 3 seconds or longer Date on frequency of OA or CA in each patient was not given.	Comprehensive PSG PSG duration 8 hours PSG timing nocturnal	Duration of obstructive sleep apneas (although these actual durations were never reported) as recorded in PSGs during infancy may be important in predicting children at risk for SIDS, suggesting PSGs MAY be helpful in the workup of at-risk children.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
35	Wang (1998)	3	To investigate predictive accuracy of clinical evaluation for OSA and outcome after adenotonsillectomy in children having PSG	Clinical series, observation Blinding absent	Eligible: n/a Completed study: 82 % males: 49/82 = 60% No controls	Cases: 6.7yrs (range 18 months – 15 years) Controls:n/a Narrow spectrum	Source not specified Self-selected groups (based on symptoms of OSA then referred for investigation) Funding not specified	Physical examination by physicians Parental symptom report	PSG criteria Other diagnostic criteria developed by authors: RDI calculated using apneas and hypopneas; OSA defined as RDI>=5 with evidence of obstructive events.	No / Yes (RDI calculated using apneas and hypopneas events at least 10 seconds in duration)	Comprehensive PSG; also used snore intensity as measured in decibels. Thermocouple was used, not nasal pressure PSG duration = 6-7 hours. No mean given. Timing = Nocturnal	Symptoms of OSA are poor predictors of PSG-defined OSA - snoring loudness (in dB, measured during PSG) was the best predictor of OSA - T&A in a subgroup of children showed a reduction in RDI in the expected direction. One sentence in the Discussion suggests that this may have been driven in particular by one child with a craniofacial anomaly (Treacher-Collins).
36	Xu (2006)	3	Review of various historical (25 questions), clinical (13 physical findings), and radiographic parameters (adenoidal-pharyngeal ratio from an x-ray of the post-nasal space ANR<0.5=nl) in all patients seen at an academic sleep lab associated with a peds dept. over a 4-yr period. Patients were divided into OSA positive, defined as AHI>5/hr, and primary snorers (AHI<=5/hr). PPV, NPV calculated for the 39 parameters studied. All patients snored.	Case control study Blinded study	Eligible: 31 # controls: 19	Cases: 7.8 +/- 3.2 yr Controls: 8.1+/-_ 3.7 yr Narrow spectrum Study included all children suspected by a community MD of having OSA—all children snored	Academic center Subjects were referred by community MDs to an academic center Strategy not specified Funding not specified	Multiple comparitors: 25 historical questions 13 physical exam signs 1 radiographic sign	PSG criteria	Yes: Sleep scored by "standard criteria"—so presumably R&K although no reference given Yes: Comments: 1) event duration defined as >10 seconds 2) hypopnea defined as 50% decrease in A/F + either arousal (non-defined) or >=4% desat 3) def of OSA=AHI>5/hr —although later in the paper they stress that the definition is somewhat arbitrary but chosen as the definition of "clinically sig't OSA"	Comprehensive PSG:) C3-A2 2) C4-A1 3) O1-A2 4) O2-A1 5) EOG non-specified 6) Submental EMG 7) Snore channel 8) EKG 9) Nasal-oral airflow--thermistor 10) Thoracic and abdominal plethysmography 11) Pulse oximeter PSG duration not stated PSG timing = nocturnal	1. combo of snoring and 6 characteristics (see study findings) has high sensitivity and good NPV with fairly good/adequate PPV and, thus, help the clinician trying to determine which children need polysomnography sooner than others; 2. combo of snoring and upper airway narrowing on x-ray or mouth breathing observed by MD and combo of snoring and UAN on x-ray or enuresis provide fairly good PPV/NPV 3. PPV of mouth breathing observed by MD for OSA was 100% (if child had mouth breathing, then child had OSA) implying this is a high risk group for OSA and would be well served by undergoing PSG ASAP 4. High PPV's (>=80%) were also seen with the following but were not statistically significant: historical factors: paradoxical breathing, resp distress, chest contractions, frequent sore throat/dry mouth; physical factors: long adenoid facies, midface hypoplasia, and high arched palate 5. High NPV of 80% (rest were lower) was also seen with the following but was not statistically significant: historical factors: snoring>3 nights/wk
37	Greenfeld (2003)	4	29 infants <18 months of age with PSG diagnosed OSA due to adenotonsillar hypertrophy were studied with regard to demographics, referring physician specialty, development, symptoms post treatment and a pediatric sleep questionnaire completed by parents.	Clincal series Blinding absent; This study was designed to evaluate the characteristics of infants <18 months of age with obstructive sleep apnea due to ATH	Eligible: unknown Completed study: 29 % males: 69	Cases: 12.3 +/- 3.9 Narrow spectrum	Community referral Expert assigned or selected groups Blinding not specified	Physical examination	PSG criteria	Yes / Yes: but no diagnostic criteria given	Comprehensive PSG No nasal pressure monitoring PSG duration = At least 6 hours Timing of PSG: Nocturnal	Since no PSG parameters were reported, conclusions are limited. OSAS due to ATH does seem to exist in children <18 months, especially males, with history of prematurity, and those who snore, suggesting PSGs would be warranted in this population. Apparent high recurrence rate in infancy would suggest repeat PSG after treatment if symptoms recurred in this population
38	Guilleminault (1982)	4	Description of a clinical cohort with no apnea on PSG but Pes swings, tachypnea and sinus arrhythmia (ie. UARS). This study was designed to evaluate children with suspected sleep apnea due to a variety of clinical symptoms who were PSG negative but had adenotonsillar hypertrophy.	Clincal series Blinding not specified	Eligible: Unknown Completed study: 25 % males: 60 # controls: 25 % males: Not specified	Cases: 7 (2-14) All prepubertal Controls: "not exactly aged matched, but similar, greatest age difference between patient and control was 12 months) Narrow spectrum	Community referral Expert assigned or selected groups Funding In part by gifts to C. Guilleminault from the Pacifica Firefighter's Wives' Association and Institute National de la Sante et Recherche Medicale	Not specified	Other diagnostic criteria developed by authors	Not applicable	Full PSG with Pes. PSG duration = 9 hours (TRT) Timing of PSG: Overnight 22:00-7:00	Findings of Pes swings and tachypnea indicate a type of sleep-disordered breathing, ie. UARS
39	Mallory (1989)	4	This study looked at 41 children referred from an academic obesity clinic who had histories suggestive of sleep disordered breathing who were obese as defined by weighing >150% of ideal body weight. (This was 20% of the new patients in the obesity clinic). 45 patients were referred but only 41 met weight criteria. These patients underwent overnight PSG and 17/41 of the older patients had PFTs. A sleep history questionnaire was obtained on 38 patients,	Prospective cohort Blinding absent	Eligible:41 Completed study:41 % males:63	Cases: 10.3 +/- 4.4 (3-20) Narrow spectrum	Academic center Self-selected groups Funding source not specified	Not specified	PSG criteria	No / Yes However they used "standard definitions for apnea and hypopnea" – not clear what this was at the time of the study, only that AHI>5 was considered abnormal	Comprehensive PSG Duration = > 300 minutes TST was obtained in 37 patients (average 451+/-56.2 minutes), however the 4 with sleep time less than that were included in the analysis as they had significant respiratory abnormalities Timing = nocturnal	1) History of sleep disordered breathing alone is not adequate to predict presence of OSA in obese children; PSG would still be indicated 2) There did not seem to be a correlation between body weight and presence or severity of SDB in this population, again making history and physical inadequate to determine need for PSG 3) This study did not address the prevalence of SDB in a cohort of obese children unselected for history of breathing problems during sleep. This paper highlights the need for PSG in obese children. There is an 8% incidence of OSA in obese kids (compared to 1-2% of the general population), but unfortunately history and degree of obesity doesn't necessarily correlate with severity of OSA.
40	Marcus (1998)	4	20 children who had undergone previous PSG as part of their routine clinical management for suspected OSA who had been found to have only primary snoring were contacted 1-3 years after initial PSG. (There were 75 potential candidates, 33 could not be contacted, 8 had undergone T&A and 14 declined – there were not significant differences between study participants and those not re-studied). Repeat PSG and symptom questionnaire as well as growth parameters were obtained.	Clinical series, observational study, case reports Blinding absent	Eligible: 75 Completed study: 20 % males: 60 # controls: The body of the text describes comparing arousal index in PS patients with 20 normal pediatric subjects recruited for other research protocols. No other information about controls is given – only that there was no significant difference in arousal index (5.2 +/-2.1 in pts. Vs 6.5 +/1 2.1 vs controls)	Cases: 6+/-4 Narrow spectrum	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical)	Not specified	PSG criteria	Yes / Yes: Hypopneas did not require specific desaturation or arousal,, just >50% amplitude reduction	Comprehensive PSG PSG duration = not specifed Timing of PSG: Nocturnal	1) Repeat PSG does not appear to be warranted in patients with primary snoring over a short follow up time (1-3 years) in the absence of changing symptoms or change in body weight 2) PSG findings are fairly consistent over time
41	Nanaware (2006)	4	56 children who were referred to a tertiary care center were evaluated with abbreviated PSGS (respiratory variables only) for suspected SDB. Information about associated symptoms were reviewed from the chart. Twelve patients who had post-treatment PSG were reported	Clincial series Blinding not applicable; The purpose of this paper was to study clinical presentation of pediatric sleep disordered breathing, causative factors and response to treatment	Eligible: 56 pts referred for SDB Completed study: 23 (41%) had OSA with an AHI>5 and desat <92% % males: 65	Cases: 12.1 (4-17) Wide spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No: No EEG/EOG was used No scoring criteria given; only techcnical equipment used	Nasal air flow, HR, O2 sat, snoring, thoracoabdominal respiratory bands, limb movement sensors Limited sleep study (describe parameters) PSG duration = not specified Timing of PSG:Nocturnal	This study suggests PSG can be helpful in diagnosing sleep disordered breathing in a wide spectrum of diseases, including craniofacial abnormalities, neuromuscular and skeletal disorders, and systemic disease associated with OSA. Postoperative PSG may be useful to document improvement in post-craniofacial surgical procedures, but the numbers are small, and specifics about PSG data pre and post op were not reported
42	Pang (2004)	4	This is a retrospective chart review involving 109 children aged 3-14, who underwent T&A for "clinical suspicion of OSA". Of this population, 36 had had a prior PSG, while 73 underwent T&A after clinical evaluation alone suggested sleep apnea (snoring and subjective respiratory complaints while sleeping). The prevalence of surgical complications in this population is discussed.	Retrospective review of all kids suspected of having OSAS – case series. Blinding not specified	Eligible: 36 Completed study: 36 % males: 66% ("sex ratio was 2:1 males to females") # controls:73 % males: not specified	Cases: "range 3-14 years" Controls: "range 3-14 years" Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Surgical outcomes were compared between those diagnosed with OSA by PSG and those diagnosed clinically.	Diagnosis was made clinically by presence of snoring and subjective "choking" symptoms	No / No	Not specified: the type of PSG and duration of PSG is not indicated in the article PSG duration = not specified Timing of PSG:Not specified	Polysomnography does not provide incremental value above clinical evaluation in the assessment and management of post-operative risk in children undergoing T&A for clinical suspicion of OSA. Surgical technique and post-operative monitoring methodology or pre-op preparation as well as intro-operative management not discussed and they all could impact likelihood of post-operative complications.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
43	Pavone (2006)	4	From 54 patients with proven prader willi syndrome who underwent all night PSG, 5 patients were selected for inclusion in this observational study. Inclusion criteria were: age 1-18 yrs, no prior adenotonsillectomy, presence of pathologic adenotonsillar hypertrophy, and presence of moderate to severe OSA on PSG. 5 patients fulfilled these criteria. These patients all underwent T&A, and their pre and post-surgical PSGs are discussed, along with the presence of postoperative complications.	Clinical series, observational study, case reports Blinding not specified	Eligible:5 Completed study: 5 % males: not stated Culled 5 PWS patients from a clinic of 54, all 5 had ATH + moderate to severe OSA 2/5 were obese	Cases: mean age 4.4 years (large range: 1.6-14.2 years) Narrow spectrum	Academic center Expert assigned or selected groups 54 patients dx with PWS followed in the Endocrinology Unit of Bambino Gesu Children's Hospital Rome part of an ongoing study. These had ATH, and had OSA on their limited cardiorespiratory study. Funding source not specified	Not specified	PSG criteria	Yes / Yes	Limited sleep study (describe parameters), thermistor was the airflow measurement (no nasal pressure transducer tracing). End-Tidal CO2 was included in the montage. Not comprehensive PSG but 7-channel recorder measured HR, pulse waveforms, SaO2, RIP (including sum), added thermistor, and recorded video; also recorded etCO2. Device: SomnoStar PT2 (Sensor Medics Corp) They calculated TST based on regularity of cardiorespiratory signals, behavioral observations and video. PSG duration = all night (performed at the usual bedtime) Timing of PSG: Nocturnal	Polysomnography shows face validity in PWS patients with adenotonsillar hypertophy, with improvement of PSG findings following T&A. Polysmnography does not add value to preoperative risk assessment in PWS patients undergoing T&A for OSA in the presence of adenotonsillar hypertrophy. MGD I do not agree with this statement Four of 5 patients had at least one post-operative complication, these patients should stay overnight in hospital after T+A The typical sleep disordered breathing in PWS more central hypoventilation, made worse by obesity, a few will have adenotonsillar hypertrophy, then have a superimposed obstructive component, remove tonsils, but hospitalize overnight because of complications.
44	Pijpers (2004)	4	A retrospective medical record review was performed for 59 children with syndromal craniofacial synostosis (SCS) to identify symptoms of OSA. A caregiver completed questionnaire was then administered to identify OSA-related symptoms. The medical history and results of the questionnaire were then compared to determine the value of each to identify OSA in children with SCS.	Clinical series, observation Blinding not applicable (Snoring, difficulty breathing, and observed apnea were reported in over 50% of children with either Apert syndrome, Crouzon syndrome, or Pfeiffer syndrome registered in one hospital over a 16 year period, but only 10/72 underwent PSG.)	Eligible: 72 Completed study: 59 % males: 71	Cases: 9.3 years (range 0-17 years) Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Parental observations	Questionnaire	No / No	Not specified	1) Regular screening for OSA with a standard questionnaire could be of additional value for the detection of OSA in children with SCS. 2) The author's propose to screen children with SCS by means of a standard questionnaire twice a year and to perform PSG if indicated.
45	Preutthipan (1997)	4	This is an observational cohort describing clinical features, polysomnographic features, and post-therapeutic outcomes information for <15 year old Thai children referred for PSG due to clinical concern over obstructive sleep apnea.	Clinical series Blinding absent	Eligible: unknown Completed study: 39 % males: not stated	Cases: "under 15 years old" Narrow spectrum	Recruitment source not specified Strategy not specified Pharmaceutical or equipment company	Not specified	PSG criteria	Yes Respiratory events clearly defined also	Comprehensive PSG PSG duration = average 7.3 hrs Timing of PSG:Nocturnal	Polysomnography has face validity in this group of children clinically suspected of having obstructive sleep apnea.
47	Rosen (1983)	4	26 infants with unexplained life-threatening apnea underwent clinical and PSG examination	Clinical series Blinding not applicable	Eligible: 26 Completed study: 26 % males: 65	Cases: 2.14+/- 1.25 weeks Narrow spectrum	Academic center Self-selected groups Government Funded	physical examination	PSG criteria clinical examination and GER data.	Yes / Yes	Comprehensive PSG Duration = 8-12 hours Nocturnal (12 hour recordings in 22 pts; 8 hour daytime recordings in 4 pts.)	1) Although subtle abnormalities may be detected by comprehensive PSG, they are not predictive of recurrent apnea or death. 2) Due to the absence of a control group in this study, differences between normal infants and infants with parent-observed apneas could not be determined. 3) GER episodes were not associated with apnea, bradycardia, or other respiratory changes during PSG.
46	Rosen (1999)	4	This appears to be a retrospective descriptive cohort, which catalogs and describes clinical questionnaire and PSG data from the records of 326 children, who had been referred to an academic sleep disorders lab by primary care or ENT, for clinical concerns of obstructive sleep apnea. Cases involving more complex disease (craniofacial abnormalities, genetic disorders, prior surgery, neuromuscular disease, prior upper airway surgery) were excluded, narrowing the spectrum of disease. The investigators decided to exclude a single Asian patient from analysis. The remaining 326 patients were roughly evenly devided between African American (38%), Caucasian (30%) and Hispanic (31%). The polysomnographic data was used to classify patients into five "levels" of sleep disordered breathing 1. No snore (no snoring, apnea, desaturation, or hypoventilation) 2. Snore (snoring without apnea, desaturation or hypoventilation) 3. UARS (snoring with marked paradoxical inward chest movements or repetitive arousals and movements) 4. OSA (snoring with apnea and/or hypercapnia, without desaturation) 5. Hypoxemia with OSA (snoring with desaturation and apnea, with or without hypercapnia) The clinical survey data and PSG characteristics of patients were then analyzed and reported. MGD: Retrospective cohort of children 1-12 y referred for suspected OSA and snoring; describes clinical features of obstructive sleep apnea hypoventilation syndrome in children, diagnosed confirmed by PSG	Case control study Blinding absent	Eligible: 326 % males: 56%	Cases: 5.8 +/-3.0 (range 1-12 yrs) Narrow spectrum	Academic center: Yale-New Haven Expert assigned or selected groups Government funded	Parental observations	PSG criteria	Yes. Obstructive apneas were quantified, but hypopneas were not. A single method of airflow was used, which was not specified ("thermistor). End-Tidal CO2 was used to determine obstructive hypoventilation. Criteria which allowed a patient to classify as having OSA were the presence of one or more of the following deviations: 1. obstructive apnea index was >1/hr 2. 4% desaturation index of >1.5/hr, or SaO2 nadir less than 92% 3. EtCO2 value >50 for over 9% of the TST, or peak EtCO2 value of 55mmHg or more	Comprehensive PSG, including End-Tidal CO2 tracing. The method of airflow assessment was not detailed, sounds to be a thermistor ("nasal-oral airflow"). A nasal pressure transducer was not apparently part of the montage. PSG duration = "overnight" Timing of PSG: Nocturnal	Neither clinical questionnaire data nor the presence of obesity can reliably predict PSG diagnosis of OSAHS (as defined by these investigators) in pediatric patients who have been referred to PSG for complaints of snoring and disturbed sleep. Though the descriptions of the PSG characteristics of their diagnostic categories are interesting, these descriptions inherently manifest a sort of circular logic; it remains to be seen whether these distinctions (ie: snoring vs UARS vs OSA) in a population of snoring, sleep disturbed children (by history) have any bearing on clinical outcomes (ie: reduction in symptoms post tonsillectomy). The fact that 10% of the cohort was classified as essentially normal ("no snore") despite the fact that 99% of the patients were classified by parental assessment as "habitual snorers" may reflect an important degree of night-to-night variation. 3-4+ tonsillomegaly increased the likelihood of discovery of frank OSA (as described by these investigators) in pediatric patients with snoring and subjective sleep complaints.This suggests face-validity of PSG for demonstration of more significant degrees of sleep disordered breathing, given the accepted causal relationship of adenotonsillar hypertrophy in the pathogenesis of pediatric OSA.
48	Sanchez-Armengol (2001)	4	A total of 101 self selected adolescent aged (12-16 yrs) volunteers underwent an 86 question symptom screening questionnaire and unattended polysomnography. "No inclusion or exclusion criteria according to the absence or presence of history of medical problems or chronic disease were established." Polysomnographic features of the studies are reported, and correlations between PSG findings and clinical parameters such as snoring, daytime impairment symptoms, and anthropomorphic data are discussed. The polysomnographic findings of those who snored were compared with those who did not snore. Snoring was ascertained via self-report or parental report.	Normative study Blinding not applicable	Eligible: 327 Completed study: 101 % males: 58 # controls: n/a	Cases: 13.2 years, +/- 0.8 years (ages include: 12-16 years) Patient Spectrum: Not clear No gold standard testing done.	12 public schools were chosen at random, and purpose of the study was explained. Those who "voluntarily agreed to take part" were included. Self-selected groups Government funded	Multiple comparators, specify: Questionnaires regarind SRBD-associated symptoms & parental observations regarding behaviors	PSG criteria	Yes	Ambulatory (unattended) sleep study PSG duration = total recording time = 546 min (+/- 59 min) Timing of PSG: Nocturnal	1. Oximetry does not reliably distinguish between snorers and nonsnorers in an unselected adolescent age population 2. Ambulatory PSG recordings in self-selected children who may or may not have sleep disorders showed a trend toward higher RDI amongst snorers compared with nonsnorers
49	Shott (2006)	4	To investigate the incidence of OSA in children with Down Syndrome. Children followed prospectively in a longitudinal study from the age of 2 through 5 years although only baseline PSG results reported in this manuscript. Authors also investigated ability of parents to identify sleep problems	Prospective cohort Blinding not specified	Eligible: 65 enrolled (unclear how many were eligible to enroll) Completed study: 56/65=86% % males: not reported # controls: n/a	Cases: 42 months (range 20-63 months) Controls: n/a Wide spectrum	Academic center Self-selected groups Privately funded (non-pharmaceutical)	Parental observations	PSG criteria Other diagnostic criteria developed by authors	Yes / Yes Nasal pressure used for airflow	Comprehensive PSG PSG duration = not reported Timing of PSG:Nocturnal	"- findings suggest that parents of children with Down syndrome underestimate the presence of sleep problems (respiratory) - findings suggest that OSA is common in children with Down syndrome - Findings support routine use of PSG in children with Down syndrome (at least in age range tested: 3-4 years)

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
50	Sisk (1999)	4	To determine frequency of OSA in children with achondroplasia and the effectiveness of T&A as a treatment. Also to review perioperative and anesthetic evaluations and precautions To determine frequency of OSA in children with achondroplasia and assess effectiveness of adenotonsillectomy.	Chart review, clinical series Blinding not specified	Eligible: 58 initially with Hx compatible with SDB but 22 eliminated when didn't have OSA by study criteria Completed study: 36 (23 with PSG-defined OSA) % males: not reported # controls:none	Cases: overall 19 months (range 1 day-14 years) Children with PSG-defined OSA had mean age of 3.7yrs at Dx; those with OSA identified by caregiver had mean age of 4.0yrs Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Expert selected by diagnosis of OSA (author criteria) Funding not specified	Multiple comparators: Clinical history Parental report Physical exam	Other diagnostic criteria developed by authors Other as below: No OSA = no desat below 90% Mild OSA = Desat 80-90% assoc with hypopneas and apneas Severe OSA = desat <80% Children whose caregivers reported observed apneas, snoring, glottal stops, gasping, neck hyperextension, nocturnal self-awakenings, irritability or EDS were classified as OSA even in if O2 desat did not reach criteria above	No / No: Comments: no information on sleep staging given or even if it was performed. No details regarding definition of apneas, hypopneas, etc	Unclear whether comprehensive or limited PSG; no mention of EEG or how airflow was measured Other diagnostic techniques included in review, e.g, echocardiography, radiographs, imaging etc PSG duration = unknown Timing of PSG: Nocturnal	*- supports previous findings that children with achondroplasia are at risk for OSA likely because of craniofacial features - findings support T&A as an intervention in children with OSA to improve respiratory symptoms - findings support T&A over adenoidectomy alone as an effective treatment to improve respiratory symptoms - Test-retest reliability is demonstrated in that the PSG demonstrated improvement in the expected (improved) direction after surgery.
51	Southall (1985)	4	10 infants with rapidly developing, severe hypoxemic episodes were studied with a variety of clinical and physiological exams to determine etiology of spells	Clinical series, observational study, case report Blinding absent	Completed study: 10 % males: 90 1 was deceased twin with similar condition	Cases: studied at mean 29.2 months (2-87 months) Controls: NONE Spectrum unclear	Not specified	No standard PSG done, but 9/10 had EEG monitoring, plus all had O2 (transcutaneous or pulse ox) BP/ECG/Ribcage and abdominal wall movements, esophageal pressures monitored. Expiratory airflow (from thermistor or expired CO2) was studied in 7/10 Expiratory muscle EMGs were done (# not clear). 2 pts.had chest fluoroscopy, 3 had microlaymgoscopy, 3 patients had muscle biopies from external oblique, 3 were studied with 100% humidified oxygen applied during quiet sleep. 6 patients had eyeball compression Neurological development was studied in all	Diagnostic criteria developed by authors	No	Limited sleep study (see alternate diagnostic measures)	Limited conclusions can be drawn relative to PSG, as it was unclear what the findings were during sleep in the "infant(s)" under two months old in whom episodes occurred prdemoninantly during sleep (and feedint) – all other episodes were during wakefulness
52	Villa (2002)	4	To investigate the clinical usefulness of a personalized oral appliance for treatment of OSA with malocclusion. - 19/32 children randomly assigned to oral appliance for 6 months then post appliance PSG, questionnaire, and physical exam compared between these children and the non-intervention children (n=13) - note that oral appliance used corrects occlusal anomalies rather than provides mandibular advancement To assess clinical usefulness and tolerance to a personalized oral jaw positioning appliance for the treatment of OSA with malocclusion	Perhaps a methodological study; Clinical series, observational study, case reports; Blinding not specified	Eligible: 32 children initially enrolled, 19 randomly assigned to treatment, 13 acted as controls Completed study: 23 (9 controls) % males: 20/32 = 62.5% enrolled; treated 53% males, controls 77% males; sex unknown of those who dropped out	Cases: 6.86±2.34 years Controls: 7.34 ±3.1 years, Narrow spectrum	Academic center Expert assigned or selected groups Assigned groups according to AI>1 and clinical signs of dysthagnia Blinding not specified	Brouillette questionnaire of OSAS symptoms Physical exam incl tonsil size	PSG criteria: Initial Dx reached by AI>1 but no more details given. Subjects had to have initial Dx of AI>1 with associated clinical signs of dysgnathia before entry into study Follow up PSG included only 2 EEG channels and airflow measured by thermocouple	No Just stated that they were scored according to R&K Were respiratory scoring methods clearly defined? No repiratory inductive pleth, saturation and thermistor used Comments: PSG included 2 EEG channels and scored in accordance with R&K and ATS. No further details given	Comprehensive PSG PSG duration = not reported Timing of PSG: Nocturnal	*- use of personalized jaw positioning device for 6 months in the presence of AI>1 and dysthagnia was associated with an improvement in AHI and AI - also associated with reduced adenotonsillar hypertrophy (? Possibly due to enlarged pharyngeal space rather than reduced hypertrophy per se) - enlarging the pharyngeal space was associated with improvement in AHI and AI in the expected direction - findings support use of PSG in characterizing respiratory parameters following treatment intervention
53	Weatherly (2004)	4	To compare clinical diagnoses with PSG in children scheduled for adenotonsillectomy. Parental questionnaires were used to determine symptoms that could assist in identifying children with normal PSGs but clinical diagnosis of SDB. PSG included esophageal pressure monitoring	Prospective cohort study Blinded study; This study was designed to compare clinical and PSG diagnoses in children on referred for adenotonsillectomy by their otolaryngologist. Parent report symptoms were also used	Eligible: unknown Completed study: 34 % males: 18/34 = 53% # controls:none	Cases: 8.2+/-1.9yr Range 5.3 – 12.9 yr Controls: N/A Narrow spectrum	Academic center and community referral Expert assigned or selected groups since they are children placed on the ENT list Government funded	Multiple comparators, specify: Compared to clinical evaluations and parental report	PSG criteria; other diagnostic criteria developed by authors, and other, specify: Physician diagnosis on H&P Parent symptom report	No The reader was referred to previously published methods Yes	Comprehensive PSG MSLT PSG duration = not reported Timing of PSG:Nocturnal	*- Poor agreement found between clinical diagnoses of SDB and PSG diagnoses. - Agreement variable depending on criteria used. - Best agreement obtained when threshold lowered to AHI>1 and subtle changes included (RERAs). - 2 negative parental symptom questions appeared helpful in identifying children who were unlikely to have abnormal PSG.
54	Wiet (1997)	4	They looked at 3 measures pre- and post-op: AHI—likely this was an obstructive AHI as both apneas and hypopneas were defined in terms of OA and OH % sleep time oxy sat below 90% % sleep time ET CO2 > 50 torr	Clinical series, observational study, case reports Retrospective chart review Blinding absent (assumed since the scorers knew these were post-op studies.)	Eligible: 48	Cases: 7.5 years (1.5-20 yr) Wide spectrum	Academic center Random selection Funding not specified	Not specified	PSG criteria and other: Some Ss were included based on a high suspicion of OSA either by history or by physical exam prior to PSG so to some extent other criteria were used	No / Yes Comments: Apnea=10" of no airflow with paradoxical chest/abd movement; Hypopnea=decrease in tidal volume, amplitude change not specified, with paradoxical breathing; implied duration is 10"; no desaturation specificed OSA=AHI>5/hr (apparently only obstructive events)	Comprehensive PSG 1. EEG (# leads unclear) 2. EOG (# leads unclear) 3. EMG 4. EKG 5. Nasal airflow 6. Oral airflow 7. Thoracic and abdominal movements 8. Tidal Volume 9. Pulse oximeter 10. ET-CO2 11. Esophageal manometer in some patients PSG duration = not specified Timing of PSG:Nocturnal	PSG demonstrates the expected improvement in respiratory parameters seen post-ENT surgery in a wide range of children demonstrating test-retest validity for PSG as a measure of OSA.
4.2.1.1.2 Audio or video recordings												
55	Lamm (1999)	2	36 healthy children aged 1.5 – 18 years old were referred by peds and ents for suspected OSA. 29 completed the study. A 19 item questionnaire was given, and parents were asked to record 15 minutes of sleep with characteristics of concerning breathing paterns (home audiotape) Recordings were analyzed independently by 7 blinded observers for presence of "struggle sounds" and respiratory pauses. Comparison was made with results of PSG. PSG and Home Audiotapes were obtained on 29 children with suspected SDB (14 with OSA and 15 with primary snoring as diagnosed by PSG) to determine if a home audiotape was useful in distinguishing children with primary snoring from those with OSA. This study was done to evaluate whether a home audiotape recording could accurately identify children with OSAS	Prospective cohort Blinded study	Eligible: 36 Completed study: 29 14 OSAS % males: 85% OSAS # controls:15 primary snoring % males: 60	Cases: 5.5 +/-4.5 Controls: 6.0 +/-4.1 Narrow spectrum	Academic center Expert assigned or selected groups Funding source: Not specified	Videotape or audio recording	PSG criteria	Yes / yes	Comprehensive PSG PSG duration = 5.7 ± 1.5 hrs Nocturnal	1) PSG is superior to home audiotaping of breathing during sleep in diagnosing obstructive sleep apnea 2) Findings on a home audiotape can be suggestive of OSA, but are not sufficiently specific to reliably distinguish primary snoring from OSA.

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17	Goldstein (2004)	2	41 children underwent PSG : 21 were initially PSG + as defined by RDI>5. The 20 pts who were PSG-were randomized to T&A or nonsurgery. Repeat PSG and 32 item clinical assessment was done on all 41 children after intervention and results compared. The goal of this study was to determine if patients with a clinical assessment of OSA but negative PSG had improvement in their clinical assessment score after T&A compared to children who did not undergo surgery	Prospective cohort study Blinded study	Eligible:78 Completed study: 41 % males: 50% (more females with –PSG randomized to T&A)	Cases: 5.8 (+/- 2.6) to 7 (3.6) Narrow spectrum	Academic center Random selection Government funded	Multiple comparators: Clinical assessment Score :Thiry two items which were differentially weighted by specificity of symptoms to OSA (as determined by authors previous data review.) Highest possible score was 164, children with >40 were considered to have OSA, <20 asymptomatic , and between 20-40 mild symptoms of upper airway obstruction	PSG criteria and Other diagnostic criteria developed by authors	No / Yes	No sleep stage scoring – only respiratory parameters were used. Used RDI >5 as definition of OSALimited sleep study (describe parameters) PSG duration = Not specified Timing of PSG:Not specified	In children with clinically determined OSA, negative PSG, without evaluation of UARS may not be sensitive in picking up children who may improve clinically with T&A. Findings suggest overnight PSG should be considered after T&A for treatment of OSA, and also may be considered if high clinical suspicion with initial negative PSG Lateral neck x-rays to assess adenoidal size were included as part of the clinical score. But the positive predictive value of the clinical score for predicting a positive PSG was only 48%.
56	Sivan (1996)	3	58 consecutive children referred for eval of possible OSA with snoring and labored breathing underwent limited, resp PSG and home videography to see if review of a 30-minute home video could predict pres-ence/absence of OSA. All children had enlarged adenoids and some additionally had enlarged tonsils.	Prospective cohort Blinded study	Eligible: 58	Cases: 4.3 (range 2-6 y.o.) Spectrum NA	Community referral Random selection Funding source not specified	Videotape or audio recording Videotape of head and naked torso for 30 minutes when child exhibited sx's (snoring, labored breathing, etc.)	PSG criteria Other diagnostic criteria developed by authors: Video graded by 1. score of greater than 10 on scoring system AND 2. investigator's subjective impression Score of 8 became the cut-off between a subjective sense of normal vs. abnormal by the investigators. Scoring system: 1. Inspiratory noise:0 - None; 1 - Weak; 2 - Loud 2. Type of inspiratory noise: 1 - Episodic; 2 - Continuous 3. Movements during sleep: 0 - No movements; 1 - Few movements (≤3); 2 - Numerous movements (>3), whole body 4. Number of waking episodes:1 point for each episode 5. Number of apnoeas: 0 - None; 1 - One or two; 2 - Numerous; >=3 6. Chest retractions: 0 - None; 1 - Intermittent (periodic); 2 - All the time 7. Mouth breathing: 0 - None; 1 - Intermittent (periodic); 2 - All the time	NA: No EEG was done Were respiratory scoring methods clearly defined? Yes Comments: 1) an average of more than one obstructive apnoea of any length per hour of sleep; 2) any episode of obstructive apnoea associated with hypoxaemia (Sa,O2 <90% or a decrease greater than 4% from baseline SaO2); 3) central apnoea >20 s or associated with desaturation; 4) hypoventilation (peak PET,CO2 >=53 mmHg), or PET,CO2 >=45 mmHg for more than 60% of total sleep time or associ-ated with hypoxaemia as above, or a change in PET,CO2 > 13 mmHg from baseline	Limited sleep study (describe parameters) 1. Thoracic impedance 2. Oxy sat 3. Oximeter pulse waveform 4. Airflow via capnography 5. ETCO2 by capnography 6. ECG PSG duration ≥ 8 hours Timing of PSG : Nocturnal	1. Expert interp of 30-min home video of a symptomatic child has a high sens for diagnosing OSA based on old criteria for pediatric OSA from a resp-only PSG; 2. Expert interp of 30-minute home video of sx'ic child has a med-high spec for ruling-out OSA; 3. Application of a weighted scoring system for scoring a 30-minute video has med-high sens for predicting OSA; 4. Application of a weighted scoring system of a 30-minute video has med-high spec for ruling-out OSA
57	Jacob (1995)	3	21 subjects aged 2-12 underwent abbreviated, unattended PSG and had a lab PSG within 1-12 days, with comparison of respiratory events, sleep efficiency, movement/arousal indices reported.	Prospective cohort Blinded study	Eligible: 24 Completed study: 21 % males: 61	Cases: 7 (range 2-12) Narrow spectrum	Community referral Expert assigned or selected groups Government funded	Portable studies	PSG criteria	Yes / Yes Apnea – 80% or greater decrease in amplitude on RIP summation channel 3 seconds in duration Central apnea – 20 seconds plus 4% desaturation ***Not clear how they distinguished CA unless duration was only criteria on home study*** Hypopnea 50-80% decrease in amplitude with 4% desat Laboratory PSGs were also scored using only video and the 7 channels used in home studies by scorers blinded to results of other methods	Comprehensive PSG Compared with Home study: ECG, pulserate, SaO2, pulse waveform, thoracic and abdominal excursion and their sums obtained from RIP PSG duration = 7-8 hours Timing of PSG: Nocturnal	Home PSG simplified recording using seven channels of data (ECG, pulse rate, SaO2, pulse waveform, thoracic and abdominal excursions and their sums) as well as audiovideo recording appears to have the ability to identify OSA in uncomplicated patients with adenotonsillar hypertrophy. Cardiorespiratory parameters were comparable to those seen in the sleep lab, with improved sleep efficiency and total sleep time at home.
4.2.1.1.3 Questionnaires												
23	Goodwin (2004)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). Sleep habits questionnaire (SHQ) assessed for presence of sleepwalking, sleeptalking, sleepterrors, eneuresis as well as measures of snoring, EDS, witnessed apneas, insomnia and learning problems. Likelihood of having a parasomnia was correlated with evidence of SDB.	Prospective cohort Blinding not applicable	Completed study: 480 % males:50	Cases: 6-8y 52.9% 9-11 47.1% Narrow spectrum	Patients recruited from school system Self-selected groups Government funded	Parental observations	PSG criteria	Yes / Yes	Ambulatory (unattended) sleep study PSG duration = 487 minutes Timing = nocturnal	1) Unattended home PSG appears to identify a large number of patients with SDB (24%) in a non-clinically referred population, suggesting possible usefulness as a screening tool 2) Study suggests that PSG might be useful in diagnosing SDB in patients with parasomnias (specifically sleepwalking, sleep talking and eneuresis)
58	Chau (2008)	2	This study was designed to see if a video-assisted questionnaire was any better than a simplified three question verbal questionnaire to produce parental responses that predict the presence of OSA (as demon-strated by PSG). 116 consecutive children referred for PSG for clinical concerns over OSA were recruited. All parents underwent a questionnaire regarding sleep habits and behaviors of their children. Half were randomized to a simple 3-question questionnaire graded on a 12-point scale (SQ group), while half were randomized to a seven question survey asking specifically about the presence or absence of 7 different be-haviors, graded on a 7 point scale (loud snoring, mouth breathing, subcostal retractions, paradoxical breath-ing, observed apnea, and struggling with arousal) and a video demonstrating these behaviors was shown to the parents to help illustrate (VQ group). The children all underwent PSG and presence or absence of OSA was determined (OSA was defined as AHI>1.5, or Et-CO2>50mmHg for >50% of TST). The sensitivity, specificity, PPV, NPV and likelihood ratios of the VQ and SQ were computed and compared.	Prospective cohort study Single blinded	116 eligible 110 completed 58 cases 77% males 52 controls 63% males	Cases:5.9 (SD=3.0) Controls: 7.0 (SD=3.0) Narrow spectrum	Academic center Self-selected groups Government funded	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Alice3, no nasal pressure transducer. EtCO2 was obtained. Duration and Timing not specified	Single-night polysomnography has good face validity and tracks with parental observations of respiratory difficulty during sleep, as gauged by standardized questionnaires.
26	Brouillette (1984)	3	This study was designed to test a questionnaire developed by the authors to determine if it is able to discriminate between children referred for suspected OSA (due to adenotonsillar hypertrophy) who need no further follow up versus those who require PSG evaluation. The investigators enrolled 23 children with PSG-diagnosed OSA and 46 matched controls (2 for each OSA subject). All subjects completed a sleep question-naire and an OSA score was derived that allowed classification of OSA and control groups. This OSA score was then used in a new group of 23 subjects - who were referred for suspected OSA - to determine how well the questionnaire predicted which of the newly-referred children likely had a diagnosis of OSA.	Clinical series Blinding not specified	Eligible: 23 OSA; 23 possible OSA subse-quently referred; Completed study: 23 OSA; 23 possible OSA % males: 16/23 (69.5%) OSA 17/23 (74%) possible OSA subsequently referred # controls:unknown number of controls eligible as controls were matched to OSA % males: Figure not stated but OSA matched to 2 controls of same sex therefore there were 32/46 (69.5%) male	Cases: OSA: 3.8±2.4 yrs (range 1-10yrs) Possible OSA 5.3±3.6 yrs (range unknwn) Controls:4.0±2.3 yrs (range 1-10yrs) Patient Spectrum =Narrow The first part of the study was a narrow spectrum (OSA and controls); the sec-ond part included children suspected of having OSA so that the predictive value of the questionnaire could be tested	Academic center and community referral Expert assigned or selected groups Privately funded (non-pharrmaceutical)	Parental observations	Diagnosis reached using other diagnostic criteria developed by authors Comment: Dx of OSA made initially by PSG using abnormal tcPO2 or PzO2, and clinically significant morbidities (cor pulmonale, FTT etc).	No / No: Comments: Reader referred to previous citations by the investigators. Dx of OSA made initially by PSG using abnormal tcPo2 or PzO2, and clinically significant morbidities (cor pulmonale, FTT etc)	Parameters: Heart rate, ECG, tcPO2, PaCO2, oral and nasal airflow, thorax, abdomen Limited sleep study (describe parameters) PSG duration = not stated Timing of PSG:Daytime naps following sleep deprivation	"- findings suggestive of a questionnaire-generated OSA score that may be useful to help clinicians decide which children with adenotonsillar hypertrophy (and without other medical comorbidities) should undergo PSG. - Definition of OSA used in this old but key paper. very much affected their conclusions, as the Definition required some clinically reported symptoms..rather than an objective diagnosis being made and then comparing to symptoms.

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59	Chervin (2007)	3	Retrospective analysis of 105 children aged 5-12.9 yrs (78 subjects underwent clinically indicated AT). Study objective: validation of SRBD scale and comparison of scale and PSG to predict OSA treatment related neurobehavioral responses.	Case control Blinded study	Eligible: 78 Completed study: 78 % males: 57 # controls: 27 % males: not stated	Cases: 8.4 +/- 1.9 yrs. (all cases) Controls: mean age not stated. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Not specified SRBD scale of the Pediatric Sleep Questionnaire, neurobehavioral scales (Child Symptom Inventory-4, IVA CPT), MSL from MSLT, and otolaryngologist Hx and PE	PSG criteria Other diagnostic criteria developed by authors Other:Clinically indicated AT defined by treating ENT.	Yes / Yes	Comprehensive PSG and MSLT PSG duration = Not Stated Timing of PSG: Not specified	1) SRBD subscale of the PSG predicts PSG results, useful for research but not reliable enough for patient care. 2) SRBD subscale may predict OSA-related neurobehavioral morbidity and its response to AT as well or better than PSG. 3) Preop PSG may serve important purposes other than to diagnosis OSA, such as to screen for severe OSA that raises risk of perioperative AT complications. 4) With persistence of OSA in significant number of children after AT, present data indicate that PSG may be more important after TA than before.
60	Villa (2007)	3	16 children were nonrandomly selected to participate in an observational cohort to evaluate the benefits of an orthodontic device called a Rapid Maxillary Expander (RME) in children with PSG documented OSA. To meet inclusion criteria for the study, children must have signs/symptoms of OSA along with AHI>1 and a high/narrow palate with malocclusion (deep bite, reclusive bite or crossbite). 78% of the children had enlarged tonsils. The RME device widens the maxillary bone by distraction osteogenesis at the suture level, widening the maxilla, and increasing the cross-sectional and volumetric space of the nasal cavity. It can also improve orophryngeal spaceby modifying the resting position of the tongue. All patients underwent a Brouillette questionnaire and PSG prior to treatment, and at 6 and 12 month follow up.	Prospective cohort Blinding not specified	Eligible:16 Completed study:14 and 2 lost to follow-up % males: not stated	Cases: children aged 4-11 Controls: no control group Narrow spectrum; none were obese	Academic center Expert assigned or selected Funding not specified	Behavioral scales Brouillette questionnaire was performed before and after surgery Orthodontic assessments and measurements	PSG criteria	Yes Not applicable; apneas defined as lasting > 5 seconds.	Comprehensive PSG no nasal pressure transducer tracing, no End-Tidal CO2 tracing used. Used thermocouples PSG duration = "standard overnight" polysomnogram Nocturnal	1. Polysomnography in children shows face validity when compared to clinical scores (Brouillette Scale) and objective assessment of airway space improvements in this group of children with high arched palate and obstructive sleep apnea using a rapid maxillary expander device. 2. Though the RME does improve PSG results, as well as the symptoms and signs of OSA, residual disease is seen. It is reasonable to pursue PSG after maximum treatment results are obtained from RME, particularly if adenotonsillar hypertrophy is present. RME was limited to only a select group of children who were of normal height and weight.
46	Rosen (1999)	4	This appears to be a retrospective descriptive cohort, which catalogs and describes clinical questionnaire and PSG data from the records of 326 children, who had been referred to an academic sleep disorders lab by primary care or ENT, for clinical concerns of obstructive sleep apnea. Cases involving more complex disease (craniofacial abnormalities, genetic disorders, prior surgery, neuromuscular disease, prior upper airway surgery) were excluded, narrowing the spectrum of disease. The investigators decided to exclude a single Asian patient from analysis. The remaining 326 patients were roughly evenly devided between African American (38%), Caucasian (30%) and Hispanic (31%). The polysomnographic data was used to classify patients into five "levels" of sleep disordered breathing 1. No snore (no snoring, apnea, desaturation, or hypoventilation) 2. Snore (snoring without apnea, desaturation or hypoventilation) 3. UARS (snoring with marked paradoxical inward chest movements or repetitive arousals and movements) 4. OSA (snoring with apnea and/or hypercapnia, without desaturation) 5. Hypoxemia with OSA (snoring with desaturation and apnea, with or without hypercapnia) The clinical survey data and PSG characteristics of patients were then analyzed and reported. MGD: Retrospective cohort of children 1-12 y referred for suspected OSA and snoring; describes clinical features of obstructive sleep apnea hypoventilation syndrome in children, diagnosed confirmed by PSG	Case control study Blinding absent	Eligible: 326 % males: 56%	Cases: 5.8 +/-3.0 (range 1-12 yrs) Narrow spectrum	Academic center: Yale-New Haven Expert assigned or selected groups Government funded	Parental observations	PSG criteria	Yes. Obstructive apneas were quantified, but hypopneas were not. A single method of airflow was used, which was not specified (?thermistor). End-Tidal CO2 was used to determine obstructive hypoventilation. Criteria which allowed a patient to classify as having OSA were the presence of one or more of the following deviations: 1. obstructive apnea index was >1/hr 2. 4% desaturation index of >1.5/hr, or SaO2 nadir less than 92% 3. EtCO2 value >50 for over 9% of the TST, or peak EtCO2 value of 55mmHg or more	Comprehensive PSG, including End-Tidal CO2 tracing. The method of airflow assessment was not detailed, sounds to be a thermistor ("nasal-oral airflow"). A nasal pressure transducer was not apparently part of the montage. PSG duration = "overnight" Timing of PSG: Nocturnal	Neither clinical questionnaire data nor the presence of obesity can reliably predict PSG diagnosis of OSAHS (as defined by these investigators) in pediatric patients who have been referred to PSG for complaints of snoring and disturbed sleep. Though the descriptions of the PSG characteristics of their diagnostic categories are interesting, these descriptions inherently manifest a sort of circular logic; it remains to be seen whether these distinctions (ie: snoring vs UARS vs OSA) in a population of snoring, sleep disturbed children (by history) have any bearing on clinical outcomes (ie: reduction in symptoms post tonsillectomy). The fact that 10% of the cohort was classified as essentially normal ("no snore") despite the fact that 99% of the patients were classified by parental assessment as "habitual snorers" may reflect an important degree of night-to-night variation. 3-4+ tonsillomegaly increased the likelihood of discovery of frank OSA (as described by these investigators) in pediatric patients with snoring and subjective sleep complaints.This suggests face-validity of PSG for demonstration of more significant degrees of sleep disordered breathing, given the accepted causal relationship of adenotonsillar hypertrophy in the pathogenesis of pediatric OSA.
195	Mallory (1989)	4	This study looked at 41 children referred from an academic obesity clinic who had histories suggestive of sleep disordered breathing who were obese as defined by weighing >150% of ideal body weight. (This was 20% of the new patients in the obesity clinic). 45 patients were referred but only 41 met weight criteria. These patients underwent overnight PSG and 17/41 of the older patients had PFTs. A sleep history questionnaire was obtained on 38 patients,	Prospective cohort Blinding absent	Eligible:41 Completed study:41 % males:63 # controls: None	Cases: 10.3 +/- 4.4 (3-20) Narrow spectrum	Academic center Self-selected groups Funding source not specified	Not specified	PSG criteria	No / Yes However they used "standard definitions for apnea and hypopnea" – not clear what this was at the time of the study, only that AHI>5 was considered abnormal	Comprehensive PSG Duration = > 300 minutes TST was obtained in 37 patients (average 451+/-56.2 minutes), however the 4 with sleep time less than that were included in the analysis as they had significant respiratory abnormalities Timing = nocturnal	1) History of sleep disordered breathing alone is not adequate to predict presence of OSA in obese children; PSG would still be indicated 2) There did not seem to be a correlation between body weight and presence or severity of SDB in this population, again making history and physical inadequate to determine need for PSG 3) This study did not address the prevalence of SDB in a cohort of obese children unselected for history of breathing problems during sleep. This paper highlights the need for PSG in obese children. There is an 8% incidence of OSA in obese kids (compared to 1-2% of the general population), but unfortunately history and degree of obesity doesn't necessarily correlate with severity of OSA.
49	Shott (2006)	4	To investigate the incidence of OSA in children with Down Syndrome. Children followed prospectively in a longitudinal study from the age of 2 through 5 years although only baseline PSG results reported in this manuscript. Authors also investigated ability of parents to identify sleep problems	Prospective cohort Blinding not specified	Eligible: 65 enrolled (unclear how many were eligible to enroll) Completed study: 56/65=86% % males: not reported # controls: n/a	Cases: 42 months (range 20-63 months) Controls: n/a Wide spectrum	Academic center Self-selected groups Privately funded (non-pharmaceutical)	Parental observations	PSG criteria and other criteria developed by authors	Yes / Yes Nasal pressure used for airflow	Comprehensive PSG PSG duration = not reported Timing of PSG:Nocturnal	"- findings suggest that parents of children with Down syndrome underestimate the presence of sleep problems (respiratory) - findings suggest that OSA is common in children with Down syndrome - Findings support routine use of PSG in children with Down syndrome (at least in age range tested: 3-4 years)
53	Weatherly (2004)	4	To compare clinical diagnoses with PSG in children scheduled for adenotonsillectomy. Parental questionnaires were used to determine symptoms that could assist in identifying children with normal PSGs but clinical diagnosis of SDB. PSG included esophageal pressure monitoring	Prospective cohort study Blinded study; This study was designed to compare clinical and PSG diagnoses in children on referred for adenotonsillectomy by their otolaryngologist. Parent report symptoms were also used	Eligible: unknown Completed study: 34 % males: 18/34 = 53% # controls:none	Cases: 8.2+/-1.9yr Range 5.3 – 12.9 yr Controls: N/A Narrow spectrum	Academic center and community referral Expert assigned or selected groups since they are children placed on the ENT list Government funded	Multiple comparators, specify: Compared to clinical evaluations and parental report	PSG criteria and other criteria developed by authors and criteria: Physician diagnosis on H&P Parent symptom report	No The reader was referred to previously published methods Yes	Comprehensive PSG MSLT PSG duration = not reported Timing of PSG:Nocturnal	"- Poor agreement found between clinical diagnoses of SDB and PSG diagnoses. - Agreement variable depending on criteria used. - Best agreement obtained when threshold lowered to AHI>1 and subtle changes included (RERAs). - 2 negative parental symptom questions appeared helpful in identifying children who were unlikely to have abnormal PSG.
4.2.1.1.4.1 Subjective Measures of Sleepiness												
22	Chervin (2006)	1	PSG, MSLT and Pediatric Sleep Questionnaire Sleepiness Subscale (PSQ-SS) were performed on 103 children aged 5-12 yrs (77 case subjects scheduled for AT; 26 controls scheduled for unrelated surgical care). Study objective was to compare validated measure of subjective childhood sleepiness (PSQ-SS) to objective measures of sleepiness (MSLT) and examine by PSG (standard and investigational measures) what measures of SDB predict subjective sleepiness.	Case control Blinded study	Eligible: 77 Completed study: 77 % males: 57 (total group) # controls: 26 % males: 57 (total group)	Cases: 8.4 +/- 1.9 yrs. (5-12.9 yrs) Mean age and range is for entire group; no designation of case and control values. Narrow spectrum	Academic center and community referral Selection: Not specified Government funded	Behavioral scales MSL on MSLT	Other diagnostic criteria developed by authors (ENT clinically determined indications for AT)	Yes / Yes	Comprehensive PSG and MSLT PSG duration = overnight Timing of PSG: Nocturnal	1) Subjective sleepiness (as measured by PSQ-SS) is a frequent problem among children with suspected SDB. 2) Subjective sleepiness (PSQ-SS) reflects MSLT results to a limited extent. 3) Standard PSG measures of SDB predict subjective sleepiness, but respiratory cycle-related EEG changes may offer additional clinical utility.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
17	Goldstein (2004)	2	41 children underwent PSG : 21 were initially PSG + as defined by RDI>5. The 20 pts who were PSG- were randomized to T&A or nonsurgery. Repeat PSG and 32 item clinical assessment was done on all 41 children after intervention and results compared. The goal of this study was to determine if patients with a clinical assessment of OSA but negative PSG had improvement in their clinical assessment score after T&A compared to children who did not undergo surgery	Prospective cohort study Blinded study	Eligible:78 Completed study: 41 % males: 50% (more females with –PSG randomized to T&A)	Cases: 5.8 (+/- 2.6) to 7 (3.6) Narrow spectrum	Academic center Random selection Government funded	Multiple comparators: Clinical assessment Score :Thiry two items which were differentially weighted by specificity of symptoms to OSA (as determined by authors previous data review.) Highest possible score was 164, children with >40 were considered to have OSA, <20 asymptomatic , and between 20-40 mild symptoms of upper airway obstruction	PSG criteria and Other diagnostic criteria developed by authors	No / Yes	No sleep stage scoring – only respiratory parameters were used. Used RDI >5 as definition of OSALimited sleep study (describe parameters) PSG duration = Not specified Timing of PSG:Not specified	In children with clinically determined OSA, negative PSG, without evaluation of UARS may not be sensitive in picking up children who may improve clinically with T&A. Findings suggest overnight PSG should be considered after T&A for treatment of OSA, and also may be considered if high clinical suspicion with initial negative PSG Lateral neck x-rays to assess adenoidal size were included as part of the clinical score. But the positive predictive value of the clinical score for predicting a positive PSG was only 48%.
24	Goodwin (2003)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). BMI, snoring, EDS, witnessed apneas, insomnia and "learning problems" were compared among the group using different cutoffs of RDI and oxygen desaturations to define SDB	Prospective cohort study Blinding: Not applicable	Eligible: Completed study 239 % males:55.2 # controls:depends on cutoff RDI +/- desats	Cases: 6-11 yrs old 55% 6-8 44.8% 9-11 not further broken down Narrow spectrum	Recruited through school district Self-selected groups Government funded	Parental observations	PSG criteria	Yes / yes	Ambulatory (unattended) sleep study PSG duration =490 minutes Timing of PSG:Nocturnal	Abnormalities on overnight, unattended PSG in a large study population of children appear to correlate with symptoms of snoring, excessive daytime sleepiness and learning problems as assessed by parental answers on questionnaire
61	Melendres (2004)	2	Prospective otherwise healthy children referred for evaluation of SDB had a PSG and were classified as PS or OSA..they also did a conners and a ESS… A control group was children from a dermatology clinic who did the Brouillette score..if < 1…presumed no OSA>.no PSG done, just ESS and Conners This study was done to investigate the hypothesis that in children with suspected SDB there would be excessive daytime sleepiness and increased hyperactivity compared to children without SDB, and that overnight PSG parameters would correlate with these behaviors.	Case control Blinding absent	Eligible: 203 Completed study: 108 % males:45 # controls: 72 % males: 40	Cases: 7 +/- 4 (2-16) Controls: 8 +/-4 (2-17) Narrow spectrum	Community referral Expert assigned or selected groups Privately funded (non-pharmaceutical)	Behavioral scales	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = Not specified Timing of PSG: Nocturnal	PSG can distinguish between primary snoring and OSA but PSG parameters show only weak correlations between daytime sleepiness either due to inappropriate instrument (ESS in children) or inappropriate/ insufficient parameters being evaluated - PSG cannot distinguish/parameters do not correlate with symptoms of ADHD in contols, snorers or children with OSA
36	Xu (2006)	3	Review of various historical (25 questions), clinical (13 physical findings), and radiographic parameters (adenoidal-pharyngeal ratio from an x-ray of the post-nasal space ANR<0.5=nl) in all patients seen at an academic sleep lab associated with a peds dept. over a 4-yr period. Patients were divided into OSA positive, defined as AHI>5/hr, and primary snorers (AHI<=5/hr). PPV, NPV calculated for the 39 parameters studied. All patients snored.	Case control study Blinded study	Eligible: 31 # controls: 19	Cases: 7.8 +/- 3.2 yr Controls: 8.1+/-_ 3.7 yr Narrow spectrum Study included all children suspected by a community MD of having OSA—all children snored	Academic center Subjects were referred by community MDs to an academic center Strategy not specified Funding not specified	Multiple compairtors: 25 historical questions 13 physical exam signs 1 radiographic sign	PSG criteria	Yes: Sleep scored by "standard criteria"—so presumably R&K although no reference given Yes: Comments: 1) event duration defined as >10 seconds 2) hypopnea defined as 50% decrease in A/F + either arousal (non-defined) or >=4% desat 3) def of OSA=AHI>5/hr —although later in the paper they stress that the definition is somewhat arbitrary but chosen as the definition of "clinically sig't OSA"	Comprehensive PSG:) C3-A2 2) C4-A1 3) O1-A2 4) O2-A1 5) EOG non-specified 6) Submental EMG 7) Snore channel 8) EKG 9) Nasal-oral airflow--thermistor 10) Thoracic and abdominal plethysmography 11) Pulse oximeter PSG duration not stated PSG timing = nocturnal	1. combo of snoring and 6 characteristics (see study findings) has high sensitivity and good NPV with fairly good/adequate PPV and, thus, help the clinician trying to determine which children need polysomnography sooner than others; 2. combo of snoring and upper airway narrowing on x-ray or mouth breathing observed by MD and combo of snoring and UAN on x-ray or enuresis provide fairly good PPV/NPV 3. PPV of mouth breathing observed by MD for OSA was 100% (if child had mouth breathing, then child had OSA) implying this is a high risk group for OSA and would be well served by undergoing PSG ASAP 4. High PPV's (>=80%) were also seen with the following but were not statistically significant: historical factors: paradoxical breathing, resp distress, chest contractions, frequent sore throat/dry mouth; physical factors: long adenoid facies, midface hypoplasia, and high arched palate 5. High NPV of 80% (rest were lower) was also seen with the following but was not statistically significant: historical factors: snoring>3 nights/wk
35	Wang (1998)	3	To investigate predictive accuracy of clinical evaluation for OSA and outcome after adenotonsillectomy in children having PSG	Clinical series, observation Blinding absent	Eligible: n/a Completed study: 82 % males: 49/82 = 60% No controls	Cases: 6.7yrs (range 18 months – 15 years) Controls:n/a Narrow spectrum	Source not specified Self-selected groups (based on symptoms of OSA then referred for investigation) Funding not specified	Physical examination by physicians Parental symptom report	PSG criteria Other diagnostic criteria developed by authors: RDI calculated using apneas and hypopneas events at least 10 seconds in duration)	No / Yes (RDI calculated using apneas and hypopneas events at least 10 seconds in duration)	Comprehensive PSG; also used snore intensity as measured in decibels. Thermocouple was used, not nasal pressure PSG duration = 6-7 hours. No mean given. Timing = Nocturnal	symptoms of OSA are poor predictors of PSG-defined OSA - snoring loudness (in dB, measured during PSG) was the best predictor of OSA - T&A in a subgroup of children showed a reduction in RDI in the expected direction. One sentence in the Discussion suggests that this may have been driven in particular by one child with a craniofacial anomaly (Treacher-Collins).
31	Pagel (2004)	3	Cohort was identified from within a pediatric psychiatry clinic. Patients who answered affirmatively to one of four indicators of daytime sleepiness (waking unrefreshed, sleepiness during the day, teacher or other adult reporting daytime sleepiness, or hard to wake up in the morning) were offered further evaluation with full Sleep Medicine evaluation and PSG. Patients with prior T&A and trisomy 21 were excluded. There is no mention of how many patients failed to complete the evaluation after meeting initial eligibility. PSG results are then discussed, and correlations with psychiatric diagnoses, tonsillar size, and question-naire responses are made.	Prospective cohort Blinding not applicable	Eligible: not stated Completed study: 45 % males: 66% # controls: 29 % males: 58%	Cases: range 3-16 30 children had AD/HD Narrow spectrum	Academic center Self-selected groups Funding source not specified	Questionnaire: Psychiatric diagnoses correlates (ADHD) and size of tonsils	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Not specified this does not state specifically that the PSG was nocturnal, but reference is made to "AASM-accredited sleep lab clinical pediatric protocol,"—probably safe to assume these were nocturnal full PSGs.	Among pediatric psychistry clinic patients, a clinical history of suggesting daytime sleepiness may be associated with a high pre-test probability of PSG showing a significant degree of sleep disordered breathing. The questionnaire was otherwise unhelpful for identify-ing those with OSA. This suggests that PSG is indicated for the further evaluation of patients in this population. In particular, pediatric patients with ADHD and daytime sleepiness appear to be at highest risk. ADHD children with tonsillar hypertrophy and daytime sleepiness are more likely to have OSA.
30	Nieminen (2000)	3	This study looked at 58 snoring children with symptoms of SDB who underwent two PSGs 6 months apart. Thirty healthy children also underwent a single PSG as a control	Prospective cohort Blinding not specified	Eligible: 78 Completed study: 58 % males: 53 # controls: 30 % males: 57	Cases: 5.8 +/- 1.8 (2.4-10.5) Controls: 7.1 +/- 1.8 (4.3-10.9) Narrow spectrum	Community referral Expert assigned or selected Funding not specified	This study used a questionnaire to determine severity of symptoms of OSA, and an OSA scoring system developed by Brouillette but not further described	PSG criteria	No (no EEG) / Yes (but not "standard" and technology poor)	No EEG or EOG was used, so no sleep stage scoring was done Duration not specified Timing was nocturnal	1)This study suggest that clinical symptoms alone are inadequate in differentiating primary snoring from obstructive sleep apnea, and that PSG is required. 2)This study suggests that an AHI of >2 on PSG may be an indication for T&A, with improvement in symptoms and PSG findings postoperatively 3) I n patients with primary snoring, short term f/u (6 months) with PSG does not appear warranted as symptoms did not worsen in this study in those patients Strain gauge, no CO2 monitoring, No nasal pressure so accuracy of test deficient ****No sleep stage scoring/EEG monitoring was done in this study
62	Montgom-ery-Downs (2004)	4	This study was designed to assess whether parental report of snoring, daytime sleepiness and other behaviors were adequate in predicting objective findings on overnight PSG in two different groups (at risk preschoolers vs typical first graders) This study was done to determine the predictive validity of parental report of snoring and health/behavior is-sues in determining PSG diagnosed sleep disordered breathing in two samples of patients without previous clinical complaints of SDB	Retrospective observational study	Eligible:127 preschoolers, 266 1st graders Completed study: 122 preschoolers, 172 1st graders completed PSGs and questionnaires successfully. (1010 preschoolers filled questionnaire = 27%; 5728 older kids = 48%) % males: 52/58	Cases: 4.3 +/- .64 And 6.2 +/- .55 Wide spectrum	Preschoolers were at risk for developmental problems or low SES 5-7 year olds were from general population of metropolitan area of Louisville Questionnaires were sent out to both groups Self-selected groups As above, 27-48% of those receiving questionnaires responded; fewer agreed to PSG Government funded	Parental observations 33 question instrument including FH, medical history of child (allergies, ear infections, asthma, etc), sleep disordered breathing questions, daytime sleepiness questions	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = up to 12 hours Timing of PSG:Nocturnal	1) Data was not specifically reported, but assumption is that PSG helps differentiate primary snorers from those with SDB 2) Questionnaires which include parentally reported behaviors as well as snoring seem to have greater predictive value for SDB than reporting of snoring alone; PSG can help make that determination 3) PSG can provide an objective measure of the presence and/or severity of OSA for the evaluation of predictive clinical scoring tools

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
37	Greenfeld (2003)	4	29 infants <18 months of age with PSG diagnosed OSA due to adenotonsillar hypertrophy were studied with regard to demographics, referring physician specialty, development, symptoms post treatment and a pediatric sleep questionnaire completed by parents.	Clincal series Blinding absent; This study was designed to evaluate the characteristics of infants <18 months of age with obstructive sleep apnea due to ATH	Eligible: unknown Completed study: 29 % males: 69	Cases: 12.3 +/- 3.9 Controls: Narrow spectrum	Community referral Expert assigned or selected groups Funding not specified	Physical examination	PSG criteria	Yes / Yes: but no diagnostic criteria given	Comprehensive PSG No nasal pressure monitoring PSG duration = At least 6 hours Timing of PSG: Nocturnal	Since no PSG paramenters were reported, conclusions are limited. OSAS due to ATH does seem to exist in children <18 months, especially males, with history of prematurity, and those who snore, suggesting PSGs would be warranted in this population. Apparent high recurrence rate in infancy would suggest repeat PSG after treatment if symptoms recurred in this population
50	Sisk (1999)	4	To determine frequency of OSA in children with achondroplasia and the effectiveness of T&A as a treatment. Also to review perioperative and anesthetic evaluations and precautions To determine frequency of OSA in children with achondroplasia and assess effectiveness of adenotonsillectomy.	Chart review, clinical series Blinding not specified	Eligible: 58 initially with Hx compatible with SDB but 22 eliminated when didn't have OSA by study criteria Completed study: 36 (23 with PSG-defined OSA) % males: not reported # controls:none	Cases: overall 19 months (range 1 day-14 years) Children with PSG-defined OSA had mean age of 3.7yrs at Dx; those with OSA identified by caregiver had mean age of 4.0yrs Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Expert selected by diagnosis of OSA (author criteria) Funding not specified	Multiple comparators: Clinical history Parental report Physical exam	Other diagnostic criteria developed by authors Other as below: No OSA = no desat below 90% Mild OSA = Desat 80-90% assoc with hypopneas and apneas Severe OSA = desat <80% Children whose caregivers reported observed apneas, snoring, glottal stops, gasping, neck hyperextension, nocturnal self-awakenings, irritability or EDS were classified as OSA even in if O2 desat did not reach criteria above	No / No: Comments: no information on sleep staging given or even if it was performed. No details regarding definition of apneas, hypopneas, etc	Unclear whether comprehensive or limited PSG; no mention of EEG or how airflow was measured Other diagnostic techniques included in review, e.g. echocardiography, radiographs, imaging etc PSG duration = unknown Timing of PSG: Nocturnal	*- supports previous findings that children with achondroplasia are at risk for OSA likely because of craniofacial features - findings support T&A as an intervention in children with OSA to improve respiratory symptoms - findings support T&A over adenoidectomy alone as an effective treatment to improve respiratory symptoms - Test-retest reliability is demonstrated in that the PSG demonstrated improvement in the expected (improved) direction after surgery.
4.2.1.1.4.2 Objective Measures of Sleepiness												
50	Wing (2003)	2	46 obese children from academic clinic (>=120% ideal body weight) were compared with age and gender-matched control children from the local schools for prevalence of OSA; pts with known clinical conditions (e.g., Down's, Prader Willi, neuromuscular dz, laryngomalacia, upper airway surgery) were excluded; One ENT evaluated the nasoropharyngeal anatomy and graded tonsil size, adenoidal size, turbinate size, and velopharngeal isthmus. Protocol: 2 consecutive nights of PSG; after second PSG, MSLT the next day; there was at least one night of PSG on all children (3 ss did not get 2 nights)	Case control study Blinded study (E-mail communication with the author indicated that the PSG interpretation was done in a blinded fashion; the ENT eval was also effectively blinded since it was done prior to the PSG)	Eligible: 46 Completed study: % males: 72% # controls: 44 % males: 66%	Cases: 10.8 (2.3) Controls: 11.7 (2.1) Wide spectrum	Academic center and local schools Random selection Non-US funding agency	Physical examination Included measurements of tonsils, adenoids, turbinates, and velopharyngeal isthmus.	PSG criteria	Yes E-mail communication with the primary author indicates that they used R & K Were respiratory scoring methods clearly defined? Yes Comments: Used duration criterion of >2 breaths for obstructive events and >20" for CA or any duration with >4% drop in oxy sat	Comprehensive PSG 1. C3-A2 2. C4-A1 3. ROC-A1 4. LOC-A2 5. Submental EMG 6. Intercostal EMG 7. Snore channel 8. EKG 9. RAT-LAT (single leg EMG over both AT's) 10. Airflow via thermistors 11. Thoracic belt 12. Abdominal belt 13. Sum of thoracic and abdominal movement 14. Position sensor 15. Pulse oximeter 16. ET-CO2 via nasal cannula PSG duration = c. 542 minutes Timing of PSG: Nocturnal	1. The presence of tonsillar enlargement (size of > 2/4) and/or narrower velopharyngeal space in obese children can help triage obese children for PSG since there is a high PPV and high specificity for diagnosing OSA in this group 2. The presence of obesity alone has a variable PPV for OSA ranging from 15.2% to 78.3%, depending on the definition of OSA (OAI>=1—PPV=26.1%; AHI>=5—PPV=32.6%); 3. The absence of obesity had a NPV of 97.7% (OAI>=1) and 95.5% (AHI>=5) 4. PSG is more likely to show respiratory abnormalities in obese children than in non-obese children
63	Chervin (2006)	2	PSG, MSLT, neuropsychological testing and parental behavioral ratings were completed on 105 children aged 5-12 (77 case subjects scheduled for AT; 27 scheduled for unrelated surgical care) at baseline and 1 year later. The study tested the hypothesis that children who undergo AT, in comparison to other surgical procedures, experience more neurobehavioral improvement one year after surgery.	Case control Blinded study	Eligible: 78 Completed study: 77 % males: 57 (of total group) # controls: 27 (23 completed study) % males: 57 (of total group)	Cases: 8.4 +/- 1.9 yrs. (5-12.9 yrs) Mean age and range is for entire study group; no designation of case and control values. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Behavioral scales MSL on MSLT Cognitive Testing Psychiatric Diagnosis	Other diagnostic criteria developed by authors Clinical indication for AT as determined by ENT.	Yes / Yes	Comprehensive PSG PSG duration = overnight Timing of PSG: Nocturnal	1) Children scheduled for AT often have mild-moderate SDB and significant neurobehavioral morbidity, including hyperactivity, inattention, ADHD and EDS. 2) All measures of neurobehavioral morbidity improve 1 year following AT. 3) Common measures of SDB by PSG did not show associations with baseline neurobehavioral morbidity other than sleepiness and one-year changes in PSG generally did not predict neurobehavioral outcomes other than sleepiness. 4) Lack of better correspondence between these variables may reflect limitations of standard SDB measures in the assessment of neurobehavioral morbidity for children with mild-moderate SDB, which is generally the most common type of SDB treated by ENT.
64	Gozal (2001)	3	PSG and MSLT were performed on 54 children with OSA, 14 children with primary snoring and 24 controls. Various PSG parameters and mean sleep latencies were compared among the three groups. To more objectively determine the frequency of excessive daytime sleepiness in prepubertal children with suspected sleep apnea due to adenotonsillar hypertrophy	Prospective cohort	Eligible: Unknown Completed study: 54 OSA 14 PS % males: 53.7 OSA; 50 PS # controls: 24 % males: 58%	Cases: 6.7 +/- 0.3 (3-12)(OSA); 7.3 +/-0.8 (PS) (4-13) Controls: 6.1 +/-0.2 (4.5-7) Narrow spectrum, all clearly affected or not	Referred population to sleep lab invited to participate	Questionnaire regarding frequency of snoring, breathing problems during sleep and daytime sleepiness. Mean sleep latency on MSLT	PSG criteria	Yes / Yes Hypopneas not quantified due to "lack of standard definition"	Comprehensive PSG and MSLT With 30 minute nap opportunities PSG duration = All night, at least 8 hours Timing of PSG: Nocturnal	Findings support the validity of comprehensive nocturnal PSG in identifying OSA in patients referred for clinical suspicion of such, and and AI was positively, although weakly correlated with shorter MSL. In children with suspected OSA, MSLT identified more children with EDS (13%) than parental questionnaire (7.5%), suggesting this problem may be underrecognized in this population. In children with OSA, few (13%) had MSL<10, suggesting need to reconsider norms in children Duration of MSLT >30 min may be more appropriate in the pediatric population (MSL were 20-23 minutes in all populations in this study)
65	Gozal (2009)	4	50 obese and 50 nonobese children with suspected OSA due to habitual snoring, and adenotonsillar hypertrophy were assessed with PSG, MSLT the following day, and results were compared. Subjective perception of EDS as reported by parents was also questioned for both groups.	Prospective cohort study Blinding not specified	Eligible:59 obese, 62 nonobese Completed study: 50 obese kids % males:50 # controls: 50 % males: 50	Cases: 7.4 +/- 0.1 yrs Controls: 7.4 +/- 0.1 (range6-9 yrs) Narrow spectrum	Academic center Expert assigned or selected groups Government funded NIH grant plus Children's Foundation endowment for sleep research , Commonwealth of Kentucky challengefor excellence trust fund; NASA	Not specified	PSG criteria	Yes / yes	Comprehensive PSG plus modified (30-minute) MSLT PSG duration = TST 483-487 minutes +/- 17-19 minutes Timing of PSG:Nocturnal	PSG variables did not vary significantly between obese and non-obese patients with OSA, however there were significant differences on subsequent MSLT, with obese patients more likely to demonstrate objective daytime sleepiness. Based on this study, MSLT does not appear to be useful in assessment of daytime sleepiness in non-obese children with OSA, Overnight PSG is useful in making the diagnosis of OSA in children, regardless of their BMI. TH: (1) Mean Sleep latency demonstrated linear correlation with OAHI, RAI, and proportion of TST spent with SaO2 <95%. (2) MSLT distinguishes obese from non-obese subjects with OSA. (3) Objecyive measures of sleepiness correlated poorly with subjective measures.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
38	Guilleminault (1982)	4	Description of a clinical cohort with no apnea on PSG but Pes swings, tachypnea and sinus arrhythmia (ie. UARS). This study was designed to evaluate children with suspected sleep apnea due to a variety of clinical symptoms who were PSG negative but had adenotonsillar hypertrophy.	Clincal series Blinding not specified	Eligible: Completed study: 25 % males: 60 # controls: 25 % males: Not specified	Cases: 7 (2-14) All prepubertal Controls: "not exactly aged matched, but similar, greatest age difference between patient and control was 12 months Narrow spectrum	Community referral Expert assigned or selected groups Funding In part by gifts to C. Guilleminault from the Pacifica Firefighter's Wives' Association and Institute National de la Sante et Recherche Medicale	Not specified	Other diagnostic criteria developed by authors	Not applicable	Full PSG with Pes. PSG duration = 9 hours (TRT) Timing of PSG: Overnight 22:00-7:00	Findings of Pes swings and tachypnea indicate a type of sleep-disordered breathing, ie. UARS
4.2.1.1.5 Physical Examination												
36	Xu (2006)	3	Review of various historical (25 questions), clinical (13 physical findings), and radiographic parameters (adenoidal-pharyngeal ratio from an x-ray of the post-nasal space — ANR<0.5=nl) in all patients seen at an academic sleep lab associated with a peds dept. over a 4-yr period. Patients were divided into OSA positive, defined as AHI>5/hr, and primary snorers (AHI<=5/hr). PPV, NPV calculated for the 39 parameters studied. All patients snored.	Case control study Blinded study	Eligible: 31 # controls: 19	Cases: 7.8 +/- 3.2 yr Controls: 8.1+/-_ 3.7 yr Narrow spectrum Study included all children suspected by a community MD of having OSA—all children snored	Academic center Subjects were referred by community MDs to an academic center Strategy not specified Funding not specified	Multiple comparitors: 25 historical questions 13 physical exam signs 1 radiographic sign	PSG criteria	Yes: Sleep scored by "standard criteria"—so presumably R&K although no reference given Yes: Comments: 1) event duration defined as >10 seconds 2) hypopnea defined as 50% decrease in A/F + either arousal (non-defined) or >=4% desat 3) def of OSA=AHI>5/hr —although later in the paper they stress that the definition is somewhat arbitrary but chosen as the definition of "clinically sig't OSA"	Comprehensive PSG:) C3-A2 2) C4-A1 3) O1-A2 4) O2-A1 5) EOG non-spectified 6) Submental EMG 7) Snore channel 8) EKG 9) Nasal-oral airflow--thermistor 10) Thoracic and abdominal plethysmography 11) Pulse oximeter PSG duration not stated PSG timing = nocturnal	1. combo of snoring and 6 characteristics (see study findings) has high sensitivity and good NPV with fairly good/adequate PPV and, thus, help the clinician trying to determine which children need polysomnography sooner than others; 2. combo of snoring and upper airway narrowing on x-ray or mouth breathing observed by MD and combo of snoring and UAN on x-ray or enuresis provide fairly good PPV/NPV 3. PPV of mouth breathing observed by MD for OSA was 100% (if child had mouth breathing, then child had OSA) implying this is a high risk group for OSA and would be well served by undergoing PSG ASAP 4. High PPV's (>=80%) were also seen with the following but were not statistically significant: historical factors: paradoxical breathing, resp distress, chest contractions, frequent sore throat/dry mouth; physical factors: long adenoid facies, midface hypoplasia, and high arched palate 5. High NPV of 80% (rest were lower) was also seen with the following but was not statistically significant: historical factors: snoring>3 nights/wk
17	Goldstein (2004)	2	41 children underwent PSG : 21 were initially PSG + as defined by RDI>5. The 20 pts who were PSG- were randomized to T&A or nonsurgery. Repeat PSG and 32 item clinical assessment was done on all 41 children after intervention and results compared. The goal of this study was to determine if patients with a clinical assessment of OSA but negative PSG had improvement in their clinical assessment score after T&A compared to children who did not undergo surgery	Prospective cohort study Blinded study	Eligible:78 Completed study: 41 % males: 50% (more females with –PSG randomized to T&A)	Cases: 5.8 (+/- 2.6) to 7 (3.6) Narrow spectrum	Academic center Random selection Government funded	Multiple comparators: Clinical assessment Score :Thiry two items which were differentially weighted by specificity of symptoms to OSA (as determined by authors previous data review.) Highest possible score was 164, children with >40 were consident to have OSA, <20 asymptomatic , and between 20-40 mild symptoms of upper airway obstruction	PSG criteria and Other diagnostic criteria developed by authors	No / Yes	No sleep stage scoring – only respiratory parameters were used. Used RDI >5 as definition of OSALimited sleep study (describe parameters) PSG duration = Not specified Timing of PSG: Not specified	In children with clinically determined OSA, negative PSG, without evaluation of UARS may not be sensitive in picking up children who may improve clinically with T&A Findings suggest overnight PSG should be considered after T&A for treatment of OSA, and also may be considered if high clinical suspicion with initial negative PSG Lateral neck x-rays to assess adenoidal size were included as part of the clinical score. But the positive predictive value of the clinical score for predicting a positive PSG was only 48%.
35	Wang (1998)	3	To investigate predictive accuracy of clinical evaluation for OSA and outcome after adenotonsillectomy in children having PSG	Clinical series, observation Blinding absent	Eligible: n/a Completed study: 82 % males: 49/82 = 60% No controls	Cases: 6.7yrs (range 18 months – 15 years) Controls:n/a Narrow spectrum	Source not specified Self-selected groups (based on symptoms of OSA then referred for investigation) Funding not specified	Physical examination by physicians Parental symptom report	PSG criteria Other diagnostic criteria developed by authors: RDI calculated using apneas and hypopneas; OSA defined as RDI>=5 with evidence of obstructive events.	No / Yes (RDI calculated using apneas and hypopneas events at least 10 seconds in duration)	Comprehensive PSG; also used snore intensity as measured in decibels. Thermocouple was used, not nasal pressure PSG duration = 6-7 hours. No mean given. Timing = Nocturnal	symptoms of OSA are poor predictors of PSG-defined OSA - snoring loudness (in dB, measured during PSG) was the best predictor of OSA - T&A in a subgroup of children showed a reduction in RDI in the expected direction. One sentence in the Discussion suggests that this may have been driven in particular by one child with a craniofacial anomaly (Treacher-Collins).
53	Weatherly (2004)	4	To compare clinical diagnoses with PSG in children scheduled for adenotonsillectomy. Parental question-naires were used to determine symptoms that could assist in identifying children with normal PSGs but clinical diagnosis of SDB. PSG included esophageal pressure monitoring	Prospective cohort study Blinded study; This study was designed to compare clinical and PSG diagnoses in children on referred for adenotonsillectomy by their otolaryngologist. Parent report symptoms were also used	Eligible: unknown Completed study: 34 % males: 18/34 = 53% # controls:none	Cases: 8.2+/-1.9yr Range 5.3 – 12.9 yr Controls: N/A Narrow spectrum	Academic center and community referral Expert assigned or selected groups since they are children placed on the ENT list Government funded	Multiple comparators, specify: Compared to clinical evaluations and parental report	PSG criteria, other criteria developed by authors, other criteria: Physician diagnosis on H&P Parent symptom report	No The reader was referred to previously published methods Yes	Comprehensive PSG MSLT PSG duration = not reported Timing of PSG:Nocturnal	*- Poor agreement found between clinical diagnoses of SDB and PSG diagnoses. - Agreement variable depending on criteria used. - Best agreement obtained when threshold lowered to AHI>1 and subtle changes included (RERAs). - 2 negative parental symptom questions appeared helpful in identifying children who were unlikely to have abnormal PSG.
52	Villa (2002)	4	To investigate the clinical usefulness of a personalized oral appliance for treatment of OSA with malocclu-sion. - 19/32 children randomly assigned to oral appliance for 6 months then post appliance PSG, questionnaire, and physical exam compared between these children and the non-intervention children (n=13) - note that oral appliance used corrects occlusal anomalies rather than provides mandibular advancement To assess clinical usefulness and tolerance to a personalized oral jaw positioning appliance for the treat-ment of OSA with malocclusion	Perhaps a methodological study; Clinical series, observational study, case reports; Blinding not specified	Eligible: 32 children initially enrolled, 19 randomly assigned to treatment, 13 acted as controls Completed study: 23 (9 controls) % males: 20/32 = 62.5% enrolled; treated 53% males, controls 77% males; sex un-known of those who dropped out	Cases: 6.86±2.34 years Controls: 7.34 ±3.1 years Narrow spectrum	Academic center Expert assigned or selected groups Assigned groups according to AI>1 and clinical signs of dysthagnia Blinding not specified	Brouillette questionnaire of OSAS symptoms Physical exam incl tonsil size	PSG criteria: Initial Dx reached by AI>1 but no more details given. Subjects had to have initial Dx of AI>1 with associated clinical signs of dysgnathia before entry into study Follow up PSG included only 2 EEG channels and airflow measured by thermocouple	No Just stated that they were scored according to R&K Were respiratory scoring methods clearly defined? No repiratory inductive pleth, saturation and thermistor used Comments: PSG included 2 EEG channels and scored in accordance with R&K and ATS. No further details given	Comprehensive PSG PSG duration = not reported Timing of PSG: Nocturnal	*- use of personalized jaw positioning device for 6 months in the presence of AI>1 and dysthagnia was associated with an improve-ment in AHI and AI - also associated with reduced adenotonsillar hypertrophy (? Possibly due to enlarged pharyngeal space rather than reduced hypertrophy per se) - enlarging the pharyngeal space was associated with improvement in AHI and AI in the expected direction - findings support use of PSG in characterizing respiratory parameters following treatment intervention
66	Shatz (2004)	3	This is a retrospective case series of infants <12 months of age who had undergone evaluation for clinical suspicion of sleep disordered breathing. The cohort included in the analysis were patients who met all three of the following criteria: 1. Upper airway obstruction symptoms: snoring, respiratory distress, or apnea (presumably a parental report of witnessed apnea, but this is not specified) 2. Adenoid enlargement causing >50% narrowing of the nasopharynx, as documented on lateral neck photograph 3. Polysomnography documenting OSA (as defined by an AHI>1). The 24 cases which were felt to meet these criteria are reviewed and analyzed. Clinical and polysomno-graphic data are presented. 24h pH monitoring was also done preoperatively and these data are presented. Postsurgical follow up data (clinical and polysomnographic) are presented as well.	Clinical series, observational Blinding not specified	Eligible:not clear Completed study: 24 infants are described % males: 75%	Cases: 10 months Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No / No	Not specified Airflow is measured by thermistor only. No mention is made regarding duration, timing (nocturnal vs daytime nap), or scoring criteria for sleep staging or respiratory events. PSG duration = not specified Timing of PSG: Not specified	Polysomnography shows face validity in this cohort of infants with adenoidal hypertrophy and clinically suspected sleep disordered breathing. Adenoid hypertrophy in infants can occur and can cause OSA (typically we think of this only occurring in older kids). Because adenoid hypertrophy in infants is not as common, should raise a concern and then use PSG to confirm presence and severity.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
37	Greenfeld (2003)	4	29 infants <18 months of age with PSG diagnosed OSA due to adenotonsillar hypertrophy were studied with regard to demographics, referring physician specialty, development, symptoms post treatment and a pediatric sleep questionnaire completed by parents.	Clincal series Blinding absent; This study was designed to evaluate the characteristics of infants <18 months of age with obstructive sleep apnea due to ATH	Eligible: unknown Completed study: 29 % males: 69	Cases: 12.3 +/- 3.9 Narrow spectrum	Community referral Expert assigned or selected groups Blinding not specified	Physical examination	PSG criteria	Yes / Yes: but no diagnostic criteria given	Comprehensive PSG No nasal pressure monitoring PSG duration = At least 6 hours Timing of PSG: Nocturnal	Since no PSG paramenters were reported, conclusions are limited. OSAS due to ATH does seem to exist in children <18 months, especially males, with history of prematurity, and those who snore, suggesting PSGs would be warranted in this population. Apparent high recurrence rate in infancy would suggest repeat PSG after treatment if symptoms recurred in this population
25	Wing (2003)	2	46 obese children from academic clinic (>=120% ideal body weight) were compared with age and gender-matched control children from the local schools for prevalence of OSA; pts with known clinical conditions (e.g., Down's, Prader Willi, neuromuscular dz, laryngomalacia, upper airway surgery) were excluded; One ENT evaluated the nasoropharyngeal anatomy and graded tonsil size, adenoidal size, turbinate size, and velopharngeal isthmus. Protocol: 2 consecutive nights of PSG; after second PSG, MSLT the next day; there was at least one night of PSG on all children (3 ss did not get 2 nights)	Case control study Blinded study (E-mail communication with the author indicated that the PSG interpretation was done in a blinded fashion; the ENT eval was also effectively blinded since it was done prior to the PSG)	Eligible: 46 Completed study: % males: 72% # controls: 44 % males: 66%	Cases: 10.8 (2.3) Controls: 11.7 (2.1) Wide spectrum	Academic center and local schools Random selection Non-US funding agency	Physical examination Included measurements of tonsils, adenoids, turbinates, and velopharyngeal isthmus.	PSG criteria	Yes E-mail communication with the primary author indicates that they used R & K Were respiratory scoring methods clearly defined? Yes Comments: Used duration criterion of >2 breaths for obstructive events and >20" for CA or any duration with >4% drop in oxy sat	Comprehensive PSG 1. C3-A2 2. C4-A1 3. ROC-A1 4. LOC-A2 5. Submental EMG 6. Intercostal EMG 7. Snore channel 8. EKG 9. RAT-LAT (single leg EMG over both AT's) 10. Airflow via thermistors 11. Thoracic belt 12. Abdominal belt 13. Sum of thoracic and abdominal movement 14. Position sensor 15. Pulse oximeter 16. ET-CO2 via nasal cannula PSG duration = c. 542 minutes Timing of PSG: Nocturnal	1. The presence of tonsillar enlargement (size of > 2/4) and/or narrower velopharyngeal space in obese children can help triage obese children for PSG since there is a high PPV and high specificity for diagnosing OSA in this group 2. The presence of obesity alone has a variable PPV for OSA ranging from 15.2% to 78.3%, depending on the definition of OSA (OAI>=1—PPV=26.1%; AHI>=5—PPV=32.6%); 3. The absence of obesity had a NPV of 97.7% (OAI>=1) and 95.5% (AHI>=5) 4. PSG is more likely to show respiratory abnormalities in obese children than in non-obese children
67	Lam (2006)	4	To investigate association between OSA, obesity, and tonsil size To determine the association between degree of obesity and severity and OSA	Retrospective review Clinical series, observational study, case reports Blinding not specified	Eligible: 482 Completed study: 482 % males: 335/482 = 69.5% # controls: none	Cases: median age 6years (range 1-15 years) Controls: n/a Patient Spectrum = Narrow spectrum Since children were referred to sleep lab for evaluation and several pt groups excluded	Community referral Random selection Non-US funding agency	Physical examination Tonsil size BMI	PSG criteria Other diagnostic criteria developed by authors Comment: AHI>1.5 used	No Just stated that R&K criteria used and AASM arousal criteria used Yes	Comprehensive PSG PSG duration = unknown; no details Timing of PSG: Nocturnal	"- Provides some support that clinical evaluation (Grade 4 tonsils, obesity) may be helpful as an indictor for OSA in young children referred for OSA evaluation - The finding that children with obesity and/or Grade 4 tonsils were more likely to have AHI > 5 provides construct validity for the AHI determined by PSG.
68	Tauman (2005)	4	Children referred with suspected OSA and snoring and 19 control non-snoring but not matched children had PSG's. The snoring children seemed to have all had OSA. Following PSG, fasting glucose, insulin, and lipid profiles were drawn and compared. Measures compared were insulin levels, glucose, I/G ratio, HOMA (homeostasis model assessment), lipid profiles. Exclusionary criteria included any chronic med'l condition, craniofacial syndromes, genetic syndromes, meds that affect glucose or lipids, psychiatric diagnoses.	Prospective cohort Blinding not applicable	Eligible: 135 Completed study:all % males:59% # controls: 0 Although they mention 19 controls, these were not matched controls and were from a different population and they lumped all of the kids together when describing demographics so I would not consider them "controls" in the rigorous sense. % males: not specified	Cases: 8.9 + 3.5 (3-18 y.o.) Wide spectrum	Academic center Random selection Government funded	Not specified	PSG criteria	Uncertain: "By standard techniques" Were respiratory scoring methods clearly defined? Yes OA=no A/F w/ chest/abd movement for >2 breaths Hypopnea= fall of nasal A/F of >=50% with either 4% drop in oxy sat or arousal over at least 2 breaths Comments: Mild OSA=AHI (defined as Obstrutive AHI)>=1 and <5 Mod-Severe OSA=AHI>=5	1. 8 leads of EEG 2. ROC-A1 3. LOC-A2 4. Submental EMG 5. EKG 6. RAT and or LAT 7. Nasal airflow thermistor 8. Nasal pressure cannula 9. Thoracic movement inductance plethysmography or respiratory impedance 10. Abdominal movement either inductance plethysmography or respiratory impedance 11. Position sensor 12. Pulse oximeter 13. ET-CO2 Timing of PSG: Nocturnal	In children who snore and have insulin resistance and dyslipidemia, PSG is not routinely indicated as elevated AHI is not correlated with insulin resistance & dyslipidemia
69	Zhang (2007)	4	The study compared sleep architecture and respiratory event frequency and distribution in children with adenotonsillar hypertrophy with and without OSA. 37 children with ATH from a Univ. hospital-based ENT practice underwent PSG. Sleep architecture and frequency of respiratory events were then compared between the group that tested positive for OSA, with an AI>=1, and the group that was OSA negative. The study mentions that controls were recruited but no PSG data or physical exam data are reported for the controls.	Case control study Blinding not applicable (Although the study was prospective in terms of "taking all comers", this was not a study comparing PSG to anything. It was defining the degree of abnormality of PSG in two subgroups of children with ATH. There was no comparison for PSG nor an independent measure of OSA.)	Eligible: 20 Completed study: 20 % males: 85% # controls: 17 % males: 65%	Cases: 7.38 (2.43) y Controls: 8.12 (3.79) y Narrow spectrum	Academic center Recruitment strategy not specified Funding source not specified	Not specified	PSG criteria: Comment: AI >= 1	Yes R&K—however, arousals were scored with a one-second shift in EEG freq Were respiratory scoring methods clearly defined? No Comments: They scored apneas and hypopneas but did not define hypopnea and defined event duration was minimum of 3 seconds	Comprehensive PSG Standard PSG but used only 1 combined EOG lead (r-l) and one combined leg EMG lead; no ET CO-2 1) C3-A2 2) C4-A1 3) ROC-LOC 4) Submental EMG 5) Snore channel 6) EKG 7) right to right triggered evaluation of heart rate 8) RAT-LAT 9) Nasal airflow thermistor 10) Thoracic and abdominal effort (strain gauge) 11) Pulse oximeter PSG duration = Timing of PSG:Nocturnal	Presence of OSA does not affect the sleep EEG in patients with ATH. Respiratory events are more frequent in PSG of patients with at least one obstructive apnea suggesting face validity of PSG in finding respiratory events in children with ATH. 20/37 children with ATH were found to have at least one apnea. Although the study was poorly designed as described below, it does provide some convergent validity. Children with at least one OA had more hypopneas than children who did not have at least one OA. Although the study mentions that the presented data demonstrate overall a decrease in REM and an increase in stage 1 in children with ATH when compared with normative data, this is a statement made in the discussion with no statistics nor normative data provided. Study design poor because arbitrary value vis-à-vis distinguishing OSA from non-OSA and no PSG- independent definition of OSA.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.1.1.6 Radiographic and Endoscopic Evaluation												
36	Xu (2006)	3	Review of various historical (25 questions), clinical (13 physical findings), and radiographic parameters (adenoidal-pharyngeal ratio from an x-ray of the post-nasal space ANR<0.5=nl) in all patients seen at an academic sleep lab associated with a peds dept. over a 4-yr period. Patients were divided into OSA positive, defined as AHI>5/hr, and primary snorers (AHI<=5/hr). PPV, NPV calculated for the 39 parameters studied. All patients snored.	Case control study Blinded study	Eligible: 31 # controls: 19	Cases: 7.8 +/- 3.2 yr Controls: 8.1+/-_ 3.7 yr Narrow spectrum Study included all children suspected by a community MD of having OSA—all children snored	Academic center Subjects were referred by community MDs to an academic center Strategy not specified Funding not specified	Multiple comparitors: 25 historical questions 13 physical exam signs 1 radiographic sign	PSG criteria	Yes: Sleep scored by "standard criteria"—so presumably R&K although no reference given Yes: Comments: 1) event duration defined as >10 seconds 2) hypopnea defined as 50% decrease in A/F + either arousal (non-defined) or >=4% desat 3) def of OSA=AHI>5/hr —although later in the paper they stress that the definition is somewhat arbitrary but chosen as the definition of "clinically sig't OSA"	Comprehensive PSG:) C3-A2 2) C4-A1 3) O1-A2 4) O2-A1 5) EOG non-spectified 6) Submental EMG 7) Snore channel 8) EKG 9) Nasal-oral airflow--thermistor 10) Thoracic and abdominal plethysmography 11) Pulse oximeter PSG duration not stated PSG timing = nocturnal	1. combo of snoring and 6 characteristics (see study findings) has high sensitivity and good NPV with fairly good/adequate PPV and, thus, help the clinician trying to determine which children need polysomnography sooner than others; 2. combo of snoring and upper airway narrowing on x-ray or mouth breathing observed by MD and combo of snoring and UAN on x-ray or enuresis provide fairly good PPV/NPV 3. PPV of mouth breathing observed by MD for OSA was 100% (if child had mouth breathing, then child had OSA) implying this is a high risk group for OSA and would be well served by undergoing PSG ASAP 4. High PPV's (>=80%) were also seen with the following but were not statistically significant: historical factors: paradoxical breathing, resp distress, chest contractions, frequent sore throat/dry mouth; physical factors: long adenoid facies, midface hypoplasia, and high arched palate 5. High NPV of 80% (rest were lower) was also seen with the following but was not statistically significant: historical factors: snoring>3 nights/wk
71	Jain (2002)	4	Correlate incidence and severity of OSA with TA size	Clincal series Blinding absent	Eligible: Completed study: 40 % males: 50	Cases:4-12 yrs Controls:none Narrow spectrum	Community referral Recruitment strategy: Not specified Funding source: Not specified	Multiple comparators: Physical exam Symptoms Inflammation Cephalometrics (laternal neck xray)	PSG criteria	Yes / Yes (used 10 seconds)	Comprehensive PSG PSG duration = not defined Timing of PSG: Nocturnal , pre T&A and 6-8 weeks post PSG	Clinical symptoms of obstruction and TA hypertrophy strongly correlates with SDB as defined (using thier definition of SDB) for OSA. Using a CD angle of 64 deg may be enough to indicated SDB and allow the surgeon to operate. Sensitivity and specificity of the clinical symptoms and measurements not reported in comparison to PSG findings.
70	Brooks (1998)	3	To determine the extant to which adenotonsillar hypertrophy contributes to the severity of OSA. Tonsil size quantitated by physical exam. Adenoid size quantitated by lateral neck x-ray.	Clinical series, observation Blinded study	Eligible:N = 33 Completed study:All % males: 19 (58%) "Controls" could be viewed as children who ended up with RDI <5. Was 16 of the 33 total.	Cases: 5.1 yrs Controls: 4.4 yrs Patient spectrum = Not applicable	Academic center Random selection Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	Parental report snoring and/or observed apneas do not predict the presence of OSA in children. Convergent validity of the PSG-determined AHI is demonstrated by the finding that obesity is significantly correlated with PSG-determined AHI and the lowest oxygen saturation. Convergent validity of the PSG-determined RDI is demonstrated by the finding that children with RDI >5 had higher AN ratio than children with RDI<5. Elevated AN ratio is present in many snoring children and was also present in children who did not have RDI>5. Consequently, PSG is needed to confirm the presence or absence of OSA in snoring children who have elevated AN ratio.
17	Goldstein (2004)	2	41 children underwent PSG : 21 were initially PSG + as defined by RDI>5. The 20 pts who were PSG-were randomized to T&A or nonsurgery. Repeat PSG and 32 item clinical assessment was done on all 41 children after intervention and results compared. The goal of this study was to determine if patients with a clinical assessment of OSA but negative PSG had improvement in their clinical assessment score after T&A compared to children who did not undergo surgery	Prospective cohort study Blinded study	Eligible:78 Completed study: 41 % males: 50% (more females with –PSG randomized to T&A)	Cases: 5.8 (+/- 2.6) to 7 (3.6) Narrow spectrum	Academic center Random selection Government funded	Multiple comparators: Clinical assessment Score :Thiry two items which were differentially weighted by specificity of symptoms to OSA (as determined by authors previous data review.) Highest possible score was 164, children with >40 were considered to have OSA, <20 asymptomatic , and between 20-40 mild symptoms of upper airway obstruction	PSG criteria and Other diagnostic criteria developed by authors	No / Yes	No sleep stage scoring – only respiratory parameters were used. Used RDI >5 as definition of OSALimited sleep study (describe parameters) PSG duration = Not specified Timing of PSG:Not specified	In children with clinically determined OSA, negative PSG, without evaluation of UARS may not be sensitive in picking up children who may improve clinically with T&A. Findings suggest overnight PSG should be considered after T&A for treatment of OSA, and also may be considered if high clinical suspicion with initial negative PSG Lateral neck x-rays to assess adenoidal size were included as part of the clinical score. But the positive predictive value of the clinical score for predicting a positive PSG was only 48%.
72	Gozal (2004)	3	1) CSA and UAC was examined in 27 controls and 27 pts with known OSA 2) Reproducibility of UAC measurements within 1 week was tested in another group of children 15 SDB and 15 controls 3)Two additional cohorts of snoring children (n=54 and n=94) were evaluated to determine cutoff values of UAC that could help differentiate primary snoring from OSA 4) UAC measurements and overnight PSG were repeated in 15 children with OSA pre and post T&A This study was designed to determine if an assessment of changes in upper airway cross sectional area (CSA) after topical anesthesia (an assessment of upper airway collapsibility) could be used to predict which snoring children have OSA. While providing much useful data, the report was confusing with regards to numbers of patients studied for which purpose. The data pre and post T&A in 15 patients does not include demographics.	Case control Blinded study	Eligible: Unclear, likely 247 *there were two different parts to this paper Completed study: 27 % males: 51 Second part of study compared 15 patients with SDB before and after T&A – demographics not given # controls: 27 % males: stated they were matched with subjects, numbers not given	Cases: 6.7 +/- 0.2 Controls: age matched Narrow spectrum	Community referral for patients, controls were community recruits Self-selected groups Government funded	Acoustic pharyngometry – plot of cross sectional area as a function of distance from the mouth. Two sets of data, before and after topical anesthesia were obtained. Pre and post curves were compared and maximal % change was defined as upper airway collapsibility for that patient UAC measurements and overnight PSG were repeated in 15 children with SDB 10-12 weeks after T&A	PSG criteria (AHI > 5/hr) ICSD criteria Other diagnostic criteria developed by authors: UAC and CSA of upper airway	Yes Sleep architecture assessed by "standard techniques" Yes Hypopneas defined as > 50% decrease in nasal flow associated with 4% or greater desat or arousal	Comprehensive PSG PSG duration = up to 12 hours Timing of PSG: Nocturnal	1)Findings support validity of comprehensive nocturnal PSG in discriminating primary snoring from SDB 2) UAC measurement show promise in discriminating patients with primary snoring from those with SDB and may help determine patients who should undergo PSG
73	Bravo (2005)	4	PSG and VNP were performed on 52 children with Pierre Robin sequence (PR) aged 1 month to 4 years of age. 31 PR patients had PSG diagnosed OSA and 21 PR subjects had normal breathing during sleep and were used as controls. The purpose of the study was to determine the sensitivity and specificity of VNP for the diagnosis of OSA in patients with PR, using PSG as the gold standard.	Clinical series Blinded study	Eligible: 52 (includes all PR subjects) Completed study: 31 PR subjects with OSA % males: 44 (for all subjects) # controls: 21 PR subjects with normal breathing during sleep % males: 44 (for all subjects)	Cases: median age of 1 yr 7 months (range 1 month-4 yrs) for all subjects with PR Narrow spectrum	Academic center and community referral Expert assigned or selected groups	Videonasopharyngoscopy (VNP)	PSG criteria	Yes / Yes apneas and hypopneas "of any duration" were included. Index of 5 or more considered positive for OSA	Comprehensive PSG Overnight Nocturnal	1) In children with PR, VNP is a safe and reliable diagnostic indicator for the detection of OSA, using PSG as the diagnostic gold standard reference. 2) VNP showed high sensitivity, specificity, PPV and NPV in the detection of OSA in children with PR. 4) Recognized weaknesses of the study: 1) criteria used to assess severity of obstruction by VNP was a global assessment that is subjective, 2) the measurement scale has not been validated, and 3) there were a relatively small number of narrow spectrum cases used for the study.
74	Valera (2005)	4	To investigate association between clinical complaints of OSA and PSG findings and to determine whether there are PSG differences in children with adenoid hypertrophy vs. adenotonsillar hypertrophy. Children grouped by age (preschool: 1-6yrs and school age: 7-13 years) to investigate role of age. Purpose was to investigate association between clinical complaints of OSA and PSG findings; to determine whether there are PSG differences in children with adenoid hypertrophy vs. adenotonsillar hypertrophy; to investgate role of age.	Prospective cohort study Blinding not specified	Eligible: unknown Completed study: 267 % males: 143/267 = 54% # controls:none	Cases: 5.5years (range 1-13 years) Controls: n/a Patient Spectrum Not applicable	Academic center Expert assigned or selected groups Expert selected by history of snoring for >3 months with frequent apneas Funding source not specified	Multiple comparators: Physician assessment which included otorhinolaryngological assessment Parental report	PSG Criteria Other diagnostic criteria developed by authors Comment: States that ATS criteria were used but no details given.	No / No: Comments: no information on sleep staging given or even if it was performed. No details regarding definition of apneas, hypopneas, etc	Unclear whether comprehensive or limited PSG; no mention of EEG or how airflow was measured PSG duration = at least 7 hours but no more details available Timing of PSG: Nocturnal	*- lack of association between clinical complaints and PSG defined OSA - >25% of preschoolers and 45% of schoolage children had clinical histories suggestive of OSA but no objective evidence of OSA on PSG - some association between endoscopic findings and PSG: both age groups without any obstruction by adenoids or tonsils had low RDI , Children with adenoid only or adenotonsillar hypertrophy had worse RDI and O2 nadir on PSG although this only reached significance in preschool children - both adenoid hypertrophy and adenotonsillar hypertrophy demonstrated similar obstructive breathing patterns - hypertrophy in younger children associated with more severe apnea than older children - The severity of the OSAS is mild overall which may affect the findings

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.1.1.7 Neurocognitive or psychological assessments												
61	Melendres (2004)	2	Prospective otherwise healthy children referred for evaluation of SDB had a PSG and were classified as PS or OSA..they also did a conners and a ESS… A control group was children from a dermatology clinic who did the Brouillette score..if < 1…presumed no OSA>.no PSG done, just ESS and Conners This study was done to investigate the hypothesis that in children with suspected SDB there would be excessive daytime sleepiness and increased hyperactivity compared to children without SDB, and that overnight PSG parameters would correlate with these behaviors.	Case control Blinding absent	Eligible: 203 Completed study: 108 % males:45 # controls: 72 % males: 40	Cases: 7 +/- 4 (2-16) Controls: 8 +/-4 (2-17) Narrow spectrum	Community referral Expert assigned or selected groups Privately funded (non-pharmaceutical)	Behavioral scales	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = Not specified Timing of PSG: Nocturnal	PSG can distinguish between primary snoring and OSA but PSG parameters show only weak correlations between daytime sleepiness either due to inappropriate instrument (ESS in children) or inappropriate/ insufficient parameters being evaluated - PSG cannot distinguish/parameters do not correlate with symptoms of ADHD in contols, snorers or children with OSA
38	Guilleminault (1982)	4	Description of a clinical cohort with no apnea on PSG but Pes swings, tachypnea and sinus arrhythmia (ie. UARS). This study was designed to evaluate children with suspected sleep apnea due to a variety of clinical symptoms who were PSG negative but had adenotonsillar hypertrophy.	Clincal series Blinding not specified	Eligible: Unclear Completed study: 25 % males: 60 # controls: 25 % males: Not specified	Cases: 7 (2-14) All prepubertal Controls: "not exactly aged matched, but similar, greatest age difference between patient and control was 12 months) Narrow spectrum	Community referral Expert assigned or selected groups Funding In part by gifts to C. Guilleminault from the Pacifica Firefighter's Wives' Association and Institute National de la Sante et Recherche Medicale	Not specified	Other diagnostic criteria developed by authors	Not applicable	Full PSG with Pes. PSG duration = 9 hours (TRT) Timing of PSG: Overnight 22:00-7:00	Findings of Pes swings and tachypnea indicate a type of sleep-disordered breathing, ie. UARS
75	O'Brien (2004)	2	299 1st graders without parent reported ADHD or hyperactivity underwent PSG and neurobehavioral assessments ((Conners'Parent rating scale, Child Behavior Checklist and Differential Ability Scales and Developmental Neuropsychological Assessment) Children with OSA defined as OAI>1, AHI>5, spO2<90% and/or etCO2 >50torr or increased arousals were excluded (n=181) Final group compared 87 primary snorers (almost always, frequent or occasional) with 31 children who reported no snoring. This study was done to evaluate whether a home audiotape recording could accurately identify children with OSAS; This study was done to determine whether primary snoring is associated with neurobehavioral deficits in children	Prospective cohort Blinded study	Eligible: 299 children underwent PSG and neurobehavioral assessments Completed study: 87 primary snorers % males:51 # controls:31 % males:58	Cases: 6.6 +/-.5 (5.4-7.5) Controls: 6.8 +/-0.4 (5.9-7.4) Narrow spectrum	11,641 questionnaires were sent to the community first graders in a county. 5728 completed the questionnaires.29% were snorers, and 491 agreed to overnight PSG (74% snorers) Self-selected groups Government funded	Behavioral scales	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = up to 12 hours Timing of PSG: Nocturnal	This study suggests that despite "normal" PSG results, children with primary snoring may have mild/subtle neurocognitive abnormalities. The definition of OSA in this study used an AHI of >5. It would be of interest to know if a more conservative value, such as 1.5 would separate out those true "primary" snorers who might not have neurocognitive involvement Because the number of patients who were diagnoses with OSA who did NOT report snoring were not presented in this report, no conclusions can be drawn about the PSGs ability to differentiate primary snoring from OSA in this community sample.
63	Chervin (2006)	2	PSG, MSLT, neuropsychological testing and parental behavioral ratings were completed on 105 children aged 5-12 (77 case subjects scheduled for AT; 27 scheduled for unrelated surgical care) at baseline and 1 year later. The study tested the hypothesis that children who undergo AT, in comparison to other surgical procedures, experience more neurobehavioral improvement one year after surgery.	Case control Blinded study	Eligible: 78 Completed study: 77 % males: 57 (of total group) # controls: 27 (23 completed study) % males: 57 (of total group)	Cases: 8.4 +/- 1.9 yrs. (5-12.9 yrs) Mean age and range is for entire study group; no designation of case and control values. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Behavioral scales MSL on MSLT Cognitive Testing Psychiatric Diagnosis	Other diagnostic criteria developed by authors Clinical indication for AT as determined by ENT.	Yes / Yes	Comprehensive PSG PSG duration = overnight Timing of PSG: Nocturnal	1) Children scheduled for AT often have mild-moderate SDB and significant neurobehavioral morbidity, including hyperactivity, inattention, ADHD and EDS. 2) All measures of neurobehavioral morbidity improve 1 year following AT. 3) Common measures of SDB by PSG did not show associations with baseline neurobehavioral morbidity other than sleepiness and one-year changes in PSG generally did not predict neurobehavioral outcomes other than sleepiness. 4) Lack of better correspondence between these variables may reflect limitations of standard SDB measures in the assessment of neurobehavioral morbidity for children with mild-moderate SDB, which is generally the most common type of SDB treated by ENT.
59	Chervin (2007)	3	Retrospective analysis of 105 children aged 5-12.9 yrs (78 subjects underwent clinically indicated AT). Study objective: validation of SRBD scale and comparison of scale and PSG to predict OSA treatment related neurobehavioral responses.	Case control Blinded study	Eligible: 78 Completed study: 78 % males: 57 # controls: 27 % males: not stated	Cases: 8.4 +/- 1.9 yrs. (all cases) Controls: mean age not stated. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	SRBD scale of the Pediatric Sleep Questionnaire, neurobehaviorial scales (Child Symptom Inventory-4, IVA CPT), MSL from MSLT, and otolaryngologist Hx and PE	PSG criteria Other diagnostic criteria developed by authors Other:Clinically indicated AT defined by treating ENT.	Yes / Yes	Comprehensive PSG and MSLT PSG duration = Not Stated Timing of PSG: Not specified	1) SRBD subscale of the PSG predicts PSG results, useful for research but not reliable enough for patient care. 2) SRBD subscale may predict OSA-related neurobehavioral morbidity and its response to AT as well or better than PSG. 3) Preop PSG may serve important purposes other than to diagnosis OSA, such as to screen for severe OSA that raises risk of perioperative AT complications. 4) With persistence of OSA in significant number of children after AT, present data indicate that PSG may be more important after TA than before.
76	Dillon (2007)	2	This study was part of a larger study. The goals of the present study were to assess the frequency of mental disorders in children referred for T&A compared to controls both before and 1 year after surgical treatment. A secondary goal was to determine whether surgical response was related to baseline PSG measures. Children clinically referred to ENT were included and inclusion was not based on PSG results. Children whose surgeons sought PSG for clinical purposes were excluded.	Case control study Blinded study	Eligible: not stated in this paper; authors refer reader to previous paper for details of participants and non-participants Completed study: 79 baseline (78 had follow up) % males: 51.9% # controls: 27 baseline; 23 at follow up % males: 70.4%	Cases: 8.1±1.8yrs range unknown Controls: 9.3±2.0yrs range unknown Wide spectrum	Academic center and community referral Self-selected groups Government funded	Multiple comparators: Pediatric sleep questionnaire clinical evaluations	PSG criteria Other diagnostic criteria developed by authors	Yes / Yes	Comprehensive PSG Duration not stated Timing = Nocturnal	Findings supportive of PSG variables being poor predictors of psychopathology at baseline and follow up after treatment Children referred for T&A who did not demonstrate OSA at baseline PSG had improved psychopathology after surgery; this may suggest that symptoms rather than objective evidence of OSA is an important indictor for intervention, thus leaving unclear the role for PSG in identifying which children need treatment Since all psychiatric symptoms were self-reported by parents and children, and psychiatrists were not blinded to the surgical status of the children, a placebo effect for surgery cannot be ruled out. Test-retest validity of obstructive apnea index determined by PSG is demonstrated in that postoperative AI improved in the expected direction.
77	Giordani (2008)	2	To compare neuropsychological functioning in children with and without PSG-confirmed OSA awaiting T&A compared to a control group. AT children were recruited from ENT wait lists and PSG was performed to group children into AT/OSA+ and AT/OSA- groups. Children underwent MSLT, parental ratings of sleep disturbance (Pediatric Sleep Questionnaire), neuropsychological assessments, and emotional/behavioral assessments	Prospective cohort study Blinded study	Eligible: unknown Completed study: 68 % males: 37/68=54% # controls: 27 (26 completed as 1 found to have OSA) % males: 19/27=70% unknown gender of the control who was excluded)	Cases: AT/OSA+ 7.83±1.8 Range 5.42-12.46 yr AT/OSA- 8.43±1.77 Range 5.49-12.11yr Controls: 9.15±1.97 Range 5-12 yrs Wide spectrum	Academic center and community referral Self-selected groups Government funded	Physical examination and outcomes measures MSLT	PSG criteria Other diagnostic criteria developed by authors	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	Findings supportive of children awaiting T&A having worse neuropsychological functioning Findings not supportive of OSA being the primary reason for the impaired neuropsychological function as AT/OSA- children were most impaired In children awaiting AT, the findings did not support convergent validity of neurocognitive function with PSG-determined OSA vs. no OSA. Children awaiting AT had higher hyperactivity scores than normal controls, supporting the concept that hyperactivity should be considered as an important control or covariate in studies of cognitive function and sleep-disordered breathing.
84	Archbold (2004)	4	To assess executive function in children with mild SDB as part of a larger study on T&A and behavior. Also to determine whether components of the PSG (SpO2 nadir, AHI etc) relate to cognitive executive functions. Mild SDB defined as AHI>1 and <10 with SpO2 above 90% Children were referred for T&A either for recurrent tonsillitis (n=7) or for obstructed airway symptoms relating to enlarged tonsils (n=5) Children had PSG and MSLT Normative published data used as comparison This study was designed to evaluate executive function in children with mild SDB	Clinical series Blinded study	Eligible: 12 Completed study: 12 % males: 7/12=58% # controls: none % males: n/a	Cases: 9.0±0.85 yrs (range 8.0-11..9yr) Controls: n/a Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Behavioral scales	Not stated	Yes / Yes	Comprehensive PSG TST 427.5 minutes Nocturnal	Findings supportive of reduced attention and possibly mental flexibility in children with mild SDB

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78	Gozal (2007)	3	Consecutive habitually snoring and non-snoring 5-7 yr olds underwent overnight PSG, and had neurocognitive testing and blood drawn for APOE epsilon 4 allele testing the following morning.	Prospective cohort study Blinding not specified	Eligible:345 Completed study: 258 habitually snoring; n=112 no OSA, 2=146 OSA % males:54.5% # controls: 87 % males: 54	Cases: 6.4 +/- 0.2 no osa, snoring; 6.3 +/- 0.3 OSA snoring (5-7) Controls:6.4 +/- 0.2 (5-7) Wide spectrum	Community referral Strategy not specified Government funded: NIH grant plus Children's foundation for sleep research, presumably private	Neurocognitive testing and APOE eps.4 alleles	PSG criteria	Yes / Yes: OSA defined as AHI>2 or AI >1 with nadir O2 sat <92%	Comprehensive PSG PSG duration = up to 12 hours Timing = Nocturnal	1. PSG is useful in distinguishing OSA from non-OSA in primary snorers. 2. Assuming that snoring is on a continuum with OSA, convergent validity of PSG-determined OSA is demonstrated by this study in that increasing percentages of children had at least 2 abnormal cognitive tests in nonsnoring vs snoring vs OSA.
79	Emancipator (2006)	3	835 children aged 8-11 from an urban community cohort designed to overrepresent African American and preterm children underwent in home sleep study. Blinded assessment of cognitive function was then compared in those with sleep disordered breathing (defined as OAHI >5, OAI>1 AND/OR habitual snoring defined as loud snoring at least 1-2 times per week in the last month) and those without SDB. The purpose of this study was to assess whether sleep disordered breathing (defined as OSA AND/OR habitual snoring) is associated with decreased cognitive functioning, and determine if preterm children were at differentially increased risk of SDB-related cognitive impairment. Correlation between degree of nocturnal hypoxemia and severity of cognitive deficits was examined. While prospective and broad spectrum, this study did not use the gold standard overnight PSG and the definition of SDB using both respiratory parameters on the overnight sleep study AND habitual snoring despite documentation of respiratory events is problematic.	Those administering cognitive tests were blinded to the SDB status	Cohort Eligible: 907 Study eligible: 835 # with OSA: 164 Controls: 0 % males:50%	Cases:9.5 +/- 0.8 Spectrum not specified	Community referral Urban, community based cohort Strategy and Funding: Not specified	5 point snoring questionnaire filled out by parents cognitive assessments (PPVT-R, K-ABC, CPT)	PSG criteria	No. Were referred to a prior publication.	Ambulatory (unattended) sleep study PSG duration = not specified Timing of PSG: Nocturnal	In children with habitual snoring, who seem to be at higher risk for cognitive dysfunction, in home sleep studies may underestimate the degree of sleep disordered breathing as defined by the apnea/hypopnea index. Ex preterm infants may be at greater risk for cognitive dysfunction as a result of sleep disordered breathing and may represent a population in which more widespread use of polysomnography should be considered.
80	Montgom-ery-Downs (2005)	3	19 children from a state-funded preschool program for at risk children with low SES underwent overnight PSG and cognitive assessment before and after T&A for OSA. 19 matched controls underwent a single PSG and cognitive eval. This study was done to examine the impact of T&A on sleep, respiration and cognitive function in preschool kids with OSA from a low income community	Case control study Blinded study	Eligible: 39 Completed study:19 % males: 53 # controls: 19 % males: 53	Cases: 4.4 +/- .7 Controls: 4.5 +/- .6 Narrow spectrum	Questionnaires to state sponsored program for at risk kids, (1951 respondents – 33 % of questionnaires) 273 of responders underwent PSG and cognitive testing; 39 had SDB diagnosed by PSG Self-selected groups Government funded	Cognitive assessment used Differential Ability Scales (DAS), preschool sion, and Pre-Reading Abilities subtest from Developmental Neuropsychological Assessment	PSG criteria Other: BMI	Yes / Yes	Comprehensive PSG PSG duration = up to 12 hours Timing of PSG: Nocturnal	1) This study suggests that it may be beneficial to screen more widely for snoring and SDB in at-risk preschoolers, using PSG to diagnose OSA. \4% (38/273) of children who snored occasionally (2 nights/week), frequently (3-4 nights/week), or often (>4 nights/week) demonstrated sleep disordered breathing on PSG. 2) This study demonstrates test-retest reliability of PSG by showing improvement in the expected direction with regard to respiratory variables (respiratory arousal index, AHI, and SpO2 nadir) in children undergoing T&A for OSA. 3) This study also demonstrated test-retest reliability of PSG by showing improvement in the expected direction with regard to slow wave sleep (increased) but failed to demonstrate improvement in other sleep stage percentages. There was a statistically significant decrease in REM sleep after T&A that could not be accounted for by methodological issues such as duration of recording.
81	Crabtree (2004)	3	PSG, Pediatric Quality of Life Inventory (PedsQL) and Children's Depression Inventory (CDI) were performed on 44 obese children (ages 8-12) with snoring and suspected SDB (ClinOb) and 41 normal BMI children (ages 8-12) with snoring and suspected SDB (ClinNl) and were compared to 31 children (ages 8-10) with no snoring or symptoms of SDB. The aim of this study was to determine if the presence of snoring and obesity in children would independently lead to increased depression and decreased QOL in comparison to normal weight and healthy children.	Case control Blinding not applicable	Eligible: Unclear Completed study: 85 clinically referred age 8-12 y % males: 55 44 of 85 had BMI >95%ile; 4 of 35 controls # controls: 31 % males: 42	Cases: 10+/-1.5 years (8-12 years) Controls: 9.5+/- 9 years (8-10 years) asymptomatic Narrow spectrum	Academic center and community referral Expert assigned or selected groups: 85 consecutive children referred to a tertiary SDC for suspected SDB; controls were "parents who reported their children had no symptoms in questionnaires mailed to ?community for another study of childhood SDB Funding source not specified	Quality of Life and Depression Questionnaires Two validated questionnaires: Pediatric QL 4.0 questionnaire Children's Depression Inventory	PSG criteria No details of PSG given other than RDI>=5 or AI>=1 considered OSA. No refs as to how respiratory parameters measured	Yes / Yes	Comprehensive PSG etCO2, NP, oronasal thermistor, SpO2 with recording of pulse waveform, respiratory effort either RIP or resp impedance. PSG duration = up to 12 hours Timing of PSG: Nocturnal	1) Children with suspected SDB, regardless of the severity of AHI or the presence of obesity, had more impairments in quality of life and depressive symptoms than did children who did not snore. 2) This study suggests that all school-aged children with symptoms of snoring should have a thorough assessment of their current mood and overall emotional functioning. 3) Another study in which the presence or absence of ONLY snoring is associated with significant pathology, severity of SDB (mild to severe SDB) does not make symptoms worse. 4) Primary snoring alone is sufficient to cause symptoms of decreased QOL, ahedonia, impaired psychosocial functioning
85	Tran (2005)	4	To investigate behavior and quality of life before and 3 months after adenotonsillectomy in children with OSA compared to those undergoing unrelated elective surgery Purpose of study was to investigate behavior and quality of life in children with OSA before and after adenotonsillectomy	Case control Blinding not specified	Eligible: number eligible not given… In total 99 agreed to participate and 83 in total completed Completed study: 42 % males: 25/42 = 60% # controls: 41 % males: 29/41 = 71%	Cases: 5.8+/-2.5yrs (range 2.0-11.5yrs) Controls: 7.3+/-3.8yrs (range 2.1-14.0yrs) Narrow spectrum	Academic center and community referral Self-selected groups Initially self selected based on ENT list for T&A then the OSA group was expert assigned based on PSG results. Controls were self selected undergoing elective surgery unrelated to oto, opthal, or neuro diseases and without a history of snoring Funding source not specified	Multiple comparators: Behavioral assessment (CBCL) Quality of life (OSA-18)	PSG criteria	No / No No details of PSG given other than RDI>=5 or AI>=1 considered OSA. No refs as to how respiratory parameters measured	Not specified	"-findings support the inability of OSA severity to predict behavioral or quality of life outcomes, except that the only PSG parameter given was RDI or AI. Since no details and no other respiratory parameters were analyzed, nothing can be stated about the SDB in this group - despite no post-op PSG to quantify AHI, behavior and quality of life improve after T&A for OSA but do not improve after unrelated elective surgeries ; some question as to the expectation of a positive outcome for an "elective" surgery, indicating there must be some impact preop that the questionnaire misses - findings suggest that treatment of OSA improves behavior and quality of life - no correlation between OSA severity and behavior scores - no correlation between OSA severity and quality of life scores pre-op but association between OSA severity and change in quality of life score post-op see above
86	Mitchell (2005)	4	Caregivers of children with PSG documented OSA (AHI>5) were asked to fill out a Behavior Assessment System for Children (BASC) before and within 6 months after T&A This study looked at the behavior of children (as assessed by a standardadized rating sclare) with PSG determined OSA before and after adenotonsillectomy	Clinical series Blinding absent	Eligible:74 Completed study: 52 % males: 56	Cases: 7.1 (2.5-14.9) Wide spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Behavioral scales	PSG criteria	No / Yes	Comprehensive PSG PSG duration = "full night" Timing of PSG: Nocturnal	1) PSG parameters of severity of OSA do not seem to correlate with degree of abnormalities in behavior as elicited by the BASC checklist, nor do they predict improvement in behavior post adenotonsillectomy 2) Postop correlatations unclear since PSG was not done on the subjects post-op….the pre-op PSG did not predict or correlate with either before or after surgery behavior
87	Mitchell (2006)	4	This study examined 23 kids after T&A for PSG determined OSA (AHI>5) and compared behavioral rating scales (BASC) pre-op, 6 months post-op and 9-18 months post op This study looked at long term behavior changes (9-18 months after adenotonsillectomy) as measured by parent reported Behavior Assessment System for Children (BASC) in children with PSG documented OSA	Clincal series Blinding absent	Completed study: 23 ****NOT CLEAR if these are some of the same patients reported in Mitchell 2005. Huge drop out rate (21 of 44 failed to complete followup questionnaries % males: 65	Cases: 7.2 (2.5-14.8) Narrow spectrum	Community referral Expert assigned or selected groups Government funded	Behavioral scales	Not stated	No / Yes	Comprehensive PSG PSG duration = "full night" Timing of PSG: Nocturnal	No conclusions can be drawn from this study. 9-18month follow up data were not reported in conjunction with any PSG parameters. No f/u PSGs were performed
88	Mitchell (2007)	4	This study was designed to evaluate the relationship between the severity of SDB and behavior (using the BASC) and to compare changes in behavior before and after T&A in children with different levels of severity of SDB	Prospective cohort study Blinding absent	Eligible: 46 Completed study: 40 % males: either 53% or 55% (calculated from data in Table 1; authors grouped children according to severity of SDB and reported %male separately; there appears to be an error in table 1 since the authors state 62% of 17 children were male but that makes 10.5 children. 10/17=59% or 11/17=65% so it can't be 62% as stated # controls: none	Cases: Mean age for mild SDB was 7.3yrs (range 3.2-12.9yr) and for OSA was 6.9yrs (range 3.1-14.9yr). Unable to calculate for whole group Controls: n/a Narrow spectrum	Academic center and community referral Expert assigned or selected groups Non-US funding agency	Outcomes measures (quality of life or academic)	PSG criteria	No / Yes	Comprehensive PSG PSG duration not specified Timing of PSG = Nocturnal	Findings supportive of lack of relationship between severity of SDB and behavioral morbidity in a narrow spectrum population. Findings supportive of improvement in behaviors with T&A in children with SDB which is not related to disease severity The behavior scale (BASC) used here is parent-reported but does not assess sleep, but behavior. This paper is not suitable for pediatric sleep questionnaire correlation with pediatric OSA results review.

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82	O'Brien (2004)	3	35 children recruited from a community sample of children who were reported to snore frequently or almost always, and had the diagnosis of SDB based on a composite score from PSG parameters underwent neuropsychological testing; results of PSG and testing were compared to 35 matched controls. SDB defined as having a composite score > or = 5, using AHI, Respiratory arousal index and spO2 nadir scaled from 0 to 3 The purpose of this study was to evaluate the relationship of SDB and neurobehavioral performance in a community sample of children	Prospective cohort Blinding not specified	Eligible: 43 with SDB Completed study: 35 could be matched % males: 49 # controls: 35 % males: 49	Cases: 6.7 +/- 0.6 Controls: 6.7 +/- 0.5 Narrow spectrum	11,963 community questionnaires, with 5728 responding (47%), 576 families contacted, 438 agreed to have PSG and neurobehavioral evals Self-selected groups Government funded	Behavioral scales	Not stated	Yes / Yes	Comprehensive PSG PSG duration =472 minutes Timing of PSG: Nocturnal	Using several PSG parameters to define sleep disordered breathing (AHI, Respiratory arousal index and Sp02 nadir) may help differentiate children at risk for neurocognitive difficulties, but the numbers are small and the differences were not dramatic
83	Mayes (2008)	3	This study aimed to determine the relative importance of sleep, IQ, neuropsychological scores, and ADHD symptoms in predicting academic achievement in a large community sample of children from kindergarten through 5th grade. Children were part of a larger epidemiological study of the prevalence of sleep disorders in children	Prospective cohort study Blinding not specified	Eligible: unknown Completed study: 412 % males: 52% # controls: None	Cases: 8.6±1.7 yrs (range 6-12yrs) Controls: n/a Wide spectrum	Community referral Random selection Government funded and Foundation funded	Parental observations	PSG criteria	No / Yes (not standardized scoring critera)	Comprehensive PSG PSG duration not specified Timing of PSG = Nocturnal	Findings not supportive of sleep variables (either subjective or objective) being predictors of either reading or math achievement in young children after IQ and ADHD symptoms were accounted for Study did not support convergent validity of neurocognitive function with PSG-determined AHI, mean oxygen saturation during sleep, oxygen saturation nadir, snoring severity, arousal index, % stage 1, or sleep efficiency. %REM was higher in children with learning disability than without learning disability in this sample. Studies of cognitive function in relationship to PSG should control for comorbid psychiatric disorders especially ADHD.
89	Owens (2008)	4	This study was a medical record review to assess which risk factors are most strongly associated with adverse neurobehavioral outcome in children referred for SDB. Other sleep disorders also evaluated using ICSD criteria	Clincal series, observational Blinded study	Eligible: 235 Completed study: 235 % males: 57.9% # controls: none	Cases: 9.06±3.66 yrs (range 3.06-18.4yrs) Controls: n/a Wide spectrum 50% overweight)	Academic center and community referral Self-selected groups Funding not specified	Behavioral scales	PSG critera ICSD criteria (Dx of non-SDB sleepdisorders made with ICSD)	Yes / Yes	Comprehensive PSG PSG duration not specified Timing of PSG = Nocturnal	Findings supportive of PSG not being useful to identify SDB threshold for children at risk of adverse neurobehavioral morbidities Findings supportive of SDB severity having weak association with behavioral outcomes Multifactorial and complex etiology of the relationship between SDB and behavioral outcomes. Treatment of SDB reverses at least some of deficits. Paper not critical addition to pediatric sleep questionnaire correlation with PSG findings.
90	Kurnatowski (2008)	4	The study aims were; 1. to show that OSA is caused by adenotonsillary hypertrophy and is associated with hypoxia and brain dysfunction 2. children with OSA are more likely to have emotional lability, depressive behavior, and anxiety	Case control study Blinding absent	Eligible: 121 Completed study: 121 % males: not specified # controls: 104 % males: not specified	Cases: mean age not reported but range was 6-13 yrs Controls: mean age not reported but range was 6-13 yrs Narrow spectrum	Community referral Self-selected groups Funding not specified	Behavioral scales Physical examination	PSG criteria Other authors cited as to criteria for OSA	No / No (OSA defined as AHI > 1 and SpO2 < 90%)	Comprehensive PSG PSG duration = = 8.2 hrs (range 6.6-9.6hrs) Timing = Nocturnal	Findings supportive of OSA with adenotonsillar hypertrophy in young children (6-9 years) being associated with emotional instability although depression and anxiety problems were not statistically significantly higher in children with OSA. Findings demonstrated a lack of relationship between OSA and depression, anxiety, and emotional instability in children 10-13 yrs. Supports convergent validity of emotional instability with PSG-determined sleep disordered breathing in younger children but not in older children.
4.2.1.1.8 Serial or Ambulatory BP Measurements												
98	Bixler (2008)	2	This community based study aimed to determine the association between SDB and clinically relevant changes in BP in young children. Since the current PSG criteria for SDB are not based on clinically relevant outcomes, the study assessed varying thresholds for SDB. This was part of a larger study on children's sleep and behavior.	Prospective cohort study PSGs scored independently (double scored) so this may count as blinded	Overall: Eligible:1000 (200 per year for 5 yrs) Completed study: 700 % males: 48% For those with SDB: N= 183 % males = approx 45% but table 1 doesn't appear to add up correctly # controls: (no SDB) n=517 % males:49%	Cases: 112 ±20 months for mild SDB and 121 ±18 months for moderate SDB Controls: 111±months Age range for all children was kinder-garten through grade 5 Wide spectrum	Community referral Random selection Government funded	Not specified	PSG criteria Other diagnostic criteria developed by authors	Yes (R&K cited) / Yes	Comprehensive PSG PSG duration = 9hrs (no means presented so TST unknown) Timing = Nocturnal	In general, findings supportive of SDB being an independent predictor of increased BP Findings supportive of a threshold of AHI>5 for significant increases in BP in a community sample of young children Findings suggestive of AHI>3 perhaps being relevant for BP changes Finding do not support AI>1 being useful in detecting elevated BP
99	Enright (2003)	2	To describe associations between objectively defined SDB and BP in a community cohort of preadolescent children (6-11yrs) in the TuCASA study. Results presented with several definitions of RDI with and without differing levels of desaturation	Prospective cohort Blinded study	Eligible: unknown Completed study: 239 % males: 55% # controls: n/a	Cases: 8.70 yrs (5th-95th centile was 6.15-11.24yrs) Controls: n/a Wide spectrum	Community referral Self-selected groups Government and privately funded	Not specified	PSG critera Other diagnostic criteria developed by authors	Yes (Referenced R&K) / Yes	Ambulatory (unattended) sleep study PSG duration = 8.15 hrs 5th-95th centile was 5.3-9.93hrs Timing = Nocturnal	Supportive of SDB being independently predictive of hypertension in children in the presence of oxygen desaturation
102	Redline (2007)	2	Study sample derived from ongoing longitudinal community cohort. The present study evaluates adolescents at 13-16 yrs for SDB (AHI≥5). BP, metabolic syndrome. Metabolic syndrome definition based on adapted adult criteria for the pediatric population	Prospective cohort study Blinding not specified	Eligible: 389 total Completed study: 270 (22 found to have SDB) % males: 140/2070=52% overall and 17/22=77% for only SDB # controls: 248 of the 389 were found not to have SDB % males: 123/248=50%	Cases: 13.4±0.5 yr Controls: 13.6±0.7 yr Range for both group 13-16 yrs Wide spectrum	Community referral Self-selected groups Government funded	Sleep diary	PSG criteria Other diagnostic criteria developed by authors	Yes (by citation to ASDA and R&K) / Yes	Comprehensive PSG PSG duration not specified Nocturnal	These cross-sectional findings are supportive of a role for SDB in pediatric (adolescent) metabolic syndrome and indices associated with metabolic syndrome Supportive of certain PSG parameters being associated with metabolic dysfunction (eg O2 desats) since no association between report of habitual snoring and metabolic dysfunction
106	Marcus (1996)	4	75 patients were referred for suspected OSA and underwent overnight PSG. Three patients were excluded due to asthma, hypertension or pre-op eval, five studies were terminated due to technical problems including 3 because of BP measurements interfering with sleep. Of the remaining 67 pts, 26 had normal PSGs and were called primary snorers and served as controls vs. 41 patients with OSAS. BP measurements were compared between the two groups.	Case control study Blinding not specified	Eligible: 75 Completed study: 41 % males:66 # controls: 26 % males:39	Cases: 5 +/-3 Controls: 8 +/-4 Wide spectrum	Academic center and community referral Expert assigned or selected groups Government funded	BP was taken every 15 minutes during study using automated system	PSG criteria	Yes / yes	Comprehensive PSG PSG duration = not specifed Timing of PSG: Nocturnal	Findings suggest that children with SDB as diagnosed by PSG have higher BP than the general pediatric population. This is more robust for OSA, but is present in primary snorers as well. PSG may be helpful in evaluating etiology of hypertension in the pediatric population if SDB is suspected. Children with moderate OSA have higher diastolic BP than control subjects awake or asleep. Although Limitations of study: concerned that the repeated BP cuff measurements caused some arousals.
104	Kohyama (2003)	4	Aims: To investigate blood pressure (BP) in children with sleep disordered breathing (SDB). Methods: BP was measured during single night polysomnography in 23 suspected SDB child patients with adenotonsillar hypertrophy, but without respiratory or heart failure, or coma. The age related changes of the observed BP were normalised to the BP index. The BP indices were examined in relation to SDB measures, such as the desaturation time (percentage of time with oxygen saturation (SaO2) <90% against the total sleep time), SaO2 nadir, apnoea-hypopnoea index (AHI), and arousal index, in addition to age and body mass index (BMI).	Clinical series, observational study, case reports Blinding absent	Eligible:32 Completed study: 23 16 pts AHI<10 7 pts AHI≥10 % males:83% # controls: N/A	AHI≥10: 6.2 (2.4) [4.0–11.1] AHI<10: 5.4 (1.0) [3.8–7.2] Narrow spectrum 23 suspected SDB child patients with adenotonsillar hypertrophy, but without respiratory or heart failure, or coma.	Academic center Expert assigned or selected groups Funding not specified	Blood pressure	Children with SDB, non-specified type	Yes R&K Were respiratory scoring methods clearly defined? Yes One episode of apnoea was defined as 10 seconds or more of respiratory suppression that did not exceed 25% of the baseline tidal volume determined during QDC.17 Hypopnoea was defined on RIP as a series of breaths that was less than 50% and greater than 25% of the baseline tidal volume determined during QDC.17 According to movements of the chest and abdominal portions during the respiratory suppression, a pause on RIP was taken as being obstructive or central.17 Following Marcus and colleagues,18 we did not count central apnoea following movement.	electroencephalogram (EEG), electro-oculogram, electromyography of the chin and trunk muscles, oxygen saturation (SaO2) monitoring (Ohmeda Biox 3740; averaging time, 6 seconds), respiratory monitoring through respiratory inductive plethysmography (RIP), and video monitoring.1 PSG duration = not specified Timing of PSG: Nocturnal	PSG is useful in studying patients with suspected SDB and finding correlations with blood pressure.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
105	Li (2009)	3	A prospective cross-sectional community based study comparing ambulatory BP (ABP) in 190 non-overweight prepubertal children (ages 6-13 y) with AND without primary snoring to investigate whether primary snoring is a part of the dose-response relationship between SDB and BP in children	Prospective cohort study Blinding not specified	Eligible: 619 subjects were admitted for over-night PSG but only 466 also complete ABP because they only had 3 ABP machines. Completed study: 466 had both ABP and overnight PSG. For purposes of the study design, they excluded overweight, children in puberty, or inadequate ABP readings. They excluded 29 controls because they had an ODI >1, a SpO2 <90% and 6 subjects with primary snoring. Final study cohort: n = 190 subjects Primary snoring n-46, 9.9 + 1.6 y, 63% male; AHI 1-3 n =62, 10.0 + 1.5 y, 76% male, AHI >3 n = 26, 10.2 + 1.4 y, 77% male % males: see above # controls: n = 56 mean age 10.0 + 1.6 y % males: 61%	See adjacent cell Narrow spectrum	Academic center Random selection Drawn from their childhood OSA epidemiologic study involving Hong Kong children ages 6-13 y recruited from 13 schools chosen at random. Parents completed Li et al validate sleep questionnaire that stratified children into low and high risk for OSA Government funded	Ambulatory BP monitoring same day as the overnight PSG done. Validated sleep questionnaire for Hong Kong children BMI z score	PSG criteria ICSD criteria Other: Computerized sleep data edited by experienced PSG technologists and clinicians using American Thoracic and ICSD- scoring criteria	Yes / yes	Comprehensive PSG A single overnight PSG done in a dedicated sleep laboratory PSG duration = 8-8.3 hours total sleep time Timing of PSG:Nocturnal	Primary snoring (PS) is not benign, contributing to the dose-response relationship between SDB and ABP. During both wakefulness and sleep, SBP, DBP, and MAP all exhibited an increasing trend across the severity spectrum of SDB from healthy controls without snoring to subjects with primary snoring and to subjects with increasing severity of OSA. Subjects with PS had significantly higher DBP compared with nonsnoring healthy controls (mean difference 3.2 mm Hg, p = .016) Children with AHI >3 had significantly less MAP nocturnal dipping than controls (p <.05). The proportion of MAP non-dippers increased across groups.
100	Leung (2006)	3	To investigate association between OSA and ambulatory blood pressure in snoring children To investigate the relationship between OSA and 24hr ambulatory blood pressure in snoring children	Prospective cohort Blinding not specified	Eligible: 106 Completed study: 96 % males: 66/96 = 69% # controls: none	Cases: 9.4+/-2.8years (range 6-15 years) Controls: n/a Narrow spectrum	Source not specified Random selection Non-US funding agency	Multiple comparators: Physician assessment Parental report Ambulatory blood pressure	PSG criteria Other diagnostic criteria developed by authors Comment: States that ATS criteria were used but no details given.	No Just stated that R&K criteria used and AASM arousal criteria used Were respiratory scoring methods clearly defined? Yes In an appendix	Minimal information on PSG; no details regarding how airflow was measured PSG duration = unknown; no details Timing of PSG: Nocturnal	"- PSG may be valuable in identifying children who are at risk of hypertension - Desaturation index may contribute to nocturnal diastolic BP - The relationship between AHI > 5 and elevated diastolic blood pressure provides some convergent (construct) validity for PSG in children since OSA is a known risk factor for hypertension in adults.
101	Li (2008)	3	This study was designed to evaluate the relationship between OSA and blood pressure in a community based group of pediatric patients. A total of 466 subjects were recruited from 13 randomly selected schools. Subjects completed a validated 54 item sleep questionnaire and underwent polysomnography and ambulatory BP monitoring. 118 of the 466 subjects were classified by PSG to have "primary snoring" and were excluded. Another 42 subjects were excluded because the data obtained from BP monitoring was not usable. 306 subjects were included in the final analysis. These were subdivided into three groups: no OSA (AHI<1, n=127), mild to moderate OSA (1<AHI<5, n=127), and moderate to severe OSA (AHI>5, n=46). The polysomnographic features are compared and BP readings are compared.	Prospective cohort study Blinding not specified	Eligible: 466 Completed study: 306 Cases (mild OSA defined as 1<AHI<5): 133 Males: 69% Cases: (moderate to severe OSA defined as AHI>5): 46 % males: 76% # controls (AHI<1): 127 % males: 57 %	Cases (mild OSA defined as 1<AHI<5): 10.6 (SD=1.6) Cases: (moderate to severe OSA defined as AHI>5):10.1 y (SD=1.6) Controls:10.4 y (SD=1.6) Narrow spectrum	Community referral Self-selected groups Government funded	Ambulatory BP, OSA screening questionnaire	PSG criteria	No / Yes	Comprehensive PSG (includes thermistor, EtCO2 monitor, but no nasal pressure transducer recording) PSG duration not stated Timing not specified	Convergent validity of PSG-determined AHI is demonstrated by the correlation between AHI and blood pressure in children, independent of obesity.
96	Amin (2008)	2	To determine the 1-yr recurrence of SDB in children with adenotonsillar hypertrophy who are undergoing T&A for clinical reasons and to investigate the impact on blood pressure. Two different measures of growth were studied: BMI and gain in velocity of BMI. The investigators tested the hypothesis that independent of obesity, rate of gain in BMI increases the risk of recurrence of SDB which in turn contributes to the elevation in BP 1 yr after T&A	Case control study Blinded study	Eligible: 97 enrolled (62 SDB and 35 controls) Completed study: 40 % males: not specified although there were 65|% males in the SDB group who had AHI<3 at 1 yr f/u and 55% males in SDB who had AHI>3 at f/u # controls: 30 % males: 40%	Cases: SDB with AHI<3 at f/u: 9.3±2.1 yrs SDB with AHI>3 at f/u: 10.3± 2.2yrs Range 7-13yrs Controls: 10.2±2.2 yrs (range 7-13yrs) Narrow spectrum	Academic center and Community referral Self-selected groups Government funded	Physical examination	PSG criteria Other criteria developed by authors	No: It is unclear as to whether or not sleep stages were scored although the AHI was determined per hour of sleep No: Statement made that PSG performed according to ATS standards	Not specified Duration not specified Timing = Nocturnal	Findings do not support use of PSG in early weeks following T&A; rather they support use of PSG to detect residual SDB much later after T&A (perhaps 1yr). Supportive of long term repeat PSG in children who may be particularly at risk of recurrence of SDB, ie those who are African American and who have rapid BMI gain, since these children may have higher risk for hypertension Although there was no specific analysis of the control group, it appears that AHI was not significantly changed across the 4 PSGs obtained during a 12 month period. This provides weak support for test-retest reliability of PSG in normal controls but there was no specific analysis to test this construct and no specific analysis of sleep architecture variables across the samples. Test-retest validity of PSG is demonstrated in that AHI improved in the expected direction postoperatively. Convergent validity of PSG is demonstrated in that subjects who had recurrence of SDB in one year had higher BP vs those without recurrence, and there was no change in BP in the control group over the study period.
103	Amin (2004)	3	Pediatric subjects referred for nightly snoring underwent overnight PSG and ambulatory BP monitoring. Subjects ages 5-17 referred to their pediatric SDC underwent H & P, BMI, and ABP. Excluded children with genetic syndromes, chronic medical conditions including ADHD, and children with conditions which could alter BP, and children receiving daily medications	Case-control study Blinding absent	Eligible: 72 consented to participate in study, but 12 requested d/c of BP recording during night and refused to complete the ABP Completed study: 60 (49 completed ABP and BP during PSG	Narrow spectrum Excluded children with genetic syndromes, chronic medical conditions including ADHD, and children with conditions which could alter BP, and children receiving daily medications	Academic center Sequentially recruited Children referred to their pediatric SDC for suspected OSA (snored nightly) They divided those children who participated into those with OSA (AHI >1), primary snoring (AHI 0-1) and no evidence of nocturnal hypoventilation. They further divided the OSA group into those with AHI 1-5, and those with AHI > Pharmaceutical or equipment company	Not specified	PSG criteria ICSD criteria Other	Yes / Yes	Comprehensive PSG PSG recorded overnight according to American Thoracic Society standards including etCO2. PSG duration = >390 minutes of sleep Nocturnal >390 minutes of sleep	Compared 24-ABPM with PSG found children with OSAS compared with those with primary snoring had significantly greater mean BP variability during wakefulness and sleep, higher night-to-day systolic BP, and smaller nocturnal dipping of mean BP. Variability in the mean arterial pressure awake could be predicted by DI, BMI, and arousal indexes, and BP variability asleep by AHI and BMI. Nocturnal BP dipping was predicted by the DI. Diastolic BP awake was significantly different between the groups and correlated negatively with the AHI. The authors showed that the early stages of BP dysregulation in children are characterized by an alteration in the circadian rhythm of BP profile and an increase in BP variability.
32	Reade (2004)	3	Records from 130 pediatric patients were reviewed. Excluded those with renal failure, transplantation, mental retardation, NMD, DM, chronic lung disease, congenital heart disease, sickle cell, or antihypertensive therapy, left 90 patients. Patients had originally been referred by their primary physicians for a polysomnogram for various reasons. Patients with medical comorbidities were excluded. 90 patients were included in the study. Polysomnographic data is reviewed, and is correlated with presence of obesity and hypertension.	Clinical series, observational study, case reports Blinding not specified	Eligible:90 Completed study: 90 % males:64%	Cases: 10.7 yrs range 4.2-18.8 Narrow spectrum	Community referral Referred by PCP for sleep study because of their clinical presentation" Expert assigned or selected groups Funding not specified	Hypertension	PSG criteria: Hypopnea defined as a 20-50% reduction in airflow with a minimum duration of 10 and associated with a desaturation of 3% or greater or a 3 sec EEG arousal.	Yes	Comprehensive PSG Oronasal airflow, etC02, PSG duration = "overnight" Timing of PSG: Nocturnal	In obese pediatric patients, the hypopnea index and arousal index are physiologically significant predictors of cardiovascular risk posed by obstructive sleep apnea. Obesity and hypertension in pediatric patients should prompt a careful evaluation for sleep disorders. Obesity is a risk factor for OSA especially in older children; hypertension in a child warrants consideration of obstructed SDB. Only elevated hypopnea index was a predictor of diastolic hypertension in children with SDB.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
97	Apostolidou (2008)	2	OSA in adults associated with metabolic syndrome. Unclear if same metabolic derangements are seen in children. Unclear if the derangements improve following T&A and correction of the OSA. This study was designed to evaluate specific markers for cardiovascular risk in a group of children with OSA, and try to determine if these markers are beneficially affected by adenotonsillectomy. To do this, children were prospectively recruited from a group of children sent for PSG due to clinical concerns about possible OSA, who had AHI>1 documented on the PSG and who agreed to go through with adenotonsillectomy. Subjects underwent a baseline (diagnostic) polysomnogram, and underwent measurements of the study outcomes, which were blood pressure and blood tests for serum CRP, clCAM-1, fasting insulin and fasting glucose. The last two variables were used to calculate the HOMA index (homeostasis model assessment) = (fasting insulin x fasting glucose)/22.5. These variables were measured again postoperatively. The "cases" (ie: children with OSA) were subdivided into those who had postoperative polysomnographic evidence of resolution of disease (postop AHI<1 n=13) and those who had residual polysomnographic disease (postop AHI>1 n=45). A control group was recruited from children scheduled for adenotonsillectomy for reasons unrelated to sleep disordered breathing (e.g.:recurrent tonsillitis). These patients underwent pre- and post-surgical PSG and had blood pressure and blood test measurements as described for the cases. Additional subgroup analysis was performed comparing the measured outcomes in (1) cases with baseline AHI>5 vs controls (2) overweight subjects vs participants with normal weight and (3) OSA cases who had CRP>0.3mg/dL vs controls.	Prospective cohort study Blinding absent	Eligible: 63 N=117 Completed study:N=58 % males=64 # controls:N=17 % males=47	Cases: 6.2 yrs Controls: 6.5 yr Narrow spectrum	Academic center Expert assigned or selected Grant Sponsor = University of Thessaly Research Committee (Privately funded)	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration = "Overnight" Timing = Nocturnal	The study used PSGs to confirm the diagnosis of OSA. Also used PSGs to confirm resolution of OSA following T&A. Some young pediatric patients have limited evidence of improvement of markers for cardiovascular risk following successful surgical treatment of OSA, suggesting that polysomnography has face value for identifying disease possibly associated with elevated cardiovascular risk. The reduction in risk markers is not universal, and tracks with PSG evidence of complete cure, which was achieved in fewer than one in four patients. This supports the notion that an AHI>1 should be considered abnormal in a pediatric population.
4.2.1.1.9 Quality of Life Measures												
116	Rosen (2002)	2	This is a community based cohort which was recruited from within a larger community based study population. Children were identified by virtue of having a first degree family member with sleep apnea. All underwent health-related QOL survey (either the Children's Sleep and Health Questionnaire (CSHQ) or the adult-oriented Health and Sleep Questionnaire (HSSQ), and an overnight in-home ambulatory PSG (Edentrace). Children were divided into one of four groups, based on clinical and PSG characteristics: (1) normal (2) + obstructive symptoms at night, but RDI<5 (3) "mild to moderate" OSA+=obstructive symptoms and RDI of 5-10 and (4) "moderate-severe OSA"=+ obstructive symptoms and RDI>10. The health related QOL data is then evaluated from within the context of these groups. 298 children participated in the study. Based on the PSG and reported symptoms, children were classified for the purpose of this study as follows: (a) Normal: 203 children (b) Obstructive Symptoms only: 50 children (c) Mild-Moderate OSA: 25 children (d) Moderate-Severe OSA: 20 children In terms of PSG parameters, the authors randomly chose 20 of the computer-scored studies to "manually" overscore. Investigators were blinded to original reports. In these records, apneas were defined as absence of airflow with continued effort, while hypopneas were defined as reduced airflow and 4% desaturation. 20 studies were randomly chosen and blindly re-scored, to provide validation for the computer-generated RDI calculated by the edentrace, with good correlation. No MGD: unless used to confirm importance of identifying SDB in children Study was designed to describe the health related QOL responses of children with varying degrees of sleep disordered breathing, as well as no sleep disordered breathing. Used data from ongoing community-based genetic-epidemiologic Cleveland Family Study cohort to determine the impact of SDB on a validated generic HRQOL questionnaire in children. Assessed the extent to which SDB (no snoring, mild to moderate SDB, moderate to severe SDB) was associated with impairment of generic HRQOL using the Child Health Questionnaire. MGD Study limitations: 1) Only 15 patients had SDB, only 3 patients had severe SDB [small sample size]; 2) Home monitoring recording only cardiorespiratory measure; 3) Study relied on parent-proxy reports of QOL, study would have been strengthened by child self-report, but this requires a child with an intellectual age of at least 10 years for validity but peak age of OSA 3-6 y of age.	Prospective cohort study Blinded study	Eligible: 298 Completed study: 298 % males: 46% (see below)	Cases: 11.1 +/- 3.5 yrs (age 5-17 y) Patient Spectrum = NA	Community referral Self-selected groups Government funded	Outcomes measures (quality of life or academic)	PSG criteria	Yes Apneas were defined as cessation of airflow of at least 10 seconds, while hypopneas were defined as discrete reductions in airflow or chest impedence, associated with a 2.5% fall in O2 sat. Total sleep time was determined by "limited movement" (no mention of actigraphy) and sleep/wake times recorded on a diary.	Abbreviated in-home respiratory testing measures oronasal thermistor, chest wall impedance, HR, and finger pulse oximetry. This was an Edentrace Ambulatory monitoring system. There is a nice reference in this article to validation of their measurement (see "study description" below). PSG duration = "overnight" Timing of PSG: Nocturnal	1. Overnight ambulatory (Edentrace) PSG with computer generated RDI's shows good face validity with respect to patient-reported symptoms of impaired QOL. 2. Overnight ambulatory PSG with computer generated RDI's produces RDI values similar to those generated by manual scoring of the same data.
81	Crabtree (2004)	3	PSG, Pediatric Quality of Life Inventory (PedsQL) and Children's Depression Inventory (CDI) were performed on 44 obese children (ages 8-12) with snoring and suspected SDB (ClinOb) and 41 normal BMI children (ages 8-12) with snoring and suspected SDB (ClinNl) and were compared to 31 children (ages 8-10) with no snoring or symptoms of SDB. The aim of this study was to determine if the presence of snoring and obesity in children would independently lead to increased depression and decreased QOL in comparison to normal weight and healthy children.	Case control Blinding not applicable	Eligible: Unknown Completed study: 85 clinically referred age 8-12 y % males: 55 44 of 85 had BMI >95%ile; 4 of 35 controls # controls: 31 % males: 42	Cases: 10+/-1.5 years (8-12 years) Controls: 9.5+/- 9 years (8-10 years) asymptomatic Narrow spectrum	Academic center and community referral Expert assigned or selected groups: 85 consecutive children referred to a tertiary SDC for suspected SDB; controls were "parents who reported their children had no symptoms in questionnaires mailed to ?community for another study of childhood SDB Funding source not specified	Quality of Life and Depression Questionnaires Two validated questionnaires: Pediatric QL 4.0 questionnaire Children's Depression Inventory	PSG criteria No details of PSG given other than RDI>=5 or AI>=1 considered OSA. No refs as to how respiratory parameters measured	Yes / Yes	Comprehensive PSG etCO2, NP, oronasal thermistor, SpO2 with recording of pulse waveform, respiratory effort either RIP or resp impedance. PSG duration = up to 12 hours Timing of PSG: Nocturnal	1) Children with suspected SDB, regardless of the severity of AHI or the presence of obesity, had more impairments in quality of life and depressive symptoms than did children who did not snore. 2) This study suggests that all school-aged children with symptoms of snoring should have a thorough assessment of their current mood and overall emotional functioning. 3) Another study in which the presence or absence of ONLY snoring is associated with significant pathology, severity of SDB (mild to severe SDB) does not make symptoms worse. 4) Primary snoring alone is sufficient to cause symptoms of decreased QOL, ahedonia, impaired psychosocial functioning
112	Franco (2000)	4	Caregivers of 61 eligible children (6 mo-12 y) completed 20-item (OSA-20) health-related QOL survey after PSG to psychometrically validate the OSA-20 as a QOL tool. Inclusion criteria: 1) tonsillar and/or adenoidal hypertrophy on exam; 2) ages 6 mo-12 years; 3) history of snoring and disrupted sleep>3 months; 4) referred to Peds Pulmonary for PSG; Exclusion criteria: 1) prior AT; 2) Down or other head and neck syndrome; 3) cleft palate or other previous pharyngeal surgery; 4) known cognitive deficit or mental retardation; 5) known psychiatric disorder; 6) caregiver unable to read and understand English.	Prospective cross-sectional study with no controls. Blinding not applicable	Eligible: 61 Completed study: 61 % males: 35 (57%) were males. No controls	Cases: n = 61; median age 4 years (range 3-7 years), 85% Black, 8% White; 7% Hispanic. Controls: No controls Narrow spectrum .	Academic center: Brooklyn University Hospital and Kings County Medical Center, Expert assigned or selected groups See inclusion and exclusion criteria Privately funded: Supported by a small projects outcomes research grant from the American Acad of Otol.	NAP PSG compared to OSA-20, physical exam, and brief demographic form. Followup OSA-20 administered 3 days after the first to establish test-retest reliability.	Not stated	NA / No / Comments: Only stated the criteria for normal/mild OSAS RDI < 5, moderate OSAO RDI 6-9, and severe OSAS RDI > 10h criteria for OSA events NOT given.	Nap PSG done after a night of sleep deprivation, used Eden Tec II, recording only cardiorespiratory parameters and body position, lasted 90 mins. Timing and duration not specified	Significant correlations (and construct validity) between the caregiver-rated scores on the OSA-18 QOL instrument and the RDI obtained from a cardiorespiratory monitor nap study (r = 0.43). Sleep disturbance and caregiver concerns had the highest associations with RDI (R = 0.45 and 0.47 respectively). The relationship between the OSA-18 summary score and RDI (R = 0.43) was only fair, but statistically significant and remained significant after adjusting for potential confounding factors such as BMI, adenoid size and age. Tonsil size was the only significant confounding factor identified in multivariate analysis. A regression model predicted 25% variability in RDI levels and was statistically significant (p = 0.007). Strengths and limitations of this study: prospective, not blinded, nap study to confirm OSDB using a cardiorespiratory monitor.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
119	Carno (2008)	4	This study examined the relationship between parent and self report of OSA as well as objectively measured severity of OSA in overweight and risk-for-overweight children and adolescents. Also investigated relationship between parent and self reported QofL and severity of obesity.	Prospective cohort Blinding absent	Eligible: unknown Completed study: 151, with 96 having PSG data % males: 60% (total group of 151) No controls	Cases: 12.52±2.85 yrs (range not stated) Controls: n/a Wide spectrum some were primary snorers, others had mild to severe OSA, all were overweight or at risk for overweight	Academic center and ""convenience sample of subjects consecutively evaluated at a regional pediatric sleep laboratory for possible OSA" Expert assigned or selected, included if being evaluated at sleep lab overweight >95th percentile and at risk for overweight BMI >85th percentile <95th Funding not specified	Parental observations Pediatric Sleep Questionnaire (PSQ) Pediatric Quality of Life Inventory 4.0	PSG criteria	Yes / Yes	Comprehensive PSG TST between 385-398 mins; overall mean not specified Timing - Nocturnal	Study supports finding that QofL is low in overweight and risk for overweight children who snore but PSG findings did not correlated with morbidity Findings supportive of PSQ (pediatric sleep questionnaire) being superior to PSG in identifying children at risk for poor QofL Findings perhaps suggest that PSG may not be sensitive enough to detect subtle changes that may identify children at risk of morbidity Neither AHI, AI, peak etCO2, time spent with EtCO2 >50 mm Hg nor sleep efficiency significantly contributed to the prediction of total or subscale QOL of either the parent or youth surveys. There were no significant differences between QOL among the primary snorers and subjects with AHI >2. No difference in QOL between those with and without OSA (defined either as AI >1 or AHI > 2 or AHI > 5 save youth emotional function. Parents consistently rated lower QOL for their children than the children rated themselves.
115	Mitchell (2007)	2	To evaluate quality of life in children pre- and post- T&A. PSGs were performed prior to T&A and again approximately 5 months (range 1-9 months) after surgery.	Prospective cohort study Blinding not specified	Eligible:118 Completed study: 79 % males: 40/79= 51% No controls	Cases: 6.3 yrs (range 3.0-15.8yrs) withmajority between 3-6 yrs Controls: n/a Narrow spectrum	Academic center Expert assigned or selected Funding not specified	Outcomes measures (quality of life or academic)	PSG criteria	No / Yes	Comprehensive PSG PSG duration = 426±54 mins pre-op and 414±78 mins post-op sleep time Timing = Nocturnal	Findings supportive of residual SDB in large minority of children undergoing T&A, especially when pre-op AHI is higher. May support a role for post-op PSG in children undergoing T&A Findings supportive of lack of robust correlation between improvement in OSA severity and improvement in outcomes (in this case quality of life) Post-op symptom reports showed good correlation with post-op persistence of OSA Mean preoperative AHI 27.5, postoperative 3.5 (p <0.001). Statistical analysis to have sufficient power to detect a significant change.
120	Constantin (2007)	4	Retrospective comparison of short- and long-term improvements in QOL among children with OSDB who did and did not receive AT for it.	Clinical series, observational study, case reports "Case-control" study compared those who had OSA but did not have AT to those who did. Retrospective cohort study of otherwise healthy children with OSA who underwent AT between 1993-2001, compared to children who had OSA but did not undergo AT. Blinding absent	Eligible: parents of 473 children (292 62% boys) received questionnaires by mail Completed study: Only 166 (35%) of 473 parent(s) returned questionnaires, and only 138 of the questionnaires were complete with written consent provided. % males: 62%	Final cohort: Complete data available for 94 of 109 subjects 3 years or older. Questionnaires returned by 138 subjects, 75 had OSAS (OAHI > 1/h), 63 did not. AT done on 87% (65/75) with OSAS, 33% (21/63) who had OAHI <1. Cases: Mean age at time of PSG 4.6 + 2.2 y (55% males); Controls: 7.4 +3.5 y, 50% boys Wide spectrum	Academic center Expert assigned or selected groups Principal investigator rec'd fellowship to do study. Government funded	Behavioral scales From each patient they tried to collect: 1) cardiorespiratory data from a home PSG; 2) pre-PSG parental questionnaire; 3) f\u parental questionnaire	PSG criteria and other diagnostic criteria developed by authors	Yes Used RIP to score events, OA = reduction in sum signal on calibrated RIP to <20% baseline for > 3 seconds paired with paradoxical mvts of ribcage and abdomen. OH = 20-50% fall in baseline associated with > 4% desat. OSAS OAHI > 1/h Respiratory methods not applicable	Ambulatory (unattended) sleep study Duration and timing not specified	QOL scores improved in 74% of children who underwent AT for OSDB but only 10% of children who did not undergo AT (p <0.001, OR 25.1, 95% CI 8.8-71.8). Children who did not undergo AT tended to have mild to no OSA (AHI 1.5 + 3.7). Parents of children with OSDB frequently report adenotonsillectomy (AT) improves sleep, breathing, and QOL but often does not improve neurobehavioral outcomes. Significant study limitation: QOL data was available for only 35% of the cohort, limiting meaningful interpretation.
117	Mitchell (2004)	3	Evaluated the impact of adenotonsillectomy on quality of life (QOL) and sleep behaviors in 30 obese children who underwent adenotonsillectomy (AT) for obstructive sleep disordered breathing (OSDB). Age and gender specific BMI >95th percentile. First prospective study of improvements in PSG findings and QOL following AT in obese children with OSA.	Prospective cohort study Blinding not specified	Eligible:30 children % males:86% # controls: None	Cases:30 children (26, 86% male) with RDI >5/h, at time enrolled in study mean age 9.3 y. Controls: None Narrow spectrum	Academic center Expert assigned or selected groups Other, specify:Funded by the individual researchers supported by the University of New Mexico as part of faculty duties.	Outcomes measures (quality of life or academic)	PSG criteria	Yes / yes	Comprehensive PSG PSG duration = >360 minutes Timing of PSG:Nocturnal	Obese children with OSA who undergo AT showed a marked improvement in RDI on comprehensive PSG and in quality of life using OSA-18 with no change in their BMI. However, in the majority of obese children with OSDB, the OSA does not fully resolve even though their sleep/wake complaints lessen and their QOL improves. OSA improved on PSG from severe to moderate OSA. Changes in QOL were even more dramatic.
118	Mitchell (2004)	3	Children with severe OSA who undergo adenotonsillectomy	Not specified / not applicable	Eligible: 35 children eligible but 3 lost to f\u, one did not have f\u PSG, and caregivers of 2 children did not complete the postop OSA-18 QOL tool. Completed study: 29 children (mean age 7.1 y, 1.4-17.0 y),	Cases: 29 children (mean age 7.1 y, 1.4-17.0 y), Controls: N/A Spectrum: NA	Not specified Pharmaceutical or equipment company	Not specified	Not stated	Not applicable	Not specified	Children with severe OSA who undergo adenotonsillectomy show a significant improvement in RDI and in quality of life over a period of several months after surgery. However, OSA does not resolve in the majority of these children and post-operative PSG is recommended to identify those who may require additional therapy.
4.2.1.1.10 Therapeutic Intervention Studies that Prove Evidence of Test-Retest Validity												
63	Chervin (2006)	2	PSG, MSLT, neuropsychological testing and parental behavioral ratings were completed on 105 children aged 5-12 (77 case subjects scheduled for AT, 27 scheduled for unrelated surgical care) at baseline and 1 year later. The study tested the hypothesis that children who undergo AT, in comparison to other surgical procedures, experience more neurobehavioral improvement one year after surgery.	Case control Blinded study	Eligible: 78 Completed study: 77 % males: 57 (of total group) # controls: 27 (23 completed study) % males: 57 (of total group)	Cases: 8.4 +/- 1.9 yrs. (5-12.9 yrs) Mean age and range is for entire study group; no designation of case and control values. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Behavioral scales MSL on MSLT Cognitive Testing Psychiatric Diagnosis	Other diagnostic criteria developed by authors Clinical indication for AT as determined by ENT.	Yes / Yes	Comprehensive PSG PSG duration = overnight Timing of PSG: Nocturnal	1) Children scheduled for AT often have mild-moderate SDB and significant neurobehavioral morbidity, including hyperactivity, inattention, ADHD and EDS. 2) All measures of neurobehavioral morbidity improve 1 year following AT. 3) Common measures of SDB by PSG did not show associations with baseline neurobehavioral morbidity other than sleepiness and one-year changes in PSG generally did not predict neurobehavioral outcomes other than sleepiness. 4) Lack of better correspondence between these variables may reflect limitations of standard SDB measures in the assessment of neurobehavioral morbidity for children with mild-moderate SDB, which is generally the most common type of SDB treated by ENT.
59	Chervin (2007)	3	Retrospective analysis of 105 children aged 5-12.9 yrs (78 subjects underwent clinically indicated AT). Study objective: validation of SRBD scale and comparison of scale and PSG to predict OSA treatment related neurobehavioral responses.	Case control Blinded study	Eligible: 78 Completed study: 78 % males: 57 # controls: 27 % males: not stated	Cases: 8.4 +/- 1.9 yrs. (all cases) Controls: mean age not stated. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	SRBD scale of the Pediatric Sleep Questionnaire, neurobehavioral scales (Child Symptom Inventory-4, IVA CPT), MSL from MSLT, and otolaryngologist Hx and PE	PSG criteria Other diagnostic criteria developed by authors Other:Clinically indicated AT defined by treating ENT.	Yes / Yes	Comprehensive PSG and MSLT PSG duration = Not Stated Timing of PSG: Not specified	1) SRBD subscale of the PSG predicts PSG results, useful for research but not reliable enough for patient care. 2) SRBD subscale may predict OSA-related neurobehavioral morbidity and its response to AT as well or better than PSG. 3) Preop PSG may serve important purposes other than to diagnosis OSA, such as to screen for severe OSA that raises risk of perioperative AT complications. 4) With persistence of OSA in significant number of children after AT, present data indicate that PSG may be more important after TA than before.
76	Dillon (2007)	2	This study was part of a larger study. The goals of the present study were to assess the frequency of mental disorders in children referred for T&A compared to controls both before and 1 year after surgical treatment. A secondary goal was to determine whether surgical response was related to baseline PSG measures. Children clinically referred to ENT were included and inclusion was not based on PSG results. Children whose surgeons sought PSG for clinical purposes were excluded.	Case control study Blinded study	Eligible: not stated in this paper; authors refer reader to previous paper for details of participants and non-participants Completed study: 79 baseline (78 had follow up) % males: 51.9% # controls: 27 baseline; 23 at follow up % males: 70.4%	Cases: 8.1±1.8yrs range unknown Controls: 9.3±2.0yrs range unknown Wide spectrum	Academic center and community referral Self-selected groups Government funded	Multiple comparators: Pediatric sleep questionnaire clinical evaluations	PSG criteria Other diagnostic criteria developed by authors	Yes / Yes	Comprehensive PSG Duration not stated Timing = Nocturnal	Findings supportive of PSG variables being poor predictors of psychopathology at baseline and follow up after treatment Children referred for T&A who did not demonstrate OSA at baseline PSG had improved psychopathology after surgery; this may suggest that symptoms rather than objective evidence of OSA is an important indictor for intervention, thus leaving unclear the role for PSG in identifying which children need treatment Since all psychiatric symptoms were self-reported by parents and children, and psychiatrists were not blinded to the surgical status of the children, a placebo effect for surgery cannot be ruled out. Test-retest validity of obstructive apnea index determined by PSG is demonstrated in that postoperative AI improved in the expected direction.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
97	Apostolidou (2008)	2	OSA in adults associated with metabolic syndrome. Unclear if same metabolic derangements are seen in children. Unclear if the derangements improve following T&A and correction of the OSA. This study was designed to evaluate specific markers for cardiovascular risk in a group of children with OSA, and try to determine if these markers are beneficially affected by adenotonsillectomy. To do this, children were prospectively recruited from a group of children sent for PSG due to clinical concerns about possible OSA, who had AHI>1 documented on the PSG and who agreed to go through with adenotonsillectomy. Subjects underwent a baseline (diagnostic) polysomnogram, and underwent measurements of the study outcomes, which were blood pressure and blood tests for serum CRP, cICAM-1, fasting insulin and fasting glucose. The last two variables were used to calculate the HOMA index (homeostasis model assessment) = (fasting insulin x fasting glucose)/22.5. These variables were measured again postoperatively. The "cases" (ie: children with OSA) were subdivided into those who had postoperative polysomnographic evidence of resolution of disease (postop AHI<1 n=13) and those who had residual polysomnographic disease (postop AHI>1 n=45). A control group was recruited from children scheduled for adenotonsillectomy for reasons unrelated to sleep disordered breathing (e.g.:recurrent tonsillitis). These patients underwent pre- and post-surgical PSG and had blood pressure and blood test measurements as described for the cases. Additional subgroup analysis was performed comparing the measured outcomes in (1) cases with baseline AHI>5 vs controls (2) overweight subjects vs participants with normal weight and (3) OSA cases who had CRP>0.3mg/dL vs controls.	Prospective cohort study Blinding absent	Eligible: 63 N=117 Completed study:N=58 % males=64 # controls:N=17 % males=47	Cases: 6.2 yrs Controls: 6.5 yr Narrow spectrum	Academic center Expert assigned or selected Grant Sponsor = University of Thessaly Research Committee (Privately funded)	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration = "Overnight" Timing = Nocturnal	The study used PSGs to confirm the diagnosis of OSA. Also used PSGs to confirm resolution of OSA following T&A. Some young pediatric patients have limited evidence of improvement of markers for cardiovascular risk following successful surgical treatment of OSA, suggesting that polysomnography has face value for identifying disease possibly associated with elevated cardiovascular risk. The reduction in risk markers is not universal, and tracks with PSG evidence of complete cure, which was achieved in fewer than one in four patients. This supports the notion that an AHI>1 should be considered abnormal in a pediatric population.
121	Gozal (2008)	2	This study was designed to better understand the role played by OSA in the pathogenesis of several factors associated with cardiovascular risk in a pediatric population, with particular attention to the change in these parameters after adenotonsillectomy, and whether obese subjects had different results from nonobese subjects. Subjects were recruited from consecutive children referred for PSG for clinical concern over sleep apnea. Those who were diagnosed with "moderate to severe" sleep apnea (defined by this study as an AHI>2) were considered eligible. Subjects who agreed to participate (n=81 of 97 potentially eligible) were subdivided into obese (BMIz score>1.2) or non obese. Subjects underwent a baseline PSG with fasting blood draw for CBC, glucose, insulin, CRP, lipid panel and ApoB. Subjects were later invited to return for a repeat PSG 6-12 months after adenotonsillectomy (n=62, of which 25 were nonobese and 37 were obese).	Prospective cohort study Blinding absent	Eligible: N=97 81 agreed to participate Completed study: N = 62 37 obese 25 nonobese All had OSA No other controls without OSA % males=43 # controls: 25 % males: 60%	Obese: 7.9 yrs 7.9+0.5 (3-12) Nonobese: 6.6 yrs 6.6+0.5 (3-11) Narrow spectrum	Academic center Expert assigned or selected groups (consecutive patients who were referred to an academic sleep disorders center were invited to participate) Government funded NIH grants, as well as private grants (Children's Foundation Endowment for Sleep Research, and Commonwealth of Kentucky Challenge for Excellence Trust Fund, and National Space Agency grant.	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG with modern pediatric montage (including nasal pressure transducer tracing and end-tidal CO2 monitoring). PSGs were done pre and post T&A PSG duration ="overnight" 7-8 hrs Timing of PSG: Nocturnal	The study used PSGs only to confirm the diagnosis of OSA. Also used PSG to confirm resolution of OSA following T&A. Not to be overlooked…nonobese children had resolution of OSA with surgery (AHI from 13 to 2). But obese children seemed to have more residual OSA following surgery (AHI from 19 to 6). Polysomnography has good face validity in this group of pediatric patients. Residual disease post T&A co-migrates with a lesser degree of improvement of accepted cardiovascular risk markers, while complete resolution of respiratory events is associated with a higher degree of improvement. Obese children are at greater risk than nonobese children for nonresolution of OSA following T&A. Obesity should be considered in the decision to recommend a postsurgical follow up study to document resolution of disease.
122	Mitchell (2007)	3	Study designed to evaluate the outcome of T&A for OSA in obese (n=33) and non-obese children (n=39). The goal was to provide qualitative data on the relative effectiveness of T&A for OSA in obese children. Children were only studied if they had AHI>2 on baseline PSG and follow up data was obtained	Clinical series, observational study, case report Blinding absent	Eligible: 78 Completed study: 72 % males: 43/72=60% # controls: n/a	Cases: 6.6 yrs (range 3.1-17.0 yrs) Controls: n/a Narrow spectrum	Academic center and community referral Expert assigned or selected Funding not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / Yes	Comprehensive PSG PSG duration: not specified PSG timing: Nocturnal	Findings supportive of obesity being a risk for persistent OSA following T&A Findings supportive of T&A being effective at decreasing severity of OSA but not eliminating it. Could lend support to obesity being an indication for post-op PSG Discriminate validity of PSG-determined AHI is demonstrated in that obese children had significant higher AHI than nonobese children both before and after AT. Test-retest validity of PSG-determined AHI is demonstrated in that both obese and nonobese children had a reduction in obstructive AHI, oxygen saturation nadir, and arousal index s/p AT.
96	Amin (2008)	2	To determine the 1-yr recurrence of SDB in children with adenotonsillar hypertrophy who are undergoing T&A for clinical reasons and to investigate the impact on blood pressure. Two different measures of growth were studied: BMI and gain in velocity of BMI. The investigators tested the hypothesis that independent of obesity, rate of gain in BMI increases the risk of recurrence of SDB which in turn contributes to the elevation in BP 1 yr after T&A	Case control study Blinded study	Eligible: 97 enrolled (62 SDB and 35 controls) Completed study: 40 % males: not specified although there were 65|% males in the SDB group who had AHI<3 at 1 yr f/u and 55% males in SDB who had AHI>3 at f/u # controls: 30 % males: 40%	Cases: SDB with AHI<3 at f/u: 9.3±2.1 yrs SDB with AHI>3 at f/u: 10.3± 2.2yrs Range 7-13yrs Controls: 10.2±2.2 yrs (range 7-13yrs) Narrow spectrum	Academic center and Community referral Self-selected groups Government funded	Physical examination	PSG criteria Other criteria developed by authors	No: It is unclear as to whether or not sleep stages were scored although the AHI was determined per hour of sleep No: Statement made that PSG performed according to ATS standards	Not specified Duration not specified Timing = Nocturnal	Findings do not support use of PSG in early weeks following T&A; rather they support use of PSG to detect residual SDB much later after T&A (perhaps 1yr) Supportive of long term repeat PSG in children who may be particularly at risk of recurrence of SDB, ie those who are African American and who have rapid BMI gain, since these children may have higher risk for hypertension Although there was no specific analysis of the control group, it appears that AHI was not significantly changed across the 4 PSGs obtained during a 12 month period. This provides weak support for test-retest reliability of PSG in normal controls but there was no specific analysis to test this construct and no specific analysis of sleep architecture variables across the samples. Test-retest validity of PSG is demonstrated in that AHI improved in the expected direction postoperatively. Convergent validity of PSG is demonstrated in that subjects who had recurrence of SDB in one year had higher BP vs those without recurrence, and there was no change in BP in the control group over the study period.
66	Shatz (2004)	3	This is a retrospective case series of infants <12 months of age who had undergone evaluation for clinical suspicion of sleep disordered breathing. The cohort included in the analysis were patients who met all three of the following criteria: 1. Upper airway obstruction symptoms: snoring, respiratory distress, or apnea (presumably a parental report of witnessed apnea, but this is not specified) 2. Adenoid enlargement causing >50% narrowing of the nasopharynx, as documented on lateral neck photograph 3. Polysomnography documenting OSA (as defined by an AHI>1). The 24 cases which were felt to meet these criteria are reviewed and analyzed. Clinical and polysomnographic data are presented. 24h pH monitoring was also done preoperatively and these data are presented. Postsurgical follow up data (clinical and polysomnographic) are presented as well.	Clinical series, observational Blinding not specified	Eligible:not clear Completed study: 24 infants are described % males: 75%	Cases: 10 months Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No / No	Not specified Airflow is measured by thermistor only. No mention is made regarding duration, timing (nocturnal vs daytime nap), or scoring criteria for sleep staging or respiratory events. PSG duration = not specified Timing of PSG: Not specified	Polysomnography shows face validity in this cohort of infants with adenoidal hypertrophy and clinically suspected sleep disordered breathing. Adenoid hypertrophy in infants can occur and can cause OSA (typically we think of this only occurring in older kids). Because adenoid hypertrophy in infants is not as common, should raise a concern and then use PSG to confirm presence and severity.
127	Gozal (2008)	4	This study looked at PSG and levels of Il-6, a pro-inflammatory cytokine, and Il-10, an anti-inflammatory cytokine, both felt to be involved in atherogenesis, in children with OSA both before and 4-6 months after T&A, vs. nonsnoring controls without OSA.	Case control study No blinding	Eligible:40 Completed study: 20 % males: 60 # controls: 20 % males: 60	Cases: pre T&A 6.5 +/- 0.6; Post T&A 7.2 +/- 0.6 Controls: 6.4 +/- 0.7 Narrow spectrum	Academic center Expert assigned or selected groups Government funded: NIH plus Children's Foundation Endowment for sleep research, commonwealth of Kentucky challenge for excellence.	Not specified	PSG criteria	Yes / Yes	Ambulatory (unattended) sleep study PSG duration = up to 12 hours Timing of PSG:Nocturnal	1) PSG is useful in determining improvement in OSA after adenotonsillectomy 2) Study demonstrates test-retest validity of PSG in that AHI, AI, SpO2 nadir, %TST with SpO2<90%, mean PetCO2, %TST with PetCO2 >50 all improved in the expected direction s/p AT 3) Study demonstrates construct validity of PSG in that measures associated with the inflammatory process (Il-10, Il-6) were abnormal in children with OSA vs normal controls, and improved to normal following treatment.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
30	Niemenen (2000)	3	This study looked at 58 snoring children with symptoms of SDB who underwent two PSGs 6 months apart. Thirty healthy children also underwent a single PSG as a control	Prospective cohort Blinding not specified	Eligible: 78 Completed study: 58 % males: 53 # controls: 30 % males: 57	Cases: 5.8 +/- 1.8 (2.4-10.5) Controls: 7.1 +/- 1.8 (4.3-10.9) Narrow spectrum	Community referral Expert assigned or selected Funding not specified	This study used a questionnaire to determine severity of symptoms of OSA, and an OSA scoring system developed by Brouillette but not further described	PSG criteria	No (no EEG) / Yes (but not "standard" and technology poor)	No EEG or EOG was used, so no sleep stage scoring was done Duration not specified Timing was nocturnal	1)This study suggest that clinical symptoms alone are inadequate in differentiating primary snoring from obstructive sleep apnea, and that PSG is required. 2)This study suggests that an AHI of >2 on PSG may be an indication for T&A, with improvement in symptoms and PSG findings postoperatively 3) I n patients with primary snoring, short term f/u (6 months) with PSG does not appear warranted as symptoms did not worsen in this study in those patients Strain gauge, no CO2 monitoring, No nasal pressure so accuracy of test deficient ****No sleep stage scoring/EEG monitoring was done in this study
123	Tunkel (2008)	3	Polysomnography and a quality of life questionnaire (OSA-18) were completed pre- and post-operatively on 14 children (ages 3-12 years) with moderate OSA, who underwent surgical treatment by powered intra-capsular tonsillectomy and adenoidectomy (PITA).	Prospective cohort study Blinding not specified	Eligible: 19 Completed study: 14 % males: 50% No controls	Cases: 71 months (range 28-113 months) Controls: NA Narrow spectrum: Excluded: obese, craniofacial abnormalities, chromo-somal abnormalities, sickle cell anemia	Academic center Expert assigned or selected groups Government funded	Outcomes measures (quality of life or academic)	PSG criteria	Not applicable / Yes	Comprehensive PSG Duration = Overnight Timing = Nocturnal	1) PITA cures otherwise healthy children with moderate OSA, at least in the short term, as documented by PSG. 2) Improvements in QOL, as measured by the OSA-18, were seen in all children as well. 3) Demonstrates test-retest validity of PSG because AHI and quality of life scores improved in the expected direction following PITA.
124	Tauman (2006)	3	Review of pre-op and post-op PSG's for 110 children who underwent T'n'A for OSAS to see if they were cured (AHI<=1) and what factors could be used to predict which children would have residual OSA. Factors examined included disease severity, relative BMI, h/o allergy, family hx of SDB in a 1st-degree relative, age, and ethnicity. Separately, age/gender/relBMI-matched controls were gathered for the group that had post-op AHI<=1 to see if there were any differences in sleep architecture.	Clincal series Blinding not specified but presumably absent since the indication for the second PSG was the surgery	Eligible: 110 Completed study: Not specified % males: 60% # controls: 22	Cases: 6.4 + 3.9 (1 y.o. -16 y.o.) Controls: not stated but age matched Patient Spectrum Not clear Criteria not specified—only that children had OSA on pre-op PSG, un-derwent T'n'A and did not have genetic disorders, CP, neuromuscular or other systemic disorders. I did not pursue finding out if it was wide spectrum since the absence of a control group (there is a control but it is for only one issue) would prevent it from being a Level 2 anyway	Academic center and community referral Strategy not specified Government funded And foundation funded	Not specified	PSG criteria	Yes R&K / Were respiratory scoring methods clearly defined? Yes OA=no A/F w/ chest/abd movement for >2 breaths Hypopnea= fall of nasal A/F of >=50% with either 4% drop in oxy sat or arousal over at least 2 breaths Comments: Cure=AHI<=1 Mild OSAS=1<AHI<5 OSAS=AHI>=5	Comprehensive PSG 1. 8 leads of EEG 2. ROC-A1 3. LOC-A2 4. Submental EMG 5. EKG 6. RAT and or LAT 7. Nasal airflow thermistor 8. Nasal pressure cannula 9. Thoracic movement inductance plethysmography or respiratory impedance 10. Abdominal movement either inductance plethysmogra-phy or respiratory impedance 11. Position sensor 12. Pulse oximeter 13. ET-CO2 PSG duration = between 432.2 and 435.8 Timing of PSG:Nocturnal	1. PSG is indicated to assess residual OSAS in post T'n'A children as the cure rate is fairly low (25% in this study); 2. Factors suggesting an increased likelihood of having residual OSA (AHI>5) include pre-op AHI and +FH of SDB but these factors account for only 25% of the likelihood of having residual OSA; 3. H/o allergy, relBMI, age, and ethnicity were not predictive of post-op AHI >5 4. A smaller %'age of obese children were fully cured (AHI<=1) than non-obese children suggesting an even greater imperative for post-op PSG in obese children; 6. This study demonstrates test-retest validity for PSG as a measure of OSA as the respiratory parameters improved after T'n'A 7. Sleep parameters are worse pre-operatively in children with OSA who are scheduled for T'n'A than post-operatively demonstrating that PSG is sensitive to abnormalities in sleep caused by OSA; 8. The finding of similar sleep parameters (except for a slight decrease in the % of stage 2 sleep) in children whose OSA is cured with T'n'A and normal controls (children without OSA) provides convergent validity that the parameters obtained during PSG are a reasonably measure of sleep.
80	Montgom-ery-Downs (2005)	3	19 children from a state-funded preschool program for at risk children with low SES underwent overnight PSG and cognitive assessment before and after T&A for OSA. 19 matched controls underwent a single PSG and cognitive eval. UARS This study was done to examine the impact of T&A on sleep, respiration and cognitive function in preschool kids with OSA from a low income community	Case control study Blinded study	Eligible: 39 Completed study:19 % males: 53 # controls: 19 % males: 53	Cases: 4.4 +/- .7 Controls: 4.5 +/- .6 Narrow spectrum	Questionnaires to state sponsored program for at risk kids, (1951 respondents – 33 % of questionnaires) 273 of responders underwent PSG and cognitive testing; 39 had SDB diagnosed by PSG Self-selected groups Government funded	Cognitive assessment used Differential Ability Scales (DAS), preschool sion, and Pre-Reading Abilities subtest from Developmental Neuropsychological Assessment	PSG criteria Other: BMI	Yes / Yes	Comprehensive PSG PSG duration = up to 12 hours Timing of PSG: Nocturnal	1) This study suggests that it may be beneficial to screen more widely for snoring and SDB in at-risk preschoolers, using PSG to diagnose OSA. \4% (38/273) of children who snored occasionally (2 nights/week), frequently (3-4 nights/week), or often (>4 nights/week) demonstrated sleep disordered breathing on PSG. 2) This study demonstrates test-retest reliability of PSG by showing improvement in the expected direction with regard to respiratory variables (respiratory arousal index, AHI, and SpO2 nadir) in children undergoing T&A for OSA. 3) This study also demonstrated test-retest reliability of PSG by showing improvement in the expected direction with regard to slow wave sleep (increased) but failed to demonstrate improvement in other sleep stage percentages. There was a statistically significant decrease in REM sleep after T&A that could not be accounted for by methodological issues such as duration of recording.
126	Walker (2008)	3	A database of PSG findings was kept for children who were diagnosed with OSA & who underwent tonsil-lectomy/adenoidectomy (T&A). Those who underwent a postsurgical PSG were eligible for inclusion in the analysis. This study reports the pre- and postsurgical PSG values in this group of pediatric subjects. A total of 34 children were included in the analysis. The spectrum of patients included was wide, and includ-ed multiple syndromic patients (one with Kabuki syndrome, 3 with Down syndrome, 1 with hydrocephalus, 1 with fragile x syndrome, and 1 with submucosal cleft palate).	Clinical series, observational study, case report Blinding not specified	Eligible: not stated Completed study: 34 % males: not stated	Cases: range 0.93y to 5 yr (mean and median 3 years, no standard deviation given) Controls: n/a Wide spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No / No	Comprehensive PSG PSG duration = "overnight" Timing = Nocturnal	1. Test-retest validity of PSG is demonstrated in that RDI and SpO2 improved in the expected direction following adenotonsillectomy. 2. Many pediatric patients who undergo T&A for OSA will have postoperative PSGs which are still considered to be abnormal. This would suggest that a postoperative PSG should be strongly considered for all pediatric patients.
128	Shine (2006)	4	This retrospective study was aimed to determine the effect of T&A on the respiratory parameters of morbidly obese children with OSA with respect to avoidance of further treatment. RDI>5 but <10 was mild SDB RDI>10 but<20 was moderate RDI>20 was severe This study was designed to assess the efficacy of T&A on respiratory sleep parameters and avoiding CPAP in morbidly obese children with OSA	Clinical series Blinding absent	Eligible: 19 Completed study: 18 % males: 14/19 = 74% # controls: none % males: n/a	Cases: MEDIAN age 78±53.3 months (range 24-212 months) Controls: n/a Narrow spectrum	Community referral Expert assigned or selected groups Funding source not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / No / no mention of sleep architecture; RDI definition given but no details provided on what constituted an apnea or hypopnea	Comprehensive PSG Except one subject who only had nocturnal oximetry PSG duration = not specified Timing of PSG: Nocturnal	Findings supportive of high prevalence of residual SDB after T&A in morbidly obese children despite improvement in severity of OSA Findings supportive of large proportion of morbidly obese children being candidates for additional treatment (CPAP) after surgery for OSA Findings could support PSG as an indication in morbidly obese children after T&A
82	O'Brien (2006)	4	PSG before and after treatment for OSA in 29 obese and 40 non-obese children were compared. Contribu-tions of disease severity and time to repeat PSG were also analyzed The purpose of this study was to determine if obesity impacted on the outcome of treatment for obstructive sleep apnea in children	Clincal series Blinding absent	Eligible:213 Completed study: 69: 29 obese, 40 non-obese % males: not stated 79%obese, 65% non-obese	Cases: 9 +/- 3.7 obese; 5.7 +/- 4.1 non-obese Narrow spectrum	Academic center Expert assigned or selected groups Funding source not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = Up to 12 hours Timing of PSG: Nocturnal	This study suggests that post treatment PSG should be perfomed to assess residual disease, particularly in obese patients with a high likelihood for persitant OSA after T&A.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
88	Mitchell (2007)	4	This study was designed to evaluate the relationship between the severity of SDB and behavior (using the BASC) and to compare changes in behavior before and after T&A in children with different levels of severity of SDB	Prospective cohort study Blinding absent	Eligible: 46 Completed study: 40 % males: either 53% or 55% (calculated from data in Table 1; authors grouped children according to severity of SDB and reported %male separately; there appears to be an error in table 1 since the authors state 62% of 17 children were male but that makes 10.5 children. 10/17=59% or 11/17=65% so it can't be 62% as stated # controls: none	Cases: Mean age for mild SDB was 7.3yrs (range 3.2-12.9yr) and for OSA was 6.9yrs (range 3.1-14.9yr). Unable to calculate for whole group Controls: n/a Narrow spectrum (excluded comorbidities; may not apply to children with comorbilities)	Academic center and community referral Expert assigned or selected groups Non-US funding agency	Outcomes measures (quality of life or academic)	PSG criteria	No / Yes	Comprehensive PSG PSG duration not specified Timing of PSG = Nocturnal	Findings supportive of lack of relationship between severity of SDB and behavioral morbidity in a narrow spectrum population. Findings supportive of improvement in behaviors with T&A in children with SDB which is not related to disease severity The behavior scale (BASC) used here is parent-reported but does not assess sleep, but behavior. This paper is not suitable for pediatric sleep questionnaire correlation with pediatric OSA results review.
130	de la Chaux (2008)	4	To evaluate tonsillotomy in 20 children with OSA using pre- and post-op PSG	Clinical series, observational study, case report Blinding absent	Eligible: unknown Completed study: 20 % males: 15/20=75% No controls	Cases: 4.1±2.0 yrs (range 2-9yrs) Controls: n/a Narrow spectrum	Academic center and Community referral Self-selected groups Funding not specified	Parental observations	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 458±33 mins pre-op and 465±46 mins post-op Timing = Nocturnal	Findings supportive of CO2 laser tonsillotomy with adenoidectomy as a therapy in non-obese, young children with OSA Test-retest validity of PSG-determined AHI is demonstrated in that there was a significant reduction in obstructive AHI following surgery, and no difference in frequency of central apneas following surgery.
131	Helfaer (1996)	4	15 children aged 1-12 years with mild OSA as determined by preop PSG (OAI 1-15/hr) and enlarged tonsils/ adenoids underwent a PSG on the night after their adenotonsillectomy to determine if more severe airway obstruction occurred immediately post-op. Groups were randomized to narcotic or non-narcotic anesthesia to determine if either group had a more severe post-op course To determine whether it is necessary to monitor patients with mild OSA s/p tonsillectomy in an ICU setting, and whether narcotics during anesthesia impact post operative course	Clincal series Blinding absent	Eligible: 18 Completed study: 15 % males: not specified	Cases: 5.1 =/+0.8 (1-12) Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Pre-op PSG compared with PSG on night immediately post-op	PSG criteria	No / Yes: OA = cessation of oronasal airflow for 5 secs plus >4% O2 desat Obstructive HYPOVENTILATION (they don't call this hypopnea) = amplitude decreased by 50% for 5 secs plus > 4% desat CA >20 sec or shorter if sats drop or bradycardia	Comprehensive PSG PSG duration = not specified Timing of PSG: Nocturnal	1) Obstructive respiratory events per hour of sleep and severity of oxygen desaturation were reduced during PSG following adeno-tonsillectomy as compared to preoperative PSG. A change in frequency of respiratory events in the expected direction following surgical intervention provides test-retest validity for PSG. 2) Patients with mild sleep disordered breathing due to adenotonsillary hypertrophy who have no other risk factors do not show evidence of worsened upper airway obstruction immediately post-op, and additional inpatient monitoring does not appear to be warranted. 3) There does not appear to be an increased complication rate after adenotonsillectomy in patients receiving narcotics. Caveat is that numbers were small
125	Gozal (2007)	3	OSA associated with cardiovascular morbidity. Endothelial dysfunction is part of the cardiovascular morbidity leading to hypertension and autonomic dysfunction.	Prospective cohort study Not blinded	Eligible: N=52 Completed study: N= 34 N= 26 OSA 16 boys (61%) N=8 controls 5 boys (19%)	Cases: 6.9 yrs + 0.6 yr Controls: 6.8 yrs + 0.5 yrs Narrow spectrum Healthy children Non Obese	Academic center Self-selected groups Excluded: obese, hypertensive, diabetes/prediabetes, craniofacial, neuromuscular, syndromic, genetic abnormalities, current/previous use of montelukast, current use of anti-inflammatories, acute URI, use of any sterior or antibiotic in previous 4 weeks, previous AT, ANY current medications Government funded	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration =8-1/2 hours Timing of PSG: Nocturnal	The study used PSGs to confirm the presence of OSA. We know adults with OSA have cardiovascular morbidity. Starting to see same cardiovascular morbidity in children with OSA. Now in children with OSA, there is evidence for endothelial dysfunction. Of note, these children had moderate to severe OSA with an AHI of 12 plus element of hypoxia and hypercapnia. Test-retest validity of PSG is demonstrated by improvement in AHI s/p adenotonsillectomy Convergent validity of PSG is demonstrated in that reperfusion kinetics and soluble CD40 ligand levels also improved in the expected direction s/p adenotonsillectomy.
43	Pavone (2006)	4	From 54 patients with proven prader willi syndrome who underwent all night PSG, 5 patients were selected for inclusion in this observational study. Inclusion criteria were: age 1-18 yrs, no prior adenotonsillectomy, presence of pathologic adenotonsillar hypertrophy, and presence of moderate to severe OSA on PSG. 5 patients fulfilled these criteria. These patients all underwent T&A, and their pre and post-surgical PSGs are discussed, along with the presence of postoperative complications.	Clinical series, observational study, case reports Blinding not specified	Eligible:5 Completed study: 5 % males: not stated Culled 5 PWS patients from a clinic of 54, all 5 had ATH + moderate to severe OSA 2/5 were obese	Cases: mean age 4.4 years (large range: 1.6-14.2 years) Narrow spectrum	Academic center Expert assigned or selected groups 54 patients dx with PWS followed in the Endocrinology Unit of Bambino Gesu Children's Hospital Rome part of an ongoing study. These had ATH, and had OSA on their limited cardiorespiratory study. Funding source not specified	Not specified	PSG criteria	Yes / Yes	Limited sleep study (describe parameters), thermistor was the airflow measurement (no nasal pressure transducer tracing). End-Tidal CO2 was included in the montage. Not comprehensive PSG but 7-channel recorder measured HR, pulse waveforms, SaO2, RIP (including sum), added thermistor, and recorded video; also recorded etCO2. Device: SomnoStar PT2 (Sensor Medics Corp) They calculated TST based on regularity of cardiorespiratory signals, behavioral observations and video. PSG duration = all night (performed at the usual bedtime) Timing of PSG: Nocturnal	Polysomnography shows face validity in PWS patients with adenotonsillar hypertophy, with improvement of PSG findings following T&A.
132	Sullivan (2008)	4	This study was designed to; 1) retrospectively investigate the impact of failure to treat increased nasal resistance in children (due to enlarged turbinates); 2) to prospectively report results of treatment by reducing the size of the turbinates via radiofrequency and to follow the children for up to 6 weeks after surgery	Clinical series, observational study, case report Blinding absent	Part 1: Retrospective: Eligible: 500 with SDB; 441 recommended T&A; 75 also had enlarged turbinates Completed study: F/U conducted on 399 of which 74/75 had enlarged turbinates and turbinate reduction occurred in 27 % males: Not reported Part 2: Prospective: Eligible: 86 Completed study: 86 % males: 59/86= 69% # controls: Non enlarged reported as controls due to the way in which the data is presented	Part 1: Retrospective: Cases: 6.2±1.2 yrs (total group, no separate data for children with enlarged turbinates) Controls: n/a Part 2: Prospective: Cases: 9.4±4.4 yrs (range 1-17 yrs) Controls: n/a Narrow spectrum	Academic center and community referral Self-selected groups Funding not specified	Physical examination	PSG criteria Unclear as how the Dx was reached; no details given in the manuscirpt.	No / No: no details of PSG scoring provided. Authors state that SDB was diagnosed by PSG but that's all	No details of PSG provided Duration is unkown Timing not reported	Part 1: Children with enlarged turbinates appear to have a higher risk for residual SDB post-T&A. Such residual SDB appears amenable to further treatment (turbinate reduction) Test-retest validity of PSG is demonstrated in that mean AHI improved in the expected direction after adenotonsillectomy or AT + RF of the turbinates. Part 2: No PSG conducted in part 2 so no conclusions drawn
71	Jain (2002)	4	Correlate incidence and severity of OSA with TA size,	Clincal series Blinding absent	Eligible: Completed study: 40 % males: 50	Cases:4-12 yrs Controls:none Narrow spectrum	Community referral Recruitment strategy: Not specified Funding source: Not specified	Multiple comparators: Physical exam Symptoms Inflammation Cephalometrics (laternal neck xray)	PSG criteria	Yes / Yes (used 10 seconds)	Comprehensive PSG PSG duration = not defined Timing of PSG: Nocturnal , pre T&A and 6-8 weeks post PSG	Clinical symptoms of obstruction and TA hypertrophy strongly correlates with SDB as defined (using thier definition of SDB) for OSA. Using a CD angle of 64 deg may be enough to indicated SDB and allow the surgeon to operate. Sensitivity and specificity of the clinical symptoms and measurements not reported in comparison to PSG findings.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
150	Chan (2009)	2	This study analyzed PSG and echocardiograms in 101 children aged 6-13 invited from a community based questionnaire: all children with high risk symptoms. Randomly chosen low risk children were chosen as controls. Reference group patients were those with AHI <1 (n=35); these were compared with those with mild OSA (AHI 1-5, n=39) and those with moderate to severe OSA (AHI>5, n=27). Echocardiograms were done at baseline, and treatments, either T&A or nasal steroids, were offered to the OSA group. Follow up echocardiograms and PSGs were done after treatment, or after the same time interval in untreated patients.	Prospective cohort study Blinded study	Eligible:101 Completed study: 66 % males: 24.5% # controls: 35 % males: 71.4	Cases: 9.65 +/- 1.85 yrs Controls: 9.5 +/- 1.9 Spectrum unclear	Community referral Large ongoing epidemiological study of 13 randomly chosen schools (kids aged 6-13 yrs) Total of 6447 schoolchildren completed OSA screening questionnaire, stratified subjects into low (n=5861) or high (Z=586) risk for OSA. A total of 410 high and 209 low risk children agreed to participate, but this study chose the first 101 consecutive children who agreed to undergo PSG and Echocardiobgram Funding = Research Grants council of Hong Kong Special administrative region	Not specified	PSG criteria	Uncertain (Used EEG, but didn't actually specify that they used standard criteria for staging sleep.) Yes	Comprehensive PSG PSG duration not specified, overnight Timing = Nocturnal	1) This study suggests that untreated OSA can lead to reversible cardiac changes. The implication is that PSG should be considered as an early screening test to diagnose OSA and treat it prior to cardiac abnormalities developing. 2) Convergent validity for some PSG-determined AHI cutoffs of normal (AHI <1), mild (AHI 1-5), and moderate to severe (AHI >5) is demonstrated in that children with AHI > 5 had more cardiac abnormalities. 3) Test-retest validity and convergent validity of PSG-determined AHI are demonstrated in that cardiac function improved in the expected direction only on children who had improvement in AHI following treatment of OSA with either adenotonsillectomy or topical nasal steroid therapy.
151	Uong (2007)	4	This study was a retrospective chart review of 46 patients aged 7-19 yrs who had persistent sleep apnea despite T&A; Initial diagnostic study was performed to diagnose OSA, then repeat PSG with PAP titration. The goal of this study was to determine the rate of compliance of PAP use, both hours nightly and nights per week.	Clinical series, observational study, case report Blinding absent	Eligible: 46 Completed study:46 % males:56.5	Cases: 13.6 +/-3.1 (7-19) Wide spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 8 or more hours Timing = Nocturnal	1) In children s/p T&A, PSG is useful in diagnosing persistent OSA, and in PAP titration useful in determining optimal treatment of residual symptoms 2) Construct validity of PSG is demonstrated in that children treated for OSA with PAP and who were adherent to PAP demonstrated improvement in nocturnal symptoms, daytime sleepiness, and school performance.
152	Scholle (2001)	4	Though not specified in the methods, this appears to be a retrospective case-control study which describes and analyzes the polysomnographic features of children with obstructive sleep apnea and a group of 20 "healthy controls" No mention is made about whether the patients were consecutive, nor about the method of selecting the control group. Children with OSA had PSGs done without/before therapy and after/under therapy (ie: after surgery, or in the presence of positive pressure Rx), and these data are presented, and compared alongside the PSG data from the control group.	Case control Blinding not specified	Eligible: unknown Completed study: 20 % males: not stated # controls:20 % males: not stated	Cases: 6.8 years (3.1 – 17.2) Controls: 7.2 y (3.1-16.8) Narrow spectrum	Academic center Expert assigned or selected groups Funding source not specified	Not specified	PSG criteria	Not completely AHI defined as >5/hr Events "counted" if > 4 seconds long No CO2 measures, no nasal pressure, unusual definition of events	Comprehensive PSG. No nasal pressure transducer or end tidal CO2 monitor used. PSG duration = 8.4 hours (SD 0.8hr) Timing of PSG: Nocturnal	1. Polysomnography has face validity in the diagnosis of OSA and in documenting treatment response. 2. Sleep microarchitecture is disturbed in pediatric patients with OSA, a feature that improves with treatment.
133	Mogayzel (1998)	3	This study is describing sleep and respiratory characteristics in 88 children with achondroplasia and a wide range of clinical problems. 43 of these children had repeat PSGs: 18 to evaluate effects of therapy, 15 to potentially discontinue oxygen, CPAP or tracheostomy; 10 who were free of symptoms At the time of the first PSG, 5 pts had already undergone tracheostomy for severe OSA, and seven required supplemental oxygen. In addition, prior to first PSG 24 pts had undergone surgery (5 trachs, 9 cervicomedullary decompression, 6 VP shunts, 11 T&A) OSA, CSA, hypoxemia, hypoventilation all reported This study describes the spectrum of sleep disordered breathing in children with achondroplasia studied with polysomnography	Clincal series Blinding absent	Eligible: 88 Completed study: 88 % males: 52	Cases: 1 month to 12.6 years (median 1.2 years) Controls: Narrow spectrum	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical)	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 387 minutes median (range 131-541) Timing of PSG: Nocturnal	1. PSG is helpful in identifying sleep disordered breathing in patients with achondroplasia 2. PSG appears useful in assessing adequacy of intervention for various causes of sleep disordered breathing in patients with achondroplasia 3. In patients with achondroplasia and no significant abnormalities on initial PSG, repeat PSG does not appear to reveal any additional abnormalities, however, these numbers are small 4. The study demonstrated test-retest reliability of PSG in that the AI improved in the expected direction in children undergoing treatment for sleep-disordered breathing.
134	Mitsukawa (2007)	4	This is a case series of young children in Japan who had craniofacial syndromes with associated snoring and sleep apnea due to micrognathia. They were awaiting tracheostomy (2 already had trachs) and in an effort to avoid trachs, mandibular distraction was undertaken. PSGs were obtained before and after distraction (between 1yr and 5.2yrs following distraction). The results in terms of OSA are presented.	Clinical series, observational study, case report Blinding absent	Eligible: unknown Completed study: 10 % males: 50%	Cases: 20.5 months; range 1month – 4yrs) Mean age 1.95±2.5 yrs (calculated by LO from raw data) Controls: n/a Narrow spectrum	Assumed to be both academic center and community referrals given the author affiliations, but not specified in the methods Expert assigned or selected (children who were waiting for a trach) Funding not specified	Parental observations	PSG criteria Other diagnostic criteria developed by authors	No / No (no details given re: PSG; stated that PSG used to obtain measures of blood oxygen and AHI but no further details)	Not specified	Supportive of mandibular distraction in improving severity of OSA in young children who would otherwise have a tracheostomy Supportive of a role for PSG following distraction to rule out persistent OSA Test-retest validity of PSG-determined AHI is demonstrated in that all of the non-trach patients had improvement in the expected direction postoperatively.
135	Miller (2007)	4	This study reported on a series of micrognathic infants undergoing mandibular distraction using a curvilinear device.	Clinical series, observational study, case report Blinding absent	Eligible: unknown Completed study: 12 % males: not specified No controls	Cases: median age 3.5 months (range 9 days – 8 months) Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria (No details given re: PSG: just stated that AHI improved)	No / No (No details given)	Not specified Duration not specified Timing = Not specified	Not enough details given although it appears that this study is supportive of an improvement in severity of SDB following distraction in micrognathic infants. Test-retest validity of PSG-determined AHI is possibly supported by this study in that the mean AHI improved in the expected direction postoperatively.
136	Monasterio (2002)	4	15 patients with mandibular hypoplasia were evaluated to determine efficacy of mandibular lengthening procedure for respiratory distress/OSA. Patients were divided into four groups: 1) Four Pts with Pierre Robin sequence who had respiratory distress and required intubation. These patients did not have pre-op PSG 2) Four patients underwent tongue-lip adhesion procedure due to respiratory distress 3) Four older patients presenting with OSA due to Pierre Robin sequence who had failed T&As 4) Three cases with different malformations who had tracheostomies for respiratory obstruction This paper reports the efficacy of distraction osteogenesis (DOG) as a procedure in treating patients with obstructive sleep apnea on the basis of mandibular hypoplasia and retrolingual airway obstruction	Clinical series Blinding absent	Eligible: 15 Completed study: 15 % males: not mentioned # controls: 0	Cases: 3 yrs 2 months (range 1 month to 15 years) Narrow spectrum	Academic center Expert assigned or selected groups	Not specified	PSG criteria	No discussion of how sleep was scored (or of what PSG parameters were even measured) / No apnea of more than 10 seconds and more than 5/hr for dx of sleep apnea	PSG type not specified Duration = 8 hours Timing not specified	This study suggests that PSG is helpful in evaluating the efficacy of surgical procedures for the treatment of OSA in a patient population with craniofacial abnormalities.
137	Zafereo (2008)	4	This study was a retrospective review of 10 patients who had polysomnography pre (4 weeks) and avg 11 weeks post surgery (supraglottoplasty) for laryngotracheomalacia. Patients were 1-9 months old, 8 had GER, two had unilateral vocal cord paralysis and one had mild subglottic stenosis. Surgeries included division of aryepiglottic folds alone (n=4) And division of aryepiglottic folds plus unilateral excision of the cuneiform cartiliage and redundant mucosa	Clinical series, observational studies, case report Blinding absent	Eligible: 10 Completed study:10 % males:60	Cases: 4 months (range 1-9 months) Narrow spectrum	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria Laryngomalacia diagnosed on clinical grounds	No / No	Polysomnography details not given PSG duration = TST mean 6.5 – s hours Timing = Nocturnal	1) PSG is helpful in identifying OSA in infants with laryngotracheaomalacia and documenting their improvement after supraglottoplasty 2) Test-retest validity of PSG is demonstrated in that OAHI and oxygenation improved in the expected direction following surgery.
138	Morita (2004)	4	16 patients with velopharyngeal insufficiency due to various causes (6 after cleft palate repair, 8 with submucous cleft palate, 2 with short palate) underwent two preoperative PSGs, one normal and the following night with nasal occlusion with tampon gauze. This forced the patient to breath orally, assuming this is the main route of breathing after pharyngeal flap due to increased nasal resistance. Based on pre-op occlusion studies,one patient did not undergo surgery. This study was done to see if it is possible to predict preoperatively the risk of OSA after pharyngeal flap surgery for velopharyngeal insuffiency	Clincal series Blinding absent	Eligible: 16 Completed study: 16 (14 had post-op PSGs) % males: 62.5	Cases: 7.3 yrs (4.7-12.9) Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	1) This study suggests that PSG with nasal occlusion may be helpful in predciting post-operative OSA in patients undergoing pharyngeal flap surgery 2) Children with normal AHI (<5/hr) prior to undergoing surgery for velopharyngeal insufficiency also had normal AHI 2 weeks postoperatively, demonstrating test-retest reliability for the AHI obtained during PSG. 3) In children with VP insufficiency, there was a strong correlation between AHI with nasal occlusion pre-operatively and postoperatively. This correlation is in the expected direction and provides further test-retest reliability for the AHI obtained during PSG.
139	Kalra (2008)	4	To determine the effect of surgical weight loss on EEG-defiend architecture in adolescents with severe obesity (>96th centile). Subjects had pre-post PSG.	Clinical series, observational study, case report Blinding absent	Eligible: 78 but only 19 had baseline and post-op PSG Completed study: 19 % males: 7/19=37% No controls	Cases: 16.5±0.35yrs Controls: n/a Wide spectrum	Academic center and community referral Self-selected groups Funding not specified	Not specified	PSG criteria	Yes / No	Comprehensive PSG PSG duration = not specified Timing of PSG: Nocturnal	Supportive of surgical weight loss to improve sleep architecture in very obese adolescents although data limited to small sample size so independent contribution of OSA cannot be determined. Test retest validity of PSG is demonstrated in that AHI, RDI, arousal index, and percent stage 1 improved in the expected directions following weight loss.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
140	Kalra (2005)	4	Retrospective chart review of severely obese adolescents aged 13-18 yrs (girls), 14-18 yrs(boys) who underwent bariatric surgery over a 3 year period. PSG (of some kind, not described) was done in 34/35 subjects prior to surgery and in 10 or the 35 after surgery. Comparison of PSG findings was done.	Clinical series, retrospective chart review Blinding not specified	Eligible: 34/35 had initial PSG (12 male) 10/35 had post-op PSG 35 # controls: none	17.57 ± 1.82 yrs Narrow spectrum All severely obese adolescents at high risk of having OSA	Academic center Government NIH and Cincinnati Children's Hospital Foundation	PSG's were performed before and after bariatric surgery 5.1 ±1.2 months post-op Mean weight 170 kg preop….58 kg post-op	PSG criteria	Not completely: AHI>5/hr was considered OSA AHI>1 was definition of abnormal No carbon dioxide measurements	Not specified AHI, AI, min and mean saturation obtained somehow PSG duration = unknown Timing of PSG:Not specified	1. PSG is likely indicated in children with severe obesity as the prevalence of OSA in this study was high 2. Resolution of obesity was associated with dramatic improvement in the frequency of apneas and in mean oxygen saturation levels during sleep 3. PSG can be helpful to follow the course of OSA in obese children undergoing weight reduction treatments
141	Brouillette (2001)	2	This study was a randomized, triple-blind placebo-controlled, parallel-group trial to test the hypothesis that a 6-week course of nasal glucocorticoid spray (NGS) would decrease the severity of OSA in children with AT hypertrophy. PSG, clinical exam and radiographic assessment were performed on 13 children who received NCS and 12 children receiving a placebo, before and 6 weeks after treatment.	Prospective cohort study Blinded study	Eligible: 44 Completed study: 13 % males: 38% (5/13) # controls: 12 % males: 75% (9/12)	Cases: 4.2 yrs (+/- 0.7) Controls: 3.4 yrs (+/- 0.3) Narrow spectrum	Academic center and community referral Random selection Non-US funding agency; Pharmaceutical or equipment	None	PSG criteria	Home studies did not include EEG, lab studies did but no mention of sleep staging . vast majority (22 of 25 total) were done as home studies / Yes	Ambulatory (unattended) sleep study or Laboratory PSG PSG duration: overnight PSG timing: nocturnal	NGS decreased the AHI, suggesting that NGS may be helpful in treating pediatric OSA.
142	Kheirandish-Gozal (2008)	2	This was a double-blind, randomized, crossover trial of the impact of intranasal budesonide on sleep in children with mild OSA. Children underwent an initial PSG that was used for entry criteria; 6 weeks of drug or placebo, a second PSG and neck radiograph followed by a 2 week washout and then a 6 week crossover followed by a third PSG and radiograph	Case control study Blinded study	Eligible: 71; 62 recruited Completed study: 48 completed treatment arm (30 in first arm and 18 in second arm); 43 children completed all phases of the study % males: 28/48= 58% completed treatment arm 25/43=58% completed all phases # controls: 32 initially treated with placebo 25 completed placebo after 2-wk washout from treatment arm % males: 18/32=56% initially treated with placebo	Cases: 8.0±0.3 yrs (n=48 in treatment group) Controls: 8.1±0.4 yrs Narrow spectrum	Academic center and community referral Random selection Pharmaceutical or equipment company funded Government and privately funded	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not reported Timing = nocturnal	Findings supportive of intranasal budesonide in improving OAHI – and in many cases, resolving OSA - in children with mild disease Test-retest validity of PSG is demonstrated in that OAHI, respiratory arousal index, SpO2 nadir, stage 4 sleep percent, and REM sleep percent improved following treatment but were unchanged or worse in the control group. Construct validity for stage 4 sleep is demonstrated in that stage 3 percent decreased and stage 4 percent increased following treatment.
144	Goldbart (2005)	2	Children with mild sleep-disordered breathing (SDB), who may not be recommended for adenotonsillectomy, frequently exhibit neurocognitive and behavioral morbidity, and may benefit from alternative therapeutic interventions, such as leukotriene modifier therapy. Methods: Twenty-four children with SDB completed an open-label intervention study for 16 weeks with daily montelukast therapy. Sleep studies and adenoid size estimates from lateral X-ray films of the neck were obtained before and after treatment.	Case control study Blinded study: "Scorers unaware that sleep studies belonged to study participants"	Eligible: 24 Completed study: 24 % males:46 # controls: 16 % males: 44	Cases: 5.4 ± 2.0 Controls: 5.7 ± 1.8 Wide spectrum	Academic center Expert assigned or selected groups Government funded	Other: Lateral soft neck x-ray	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = at least 8 hours Timing of PSG: Nocturnal	This study provides evidence of test-retest reliability for a nonsurgical intervention.
146	Alexopoulos (2004)	3	This study tested whether the administration of nasal corticosteroids for 4 weeks to snoring children with only mild elevation in their apnea-hypopnea index would improve both polysomnography findings and symptoms of sleep-disordered breathing. Budesonide 50 mcg per nostril twice daily was administered for 4 weeks to children (2–14 years old) with habitual snoring and an apnea-hypopnea index of 1–10 episodes/hr. Subjects were evaluated before treatment and at 2 weeks and 9 months after its completion. Primary outcome variables were changes in apnea-hypopnea index and symptom score. Twenty-seven children were studied. Four weeks of nasal budesonide improved both polysomnography findings and symptoms in children with mild sleep-disordered breathing. The clinical effect is maintained for several months after treatment.	Prospective cohort study Blinded study: Blinded scoring	Eligible: 31 Completed study: 27 % males: 56 # controls: N/A	Cases: Median 7 yrs (2-14) Wide spectrum	Academic center Expert assigned or selected groups Funding not specified	SDB symptom frequency (scale) OSA symptom score Parental observations	PSG criteria	Yes (R&K) / Yes	Comprehensive PSG PSG duration = per each subject's routine bedtime and waking time Timing of PSG: Nocturnal	This study provides evidence of test-retest reliability for a nonsurgical intervention.
147	Kheirandish (2006)	3	Investigation of whether a combined therapy of leukotriene receptor antagnonist montelukast and intranasal budesonide would normalize residual SDB after T%A, which it did.	Case control study Blinding absent	Eligible: 22 Completed study: 22 % males: 59 # controls: 14 % males: 64	Cases: 6.3 ± 1.3 Controls: 6.5 ± 1.8 Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	None	PSG criteria	Yes (R&K) / Yes	Comprehensive PSG PSG duration = at least 8 hours Timing of PSG: Nocturnal	This study provides evidence of test-retest reliability for a nonsurgical intervention.
143	Buchenau (2007)	2	This study used a randomized crossover design to evaluate the usefulness of an oral device (Pre-Epiglottic Baton plate) in 11 children with isolated Pierre Robin Sequence and upper airway obstruction on initial PSG. Half the group was assigned to the PEBP and half to a conventional palatal plate (only closes cleft, has no effect on opening hypopharynx), restudied, then crossed over to the other device and studied again. Infants received appliance for at least 36 hours before sleep study was done. Infants were up to 3 months of age, most of whom had been referred after prone positioning to sleep had failed.	Clinical series, observational study, case report Blinded study	Eligible: 11 Completed study:11 % males:27	Cases: 3 days (0-60) GA 39 weeks (36-41) Narrow spectrum	Academic center Expert assigned or selected Privately funded (non pharma) - German Foundation	Not specified	PSG criteria	No / Yes	Limited sleep study - No EEG was used; sleep determined by video and behavioral analysis PSG duration =at least 8 hours Timing: Nocturnal (began in the evening)	1) PSG is can be useful in determining the effectiveness of orthodontic treatment of upper airway obstruction in selected populations. 2) Test-retest validity of PSG is demonstrated in that AI improved in the expected direction when infants were using the appliance.
60	Villa (2007)	3	16 children were nonrandomly selected to participate in an observational cohort to evaluate the benefits of an orthodontic device called a Rapid Maxillary Expander (RME) in children with PSG documented OSA. To meet inclusion criteria for the study, children must have signs/symptoms of OSA along with AHI>1 and a high/narrow palate with malocclusion (deep bite, reclusive bite or crossbite). 78% of the children had enlarged tonsils. The RME device widens the maxillary bone by distraction osteogenesis at the suture level, widening the maxilla, and increasing the cross-sectional and volumetric space of the nasal cavity. It can also improve orophryngeal spaceby modifying the resting position of the tongue. All patients underwent a Brouillette questionnaire and PSG prior to treatment, and at 6 and 12 month follow up.	Prospective cohort Blinding not specified	Eligible:16 Completed study:14 and 2 lost to follow-up % males: not stated	Cases: children aged 4-11 Controls: no control group Narrow spectrum; none were obese	Academic center Expert assigned or selected Funding not specified	Behavioral scales Brouillette questionnaire was performed before and after surgery Orthodontic assessments and measurements	PSG criteria	Yes Not applicable; apneas defined as lasting > 5 seconds.	Comprehensive PSG no nasal pressure transducer tracing, no End-Tidal CO2 tracing used. Used thermocouples PSG duration = "standard overnight" polysomnogram Nocturnal	1. Polysomnography in children shows face validity when compared to clinical scores (Brouillete Scale) and objective assessment of airway space improvements in this group of children with high arched palate and obstructive sleep apnea using a rapid maxillary expander device. 2. Though the RME does improve PSG results, as well as the symptoms and signs of OSA, residual disease is seen. It is reasonable to pursue PSG after maximum treatment results are obtained from RME, particularly if adenotonsillar hypertrophy is present. RME was limited to only a select group of children who were of normal height and weight.
145	Groswasser (2000)	3	35 infants underwent two overnight PSG studies, one with and one without a pH probe in the distal portion of the esophagus. 25 patients had OSA (defined as OA >0,3 events per hour) and 10 were controls. PSGs with and without nasoesophageal probes were compared This study was designed to determine if a nasoesophageal probe modifies sleep and cardiorespiratory patterns in infants with OSA	Clinical series, observation Blinded study	Eligible: 35 infants with suspected OSA Completed study: 25 infants with OSA % males: 76# controls: 10 patients without OSA were considered controls % males: 33%	Cases: 12 months (9.1 - 15.5 months) Controls (defined post hoc as having no apnea): 12.5 months (10.5 - 20.25 months) Spectrum Not clear All infants were healthy and receiving no meds, so I believe a narrow spectrum, but exclusions were not specified	Recruitment source: Not specified Expert assigned or selected groups Not really clear – infants were admitted to evaluate for OSA, but referral source not really specified Government funded I am assuming grant from FNRS is federal agency	Not specified	PSG criteria	Yes / Yes: Apneas defined if they lasted longer than 3 seconds, no hypopneas scored OSA defined as more than 0.3 OA per hour based on ?Kahn et al 1992	Comprehensive PST Duration not specified Timing = Nocturnal	Findings suggest that the presence of a nasoesophageal probe may alter characteristics of the PSG, modest, but statistically significant changes in frequency of obstructive and central apneas, as well as possibly changing the sleep architecture While a liberal definition of OSA was used in this study, and the numbers were small, the finding that 71% of infants with suspected SDB were found to have OSA suggests PSG can be used in this patient population

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
52	Villa (2002)	4	To investigate the clinical usefulness of a personalized oral appliance for treatment of OSA with malocclusion. - 19/32 children randomly assigned to oral appliance for 6 months then post appliance PSG, questionnaire, and physical exam compared between these children and the non-intervention children (n=13) - note that oral appliance used corrects occlusal anomalies rather than provides mandibular advancement To assess clinical usefulness and tolerance to a personalized oral jaw positioning appliance for the treatment of OSA with malocclusion	Perhaps a methodological study; Clinical series, observational study, case reports; Blinding not specified	Eligible: 32 children initially enrolled, 19 randomly assigned to treatment, 13 acted as controls Completed study: 23 (9 controls) % males: 53% males, controls 77% males20/32 = 62.5% enrolled; sex unknown of those who dropped out	Cases: 6.86±2.34 years Controls: 7.34 ±3.1 years, Narrow spectrum	Academic center Expert assigned or selected groups Assigned groups according to AI>1 and clinical signs of dysthagnia Blinding not specified	Brouillette questionnaire of OSAS symptoms Physical exam incl tonsil size	PSG criteria: Initial Dx reached by AI>1 but no more details given. Subjects had to have initial Dx of AI>1 with associated clinical signs of dysgnathia before entry into study Follow up PSG included only 2 EEG channels and airflow measured by thermocouple	Yes (R&K) No: repiratory inductive pleth, saturation and thermistor used Comments: PSG included 2 EEG channels and scored in accordance with R&K and ATS. No further details given	Comprehensive PSG PSG duration = not reported Timing of PSG: Nocturnal	"- use of personalized jaw positioning device for 6 months in the presence of AI>1 and dysthagnia was associated with an improvement in AHI and AI - also associated with reduced adenotonsillar hypertrophy (? Possibly due to enlarged pharyngeal space rather than reduced hypertrophy per se) - enlarging the pharyngeal space was associated with improvement in AHI and AI in the expected direction - findings support use of PSG in characterizing respiratory parameters following treatment intervention
149	Miller (2006)	4	25 patients with PWS (17 with del'n of chr 15q11-13 and 8 with maternal uniparental disomy of chr. 15) agreed to stop GH or were na/ve to GH therapy. They underwent PSG off GH, then 6 weeks after starting. PSG was repeted in 2 patients 6 months after GH was instituted This study was done to determine if growth hormone therapy in patients with Prader Willi Syndrome effects sleep disordered breathing	Clinical series Blinding absent	Eligible: 25 Completed study: 25 % males: 60	Cases: 6 months to 39 years Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Not specified	PSG criteria	Yes / Yes but no definition of OSA	Comprehensive PSG Duration not specified Timing not specified, presumably nocturnal	1) Pts with PWS seem to have a high incidence of SDB; PSG should be considered prior to starting GH and within several months after starting, especially in patients susceptible to URIs and with adenotonsillar hypertrophy 2) The administration of GH appears to change respiratory patterns in subjects with PWS on GH and suggest they undergo surveillance or follow-up PSG if they are taking GH
148	Kakkis (2001)	4	10 patients with MPS I were checked at baseline and at week 26 after receiving weekly infusions of alpha-L-iduronase replacement therapy. Multiple other parameters (clinical exam, MRI of brain and abdomen, ECG, echo, range of motion measurements, clinical lab evals, urinary GAG secretion, leukocyte enzyme activity) were tested at variable intervals during the year long trial.	Clinical series, observational study, case reports Blinding absent	Eligible: 10 Completed study:10 % males:60	Cases:12.9 years (5-22) Controls: Narrow spectrum	Academic center Expert assigned or selected groups Government funded Privately funded Pharmaceutically funded (all 3)	Not specified	PSG criteria	No / Yes: Apnea – 10 second cessation; hyp0nea 50% decrease in oronasal airflew with 2% desat or arousal	Comprehensive PSG PRESUMABLY – stated it was performed according to the guidelines of the American Thoracic Society PSG duration = not specified Timing of PSG:Nocturnal , PRESUMABLY	PSG appears helpful in tracking improvement in patients with MPS I on enzyme replacement therapy.
4.2.1.1.11 Other Measures												
102	Redline (2007)	2	Study sample derived from ongoing longitudinal community cohort. The present study evaluates adolescents at 13-16 yrs for SDB (AHI≥5), BP, metabolic syndrome. Metabolic syndrome definition based on adapted adult criteria for the pediatric population	Prospective cohort study Blinding not specified	Eligible: 389 total Completed study: 270 (22 found to have SDB) % males: 140/2070=52% overall and 17/22=77% for only SDB # controls: 248 of the 389 were found not to have SDB % males: 123/248=50%	Cases: 13.4±0.5 yr Controls: 13.6±0.7 yr Range for both group 13-16 yrs Wide spectrum	Community referral Self-selected groups Government funded	Sleep diary	PSG criteria Other diagnostic criteria developed by authors	Yes (by citation to ASDA and R&K) / Yes	Comprehensive PSG PSG duration not specified Nocturnal	These cross-sectional findings are supportive of a role for SDB in pediatric (adolescent) metabolic syndrome and indices associated with metabolic syndrome Supportive of certain PSG parameters being associated with metabolic dysfunction (eg O2 desats) since no association between report of habitual snoring and metabolic dysfunction
157	Tauman (2007)	4	This study attempted to find a correlation between AHI, and BMI in relation to blood levels of circulating adipokines (leptin, adiponectin and resistan) as well as evidence of insulin resistance and metabolic syndrome (fasting glucose, insulin levels and CRP) in 130 children referred for snoring and suspected SDB using PSG. This study was done to investigate the association between sleep disordered breathing and circulating levels of adipokines in children; Blinding status not clear to me. Not clear how the control group was identified either.	Prospective cohort Blinding not specified	Eligible: 130 Completed study: 130 % males: 54 43 had SDB (AHI>5 per hour), 42 had mild SDB (< 5 /hr) # controls: 45	Cases: 8.2 +/- 2.8 (range 1-17) Controls: combined with above 45 in control group Wide spectrum	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical)	PSG results compared with blood samples if insulin, glucose, CRP, adiponectin, leptin and resistin	PSG criteria	Yes: "standard techniques" The PSG parameters were described in another referenced paper Tauman, pediatrics 2005 Were respiratory scoring methods clearly defined? Yes Hypopneas with >4% desat or arousal and >50% decrease in nasal flow AHI>1, <5 was mild SDB AHI>5 was SDB Minimal hypoxemia >90% Moderate 80-89% Severe <80%	Comprehensive PSG Presumably; further information in Tauman, pediatrics 2005 PSG duration = not specified Timing of PSG: Nocturnal	PSG findings of SDB are only weakly correlated with plasma leptin levels; obesity is more significant factor; PSG does not therefore significantly help predict abnormal adipokine level abnormalities.
68	Tauman (2005)	4	Children referred with suspected OSA and snoring and 19 control non-snoring but not matched children had PSG's. The snoring children seemed to have all had OSA. Following PSG, fasting glucose, insulin, and lipid profiles were drawn and compared. Measures compared were insulin levels, glucose, I/G ratio, HOMA (homeostasis model assessment), lipid profiles. Exclusionary criteria included any chronic med'l condition, craniofacial syndromes, genetic syndromes, meds that affect glucose or lipids, psychiatric diagnoses.	Prospective cohort Blinding not applicable	Eligible: 135 Completed study:all % males:59% # controls: 0 Although they mention 19 controls, these were not matched controls and were from a different population	Cases: 8.9 + 3.5 (3-18 y.o.) Wide spectrum	Academic center Random selection Government funded	Not specified	PSG criteria	Uncertain: "By standard techniques" Were respiratory scoring methods clearly defined? Yes OA=no A/F w/ chest/abd movement for >2 breaths Hypopnea= fall of nasal A/F of >=50% with either 4% drop in oxy sat or arousal over at least 2 breaths Comments: Mild OSA=AHI (defined as Obstrutive AHI)>=1 and <5 Mod-Severe OSA=AHI>=5	1. 8 leads of EEG 2. ROC-A1 3. LOC-A2 4. Submental EMG 5. EKG 6. RAT and or LAT 7. Nasal airflow thermistor 8. Nasal pressure cannula 9. Thoracic movement inductance plethysmography or respiratory impedance 10. Abdominal movement either inductance plethysmography or respiratory impedance 11. Position sensor 12. Pulse oximeter 13. ET-CO2 Timing of PSG: Nocturnal	In children who snore and have insulin resistance and dyslipidemia, PSG is not routinely indicated as elevated AHI is not correlated with insulin resistance & dyslipidemia

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
153	Verhulst (2008)	2	Exhaled Nitric Oxide (eNO) is a marker for airway inflammation. This study was designed to investigate the relationship between OSA snoring, obesity, and exhaled Nitric Oxide in a pediatric population without a history of asthma or allergy. Children were recruited from an academic center for treatment of obesity. Control group children were recruited from a lung function study. All children underwent overnight polysomnography, BMI calculation, pulmonary function testing, and evaluation of morning and evening exhaled NO levels. The values for PFTs were then evaluated in four groups: normal weight/normal PSG, overweight/normal PSG, overweight/ habitual snorers, and overweight/OSA by PSG.	Clinical series, observational study, case reports Blinding Not specified	Eligible: not stated Completed study: 48 Cases: 1. Overweight, normal PSG n=17 35% male 2. Overweight, habitual snoring N=7\ 43% male 3. Overweight, OSA, n=11 45% male # controls: 13 normal weight, normal PSG % males: 38%	Cases: 1. Overweight, normal PSG: 11.2 +3.1 2. Overweight, habitual snoring 11.1 +1.8 3. Overweight, OSA 12.2 +1.9 Controls: Normal weight, normal PSG: 11.2 +2.5 Narrow spectrum	Academic center Recruitment: not specified Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Nocturnal but duration not specified	Standard nocturnal PSG has face validity for detection of a physiologic condition associated with increased airway inflammation (OSA). This evidence suggests that quantification of snoring may add incremental information to the standard PSG montage.
28	Goldbart (2006)	3	PSGs and exhaled breath condensate testing for leuokotrienes and prostaglandins from 50 snoring children were compared with PSGs and EBC from 12 non-snoring children . Collected EBC samples from 50 of 56 snoring children and 12 non-snoring controls over a 4 month period, assayed these for cys-LT levels, The primary objective of this study was to determine if there are difference in inflammatory markers (eicosenoids such as leukotrienes and progstaglandins) in children with and without sleep disordered breathing	Case control study Blinding not specified	Eligible: Unknown Completed study: 50 % males: 58 # controls:12 % males: 58	Cases: 9.6 +/- 2.9 (mild SDB) and 10.3 +/- ".7 (SDB, AHI>5) Controls: 7.1 +/- 1.6 Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Parental observations	Diagnosis reached using PSG criteria R & K for EEG, AASM Task Force for arousals Hypopneas scored: 50% drop in nasal flow for 2 breaths with > 4% desat or arousal.	Yes / Yes	Comprehensive PSG But refer for protocol to 2005 paper PSG duration = Not stated Timing of PSG: Nocturnal	1) In children aged 6-16 referred for PSG for habitual snoring (reported by parents >3 nights per week), 29 had an AHI<5, and 21 had an AHI >.5. 2) Children with SDB showed a statistically significant increase in exhaled breath condensate for inflammatory markers (leukotrienes) in a dose-dependent fashion, although this was confounded by higher BMI in SDB group. Results suggest this may have some clinical utility in assessing snoring patients.
154	Li (2008)	2	Consecutively evaluated children with habitual snoring were assessed via an unspecified SDB questionnaire, yielding 142 children with suspected SDB who were further assessed via PSG. PSG identified 47 children with OSA (OAI>1) and 95 children without OSA, who were used as the control group for subsequent analyses. The presence of inflammatory mediators was then compared between children with OSA and those without. Sixteen of the OSA subjects received treatment and received follow-up PSG and repeat assessment of inflammatory markers after 2-3 months of treatment.	Prospective cohort study Blinding not specified	Eligible: 47 Completed study: 47 % males: 70% # controls: 95 % males: 67%	Cases: 11.1y (8.8-13.2y) Controls: 10.7y (8.2-12.8y) Narrow spectrum	Academic center Recruitment: consecutive children presenting with snoring who then screened positive on a sleep-disordered breathing questionnaire Funding not specified	inflammatory markers: IL-6, IL-8, TNF-alpha	PSG criteria	Yes / Yes: OSA defined as OI>1 event/hr	Comprehensive PSG - specific information not provided in this paper, reported elsewhere. PSG duration = full night, specific duration not stated Timing of PSG: Nocturnal	1. Among 142 children identified to be at risk for SDB as determined by a history of habitual snoring and positive screening using an unspecified questionnaire, 47 (33%) were found to have OSA on PSG (defined as OAI>1) 2. The presence of PSG-defined OSA (OAI > 1) at baseline was associated with significantly increased levels of IL-6 and IL-8, but not TNF-alpha. The association between OSA and elevated IL-6 levels remained significant when alternative criteria for the diagnosis of OSA were used: AHI>1, AHI>1.5, and AHI>5. 3. PSG-defined resolution of OSA was associated with significant declines in IL-8 following 2-3 months of treatment.
127	Gozal (2008)	4	This study looked at PSG and levels of Il-6, a pro-inflammatory cytokine, and Il-10, an anti-inflammatory cytokine, both felt to be involved in atherogenesis, in children with OSA both before and 4-6 months after T&A, vs. nonsnoring controls without OSA.	Case control study No blinding	Eligible:40 Completed study: 20 % males: 60 # controls: 20 % males: 60	Cases: pre T&A 6.5 +/- 0.6; Post T&A 7.2 +/- 0.6 Controls: 6.4 +/- 0.7 Narrow spectrum	Academic center Expert assigned or selected groups Government funded: NIH plus Children's Foundation Endowment for sleep research, commonwealth of Kentucky challenge for excellence.	Not specified	PSG criteria	Yes / Yes	Ambulatory (unattended) sleep study PSG duration = up to 12 hours Timing of PSG:Nocturnal	1) PSG is useful in determining improvement in OSA after adenotonsillectomy 2) Study demonstrates test-retest validity of PSG in that AHI, AI, SpO2 nadir, %TST with SpO2<90%, mean PetCO2, %TST with PetCO2 >50 all improved in the expected direction s/p AT 3) Study demonstrates construct validity of PSG in that measures associated with the inflammatory process (Il-10, Il-6) were abnormal in children with OSA vs normal controls, and improved to normal following treatment.
150	Chan (2009)	2	This study analyzed PSG and echocardiograms in 101 children aged 6-13 invited from a community based questionnaire: all children with high risk symptoms. Randomly chosen low risk children were chosen as controls. Reference group patients were those with AHI <1 (n=35); these were compared with those with mild OSA (AHI 1-5, n=39) and those with moderate to severe OSA (AHI>5, n=27). Echocardiograms were done at baseline, and treatments, either T&A or nasal steroids, were offered to the OSA group. Follow up echocardiograms and PSGs were done after treatment, or after the same time interval in untreated patients.	Prospective cohort study Blinded study	Eligible:101 Completed study: 66 % males: 24.5% # controls: 35 % males: 71.4	Cases: 9.65 +/- 1.85 yrs Controls: 9.5 +/- 1.9 Spectrum unclear	Community referral Large ongoing epidemiological study of 13 randomly chosen schools (kids aged 6-13 yrs) Total of 6447 schoolchildren completed OSA screening questionnaire, stratified subjects into low (n=5861) or high (2=586) risk for OSA. A total of 410 high and 209 low risk children agreed to participate, but this study chose the first 101 consecutive children who agreed to undergo PSG and Echocardiobgram Funding = Research Grants council of Hong Kong Special administrative region	Not specified	PSG criteria	Uncertain (Used EEG, but didn't actually specify that they used standard criteria for staging sleep.) Yes	Comprehensive PSG PSG duration not specified, overnight Timing = Nocturnal	1) This study suggests that untreated OSA can lead to reversible cardiac changes. The implication is that PSG should be considered as an early screening test to diagnose OSA and treat it prior to cardiac abnormalities developing. 2) Convergent validity for some PSG-determined AHI cutoffs of normal (AHI <1), mild (AHI 1-5), and moderate to severe (AHI >5) is demonstrated in that children with AHI > 5 had more cardiac abnormalities. 3) Test-retest validity and convergent validity of PSG-determined AHI are demonstrated in that cardiac function improved in the expected direction only on children who had improvement in AHI following treatment of OSA with either adenotonsillectomy or topical nasal steroid therapy.
9	Ugur (2008)	2	To measure left ventricular and right ventricular systolic and diastolic functions in children with OSA and adenotonsillar hypertrophy who underwent T&A (or tonsillectomy or adenoidectomy). The goal was to determine changes in cardiac function 6 months after T&A. Control group of children with primary snoring and grade I or II adenoids/tonsits was included at baseline but not follow up	Case control study Blinded study	Eligible: unknown but 37 completed baseline Completed study: 29 % males: 13/29=45% # controls: 26 % males: 16/26= 61.5%	Cases: 6.7±2.4 yrs Controls: 7.8±2.3 yrs Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	NA / Yes	Limited sleep study: Airflow, snore mic, ECG, breathing, body position, SpO2 PSG duration = not specified but PSG conducted between 10.30pm and 6.00am Timing of PSG: Nocturnal	Findings supportive of a role for OSA in altered cardiovascular parameters even in a sample of children with relatively mild disease Support treatment of OSA by T&A improves myocardial velocities
125	Gozal (2007)	3	OSA associated with cardiovascular morbidity. Endothelial dysfunction is part of the cardiovascular morbidity leading to hypertension and autonomic dysfunction.	Prospective cohort study Not blinded	Eligible: 52 Completed study: 34 N= 26 OSA 16 boys (61%) N=8 controls 5 boys (19%)	Cases: 6.9 yrs + 0.6 yr Controls: 6.8 yrs + 0.5 yrs Narrow spectrum Healthy children Non 0bese	Academic center Self-selected groups Excluded: obese, hypertensive, diabetes/prediabetes, craniofacial, neuromuscular, syndromic, genetic abnormalities, current/previous use of montelukast, current use of anti-inflammatories, acute URI, use of any sterior or antibiotic in previous 4 weeks, previous AT, ANY current medications Government funded	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration =8-1/2 hours Timing of PSG:Nocturnal	The study used PSGs to confirm the presence of OSA. We know adults with OSA have cardiovascular morbidity. Starting to see same cardiovascular morbidity in children with OSA. Now in children with OSA, there is evidence for endothelial dysfunction. Of note, these children had moderate to severe OSA with an AHI of 12 plus element of hypoxia and hypercapnia. Test-retest validity of PSG is demonstrated by improvement in AHI s/p adenotonsillectomy Convergent validity of PSG is demonstrated in that reperfusion kinetics and soluble CD40 ligand levels also improved in the expected direction s/p adenotonsillectomy.
78	Gozal (2007)	3	Consecutive habitually snoring and non-snoring 5-7 yr olds underwent overnight PSG, and had neurocognitive testing and blood drawn for APOE epsilon 4 allele testing the following morning.	Prospective cohort study Blinding not specified	Eligible:345 Completed study: 258 habitually snoring; n=112 no OSA, 2=146 OSA % males:54.5% # controls: 87 % males: 54	Cases: 6.4 +/- 0.2 no osa, snoring; 6.3 +/- 0.3 OSA snoring (5-7) Controls:6.4 +/- 0.2 (5-7) Wide spectrum	Community referral Strategy not specified Government funded: NIH grant plus Children's foundation for sleep research, presumably private	Neurocognitive testing and APOE eps.4 alleles	PSG criteria	Yes / Yes: OSA defined as AHI>2 or AI >1 with nadir O2 sat <92%	Comprehensive PSG PSG duration = up to 12 hours Timing = Nocturnal	1. PSG is useful in distinguishing OSA from non-OSA in primary snorers. 2. Assuming that snoring is on a continuum with OSA, convergent validity of PSG-determined OSA is demonstrated by this study in that increasing percentages of children had at least 2 abnormal cognitive tests in nonsnoring vs snoring vs OSA.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
155	Hill (2006)	2	Determination of cerebral blood flow velocity (CBFV) differences in children with mild SBD (AHI <5hr, AHI was 2/hr, ave sat=96%), and association with neuropsych testing compared to age and socioeconomically similar controls.	Case control study Blinded study independent scoring of PSG, blinding of the neuropsych status, behave and SDB status.	Eligible: 30/31 had psgs Completed study: 21 children (AHI <5/hr); but only 16 had complete data. Non-obese children % males: 9/21 males # controls:17 % males: 9/17 males – did not undergo PSG, just PSQ	Cases: 3-7 yr olds Narrow spectrum	ENT waiting lists for children who were awaiting surgery Sunday school or siblings, similar socioecomic status Government funded	Cerebral blood flow velocity and neuropsychological testing	PSG criteria	Not applicable	Not specified	Exploratory study and preliminary findings: relationship between snoring, increased CBFV, and indices of cognition (processing speed and visual attention) and behavior (behavior rating of executive function). No relationship was identified between alterations in CBFV to any PSG parameter. CBFV is not surrogate markers of SDB for PSG.
156	Khadra (2008)	3	This study tested the hypothesis that biological factors (cerebral oxygenation) may modify the effect of SDB on cognition. The investigators compared differences in cerebral oxygenation in SDB and controls (n=14) and then used the results to develop a predictive model. SDB children were those with habitual snoring and adenotonsillar hypertrophy who were receiving care at the institution. They were divided into primary snoring (AHI<1; n=32) and OSA (AHI>1, n=46). All three groups were matched for age, sex, and race. An index of normalized cerebral oxygenation determined by referencing sleep value to wake value to account for anatomic variability (rSO2)	Case control study Blinding not specified	Eligible: unknown Completed study: 92 % males: Total 51% (calc by LO from table 1) # controls: 14 % males: 57%	Cases: Mean age 10±1.96yrs overall (range 7-13yr) (10±1.8 in primary snoring gp and 10±2 in OSA gp Controls: 10.2±1.9yr Narrow spectrum	Academic center and community referral Self-selected groups Government funded	Physical examination	PSG criteria	Yes (cited R&K) Yes	Comprehensive PSG (assumed given the citation to ATS standards). However, no details of PSG given PSG duration = 386±54 mins primary snoring gp; 401±41 mins OSA; and 394±50 control gp Timing of PSG: Nocturnal	Findings supportive of SDB having effects that augment and diminish rSO2 depending on the severity of disease Given the opposing effects of SDB, these findings provide some objective support of why studies of SDB and neurocognitive outcome frequently have conflicting data
4.2.1.2 Test-Retest Reliability and Scoring Reliability												
159	Rebuffat (1994)	2	A total of 19 infants underwent polysomnography over a two-night (19 infants) or three-night (11 infants) time course. 8 of the infants had been referred following an ALTE, with negative medical workup. The other 11 were healthy control patients. Polysomnographic features from the studies are then compared to evaluate for night to night variability in results.	Prospective cohort Blinded study	Eligible: Unknown Completed study: 19 % males: 68% This study did have 8 "cases" (post ALTE) and 11 "controls" (healthy) but data regarding ages and genders within-groups is not provided	Cases: 11 wks (range 5-36 wks) Narrow spectrum	Academic center and community referral Self-selected groups Non-US funding agency	Repeat PSG (night-to-night variability)	PSG criteria	Yes	Comprehensive PSG: recorded entire night supine, repositioned infant "without awakening" if neck flexion noted; Feeding upon demand. EEG, EOG, EKG, thoracic respiratory mvts, oronasal thermistor, actigraph to record gross body mvts, and tcCO2. Alice III system. PSG duration = 9 hours (infant admitted to sleep lab at 2 pm, allowed to nap in afternoon, habituation period, then study recorded 2100 + 9 hours.) Timing = Nocturnal	When adequate study conditions are met, a single night polysomnogram is sufficient to accurately describe sleep characteristics as well as respiratory events in infants. This finding is true both for those who are undergoing workup for ALTE and healthy infants. Whether these findings are generalizable to infants who are clinically suspected of having OSA is not known.
160	Katz (2002)	3	Assessment of night to night variability between PSG's	Prospective cohort Blinding not applicable	Eligible:34 Completed study:30 % males:19/30	Cases:4.1 ± 2 yrs Controls:none Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Repeat night study	PSG criteria	Yes / Yes (2 breath rule)	Comprehensive PSG PSG duration =21 days between studies Timing of PSG: Nocturnal	No significant variatition in disease definition was noted between studies of the same patient. There was a slightly higher stage 2 percentage of sleep on the second night, addressing the second night effect.
161	Li (2004)	4	To investigate night-to-night variability in sleep parameters (including respiratory measures) across 2 consecutive nights To assess night-to-night variability of sleep parameters	Prospective cohort study Blinding not specified	Eligible: unknown Completed study: 46 obese , and 44 controls. 44 obese % males: unknown although total male % for cases and controls was 59/87 = 68% # controls: 43 non-obese % males: see above	Cases: 10.8 years (SD 2.3) and overall mean was 11.21+/-2.21 yrs (range 7-15yrs) Controls: 44 age 11.7 (SD 2.1 yrs) Narrow spectrum since cases recruited through obesity clinics and controls recruited from community; syndromes excluded	Academic center and community referral Self-selected groups children attending obesity clinics and children attending local schools. Syndromes excluded Non-US funding agency	Parental observations	PSG criteria Other diagnostic criteria developed by authors	No / Yes: Referred reader to previous publications of authors as well as ATS for information on scoring	Comprehensive PSG MSLT mentioned in methods but not in results PSG duration = approximately 540 minutes but results presented separately for OSA, snoring, and non-OSA groups Timing of PSG: Nocturnal	"- in general the findings support the use of a single night PSG to detect SDB in children - the findings support a first night effect in children undergoing PSG
30	Niemenen (2000)	3	This study looked at 58 snoring children with symptoms of SDB who underwent two PSGs 6 months apart. Thirty healthy children also underwent a single PSG as a control	Prospective cohort Blinding not specified	Eligible: 78 Completed study: 58 % males: 53 # controls: 30 % males: 57	Cases: 5.8 +/- 1.8 (2.4-10.5) Controls: 7.1 +/- 1.8 (4.3-10.9) Narrow spectrum	Community referral Expert assigned or selected Funding not specified	This study used a questionnaire to determine severity of symptoms of OSA, and an OSA scoring system developed by Brouillette but not further described	PSG criteria	No (no EEG) / Yes (but not "standard" and technology poor)	No EEG or EOG was used, so no sleep stage scoring was done Duration not specified Timing was nocturnal	1)This study suggest that clinical symptoms alone are inadequate in differentiating primary snoring from obstructive sleep apnea, and that PSG is required. 2)This study suggests that an AHI of >2 on PSG may be an indication for T&A, with improvement in symptoms and PSG findings postoperatively 3) I n patients with primary snoring, short term f\u (6 months) with PSG does not appear warranted as symptoms did not worsen in this study in those patients Strain gauge, no CO2 monitoring, No nasal pressure so accuracy of test deficient ****No sleep stage scoring/EEG monitoring was done in this study
162	Abreue e Silva (1985)	4	Comparison of PSG data of healthy term infants and 3 subgroups of "index" infants: (a) SYMPTOMS GROUP: hospitalzed infants with mild breathing sx's from bronchiolitis/URTI/cong'l laryngeal stridor/rec't vomiting from cong'l hypertrophic pyloric stenosis; (b) SIBS: siblings of infants who had SIDS; (c) NEAR-MISS: near-miss for SIDS infants	Prospective cohort: Although it was a prospective study, there was no statistical analysis of results and no discussion of blinding or selection process. Blinding not specified	Eligible:86 Completed study: % males: Not specified # controls:11 % males: Not specified	Cases: not specified but all were infants	Academic center Strategy not specified Privately funded (non-pharmaceutical)	Not specified	Not specified	No But they do describe active and quiet sleep Were respiratory scoring methods clearly defined? No Comments: Looked for CA and OA and oxy falls Reported on 3-6 sec, > 6 sec obstructive apneas and dips in TCo2 of > 15 mmHg	1. EOG 2. EOG 3. EMG (likely chin) 4. EEG (single lead) 5. EKG 6. Nasal airflow 7. Chest band 8. Unknown if abd lead sometimes 9. Oxygen tension--PtcO2 PSG duration =3-4 hours Timing of PSG: After last evening feed between 10PM and 4AM	This study demonstrates face validity of PSG in infants to differentiate normal from abnormal breathing patterns;
158	Crowell (1997)	1	To assess intra-reader and inter-reader reliability of scoring infant sleep and develop a kappa statistic	Methodological study Blinding NA	Completed study: 15 5 healthy full term infants, 4 preterm, 4 siblings of SIDS babies, 2 apnea of infancy infants	Cases: 36 – 58 weeks postconceptional age Wide spectrum	Not specified Expert assigned or selected groups Government funded	Not applicable	Not applicable	Yes / Yes; Anders et al.	Comprehensive PSG about 8 hours Nocturnal	This study directly assesses inter rater and intrarater reliability of infant sleep. IPSG is a reliable source of clinical and research data when supported by significant kappas and confidence intervals. Reliability can be maximized with strictly detailed scoring guidelines and training.

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4.2.1.3 Daytime Nap PSG Compared with Full Night PSG												
163	Saeed (2000)	4	Although it is not stated explicitly, this appears to be a retrospective data review of the records of 143 children with adenotonsillar hypertrophy, who had undergone a daytime nap-polysomnogram, which was classified as normal or mildly abnormal, and who were referred back for overnight polysomnography due to "persistent symptoms." (these symptoms were not specified) Subjects with significant concomitant medical problems were excluded. The characteristics of the nap studies and the overnight polysomnography were compared.	Retrospective data review Blinding not applicable	Eligible:143 Completed study: 143 % males: 48%	Cases: 5.6 yrs +/- 3 Patient Spectrum: Not applicable	Academic center Self-selected groups Funding source not specified	abbreviated studies	PSG criteria	Yes	Multiple PSG types, specify: 1. daytime nap, "the majority of the children received chloral hydrate", 1 hour study 2. overnight comprehensive PSG PSG duration = see above Timing of PSG:Not specified: See above	A normal daytime nap study does not reliably exclude the later discovery of OSA by nocturnal PSG in patients who have parentally reported symptoms of OSA.
164	Marcus (1992)	4	40 children with suspected sleep apnea of various etiology (16 with Down's syndrome previously reported in Marcus, 1991; 14 with enlarged tonsils, 2 with laryngomalacia, 2 with craniofacial abnormalities and central apnea of infancy; one each with CP, subglottic stenosis, BPD and ventilatory muscle weakness) underwent both overnight PSG as well as daytime 1 hour nap study and respiratory results were compared. This study was done to compare 1 hour daytime nap polysomnography with overnight PSG with respect to diagnosing sleep disordered breathing	Prospective cohort Blinding absent	Eligible: 40 Completed study: 40 % males: 45	Cases: 5.4 +/1 0.8 yrs (1 month – 16.3 yrs) Wide spectrum	Community referral Expert assigned or selected groups Privately funded (non-pharmaceutical)	1 hour nap study (77.5% were sedated with chloral hydrate)	PSG criteria	No Rather, they wre not studied – only EOG leads were used / Yes	Limited sleep study (describe parameters) Overnight PSG without sleep staging/EEG leads Vs. 1 hour, 77% sedated nap study with same parameters measured PSG duration = 8 hours overnight vs 1 hour Timing of PSG: Nocturnal and daytime naps	1)Nap PSG is less sensitive in detecting SDB than overnight studies; a normal nap study, even using sedation, should not be considered sufficient to exclude SDB 2) One hour PSG nap studies, with or without sedation, might be an effective screening method for SDB in children with a variety of potential etiologies, but should be followed up with an overnight study if negative If a nap study is positive, then the overnight sleep study will be positive, although the nap study may underestimate the severity. If nap study is negative, then may still need to do an overnight study.
165	Marcus (1991)	4	53 children with Down syndrome were studied: 17 (32%) referred by physicians for suspected OSA, the rest (presumably) recruited from Down Syndrome parent group. 19 (39%) had OSA suspected by parents but is in unclear whether this overlaps with the physician referred group. All patients underwent nap PSG, many of which required sedation. 16 had both nap test and overnight PSG The 16 patients who had both studies did not differ with regard to age, sex, or clinical suspicion of OSA; none had cardiac disease 13/16 (81%) were sedated for nap, none for overnight Of note, 44% of patients had minor or corrected congenital heart disease and 40% were obese	Prospective cohort Blinding absent	Eligible: 53 Completed study: 53 (all with nap PSG, 16 with additional overnight PSG) % males: 60 # controls: 8 % males: not mentioned	Cases:7.4+/- 1.2 years (2 weeks – 51 yrs) Controls: 9.2 +/- 1.7 (range 1.3-15.3 y) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Also self selected (Down Syndrome Parent Group) Privately funded (non-pharmaceutical)	Abbreviated studies (nap studies)	PSG criteria	No - no EEG / Yes - No hypopneas reported OA only 2 breath duration, no desat or arousal criteria Hypoventilation >45 mmHg	All patients had 1-2 hour nap studies, and some had chloral hydrate sedation – it is not clear how many of the total 53 required sedation; of the patients who also had PSGs, 80% (13/16) required sedation Limited sleep study PSG duration = nap test 1-[a] hours/ Daytime naps and night-time naps reported also	1) In Patients's with Down syndrome, overnight polysomnography should be considered to diagnose obstructive sleep apnea. Nap studies do not appear to be as sensitive. 2) Gender, weight, presence of heart disease and clinical suspicion do not appear to be adequate to predict those patients with OSA; All overnight PSG studies were abnormal. But in 68% of the children there was no clinical suspicion for any type of SDB. Makes a strong case for the clinical utility of PSG in Downs kids as perhaps part of their general health care. No specific feature of Downs (age, weight, CHD) affected incidence or severity of OSA. Makes it more difficult to screen who should get a PSG vs everyone.
4.2.2.1 Obesity												
174	Xu (2008)	1	To determine the prevalence of OSA in obese and non-obese Chinese children. Also to determine the relationship between severity of obesity and severity of OSA. Children classified into 4 groups; 1. obese 2. obese + ATH (T&A hypertrophy) 3. normal weight 4. normal weight + ATH	Prospective cohort study Blinded study	Eligible: 124 obese eligible Completed study: 99 % males: not specified although approx 2.5 males for every female Data presented in 4 groups (obese, obese + T&A hypertrophy; normal weight; normal weight + T&A hypertrophy) # controls: 99 matched controls % males: not specified but approx 2 males for every female	Cases: obese only = 10.3±2.1yrs Obese+ATH= 8.6±1.2yrs Controls: Normal weight only = 9.6±2.4 yrs Normal weight + ATH = 8.5±1.4yrs Wide spectrum	Academic center Self-selected groups Funding source not specified	Physical examination	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = only stated as longer than 7 hrs for each subject Timing = Nocturnal	Findings supportive of obesity as a risk for OSA in children Findings supportive of a positive correlation between obesity severity and OSA severity
25	Wing (2003)	2	46 obese children from academic clinic (>=120% ideal body weight) were compared with age and gender-matched control children from the local schools for prevalence of OSA; pts with known clinical conditions (e.g., Down's, Prader Willi, neuromuscular dz, laryngomalacia, upper airway surgery) were excluded; One ENT evaluated the nasoropharyngeal anatomy and graded tonsil size, adenoidal size, turbinate size, and velopharngeal isthmus. Protocol: 2 consecutive nights of PSG; after second PSG, MSLT the next day; there was at least one night of PSG on all children (3 ss did not get 2 nights)	Case control study Blinded study (E-mail communication with the author indicated that the PSG interpretation was done in a blinded fashion; the ENT eval was also effectively blinded since it was done prior to the PSG)	Eligible: 46 % males: 72% # controls: 44 % males: 66%	Cases: 10.8 (2.3) Controls: 11.7 (2.1) Wide spectrum	Academic center and local schools Random selection Non-US funding agency	Physical examination Included measurements of tonsils, adenoids, turbinates, and velopha-ryngeal isthmus.	PSG criteria	Yes E-mail communication with the primary author indicates that they used R & K Were respiratory scoring methods clearly defined? Yes Comments: Used duration criterion of >2 breaths for obstructive events and >20" for CA or any duration with >4% drop in oxy sat	Comprehensive PSG 1. C3-A2 2. C4-A1 3. ROC-A1 4. LOC-A2 5. Submental EMG 6. Intercostal EMG 7. Snore channel 8. EKG 9. RAT-LAT (single leg EMG over both AT's) 10. Airflow via thermistors 11. Thoracic belt 12. Abdominal belt 13. Sum of thoracic and abdominal movement 14. Position sensor 15. Pulse oximeter 16. ET-CO2 via nasal cannula PSG duration = c. 542 minutes Timing of PSG: Nocturnal	1. The presence of tonsillar enlargement (size of > 2/4) and/or narrower velopharyngeal space in obese children can help triage obese children for PSG since there is a high PPV and high specificity for diagnosing OSA in this group 2. The presence of obesity alone has a variable PPV for OSA ranging from 15.2% to 78.3%, depending on the definition of OSA (OAI>=1—PPV=26.1%; AHI>=5—PPV=32.6%); 3. The absence of obesity had a NPV of 97.7% (OAI>=1) and 95.5% (AHI>=5) 4. PSG is more likely to show respiratory abnormalities in obese children than in non-obese children
175	Chay (2000)	3	Prospective study of schoolchildren (ages 6 to 18 years) seen at an obesity clinic in Singapore. Phase 1: 3671 children were seen at their obesity clinic over enrollment period, ages 6-18 yrs, parent(s) completed questionnaire which identified either 1) children with symptoms at risk for OSA (daily or frequent snoring, apnea or difficulty breathing; or 2) body weight > 180% IBW Phase 2: these subjects underwent comprehensive clinical evaluation ; Phase 3 they enrolled all morbidly obese > 180% IBW (they estimated 5% of all obese children would have IBW > 180% and those overweight or obese children with suspected OSA based upon sleep questionnaire and comprehensive clinical evaluations.	Prospective cohort study Blinding absent	Eligible: Phase 1: 3671 children were seen at their obesity clinic over enrollment period, ages 6-18 yrs, parent(s) completed question-naire were seen for obesity ,	Narrow spectrum: all were obese	Academic center Expert assigned or selected groups Pharmaceutical or equipment company	Parental observations	PSG criteria Comment: OSA defined as an AHI >5/h on overnight PSG. Morbidly obese defined as body weight > 180% IBW.	Yes Central and occipital EEG, thermal sensor only NO nasal pressure sensor but used calibrate RIP. NA All PSGs were scored by a respiratory physician trained in sleep medicine.	Comprehensive PSG PSG duration = not provided. Timing of PSG:Not specified	1. Difficult to distinguish primary snoring by clinical assessment, PSG remains gold standard 2. Males more likely to develop OSA (especially among the obese 10-14 years).3. Morbidly obese children (body weight > 180% IBW) were more likely to develop OSA (AHI >5) 3.9% vs. 0.5%. Difficulty breathing during sleep was reported in 18% of this group but only 4% of the total had AHI >5, i.e. OSA. EDS not common complaint.4. OSA in 60% of the obese children would have been missed using the Brouillette score.5. Clini-cians only able to pick out 4 of 5 cases of OSA after doing H & P. 6.We still do not have an accurate way of identifying the children with OSA without subjecting every child who snores to a PSG. Obese children with OSAS were 7 times more likely to have ATH, 4 times more likely to have adenoidal hypertrophy.With increasing obesity, the risk was higher with enlarged tonsils but not for enlarged adenoids. In conclusion, the estimated prevalence of OSAS (AHI >5) in obese schoolage children was 0.7%, could be as high as 5.7%. Risk is higher among the morbidly obese (13.7%).

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176	Beebe (2007)	3	Compared 60 pediatric patients (ages 10-16.9 y) recruited from a hospital-based pediatric weight management clinic to 22 healthy controls using actigraphy, PSG, parent- and self-report questionnaires.	Case-control study Blinding NA Controls were from a previous study published in 2003. Cross-sectional research design assessing subjective and objective data on 60 overweight children attending a pediatric weight management clinic.	Eligible: 60 (ages 10-16.9 y) recruited from a hospital-based pediatric weight management clinic:sex not specified. BMI 37.6 + 7.5 Completed study: 22 children BMI 19.4 + 2.6 who were healthy controls or their siblings in a previous study (Zeller, Ramey & Allen 2003) % males: not specified # controls: 22 controls % males: not specified.	Cases: 12.6 + 1.7 years Controls: 13.1 + 1.8 years Narrow spectrum	Academic center Expert assigned or selected groups Pharmaceutical or equipment company	Actigraphy 1 week of actigraphy, PSG, parent- and self-report questionnaires.	Diagnosis reached using PSG criteria analyzed data with AHI >1, AHI >5, PSG SDB score >0.5 Scored sleep stages using R & K 1968 and AASM 1992 arousal scoring criteria. other diagnostic criteria developed by authors Comment: Measures: 1) anthropometric data BMI-z score used 2000 US CDC tables; 2) Single night overnight attended PSG in hospital lab, 3) Parent and self reported sleep questionnaires; Owens Spirito and McGuinn 2000 Child Sleep Habits Questionnaire (CSHQ) and Chervin Hedge et al. 2000 Pediatric Sleep Questionnaire (PSQ). 4) 1 week of actigraphy compared with sleep diary entries, worn in the evening and overnight hours,non-dominant wrist, 5) Demographic data, academic grades and symptoms of depression reported by parents using the depression subscale from the Bahvioral Assessment System for Children (Reynolds and Kamphaus 1992). After a mid-study protocol change, a subset of the children (16 overweight and 21 control) completed the Children's Depression Inventory (Kovacs 1992). Why the protocol change mid-study?	Yes / yes	Comprehensive PSG duration = TST sleep duration 394 +/- 55 min in controls vs. 396 + 60 in overweight children on PSG. Nocturnal	13% of 60 overweight older children (ages 10 to 16.9 years) had an AHI >5, and 50% had an AHI >1, whereas only none of the normal weight controls had an AHI >5 and only 14% had an AHI >1.148 Excessive weight in children with OSA was associated with an increased risk of short sleep duration, poorer sleep quality, more likely to have OSDB on PSG, daytime sleepiness, and poorer academic grades. Study limitations: overweight participants were not referred because of sleep problems; 2) narrow spectrum may not apply to children with co-morbidities; 3) minorities and low-income families who participated often did not complete the study. 4) Some of the questionnaires used validated for children, may not be as applicable to adolescents. Strengths of study: most comprehensive assessment of sleep in a sample of overweight adolescents, providing both objective and subjective assessements.
39	Mallory (1989)	4	This study looked at 41 children referred from an academic obesity clinic who had histories suggestive of sleep disordered breathing who were obese as defined by weighing >150% of ideal body weight. (This was 20% of the new patients in the obesity clinic). 45 patients were referred but only 41 met weight criteria. These patients underwent overnight PSG and 17/41 of the older patients had PFTs. A sleep history questionnaire was obtained on 38 patients,	Prospective cohort Blinding absent	Eligible:41 Completed study:41 % males:63	Cases: 10.3 +/- 4.4 (3-20) Narrow spectrum	Academic center Self-selected groups Funding source not specified	Not specified	PSG criteria	No / Yes However they used "standard definitions for apnea and hypopnea" – not clear what this was at the time of the study, only that AHI>5 was considered abnormal	Comprehensive PSG Duration = > 300 minutes TST was obtained in 37 patients (average 451+/-56.2 minutes), however the 4 with sleep time less than that were included in the analysis as they had significant respiratory abnormalities Timing = nocturnal	1) History of sleep disordered breathing alone is not adequate to predict presence of OSA in obese children; PSG would still be indicated 2) There did not seem to be a correlation between body weight and presence or severity of SDB in this population, again making history and physical inadequate to determine need for PSG 3) This study did not address the prevalence of SDB in a cohort of obese children unselected for history of breathing problems during sleep. I agree. This is a great paper to highlight the need for PSG in obese children. There is an 8% incidence of OSA in obese kids (compared to 1-2% of the general population), but unfortunately history and degree of obesity doesn't necessarily correlate with severity of OSA.
177	de la Eva (2002)	4	62 obese children (age 5-16) underwent PSG and metabolic studies to examine the association between OSA, insulin resistance and dyslipidemia.	Prospective cohort Blinding not specified	Eligible: 62 Completed study: 62 % males: 74 # controls: NA	Cases: 10.9+/- 3.2 years (5-16 years) Controls: no control group Narrow spectrum	Academic center and community referral Strategy not specified Government funded	Physical examination	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = overnight Timing of PSG: Nocturnal	In obese children (all with BMI Z scores of 1.7 or higher), the severity of OSA correlated with fasting insulin levels, independent of BMI and age.
178	Marcus (1996)	4	22 obese children and adolescents (184 +/- 36% ideal body weight) were referred from a primary care clinic in an inner city and underwent PSG, MSLT (n=18), and PFTs (n=17), as well as filling out a questionnaire regarding symptoms of OSAS (n=17)	Clinical series, observation Blinding absent	Eligible: 35 Completed study: 22 % males:27	Cases: 10 +/- 5 (2-20) Narrow spectrum	Community referral obese patients recruited from pirimary care clinics at Hopkins . No history of SDB clinics asked to choose obese patients w/without respiratory symptoms Privately funded (non-pharmaceutical)	17 children old enough performed PFTs 17 filled out questionnaires regarding symptoms of SDB	PSG criteria	Yes "standard techniques" / Yes	Comprehensive PSG 18 patients older than 5 underwent MSLT PSG duration =7 +/- 1 TST Timing of PSG:Nocturnal	In obese children with absence of clinical history of sleep disordered breathing, there is a high percentage (45%)of patients with abnormalities on PSG to suggest obstructive sleep apnea. This patient population should be considered for PSG even in the absence of frank clinical history of SDB Here there is a correlation between degree of obesity and severity of OSA. This is in contrast to the 195 Mallory 1989 paper. But the key point is that the kids were studied because they were obese, not because they had symptoms. And yet the authors found a high degree of OSA.
179	McKenzie (2008)	4	To identify clinical features which are predictive of OSA in obese children using oximeetry and audiovisual recordings. OSA defined using desat criteria. Families unwilling to visit lab studied at home. Children with no apnea on a home study were re-studied in the lab to ensure OSA associated with resp arousals without O2 desat not missed. All children had full exam by pediatrician and those with OSA also had exam by ENT	Prospective cohort study Blinded study	Eligible: 203 Completed study: 158 % males: 97/158 = 61% No controls	Cases: 9.8yrs (range 2.0-16yrs) Controls: n/a Wide spectrum	Community referral Self-selected groups Non-US funding agency	Multiple comparaters:The limited PSG was compared to questionnaire report and physical exam	PSG criteria Other diagnostic criteria developed by authors	Not applicable / Not applicable (This limited PSG used SpO2 desats to determine OSA severity and video analysis to determine arousals)	Limited sleep study (SpO2, pulse, audiovisual (for movement and snoring), ECG) PSG duration = 447 mins (range 260-480 mins) Timing = Nocturnal	Findings supportive of obesity associated with OSA Suggest that children with significant OSA highly likely to have features such as apnea, restless sleep and tonsillar hypertrophy (95% of significant OSA children had one of these) but these features are poorly specific for OSA Findings supportive of role for good screening to identify children who are likely to have OSA and who can be triaged for PSG Although this study did not compare the limited sleep studies with comprehensive PSG, the findings hint that here may be a role for SpO2 screening for OSA particularly in locations where full PSG is not possible. 26% of 158 consecutive obese British children (ages 2-16 years, mean BMI z score 3.7) had significant OSA (> 5 dips/h of > 4% oxygen saturation or > 5 respiratory-event related arousals/h) using home overnight oximetry and audiovisual recordings
140	Kalra (2005)	4	Retrospective chart review of severely obese adolescents aged 13-18 yrs (girls), 14-18 yrs(boys) who underwent bariatric surgery over a 3 year period. PSG (of some kind, not described) was done in 34/35 subjects prior to surgery and in 10 or the 35 after surgery. Comparison of PSG findings was done.	Clinical series, retrospective chart review Blinding not specified	Eligible: 34/35 had initial PSG (12 male) 10/35 had post-op PSG 35 # controls: none	17.57 ± 1.82 yrs Narrow spectrum All severely obese adolescents at high risk of having OSA	Academic center Government NIH and Cincinnati Children's Hospital Foundation	PSG's were performed before and after bariatric surgery 5.1 ±1.2 months post-op Mean weight 170 kg preop….58 kg post-op	PSG criteria	uncertain / no: AHI>5/hr was considered OSA AHI>1 was definition of abnormal No carbon dioxide measurements	Not specified AHI, AI, min and mean saturation obtained somehow PSG duration = unknown Timing of PSG:Not specified	1. PSG is likely indicated in children with severe obesity as the prevalence of OSA in this study was high 2. Resolution of obesity was associated with dramatic improvement in the frequency of apneas and in mean oxygen saturation levels during sleep 3. PSG can be helpful to follow the course of OSA in obese children undergoing weight reduction treatments
180	Redline (1999)	3	This study examined risk factors for SDB in children; specifically quantifying risk associated with obesity, race, and upper and lower respiratory tract problems. Children were recruited from participants in the larger Cleveland Family Study, a genetic-epidemiologic study of sleep apnea. Children were classified as being from an index family if one family member had PSG-confirmed OSA and controls were recruited from a random sample (not specified how they did that or who was chosen) of names of friends and neighbors provided by the index family. There were 31 index families and 30 control families. From the 31 index families, 273 children participated in the present study; from the 30 control families 126 control children participated Children with AHI>10 classified as SDB. Children with AHI5-10 not included in analysis in which SDB was the outcome variable (n=35). This study was designed to assess risk factors for pediatric SDB using a genetic-epidemiological study	Prospectice cohort Blinding not specified	Eligible: unknown; these data are of subjects participating in a larger study Completed study: 273 children from index families % males: 49% # controls: 126 children from control families % males: 47%	Cases: 11.1±4.3 yrs (range 2-18yrs) Controls: 10.7±3.9yrs (range 2-18yrs) Wide spectrum	Community referral Self-selected groups cases were children from index families (1 member with PSG-confirmed OSA); controls from neighbors/friends of the index family Government funded	Not specified	PSG criteria Other diagnostic criteria developed by authors	NA / Yes. Adult definitions were used (10 seconds) and AHI > 5 Comments: Respiratory scoring parameters developed by the authors which may limit comparison with other studies	Unattended ambulatory sleep study comprised of airflow, chest wall, pulse oximetry, and heart rate (edentrace I and II) Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG:Nocturnal	In this community based study, the findings are supportive of obesity, African American race, and upper- and lower-respiratory tract conditions being independent risk factors for SDB in children based on ambulatory sleep studies for defining SDB. Findings do not support a role for sex as a risk for SDB in children

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
68	Tauman (2005)	4	Children referred with suspected OSA and snoring and 19 control non-snoring but not matched children had PSG's. The snoring children seemed to have all had OSA. Following PSG, fasting glucose, insulin, and lipid profiles were drawn and compared. Measures compared were insulin levels, glucose, I/G ratio, HOMA (homeostasis model assessment), lipid profiles. Exclusionary criteria included any chronic med'l condition, craniofacial syndromes, genetic syndromes, meds that affect glucose or lipids, psychiatric diagnoses.	Prospective cohort Blinding not applicable	Eligible: 135 Completed study:all % males:59% # controls: 0 Although they mention 19 controls, these were not matched controls and were from a different population and they lumped all of the kids together when describing demographics so I would not consider them "controls" in the rigorous sense.	Cases: 8.9 + 3.5 (3-18 y.o.) Wide spectrum	Academic center Random selection Government funded	Not specified	PSG criteria	Uncertain: "By standard techniques" Were respiratory scoring methods clearly defined? Yes OA=no A/F w/ chest/abd movement for >2 breaths Hypopnea= fall of nasal A/F of >=50% with either 4% drop in oxy sat or arousal over at least 2 breaths Comments: Mild OSA=AHI (defined as Obstrutive AHI)>=1 and <5 Mod-Severe OSA=AHI>=5	1. 8 leads of EEG 2. ROC-A1 3. LOC-A2 4. Submental EMG 5. EKG 6. RAT and or LAT 7. Nasal airflow thermistor 8. Nasal pressure cannula 9. Thoracic movement inductance plethysmography or respiratory impedance 10. Abdominal movement either inductance plethysmography or respiratory impedance 11. Position sensor 12. Pulse oximeter 13. ET-CO2 Timing of PSG: Nocturnal	In children who snore and have insulin resistance and dyslipidemia, PSG is not routinely indicated as elevated AHI is not correlated with insulin resistance & dyslipidemia
24	Goodwin (2003)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). BMI, snoring, EDS, witnessed apneas, insomnia and "learning problems" were compared among the group using different cutoffs of RDI and oxygen desaturations to define SDB	Prospective cohort study Blinding: NA	Eligible: Unknown Completed study 239 % males:55.2 # controls:depends on cutoff RDI +/- desats	Cases: 6-11 yrs old 55% 6-8 44.8% 9-11 not further broken down Narrow spectrum	Recruited through school district Self-selected groups Government funded	Parental observations	PSG criteria	Yes / yes	Ambulatory (unattended) sleep study PSG duration =490 minutes Timing of PSG:Nocturnal	Abnormalities on overnight, unattended PSG in a large study population of children appear to correlate with symptoms of snoring, excessive daytime sleepiness and learning problems as assessed by parental answers on questionnaire
64	Gozal (2001)	3	PSG and MSLT were performed on 54 children with OSA, 14 children with primary snoring and 24 controls. Various PSG parameters and mean sleep latencies were compared among the three groups. To more objectively determine the frequency of excessive daytime sleepiness in prepubertal children with suspected sleep apnea due to adenotonsillar hypertrophy	Prospective cohort Blinding NA	Eligible: Unknown Completed study: 54 OSA 14 PS % males: 53.7 OSA; 50 PS # controls: 24 % males: 58%	Cases: 6.7 +/- 0.3 (3-12)(OSA); 7.3 +/-0.8 (PS) (4-13) Controls: 6.1 +/-0.2 (4.5-7) Narrow spectrum, all clearly affected or not	Referred population to sleep lab invited to participate	Questionnaire regarding frequency of snoring, breathing problems during sleep and daytime sleepiness. Mean sleep latency on MSLT	PSG criteria	Yes / Yes Hypopneas not quantified due to "lack of standard definition"	Comprehensive PSG and MSLT With 30 minute nap opportunities PSG duration = All night, at least 8 hours Timing of PSG: Nocturnal	Findings support the validity of comprehensive nocturnal PSG in identifying OSA in patients referred for clinical suspicion of such, and and AI was positively, although weakly correlated with shorter MSL. In children with suspected OSA, MSLT identified more children with EDS (13%) than parental questionnaire (7.5%), suggesting this problem may be underrecognized in this population. In children with OSA, few (13%) had MSL<10, suggesting need to reconsider norms in children Duration of MSLT >30 min may be more appropriate in the pediatric population (MSL were 20-23 minutes in all populations in this study)
65	Gozal (2009)	4	50 obese and 50 nonobese children with suspected OSA due to habitual snoring, and adenotonsillar hypertrophy were assessed with PSG, MSLT the following day, and results were compared. Subjective perception of EDS as reported by parents was also questioned for both groups.	Prospective cohort study Blinding not specified	Eligible:59 obese, 62 nonobese Completed study: 50 obese kids % males:50 # controls: 50 % males: 50	Cases: 7.4 +/- 0.1 yrs Controls: 7.4 +/- 0.1 (range6-9 yrs) Narrow spectrum	Academic center Expert assigned or selected groups Government funded NIH grant plus Children's Foundation endowment for sleep research , Commonwealth of Kentucky challengefor excellence trust fund; NASA	Not specified	PSG criteria	Yes / yes	Comprehensive PSG plus modified (30-minute) MSLT PSG duration = TST 483-487 minutes +/- 17-19 minutes Timing of PSG:Nocturnal	PSG variables did not vary significantly between obese and non-obese patients with OSA, however there were significant differences on subsequent MSLT, with obese patients more likely to demonstrate objective daytime sleepiness. Based on this study, MSLT does not appear to be useful in assessment of daytime sleepiness in non-obese children with OSA, Overnight PSG is useful in making the diagnosis of OSA in children, regardless of their BMI. TH: (1) Mean Sleep latency demonstrated linear correlation with OAHI, RAI, and proportion of TST spent with SaO2 <95%. (2) MSLT distinguishes obese from non-obese subjects with OSA. (3) Objecyive measures of sleepiness correlated poorly with subjective measures.
67	Lam (2006)	4	To investigate association between OSA, obesity, and tonsil size To determine the association between degree of obesity and severity and OSA	Retrospective review Clinical series, observational study, case reports Blinding not specified	Eligible: 482 Completed study: 482 % males: 335/482 = 69.5% # controls: none	Cases: median age 6years (range 1-15 years) Controls: n/a Narrow spectrum Since children were referred to sleep lab for evaluation and several pt groups excluded	Community referral Random selection Non-US funding agency	Physical examination Tonsil size BMI	PSG criteria Other diagnostic criteria developed by authors Comment: AHI>1.5 used	No Just stated that R&K criteria used and AASM arousal criteria used Yes	Comprehensive PSG PSG duration = unknown; no details Timing of PSG: Nocturnal	"- Provides some support that clinical evaluation (Grade 4 tonsils, obesity) may be helpful as an indictor for OSA in young children referred for OSA evaluation - The finding that children with obesity and/or Grade 4 tonsils were more likely to have AHI > 5 provides construct validity for the AHI determined by PSG.
96	Amin (2008)	2	To determine the 1-yr recurrence of SDB in children with adenotonsillar hypertrophy who are undergoing T&A for clinical reasons and to investigate the impact on blood pressure. Two different measures of growth were studied: BMI and gain in velocity of BMI. The investigators tested the hypothesis that independent of obesity, rate of gain in BMI increases the risk of recurrence of SDB which in turn contributes to the elevation in BP 1 yr after T&A	Case control study Blinded study	Eligible: 97 enrolled (62 SDB and 35 controls) Completed study: 40 % males: not specified although there were 65)% males in the SDB group who had AHI<3 at 1 yr f/u and 55% males in SDB who had AHI>3 at f/u # controls: 30 % males: 40%	Cases: SDB with AHI<3 at f/u: 9.3±2.1 yrs SDB with AHI>3 at f/u: 10.3± 2.2yrs Range 7-13yrs Controls: 10.2±2.2 yrs (range 7-13yrs) Narrow spectrum	Academic center and Community referral Self-selected groups Government funded	Physical examination	PSG criteria Other criteria developed by authors	No: It is unclear as to whether or not sleep stages were scored although the AHI was determined per hour of sleep No: Statement made that PSG performed according to ATS standards	Not specified Duration not specified Timing = Nocturnal	Findings do not support use of PSG in early weeks following T&A; rather they support use of PSG to detect residual SDB much later after T&A (perhaps 1yr) Supportive of long term repeat PSG in children who may be particularly at risk of recurrence of SDB, ie those who are African American and who have rapid BMI gain, since these children may have higher risk for hypertension Although there was no specific analysis of the control group, it appears that AHI was not significantly changed across the 4 PSGs obtained during a 12 month period. This provides weak support for test-retest reliability of PSG in normal controls but there was no specific analysis to test this construct and no specific analysis of sleep architecture variables across the samples. Test-retest validity of PSG is demonstrated in that AHI improved in the expected direction postoperatively. Convergent validity of PSG is demonstrated in that subjects who had recurrence of SDB in one year had higher BP vs those without recurrence, and there was no change in BP in the control group over the study period.
122	Mitchell (2007)	3	Study designed to evaluate the outcome of T&A for OSA in obese (n=33) and non-obese children (n=39). The goal was to provide qualitative data on the relative effectiveness of T&A for OSA in obese children. Children were only studied if they had AHI>2 on baseline PSG and follow up data was obtained	Clinical series, observational study, case report Blinding absent	Eligible: 78 Completed study: 72 % males: 43/72=60% # controls: n/a	Cases: 6.6 yrs (range 3.1-17.0 yrs) Controls: n/a Narrow spectrum	Academic center and community referral Expert assigned or selected Funding not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / Yes	Comprehensive PSG / duration not specified / Nocturnal	Findings supportive of obesity being a risk for persistent OSA following T&A Findings supportive of T&A being effective at decreasing severity of OSA but not eliminating it. Could lend support to obesity being an indication for post-op PSG Discriminate validity of PSG-determined AHI is demonstrated in that obese children had significant higher AHI than nonobese children both before and after AT. Test-retest validity of PSG-determined AHI is demonstrated in that both obese and nonobese children had a reduction in obstructive AHI, oxygen saturation nadir, and arousal index s/p AT.

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124	Tauman (2006)	3	Review of pre-op and post-op PSG's for 110 children who underwent T'n'A for OSAS to see if they were cured (AHI<=1) and what factors could be used to predict which children would have residual OSA. Factors examined included disease severity, relative BMI, h/o allergy, family hx of SDB in a 1st-degree relative, age, and ethnicity. Separately, age/gender/relBMI-matched controls were gathered for the group that had post-op AHI<=1 to see if there were any differences in sleep architecture.	Clincal series Blinding not specified but presumably absent since the indication for the second PSG was the surgery	Eligible: 110 Completed study: % males: 60% # controls: 22	Cases: 6.4 + 3.9 (1 y.o. -16 y.o.) Controls: not stated but age matched Patient Spectrum not clear Criteria not specified—only that children had OSA on pre-op PSG, underwent T'n'A and did not have genetic disorders, CP, neuromuscular or other systemic disorders. I did not pursue finding out if it was wide spectrum since the absence of a control group (there is a control but it is for only one issue) would prevent it from being a Level 2 anyway	Academic center and community referral Recruitment strategy not specified Government funded And foundation funded	Not specified	PSG criteria	Yes R&K / Were respiratory scoring methods clearly defined? Yes OA=no A/F w/ chest/abd movement for >2 breaths Hypopnea= fall of nasal A/F of >=50% with either 4% drop in oxy sat or arousal over at least 2 breaths Comments: Cure=AHI<=1 Mild OSAS=1<AHI<5 OSAS=AHI>=5	Comprehensive PSG 1. 8 leads of EEG 2. ROC-A1 3. LOC-A2 4. Submental EMG 5. EKG 6. RAT and or LAT 7. Nasal airflow thermistor 8. Nasal pressure cannula 9. Thoracic movement inductance plethysmography or respiratory impedance 10. Abdominal movement either inductance plethysmography or respiratory impedance 11. Position sensor 12. Pulse oximeter 13. ET-CO2 PSG duration = between 432.2 and 435.8 Timing of PSG: Nocturnal	1. PSG is indicated to assess residual OSAS in post T'n'A children as the cure rate is fairly low (25% in this study); 2. Factors suggesting an increased likelihood of having residual OSA (AHI>5) include pre-op AHI and +FH of SDB but these factors account for only 25% of the likelihood of having residual OSA; 3. H/o allergy, relBMI, age, and ethnicity were not predictive of post-op AHI >5 4. A smaller %'age of obese children were fully cured (AHI<=1) than non-obese children suggesting an even greater imperative for post-op PSG in obese children; 6. This study demonstrates test-retest validity for PSG as a measure of OSA as the respiratory parameters improved after T'n'A 7. Sleep parameters are worse pre-operatively in children with OSA who are scheduled for T'n'A than post-operatively demonstrating that PSG is sensitive to abnormalities in sleep caused by OSA; 8. The finding of similar sleep parameters (except for a slight decrease in the % of stage 2 sleep) in children whose OSA is cured with T'n'A and normal controls (children without OSA) provides convergent validity that the parameters obtained during PSG are a reasonably measure of sleep.
128	Shine (2006)	4	This retrospective study was aimed to determine the effect of T&A on the respiratory parameters of morbidly obese children with OSA with respect to avoidance of further treatment. RDI>5 but <10 was mild SDB RDI>10 but<20 was moderate RDI>20 was severe This study was designed to assess the efficacy of T&A on respiratory sleep parameters and avoiding CPAP in morbidly obese children with OSA	Clinical series Blinding absent	Eligible: 19 Completed study: 18 % males: 14/19 = 74% # controls: none % males: n/a	Cases: MEDIAN age 78±53.3 months (range 24-212 months) Controls: n/a Narrow spectrum	Community referral Expert assigned or selected groups Funding source not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / No / no mention of sleep architecture; RDI definition given but no details provided on what constituted an apnea or hypopnea	Comprehensive PSG Except one subject who only had nocturnal oximetry PSG duration = not specified Timing of PSG: Nocturnal	Findings supportive of high prevalence of residual SDB after T&A in morbidly obese children despite improvement in severity of OSA Findings supportive of large proportion of morbidly obese children being candidates for additional treatment (CPAP) after surgery for OSA Findings could support PSG as an indication in morbidly obese children after T&A
129	O'Brien (2006)	4	PSG before and after treatment for OSA in 29 obese and 40 non-obese children were compared. Contributions of disease severity and time to repeat PSG were also analyzed The purpose of this study was to determine if obesity impacted on the outcome of treatment for obstructive sleep apnea in children	Clincal series Blinding absent	Eligible:213 Completed study: 69: 29 obese, 40 non-obese % males: 79%obese, 65% non-obese	Cases: 9 +/- 3.7 obese; 5.7 +/- 4.1 non-obese Narrow spectrum	Academic center Expert assigned or selected groups Funding source not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = Up to 12 hours Timing of PSG: Nocturnal	This study suggests that post treatment PSG should be perfomed to assess residual disease, particularly in obese patients with a high likelihood for persitant OSA after T&A.
182	Morton (2001)	4	577 subjects who were part of a longerterm epidemiological study of SDB underwent overnight in-home cardiorespiratory monitoring. Children's sleep and health questionnaire, and Health and Sleep study questionnaire (for those >13yrs) were filled out, and information about medical history, family history, ethnicity, prior T&A were obtained. Results from overnight studies were analyzed to determine presence of any predictive data	Clinical series Blinding absent; This study was done to identify predictors of SDB in patients s/p tonsillectomy and/ or adenoidectomy	Eligible: 577 Completed study:577 % males:47	Cases: 10.8 +/-4.2 Wide spectrum	Other, specify Longitudinal genetic epidemiological cohort study of SDB and Self-selected groups Government funded	No comparison was made .these children did not have PSG done	Diagnosis based on home device testing…AHI≥5/ hr + SDB	Not completely: no sleep stage scoring as no EEG; just behavioral and note taking (asleep or awake estimates) Cessation or reduction in airflow or impedance for 10 seconds with a >2.5% drop in oxygen saturation.	Ambulatory (unattended) sleep study PSG duration = not specified Timing of PSG:Nocturnal	1) This study suggests that patients, particularly if black or obese, who have undergone T&A should continue to be followed for symptoms of SDB and consider f/u PSG 2) A reasonable epidemiologic study to support post-op followup but not necessarily postop PSG in all patients
181	Apostolidou (2008)	2	This study was designed to assess the efficacy of adenotonsillectomy as treatment for OSA in obese patients, and to compare outcomes found with nonobese patients. Pediatric patients who had a history of frequent snoring and adenotonsillar hypertrophy, and who had undergone PSG and received a diagnosis of OSA were recruited at the time of surgery (adenotonsillectomy). If the parents agreed to having the child return for f/u PSG, the child was eligible to participate in the study. Children with neuromuscular disorders, craniofacial abnormalities, or previous T&A were excluded. In addition to the baseline PSG, subjects underwent a postsurgical PSG, "at least two months after T&A according to the availability of PSG appointments and at the convenience of the parents". Subjects also had height and weight measurements at baseline and at follow up. Primary outcome measure was the achievement of AHI<1. A secondary outcome measure was the achievement of AHI<5 with SaO2 nadir of >88%.	Children were included only if parents consented to PSG following AT Prospective cohort study Blinding not specified	Eligible: not stated Completed study: 70 Cases (obese): 22 # control (nonobese): 48	Cases: 5.8 + 1.8 Controls: 6.9 + 2.6 Narrow spectrum	Academic center Expert assigned or selected groups Non-US funding agency	Not specified	PSG criteria	No / yes	Comprehensive PSG PSG duration = "overnight" Timing of PSG: Nocturnal	1. Polysomnography has face validity in this pediatric population, in that obese children had higher AHI than nonobese children preoperatively. 2. PSG demonstrated test-retest validity in that AHI improved in the expected direction postoperatively. 3. PSG face validity was NOT demonstrated postoperatively in that a substantial percentage of both obese and nonobese patients did not reach the threshold of surgical cure postoperatively, and obesity was NOT a significant predictor of whether or not OSA was cured following surgery.
184	Stepanski (1999)	2	The goal of this study was to characterize sleep and respiratory parameters in African-American children with sleep-disordered breathing (SDB) as compared to children without SDB.	Case control study Although the study is prospective in that they took "all comers" referred to the sleep center to r/o SDB and is thus a cohort study, with respect to the conclusions related to PSG, they divided the group into diagnostic categories and eventually did a case-controlled study Blinded study By definition, the interpreting MD's did not know in advance who had OSA and who did not	Eligible: 128 Completed study: % males: 52% Data reported ONLY for entire sample and not for cases versus controls # controls: 62 % males: Not stated	Cases: 5.9 + 3.7 Controls: Data reported ONLY for entire sample and not for cases versus controls Wide spectrum	Community referral to an academic center Strategy: 198 consecutive children referred for eval of OSA. 2/3 were referred from otolaryngology and the remainder were referred from pediatric medicine. Funding source not specified	Not specified	PSG criteria Other diagnostic criteria developed by the authors	No: Only scoring of arousals was defined as ASDA task force standard Were respiratory scoring methods clearly defined? Yes Comments: OA: absent A/F for 10 sec. with persistent thoracoabd movement OH: decrease in A/F by >=20% lasting 10 second with either an arousal or a fall in oxy sat of >1% OSA="obstructive index" of >=5/hr OR review of audiovisual data for 30 or more events of increased accessory muscle use followed by gasping, stridor, or choking, or loud interrupted snoring, paradoxical breathing, jaw and/or sterna retractions –5 kids were diagnosed with these alternative criteria	Comprehensive PSG 1. Central EEG (# of leads not specified) 2. Occipital EEG 3. ROC-A1 4. LOC-A2 5. Submental EMG 6. EKG 7. Nasal-oral airflow thermistor 8. Thoracic belt 9. Abdominal belt 10. Inductance plethysmography 11. Pulse oximeter PSG duration = Not specified Timing of PSG: Nocturnal	1. Witnessed apnea is an indication for PSG since sleep apnea is highly prevalent in children with witnessed apneas; 2. Absence of witnessed apneas, however, does not rule-out the need for PSG; 3. In children older than 8 y.o., obesity is a risk factor for OSA; 4. Children younger than 8 y.o. with OSA are not more obese than children without OSA on average; lack of obesity does not indicate that OSA is absent in this age group; 5. PSG is likely to show differences in arousal indices between children with OSA and those without; 6. SDB was equally prevalent in Caucasian, African-American and Latino children—race did not predispose children to OSA;

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70	Brooks (1998)	3	To determine the extant to which adenotonsillar hypertrophy contributes to the severity of OSA. Tonsil size quantitated by physical exam. Adenoid size quantitated by lateral neck x-ray.	Clinical series, observation Blinded study	Eligible:N = 33 Completed study:All % males: 19 (58%) "Controls" could be viewed as children who ended up with RDI <5. Was 16 of the 33 total.	Cases: 5.1 yrs Controls: 4.4 yrs Patient spectrum = Not applicable	Academic center Random selection Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	Parental report snoring and/or observed apneas do not predict the presence of OSA in children. Convergent validity of the PSG-determined AHI is demonstrated by the finding that obesity is significantly correlated with PSG-determined AHI and the lowest oxygen saturation. Convergent validity of the PSG-determined RDI is demonstrated by the finding that children with RDI >5 had higher AN ratio than children with RDI<5. Elevated AN ratio is present in many snoring children and was also present in children who did not have RDI>5. Consequently, PSG is needed to confirm the presence or absence of OSA in snoring children who have elevated AN ratio.
46	Rosen (1999)	4	This appears to be a retrospective descriptive cohort, which catalogs and describes clinical questionnaire and PSG data from the records of 326 children, who had been referred to an academic sleep disorders lab by primary care or ENT, for clinical concerns of OSA. Cases involving more complex disease (craniofacial abnormalities, genetic disorders, prior surgery, neuromuscular disease, prior upper airway surgery) were excluded, narrowing the spectrum of disease. The investigators decided to exclude a single Asian patient from analysis. The remaining 326 patients were roughly evenly devided between African American (38%), Caucasian (30%) and Hispanic (31%). The polysomnographic data was used to classify patients into five levels of sleep disordered breathing 1. No snore (no snoring, apnea, desaturation, or hypoventilation) 2. Snore (snoring without apnea, desaturation or hypoventilation) 3. UARS (snoring with marked paradoxical inward chest movements or repetitive arousals and movements) 4. OSA (snoring with apnea and/or hypercapnia, without desaturation) 5. Hypoxemia with OSA (snoring with desaturation and apnea, with or without hypercapnia) The clinical survey data and PSG characteristics of patients were then analyzed and reported.	Case control study Blinding absent	Eligible: 326 % males: 56%	Cases: 5.8 +/-3.0 (range 1-12 yrs) Narrow spectrum	Academic center: Yale-New Haven Expert assigned or selected groups Government funded	Parental observations	PSG criteria	Yes. Obstructive apneas were quantified, but hypopneas were not. A single method of airflow was used, which was not specified ("thermistor). End-Tidal CO2 was used to determine obstructive hypoventilation. Criteria which allowed a patient to classify as having OSA were the presence of one or more of the following deviations: 1. obstructive apnea index was >1/hr 2. 4% desaturation index of >1.5/hr, or SaO2 nadir less than 92% 3. EtCO2 value >50 for over 9% of the TST, or peak EtCO2 value of 55mmHg or more	Comprehensive PSG, including End-Tidal CO2 tracing. The method of airflow assessment was not detailed, sounds to be a thermistor ("nasal-oral airflow"). A nasal pressure transducer was not apparently part of the montage. PSG duration = "overnight" Timing of PSG: Nocturnal	Neither clinical questionnaire data nor the presence of obesity can reliably predict PSG diagnosis of OSAHS (as defined by these investigators) in pediatric patients who have been referred to PSG for complaints of snoring and disturbed sleep. Though the descriptions of the PSG characteristics of their diagnostic categories are interesting, these descriptions inherently manifest a sort of circular logic; it remains to be seen whether these distinctions (ie: snoring vs UARS vs OSA) in a population of snoring, sleep disturbed children (by history) have any bearing on clinical outcomes (ie: reduction in symptoms post tonsillectomy). The fact that 10% of the cohort was classified as essentially normal ("no snore") despite the fact that 99% of the patients were classified by parental assessment as "habitual snorers" may reflect an important degree of night-to-night variation. 3-4+ tonsillomegaly increased the likelihood of discovery of frank OSA (as described by these investigators) in pediatric patients with snoring and subjective sleep complaints.This suggests face-validity of PSG for demonstration of more significant degrees of sleep disordered breathing, given the accepted causal relationship of adenotonsillar hypertrophy in the pathogenesis of pediatric OSA.
36	Xu (2006)	3	Review of various historical (25 questions), clinical (13 physical findings), and radiographic parameters (adenoidal-pharyngeal ratio from an x-ray of the post-nasal space ANR<0.5=nl) in all patients seen at an academic sleep lab associated with a peds dept. over a 4-yr period. Patients were divided into OSA positive, defined as AHI>5/hr, and primary snorers (AHI<=5/hr). PPV, NPV calculated for the 39 parameters studied. All patients snored.	Case control study Blinded study	Eligible: 31 # controls: 19	Cases: 7.8 +/- 3.2 yr Controls: 8.1+/-_ 3.7 yr Narrow spectrum Study included all children suspected by a community MD of having OSA—all children snored	Academic center Subjects were referred by community MDs to an academic center Strategy not specified Funding not specified	Multiple comparitors: 25 historical questions 13 physical exam signs 1 radiographic sign	PSG criteria	Yes: Sleep scored by "standard criteria"—so presumably R&K although no reference given Yes: Comments: 1) event duration defined as >10 seconds 2) hypopnea defined as 50% decrease in A/F + either arousal (non-defined) or >=4% desat 3) def of OSA=AHI>5/hr —although later in the paper they stress that the definition is somewhat arbitrary but chosen as the definition of "clinically sig't OSA"	Comprehensive PSG:) C3-A2 2) C4-A1 3) O1-A2 4) O2-A1 5) EOG non-specified 6) Submental EMG 7) Snore channel 8) EKG 9) Nasal-oral airflow--thermistor 10) Thoracic and abdominal plethysmography 11) Pulse oximeter PSG duration not stated PSG timing = nocturnal	1. combo of snoring and 6 characteristics (see study findings) has high sensitivity and good NPV with fairly good/adequate PPV and, thus, help the clinician trying to determine which children need polysomnography sooner than others; 2. combo of snoring and upper airway narrowing on x-ray or mouth breathing observed by MD and combo of snoring and UAN on x-ray or enuresis provide fairly good PPV/NPV 3. PPV of mouth breathing observed by MD for OSA was 100% (if child had mouth breathing, then child had OSA) implying this is a high risk group for OSA and would be well served by undergoing PSG ASAP 4. High PPV's (>=80%) were also seen with the following but were not statistically significant: historical factors: paradoxical breathing, resp distress, chest contractions, frequent sore throat/dry mouth; physical factors: long adenoid facies, midface hypoplasia, and high arched palate 5. High NPV of 80% (rest were lower) was also seen with the following but was not statistically significant: historical factors: snoring>3 nights/wk
32	Reade (2004)	3	Records from 130 pediatric patients were reviewed. Excluded those with renal failure, transplantation, mental retardation, NMD, DM, chronic lung disease, congenital heart disease, sickle cell, or antihypertensive therapy, left 90 patients. Patients had originally been referred by their primary physicians for a polysomnogram for various reasons. Patients with medical comorbidities were excluded. 90 patients were included in the study. Polysomnographic data is reviewed, and is correlated with presence of obesity and hypertension.	Clinical series, observational study, case reports Blinding not specified	Eligible:90 Completed study: 90 % males:64%	Cases: 10.7 yrs range 4.2-18.8 Controls: None Narrow spectrum	Community referral Referred by PCP for sleep study because of their clinical presentation" Expert assigned or selected groups Funding not specified	Hypertension	PSG criteria: Hypopnea defined as a 20-50% reduction in airflow with a minimum duration of 10 and associated with a desaturation of 3% or greater or a 3 sec EEG arousal.	Yes	Comprehensive PSG Oronasal airflow, etC02 PSG duration = "overnight" Timing of PSG: Nocturnal	In obese pediatric patients, the hypopnea index and arousal index are physiologically significant predictors of cardiovascular risk posed by obstructive sleep apnea. Obesity and hypertension in pediatric patients should prompt a careful evaluation for sleep disorders. Obesity is a risk factor for OSA especially in older children; hypertension in a child warrants consideration of obstructed SDB. Only elevated hypopnea index was a predictor of diastolic hypertension in children with SDB.
100	Leung (2006)	3	To investigate association between OSA and ambulatory blood pressure in snoring children To investigate the relationship between OSA and 24hr ambulatory blood pressure in snoring children	Prospective cohort Blinding not specified	Eligible: 106 Completed study: 96 % males: 66/96 = 69% # controls:none	Cases: 9.4+/-2.8years (range 6-15 years) Controls: n/a Narrow spectrum	Source not specified Random selection Non-US funding agency	Multiple comparators: Physician assessment Parental report Ambulatory blood pressure	PSG criteria Other diagnostic criteria developed by authors Comment: States that ATS criteria were used but no details given.	No Just stated that R&K criteria used and AASM arousal criteria used Were respiratory scoring methods clearly defined? Yes In an appendix	Minimal information on PSG; no details regarding how airflow was measured PSG duration = unknown; no details Timing of PSG: Nocturnal	*- PSG may be valuable in identifying children who are at risk of hypertension - Desaturation index may contribute to nocturnal diastolic BP - The relationship between AHI > 5 and elevated diastolic blood pressure provides some convergent (construct) validity for PSG in children since OSA is a known risk factor for hypertension in adults.
102	Redline (2007)	2	Study sample derived from ongoing longitudinal community cohort. The present study evaluates adolescents at 13-16 yrs for SDB (AHI≥5), BP, metabolic syndrome. Metabolic syndrome definition based on adapted adult criteria for the pediatric population	Prospective cohort study Blinding not specified	Eligible: 389 total Completed study: 270 (22 found to have SDB) % males: 140/2070=52% overall and 17/22=77% for only SDB # controls: 248 of the 389 were found not to have SDB % males: 123/248=50%	Cases: 13.4±0.5 yr Controls: 13.6±0.7 yr Range for both group 13-16 yrs Wide spectrum	Community referral Self-selected groups Government funded	Sleep diary	PSG criteria Other diagnostic criteria developed by authors	Yes (by citation to ASDA and R&K) / Yes	Comprehensive PSG PSG duration not specified Nocturnal	These cross-sectional findings are supportive of a role for SDB in pediatric (adolescent) metabolic syndrome and indices associated with metabolic syndrome Supportive of certain PSG parameters being associated with metabolic dysfunction (eg O2 desats) since no association between report of habitual snoring and metabolic dysfunction
187	Verhulst (2007)	3	To determine whether SDB is a risk for the metabolic syndrome in children and adolescents who are overweight/obese (31% / 69% respectively) and to examine whether the severity of SDB is independently associated with glucose intolerance, insulin resistance, and/or dyslipidemia. All children were undergoing routine assessments, including PSG and data was obtained from these assessments.	Prospective cohort study Blinding not specified	Eligible: 104 Completed study: 104 % males: 44% # controls: none % males: n/a	Cases: 11.1±2.6 yrs (range 6.1-16.7 yr) Controls: n/a Wide spectrum	Academic center and community referral since most referrals from community physicians Expert assigned or selected groups appears that all children who attend the obesity clinic were in the study providing they did not have craniofacial anomalies, neuromuscular disorders etc All measurements taken as a routine Funding not specified	Not specified	PSG criteria Comment: Used published ref to determine diagnosis and also subdivided that group depending on RDI	No / Yes	Comprehensive PSG but had to look at another manuscript to determine this since the authors just stated that the details of PSG have been described in another paper. No details re type of PSG were provided for this current manuscript PSG duration = approx 7.7 ± hours (all children had at least 6 hours of PSG) Timing of PSG: Nocturnal	Supportive of OSA being independently associated with some parameters of the metabolic syndrome such as insulin levels and triglycerides, in overweight and obese children/adolescents Also supportive of desaturations being the variable that is predictive of the presence of metabolic syndrome

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
188	Kheirandish-Gozal (2008)	3	A convenience sample of 518 consecutive snoring children age 4-17 was divided into overweight (n=142) vs. nonobese (n=376). All underwent PSG and assessment of liver function, insulin resistance, and serum lipids. Demographic, PSG, and metabolic characteristics were compared between children with OSA (n=343) vs children without OSA (n-175), overweight vs nonobese. Overweight children with OSA and fatty liver disease (FLD) (n=46) were compared with overweight children with OSA who did not have FLD (n=96). 42 children with OSA and elevated AST levels were underwent T & A and had additional repeat testing with PSG.	Prospective cohort study Blinding not specified	Eligible: 518 Completed study: 518 % males: approximately 50	Cases: 8.4 (1.3) Controls: n/a Patient Spectrum not applicable	Academic center Self-selected groups Government funded	Not specified	PSG criteria	Yes / yes	Comprehensive PSG PSG duration = not specified but TST was approximately 8 hours Nocturnal	OSA is frequent and more prevalent among obese snoring children with elevated ALT levels compared with obese snoring children without elevated ALT levels, and effective treatment of OSA results in improvement in ALT in a substantial proportion of children with FLD. This suggests the possibility that obese snoring children with elevated liver functions may benefit by undergoing evaluation and treatment for OSA.
173	Verhulst (2008)	4	OBJECTIVES: To assess whether sleep-disordered breathing (SDB) in overweight children and adolescents has an additional effect on the spectrum of urinary albumin to protein loss, as markers of early kidney dysfunction. METHODS: Prospective study in a clinical sample of overweight children and adolescents. Each subject underwent anthropometry, blood sampling, oral glucose tolerance test and polysomnography. From a 24-hour urine collection, albumin excretion rate and total urinary protein to creatinine ratio (UPCR) were calculated. CONCLUSION: Insulin resistance, and not SDB, was associated with increased levels of albuminuria, indicating early renal dysfunction, in this clinical sample of overweight children and adolescents.	Clinical series, observational study, case reports Blinding absent	Eligible: 94 Excluded: chronic renal disease, diabetes, chronic lung disease, neuromuscular disease, laryngomalacia, any genetic or craniofacial syndrome Completed study: 94 % males: 45% # controls:None	Cases: 11.0 ± 2.5 yrs (6.3 – 16.7) Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Other, specify Anthropometry, blood (glucose, insulin, C-peptide, total cholesterol, HDL cholesterol, triglycerides), oral glucose tolerance test, albumin excretion rate, total urinary protein to creatinine ratio	PSG criteria	Yes / yes	Not specified	No association was demonstrated between PSG respiratory findings and albuminuria as a marker of SRBD in overweight or obese children.
185	Kohler (2008)	3	A retrospective analysis of polysomnography, demographic and physical examination data from 190 children (referred for evaluation of upper airway obstruction), were completed to examine the interaction between obesity, age and upper airway obstruction.	Clinical series, observational study, case reports 3 groups: Intermittent Snorer/ Habitual Snorer/ OSAS Blinding NA	Eligible: 190 Completed study: 190 (80/68/42) % males: (54%/ 59%/ 55%) # controls: NA	Cases: 7.2 yrs/ 6.5 yrs/ 6.9 yrs (range 4-12 years) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Physical examination	PSG criteria	Yes / yes	Comprehensive PSG PSG duration = overnight Timing of PSG: Nocturnal	In Australian Caucasian children aged 4-12 years who snore, obesity but not age was a significant, albeit weak, predictor of upper airway obstruction during sleep.
121	Gozal (2008)	2	This study was designed to better understand the role played by OSA in the pathogenesis of several factors associated with cardiovascular risk in a pediatric population, with particular attention to the change in these parameters after adenotonsillectomy, and whether obese subjects had different results from nonobese subjects. Subjects were recruited from consecutive children referred for PSG for clinical concern over sleep apnea. Those who were diagnosed with "moderate to severe" sleep apnea (defined by this study as an AHI>2) were considered eligible. Subjects who agreed to participate (n=81 of 97 potentially eligible) were subdivided into obese (BMIz score>1.2) or non obese. Subjects underwent a baseline PSG with fasting blood draw for CBC, glucose, insulin, CRP, lipid panel and ApoB. Subjects were later invited to return for a repeat PSG 6-12 months after adenotonsillectomy (n=62, of which 25 were nonobese and 37 were obese).	Prospective cohort study Blinding absent	Eligible: N=97 81 agreed to participate Completed study: N = 62 37 obese 25 nonobese All had OSA No other controls without OSA % males=43 # controls: 25 % males: 60%	Cases: Obese: 7.9 yrs 7.9+0.5 (3-12) Controls: Nonobese: 6.6 yrs 6.6+0.5 (3-11) Narrow spectrum	Academic center Expert assigned or selected groups (consecutive patients who were referred to an academic sleep disorders center were invited to participate) Government funded NIH grants, as well as private grants (Children's Foundation Endowment for Sleep Research, and Commonwealth of Kentucky Challenge for Excellence Trust Fund, and National Space Agency grant.	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG with modern pediatric montage (including nasal pressure transducer tracing and end-tidal CO2 monitoring). PSGs were done pre and post T&A PSG duration ="overnight" 7-8 hrs Timing of PSG: Nocturnal	The study used PSGs only to confirm the diagnosis of OSA. Also used PSG to confirm resolution of OSA following T&A. Not to be overlooked…nonobese children had resolution of OSA with surgery (AHI from 13 to 2). But obese children seemed to have more residual OSA following surgery (AHI from 19 to 6). Polysomnography has good face validity in this group of pediatric patients. Residual disease post T&A co-migrates with a lesser degree of improvement of accepted cardiovascular risk markers, while complete resolution of respiratory events is associated with a higher degree of improvement. Obese children are at greater risk than nonobese children for nonresolution of OSA following T&A. Obesity should be considered in the decision to recommend a postsurgical follow up study to document resolution of disease.
4.2.2.2 Prematurity												
189	Hibbs (2008)	3	383 children originally identified in a population based cohort from the Cleveland Children's sleep and health study who were born <37 weeks gestational age and had sleep studies between 8-11 years (92% of all preterm children in cohort) were evaluated by reviewing their neonatal medical records to determine what perinatal and neonatal risk factors might be associated with later childhood SDB	This was a population based cohort, but a retrospective chart review from birth, when the children had sleep studies at age 8-11 Blinded study	Eligible: 383 preterm infants had medical chart review and technically acceptable sleep study between 8 and 11 Completed study: 383 % males: 50.4	Cases: GA 32 weeks (29-34); studied at ages 8-11 yrs with PSG Wide spectrum	Population based cohort at 3 Cleveland area hospitals Random selection Government funded	Portable studies	PSG criteria	Uncertain (No EEG parameters were used. Sleep was identified when there was little movement and reduced heartrate AND compared with sleep-wake times recorded by the parent in a sleep diary) Yes	Ambulatory (unattended) sleep study [Limited channel cardiorespiratory recordings included thoracic and abdominal excursions, and estimated tidal volume by inductance plethysmography, pulse ox, heart rate and body position ** AHI from home study was compared with AHI from attended psg within 3 months of home study in 55 children with a wide range of SDB; AHI 2.6+/- 8 vs 2.9 +/-7.5 in lab vs home studie (ICC=.85)] Duration not specified Timing = Nocturnal	Study showed higher rates of PSG-defined SDB in premature subjects drawn from a population-based cohort than the genrally accepted prevalences rate for the pediatric population as a whole. Several specific factors (e.g. single-parent household, mild maternal pre-eclampsia) were specifically tied to increased risk within the cohort.
79	Emancipator (2006)	3	835 children aged 8-11 from an urban community cohort designed to overrepresent African American and preterm children underwent in home sleep study. Blinded assessment of cognitive function was then compared in those with sleep disordered breathing (defined as OAHI >5, OAI>1 AND/OR habitual snoring defined as loud snoring at least 1-2 times per week in the last month) and those without SDB. The purpose of this study was to assess whether sleep disordered breathing (defined as OSA AND/OR habitual snoring) is associated with decreased cognitive functioning, and determine if preterm children were at differentially increased risk of SDB-related cognitive impairment. Correlation between degree of nocturnal hypoxemia and severity of cognitive deficits was examined. While prospective and broad spectrum, this study did not use the gold standard overnight PSG and the definition of SDB using both respiratory parameters on the overnight sleep study AND habitual snoring despite documentation of respiratory events is problematic.	Those administering cognitive tests were blinded to the SDB status	Cohort Eligible: 907 Study eligible: 835 # with OSA: 164 Controls: 0 % males:50%	Cases:9.5 +/- 0.8	Community referral Urban, community based cohort Strategy and Funding: not specified	Not specified 5 point snoring questionnaire filled out by parents cognitive assessments (PPVT-R, K-ABC, CPT)	PSG criteria	No. Were referred to a prior publication.	Ambulatory (unattended) sleep study PSG duration = not specified Timing of PSG: Nocturnal	In children with habitual snoring, who seem to be at higher risk for cognitive dysfunction, in home sleep studies may underestimate the degree of sleep disordered breathing as defined by the apnea/hypopnea index. Ex preterm infants may be at greater risk for cognitive dysfunction as a result of sleep disordered breathing and may represent a population in which more widespread use of polysomnography should be considered.
190	Paul (2009)	4	29 preterm newborns who had been diagnosed with clinically significant apneas and who had NOT responded to aminophylline treatment were studied with the basic PSG apparatus, however after a morning feed and not necessarily while sleeping. Behavior as well as polygraphic variables were recorded. Because of persistent apneas, both central and obstructive, as well as EEG changes and perioral EMG increases, the child was presumed to have reflux as the etiology of the breathing disturbance. Aminophyilline was stopped, reflux treatment instituted (consisting of left side postioning, thickened feeds and frequent small feeds) and study was repeated.	Clinical series, observational study, case report Blinding absent	Eligible:29 Completed study:29 % males: not specified	Cases: studied at GA 33.4 +/-2.5 weeks (Born at GA 25-35 weeks mean 28.9 +/-2.6) Wide spectrum While all preemies, they included pts. with IVH, leukomalacia, PDA, kids with tube feeds	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria	No (not really a poly SOMNogram – no sleep really mentioned although EEG arousals were noted around the times of apneas) Yes (however, no hypopneas were scored)	Comprehensive PSG PSG duration =120 minutes Daytime naps	While not technically a PSG, recording of premature infants before and after treatment for GE reflux might help determine clinical improvement. There were a lot of assumptions – no clear diagnosis of GE reflux, treatment was not pharmacologic, etc. TH: among premature children with sleep-related desaturation not responding to treatment with aminophylline, nap polysomnograms demonstrated that central and mixed apneas were more frequent than pure obstructive apnea.
37	Greenfeld (2003)	4	29 infants <18 months of age with PSG diagnosed OSA due to adenotonsillar hypertrophy were studied with regard to demographics, referring physician specialty, development, symptoms post treatment and a pediatric sleep questionnaire completed by parents.	Clincal series Blinding absent; This study was designed to evaluate the characteristics of infants <18 months of age with obstructive sleep apnea due to ATH	Eligible: Unknown Completed study: 29 % males: 69	Cases: 12.3 +/- 3.9 Narrow spectrum	Community referral Expert assigned or selected groups Blinding not specified	Physical examination	PSG criteria	Yes / Yes: but no diagnostic criteria given	Comprehensive PSG No nasal pressure monitoring PSG duration = At least 6 hours Timing of PSG: Nocturnal	Since no PSG paramenters were reported, conclusions are limited. OSAS due to ATH does seem to exist in children <18 months, especially males, with history of prematurity, and those who snore, suggesting PSGs would be warranted in this population. Apparent high recurrence rate in infancy would suggest repeat PSG after treatment if symptoms recurred in this population

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.2.3 Race/Ethnicity												
24	Goodwin (2003)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). BMI, snoring, EDS, witnessed apneas, insomnia and "learning problems" were compared among the group using different cutoffs of RDI and oxygen desaturations to define SDB	Prospective cohort study Blinding: NA	Eligible: Unknown Completed study 239 % males:55.2 # controls:depends on cutoff RDI +/- desats	Cases: 6-11 yrs old 55% 6-8 44.8% 9-11 not further broken down Narrow spectrum	Recruited through school district Self-selected groups Government funded	Parental observations	PSG criteria	Yes / yes	Ambulatory (unattended) sleep study PSG duration =490 minutes Timing of PSG:Nocturnal	Abnormalities on overnight, unattended PSG in a large study population of children appear to correlate with symptoms of snoring, excessive daytime sleepiness and learning problems as assessed by parental answers on questionnaire
23	Goodwin (2004)	2	Children aged 6-11 were recruited through the Tucson school system to undergo unattended home PSG, complete a sleep habits questionnaire and have neurocognitive assessment (Latter not reported). Sleep habits questionnaire (SHQ) assessed for presence of sleepwalking, sleeptalking, sleepterrors, eneuresis as well as measures of snoring, EDS, witnessed apneas, insomnia and learning problems. Likelihood of having a parasomnia was correlated with evidence of SDB.	Prospective cohort Blinding not applicable	Completed study: 480 % males:50	Cases: 6-8y 52.9% 9-11 47.1% Narrow spectrum	Patients recruited from school system Self-selected groups Government funded	Parental observations	PSG criteria	Yes / Yes	Ambulatory (unattended) sleep study PSG duration = 487 minutes Timing = nocturnal	1) Unattended home PSG appears to identify a large number of patients with SDB (24%) in a non-clinically referred population, suggesting possible usefulness as a screening tool 2) Study suggests that PSG might be useful in diagnosing SDB in patients with parasomnias (specifically sleepwalking, sleep talking and eneuresis)
184	Stepanski (1999)	2	The goal of this study was to characterize sleep and respiratory parameters in African-American children with sleep-disordered breathing (SDB) as compared to children without SDB.	Case control study Although the study is prospective in that they took "all comers" referred to the sleep center to r/o SDB and is thus a cohort study, with respect to the conclusions related to PSG, they divided the group into diagnostic categories and eventually did a case-controlled study Blinded study By definition, the interpreting MD's did not know in advance who had OSA and who did not	Eligible: 128 Completed study: % males: 52% Data reported ONLY for entire sample and not for cases versus controls # controls: 62 % males: Not stated	Cases: 5.9 + 3.7 Controls: Data reported ONLY for entire sample and not for cases versus controls Wide spectrum	Community referral to an academic center Strategy: 198 consecutive children referred for eval of OSA. 2/3 were referred from otolaryngology and the remainder were referred from pediatric medicine. Funding source not specified	Not specified	PSG criteria Other diagnostic criteria developed by the authors	No: Only scoring of arousals was defined as ASDA task force standard Were respiratory scoring methods clearly defined? Yes Comments: OA: absent A/F for 10 sec. with persistent thoracoabd movement OH: decrease in A/F by >=20% lasting 10 second with either an arousal or a fall in oxy sat of >1% OSA="obstructive index" of >=5/hr OR review of audiovisual data for 30 or more events of increased accessory muscle use followed by gasping, stridor, or choking, or loud interrupted snoring, paradoxical breathing, jaw and/or sterna retractions –5 kids were diagnosed with these alternative criteria	Comprehensive PSG 1. Central EEG (# of leads not specified) 2. Occipital EEG 3. ROC-A1 4. LOC-A2 5. Submental EMG 6. EKG 7. Nasal-oral airflow thermistor 8. Thoracic belt 9. Abdominal belt 10. Inductance plethysmography 11. Pulse oximeter PSG duration = Not specified Timing of PSG: Nocturnal	1. Witnessed apnea is an indication for PSG since sleep apnea is highly prevalent in children with witnessed apneas; 2. Absence of witnessed apneas, however, does not rule-out the need for PSG; 3. In children older than 8 y.o., obesity is a risk factor for OSA; 4. Children younger than 8 y.o. with OSA are not more obese than children without OSA on average; lack of obesity does not indicate that OSA is absent in this age group; 5. PSG is likely to show differences in arousal indices between children with OSA and those without; 6. SDB was equally prevalent in Caucasian, African-American and Latino children—race did not predispose children to OSA;
182	Morton (2001)	4	577 subjects who were part of a longerterm epidemiological study of SDB underwent overnight in-home cardiorespiratory monitoring. Children's sleep and health questionnaire, and Health and Sleep study questionnaire (for those >13yrs) were filled out, and information about medical history, family history, ethnicity, prior T&A were obtained. Results from overnight studies were analyzed to determine presence of any predictive data	Clinical series, observational study, case report Blinding absent	Eligible: 577 Completed study:577 % males:47	Cases: 10.8 +/-4.2 Wide spectrum	Longitudinal genetic epidemiological cohort study of SDB Self=selected groups Government funded	Portable studies (No comparison was made .these children did not have PSG done)	PSG criteria Home device testing…AHI≥5/hr + SDB	Yes (no sleep staqge scoring as no EEG..just behavioral and note taking..asleep or awake estimates) NA (cessation or reduction in airflow or impedance for 10 seconds with a >2.5% drop in oxygen saturation.)	Ambulatory (unattended) sleep study Duration not specfied Timing = Nocturnal	1) This study suggests that patients, particularly if black or obese, who have undergone T&A should continue to be followed for symptoms of SDB and consider f/u PSG 2) I agree that this is a reasonable epidemiologic study to support post-op followup but not necessarily postop PSG in all patients
180	Redline (1999)	3	This study examined risk factors for SDB in children; specifically quantifying risk associated with obesity, race, and upper and lower respiratory tract problems. Children were recruited from participants in the larger Cleveland Family Study, a genetic-epidemiologic study of sleep apnea. Children were classified as being from an index family if one family member had PSG-confirmed OSA and controls were recruited from a random sample (not specified how they did that or who was chosen) of names of friends and neighbors provided by the index family. There were 31 index families and 30 control families. From the 31 index families, 273 children participated in the present study; from the 30 control families 126 control children participated Children with AHI>10 classified as SDB. Children with AHIS-10 not included in analysis in which SDB was the outcome variable (n=35). This study was designed to assess risk factors for pediatric SDB using a genetic-epidemiological study	Prospectice cohort Blinding not specified	Eligible: unknown; these data are of subjects participating in a larger study Completed study: 273 children from index families % males: 49% # controls: 126 children from control families % males: 47%	Cases: 11.1±4.3 yrs (range 2-18yrs) Controls: 10.7±3.9yrs (range 2-18yrs) Wide spectrum	Community referral Self-selected groups cases were children from index families (1 member with PSG-confirmed OSA); controls from neighbors/friends of the index family Government funded	Not specified	PSG criteria Other diagnostic criteria developed by authors	NA / Yes. Adult definitions were used (10 seconds) and AHI > 5 Comments: Respiratory scoring parameters developed by the authors which may limit comparison with other studies	Unattended ambulatory sleep study comprised of airflow, chest wall, pulse oximetry, and heart rate (edentrace I and II) Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG:Nocturnal	In this community based study, the findings are supportive of obesity, African American race, and upper- and lower-respiratory tract conditions being independent risk factors for SDB in children based on ambulatory sleep studies for defining SDB. Findings do not support a role for sex as a risk for SDB in children
46	Rosen (1999)	4	This appears to be a retrospective descriptive cohort, which catalogs and describes clinical questionnaire and PSG data from the records of 326 children, who had been referred to an academic sleep disorders lab by primary care or ENT, for clinical concerns of obstructive sleep apnea. Cases involving more complex disease (craniofacial abnormalities, genetic disorders, prior surgery, neuromuscular disease, prior upper airway surgery) were excluded, narrowing the spectrum of disease. The investigators decided to exclude a single Asian patient from analysis. The remaining 326 patients were roughly evenly devided between African American (38%), Caucasian (30%) and Hispanic (31%). The polysomnographic data was used to classify patients into five "levels" of sleep disordered breathing 1. No snore (no snoring, apnea, desaturation, or hypoventilation) 2. Snore (snoring without apnea, desaturation or hypoventilation) 3. UARS (snoring with marked paradoxical inward chest movements or repetitive arousals and movements) 4. OSA (snoring with apnea and/or hypercapnia, without desaturation) 5. Hypoxemia with OSA (snoring with desaturation and apnea, with or without hypercapnia) The clinical survey data and PSG characteristics of patients were then analyzed and reported.	Case control study Blinding absent	Eligible: 326 Completed study: % males: 56%	Cases: 5.8 +/-3.0 (range 1-12 yrs) Narrow spectrum	Academic center: Yale-New Haven Expert assigned or selected groups Government funded	Parental observations	PSG criteria	Yes. Obstructive apneas were quantified, but hypopneas were not. A single method of airflow was used, which was not specified ("thermistor). End-Tidal CO2 was used to determine obstructive hypoventilation. Criteria which allowed a patient to classify as having OSA were the presence of one or more of the following deviations: 1. obstructive apnea index was >1/hr 2. 4% desaturation index of >1.5/hr, or SaO2 nadir less than 92% 3. EtCO2 value >50 for over 9% of the TST, or peak EtCO2 value of 55mmHg or more	Comprehensive PSG, including End-Tidal CO2 tracing. The method of airflow assessment was not detailed, sounds to be a thermistor ("nasal-oral airflow"). A nasal pressure transducer was not apparently part of the montage. PSG duration = "overnight" Timing of PSG: Nocturnal	Neither clinical questionnaire data nor the presence of obesity can reliably predict PSG diagnosis of OSAHS (as defined by these investigators) in pediatric patients who have been referred to PSG for complaints of snoring and disturbed sleep. Though the descriptions of the PSG characteristics of their diagnostic categories are interesting, these descriptions inherently manifest a sort of circular logic; it remains to be seen whether these distinctions (ie: snoring vs UARS vs OSA) in a population of snoring, sleep disturbed children (by history) have any bearing on clinical outcomes (ie: reduction in symptoms post tonsillectomy). The fact that 10% of the cohort was classified as essentially normal ("no snore") despite the fact that 99% of the patients were classified by parental assessment as "habitual snorers" may reflect an important degree of night-to-night variation. 3-4+ tonsillomegaly increased the likelihood of discovery of frank OSA (as described by these investigators) in pediatric patients with snoring and subjective sleep complaints.This suggests face-validity of PSG for demonstration of more significant degrees of sleep disordered breathing, given the accepted causal relationship of adenotonsillar hypertrophy in the pathogenesis of pediatric OSA.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.2.4 Family History of SRBD												
180	Redline (1999)	3	This study examined risk factors for SDB in children; specifically quantifying risk associated with obesity, race, and upper and lower respiratory tract problems. Children were recruited from participants in the larger Cleveland Family Study, a genetic-epidemiologic study of sleep apnea. Children were classified as being from an index family if one family member had PSG-confirmed OSA and controls were recruited from a random sample (not specified how they did that or who was chosen) of names of friends and neighbors provided by the index family. There were 31 index families and 30 control families. From the 31 index families, 273 children participated in the present study; from the 30 control families 126 control children participated Children with AHI>10 classified as SDB. Children with AHI5-10 not included in analysis in which SDB was the outcome variable (n=35). This study was designed to assess risk factors for pediatric SDB using a genetic-epidemiological study	Prospectice cohort Blinding not specified	Eligible: unknown; these data are of subjects participating in a larger study Completed study: 273 children from index families % males: 49% # controls: 126 children from control families % males: 47%	Cases: 11.1±4.3 yrs (range 2-18yrs) Controls: 10.7±3.9yrs (range 2-18yrs) Wide spectrum	Community referral Self-selected groups cases were children from index families (1 member with PSG-confirmed OSA); controls from neighbors/friends of the index family Government funded	Not specified	PSG criteria Other diagnostic criteria developed by authors	NA / Yes. Adult definitions were used (10 seconds) and AHI > 5 Comments: Respiratory scoring parameters developed by the authors which may limit comparison with other studies	Unattended ambulatory sleep study comprised of airflow, chest wall, pulse oximetry, and heart rate (edentrace I and II) Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG:Nocturnal	In this community based study, the findings are supportive of obesity, African American race, and upper- and lower-respiratory tract conditions being independent risk factors for SDB in children based on ambulatory sleep studies for defining SDB. Findings do not support a role for sex as a risk for SDB in children
191	Ovchinsky (2002)	4	600 nap PSGs were retrospectively reviewed, and 497 children were identified as having OSA. OSA was defined as "respiratory disturbance index score of 5 or greater or the presence of moderate or severe desaturations during sleep (SaO2 <92%)." Of these 497 children, the investigators were able to locate a caretaker of 200 of them. Of these, 115 agreed to be enrolled in the study. Caretakers of these 115 patients were then interviewed regarding symptoms in first-degree relatives of children. Symptoms included snoring, gasping, witnessed apnea, restless sleep, and daytime impairment symptoms of sleepiness and fatigue. Data obtained during the interviews are presented.	Clinical series, observational study, case report Blinding not specified	Eligible: 200 Completed study: 115 % males: 77% No controls	Cases: mean = 75 months (range 7-217 months) Narrow spectrum	Academic center Strategy not specified Funding not specified	Not specified	PSG criteria	No / No	Not specified PSG duration = not specified ("nap polysomnogram") Daytime naps	1. Nap studies may effectively identify OSA in children, though comments regarding the sensitivity/specificity with respect to overnight PSG cannot be made 2. A family history of OSA may suggest a higher pre-test probability of disease, though further studies would be needed to make this conclusion.
4.2.2.5 Allergic Rhinitis or Recurrent Sinusitis												
180	Redline (1999)	3	This study examined risk factors for SDB in children; specifically quantifying risk associated with obesity, race, and upper and lower respiratory tract problems. Children were recruited from participants in the larger Cleveland Family Study, a genetic-epidemiologic study of sleep apnea. Children were classified as being from an index family if one family member had PSG-confirmed OSA and controls were recruited from a random sample (not specified how they did that or who was chosen) of names of friends and neighbors provided by the index family. There were 31 index families and 30 control families. From the 31 index families, 273 children participated in the present study; from the 30 control families 126 control children participated Children with AHI>10 classified as SDB. Children with AHI5-10 not included in analysis in which SDB was the outcome variable (n=35). This study was designed to assess risk factors for pediatric SDB using a genetic-epidemiological study	Prospectice cohort Blinding not specified	Eligible: unknown; these data are of subjects participating in a larger study Completed study: 273 children from index families % males: 49% # controls: 126 children from control families % males: 47%	Cases: 11.1±4.3 yrs (range 2-18yrs) Controls: 10.7±3.9yrs (range 2-18yrs) Wide spectrum	Community referral Self-selected groups cases were children from index families (1 member with PSG-confirmed OSA); controls from neighbors/friends of the index family Government funded	Not specified	PSG criteria Other diagnostic criteria developed by authors	NA / Yes. Adult definitions were used (10 seconds) and AHI > 5 Comments: Respiratory scoring parameters developed by the authors which may limit comparison with other studies	Unattended ambulatory sleep study comprised of airflow, chest wall, pulse oximetry, and heart rate (edentrace I and II) Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG:Nocturnal	In this community based study, the findings are supportive of obesity, African American race, and upper- and lower-respiratory tract conditions being independent risk factors for SDB in children based on ambulatory sleep studies for defining SDB. Findings do not support a role for sex as a risk for SDB in children
182	Morton (2001)	4	577 subjects who were part of a longerterm epidemiological study of SDB underwent overnight in-home cardiorespiratory monitoring. Children's sleep and health questionnaire, and Health and Sleep study questionnaire (for those >13yrs) were filled out, and information about medical history, family history, ethnicity, prior T&A were obtained. Results from overnight studies were analyzed to determine presence of any predictive data	Clinical series, observational study, case report Blinding absent	Eligible: 577 Completed study:577 % males:47	Cases: 10.8 +/-4.2 Wide spectrum	Longitudinal genetic epidemiological cohort study of SDB Self=selected groups Government funded	Portable studies (No comparison was made .these children did not have PSG done)	PSG criteria Home device testing…AHI≥5/hr + SDB	Yes (no sleep staqge scoring as no EEG..just behavioral and note taking..asleep or awake estimates) NA (cessation or reduction in airflow or impedance for 10 seconds with a >2.5% drop in oxygen saturation.)	Ambulatory (unattended) sleep study Duration not specfied Timing = Nocturnal	1) This study suggests that patients, particularly if black or obese, who have undergone T&A should continue to be followed for symptoms of SDB and consider f/u PSG 2) I agree that this is a reasonable epidemiologic study to support post-op followup but not necessarily postop PSG in all patients
192	McColley (1997)	4	To determine whether young children with habitual snoring have a high prevalence of allergic sensitization and whether allergy predicts presence or severity of OSA. Children presenting at sleep clinic were enrolled and underwent RAST testing as well as PSG. Groups defined as allergic (n=14) or non-allergic (n=25) based on RAST testing.	Prospective cohort Blinded study	Eligible: 156 Completed study: 39 % males: 24/39=61.5% No controls	Cases: 4.7±1.8 yrs (range 1-7 yrs) Wide spectrum	Academic center Self-selected groups Privately funded (Non-pharma)	Not specified	PSG criterai Other diagnostic criteria developed by authors	No / Yes	Comprehensive PSG PSG duration = 330±55 mins for allergic children 363±40 mins for non-allergic children Timing = Nocturnal	Findings supportive of children presenting for evaluation of snoring and who have allergies being more likely to have OSA than those who don't have allergies
4.2.2.6 Systemic Hypertension												
98	Bixler (2008)	2	This community based study aimed to determine the association between SDB and clinically relevant changes in BP in young children. Since the current PSG criteria for SDB are not based on clinically relevant outcomes, the study assessed varying thresholds for SDB. This was part of a larger study on children's sleep and behavior.	Prospective cohort study Blinding unclear	Overall: Eligible:1000 (200 per year for 5 yrs) Completed study: 700 % males: 48% For those with SDB: N= 183 % males = approx 45% but table 1 doesn't appear to add up correctly # controls: (no SDB) n=517 % males:49%	Cases: 112 ±20 months for mild SDB and 121 ±18 months for moderate SDB Controls: 111±months Age range for all children was kinder-garten through grade 5 Wide spectrum	Community referral Random selection Government funded	Not specified	PSG criteria Other diagnostic criteria developed by authors	Yes (R&K cited) / Yes	Comprehensive PSG PSG duration = 9hrs (no means presented so TST unknown) Timing = Nocturnal	In general, findings supportive of SDB being an independent predictor of increased BP Findings supportive of a threshold of AHI>5 for significant increases in BP in a community sample of young children Findings suggestive of AHI>3 perhaps being relevant for BP changes Finding do not support AI>1 being useful in detecting elevated BP AHI > 5 was an independent risk factor for elevated SBP (2.9 mm Hg in AHI > 1, 7.1 mm AHI > 3, and 12.9 mm Hg with AHI > 5). AHI during NREM sleep (but not REM sleep) was significantly associated with elevated BP, especially SBP and mean arterial BP
99	Enright (2003)	2	To describe associations between objectively defined SDB and BP in a community cohort of preadolescent children (6-11yrs) in the TuCASA study. Results presented with several definitions of RDI with and without differing levels of desaturation	Prospective cohort Blinded study	Eligible: unknown Completed study: 239 % males: 55% # controls: n/a	Cases: 8.70 yrs (5th-95th centile was 6.15-11.24yrs) Controls: n/a Wide spectrum	Community referral Self-selected groups Government and privately funded	Not specified	PSG critera Other diagnostic criteria developed by authors	Yes (Referenced R&K) / Yes	Ambulatory (unattended) sleep study PSG duration = 8.15 hrs 5th-95th centile was 5.3-9.93hrs Timing = Nocturnal	Supportive of SDB being independently predictive of hypertension in children in the presence of oxygen desaturation HTN (determined by measuring BP awake sitting within one hour before bedtime for home PSG) found in 6.2% of the first 239 children enrolled. AHI was independently associated with >90th percentile BP in a community sample of White and Hispanic children. Obesity, sleep efficiency and RDI were associated with an increase in BP in these preadolescent children.
101	Li (2008)	3	This study was designed to evaluate the relationship between OSA and blood pressure in a community based group of pediatric patients. A total of 466 subjects were recruited from 13 randomly selected schools. Subjects completed a validated 54 item sleep questionnaire and underwent polysomnography and ambulatory BP monitoring. 118 of the 466 subjects were classified by PSG to have "primary snoring" and were excluded. Another 42 subjects were excluded because the data obtained from BP monitoring was not usable. 306 subjects were included in the final analysis. These were subdivided into three groups: no OSA (AHI<1, n=127), mild to moderate OSA (1<AHI<5, n=127), and moderate to severe OSA (AHI>5, n=46). The polysommographic features are compared and BP readings are compared.	Prospective cohort study Blinding not specified	Eligible: 466 Completed study: 306 Cases (mild OSA defined as 1<AHI<5): 133 Males: 69% Cases: (moderate to severe OSA defined as AHI>5): 46 % males: 76% # controls (AHI<1): 127 % males: 57 %	Cases (mild OSA defined as 1<AHI<5): 10.6 (SD=1.6) Cases: (moderate to severe OSA defined as AHI>5):10.1 y (SD=1.6) Controls:10.4 y (SD=1.6) Narrow spectrum	Community referral Self-selected groups Government funded	Ambulatory BP, OSA screening questionnaire	PSG criteria	No / Yes	Comprehensive PSG (includes thermistor, EtCO2 monitor, but no nasal pressure transducer recording) PSG duration not stated Timing not specified	Convergent validity of PSG-determined AHI is demonstrated by the correlation between AHI and blood pressure in children, independent of obesity.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
102	Redline (2007)	2	Study sample derived from ongoing longitudinal community cohort. The present study evaluates adolescents at 13-16 yrs for SDB (AHI≥5), BP, metabolic syndrome. Metabolic syndrome definition based on adapted adult criteria for the pediatric population	Prospective cohort study Blinding not specified	Eligible: 389 total Completed study: 270 (22 found to have SDB) % males: 140/2070=52% overall and 17/22=77% for only SDB # controls: 248 of the 389 were found not to have SDB % males: 123/248=50%	Cases: 13.4±0.5 yr Controls: 13.6±0.7 yr Range for both group 13-16 yrs Wide spectrum	Community referral Self-selected groups Government funded	Sleep diary	PSG criteria Other diagnostic criteria developed by authors	Yes (by citation to ASDA and R&K) / Yes	Comprehensive PSG PSG duration not specified Nocturnal	These cross-sectional findings are supportive of a role for SDB in pediatric (adolescent) metabolic syndrome and indices associated with metabolic syndrome Supportive of certain PSG parameters being associated with metabolic dysfunction (eg O2 desats) since no association between report of habitual snoring and metabolic dysfunction
32	Reade (2004)	3	Records from 130 pediatric patients were reviewed. Excluded those with renal failure, transplantation, mental retardation, NMD, DM, chronic lung disease, congenital heart disease, sickle cell, or antihypertensive therapy, left 90 patients. Patients had originally been referred by their primary physicians for a polysomnogram for various reasons. Patients with medical comorbidities were excluded. 90 patients were included in the study. Polysomnographic data is reviewed, and is correlated with presence of obesity and hypertension.	Clinical series, observational study, case reports Blinding not specified	Eligible:90 Completed study: 90 % males:64%	Cases: 10.7 yrs range 4.2-18.8 Controls: None Narrow spectrum	Community referral Referred by PCP for sleep study because of their clinical presentation" Expert assigned or selected groups Funding not specified	Hypertension	PSG criteria: Hypopnea defined as a 20-50% reduction in airflow with a minimum duration of 10 and associated with a desaturation of 3% or greater or a 3 sec EEG arousal.	Yes	Comprehensive PSG Oronasal airflow, etC02, PSG duration = "overnight" Timing of PSG: Nocturnal	In obese pediatric patients, the hypopnea index and arousal index are physiologically significant predictors of cardiovascular risk posed by obstructive sleep apnea. Obesity and hypertension in pediatric patients should prompt a careful evaluation for sleep disorders. Obesity is a risk factor for OSA especially in older children; hypertension in a child warrants consideration of obstructed SDB. Only elevated hypopnea index was a predictor of diastolic hypertension in children with SDB.
193	Amin (2008)	3	Designed to test the hypothesis that morning BP surge, BP load, and diurnal and nocturnal BP are higher in children with SDB than controls. Also to determine the level of SDB severity in children with specific BP measures differ from controls and how these measures relate to ventricular remodeling. Children underwent PSG, 24-hr ambulatory BP, actigraphy to assess physical activity, and echocardiography	Case control study Blinded study	Eligible: 140 (incl controls) Completed study: 134 (incl controls) % males: not stated although 64% of mild SDB were male and 53% of severe SDB were male # controls: Included in aggregate figures above % males: see above	Cases: 9.6±2.1yrs for mild SDB and 9.8±2.3yrs for severe SDB Age range 7-13yrs Controls: 10.2±2.1 yrs Age range 7-13yrs Narrow spectrum	Not specified Expert assigned or selected groups Government funded	Not specified	PSG criteria	No / Yes: cited ATS	Comprehensive PSG PSG duration = 398.7±43.4 mins for mild SDB 387.5±76.9 mins for severe SDB 394.6±55.1 mins for controls Timing of PSG: Nocturnal	Supportive of increase in BP and ventricular remodeling with increasing severity of SDB and that these alterations may start to occur at levels of SDB currently believed to be mild. Supportive of PSG as a method of identifying children who may be at higher risk of developing cardiovascular problems
4.2.2.8.1.1 Down Syndrome												
49	Shott (2006)	4	To investigate the incidence of OSA in children with Down Syndrome. Children followed prospectively in a longitudinal study from the age of 2 through 5 years although only baseline PSG results reported in this manuscript. Authors also investigated ability of parents to identify sleep problems	Prospective cohort Blinding not specified	Eligible: 65 enrolled (unclear how many were eligible to enroll) Completed study: 56/65=86% % males: not reported # controls: n/a	Cases: 42 months (range 20-63 months) Controls: n/a Wide spectrum	Academic center Self-selected groups Privately funded (non-pharmaceutical)	Parental observations	PSG criteria and other criteria developed by authors	Yes / Yes Nasal pressure used for airflow	Comprehensive PSG PSG duration = not reported Timing of PSG:Nocturnal	"- findings suggest that parents of children with Down syndrome underestimate the presence of sleep problems (respiratory) - findings suggest that OSA is common in children with Down syndrome - Findings support routine use of PSG in children with Down syndrome (at least in age range tested: 3-4 years)
165	Marcus (1991)	4	53 children with Down syndrome were studied: 17 (32%) referred by physicians for suspected OSA, the rest (presumably) recruited from Down Syndrome parent group. 19 (39%) had OSA suspected by parents but is in unclear whether this overlaps with the physician referred group. All patients underwent nap PSG, many of which required sedation. 16 had both nap test and overnight PSG The 16 patients who had both studies did not differ with regard to age, sex, or clinical suspicion of OSA; none had cardiac disease 13/16 (81%) were sedated for nap, none for overnight Of note, 44% of patients had minor or corrected congenital heart disease and 40% were obese This study was done to compare 1 hour daytime nap polysomnography with overnight PSG with respect to diagnosing sleep disordered breathing No BlindingThis study looked at 53 children with Down's syndrome to attempt to determine nature and severity of OSA in this population (obese, non-obese and with and without congenital heart disease)	Prospective cohort Blinding absent	Eligible: 53 Completed study: 53 (all with nap PSG, 16 with additional overnight PSG) % males: 60 # controls: 8 % males: not mentioned	Cases:7.4+/- 1.2 years (2 weeks – 51 yrs) Controls: 9.2 +/- 1.7 (range 1.3-15.3 y) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Also self selected (Down Syndrome Parent Group) Privately funded (non-pharmaceutical)	Abbreviated studies (nap studies)	PSG criteria	No - no EEG / Yes - No hypopneas reported OA only 2 breath duration, no desat or arousal criteria Hypoventilation >45 mmHg	All patients had 1-2 hour nap studies, and some had chloral hydrate sedation – it is not clear how many of the total 53 required sedation; of the patients who also had PSGs, 80% (13/16) required sedation Limited sleep study (describe parameters) PSG duration = nap test 1-^ hours/ Daytime naps and night-time naps reported also	1) In Patients's with Down syndrome, overnight polysomnography should be considered to diagnose obstructive sleep apnea. Nap studies do not appear to be as sensitive. 2) Gender, weight, presence of heart disease and clinical suspicion do not appear to be adequate to predict those patients with OSA; All overnight PSG studies were abnormal. But in 68% of the children there was no clinical suspicion for any type of SDB. Makes a strong case for the clinical utility of PSG in Downs kids as perhaps part of their general health care. No specific feature of Downs (age, weight, CHD) affected incidence or severity of OSA. Makes it more difficult to screen who should get a PSG vs everyone.
194	Dyken (2003)	4	19 patients consecutively seen in a Down's syndrome clinic underwent overnight PSG to evaluate for OSA and efficacy of therapy for OSA	Clinical series, observation Blinding absent; To look at incidence of OSA in children with Down syndrome by using overnight PSG, and determine effects of therapy	Eligible: 21 Completed study: 19 % males: 47	Cases:9.1 +/- 4.7 Controls: N/A Wide spectrum	Academic Center and Consecutively encountered patients seen in Down syndrome clinic	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Overnight, time not specified Nocturnal	In this small unblinded clinical series of consecutive patients with Down syndrome, Findings suggest that PSG could be recommended in all Down syndrome patients given high incidence of OSA Repeat PSG would be warranted if symptoms persist or worsen. Given small sample size, the optimal age for studying Down syndrome patients is not clear.
195	Levanon (1999)	4	To describe sleep characteristics in children with Down syndrome (DS) compared to controls and to investigate associations between respiratory disturbances and sleep architecture. Note that controls were essentially primary snorers	Clinical series, prospective cohort / not specified; To describe sleep characteristics and respiratory parameters in children with Down Syndrome	Eligible: 30 Down syndrome; unknown controls Completed study: 23 Down syndrome % males: 14/23 = 61% # controls: 13 children with symptoms of SDB and no OSA on PSG % males: 9/13 = 69%	Cases: 4.8yrs (range 1.7-8.0yrs) Controls: 5.1yrs (range 2.7-7.1yrs) Wide spectrum for DS children; Narrow spectrum for controls	Academic center and community referral Self-selected groups Non-US funding agency	Not specified	PSG criteria and other criteria developed by authors	Yes / Yes	Comprehensive PSG Partial PSG (no EEG) used in (12/23) some children when comprehensive PSG could not be obtained because of non-cooperation PSG duration = 6.35+/-0.28 hrs for Down syndrome children and 6.43+/-0.19hrs for controls Timing of PSG: Nocturnal	-DS children have increased sleep fragmentation compared to children with primary snoring controls - Findings support role of PSG in characterization of sleep architecture in children with DS -Recording technique insufficient to fully characterize respiratory patterns during sleep in DS children Sleep technologist expertise is crucial in obtaining sufficient PSG data in children with DS
196	Mitchell (2003)	4	Chart review of 29 pts with down syndrome referred for ENT evaluation; looked at demographics, primary and secondary ENT diagnoses, and morbidities of surgical interventions	Clinical series, observational study, case reports Blinding absent; This study was a retrospective review to determine the reasons for which children with Down syndrome were referred to a pediatric ENT practice	Eligible: 29 Completed study: 23 referred for upper airway obstruction; 11/23 had OSA % males: 58 (for entire 29 patients, otherwise not broken down)	Cases: For OSA 2.9 yrs (3 mo-10 Y); entire group age range 1 day to 10 yrs, individual ages not reported to determine mean Controls: None Narrow spectrum	Academic center Expert assigned or selected groups Not specified	Not specified	PSG criteria	Yes with mistake: just stated that RDI of (LESS THAN -MUST HAVE BEEN A TYPO) 1 was considered OSA	Type not specified Stated only full night polysomnogram, parameters not reported PSG duration = not reported Timing of PSG:Nocturnal	Limited data: It appears that only half of the patients referred for upper airway obstruction had diagnosed OSA by PSG, therefore reinforcing the concept that clinical judgement alone is not sufficient to make the diagnosis.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.2.8.1.2 Prader-Willi Syndrome												
43	Pavone (2006)	4	From 54 patients with proven prader willi syndrome who underwent all night PSG, 5 patients were selected for inclusion in this observational study. Inclusion criteria were: age 1-18 yrs, no prior adenotonsillectomy, presence of pathologic adenotonsillar hypertrophy, and presence of moderate to severe OSA on PSG. 5 patients fulfilled these criteria. These patients all underwent T&A, and their pre and post-surgical PSGs are discussed, along with the presence of postoperative complications.	Clinical series, observational study, case reports Blinding not specified	Eligible:5 Completed study: 5 % males: not stated Culled 5 PWS patients from a clinic of 54, all 5 had ATH + moderate to severe OSA 2/5 were obese	Cases: mean age 4.4 years (large range: 1.6-14.2 years) Controls: None Narrow spectrum	Academic center Expert assigned or selected groups 54 patients dx with PWS followed in the Endocrinology Unit of Bambino Gesu Children's Hospital Rome part of an ongoing study. These had ATH, and had OSA on their limited cardiorespiratory study. Funding source not specified	Not specified	PSG criteria	Yes / Yes	Limited sleep study (describe parameters), thermistor was the airflow measurement (no nasal pressure transducer tracing). End-Tidal CO2 was included in the montage. Not comprehensive PSG but 7-channel recorder measured HR, pulse waveforms, SaO2, RIP (including sum), added thermistor, and recorded video; also recorded etCO2. Device: SomnoStar PT2 (Sensor Medics Corp) They calculated TST based on regularity of cardiorespiratory signals, behavioral observations and video. PSG duration = all night (performed at the usual bedtime) Timing of PSG: Nocturnal	Polysomnography shows face validity in PWS patients with adenotonsillar hypertophy, with improvement of PSG findings following T&A. Polysomnography does not add value to preoperative risk assessment in PWS patients undergoing T&A for OSA in the presence of adenotonsillar hypertrophy. Four of 5 patients had at least one post-operative complication, these patients should stay overnight in hospital after T+A The typical sleep disordered breathing in PWS more central hypoventilation, made worse by obesity, a few will have adenotonsillar hypertrophy, then have a superimposed obstructive component, remove tonsils, but hospitalize overnight because of complications.
149	Miller (2006)	4	25 patients with PWS (17 with del'n of chr 15q11-13 and 8 with maternal uniparental disomy of chr. 15) agreed to stop GH or were naïve to GH therapy. They underwent PSG off GH, then 6 weeks after starting. PSG was repeted in 2 patients 6 months after GH was instituted This study was done to determine if growth hormone therapy in patients with Prader Willi Syndrome effects sleep disordered breathing	Clinical series Blinding absent	Eligible: 25 Completed study: 25 % males: 60	Cases: 6 months to 39 years Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Not specified	PSG criteria	Yes / Yes but no definition of OSA	Comprehensive PSG Duration not specified Timing not specified, presumably nocturnal	1) Pts with PWS seem to have a high incidence of SDB; PSG should be considered prior to starting GH and within several months after starting, especially in patients susceptible to URIs and with adenotonsillar hypertrophy 2) The administration of GH appears to change respiratory patterns in subjects with PWS on GH and suggest they undergo surveillance or follow-up PSG if they are taking GH
197	Festen (2006)	3	Original study was a randomized controlled clinical trial of 6 months of GH Rx in prepubertal PWS children on growth, body composition, activity level, and psychosocial development. After start of study, a PSG was added so this is an analysis of a sub-group of the entire study. GH was dosed initially at 0.5 mg/m2-d for one month and then 1.0 mg/ m2-d for the rest of the study OSA and CSA	Case control	Eligible: 53had initial PSG (57% male) Completed study: 35 (57% male) 39 (59% male) had second PSG but 4 had to be excluded because of concurrent URTI	Cases: 5.4 (2.1-7.2) Of the 35 who completed the study: 6.0 (2.4-8.6) at start of study Controls: none Wide spectrum All PWS without selection of those with resp sxs	Recruitment source not specified Random selection Pharmaceutical or equip	PSG's were performed before and after c. 6 months of Growth Hormone Rx	PSG criteria	Yes; R&K / Yes Comments: Apnea=decrease in A/F of > 90% for >=3 breaths; Hypopnea=decrease in A/F of >50% with a fall in oxy sat of >=4% for >=3 breaths; AHI>1/hr was considered ABNORMAL; OAI>1 was definition of OSA; Both central and obstructive events were noted	Comprehensive PSG 1. EEG 2. EOG 3. Submental EMG 4. EKG 5. RAT 6. LAT 7. Nasal pressure prong 8. Thoracic strain gauge 9. Abdominal strain gauge 10. Pulse oximeter Note, no CO2 data Nocturnal	1. PSG is likely indicated in children with Prader-Willi syndrome who are obese (BMI + 2SDS) as the prevalence of OSA in this study was high in obese PWS subjects (50%) although the number who were obese was small (8); 2. PSG may be indicated in children with Prader-Willi syndrome who are non-obese as the prevalence of OSA, although much smaller, was still 9% (n=45); 3. PSG is unlikely to change significantly in those children with PWS given growth hormone if there are no other clinical changes (e.g., no change in tonsil/adenoid size)
198	Festen (2008)	4	To determine association between sleep and behavior in children with PWS. This was part of a larger study on the effect of growth hormone on body composition, activity level and psychosocial development. Children underwent Wechsler scale subtests and parental report of behavior	Prospective cohort study Blinded study since PSGs scored independently by 2 raters	Eligible: unknown Completed study: 31 % males: 14/31=45% # controls:none	Cases: 6.4 yrs (IQR 6.0-9.1 yr) Controls: n/a Wide spectrum	Academic center and community referral Self-selected groups Pfizer (but study performed outside the US) Pharmaceutical or equipment company	Not specified	PSG criteria	Yes R&K cited Yes	Comprehensive PSG PSG duration = not specified Timing of PSG:Nocturnal	Findings supportive of sleep efficiency being associated with better performance in PWS children Findings not supportive of a role for SDB in worse behavior/cognition in children with PWS
199	Festen (2007)	4	This study was part of a larger RCT to investigate the effect of growth hormone on sleep-related breathing disorders and psychomotor development (among other things) in children with PWS. Later in the protocol PSGs were added; this current study looked at the association between psychomotor development and sleep-related breathing disorders in children with PWS.	Prospective cohort study Blinding not specified	Eligible: unknown Completed study: 22 % males: 15/22 = 68% No controls	Cases: MEDIAN age was 1.8 yrs (IQR 1.1-3.4yr) Wide spectrum	infants recruited were part of an ongoing RCT growth hormone trial and PSGs were added to the protocol. Appears that multiple centers were involved in recruitment Self-selected groups Pharmaceutical or equipment company (Larger growth hormone trial sponsored by Pfizer)	Behavioral scales	Other diagnostic criteria devleoped by authors (Although respiratory scoring was clearly defined, the authors used a 3-breath criteria for apnea/hypopnea rather than the usual 2-breath method.)	Yes (R&K) Yes (AHI>1; no CO2 analysis)	Comprehensive PSG PSG duration = not stated; infants were admitted to the sleep lab at 17:00hrs to undergo overnight PSG but no further details provided Timing = Nocturnal	"- Findings support that infants with PWS frequently have sleep-related breathing problems - Findings support PWS as a risk for OSA in infancy - Findings have some limited support for association between OSA and impaired mental development in PWS..the four subjects that had OSA were older (it is easier to evaluate cognitive function/developmental level in older children and the mean age of of the OSA group was 2.5 years versus only 1.6 years) Conclusions need to be tentative and mild given the small number
200	Lin (2007)	4	30 patients with known Prader Willi Syndrome (80% with deletion, 17% with uniparental disomy, 3% with probably imprinting center deletion or defect) but no sleep complaints were recruited from three city hospitals. None had had T&A , craniofacial surgery or had received growth hormone. They all underwent overnight comprehensive PSG.	Clinical series, observational study, case reports Blinding not specified	Eligible: 30 Completed study:30 % males:53	Cases: 7.4 +/-4.1 (1-19) yrs Narrow spectrum	Academic center Expert assigned or selected groups Government funded: Mackay Memorial Hospital in Tapei	Not specified	PSG criteria	Yes (R&K rules) / Not applicable	Comprehensive PSG PSG duration = not specified; TST was mean 381 minutes Timing of PSG:Nocturnal	Patients with PWS, even in the absence of sleep complaints, would benefit from PSG due to the high prevalence of sleep disordered breathing demonstrated in this unselected sample.
201	Williams (2008)	4	This study was designed to review PSGs of children with PWS, some of whom were treated with growth hormone. The investigators wanted to determine the prevalence of SDB and the relationship between SDB, daytime sleepiness, and BMI. The following were assessed: PSG, MSLT, Epworth Sleepiness score, FISH testing, any growth hormone prescription	Clinical series, observational study, case reports Blinding absent	Eligible: 37 Completed study: 37 % males: 57 # controls: none % males: n/a	Cases: 9.1±5.8yrs (range 15 months – 24 yrs) Controls: n/a Wide spectrum	Academic center and community referrals Self-selected groups Funding not specified	Not specified	PSG criteria	Yes (referenced R&K) Yes	Multiple PSG types, specify: Comprehensive PSG MSLT PSG duration = 408±142 minutes Timing of PSG: Nocturnal	Findings supportive of the presence of SDB in children with PWS Findings support other work demonstrating no association between PSG parameters (eg AHI) and sleepiness measured either by Epworth or MSLT Findings did not identify markers (eg BMI, questionnaire results, growth hormone, type of genetic abnormality) that could predict SDB Findings support use of PSG in patients with PWS given the high frequency of SDB found
4.2.2.8.1.3 Rett Syndrome												
202	Marcus (1994)	4	Thirty girls with Rett syndrome were studied with overnight PSG to determine sleep architecture and sleep related breathing abnormalities. They were compared with 30 controls who were retrospectively chosen to be age matched and had been referred for PSG for suspicion of SDB but were normal, therefore diagnosed with primary snoring In addition, a questionnaire was administered to the last 17 subjects studied to determine symptoms regarding daytime as well as nighttime breathing disorders	Case control / Blinding absent; The paper looked at PSGs in children with Rett syndrome to clarify the nocturnal respiratory patterns and sleep architecture in these patients	Eligible: 30 Completed study:30 % males:0 # controls:30 (retrospectively age matched pts. With primary snoring) % males:0	Cases: median 7 (1-32 yrs) Controls: median 6 (1-17 years) Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Not specified	Diagnosis reached using PSG criteria	Yes / yes: Hypopneas not scored due to lack of standard definition	Comprehensive PSG PSG duration: not mentioned PSG timing: nocturnal	Unless there is a clinical concern for sleep disordered breathing, PSGs are not warranted in Rett syndrome patients. The hyperventilation followed by apnea appears to be a waking phenomenon, and basic respiratory control mechanisms as well as sleep architecture appear to be normal in pts. with Rett syndrome
4.2.2.8.2 Disorders with Craniofacial Anomalies												
143	Buchenau (2007)	2	This study used a randomized crossover design to evaluate the usefulness of an oral device (Pre-Epiglottic Baton plate) in 11 children with isolated Pierre Robin Sequence and upper airway obstruction on initial PSG. Half the group was assigned to the PEBP and half to a conventional palatal plate (only closes cleft, has no effect on opening hypopharynx), restudied, then crossed over to the other device and studied again. Infants received appliance for at least 36 hours before sleep study was done. Infants were up to 3 months of age, most of whom had been referred after prone positioning to sleep had failed.	Clinical series, observational study, case report Blinded study	Eligible: 11 Completed study:11 % males:27	Cases: 3 days (0-60) GA 39 weeks (36-41) Narrow spectrum	Academic center Expert assigned or selected Privately funded (non pharma) - German Foundation	Not specified	PSG criteria	No / Yes	Limited sleep study - No EEG was used; sleep determined by video and behavioral analysis PSG duration =at least 8 hours Timing: Nocturnal (began in the evening)	1) PSG is can be useful in determining the effectiveness of orthodontic treatment of upper airway obstruction in selected populations. 2) Test-retest validity of PSG is demonstrated in that AI improved in the expected direction when infants were using the appliance.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
73	Bravo (2005)	4	PSG and VNP were performed on 52 children with Pierre Robin sequence (PR) aged 1 month to 4 years of age. 31 PR patients had PSG diagnosed OSA and 21 PR subjects had normal breathing during sleep and were used as controls. The purpose of the study was to determine the sensitivity and specificity of VNP for the diagnosis of OSA in patients with PR, using PSG as the gold standard.	Clinical series Blinded study	Eligible: 52 (includes all PR subjects) Completed study: 31 PR subjects with OSA % males: 44 (for all subjects) # controls: 21 PR subjects with normal breathing during sleep % males: 44 (for all subjects)	Cases: median age of 1 yr 7 months (range 1 month-4 yrs) for all subjects with PR Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Videonasopharyngoscopy (VNP)	PSG criteria	Yes / Yes apneas and hypopneas "of any duration" were included. Index of 5 or more considered positive for OSA	Comprehensive PSG Overnight Nocturnal	1) In children with PR, VNP is a safe and reliable diagnostic indicator for the detection of OSA, using PSG as the diagnostic gold standard reference. 2) VNP showed high sensitivity, specificity, PPV and NPV in the detection of OSA in children with PR. 4) Recognized weaknesses of the study: 1) criteria used to assess severity of obstruction by VNP was a global assessment that is subjective, 2) the measurement scale has not been validated, and 3) there were a relatively small number of narrow spectrum cases used for the study.
136	Monasterio (2002)	4	15 patients with mandibular hypoplasia were evaluated to determine efficacy of mandibular lengthening procedure for respiratory distress/OSA. Patients were divided into four groups: 1) Four Pts with Pierre Robin sequence who had respiratory distress and required intubation. These patients did not have pre-op PSG 2) Four patients underwent tongue-lip adhesion procedure due to respiratory distress 3) Four older patients presenting with OSA due to Pierre Robin sequence who had failed T&As 4) Three cases with different malformations who had tracheostomies for respiratory obstruction This paper reports the efficacy of distraction osteogenesis (DOG) as a procedure in treating patients with obstructive sleep apnea on the basis of mandibular hypoplasia and retrolingual airway obstruction	Clinical series Blinding absent	Eligible: 15 Completed study: 15 % males: not mentioned # controls: 0	Cases: 3 yrs 2 months (range 1 month to 15 years) Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No discussion of how sleep was scored (or of what PSG parameters were even measured) / No apnea of more than 10 seconds and more than 5/hr for dx of sleep apnea	PSG type not specified Duration = 8 hours Timing not specified	This study suggests that PSG is helpful in evaluating the efficacy of surgical procedures for the treatment of OSA in a patient population with craniofacial abnormalities.
203	MacLean (2008)	4	Retrospective study designed to describe clinical characteristics and PSG results on children with cleft palate who underwent PSG in the sleep lab. Follow up studies included where PSG was performed.	Clinical series, observational study, case reports Blinding absent	Eligible: 62 Completed study: 62 % males: 33/62 = 53% # controls :none % males: n/a	Cases: 50.4 ± 52.8 months (range not reported) Controls: n/a Wide spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Nocturnal	Findings of more severe SDB prior to palate closure contradicts studies suggesting closure predisposes to SDB; methodology highly likely to explain this odd result (see limitations) Findings support in general that children with cleft and Pierre Robin sequence or other syndromes at higher risk for SDB but there are major limitations with this study. I do not think this study can be used to assess the risk of children with isolated cleft palates. They may have been underpowered in their comparison of subgroups of the population.
204	McNamara (1999)	4	24 infants with various diagnoses (FH of SIDS, ALTE, anatomic abnormalities including Pierre Robin, micrognathia, choanal atresia, laryngomalacia, other syndromes Beckwith Wiedemann, SLOS, Moebius) were diagnosed with OSA by PSG and then had repeat PSG with nCPAP titration. Additional f/u PSGs at 2–4 month intervals until age one, and then q 6 months were done to determine continued need for CPAP	Clinical series, observational study, case reports Blinding absent	Eligible: 24 Completed study: 24 % males: 62.5	Cases: 37.6 +/-.7 weeks (30-42 week) Wide spectrum	Community referral Expert assigned or selected groups Government funded	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 9-11 hrs Timing of PSG:Nocturnal	1) PSG can be used successfully in infants with a wide range of suspected etiologies for OSA, both diagnostically and therapeutically with nasal CPAP 2) Serial PSG is helpful in determining ongoing need for CPAP as well as retitrating pressures in this population.
205	Muntz (2008)	4	This retrospective chart review was conducted to investigate the incidence of SDB symptoms and PSG-confirmed SDB in children with a cleft. A secondary aim was to assess the outcome of surgical intervention. Multidisciplinary team discussed clinical findings and a PSG was ordered if clinically indicated. Intervention was based on clinical data and PSG results	Clinical series, observational study, case reports Blinding absent	Eligible: 539 Completed study: 539 % males: unknown but female:male ratio was 3:2 # controls: none	Cases: 5.3yrs (no SD noted); range 0-17yrs Controls: n/a Wide spectrum	Academic center Self-selected groups Funding not specified	Parental observations	PSG criteria	No / No: Comments: RDI thresholds stated but no details on what constituted a respiratory event and no citations to other publications either	Not specified	Findings supportive of the presence of SDB in children with cleft palate with the caveat that only symptomatic children were studied, and many fo the children had associated syndromes. Findings supportive of the persistence of SDB despite surgical intervention aimed at improving the airway in children with clefts.
133	Mogayzel (1998)	3	This study is describing sleep and respiratory characteristics in 88 children with achondroplasia and a wide range of clinical problems. 43 of these children had repeat PSGs: 18 to evaluate effects of therapy, 15 to potentially discontinue oxygen, CPAP or tracheostomy; 10 who were free of symptoms At the time of the first PSG, 5 pts had already undergone tracheostomy for severe OSA, and seven required supplemental oxygen. In addition, prior to first PSG 24 pts had undergone surgery (5 trachs, 9 cervicomedullary decompression, 6 VP shunts, 11 T&A) OSA, CSA, hypoxemia, hypoventilation all reported This study describes the spectrum of sleep disordered breathing in children with achondroplasia studied with polysomnography	Clincal series Blinding absent	Eligible: 88 Completed study: 88 % males: 52	Cases: 1 month to 12.6 years (median 1.2 years) Controls: None Narrow spectrum	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical)	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 387 minutes median (range 131-541) Timing of PSG: Nocturnal	1. PSG is helpful in identifying sleep disordered breathing in patients with achondroplasia 2. PSG appears useful in assessing adequacy of intervention for various causes of sleep disordered breathing in patients with achondroplasia 3. In patients with achondroplasia and no significant abnormalities on initial PSG, repeat PSG does not appear to reveal any additional abnormalities, however, these numbers are small 4. The study demonstrated test-retest reliability of PSG in that the AI improved in the expected direction in children undergoing treatment for sleep-disordered breathing.
50	Sisk (1999)	4	To determine frequency of OSA in children with achondroplasia and the effectiveness of T&A as a treatment. Also to review perioperative and anesthetic evaluations and precautions To determine frequency of OSA in children with achondroplasia and assess effectiveness of adenotonsillectomy.	Chart review, clinical series Blinding not specified	Eligible: 58 initially with Hx compatible with SDB but 22 eliminated when didn't have OSA by study criteria Completed study: 36 (23 with PSG-defined OSA) % males: not reported # controls:none	Cases: overall 19 months (range 1 day-14 years) Children with PSG-defined OSA had mean age of 3.7yrs at Dx; those with OSA identified by caregiver had mean age of 4.0yrs Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Expert selected by diagnosis of OSA (author criteria) Funding not specified	Multiple comparators: Clinical history Parental report Physical exam	Other diagnostic criteria developed by authors Other as below: No OSA = no desat below 90% Mild OSA = Desat 80-90% assoc with hypopneas and apneas Severe OSA = desat <80% Children whose caregivers reported observed apneas, snoring, glottal stops, gasping, neck hyperextension, nocturnal self-awakenings, irritability or EDS were classified as OSA even in if O2 desat did not reach criteria above	No / No: Comments: no information on sleep staging given or even if it was performed. No details regarding definition of apneas, hypopneas, etc	Unclear whether comprehensive or limited PSG; no mention of EEG or how airflow was measured Other diagnostic techniques included in review, e.g. echocardiography, radiographs, imaging etc PSG duration = unknown Timing of PSG: Nocturnal	*- supports previous findings that children with achondroplasia are at risk for OSA likely because of craniofacial features - findings support T&A as an intervention in children with OSA to improve respiratory symptoms - findings support T&A over adenoidectomy alone as an effective treatment to improve respiratory symptoms - Test-retest reliability is demonstrated in that the PSG demonstrated improvement in the expected (improved) direction after surgery.
206	Gonsalez (1998)	4	Children were recruited from a cohort of patients followed at an academic Craniofacial Unit. 13 patients with a history of syndromic craniofacial dysostosis and who were found on routine MRI testing to have evidence of hindbrain herniation underwent overnight diagnostic polysomnography. Parents and children were interviewed regarding the presence of respiratory symptoms. Results of these interviews and polysomnographic data are presented and reviewed.	Clincal series Blinding absent	Eligible:13 Completed study:13 % males: not specified	Cases: ages ranged0.3-11.4 years No controls Narrow spectrum	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical)	Clinical history, parental observations	Other criteria deveoped by authors	Yes Were respiratory scoring methods clearly defined? Yes used primarily oxygen desaturation and evidence of thoaracoabdominal dyssynchrony to classify respiratory obstruction	Limited sleep study (describe parameters) Oximetry, ECG, thoracoabdominal movement and body movement sensors PSG duration = "overnight:" 4.5-10h Timing of PSG: Nocturnal	Diagnostic polysomnography should be considered in children with a history of craniofacial dysostosis associated with hindbrain herniation due to a high prevalence of obstructive sleep disordered breathing in this patient population. Low clinical suspicion of sleep disordered breathing based on parental assessment of symptoms thereof provides poor negative predictive value in non-tracheostomy patients and should not preclude further assessment. High clinical suspicion of sleep disordered breathing based on parental observation has good positive predictive value for the presence of sleep-disordered breathing in this patient population. 0/7 patients with a positive history had a negative PSG.
44	Pijpers (2004)	4	A retrospective medical record review was performed for 59 children with syndromal craniofacial synostosis (SCS) to identify symptoms of OSA. A caregiver completed questionnaire was then administered to identify OSA-related symptoms. The medical history and results of the questionnaire were then compared to determine the value of each to identify OSA in children with SCS.	Clinical series, observation Blinding not applicable; Snoring, difficulty breathing, and observed apnea were reported in over 50% of children with either Apert syndrome, Crouzon syndrome, or Pfeiffer syndrome registered in one hospital over a 16 year period, but only 10/72 underwent PSG.	Eligible: 72 Completed study: 59 % males: 71	Cases: 9.3 years (range 0-17 years) Controls: NA Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Parental observations	Questionnaire	No / No	Not specified	1) Regular screening for OSA with a standard questionnaire could be of additional value for the detection of OSA in children with SCS. 2) The author's propose to screen children with SCS by means of a standard questionnaire twice a year and to perform PSG if indicated.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
207	Sirois (1994)	4	To assess incidence of OSA post pharyngeal flap surgery for velopharyngeal insufficiency. All children underwent pre (1-2 days before surgery) and post operative (1-15 days, mean 5 days) respiratory recordings	Clincial series Blinding absent; Designed to assess incidence of OSA following pharyngeal flap surgery	Eligible: 41 Completed study: 40 % males: 23/40 = 57.5% # controls:none	Cases: 6.7 yrs (range 2-22yrs) Controls: n/a Wide spectrum	Academic center Self-selected groups: all children undergoing pharyngeal flap surgery. Funding not specified	abbreviated studies Apnea monitor and pulse oximeter used post-operatively	PSG criteria and other criteria developed by authors	NA / Yes No EEG recorded	Heart rate, arterial saturation, airflow (thermistor), abdominal and thoracic movements Post-op only apnea monitor, pulse ox and clinical obs made Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG:Nocturnal	*- findings support OSA as a complication of pharyngeal flap surgery at least in the immediate post-op period - limited follow up beyond immediate post-op period (timing not stated) suggests that OSA not apparent later on - findings do not support routine use of PSG in children with velopharyngeal insufficiency prior to pharyngeal flap repair - Test-retest reliability of PSG is demonstrated in that 13/14 children had change in obstructive AHI in the expected direction (increased) following VP repair.
138	Morita (2004)	4	16 patients with velopharyngeal insufficiency due to various causes (6 after cleft palate repair, 8 with submucous cleft palate, 2 with short palate) underwent two preoperative PSGs, one normal and the following night with nasal occlusion with tampon gauze. This forced the patient to breath orally, assuming this is the main route of breathing after pharyngeal flap due to increased nasal resistance. Based on pre-op occlusion studies,one patient did not undergo surgery. This study was done to see if it is possible to predict preoperatively the risk of OSA after pharyngeal flap surgery for velopharyngeal insufficiency	Clincal series Blinding absent	Eligible: 16 Completed study: 16 (14 had post-op PSGs) % males: 62.5	Cases: 7.3 yrs (4.7-12.9) Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	1) This study suggests that PSG with nasal occlusion may be helpful in predicting post-operative OSA in patients undergoing pharyngeal flap surgery 2) Children with normal AHI (<5/hr) prior to undergoing surgery for velopharyngeal insufficiency also had normal AHI 2 weeks postoperatively, demonstrating test-retest reliability for the AHI obtained during PSG. 3) In children with VP insufficiency, there was a strong correlation between AHI with nasal occlusion pre-operatively and postoperatively. This correlation is in the expected direction and provides further test-retest reliability for the AHI obtained during PSG.
208	Liao (2003)	4	This study evaluated 10 patients with VPI who were to undergo palatoplasty. A PSG was done one day prior to surgery, and then repeated at one week, and approximately 3 and 6 months after surgery for a total of 4 studies per patient. Abnormal RDI was defined as >1, symptoms consistent with OSA (snoring, dyspnea, fragmented sleep, witnessed apnea, nocturnal awakening) were ascertained	Clinical series, observational Blinding absent; This study was designed to determine the incidence and severity of OSA in children with velopalatal insufficiency (VPI) before and after a procedure to correct this (Furlow palatoplasty)	Eligible: 15 Completed study: 10 % males: 60 # controls: None	Cases: 5.1 +/-1.1 yrs Controls: None Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	Diagnosis reached using PSG criteria	Yes / yes (no CO2 or NP)	Comprehensive PSG Duration not specified Nocturnal	If there are concerns for OSA in pts with VPI after palatal surgery, PSG should be performed 6 months or more AFTER surgery, as there may be transient abnormalities on PSG in the first 3-6 months. Very small numbers. Snoring did not really seem to predict abnormalities in RDI, as we know..this may be due to the general poor correlation between history and PSG findings, or due to the inability of the testing to identify subtle forms of SDB or both,
4.2.2.8.3 Sickle Cell Disease												
210	Samuels (1992)	2	Case control study evaluating sleep related upper airway obstruction and hypoxemia in SCD	Case control study Blinded study	Eligible: 53 Completed study:50 % males: 17 boys # controls: 50 % males: boys in total	Cases: 1.9-16.5 yrs; median 8.0 yrs Controls: 2 grps: random selection: mean 6.9; 1.9-16.3 yrs Median 8.8;2.0-13.3 year. Narrow spectrum	Academic center 25 randomly selected and additional group of siblings Privately funded (Non-pharma)	Parental history Clinical examination (snoring history and tonsil size)	Not stated	No / Yes (non standard methods to define changes in waveforms)	Limited sleep study (Chest wall movement using respiratory inductance plethysmography Arterial oxygen saturation Endtidal carbon dioxide levels PSG duration = overnight 12 hrs Timing = Nocturnal	The median baseline SpO2 in sleep was significantly lower in 53 SCD children (99.0%, range 88.6-100%, 16% below control range) compared with Afro-Caribbean (99.2%, range 95.8-100%) and white (99.5%, range 96.2-100%). None of the controls but 8% of the SCD patients had episodes when their SpO2 fell to < 80% (p >0.04) averaging 0.2, 0.5, 16.4 and 80.7 desaturations per hour of sleep.
211	Needleman (1999)	4	20 children (ages 7-21 years) with sickle cell disease (SCD) underwent PSG and pulmonary function testing, to determine if OSA played a role in nocturnal oxyhemoglobin desaturation (NOD) in SCD patients.	Prospective cohort study Blinding absent	Eligible: 20 Completed study: 20 % males: 40	Cases: 11.8+/- 3.7 years; Narrow spectrum	Academic center and Self-selected group; government funded	Not specified	PSG criteria	Uncertain / Yes	Comprehensive PSG Overnight Nocturnal	1) While NOD may be common in children and adolescents with SCD, upper airway obstruction does not appear to play an important role in its genesis. 2) The only factor found to be predictive of sleeping saturation was awake saturation. 3) PSG may be useful in elucidating mechanisms of desaturation in SCD patients, when upper airway obstruction is a clinical concern.
212	Brooks (1996)	4	To determine whether OSA and/or nocturnal O2 desats are contribute to the clinical severity of sickle cell disease. Three groups of children studied: those with severe sickle cell, mild sickle cell, and those who were referred to a sleep lab. All children underwent PSG and PFTs	Prospective cohort study Blinded study	Eligible: 138 within 1993 Completed study: 28 % males: 8/28= 29% 28% were 6 years or younger, 14% 18 years or older (3.4 to 24.9 years) All BMI <25 No controls	Cases: Mean age of those with severe sickle cell 17.7±4.8 yrs Mean age of those with mild sickle cell 15.5±5.8 yrs Mean age of children with sickle cell referred to sleep lab was 8.1±3.1yrs for those found to have OSA and 7.8±3.6 yrs for those without OSA Wide spectrum: All referred for suspected SDB reported snoring and apnea; 4/9 reported EDS. No difference in tonsillar size, none had Tonsillectomy	Academic center and community referral Expert assigned or selected groups Privately funded (Non-Pharma)	Physical examination	PSG criteria Other diagnostic criteria developed by authors	Yes (cited R&K) Yes	Comprehensive PSG PSG duration = For children with mild and severe sickle cell disease the TST was 336.8±51.7 mins and 345.0±78.3 mins respectively. For those referred for evaluation of snoring, the TST was 379.5±39.2 mins in children with OSA and 396.6±21.6 mins in those without OSA Timing = Nocturnal	Findings do not support an increased frequency of OSA in sickle cell disease; however, given the limitations of sample size and age range it is difficult to draw any conclusions from this study. Among this retrospective descriptive level 4 study of patients with SCD ranging from 3.4 to 24.9 years, no significant difference in RDI among patients with mild vs severe SCD.
213	Spivey (2008)	4	Determine if low daytime oxygen saturation is associated with nocturnal desaturation and OSA in children with SCD	Clinical case series, observational study, case report Not applicable	Eligible: Completed study:20 % males: 11/20 No controls	Cases: 1-19 years of age, mean age 9.6 yrs, median 9.5 years; one make would be excluded b/c he is 19 yrs. Spectrum not applicable	Academic center Strategy not specified Pharmaceutical or equipment company funded	Oximetry Daytime oxygen saturation	PSG criteria	Yes (ATS criteria)	Other Duration not specified Timing = Nocturnal (not defined, but sleep efficiency 61-97%)	1. Patients with SCD who have a baseline daytime saturation of <94% are likely to have nocturnal desaturations but not necessarily OSA. 2. Oximetry values, either day or night, alone cannot predict who will have OSA 3. Children with SCD whose baseline saturation during the day is <94% are likely to have PSG related abnormalities A retrospective medical record review by Spivey JD et al. (2008, level 4) studied whether low baseline waking SpO2 in children with SCD should prompt consideration of nocturnal hypoxemia with or without superimposed OSBD. They studied 20 SCD children who had low daytime SpO2 (<94%) based upon daytime pulse oximetry. They defined oxygen desaturation as a SpO2 <94% while breathing room air (FiO2 = 0.21) analyzed by peripheral pulse oximetry. OSA was defined as any degree of UAO. A mean nighttime SpO2 among the 11 individuals with nocturnal desaturation without OSA was 88.9% (range 84-91%). They found the average nighttime SpO2 among these children with low SpO2 awake was 89.1% (range 83-94%). They found average daytime SpO2 correlated with nocturnal SpO2 (Spearman correlation coefficient = 0.453; p = 0.045) and children with the lower SpO2 awake had the lowest desaturations during sleep. They found OSDB in 35% (7/20) patients (mean AI 3.4/h, RDI 14.3/h TST, average nighttime SpO2 89.3%, average etCO2 43.1 torr). Based upon their study, the authors recommended that in children with SCA, a daytime SpO2 < 94% is a reasonable threshold to recommend pulmonary evaluation, including a PSG because one-third will prove to have concomitant OSDB.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
209	Kaleyias (2008)	4	19 children with Sickle Cell Disease (SCD), suspected of having SDB, underwent overnight PSG . The results of the PSG findings of the SCD subjects with OSA, were then compared to 10 matched children with OSA and no medical comorbidities. 100 consecutively referred children with SCD completed CSHQ questionnaire, 48 identified as suspicious for OSDB based upon sleep questionnaire, 19 of 48 agree to participate (TERRIBLE SAMPLE SIZE AND SAMPLING)	Case control study Blinding not specified	Eligible: 48 Completed study: 19 % males: 68% # controls: 10 % males: 70%	Cases: 10.7 years (range 6.4-13.3) Controls: 8.5 (6.7-12) Narrow spectrum	Academic center Expert assigned or selected Government funded	Physical examination	PSG criteria Children with SCD	Yes / Yes	Comprehensive PSG (Attended overnight comprehensive PSG with CO2 monitoring and nasal pressure and thermal sensors) PSG duration = overnight Timing = Nocturnal	1) Children with SCD, suspected of having SDB, may have a higher incidence of OSA, more severe nocturnal desaturations and hypercapnia, compared to children with uncomplicated OSA. A small retrospective case-control level 4 study by Kaleyias J et al. (2008) found no significant difference in the mean AHI on PSG among 19 SCD children self-referred for suspected OSDB compared with 10 children matched for age, sex and ethnicity but without SCD or other co-morbidities (AHI 7.5/h vs. 6.9/h, respectively)(Kaleyias et al. 2008). However, they found the SCD children with OSDB had significantly lower nadir SpO2 than the uncomplicated OSA group (81% vs. 89%, respectively), greater percentage of TST with SpO2 <92% ((9.5% vs 0.25%) and greater time of desaturation (33.5 vs. 1.2 minutes <92%). The percentage of the TST with etCO2 > 50 torr was significantly greater in the SCD-OSA group (28%) compared with the uncomplicated OSA subjects (16%). Limitations of this study included: small sample size, asymptomatic children were not tested, only a small number of the symptomatic agreed to have PSG leading to self-selection. The authors reported that in their lab approximately 30% of people who undergo a PSG for suspected OSDB have OSA on their PSG, 63% in this self-selected small group of SCD patients. Limitations: 19 of 48 subjects with suspected OSDB underwent PSG, small sample size, defined OSA as AHI > 1, of interest 5 had AHI = 1 "normal" which would reduce positive cases to 8 = 50%.
214	Souza (2007)	4	Nocturnal polysomnography and spirometry were performed on 50 adolescents with clinically stable sickle cell anemia (SCA) to evaluate quality of sleep and pulmonary function. Patients were divided into two groups, based on O2 saturation by pulse oximetry (SpO2 > 93% and SpO2 <93%)	Clinical series, observational study, case report Blinding absent	Eligible: 50 Completed study: 50 % males: 50% No controls	Cases: 13.9 +/- 2.5 years (range, 10-18 years) Narrow spectrum	Academic center Expert assigned or selected Funding not specified	Spirometry	PSG criteria Spirometry	Yes / Yes	Comprehensive PSG PSG duration = approximately 9:30pm-7:00am. Timing = Nocturnal	Sleep impairment in clinically stable SCA patients is probably due to desaturation, as determined by SpO2 and not due to individual alterations in pulmonary function. Overnight PSG in 50 adolescents (13.9 +2.5 y) with SCD. The mean SDB index was 2 + 3 events per h, the obstructive AI 0.2 + 0.8/h, 63% snored, and the nadir SpO2 was 73 + 13%. Pulse oximetry may overestimate oxyhemoglobin saturation in children with SCA and has a low specificity in determining the true degree of SpO2 in such patients. SpO2 in patients with SCD does not neces-sarily indicate hypoxemia but rther a decrease in arterial oxygen content probably due to the presence of carboxyhemoglobin and methemoglobin, as well as decreased affinity of hemoglobin S for oxygen even with a normal SpO2.
4.2.2.8.4 Neurological Disorders												
21	Masters (1999)	1	This study compared clinical symptoms with PSG findings. Could sx predict PSG findings? The majority of children were neurologically normal, however 16 children were neurologically abnormal.	Clinical series, observational Blinding absent; This paper attempted to identify a relationship between the clinical and PSG char-acteristics of neurologically normal and abnormal children with OSA.	Eligible: 56 Completed study: 56 16 neurologically abnormal % males:61	Cases: median 35 months (2- 60) Wide spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Clinical history classification devised by authors, with maximum clinical score of 37 reflecting various symptoms including snoring, witnessed apneas, EDS, restless-ness, behavioural abnormality, neurodevelopmental delay, ALTE, respiratory failure related to UAO, cardiac or growth abnormalities	Diagnosis reached using PSG criteria	Yes / yes	Comprehensive PSG Duration not specified Nocturnal	1) Findings suggest that for neurologically normal children there is a poor correlation between findings on PSG and the clinical rating scale used by these authors to determine severity of obstructive sleep apnea. It is not clear, however, that the clinical rating score used had been validated or correlated in any way with actual pathophysiology of disease. 2) PSG findings were generally worse in this small group of neurologically abnormal children with a diverse group of diagnoses, although individual PSG characteristics of patients were not reported.
233	Suresh (2005)	4	Evaluate the spectrum of SDB in all DMD patients. Found younger boys more likely to have OSA and older boys more likely to have hypoventilation.	Clinical series, observational study, case reports Blinding NA	Eligible: 34 Completed study: 32 % males: 100%	Cases: 10 yr (1-15 yr) Narrow spectrum	Academic center Random selection Funding not specified	Most of the patients had PFTs.	PSG criteria	Yes / yes	Comprehensive PSG Timing: nocturnal	1. PSG identifies SDB in boys with DMD. Younger boys had OSA. The incidence of OSA seems higher in this patient population (30% compared to the incidence of 2% in "normal healthy" children). So emphasizes need to do PSG on all these boys. 2. PSG identifies hypoventilation in older boys, many of whom where asymptomatic. Symptoms and PSG abnormalities improved with NIV. Again emphasizes need to do PSG on these older boys.
229	Khan (1994)	3	21 non-ambulant patients with Duchenne muscular dystrophy (DMD) underwent overnight PSG at home for 2 consecutive nights with the "purpose of recruiting them into two clinical therapeutic trials"; their average age was 15 y, 10 had scoliosis surgery, all completed a sleep questionnaire reviewed blinded by one of the authors. They compared the study results to 12 healthy adolescent males (mean age 14, range 10-22). : Case-control study of 21 non-ambulatory DMD males compared with 12 healthy adolescent males, 2 nights of home PSG with EEG, respiratory BUT no CO2 monitored. Repeat sleep studies done on 14 of 21 DMD, 7 followed >18 mo, 2 for 3 years.	Normative study Blinding absent	Eligible:21 non-ambulant DMD patients % males: all males # controls: to 12 healthy adolescent males (mean age 14, range 10-22). % males: all	Cases: 15 years (range 13 to 23 y) Controls:12 health male adolescents (mean age 14) recruitment not specified Narrow spectrum	Academic center Attending the Muscle clinic at Hammersmith Hospital Expert assigned or selected groups Government funded	Other, specify 1. Sleep questionnaire analyzed blind by one of the authors 2. Vital capacity measured sitting and supine. 3. BMI	PSG criteria Other diagnostic criteria developed by authors	Yes / yes	Ambulatory (unattended) sleep study 8 channel 4 EEG, 4 respiratory L and R EOG, C4-A1, chin EMG, thoracoabd movements by Respibands oronala thermistor and pulse oximetry NO CO2 monitoring bad in DMD PSG duration = mean 439 min range 361-543 Timing of PSG: 2 consecutive nights at home Nocturnal	13 of 21 patients had hypoxemia <90% during sleep (CO2 not monitored), 12/13 had episodic dips in SpO2 suggestive of apnea. 60% of apneas were obstructive. The hypoxemic periods became more frequent with increased age, and in 2 patients at 3 year followup were more frequently associated with central apneas. They found a strong correlation between severity and frequency of hypoxemic dips and age (p< .005), and number of years in wheelchair (p< .005). No correlation in hypoxemic dips with BMI, vital capacity. Clinical correlations with sleep questionnaire data: presleep study questionnaire did not predict hypoxemia. Morning headache, tired-ness, was not predictive of sleep disordered breathing present in 2 patients who were normal, 1 who was abnormal. They claimed obstructive apneas were more common early in course of disease of DMD once patients became wheelchair bound, later in the disease more hypoxemia and central events. Of note, CO2 not monitored.
234	Smith (1988)	4	To evaluate the spectrum of SDB in advanced but clinically stable DMD patients. No patients had identified sleep disturbances.	Clinical series, observational study, case reports Blinding: NA	Eligible:14 Completed study: 14 % males: 100%	Cases: 18.3 yr (15-22 yr) Narrow Spectrum	Academic center Random selection Funding not specified	Most subjects had PFTs and ABGs.	PSG criteria	Yes / yes	Comprehensive PSG PSG duration = 490 minutes Timing of PSG:Nocturnal	1. PSGs identify SDB in DMD patients. Most common findings were desaturations or hypopneas in REM. 2. Unfortunately, PFTs and ABGs don't serve as perfect screening tools to identify which patients should go on to have PSGs. 3. They suggest more patients with DMD have sleep studies to identify SDB that may affect treatment and prognosis.
235	Barbe (1994)	4	Evaluation of SDB in older DMD patients with severe restrictive lung disease but relatively normal awake gas-exchange.	Clinical series, observational study, case reports Not applicable	Eligible: 6 Completed study: 6 % males: 100% # controls: 0	Cases: 18 yr (12-22 yr) Narrow spectrum	Academic center Random selection Funding not specified	Not specified	PSG criteria	Yes / yes	Comprehensive PSG Duration not specified Timing = Nocturnal	PSG should be used to identify and assess severity of SDB in boys with DMD, especially those with more severe restrictive lung disease on PFTs.
236	Manni (1989)	4	Evaluation for SDB in relatively healthy clinically stable older DMD boys. All were wheel-chair bound with restrictive lung disease. None had subjective sleep complaints.	Clinical series, observational study, case reports NA	Eligible: 11 Completed study:11 % males: 100% # controls: 0	Cases: 15.97 yr Narrow spectrum	Academic center Random selection Funding Not specified	Not specified	PSG criteria	Yes / Not applicable	Comprehensive PSG nocturnal	Would seem to suggest that even advanced DMD patients have preserved nocturnal oxygenation/ventilation without significant SDB.
237	Kerr (1994)	4	The purpose of the study was to correlate PSG abnormalities with clinical respiratory function (PFT data) and outcomes (eg mortality).	Clinical series, observational study, case reports Blinding: NA	Eligible: 11 Completed study: 11 % males: 100% # controls: 0	Cases: 10 yr Range: 4-16 yrs Narrow spectrum	Academic center Expert assigned or selected groups Pharmaceutical or equipment company	Pulmonary function tests.	PSG criteria Prognosis of patient (e.g. mortality)	Yes / yes	Comprehensive PSG PSG duration = Not stated, but studies were not considered adequate unless REM was seen. Timing of PSG: Nocturnal	PSG is useful in detecting progressive respiratory decline (which the authors attribute to diaphragm dysfunction) and findings during the PSG may be prognostic of an earlier mortality.
238	Kotagal (1994)	4	Retrospective look through polysomnography studies that had been done on 9 children with CP and 9 "controls" to see if EEG changes related to respiratory events were different between the two groups	Retrospective case series Blinding NA	Eligible: 9 with CP Completed study: all % males: 3/9 # controls:9 controls with apnea or enuresis % males: 7/9	Cases: 36.7 months (7-125 range) Controls:37.4 months (11-126 range) Patient Spectrum: Narrow- all had CP with symptoms of OSA	Not specified	Not specified	PSG criteria	Incomplete: hypopneas defined only	GRASS polygraphy study PSG duration = 456.2 ± 28.4 minutes Timing of PSG:nocturnal	Interesting though limited in data. Small retrospective sample showing perhaps increased microarousals in CP but arguably the EEGs were difficult to read because of the abnormal background and epileptiform discharges. Compared with children symptomatic for OSA but otherwise well, there were more respiratory events and many fewer body movements.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
239	Cohen (1997)	4	A surgical procedure was performed in lieu of tracheostomy in these children with pre and post op studies. Various surgical procedures were performed.	Prospective case series of pre and post op PSG findings in children with CP Blinding NA	Eligible 18 with CP and OSA Completed study: 13/18 % males: 50% # controls:none	Cases: 7.65 years (9months to 17 years, 6 months) Patient Spectrum: Narrow- all had CP and OSA	Academic center Selection: not specified Funding source: not specified	History, physical exam, lateral neck XRAY ± nasendoscopy, PSG	PSG criteria	No- no mention of EEG Were respiratory scoring methods clearly defined? Yes, apnea = cessation of airflow for >10 sec, hypopnea if reduced by 50% for > 10 sec Comments: No description of PSG beyond that above.	Some 12 channel study Timing of PSG: nocturnal	PSG can be helpful to identify SDB in children with CP and can be helpful to evaluate treatment effects.
230	Dauvilliers (2007)	3	46 consecutive adults and children with Chiari malformation underwent PSG, MRI, and clinical evaluation.	Prospective cohort study Blinding NA	Eligible: 46 (20 children, 26 adults) from two hospitals in France recruited over a 5 year period. Completed study: 46 % males: 8/20 (children); 12/26 (adults)	Cases: Children's age range was 4-17 (mean not reported) No patients were taking psychotropic medication or other medications known to influence sleep and/or SDB In the child group, 15 had Chiari I and 5 had Chiari II Controls: none Narrow spectrum	Community referral Selection: not specified Funding: not specified	MRI Physical, neurological, and otorhino-laryngoscopic exam Epworth used in patients >age 16	PSG criteria Other criteria developed by authors	Yes / yes: Pediatric definitions: CA: >20 seconds or>10 sec with >3% decrease in SpO2 and/ or "microarousal" Mixed apnea: starts with central apnea, becomes obstructive Hypopnea: >50% reduction in airflow Cutoff for using pediatric vs. adult is not clear; may be age 15. Adults had nasal pressure sensor and also underwent a second PSG with Pes if more than 20% of the apneas were central on the first PSG. AHI>1 = Sleep apnea syndrome (children) Central Sleep apnea syndrome: >50% of apneas were central Severe sleep apnea: AHI>10 (children)	Comprehensive PSG Children <age 15 had oronasal thermistor and it is not clear whether they also had nasal pressure monitoring. PetCO2 was obtained in adult patients only. EEG was recorded using C3-A2 and C4-A1 (no occipital or frontal EEG) PSG duration = approximately 8 hours Timing of PSG: Nocturnal	PSG in children with Chiari malformation reveals a high rate of sleep apnea (60%), both obstructive (35%) and central (25%). The authors believe that all patients with Chiari malformation should be screened for sleep-related respiratory disturbances.
240	Waters (1998)	4	105/109 children attending a spina bifida clinic were invited to particpate . All completed questionnaires and 83 agreed to overnight testing. 40 had lab PSG and 43 had home PSG. A blinded investigator looked at the oximetry results and scored them using a 1-4 rating system. All also had previous MRI (n=43) , ENT evaluations reviewed (when done), and spirometry was done in those able (n=38). Predictors of SDB were evaluated.	Cross-sectional cohort study Oximetry interpreted by blinded investigator	Eligible: 109 Completed study: 83 % males: not specified # controls: NA	Cases: not specified Spectrum not specified	Academic center Non-US granting agencies	Not specified	PSG criteria other diagnostic criteria developed by authors	Yes / yes	Multiple: all underwent overnight testing, some in the lab and some with comprehensive home testing PSG duration = 7.7 hours Timing of PSG: Nocturnal	SDB is common in children with spina bifida, especially those with high sensory lesions, severe Chiari malformations and non-ambulatory status. Overnight oximetry may be useful to rule out SDB (if normal) in this population but it has poor positive predictive value. PSG is useful to identify the presence and type of SDB in this population. Complex pathophysiology results in various patterns of SDB including a predominance of central apnea and hypoventilation.
241	Kirk (2000)	4	The charts were reviewed on 73 patients with myelomeningocele and moderate to severe SDB seen at seven peds centers. 27 came from McGill University, the others had 1-13 patients. All centers used lab PSG with EEG and several used home studies for f/u, but details about the studies are not given, including technical details. This paper is essentially reporting types of successful treatment in the PSG-diagnosed major categories of SDB in these patients. OSA, CSA hypoventilation	Clinical series, blinding absent; This study was done to look at identification and treatment of SDB in patients with myelomeningocele in a variety of academic centers	Eligible: 73 ots Completed study: 73 % males: 53	Cases: 15 pts (20%) <1 yr; 23 pts (31%) 1-5 yrs; 20(27%) 6-12 years 11(15%) 13-18 yrs 4 (5%) greater than 18 years Narrow spectrum	Academic center 35 peds sleep centers contacted 7/22 responding centers had adequate clinical and lab data to participate Expert assigned or selected groups Pts included by participating centers if they had moderate to sever e SDB (would require close f/u or treatment) Privately funded (non-p)	Not specified	PSG criteria	No / No	Not specified	1) Pts. with meningomyelocele should undergo early PSG to diagnose multiple potential types of sleep disordered breathing. 2) Oximetry alone is insufficient in the evaluation of children with meningomyelocele because they are at risk for multiple types of SDB including obstructive sleep apnea, central sleep apnea, central hypoventilation, and sleep-exacerbated restrictive lung disease.. 3) Treatments of SDB are variably effective and physicians should have a low threshold to do a follow up study to assess treatment efficacy
242	Murray (2006)	4	3 girls with CM type 1 were referred for sleep evaluation, 2 for snoring and witnessed apnea, one for failing to exhibit appropriate levels of respiratory drive during general anesthesia. All had central apneas and marked bradypnea during NREM sleep. Underwent posterior fossa decompression for this and SDB normalized.	Clinical series, observational study, case reports Blinding NA	Eligible: 3 children, all girls, with CM type 1 Completed study: three % males: none	Cases: 3, 9, and 13 years	Recruitment source: Not specified Referred to evaluate for SDB had Chiari type 1 malforma-tions Author is pediatric pulmonary sleep specialist at U of Sydney	Brain MRI showed CM type 1	Authors described SDB seen in the PSG without providing classification system used.	No / No: Authors only provide brief summary of PSG findings.	Not specified	Only three cases, but is a rare condition. Brief case report discussion focuses on symptoms of CM1 at varying pediatric ages. Discusses SDB when present can include obstructive apneas, mixed and central, or pure central apneas with bradypnea. Central apnea hypothesized to be secondary to compression or ischemia of the respiratory center in medulla, dysfunction of ARAS, abnormal ventilator chemosensitivity and/or paralysis of the upper respiratory wall. The authors concluded that marked central apneas and bradypnea on a PSG in a child or adolescent warrants consideration of CM type 1.
243	Quera Salva (2006)	4	32 Consecutive cases of children, teenagers, and young adults with MyD1 ages 6-19 who had their disease present in childhood. See at the Muscle Diseases Institute , Salpetriere Hospital, Paris, and accepted to undergo sleep studies. Part of a larger neuropsychological evaluation of patients with MyD1. Patients underwent spirometry, overnight PSG, MSLT to assess EDS, and a Clinical and NP evaluation, and asked whether they felt fatigue and/or somnolence on a daily basis.	Clinical series, observational study, case reports Blinding NA	Eligible:32 consecutive patients ages 6-19 attending f/u at Muscle Diseases Institute with MyoD1 Completed study: 21 (12 boys, 9 girls) mean age 15.0 + 3.0 y % males: 12/21 were male	Cases: mean age 15.0 + 3.0 y Controls: N/a Narrow spectrum	Academic center Expert assigned or selected groups Consecutive cases of children, teenagers, and young adults with MyD1 ages 6-19 who had their disease present in childhood. See at the Muscle Diseases Institute , Salpetriere Hospital, Paris, and accepted to undergo sleep studies. Part of a larger neuropsychological evaluation of patients with MyD1 Non-US funding agency	Multiple comparators, specify: Clinical interview PSG followed by MSLT Standard lung function testing	PSG criteria ICSD criteria	Yes: R & K, AASM arousal scoring rules, AASM Task force 1993 respiratory scoring rules, PLMS AASM PLMS scoring criteria 1993 Yes	Comprehensive PSG Overnight inlab PSG followed by MSLT PSG duration = 415 +/- 93 min TST Timing of PSG: Nocturnal	Authors argue that In young pts with MyD1, complaints of fatigue and/or somnolence should prompt a PSG to search for SDB or PLMS which were present in 2/3 of these patients.
231	Mellies (2004)	3	Aim: characterize SDB and associated symptoms in SMA-patients and to verify our hypothesis that in SMA NIV as treatment of SDB is beneficial.	Case control study Blinding absent	Eligible: 15; 10 with SDB and 5 without. Completed study: 7 % males: 3 males # controls: 5 % males: not stated	Cases: 8.1±1.6 yrs (range=6-11 yrs). 6 with SMA type I and one type II Controls: 7.8±1.9 yrs; one with SMA type I and four with type II Narrow spectrum	Academic center Self-selected groups Funded by University of Essen and Vitalaire and Foundation support	None	PSG criteria Comment: also used a questionnaire to evaluate sleep disturbance, nocturnal sweating, morning headaches, nausea, fatigue, impaired concentration – not validated questionnaire.	Yes / Yes (used the two breath rule for defining respiratory events, RDI > 5/hr and hypoventilation as CO2> 55 mmHG or saturation < 90%	Comprehensive PSG standard but not specified, including CO2 PSG duration = in minutes – not specified Timing of PSG:Nocturnal	1) patients with SMA may develop SRBD before reported symptoms or obvious abnormalities detectable on pulse oximetry or blood gas 2) children with SMA should be systematically evaluated with PSG to look for evidence of SRBD. The optimal timing and frequency of PSG is not known. 3) Initiation of NIV and continuation of NIV use can be monitored using PSG, but optimal timing is not known.
244	Santamaria (2007)	4	Aim: cross-sectional study aimed at evaluating the role of three different techniques, i.e. polysomnography, upper airway computed tomography (CT) and nasal endoscopy, in assessing upper airway obstructive disease in patients with MPS. Only 5 children included in the study.	Clinical series, observational study, case reports Blinded study Blinding to other tests	Eligible: 11 Completed study: 5 children and 6 adults % males: males # controls: N/A	Cases: Children only: ave: 7.36 (2.0-11.3) yrs; 3 males. Median: 6.9 yrs with adults and children 2.9-29.6 year Completed study: 5 children and 6 adults Controls: N/A Narrow spectrum	Academic center Self-selected groups Funding not specified	Upper airway CT scan	PSG criteria and Comment: also evaluated upper airway obstruction using CT scan and upper airway endoscopy.	Yes / Yes (used the two breath rule for defining respiratory events, hypopneas required 50% decrease in flow with desat >4% or arousal. AHI > 1.5 per hour considered abnormal	Comprehensive PSG including standard format with thermis-ters, resp effort with RIP, no recording of CO2. PSG duration = 388.4 min in children PSG timing: Nocturnal	Patients with MPS have a high likelihood of OSAS and should be considered for PSG to evaluate SRBD
232	McGrath-Morrow (2008)	3	Aim: use PSG to define patterns of sleep and respiration during sleep in patients with AT, and to define SRBD in 11 teens with AT. All had reduced FVC (median 1.2 L) and median FVC% 44%	Clinical series, observational study, case reports Cross-sectional Blinding absent	Eligible: 12 Completed study:11 % males: 6/11 males # controls: N/A	Cases: 15.7 ± 2.1 yrs BMI percentile 3% ile Controls: N/A Narrow spectrum	Academic center Self-selected groups Funding not specified	None	PSG criteria	NA / Yes (used the two breath rule for defining respiratory events, hypopneas required 50% decrease in flow with desat or 3% or arousal.)	Comprehensive PSG including EEG, piezo bands, end tidal CO2, thermister and nasal pressure. PSG timing = nocturnal; PSG duration: 443.5 ± 27.6 minutes of recording time, and 317 ± 85.6 minutes	1) the majority of A-T subjects did not have frequent sleep related partial or complete obstructions during sleep or nighttime hypoxemia and they had reduced sleep efficiency which may affect degree of SRBD seen. 2) PSG is indicated in those with AT with symptoms of SRBD, but not routinely and end-tidal CO2 should be measured to evaluate them for hypoventilation also.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
245	Kaleyias (2008)	4	Aim: evaluate PSG abnormalities in a cohort of children with epilepsy, referred with diverse sleep problems. Study group (epilepsy group): 40 children with epilepsy (>2 unprovoked seizures) who underwent PSG for various sleep complaints. 8 of the children with OSA out of this group compared to the 11 controls. Control group (OSAS): Eleven patients with moderate obstructive sleep apnea syndrome, with an apnea-hypopnea index of 5-10/hour and without epilepsy or any other comorbidity, were randomly selected from the sleep-study database median follow up 15 months (range 12-24 months)	Case control study Blinding absent	Eligible: not known Completed study: 40 % males: 21 males # controls: 11	Cases: 9.5 yrs (6-14) Controls: N/A Narrow spectrum	Academic center Self-selected groups Funding not specified	None	PSG criteria	Yes / Yes (used the two breath rule for defining respiratory events, hypopneas required 50% decrease in flow with desat >4% or arousal. AHI > 1 per hour)	Comprehensive PSG including EEG, piezo bands, end tidal CO2, thermister and nasal pressure. PSG duration = in minutes Free of seizures: n=17 430 (371-461) Good control: n=12 375(321-409) Poor control n=11 365(325-373) Timing of PSG:Nocturnal	1) patients with epilepsy may present with a wide range of sleep complaints including OSAS, or other abnormalities detected on PSG. Of those that present with sleep complaints, only a minority have completely normal PSG. 2) Children with poorly controlled epilepsy tend to have more disrupted sleep 3) Children with OSAS and epilepsy tend to have poorer sleep compared to children with OSAS alone and may have moderate OSAS based on either oxygen saturation nadir or AHI. Children with epilepsy should have a PSG particularly if there are symptoms of SRBD, (including snoring and/or daytime sleepiness), or risk factors of OSAS (obesity or other complaints of poor sleep, or if the seizures are poorly controlled.
246	Nagarajan (2003)	4	Aim: to evaluate respiratory pattern changes in sleep (RPCS) in children with VNS	Clinical series, observational study, case reports Blinding absent	Eligible: not known Completed study: 8 % males: 5/8 males	Cases: uncertain about age at wheich PSG performed, but all after VNS. Controls: N/A Narrow spectrum	Academic center Self-selected groups Funding not specified	None	PSG criteria	Yes / yes: used 3 breath rule to define respiratory events	Comprehensive PSG including EEG, RIP, end tidal CO2, thermister and no nasal pressure. Transcutaneous CO2 checked with endtidal CO2 PSG duration = in minutes Timing of PSG:Nocturnal	1) Children with refractory epilepsy with implanted VNS may have altered RPCS, but not overt OSAS. However there is a paucity of data comparing degree of RPCS in those with vs without VNS. All these children with documented RPCS (7/8) were studied with PSG after the VNS. 2) SRBD, depending on how one defines it, commonly occurs in those with VNS, but not in the common form of OSAS.
247	Hsieh (2008)	4	Purpose of study was to look for sleep-disordered breathing in children with VNS placement.	Clinical series, observational study, case reports Blinding not specified	Eligible:N=9 Completed study: % males: 33% # controls: 0	Cases: VNS: 11.6 yr PSG: 13.9 yr Narrow spectrum	Academic center Not specified Funding not specified	Not specified	Not stated	Yes / yes	Comprehensive PSG Nocturnal	1. OSA is seen in children after VNS placement. 2. No comment on whether this is association or causation, but maybe doesn't matter. Point is that these children need to be monitored for OSA.
248	Khurana (2007)	4	Overall theme was to provide demographics for children treated with VNS (eg age, type of seizure, # of seizures, response to VNS,etc). They also looked for complications or "associations" including sleep-disordered breathing.	Clinical series, observational study, case reports Blinding not applicable	Eligible: 26 children with VNS but only 5 had PSG Completed study: % males: 61% # controls: 0	Cases: 3-17 yrs Patient Spectrum=unclear	Academic center Strategy ot specified Funding not specified	They did have a questionnaire. If the questionnaire was positive for OSA, then the children were referred for PSG	Not stated	No / no	Not specified	1. SRBD common in children with epilepsy. 2. SRBD may exacerbate the epilepsy. 3. VNS can cause SRBD by altering UA resistance. 4. So evaluation for SRBD is important prior to VNS placement and on-going after placement.
249	Zaaimi (2005)	4	Purpose of study was to assess for respiratory alterations during sleep in children with VNS.	Clinical series, observational study, case reports Blinding absent	Eligible: 10 % males: 40% # controls: 0	Cases: 7-18 yrs Narrow spectrum	Academic center Recruitment strategy: Not specified Funding: Not specified	Not specified	Not stated	Yes / yes	Comprehensive PSG Timing: Nocturnal	VNS can alter respiratory mechanics during sleep. Children with VNS should monitored for SRBD.
250	Biavati (1997)	4	A retrospective chart review of 355 patients, who were undergoing TA for SDB, was completed for the purpose of determining risk factors predictive of outcomes, to aid in the cost-effective preoperative evaluation and postoperative management of patients undergoing clinically indicated TA.	Retrospective chart review of children who had T&A for clinically diagnosed OSA to determine risks for postoperative complications.	Eligible: 355 Completed study: 355 % males:not reported	Cases: not reported Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Historical information regarding snoring, enuresis, EDS and hyperactivity	Other (not specfied)	No / No	Not specified	It is suggested that preoperative PSG may be predictive of postoperative complications after clinically indicated TA, but the small percentage of subjects (23/355) that underwent PSG does not allow this question to be answered by this study. "PSG" definition unclear; no information about the testing is given at all
54	Wiet (1997)	4	They looked at 3 measures pre- and post-op: AHI—likely this was an obstructive AHI as both apneas and hypopneas were defined in terms of OA and OH % sleep time oxy sat below 90% % sleep time ET CO2 > 50 torr	Clinical series, observational study, case reports Retrospective chart review Blinding absent (assumed since the scorers knew these were post-op studies.)	Eligible: 48	Cases: 7.5 years (1.5-20 yr) Controls: None Wide Spectrum	Academic center Random selection Funding not specified	Not specified	PSG criteria; other criteria: Some Ss were included based on a high suspicion of OSA either by history or by physical exam prior to PSG so to some extent other criteria were used	No / Yes Comments: Apnea=10" of no airflow with paradoxical chest/abd movement; Hypopnea=decrease in tidal volume, amplitude change not specified, with paradoxical breathing; implied duration is 10"; no desaturation specificed OSA=AHI>5/hr (apparently only obstructive events)	Comprehensive PSG 1. EEG (?2 leads?) 2. EOG (?2leads or 1?) 3. EMG 4. EKG 5. Nasal airflow 6. Oral airflow 7. Thoracic and abdominal movements 8. Tidal Volume 9. Pulse oximeter 10. ET-CO2 11. Esophageal manometer in some patients PSG duration = not specified Timing of PSG:Nocturnal	PSG demonstrates the expected improvement in respiratory parameters seen post-ENT surgery in a wide range of children demonstrating test-retest validity for PSG as a measure of OSA.
4.2.3 Clinical Utility of PSG Prior to Adenotonsillectomy												
17	Goldstein (2004)	2	41 children underwent PSG : 21 were initially PSG + as defined by RDI>5. The 20 pts who were PSG-were randomized to T&A or nonsurgery. Repeat PSG and 32 item clinical assessment was done on all 41 children after intervention and results compared. The goal of this study was to determine if patients with a clinical assessment of OSA but negative PSG had improvement in their clinical assessment score after T&A compared to children who did not undergo surgery	Prospective cohort study Blinded study	Eligible:78 Completed study: 41 % males: 50% (more females with –PSG randomized to T&A)	Cases: 5.8 (+/- 2.6) to 7 (3.6) Narrow spectrum	Academic center Random selection Government funded	Multiple comparators: Clinical assessment Score :Thiry two items which were differentially weighted by specificity of symptoms to OSA (as determined by authors previous data review.) Highest possible score was 164, children with >40 were considered to have OSA, <20 asymptomatic , and between 20-40 mild symptoms of upper airway obstruction	PSG criteria and Other diagnostic criteria developed by authors	No / Yes	No sleep stage scoring – only respiratory parameters were used. Used RDI >5 as definition of OSALimited sleep study (describe parameters) PSG duration = Not specified Timing of PSG:Not specified	In children with clinically determined OSA, negative PSG, without evaluation of UARS may not be sensitive in picking up children who may improve clinically with T&A. Findings suggest overnight PSG should be considered after T&A for treatment of OSA, and also may be considered if high clinical suspicion with initial negative PSG Lateral neck x-rays to assess adenoidal size were included as part of the clinical score. But the positive predictive value of the clinical score for predicting a positive PSG was only 48%.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
66	Shatz (2004)	3	This is a retrospective case series of infants <12 months of age who had undergone evaluation for clinical suspicion of sleep disordered breathing. The cohort included in the analysis were patients who met all three of the following criteria: 1. Upper airway obstruction symptoms: snoring, respiratory distress, or apnea (presumably a parental report of witnessed apnea, but this is not specified) 2. Adenoid enlargement causing >50% narrowing of the nasopharynx, as documented on lateral neck photograph 3. Polysomnography documenting OSA (as defined by an AHI>1). The 24 cases which were felt to meet these criteria are reviewed and analyzed. Clinical and polysomnographic data are presented. 24h pH monitoring was also done preoperatively and these data are presented. Postsurgical follow up data (clinical and polysomnographic) are presented as well.	Clinical series, observational Blinding not specified	Eligible:not clear Completed study: 24 infants are described % males: 75%	Cases: 10 months Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No / No	Not specified Airflow is measured by thermistor only. No mention is made regarding duration, timing (nocturnal vs daytime nap), or scoring criteria for sleep staging or respiratory events. PSG duration = not specified Timing of PSG: Not specified	Polysomnography shows face validity in this cohort of infants with adenoidal hypertrophy and clinically suspected sleep disordered breathing. Adenoid hypertrophy in infants can occur and can cause OSA (typically we think of this only occurring in older kids). Because adenoid hypertrophy in infants is not as common, should raise a concern and then use PSG to confirm presence and severity.
30	Nieminen (2000)	3	This study looked at 58 snoring children with symptoms of SDB who underwent two PSGs 6 months apart. Thirty healthy children also underwent a single PSG as a control	Prospective cohort Blinding not specified	Eligible: 78 Completed study: 58 % males: 53 # controls: 30 % males: 57	Cases: 5.8 +/- 1.8 (2.4-10.5) Controls: 7.1 +/- 1.8 (4.3-10.9) Narrow spectrum	Community referral Expert assigned or selected Funding not specified	This study used a questionnaire to determine severity of symptoms of OSA, and an OSA scoring system developed by Brouillette but not further described	PSG criteria	No (no EEG) / Yes (but not "standard" and technology poor)	No EEG or EOG was used, so no sleep stage scoring was done Duration not specified Timing was nocturnal	1)This study suggest that clinical symptoms alone are inadequate in differentiating primary snoring from obstructive sleep apnea, and that PSG is required. 2)This study suggests that an AHI of >2 on PSG may be an indication for T&A, with improvement in symptoms and PSG findings postoperatively 3) I n patients with primary snoring, short term f/u (6 months) with PSG does not appear warranted as symptoms did not worsen in this study in those patients Strain gauge, no CO2 monitoring, No nasal pressure so accuracy of test deficient ****No sleep stage scoring/EEG monitoring was done in this study
53	Weatherly (2004)	4	To compare clinical diagnoses with PSG in children scheduled for adenotonsillectomy. Parental questionnaires were used to determine symptoms that could assist in identifying children with normal PSGs but clinical diagnosis of SDB. PSG included esophageal pressure monitoring	Prospective cohort study Blinded study: This study was designed to compare clinical and PSG diagnoses in children on referred for adenotonsillectomy by their otolaryngologist. Parent report symptoms were also used	Eligible: unknown Completed study: 34 % males: 18/34 = 53% # controls:none % males: not stated	Cases: 8.2+/-1.9yr Range 5.3 – 12.9 yr Controls: N/A Narrow spectrum	Academic center and community referral Expert assigned or selected groups since they are children placed on the ENT list Government funded	Multiple comparators, specify: Compared to clinical evaluations and parental report	PSG criteria, other criteria defined by authors, and other: Physician diagnosis on H&P Parent symptom report	No The reader was referred to previously published methods Yes	Comprehensive PSG MSLT PSG duration = not reported Timing of PSG:Nocturnal	*- Poor agreement found between clinical diagnoses of SDB and PSG diagnoses. - Agreement variable depending on criteria used. - Best agreement obtained when threshold lowered to AHI>1 and subtle changes included (RERAs). - 2 negative parental symptom questions appeared helpful in identifying children who were unlikely to have abnormal PSG.
35	Wang (1998)	3	To investigate predictive accuracy of clinical evaluation for OSA and outcome after adenotonsillectomy in children having PSG	Clinical series, observation Blinding absent	Eligible: n/a Completed study: 82 % males: 49/82 = 60% No controls	Cases: 6.7yrs (range 18 months – 15 years) Controls:n/a Narrow spectrum	Source not specified Self-selected groups (based on symptoms of OSA then referred for investigation) Funding not specified	Physical examination by physicians Parental symptom report	PSG criteria Other diagnostic criteria developed by authors: RDI calculated using apneas and hypopneas; OSA defined as RDI>=5 with evidence of obstructive events.	No / Yes (RDI calculated using apneas and hypopneas events at least 10 seconds in duration)	Comprehensive PSG; also used snore intensity as measured in decibels. Thermocouple was used, not nasal pressure PSG duration = 6-7 hours. No mean given. Timing = Nocturnal	symptoms of OSA are poor predictors of PSG-defined OSA - snoring loudness (in dB, measured during PSG) was the best predictor of OSA - T&A in a subgroup of children showed a reduction in RDI in the expected direction. One sentence in the Discussion suggests that this may have been driven in particular by one child with a craniofacial anomaly (Treacher-Collins).
38	Guilleminault (1982)	4	Description of a clinical cohort with no apnea on PSG but Pes swings, tachypnea and sinus arrhythmia (ie. UARS). This study was designed to evaluate children with suspected sleep apnea due to a variety of clinical symptoms who were PSG negative but had adenotonsillar hypertrophy.	Clincal series Blinding not specified	Eligible: Unknown Completed study: 25 % males: 60 # controls: 25 % males: Not specified	Cases: 7 (2-14) All prepubertal Controls: "not exactly aged matched, but similar, greatest age difference between patient and control was 12 months) Narrow spectrum	Community referral Expert assigned or selected groups Funding In part by gifts to C. Guilleminault from the Pacifica Firefighter's Wives' Association and Institute National de la Sante et Recherche Medicale	Not specified	Other diagnostic criteria developed by authors	Not applicable	Full PSG with Pes. PSG duration = 9 hours (TRT) Timing of PSG: Overnight 22:00-7:00	Findings of Pes swings and tachypnea indicate a type of sleep-disordered breathing, ie. UARS
115	Mitchell (2007)	2	To evaluate quality of life in children pre- and post- T&A. PSGs were performed prior to T&A and again approximately 5 months (range 1-9 months) after surgery.	Prospective cohort study Blinding not specified	Eligible:118 Completed study: 79 % males: 40/79= 51% No controls	Cases: 6.3 yrs (range 3.0-15.8yrs) withmajority between 3-6 yrs Controls: n/a Narrow spectrum	Academic center Expert assigned or selected Funding not specified	Outcomes measures (quality of life or academic)	PSG criteria	No / Yes	Comprehensive PSG PSG duration = 426±54 mins pre-op and 414±78 mins post-op sleep time Timing = Nocturnal	Findings supportive of residual SDB in large minority of children undergoing T&A, especially when pre-op AHI is higher. May support a role for post-op PSG in children undergoing T&A Findings supportive of lack of robust correlation between improvement in OSA severity and improvement in outcomes (in this case quality of life) Post-op symptom reports showed good correlation with post-op persistence of OSA Mean preoperative AHI 27.5, postoperative 3.5 (p <0.001). Statistical analysis to have sufficient power to detect a significant change.
181	Apostolidou (2008)	2	This study was designed to assess the efficacy of adenotonsillectomy as treatment for OSA in obese patients, and to compare outcomes found with nonobese patients. Pediatric patients who had a history of frequent snoring and adenotonsillar hypertrophy, and who had undergone PSG and received a diagnosis of OSA were recruited at the time of surgery (adenotonsillectomy). If the parents agreed to having the child return for f/u PSG, the child was eligible to participate in the study. Children with neuromuscular disorders, craniofacial abnormalities, or previous T&A were excluded. In addition to the baseline PSG, subjects underwent a postsurgical PSG, "at least two months after T&A accordning to the availability of PSG appointnments and at the convenience of the parents". Subjects also had height and weight measurements at baseline and at follow up. Primary outcome measure was the achievement of AHI<1. A secondary outcome measure was the achievement of AHI<5 with SaO2 nadir of >88%.	Prospective cohort study (Children were included only if parents consented to PSG following AT) Blinding not specified	Eligible: not stated Completed study: 70 Cases (obese): 22 # control (nonobese): 48	Cases: 5.8 + 1.8 Controls: 6.9 + 2.6 Narrow spectrum	Academic center Expert assigned or selected Non-US funding agency	Not specified	PSG criteria	No / Yes	Comprehensive PSG PSG duration = "overnight" Timing = Nocturnal	1. Polysomnography has face validity in this pediatric population, in that obese children had higher AHI than nonobese children preoperatively. 2. PSG demonstrated test-retest validity in that AHI improved in the expected direction postoperatively. 3. PSG face validity was NOT demonstrated postoperatively in that a substantial percentage of both obese and nonobese patients did not reach the threshold of surgical cure postoperatively, and obesity was NOT a significant predictor of whether or not OSA was cured following surgery.
63	Chervin (2006)	2	PSG, MSLT, neuropsychological testing and parental behavioral ratings were completed on 105 children aged 5-12 (77 case subjects scheduled for AT; 27 scheduled for unrelated surgical care) at baseline and 1 year later. The study tested the hypothesis that children who undergo AT, in comparison to other surgical procedures, experience more neurobehavioral improvement one year after surgery.	Case control Blinded study	Eligible: 78 Completed study: 77 % males: 57 (of total group) # controls: 27 (23 completed study) % males: 57 (of total group)	Cases: 8.4 +/- 1.9 yrs. (5-12.9 yrs) Mean age and range is for entire study group; no designation of case and control values. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	Behavioral scales MSL on MSLT Cognitive Testing Psychiatric Diagnosis	Other diagnostic criteria developed by authors Clinical indication for AT as determined by ENT.	Yes / Yes	Comprehensive PSG PSG duration = overnight Timing of PSG: Nocturnal	1) Children scheduled for AT often have mild-moderate SDB and significant neurobehavioral morbidity, including hyperactivity, inattention, ADHD and EDS. 2) All measures of neurobehavioral morbidity improve 1 year following AT. 3) Common measures of SDB by PSG did not show associations with baseline neurobehavioral morbidity other than sleepiness and one-year changes in PSG generally did not predict neurobehavioral outcomes other than sleepiness. 4) Lack of better correspondence between these variables may reflect limitations of standard SDB measures in the assessment of neurobehavioral morbidity for children with mild-moderate SDB, which is generally the most common type of SDB treated by ENT.

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131	Helfaer (1996)	4	15 children aged 1-12 years with mild OSA as determined by preop PSG (OAI 1-15/hr) and enlarged tonsils/ adenoids underwent a PSG on the night after their adenotonsillectomy to determine if more severe airway obstruction occurred immediately post-op. Groups were randomized to narcotic or non-narcotic anesthesia to determine if either group had a more severe post-op course To determine whether it is necessary to monitor patients with mild OSA s/p tonsillectomy in an ICU setting, and whether narcotics during anesthesia impact post operative course	Clincal series Blinding absent	Eligible: 18 Completed study: 15 % males: not specified	Cases: 5.1 =/+0.8 (1-12) Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Pre-op PSG compared with PSG on night immediately post-op	PSG criteria	No / Yes: OA = cessation of oronasal airflow for 5 secs plus >4% O2 desat Obstructive HYPOVENTILATION (they don't call this hypopnea) = amplitude decreased by 50% for 5 secs plus > 4% desat CA >20 sec or shorter if sats drop or bradycardia	Comprehensive PSG PSG duration = not specified Timing of PSG: Nocturnal	1) Obstructive respiratory events per hour of sleep and severity of oxygen desaturation were reduced during PSG following adeno-tonsillectomy as compared to preoperative PSG. A change in frequency of respiratory events in the expected direction following surgical intervention provides test-retest validity for PSG. 2) Patients with mild sleep disordered breathing due to adenotonsillary hypertrophy who have no other risk factors do not show evidence of worsened upper airway obstruction immediately post-op, and additional inpatient monitoring does not appear to be warranted. 3) There does not appear to be an increased complication rate after adenotonsillectomy in patients receiving narcotics. Caveat is that numbers were small
71	Jain (2002)	4	Correlate incidence and severity of OSA with TA size,	Clincal series Blinding absent	Eligible: Unknown Completed study: 40 % males: 50	Cases:4-12 yrs Controls:none Narrow spectrum	Community referral Recruitment strategy: Not specified Funding source: Not specified	Multiple comparators: Physical exam Symptoms Inflammation Cephalometrics (laternal neck xray)	PSG criteria	Yes / Yes (used 10 seconds)	Comprehensive PSG PSG duration = not defined Timing of PSG: Nocturnal , pre T&A and 6-8 weeks post PSG	Clinical symptoms of obstruction and TA hypertrophy strongly correlates with SDB as defined (using thier definition of SDB) for OSA. Using a CD angle of 64 deg may be enough to indicated SDB and allow the surgeon to operate. Sensitivity and specificity of the clinical symptoms and measurements not reported in comparison to PSG findings.
30	Nieminen (2000)	3	This study looked at 58 snoring children with symptoms of SDB who underwent two PSGs 6 months apart. Thirty healthy children also underwent a single PSG as a control	Prospective cohort Blinding not specified	Eligible: 78 Completed study: 58 % males: 53 # controls: 30 % males: 57	Cases: 5.8 +/- 1.8 (2.4-10.5) Controls: 7.1 +/- 1.8 (4.3-10.9) Narrow spectrum	Community referral Expert assigned or selected Funding not specified	This study used a questionnaire to determine severity of symptoms of OSA, and an OSA scoring system developed by Brouillette but not further described	PSG criteria	No (no EEG) / Yes (but not "standard" and technology poor)	No EEG or EOG was used, so no sleep stage scoring was done Duration not specified Timing was nocturnal	1)This study suggest that clinical symptoms alone are inadequate in differentiating primary snoring from obstructive sleep apnea, and that PSG is required. 2)This study suggests that an AHI of >2 on PSG may be an indication for T&A, with improvement in symptoms and PSG findings postoperatively 3) I n patients with primary snoring, short term f/u (6 months) with PSG does not appear warranted as symptoms did not worsen in this study in those patients Strain gauge, no CO2 monitoring, No nasal pressure so accuracy of test deficient ****No sleep stage scoring/EEG monitoring was done in this study
129	O'Brien (2006)	4	PSG before and after treatment for OSA in 29 obese and 40 non-obese children were compared. Contribu-tions of disease severity and time to repeat PSG were also analyzed The purpose of this study was to determine if obesity impacted on the outcome of treatment for obstructive sleep apnea in children	Clincal series Blinding absent	Eligible:213 Completed study: 69: 29 obese, 40 non-obese % males: 79%obese, 65% non-obese	Cases: 9 +/- 3.7 obese; 5.7 +/- 4.1 non-obese Narrow spectrum	Academic center Expert assigned or selected groups Funding source not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = Up to 12 hours Timing of PSG: Nocturnal	This study suggests that post treatment PSG should be perfomed to assess residual disease, particularly in obese patients with a high likelihood for persitant OSA after T&A.
124	Tauman (2006)	3	Review of pre-op and post-op PSG's for 110 children who underwent T'n'A for OSAS to see if they were cured (AHI<=1) and what factors could be used to predict which children would have residual OSA. Factors examined included disease severity, relative BMI, h/o allergy, family hx of SDB in a 1st-degree relative, age, and ethnicity. Separately, age/gender/relBMI-matched controls were gathered for the group that had post-op AHI<=1 to see if there were any differences in sleep architecture.	Clincal series Blinding not specified but presumably absent since the indication for the second PSG was the surgery	Eligible: 110 % males: 60% # controls: 22	Cases: 6.4 + 3.9 (1 y.o. -16 y.o.) Controls: not stated but age matched Patient spectrum unclear	Academic center and community referral Strategy ot specified Government funded And foundation funded	Not specified	PSG criteria	Yes R&K / Were respiratory scoring methods clearly defined? Yes OA=no A/F w/ chest/abd movement for >2 breaths Hypopnea= fall of nasal A/F of >=50% with either 4% drop in oxy sat or arousal over at least 2 breaths Comments: Cure=AHI<=1 Mild OSAS=1<AHI<5 OSAS=AHI>=5	Comprehensive PSG 1. 8 leads of EEG 2. ROC-A1 3. LOC-A2 4. Submental EMG 5. EKG 6. RAT and or LAT 7. Nasal airflow thermistor 8. Nasal pressure cannula 9. Thoracic movement inductance plethysmography or respiratory impedance 10. Abdominal movement either inductance plethysmogra-phy or respiratory impedance 11. Position sensor 12. Pulse oximeter 13. ET-CO2 PSG duration = between 432.2 and 435.8 Timing of PSG:Nocturnal	1. PSG is indicated to assess residual OSAS in post T'n'A children as the cure rate is fairly low (25% in this study); 2. Factors suggesting an increased likelihood of having residual OSA (AHI>5) include pre-op AHI and +FH of SDB but these factors account for only 25% of the likelihood of having residual OSA; 3. H/o allergy, relBMI, age, and ethnicity were not predictive of post-op AHI >5 4. A smaller %'age of obese children were fully cured (AHI<=1) than non-obese children suggesting an even greater imperative for post-op PSG in obese children; 6. This study demonstrates test-retest validity for PSG as a measure of OSA as the respiratory parameters improved after T'n'A 7. Sleep parameters are worse pre-operatively in children with OSA who are scheduled for T'n'A than post-operatively demonstrating that PSG is sensitive to abnormalities in sleep caused by OSA; 8. The finding of similar sleep parameters (except for a slight decrease in the % of stage 2 sleep) in children whose OSA is cured with T'n'A and normal controls (children without OSA) provides convergent validity that the parameters obtained during PSG are a reasonably measure of sleep.
123	Tunkel (2008)	3	Polysomnography and a quality of life questionnaire (OSA-18) were completed pre- and post-operatively on 14 children (ages 3-12 years) with moderate OSA, who underwent surgical treatment by powered intra-capsular tonsillectomy and adenoidectomy (PITA).	Prospective cohort study Blinding not specified	Eligible: 19 Completed study: 14 % males: 50% No controls	Cases: 71 months (range 28-113 months) Controls: NA Narrow spectrum: Excluded: obese, craniofacial abnormalities, chromo-somal abnormalities, sickle cell anemia	Academic center Expert assigned or selected groups Government funded	Outcomes measures (quality of life or academic)	PSG criteria	Not applicable / Yes	Comprehensive PSG Duration = Overnight Timing = Nocturnal	1) PITA cures otherwise healthy children with moderate OSA, at least in the short term, as documented by PSG. 2) Improvements in QOL, as measured by the OSA-18, were seen in all children as well. 3) Demonstrates test-retest validity of PSG because AHI and quality of life scores improved in the expected direction following PITA.
126	Walker (2008)	3	A database of PSG findings was kept for children who were diagnosed with OSA & who underwent tonsil-lectomy/adenoidectomy (T&A). Those who underwent a postsurgical PSG were eligible for inclusion in the analysis. This study reports the pre- and postsurgical PSG values in this group of pediatric subjects. A total of 34 children were included in the analysis. The spectrum of patients included was wide, and includ-ed multiple syndromic patients (one with Kabuki syndrome, 3 with Down syndrome, 1 with hydrocephalus, 1 with fragile x syndrome, and 1 with submucosal cleft palate).	Clinical series, observational study, case report Blinding not specified	Eligible: not stated Completed study: 34 % males: not stated%	Cases: range 0.93y to 5 yr (mean and median 3 years, no standard deviation given) Controls: n/a Wide spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No / No	Comprehensive PSG PSG duration = "overnight" Timing = Nocturnal	1. Test-retest validity of PSG is demonstrated in that RDI and SpO2 improved in the expected direction following adenotonsillectomy. 2. Many pediatric patients who undergo T&A for OSA will have postoperative PSGs which are still considered to be abnormal. This would suggest that a postoperative PSG should be strongly considered for all pediatric patients.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
54	Wiet (1997)	4	They looked at 3 measures pre- and post-op: AHI—likely this was an obstructive AHI as both apneas and hypopneas were defined in terms of OA and OH % sleep time oxy sat below 90% % sleep time ET CO2 > 50 torr	Clinical series, observational study, case reports Retrospective chart review Blinding absent since the scorers knew these were post-op studies.	Eligible: 48	Cases: 7.5 years (1.5-20 yr) Wide Spectrum	Academic center Random selection Not specified	Not specified	PSG criteria; other criteria: Some Ss were included based on a high suspicion of OSA either by history or by physical exam prior to PSG so to some extent other criteria were used	Yes; Comments: Apnea=10" of no airflow with paradoxical chest/abd movement; Hypopnea=decrease in tidal volume, amplitude change not specified, with paradoxical breathing; implied duration is 10"; no desaturation specificed OSA=AHI>5/hr (apparently only obstructive events)	Comprehensive PSG 1. EEG (?2 leads?) 2. EOG (?2leads or 1?) 3. EMG 4. EKG 5. Nasal airflow 6. Oral airflow 7. Thoracic and abdominal movements 8. Tidal Volume 9. Pulse oximeter 10. ET-CO2 11. Esophageal manometer in some patients PSG duration = not specified Timing of PSG:Nocturnal	PSG demonstrates the expected improvement in respiratory parameters seen post-ENT surgery in a wide range of children demonstrating test-retest validity for PSG as a measure of OSA.
130	de la Chaux (2008)	4	To evaluate tonsillotomy in 20 children with OSA using pre- and post-op PSG	Clinical series, observational study, case report Blinding absent	Eligible: unknown Completed study: 20 % males: 15/20=75% No controls	Cases: 4.1±2.0 yrs (range 2-9yrs) Controls: n/a Narrow spectrum	Academic center and Community referral Self-selected groups Funding not specified	Parental observations	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 458±33 mins pre-op and 465±46 mins post-op Timing = Nocturnal	Findings supportive of CO2 laser tonsillotomy with adenoidectomy as a therapy in non-obese, young children with OSA Test-retest validity of PSG-determined AHI is demonstrated in that there was a significant reduction in obstructive AHI following surgery, and no difference in frequency of central apneas following surgery.
80	Montgomery-Downs (2005)	3	19 children from a state-funded preschool program for at risk children with low SES underwent overnight PSG and cognitive assessment before and after T&A for OSA. 19 matched controls underwent a single PSG and cognitive eval. This study was done to examine the impact of T&A on sleep, respiration and cognitive function in preschool kids with OSA from a low income community	Case control study Blinded study	Eligible: 39 Completed study:19 % males: 53 # controls: 19 % males: 53	Cases: 4.4 +/- .7 Controls: 4.5 +/- .6 Narrow spectrum	Questionnaires to state sponsored program for at risk kids, (1951 respondents – 33 % of questionnaires) 273 of responders underwent PSG and cognitive testing; 39 had SDB diagnosed by PSG Self-selected groups Government funded	Cognitive assessment used Differential Ability Scales (DAS), preschool sion, and Pre-Reading Abilities subtest from Developmental Neuropsychological Assessment	PSG criteria Other: BMI	Yes / Yes	Comprehensive PSG PSG duration = up to 12 hours Timing of PSG: Nocturnal	1) This study suggests that it may be beneficial to screen more widely for snoring and SDB in at-risk preschoolers, using PSG to diagnose OSA. 14% (38/273) of children who snored occasionally (2 nights/week), frequently (3-4 nights/week), or often (>4 nights/week) demonstrated sleep disordered breathing on PSG. 2) This study demonstrates test-retest reliability of PSG by showing improvement in the expected direction with regard to respiratory variables (respiratory arousal index, AHI, and SpO2 nadir) in children undergoing T&A for OSA. 3) This study also demonstrated test-retest reliability of PSG by showing improvement in the expected direction with regard to slow wave sleep (increased) but failed to demonstrate improvement in other sleep stage percentages. There was a statistically significant decrease in REM sleep after T&A that could not be accounted for by methodological issues such as duration of recording.
261	Sanders (2006)	2	Children aged 2-16yrs presenting to ENT for T&A due to either sleep disturbance or recurrent tonsillitis were eligible for this study. Children were classified as OSA or non-OSA based upon PSG findings prior to surgery. All children with OSA and those <3yrs without OSA were monitored post-op. The study period was divided into 4 time frames: induction/intubation; maintenance of anesthesia; emergence from anesthesia; and post-op recovery. The goal of the study was to identify risk factors for perioperative complications in children with OSA who undergo T&A	Case control study Blinded study	Eligible: 62 Completed study: 61 % males: 56% # controls: 21 controls were children undergoing T&A for recurrent tonsillitis % males: 52%	Cases: 6.5yrs (range 2.1-13.3yr) Controls: 7.0 yrs (range 3.4-12.9yr) Narrow spectrum	Academic center and community referral Expert assigned or selected Funding not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / Yes (definition of apnea/hypopnea given although no details on how airflow etc was recorded)	Not specified: no details of PSG methodology (other than definition of RDI) PSG duration = not specified Timing of PSG:Not specified	T&A in children with OSA is associated with increased frequency of complications Children with more severe OSA had more complications post-operatively; these data give some support to a role for PSG pre-T&A particularly in younger children
262	Wilson (2002)	3	Chart review of all children referred by specialists for sleep study who subsequently underwent T'n'A. Pts who had undergone ambulatory recording with only resp data were included (and comprised 136 of the 163 subjects). Question was whether certain obstructive AHI values or oxy nadirs pre-op were predictive of the need for medical intervention post-op based on the appearance of respiratory complications (defined as a post-op oxy sat below 95%--unclear but likely in the setting of supplemental O2—or report of airway obstruction (witnessed apneas).	Not specified Retrospective chart review Blinded study PSG's were performed and scored pre-op	Eligible: Not stated Completed study: 163	Narrow spectrum Patients were referred by specialists and all were thought to have indications for T'n'A BUT AHI's were all over the place	Academic center All children who underwent PSG and then T'n'A within 6 months Funded by McGill departmentsPrivately funded (non-pharmaceutical)	Not specified	Not stated	No NO sleep stages were scored. Were respiratory scoring methods clearly defined? Yes Comments: Apnea—decrease ampl >80% for at least one breath; Hypopnea—decrease ampl 50-80% with oxy fall of at least 4%	Comprehensive PSG for some children and ambulatory, respiratory-only studies in other children Both studies had the following: 1. Thoracic belt; 2. abdominal belt; (The above were combined into a single summation channel for a measure of respiratory effort) 3. either toe or finger oxygen saturation/plethysmography 5. video recording The full PSG's also had EEG (channels not specified), EOG, and submental EMG PSG duration not specified Timing of PSG:Nocturnal	1. Pre-op PARTIAL (resp only) PSG finding of obstructive AHI>=5/hr increased chance of requiring post-op intervention for a resp complications 2. Pre-op oxy nadir of <=80% increased chance of requiring post-op intervention for a resp complications; 3. Absence of OSA (O-AHI<1) was a good predictor of NOT requiring a post-op intervention; 4. Although all patients who required an intervention were picked-up by PSG at a cut-off of O-AHI>=1, using PSG alone at that cut-off would result in a fair number of false positives. 5. Paper suggests that pre-op resp monitoring with either a partial PSG or pulse ox may identify high-risk group for post-TnA complications
263	McColley (1992)	4	The aim of this study was to review charts of children who had T&A for PSG-documented OSA and who were monitored post-op in the PICU to determine if there are identifiable risk factors for post-op airway compromise	Clinical series, observational Bliding not specified; This study was designed to determine post-op respiratory compromise in children undergoing surgery for OSA and whether there are factors that can predict it	Eligible: 69 Completed study: 61 % males: not specified # controls: none	Cases: range 0-18yrs Mean age of 16 children with post-op complications was 3.4yr±4yr Mean age of 45 children without post-op complications was 6.1±4yrs Children with mild post-op resp compromise not included in analysis (n=8) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Cases identified retrospectively from children having T&A who had PSG beforehand and who were monitored in the PICU post-op Privately funded (non-pharmaceutical)	Physical examination	Diagnosis reached using PSG criteria	No / Yes	Comprehensive PSG PSG duration: not reported PSG timing: nocturnal	Findings suggest that age <3yrs and obstructive event index>10/hr are strong predictors of respiratory compromise in children following T&A for OSA Findings support use of overnight monitoring following T&A for OSA in young children Gets to the heart of the question of clinical utility of PSG. 1. To determine if child has OSA 2. To determine severity of OSA 3. To determine treatment response This study looks at issue #2 and says that need PSG to determine severity so can better monitor children following surgery and figure out which children need to be monitored..
264	Rosen (1994)	4	The aim of this study was to; 1) describe post-op respiratory complications after Tand/orA for OSA; 2) define which children are at risk of these complications; 3) determine whether CPAPis an effective strategy for dealing with these complications. The authors investigated whether post-operative monitoring of children undergoing T&A for OSA is appropriate.	Clinical series, observational Blinding not specified; This study was designed to evaluate whether children undergoing Tand/orA for OSA should be monitored post-operatively through an entire sleep period	Eligible: 37 Completed study: 37 % males: 23/37 = 62%	Cases: range 0-15yrs Mean age of 10 children with post-op complications was 1.8y±1.4yr Mean age of 26 children without post-op complications was 5.2±3.0yrs Note that I child was not included in the data (had pre-op use of CPAP and no post-op complications) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Cases identified retrospectively from children having Tand/orA who also had PSG beforehand Funding not specified	Physical examination	Diagnosis reached using PSG criteria and Diagnosis reached using other diagnostic criteria developed by authors	Yes Specified that R&K used Yes	Comprehensive PSG PSG duration: not reported PSG timing: nocturnal	Findings suggest that children with OSA who have other comorbid conditions in addition to adenotonsillar hypertrophy are at high risk of post-op respiratory compromise. Findings support overnight monitoring post-operatively(eg with apnea montior and SpO2) Findings support PAP therapy if post-op UAO apparent Identified an increased risk of immediate postoperative respiratory compromise in children with "high-risk" polysomnogram results (e.g., respiratory disturbance index >40 and SpO2 nadir <70%. Similar to 388 McColley makes a case for the clinical utility of PSG to identify those children with more severe disease in order to provide appropriate post-surgery monitoring.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
265	Ye (2008)	4	This was a retrospective study of children aged 4-14yrs who underwent T&/orA for OSA and who had both pre-op PSG and post-op monitoring in the PACU. Children with craniofacial anomalies, syndromes etc were excluded. Children were divided into 2 groups for comparison; those who required major medical intervention post-op and those who did not. Quality of life assessments also made using OSA-18	Clinical series, observational study, case report Blinding absent	Eligible: 321 Completed study: 321 % males: 210/321= 65% No controls	Cases: 8.0±3.4yrs (range 4-14yr) Narrow spectrum	Academic center that had community referrals Expert assigned or selected Funding not specified	Outcomes measures (quality of life or academic)	PSG criteria	No / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	Findings supportive of increased post-op risk of respiratory complications in children with more severe OSA pre-operatively Supportive of a role for pre-op PSG in children undergoing surgical intervention for OSA in order to identify which children are at risk of post-op compromise. ** interesting that even though young children (<4yr), those with craniofacial anomalies and other comorbid conditions excluded, a lack of obese children in this population, the results are still very similar to studies that have included these children ** (i.e young age, obesity etc predictive of post-op complicatons)
250	Biavati (1997)	4	A retrospective chart review of 355 patients, who were undergoing TA for SDB, was completed for the purpose of determining risk factors predictive of outcomes, to aid in the cost-effective preoperative evaluation and postoperative management of patients undergoing clinically indicated TA.	Clinical series; retrospective chart review of children who had T&A for clinically diagnosed OSA to determine risks for postoperative complications.	Eligible: 355 Completed study: 355 % males:not reported	Cases: not reported Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Historical information regarding snoring, enuresis, EDS and hyperactivity	Other criteria (not specified)	No / No	Not stated	It is suggested that preoperative PSG may be predictive of postoperative complications after clinically indicated TA, but the small percentage of subjects (23/355) that underwent PSG does not allow this question to be answered by this study. "PSG" undefined in this study; no information about the testing is given at all.
42	Pang (2004)	4	This is a retrospective chart review involving 109 children aged 3-14, who underwent T&A for "clinical suspicion of OSA". Of this population, 36 had had a prior PSG, while 73 underwent T&A after clinical evaluation alone suggested sleep apnea (snoring and subjective respiratory complaints while sleeping). The prevalence of surgical complications in this population is discussed.	Not specified this is not a case control study but rather a retrospective review of all kids suspected of having OSAS – case series. Blinding not specified	Eligible: 36 Completed study: 36 % males: 66% ("sex ratio was 2:1 males to females") # controls:73	Cases: "range 3-14 years" Controls: "range 3-14 years" Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified--surgical outcomes were compared between those diagnosed with OSA by PSG and those diagnosed clinically.	PSG criteria, other criteria: diagnosis was made clinically by presence of snoring and subjective "choking" symptoms	No / No	Not specified: the type of PSG and duration of PSG is not indicated in the article PSG duration = not specified Timing of PSG:Not specified	Polysomnography does not provide incremental value above clinical evaluation in the assessment and management of post-operative risk in children undergoing T&A for clinical suspicion of OSA. Surgical technique and post-operative monitoring methodology or pre-op preparation as well as intro-operative management not discussed and they all could impact likelihood of post-operative complications.
267	Rieder (2005)	4	This is a retrospective chart review of the hospital course of children <3 years old who underwent PSG. Children were separated into two groups: those that underwent PSG prior to the surgery, and those who did not. Complication rates and length of stay data were compared between groups. In addition, the authors evaluated the presence of comorbidities and compared these data between groups.	Retrospective chart review Not blinded	Eligible: Unknown Completed study:43 % males: not stated # controls:282 % males: not stated	Cases: avg age 25.9 months Controls: avg age 30 months Narrow spectrum	Academic center Other, specify: retrospective chart review; study from pediatric ENT department, Medical College of Wisconsin, Funding not specified	Outcomes measures (quality of life or academic) Post surgical outcomes	PSG criteria, other criteria: diagnosis in control group made clinically	No	Multiple PSG types, specify: 38 patients had "16 channel PSG"; 3 patients had "4-channel PSG" and 2 patients had overnight pulse oximetry ONLY 38 of 282 children had 16-channel PSG, PSG duration = not stated Timing of PSG: Nocturnal	In cases where obstructive sleep apnea is clinically suspected, PSG should not be used to assist with post-operative risk stratification in children <3 years old. The authors state that in "the 3 years and younger group in the absence of other comorbities can safely undergoing adenotonsillectomy without undergoing preop PSG provided that close attention is paid to postop clinical findings while patients are being monitored." Study at least suggests that children <3 with comorbities at great risk for postop complications and longer LOS. Cannot say PSG invalid tool unless studied all children <3 in whom T+A done.
268	Yuan (2004)	4	This retrospective review looked at medical records of children undergoing surgery for scoliosis and aimed to determine whether PSG or infant PFTs could predict the need for prolonged mechanical ventilation post-op (>3 days). PFTs appear to predict the need for prolonged ventilation but this group of children were unable to perform PFTs, hence why infant PFTs and PSG were evaluated. 66% of children had daytime nap studies and the rest had overnight PSG	Clinical series, observational study, case reports Blinding not specified	Eligible: 110 Completed study: 110 % males: 56/110 = 51% No controls	Cases: 10.8±4.9 yrs (range 1.6-20.5yrs) Wide spectrum	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / Yes	Comprehensive PSG (34%) or Daytime nap studies 66% of subjects) PSG duration = at least 6 hrs for both nocturnal and daytime PSG Nocturnal or daytime naps	Findings not supportive of PSG parameters predicting prolonged mechanical ventilation in children undergoing scoliosis surgery
133	Mogayzel (1998)	3	This study is describing sleep and respiratory characteristics in 88 children with achondroplasia and a wide range of clinical problems. 43 of these children had repeat PSGs: 16 to evaluate effects of therapy, 15 to potentially discontinue oxygen, CPAP or tracheostomy; 10 who were free of symptoms At the time of the first PSG, 5 pts had already undergone tracheostomy for severe OSA, and seven required supplemental oxygen. In addition, prior to first PSG 24 pts had undergone surgery (5 trachs, 9 cervicomedullary decompression, 6 VP shunts, 11 T&A) OSA, CSA, hypoxemia, hypoventilation all reported	Clincal series Blinding absent	Eligible: 88 Completed study: 88 % males: 52	Cases: 1 month to 12.6 years (median 1.2 years) Narrow spectrum	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical)	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 387 minutes median (range 131-541) Timing of PSG: Nocturnal	1. PSG is helpful in identifying sleep disordered breathing in patients with achondroplasia 2. PSG appears useful in assessing adequacy of intervention for various causes of sleep disordered breathing in patients with achondroplasia 3. In patients with achondroplasia and no significant abnormalities on initial PSG, repeat PSG does not appear to reveal any additional abnormalities, however, these numbers are small 4. The study demonstrated test-retest reliability of PSG in that the AI improved in the expected direction in children undergoing treatment for sleep-disordered breathing.
266	Brown (2003)	4	This study is a retrospective medical chart review performed to determine the frequency and type of respiratory complications after urgent AT (study group, n=54) and compare these results to elective AT (control group, n=44), to assess risk factors predictive of complications after urgent AT.	Case control Blinding not applicable	Eligible: 54 Completed study: 54 % males: 80 # controls: 44 % males: 57	Cases: 4.0 +/- 2.4 yrs. Controls: 3.5+/- 1.9 yrs. Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	physical examination by ENT	PSG criteria, other criteria:clinical determination of OSA and indication for adenotonsillectomy (AT) as determined by ENT.	No / No	Multiple PSG types, specify: limited sleep study and oximetry. PSG duration = not defined. Timing of PSG: Not specified	1) The most important risk factors predictive of respiratory complications after urgent AT are severe OSA (as defined by preoperative oxygen nadir) and an associated medical condition. 2) The rationale for urgent AT, based on a very low preoperative O2 saturation nadir, requires critical review, due to the increased rate of respiratory complications compared to elective AT.
4.2.4 Clinical utility of PSG for assessment of infants less than 12 months of age with suspected SRBD or related conditions												
269	Simakajornboon (2002)	2	To investigate the effect of low-flow supplemental oxygen (SupOx) on sleep architecture and cardiorespiratory events in asymptomatic preterm infants.	Prospective cohort study Blinded study	Eligible:28 Completed study:23 % males:57% # controls: Same as cases; crossover study % males: Same as cases; crossover study	Cases: Premature infants who were born at 30.0 ± 3.2 (SD) weeks' gestational age and studied at 38.1 ± 4.4 weeks' postconceptional age. Narrow spectrum All infants were considered stable and were ready for discharge from the nursery by their medical and other caregivers. Infants were excluded from the study when they had significant medical problems, including genetic diseases, craniofacial anomalies, grade 3 and 4 intraventricular hemorrhage, chronic lung disease requiring continuous oxygen supplementation, and neuromuscular diseases.	Academic center Expert assigned or selected groups Privately funded (non-pharmaceutical) And NIH/state funding for one author	Not applicable	PSG criteria	Yes Anders T, Emde R, Parmelee A, eds. A Manual of Standardized Terminology, Techniques and Criteria for the Scoring of States of Sleep and Wakefulness in Newborn Infants. Los Angeles, CA: UCLA Brain Information Services; 1971 Were respiratory scoring methods clearly defined? Yes Periodic breathing was defined as a series of 3 or more apneic events of at least 3 seconds' duration, separated by <20 seconds of uninterrupted breathing.10 Apnea (central, obstructive, or mixed) that lasted >5 seconds was scored; however, hypopneic events were not scored. The distribution of different type of apnea was calculated as percentage of total apnea.	Standard infant montage was used, and the following variables were recorded simultaneously: body position, left and right electrooculogram, 3-channel electroencephalogram (C3A2, C4A1, and O1A2), chin electromyogram, pulse oximetry and pulse wave form, thoracic and abdominal inductance plethysmography, nasal airflow, end-tidal Pco2, and transcutaneous Po2 and Pco2. An accelerometer was also placed on 1 arm to measure gross body movements. PSG duration =10 hours Timing of PSG: Not specified	This study shows that otherwise healthy premature infants evaluated with full PSG have frequent, unsuspected advese cardiorespiratory events including apnea and bradycardia. Findings also support that administration of low-flow supplemental oxygen improved respiratory stability in several ways, and PSG was helpful in confirming this improvement.
270	Witcombe (2008)	4	25 infants born preterm were studied during daytime naps and sleep states, BP and HR were recorded and compared to 20 term infants also studied under same conditions. Each infant was studied at 2-4 weeks, 2-3 months and 5-6 months corrected age. None of the infants were born to smoking mothers, none had major medical problems, abnormal cranial US or significant cardiorespiratory problems. 3/22 preemies had been SGA; the remainder were AGA	Case control study Blinding not specified	Eligible:25 Completed study:25 % males:44 # controls:20 % males:40	Cases: born at 28-32 weeks; studied at CA of 2-4 wks, 2-3 monts and5-6 months Controls: born at 38-42 weeks; studied at same times Wide spectrum	Academic center Strategy not specified Government funded (National Health Med Res.Council of Australia)	BP using non-invasive photoplethysmographic cuff	No real diagnosis, just norms of preterms compared to term infants	Yes (Quiet vs Active – indeterminate sleep not used for analysis) No (No respiratory parameters recorded)	Limited sleep study (EEG, video, EMG, EKG, thoracic and abndominal effort, O2sats with pulse ox, abdominal skin temp (as surrogate for vasodilation), and BP) PSG duration = not specified Daytime naps	PSG utilizing EEG to determine sleep state can be useful in determining differences in HR and BP during sleep in preterm and term infants; however, even though resp and abd belts were utilized, a video EEG , EKG and BP monitoring would have achieved the same results

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
271	Yiallourou (2008)	4	20 normal infants were studied with modified PSG as described above, at 2-4 weeks, 2-3 months and 5-6 months in both the prone and supine position to determine effects of age and sleeping postion, as well as sleep stage on HR and BP	Clinical series, observational study, case report Blinding not specified	Eligible: 20 Completed study: 20 % males: 40	Cases: FT infants (38-42 wks GA) were studied at 2-4 weeks, 2-3 months and 5-6 months of age Wide spectrum	Academic center Strategy not specified Government funded	Looked at continuous BP monitoring	Healthy infants, to determine norms	Yes (Determined as active or quiet sleep using EEG, behavioral, HR and breathing pattern criteria) No (No air flow was measured, just chest'/abdominal movement)	Limited sleep study (EEG, EOG, chin EMG, ECG, chest and abd belts, pulse ox, abdominal skin temp) PSG duration = Not mentioned "allowed to sleep naturally" Daytime naps	PSG can help identify autonomic changes during different post-natal ages during different sleep stages.
162	Abreu e Silva (1985)	4	Comparison of PSG data of healthy term infants and 3 subgroups of "index" infants: (a) SYMPTOMS GROUP: hospitalzed infants with mild breathing sx's from bronchiolitis/URTI/cong'l laryngeal stridor/rec't vomiting from cong'l hypertrophic pyloric stenosis; (b) SIBS: siblings of infants who had SIDS; (c) NEAR-MISS: near-miss for SIDS infants	Prospective cohort: Although it was a prospective study, there was no statistical analysis of results and no discussion of blinding or selection process. Blinding not specified	Eligible:86 Completed study: % males: Not specified # controls:11 % males: Not specified	Cases: not specified but all were infants	Academic center Strategy not specified Privately funded (non-pharmaceutical)		Not stated	No But they do describe active and quite sleep Were respiratory scoring methods clearly defined? No Comments: Looked for CA and OA and oxy falls Reported on 3-6 sec, > 6 sec obstructive apnjeas and dips in TCo2 of > 15 mmHg	1. EOG 2. EOG 3. EMG (?chin?) 4. EEG (single lead) 5. EKG 6. Nasal airflow 7. Chest band 8. ?Abd lead sometimes? 9. Oxygen tension--PtcO2 PSG duration =3-4 hours Timing of PSG: Not specified After last evening feed between 10PM and 4AM	This study demonstrates face validity of PSG in infants to differentiate normal from abnormal breathing patterns;
33	Rimell (1998)	3	17 children (under 10 months of age), with airway problems, underwent full PSG to evaluate the usefulness of obtaining a PSG for the evaluation of stridor or stertor.	Clinical series Blinding not applicable	Eligible: 17 Completed study: 17 % males: not specified	Cases: range 2-8 months Controls: NA Narrow spectrum	Academic center and community referral and Expert assigned or selected groups	physical examination	PSG criteria	Yes / Yes	Comprehensive PSG	1) Full PSG provides physiological data that complement anatomical data obtained via endoscopy and is a useful tool for evaluating the significance of airway disorders in infants. 2) Performing 4- or 6-channel studies is less than adequate and significant problems are often missed. 3) The presence of observed apneas plus stertor in an infant appears to be correlated with the presence of sleep-disordered breathing during PSG.
272	Guilleminault (2007)	2	This study investigated the presence of SDB in children with cyanotic breath holding. Parents chose SDB treatment (cases, n=14) or observation (n=5). Children were followed at 12 months, 18 months, and 24 months of age.	Prospective cohort Blinded study	Eligible: 19 Completed study: 19 (with 14 consenting to SDB intervention if necessary) % males: 11/19 = 58% # controls: the 5 children whose parents did not consent to SDB intervention were classified as controls	Cases: 31±3 weeks (includes all 19 children) Controls: not described separately; included in the above Wide spectrum	Academic center and community referral Self-selected groups Funding not specified	Pediatric Sleep Questionnaire; Craniofacial and upper airway/soft tissue evaluations	PSG criteria Other diagnostic criteria developed by authors	Yes / Yes (PSG included Pes)	Comprehensive PSG PSG duration = 438±22 mins (cases); 442±18 mins (controls) Timing = Nocturnal	- Results support use of Pes in pediatric PSG - Pilot results supportive of a role for PSG in children presenting with breath holding Note that several measures were obtained but results not fully presented/discussed (e.g., PSQ, airway evaluations)
4.2.4.1 Suspected Primary Sleep Apnea of Infancy												
273	Tirosh (1996)	4	17 infants sequentially admitted for evaluation of apnea of infancy or ALTE and associated regurgitation were studied with an overnight polysomnogram with pH probe in place.	Clinical series, observational study, case report Blinding absent	Eligible:17 Completed study:17 % males: 58.8 % males: 10 males, 7 females	Cases: 3-37 weeks (median 11 weeks) Narrow spectrum	Academic center (Haifa Israel (Technion)) Expert assigned or selected (17 infants sequentially admitted to pediatric department for apnea of infancy or ALTE and GERD) Funding not specified	pH probe	PSG criteria pH probe	No / No (Apnea > 5 sec)	Comprehensive PSG) pH probe calibrated before study with standard buffers (pH 4 and 7) and placed at the level of 75% of esophageal length; position confirmed by CXR or fluoroscopy "if required". 2) Video-monitored and any unusual behavior documented by sleep tech 3) Thermocouple, A1-C3, A2-C4, piezoelectric resp effort 4) video-PSG PSG duration = at least 6 hours Timing = Nocturnal	This study suggests that overnight PSG would be useful in evaluating infants with ALTE or suspected apnea of infancy, particulary with simultaneous evaluation with pH probe. Full EEG montage might be a consideration in this patient population, as 2/17 of these patients had epileptiform discharges preceding apneic events, with clinical improvement after anticonvulsant treatment Some infants with apnea of infancy (n= 17) may have seizures and/or GERD. (9) GERD cannot be consistently related to either of these. GERD (or seizures) when present in infants with apnea of infancy is best treated. Diagnostic yield of esophageal pH probe in this population is limited since GERD when present cannot be attributed to other apnea, seizure. GERD may occur after the onset of a seizure. Some episodes of apnea of prematurity may have GERD. Some children with apnea of prematurity have seizures. None particularly correlates with the other. Diagnostic yield of placing an esophageal pH probe to confirm GERD in an infant may not be valuable in 2009, not much done.
190	Paul (2009)	4	29 preterm newborns who had been diagnosed with clinically significant apneas and who had NOT responded to aminophylline treatment were studied with the basic PSG apparatus, however after a morning feed and not necessarily while sleeping. Behavior as well as polygraphic variables were recorded. Because of persistent apneas, both central and obstructive, as well as EEG changes and perioral EMG increases, the child was presumed to have reflux as the etiology of the breathing disturbance. Aminophylline was stopped, reflux treatment instituted (consisting of left side postioning, thickened feeds and frequent small feeds) and study was repeated.	Clinical series, observational study, case report Blinding absent	Eligible:29 Completed study:29 % males: not specified	Cases: studied at GA 33.4 +/-2.5 weeks (Born at GA 25-35 weeks mean 28.9 +/-2.6) Wide spectrum While all preemies, they included pts. with IVH, leukomalacia, PDA, kids with tube feeds	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria	No (not really a poly SOMNogram – no sleep really mentioned although EEG arousals were noted around the times of apneas) Yes (however, no hypopneas were scored)	Comprehensive PSG PSG duration =120 minutes Daytime naps	While not technically a PSG, recording of premature infants before and after treatment for GE reflux might help determine clinical improvement. There were a lot of assumptions no clear diagnosis of GE reflux, treatment was not pharmacologic, etc. TH: among premature children with sleep-related desaturation not responding to treatment with aminophylline, nap polysomnograms demonstrated that central and mixed apneas were more frequent than pure obstructive apnea.
4.2.4.2 Suspected Congenital Central Hypoventilation												
282	Weese-Mayer (1992)	4	This study summarizes the diagnosis, management and long-term outcomes of 32 patients with CCHS.	Prospective cohort study Blinding absent	Eligible: not specified, assuming all. Completed study: 32 patients from 3 countries and 14 states % males: 56% males (18 males) 14/32 girls (44%)	Cases: 3 months (range: 0.2-56 months) 91% born >37 wks gestation,, polyhydramnios in 3/32 otherwise N pregnancy 26/32, 81% white; Controls: n/a Narrow spectrum	Academic center Self-selected groups Funding not specified	Multiple comparators, specify: used as part of the evaluation globally not for comparison to PSG – CXR, ECG, ECHO< CT or MRI of head, brainstem ABR, metabolic workup,	PSG criteria Other diagnostic criteria developed by authors	No / no	Comprehensive PSG ventilation measured via trach using a pneumotach. , resp using RIP or strain gauges, infants less than 6 months were evluated for REM vs NREM sleep using behave criteria . Older kids using PSG critera to measure REM, NREM. the patients also underwent hypoxic challenges because they were tried off supplemental oxygen. Subsequent evaluations using CHLORAL HYDRATE 70 mg/kg PSG duration = measured ventilation during natural sleep, REM and NREM sleep Timing of PSG: Not specified	1) There was no way to predict who would be affected prior to presentation of respiratory failure. Dx often made in the neonatal period. 2) CCHS can present with either sleep or awake hypoventilation with associated conditions that can affect any other autonomic system. 3) There is a very high risk of morbidity and mortality in children with CCHS. Every child suspected of CCHS should have sleep and wake ventilation evaluated, with cardiorespiratory monitoring, including a PSG. Early diagnosis and management may improve morbidity and mortality in this high risk group. In this group, none responded to medications for ventilation.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
281	Huang (2008)	2	To test the hypothesis that children with CCHS (who were beyond infancy) would have more severe hypoventilation during REM and NEM. Also, to determine whether arousal occurs in response to endogenous gas exchange abnormalities. Genetic testing was performed on all subjects. Hypercapnic ventilatory response testing was conducted during wakefulness and spontaneous breathing trials were conducted during NREM and REM sleep.	Prospective cohort Blinded study	Eligible: unknown Completed study: 9 % males: 4/9=44% # controls: 9 % males: 4/9 = 44%	Cases: 13±7yr (range 5-20yrs) Controls: 13±7yr (range 5-20yrs) Wide spectrum	Academic center and communtity referral Self-selected groups Government funded and Respironics	Not specified	PSG criteria	Yes (R&K) / No	Comprehensive PSG Duration not specified Timing = Nocturnal	Findings supportive of more severe hypoventilation during NREM in CCHS although impairment still apparent in REM Supportive of CCHS subjects having frequent arousals with gas exchange abnormalities Supportive of central apneas being relatively common in CCHS
4.2.4.3 Suspected SRBD and gastroesophageal reflux												
287	Harris (2004)	4	This was an observational case series of 102 consecutive patients who were referred for PSG with overnight pH probe for various reasons. Polysomnographic findings and pH probe results are discussed and correlated.	Clinical series, observational study, case report (Infants were referred for apnea>>>GERD > SIDS, ALTE and SZs) Blinded study (the pH probe data was interpreted by investigator blinded to PSG results)	Completed study:102 % males:53%	Cases: 2.6 mo Wide spectrum ("Patients were enrolled without attempt to exclude any patient other than those in whom a pH probe study was not requested by the referring physician")	Community referral and academic center: Pontificia Universidad Catolica de Chile School of Medicine department of pediatrics Strategy: 102 consecutive patients prospectively referred to their medical school for "PSG with simultaneous pH probe". Their SDC performs pH probe for PSG only when requested by referring physician (implies GERD suspected as part of the sleep/wake complaint) Medical school study, no evidence of funding	Other forms of PSG	PSG criteria Other (not stated)	Yes (Defined acid reflux episode as a drop in pH to <4 for >6 seconds. Central apnea = cessation of breathing >20 sec without respiratory effort. Central pause = cessation of breathing >6 sec children <1 year, >3 but < 10 sec in children > 1 year. They differentiated apneas from briefer "pauses" Not applicable	Comprehensive PSG with pH probe 8 channels of EEG, pH probe (single antimony electrode) placed in distal third of esophagus as recommended by working group of ESPGHAN 1992. Probe calibrated before each procedure isomg 1.0-7.0 reference buffers. CXR to document probe position when necessary. PSG duration =8-10 hours Timing of PSG: Nocturnal in children older than 3 months, optionally during the day or night in children younger than 3 months; 50% were done daytime, 50% nighttime but these were infants <3 months of age	Simultaneous pH probe performed during PSG reveals pathologic GER in nearly half of all patients referred for overnight polysomnography in this patient population, though whether this information provides incremental diagnostic value above clinical diagnosis of GER is not investigated by this study. Pathologic GERD in 43%, physiologic GERD in 36%, 42% had no reflux; Re: Apneas: 86% had no apnea; 12% had obstructive apneas (0.9 per hour of sleep); 35% had "central pauses" averaging 9.2 per hour of sleep; 20% had obstructive pauses averaging 1.8 per h. Periodic breathing in 3%. In addition, since there did not appear to be a consistent relationship between GER and apnea events, simultaneous pH probe in a standard PSG should not be routinely recommended.
47	Rosen (1983)	4	26 infants with unexplained life-threatening apnea underwent clinical and PSG examination	Clinical series Blinding not applicable	Eligible: 26 Completed study: 26 % males: 65	Cases: 2.14+/- 1.25 weeks Narrow spectrum	Academic center Self-selected groups Government Funded	physical examination	PSG criteira, other criteria: clinical examination and GER data.	Yes / Yes	Comprehensive PSG Duration = 8-12 hours Nocturnal (12 hour recordings in 22 pts; 8 hour daytime recordings in 4 pts.)	1) Although subtle abnormalities may be detected by comprehensive PSG, they are not predictive of recurrent apnea or death. 2) Due to the absence of a control group in this study, differences between normal infants and infants with parent-observed apneas could not be determined. 3) GER episodes were not associated with apnea, bradycardia, or other respiratory changes during PSG.
273	Tirosh (1996)	4	17 infants sequentially admitted for evaluation of apnea of infancy or ALTE and associated regurgitation were studied with an overnight polysomnogram with pH probe in place.	Clinical series, observational study, case report Blinding absent	Eligible:17 Completed study:17 % males: 58.8 # controls: % males: 10 males, 7 females	Cases: 3-37 weeks (median 11 weeks) Narrow spectrum	Academic center (Haifa Israel (Technion)) Expert assigned or selected (17 infants sequentially admitted to pediatric department for apnea of infancy or ALTE and GERD) Funding not specified	pH probe	PSG criteria pH probe	No / No (Apnea > 5 sec)	Comprehensive PSG) pH probe calibrated before study with standard buffers (pH 4 and 7) and placed at the level of 75% of esophageal length; position confirmed by CXR or fluoroscopy "if required". 2) Video-monitored and any unusual behavior documented by sleep tech 3) Thermocouple, A1-C3, A2-C4, piezoelectric resp effort 4) video-PSG PSG duration = at least 6 hours Timing = Nocturnal	This study suggests that overnight PSG would be useful in evaluating infants with ALTE or suspected apnea of infancy, particulary with simultaneous evaluation with pH probe. Full EEG montage might be a consideration in this patient population, as 2/17 of these patients had epileptiform discharges preceding apneic events, with clinical improvement after anticonvulsant treatment Some infants with apnea of infancy (n= 17) may have seizures and/or GERD. (9) GERD cannot be consistently related to either of these. GERD (or seizures) when present in infants with apnea of infancy is best treated. Diagnostic yield of esophageal pH probe in this population is limited since GERD when present cannot be attributed to other apnea, seizure. GERD may occur after the onset of a seizure. Some episodes of apnea of prematurity may have GERD. Some children with apnea of prematurity have seizures. None particularly correlates with the other. Diagnostic yield of placing an esophageal pH probe to confirm GERD in an infant may not be valuable in 2009, not much done.
285	Arad-Cohen (2000)	3	1. To determine the prevalence and relationship between apnea and GER in infants with ALTEs. 2. Included infants hospitalized with an ALTE who had no other obvious cause and who underwent the full testing (PSG and pH monitoring.	Clinical series, observational study, case report Blinding not applicable	Eligible: N= 67 Completed study:N=21 infants who had discrete apnea and reflux events. Excluded: (N=32 infants had no reflux) (N=14 had very prolonged reflux) % males: 15 M: 6 F	Cases: Not specified except they say "up to 6 mo). Narrow spectrum	Academic center Strategy not specified Pharmaceutical or equipment company	Not specified	Not stated	No / Yes	Comprehensive PSG PSG duration = >6 hours Timing = Nocturnal	1. PSG with pH monitoring should be considered as part of the evaluation in infants who present with ALTE and no obvious cause. 2. It is duly noted that in the majority of cases, no relationship to apnea and GER is found, but in some infants can very clearly see a relationship during this monitoring. 3. When a relationship between GER and apnea was noted, the sequence of events appeared to be obstructive or mixed apnea followed by reflux rather than vice-versa. 4. The authors speculate there may be non-acid reflux occurring which our current monitors don't detect.
284	Sacré (1989)	2	Aims: 1) to determine if gastroesophageal reflux GER is a possible cause of ALTE apparent life threatening event 2) whether a prolonged apnea can be caused by GER episode 3) whether an irregular pattern in sleep (unquiet, disrupted sleep with irregularly repeated apneas) can be associated with GER Continuous sleep study and esophageal ph monitoring were simultaneously performed in 4 groups: control infants, infants with ALTE, infants with GER (GERD) and infants with resp dysfunction All infants in PRONE position when asleep Respiratory function assessed by PSG (n=585) respiratory inductance plethysmography during sleep of one night.	Prospective cohort study Blinded study	418 but data on 387 infants 6-10 weeks old	Group 1: ALTE: 62 infants: 27 (44%) awake during episode; but in 35 (56%) possibly asleep; if abnormal Ph study found – treated with various interventions. Group 2: 387 infants monitored with Ph probe and sleep study because of anxious parents; if abnormal treated like group 1 Group 3: 61 infants, 6-10 weeks of age with frequent vomiting and other causes ruled out Group 4: 76 infants, 6-10 weeks old, with respiratory dysfunction; 11 with freq. Vomiting, 39 rarely vomited.	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	Yes: prolonged apneas: lasting > 15 sec periodic breathing – proper definition. Periodic breathing and obstructive apneas excluded. Respiratory dysfunction: irregular apneas (5-15 sec) as percentage of time of recording (> 10%)	Limited sleep study : only respiratory inductance plethysmography, thus may have confused REM with irregular breathing. No carbon dioxide or pulse oximetry data. PSG duration = one night, but details not specified Timing of PSG: Nocturnal	No temporal association was found between GER and prolonged apnea however, infants presenting with ALTE or irregular breathing may have GER. GER may be present in the absence of overt symptoms of GERD. Treating the GER may improve majority of the respiratory dysfunction, but there are still a few infants that may continue to have respiratory dysfunction with it without GER.
286	Bhat (2007)	4	Premature infants were monitored during sleep in both the prone and supine positions, looking at both GE reflux with a pH probe, and apneas	In some ways a normative study Prospective cohort study Blinding not specified	Eligible:27 Completed study: 21 % males: not specified	Cases:GA 27.9 wks (24.9-32 wks) studied at post menstrual age of 36.3 wks (34.6-40.7) Patient Spectrum: Narrow spectrum	Academic center Random selection Government funded King's college hospital joint research committee AND foundation for the study of infant death	Abbreviated studies	PSG criteria	No: No EEG, not clear how sleep was determined, unless it was behavioral NA: Apnea defined as pause for 5 seconds (no O2sat parameters)	Limited study, "videopolysomnographic recordings" of nasal airflow, chest and abdominal wall movements, limb movements, EKG activity and oxygen saturation; thoracic and abdominal respiratory movements measured by impedeance, airflow measured with thermisters. Gross body movments with activity meters, and video. Oxygen via pulse ox PSG duration =161 minutes Timing of PSG: Daytime naps (they refer to studies on "successive days" after feeds)	Despite lack of full PSG, absence of scoring for hypopneas, and slightly liberal definition of apnea, this study suggests that PSG can be useful in determining likelihood that a preterm infant will have reflux-related apneic episodes in various sleeping positions.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
145	Groswasser (2000)	3	35 infants underwent two overnight PSG studies, one with and one without a pH probe in the distal portion of the esophagus. 25 patients had OSA (defined as OA >0,3 events per hour) and 10 were controls. PSGs with and without nasoesophageal probes were compared	Clinical series, observational study, case reports Blinded study	Eligible: 35 infants with suspected OSA Completed study: 25 infants with OSA % males: 76 # controls: 10 patients without OSA were considered controls % males: 33%	Cases: 12 months (9.1-15.5 months) Controls (defined post hoc as having no apnea): 12.5 months (10.5-20.25 months) Patient Spectrum: Not clear: All infants were healthy and receiving no meds, assume narrow spectrum, but exclusions were not specified	Not specified Expert assigned or selected groups Funding not clear – infants were admitted to evaluate for OSA, but referral source not really specified Government funded (assuming grant from FNRS is federal agency)	Not specified	PSG criteria	Yes / yes: Apneas defined if they lasted longer than 3 seconds, no hypopneas scored OSA defined as more than 0.3 OA per hour based on Kahn et al 1992	Comprehensive PSG PSG duration: not specified PSG timing: nocturnal	Findings suggest that the presence of a nasoesophageal probe may alter characeristics of the PSG, modest, but statistically significant changes in frequency of obstructive and central apneas, as well as possibly changing the sleep architecture While a liberal definition of OSA was used in this study, and the numbers were small, the finding that 71% of infants with suspected SDB were found to have OSA suggests PSG can be used in this patient population
4.2.4.4 Apparent life-threatening events												
288	Hoppenbrouwers (2005)	1	1) to examine the similarity in sleep architecture in infants at perceived increased risk for sudden infant death syndrome (SIDS) compared with healthy term infants. 2) to confirm previous findings of sleep and waking in preterm infants, to uncover delays or advances in sleep architecture of preterm compared with term infants. 3) to determine the effects of ventilatory support, an estimate of morbidity, and gestational age on the rate of sleep maturation. 4) to examine whether steroid administration affects sleep maturation. In addition, the potential confounding influences of sex, being small for gestational age (SGA), and maternal smoking during pregnancy were assessed. 193 preterm infants sorted into 5 age catergories by PMA post menstrual age. 42 infants who were ventilated were matched with an equal subset, exp range 5-74 ,mean # of ventilation 20.5, mean oxygen use 28	Prospective cohort study Blinded study	Eligible: 399 PSG Completed study: 201 preterm and 198 term infants; 51 term ALTE (apnea of infancy (AOI) 59 sibs of babies that died of SIDS and 88 healthy term infants % males: 52.6% in preterm; 50-54% males in the other groups	Cases: 33 to 58 weeks Wide spectrum	Academic center Random selection Government funded orange county guild for infant survival in addition to NIH funding.	Not specified	Other diagnostic criteria developed by authors	yes – QS,AS and IS – effort to smooth data and explanation provided. Rigorous efforts to train scorers. Were respiratory scoring methods clearly defined? NA Comments: Extracted periods with hypoxemia (sao2<90%) for at least 5 seconds) and associated dec. in HR. defined hypopnea as one or more breaths with paradoxical movement with dec in SaO2 < 90%.	Comprehensive PSG In lab in hospital, efforts to standardize scoring and collection. 2 EEG, EMG, EOG, movement sensor, RIP, end tidal CO2, and thermistor, EKG, SaO2, on ALICE III. PSG duration = nocturnal, 8 to 8.1 hrs with up to +/- 0.5 hrs Timing of PSG:Not specified	1) Apnea of infancy and healthy term infants had similar tracings 2) Subsequent sibs of babies that died from SIDS had less QS and may have more immature sleep. 3) Preterm infants had immature architecture compared to term infants 4) Term infants had lower QS and more indeterminate sleep. 5) Neither sex nor steroids affect sleep. 6) More preterm infants lagged behind older preterm infants 7) Assisted ventilation was associated with delay in maturation 8) SGA infants had more AS and maternal smoking resulted in more time awake Preterm infants do not exhibit delays in sleep architecture unless the gestational age is early or the infants have associated morbidity.
289	Harrington (2002)	2	To examine cardiorespiratory control in infants presenting with ALTE. Performed 6-8 45 degree head tilts in 10 ALTE and 12 matched controls. BP also monitored using beat to beat BP invasively	Case control study Blinding not specified	Eligible: Unknown Completed study: 10 infants with ALTE # controls: 12 full term healthy infants	Cases:14 3 weeks Controls: 13 2 weeks Patient Spectrum: NA	Academic center Strategy: Not specified Funding: Not specified	Not specified	PSG criteria	Yes / yes: Obstructive RDI>2 considered abnormal, hypopneas not measured.	Not specified: details not provided in manuscript, invasive BP monitoring, HR monitoring with beat to beat changes PSG duration = nocturnal Timing of PSG:Nocturnal	1) Clinical history did not distinguish between groups or subjects but the sleep data did 2) ALTE infants with normal breathing had cardiovascular and arousal responses similar to controls 3) ALTE infants (5/10): > 2 obstructive events/hr during sleep with short hypoxic episodes. ALTE infants with OSA with tilt in SWS, reduced HR response, 3/5 showed postural hypotension, altered HR and BP variability and increased arousal threshold in REM (p=0.0002). ALTE with OSA had decreased arousal response. 4) OSAS can be common in the infants that present with ALTE. 5) ALTE infants with and without OSA could be clearly differentiated based on HRV and BPV. 6) Infants with OSAS have increased BPV in SWS compared to control subjects
290	Horemuzova (2002)	2	To examine the results of PSG between infants with a hx of 40 ALTE (age 2-36 wks) with 40 age and sex matched controls. Sleep was scored behaviorally rather than EEG. Measured various parameters including: oxygen saturation, transcut oxygen and carbon dioxide, HR, phase angle as a measure of inspiratory effort Infants with GERD were excluded.	Case control study Blinded study	Eligible: 48 Completed study: 40 infants with ALTE % males: 18/40 boys # controls: 40 full term healthy infants, born 14 days after the infant with the ALTE % males: 18/40 boys	Cases:2.6 1.9 mos (0.4 – 8.8) Controls: 2.8 2 mos (0.5-9.0) Patient Spectrum: NA	Academic center Random selection Privately funded (non-pharmaceutical)	Not specified	Other diagnostic criteria developed by authors	yes – QS,AS and IS yes: Extracted periods with hypoxemia (sao2<90%) for at least 5 seconds) and associated dec. in HR. defined hypopnea as one or more breaths with paradoxical movement with dec in SaO2 < 90%.	Limited sleep study (describe parameters) thoracic and abdominal movements by strain gauges, HR, Sao2, TcCo2 and Po2, body novements, phase angle calculated as a function of thoracic abdominal asynchrony – no EEG data. PSG duration = nocturnal; between 21:00 and 0600 hrs. TST=295 ± 46 min Timing of PSG:Nocturnal	1) Infants with ALTE show a higher phase angle to suggest more inspiratory effort and ALTE infants showed more hypoxemic episodes, and lower saturation nadir 2) Periodic breathing similar in both groups.
159	Rebuffat (1994)	2	A total of 19 infants underwent polysomnography over a two-night (19 infants) or three-night (11 infants) time course. 8 of the infants had been referred following an ALTE, with negative medical workup. The other 11 were healthy control patients. Polysomnographic features from the studies are then compared to evaluate for night to night variability in results.	Prospective cohort Blinded study	Eligible: Unknown Completed study: 19 % males: 68% This study did have 8 "cases" (post ALTE) and 11 "controls" (healthy) but data regarding ages and genders within-groups is not provided	Cases: 11 wks (range 5-36 wks) Narrow spectrum	Academic center and community referral Self-selected groups Non-US funding agency	Repeat PSG (night-to-night variability)	PSG criteria	Yes	Comprehensive PSG: recorded entire night supine, repositioned infant "without awakening" if neck flexion noted; Feeding upon demand. EEG, EOG, EKG, thoracic respiratory mvts, oronasal thermistor, actigraph to record gross body mvts, and tcCO2. Alice III system. PSG duration = 9 hours (infant admitted to sleep lab at 2 pm, allowed to nap in afternoon, habituation period, then study recorded 2100 + 9 hours.) Timing = Nocturnal	When adequate study conditions are met, a single night polysomnogram is sufficient to accurately describe sleep characteristics as well as respiratory events in infants. This finding is true both for those who are undergoing workup for ALTE and healthy infants. Whether these findings are generalizable to infants who are clinically suspected of having OSA is not known.
284	Sacré (1989)	2	Aims: 1) to determine if gastroesophageal reflux GER is a possible cause of ALTE apparent life threatening event 2) whether a prolonged apnea can be caused by GER episode 3) whether an irregular pattern in sleep (unquiet, disrupted sleep with irregularly repeated apneas) can be associated with GER Continuous sleep study and esophageal ph monitoring were simultaneously performed in 4 groups: control infants, infants with ALTE, infants with GER (GERD) and infants with resp dysfunction All infants in PRONE position when asleep Respiratory function assessed by PSG (n=585) respiratory inductance plethysmography during sleep of one night.	Prospective cohort study Blinded study	418 but data on 387 infants 6-10 weeks old	Group 1: ALTE: 62 infants: 27 (44%) awake during episode; but in 35 (56%) possibly asleep; if abnormal Ph study found – treated with various interventions. Group 2: 387 infants monitored with Ph probe and sleep study because of anxious parents; if abnormal treated like group 1 Group 3: 61 infants, 6-10 weeks of age with frequent vomiting and other causes ruled out Group 4: 76 infants, 6-10 weeks old, with respiratory dysfunction; 11 with freq. Vomiting, 39 rarely vomited.	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	No / Yes: prolonged apneas: lasting > 15 sec periodic breathing – proper definition. Periodic breathing and obstructive apneas excluded. Respiratory dysfunction: irregular apneas (5-15 sec) as percentage of time of recording (> 10%)	Limited sleep study : only respiratory inductance plethysmography, thus may have confused REM with irregular breathing. No carbon dioxide or pulse oximetry data. PSG duration = one night, but details not specified Timing of PSG: Nocturnal	No temporal association was found between GER and prolonged apnea however, infants presenting with ALTE or irregular breathing may have GER. GER may be present in the absence of overt symptoms of GERD. Treating the GER may improve majority of the respiratory dysfunction, but there are still a few infants that may continue to have respiratory dysfunction with it without GER.
47	Rosen (1983)	4	26 infants with unexplained life-threatening apnea underwent clinical and PSG examination	Clinical series Blinding not applicable	Eligible: 26 Completed study: 26 % males: 65	Cases: 2.14+/- 1.25 weeks Narrow spectrum	Academic center Self-selected groups Government Funded	physical examination	PSG criteria, other criteria: clinical examination and GER data.	Yes / Yes	Comprehensive PSG Duration = 8-12 hours Nocturnal (12 hour recordings in 22 pts; 8 hour daytime recordings in 4 pts.)	1) Although subtle abnormalities may be detected by comprehensive PSG, they are not predictive of recurrent apnea or death. 2) Due to the absence of a control group in this study, differences between normal infants and infants with parent-observed apneas could not be determined. 3) GER episodes were not associated with apnea, bradycardia, or other respiratory changes during PSG.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
294	Kahn (1987)	3	This retrospective study described diagnostic categories in infants referred following an ALTE; all infants underwent PSG and complete clinical investigation. Special procedures such as CT, pH monitoring when needed.	Clinical series, observational study, case report Blinding not specified	Eligible: 857 Completed study: 857 % males: not specified No controls	Cases: not specified but all were infants Narrow spectrum	Academic center and community referral Expert assigned or selected Funding not specified	Not specified	ALTE diagnosed by episode characterized by pallor or cyanosis, and apparent apnea	No / No (no details given re PSG other than abnormal considered if central apnea >15sec, OA >3 sec, or periodic breathing for >5% of TST)	Not specified	Findings supportive of only a minority of infants with ALTE having abnormalities on PSG but no data to show predictive ability of PSG
273	Tirosh (1996)	4	17 infants sequentially admitted for evaluation of apnea of infancy or ALTE and associated regurgitation were studied with an overnight polysomnogram with pH probe in place.	Clinical series, observational study, case report Blinding absent	Eligible:17 Completed study:17 % males: 58.8 % males: 10 males, 7 females	Cases: 3-37 weeks (median 11 weeks) Narrow spectrum	Academic center (Haifa Israel (Technion)) Expert assigned or selected (17 infants sequentially admitted to pediatric department for apnea of infancy or ALTE and GERD) Funding not specified	pH probe	PSG criteria pH probe	No / No (Apnea > 5 sec)	Comprehensive PSG) pH probe calibrated before study with standard buffers (pH 4 and 7) and placed at the level of 75% of esophageal length; position confirmed by CXR or fluoroscopy "if required". 2) Video-monitored and any unusual behavior documented by sleep tech 3) Thermocouple, A1-C3, A2-C4, piezoelectric resp effort 4) video-PSG PSG duration = at least 6 hours Timing = Nocturnal	This study suggests that overnight PSG would be useful in evaluating infants with ALTE or suspected apnea of infancy, particulary with simultaneous evaluation with pH probe. Full EEG montage might be a consideration in this patient population, as 2/17 of these patients had epileptiform discharges preceding apneic events, with clinical improvement after anticonvulsant treatment Some infants with apnea of infancy (n= 17) may have seizures and/or GERD. (9) GERD cannot be consistently related to either of these. GERD (or seizures) when present in infants with apnea of infancy is best treated. Diagnostic yield of esophageal pH probe in this population is limited since GERD when present cannot be attributed to other apnea, seizure. GERD may occur after the onset of a seizure. Some episodes of apnea of prematurity may have GERD. Some children with apnea of prematurity have seizures. None particularly correlates with the other. Diagnostic yield of placing an esophageal pH probe to confirm GERD in an infant may not be valuable in 2009, not much done.
285	Arad-Cohen (2000)	3	1. To determine the prevalence and relationship between apnea and GER in infants with ALTEs. 2. Included infants hospitalized with an ALTE who had no other obvious cause and who underwent the full testing (PSG and pH monitoring.	Clinical series, observational study, case report Blinding not applicable	Eligible: N= 67 Completed study:N=21 infants who had discrete apnea and reflux events. Excluded: (N=32 infants had no reflux) (N=14 had very prolonged reflux) % males: 15 M: 6 F	Cases: Not specified except they say "up to 6 mo). Narrow spectrum	Academic center Strategy not specified Pharmaceutical or equipment company	Not specified	Not stated	No / Yes	Comprehensive PSG PSG duration = >6 hours Timing = Nocturnal	1. PSG with pH monitoring should be considered as part of the evaluation in infants who present with ALTE and no obvious cause. 2. It is duly noted that in the majority of cases, no relationship to apnea and GER is found, but in some infants can very clearly see a relationship during this monitoring. 3. When a relationship between GER and apnea was noted, the sequence of events appeared to be obstructive or mixed apnea followed by reflux rather than vice-versa. 4. The authors speculate there may be non-acid reflux occurring which our current monitors don't detect.
162	Abreue e Silva (1985)	4	Comparison of PSG data of healthy term infants and 3 subgroups of "index" infants: (a) SYMPTOMS GROUP: hospitalzed infants with mild breathing sx's from bronchiolitis/URTI/cong'l laryngeal stridor/rec't vomiting from cong'l hypertrophic pyloric stenosis; (b) SIBS: siblings of infants who had SIDS; (c) NEAR-MISS: near-miss for SIDS infants	Prospective cohort: Although it was a prospective study, there was no statistical analysis of results and no discussion of blinding or selection process. Blinding not specified	Eligible:86 % males: Not specified # controls:11	Cases: not specified but all were infants	Academic center Strategy not specified Privately funded (non-pharmaceutical)		Not stated	No, but they do describe active and quiet sleep Were respiratory scoring methods clearly defined? No Comments: Looked for CA and OA and oxy falls Reported on 3-6 sec, > 6 sec obstructive apnjeas and dips in TCo2 of > 15 mmHg	1. EOG 3. EMG (likely chin) 4. EEG (single lead) 5. EKG 6. Nasal airflow 7. Chest band 8. Abd lead sometimes, but unclear 9. Oxygen tension--PtcO2 PSG duration =3-4 hours Timing of PSG: After last evening feed between 10PM and 4AM	This study demonstrates face validity of PSG in infants to differentiate normal from abnormal breathing patterns;
292	Guilleminault (1984)	3	This paper reported on 5 children (out of an initial cohort of 300) with "near miss SIDS" who underwent serial PSGs – after initial 24 hour monitoring at time of presentation – at 5.5 – 7.5 months, 11-13 months, 16-21 months, and 3 years. Three out of five patients that had surgery between age 3-4 had follow up PSG after surgery.	Case control study Blinding absent	Eligible: 300 with near miss SIDS Completed study: 5 who developed OSA % males:80 # controls: 10 normals, 15 with near miss SIDS Two control groups were compared with the 5 index cases: normal control infanta as well as other near-miss SIDS cases. Controls were age matched to the approximate age of the index cases.	Cases: each case was studied several times, at different ages Followed from 3-12 weeks to up to 4 yrs Narrow spectrum	Academic center Report on 5 out of 300 near miss SIDS who were found to have OSA Funding not specified	Not specified	PSG criteria	Yes / yes: Apnea defined as complete cessation of air exchange at nose and mouth for 3-10 seconds (under 12 montrs only) or >10 seconds. After 12 months, pauses shorter than 10 seconds were ignored	Comprehensive PSG PSG duration = 24 hour recording done in patients <6 mo old, nocturnal polysomnogram done in subjects >6mo old. (mean duration of 10 hours 40min) 10 hours, 40 minutes mean. Prior to 6 months, 24 hour monitoring Timing of PSG:Nocturnal or 24 hour	In this very small number of patients followed longitudinally, findings suggest PSG is helpful in diagnosing OSA in snoring children with a history of "near miss SIDS" or ALTEs .
293	Guilleminault (1992)	3	This study attempted to follow full-term infants till age 5 yrs that initially presented with ALTE between 3 weeks and 4.5 months of life. This is a case series of 25 infants who had progressive symptoms and polygraphic findings from a database of 700 ALTE infants compared them to 3 control groups – Group a: normal, healthy controls, Group B – index cases; group C – matched ATLE infants and Group D – presented with ALTE but abnormal blood cultures. Some data has been presented elsewhere in smaller numbers.	Clinical series, observational study, case reports Blinding not specified	Eligible: 700 ALTE infants Completed study: 3 groups of ALTE infants 25 in each, but 25 index cases % males: 52 # controls: 50 + 30 (2 groups of 25) Group C (matched ALTE infants) and Group D (Matched ALTE with + cultures % males: 56% and 40% respectively Group A (30 infants normal full-term monitored at different ages)	Cases: 3 weeks to 4.5 months at time of ALTE, Controls: similar age groups with ALTE within 4 weeks when possible but group A or D later Narrow spectrum	Academic center Expert assigned or selected groups *Self-selected because symptomatic Privately funded (non-pharmaceutical) Gifts from the Guild for Infant Survival (Bay Area Chapter)	Esophageal pressure monitoring and CPAP in selected cases.	PSG criteria	Yes "standard techniques" / Yes: Respiratory pauses of 3-10 seconds in duration and apnea lasting 10 second or longer were scored. Obstructive and mixed events were scored together and differentiated from central events. Significant bradycardia was scored as HR < 70 bpm.	Comprehensive PSG Thermistors, strain gauges, esophageal pressure in 68/75 infants PSG duration = not specified Timing of PSG: Nocturnal ; 4.5 and 6 mon polygraphs were 24 hr duration, then nocturnal after.	1) PSG findings of SDB in infants that present with ALTE may be abnormal within the first year of life. 2) Family history of OSAS and early history of snoring or noisy breathing seem to be the only factors that differentiate these infants from other infants that present with ALTE 3) Follow-up of infants presenting with ALTE should include periodic PSGs especially if the parents report ongoing symptoms
291	Guilleminault (2000)	2	This is a systematic evaluation of 346 infants who presented with ALTE over a 10 year period who were evaluated in the same manner (hx, physical exam and PSGs). The scorer was blinded to the clinical data.	Prospective cohort study Blinded study	Eligible: 348 Completed study: 346 Group A: 42.6% with normal PSGs Group B: 57.4% with obstructive breathing over time % males: 162 girls # controls: 68 potential, 48 healthy, no family h x of SIDS, etc. 25 girls	Cases: Group A: 5.8 ± 1 week ; few premature infants Group B: 3.3 ± 0.6 weeks. Controls: 3.8 weeks ± 1.9 weeks Majority are Caucasian, 79% Narrow spectrum	Academic center Self-selected groups Other Funding	Multiple comparators, specify: clinical interviews re: awake and sleep behavior, reconstruction of sleep and wake behavior over 3 days, questionnaire regarding breathing and sleep. Systematic physical examination of the face	PSG criteria Other diagnostic criteria developed by authors	Yes: hand scored for sleep and wakefulness, Were respiratory scoring methods clearly defined? Yes Comments: Apneas, hypopneas, obstructive breathing, increased resp effort and Pes reversal and crescendos defined.	Comprehensive PSG videotaping, EEG, EOG, EMG, oronasal flow, thoracic and abdominal effort, intercostals EMG, saturation, microphone monitored breathing sounds, esophageal pressure, ECG, endtidal 51 children and trancut. CO2 in 301). Regular fiu in the first 10 months of life. PSG duration = 12 hrs Timing of PSG:Nocturnal	1) 57% of infants who presented with ALTe had abnormalities in their PSG with increased apneas (mixed and obstructive) and increased inspiratory effort 2) infants who present with ALTE have mild dysmorphic features that predispose them to SDB and these features are noted as early as 3-6 months. 3) Even control infants has some apneas although less so than group A and B

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.2.4.5 Laryngotracheomalacia and suspected SRBD												
137	Zafereo (2008)	4	This study was a retrospective review of 10 patients who had polysomnography pre (4 weeks) and avg 11 weeks post surgery (supraglottoplasty) for laryngotracheomalacia. Patients were 1-9 months old, 8 had GER, two had unilateral vocal cord paralysis and one had mild subglottic stenosis. Surgeries included division of aryepiglottic folds alone (n=4) And division of aryepiglottic folds plus unilateral excision of the cuneiform cartiliage and redundant mucosa	Clinical series, observational studies, case report Blinding absent	Eligible: 10 Completed study:10 % males:60	Cases: 4 months (range 1-9 months) Narrow spectrum	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria Laryngomalacia diagnosed on clinical grounds	No / No	Polysomnography details not given PSG duration = TST mean 6.5 – s hours Timing = Nocturnal	1) PSG is helpful in identifying OSA in infants with laryngotracheaomalacia and documenting their improvement after supraglot-toplasty 2) Test-retest validity of PSG is demonstrated in that OAHI and oxygenation improved in the expected direction following surgery.
4.2.4.6 Assessing risk of Sudden Infant Death Syndrome (SIDS)												
295	Kahn (1988)	3	This study compared PSG characteristics of 11 patients later determined to have died of SIDS wit h 22 age/ sex matched healthy infants in order to determine if any parameters were more prevalent in SIDS cases	Case control study Blinded study	Eligible:11 Completed study:11 % males: 45 # controls: 22 % males: 45	Cases: 10.5 weeks (4.5-20) Controls: 10.5 weeks (4.5-20) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	ECG, chest Xray, chemical & bacteriologic analysis of blood, urine, and CSF	Unexpected death attributed to SIDS after postmortem	Yes / Yes	Comprehensive PSG PSG duration = 12 hours Timing = Nocturnal	PSG may be helpful in evaluating infants at risk for SIDS, with the finding of increased obstructive apneas most significant. Other predictors included maximal duration of central apneas, number of sighs followed by a central apnea (fewer in SIDS victims), and presence of mixed apneas. Evidence is weak due to small sample size
296	Kahn (1992)	3	PSG variables of 30 future SIDS victims and 60 matched controls *again, 11/30 were previously reported, but those patients are not able to be differentiated in the paper* Additional clinical history including FH, nocturnal symptoms (profuse sweating, regurgitations, snoring, breathholding spells) was also obtained.	Case control study Blinded study	Eligible:30 Completed study:30 % males:63 # controls:60 % males:63	Cases: 39 (31-40) weeks Controls: 39 (31-40) weeks Wide spectrum	Academic center and community referral Expert assigned or selected Government funded	Not specified	Post mortem determination of SIDS	Yes / Yes (no CO2 data, no quantitative airflow signal 3 second apneas scored)	Comprehensive PSG including pH probe PSG duration = 10 hours Timing = Nocturnal	PSG may be helpful in determining infants at risk for SIDS, with particular attention regarding body movements and obstructive apneas; but the differences between the groups were small, the heterogeneity of the groups large. Insufficient evidence to suggest it would be a helpful predictor
297	Kato (2001)	3	This study compared breathing characteristics of (40) future SIDS victims, {again, 30 already reported but not differentiated in this report} to 607 healthy infants matched for age and sex, looking predominantly at apneic events	Case control study Blinded study	Completed study: 40 % males: 30 # controls: 607 % males: 27.8	Cases: Divided into two groups: Mean 7 week (4-8) Mean 12 week (9-19) Controls: same Narrow spectrum	Academic center and community referral Expert assigned or selected Funding not specified	Not specified	Post mortem exam to diagnose SIDS	Yes / Yes	Comprehensive PSG PSG duration = 8 hours Timing = Nocturnal	Findings suggest that future SIDS victims, particularly males studied at 9-19 weeks , may have a higher rate of OSA than controls. The absence of obstructive events in 25% of future SIDs victims makes this an insensitive and non-specific way of evaluating these patients.
298	Kato (2003)	3	This study looked at characteristics of cortical and subcortical arousals from sleep in 16 future SIDS victims and compared them to 16 age and gender matched controls	Case control study Blinded study	Eligible: 16 Completed study:16 % males: 62.5% # controls: 16 % males: 62.5%	Cases: median 11 weeks (7-19) Controls: same Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Not specified	Autopsy confirmation of SIDS	Yes / Yes	Comprehensive PSG PSG duration = 8 hours Timing = Nocturnal	There tended to be minor differences in arousal characteristics on PSG in future SIDS victims vs. controls Small number of patients and minor differences do not suggest PSG findings of cortical vs subcortical arousals would be helpful in distinguishing future SIDS victims from normals
34	Sawaguchi (2002)	3	From a large (27,000 infants) cohort of infants studied in a sleep lab over 20 years, 38 infants died suddenly 3-12 weeks after the sleep recording. 27 were considered to be SIDS victims, and characteristics of these children were examined, including frequency and duration of sleep apneas, characteristics of brain stem changes consistent with gliosis, and epidemiological data on sleep position. These data were compared to findings in 12 infants who died of other causes.	Clinical series Blinded study: This study was done to determine if there were autopsy findings in SIDS victims that correlated with sleep apnea or sleep position	Eligible: 27 Completed study: 26 % males: 61 # controls: 12 % males: 66	Cases: 3-40 weeks Controls: 4-24 weeks (died of other various causes – cardiac, infected pulmonary dysplasia, septic shock, prolonged hypoxemia, prolonged seizure) Narrow spectrum	Academic center Self-selected groups Government funded	Other, specify Autopsy results of infants brainstems	PSG criteria, other criteria: Diagnosis of SIDS made when infant died unexpectedly and no other cause found.	Yes / Yes Apneas 3 seconds or longer Date on frequency of OA or CA in each patient was not given.	Comprehensive PSG; PSG Duration 8 hours PSG Timing: Nocturnal	Duration of obstructive sleep apneas (although these actual durations were never reported) as recorded in PSGs during infancy may be important in predicting children at risk for SIDS, suggesting PSGs MAY be helpful in the workup of at-risk children.
299	Franco (1999)	3	The authors compared autonomic responses to apnea and the number of apneas from PSG's of 18 infants who died of SIDS and had previously had a PSG (either for concern about apnea or as part of a sleep research project) with those of matched control infants (2 controls for each case). Specifically, the authors used an autoregressive spectral analysis of the pre-apnea vs. post-apnea heart rate. Authors selected two obstructive apneas per infant, matched with respect to time of night, sleep stage, duration, prior apnea oxy sat, post-apnea desat, and postapnea HR deceleration. All chosen OA's occurred in REM sleep.	Case control study Blinded study	Eligible:18 Completed study:18 % males:72% # controls:36 % males: 72% Controls were matched for gender, gesta-tional age, postnatal age, weight at birth, and sleeping position	Cases: 8 weeks (5-19 weeks) (GA=38 wks (27-41)) Controls: 8 weeks (5-19 weeks) (GA=38 wks (27-41)) Wide spectrum	Academic center and likely other—not well specified Strategy not specified Funding not specified	Not specified	Clinical outcome	Yes / Yes (Apneas scored as 3 seconds of absent airflow and categorized as central, obstructive, or mixed. Periodic breathing =>=3 CA's separated by <20 seconds of breathing)	Comprehensive PSG 1. EEG 2. EEG 3. ROC-A1 4. LOC-A2 5. Digastric EMG 6. EKG 7. Nasal and oral airflow thermistor 8. Thoracic inductive plethysmography 9. Abdominal inductive plethysmography 10. Pulse oximeter 11. Actigraph PSG duration = 8-9 hours Timing = Nocturnal	1. Routine PSG may pick up infants with a greater risk of SIDS based on the appearance of OA's and MA's; 2. Spectral analysis of HR pre and post OA may identify infants at risk for SIDS 3. Compared to control infants, PSG recordings from a small group of infants who subsequently died of SIDS showed evidence of al-tered heart rate power spectral analysis suggesting a potential role in abnormal autonomic cardiac responsed in the etiology of SIDS.
300	Franco (2008)	3	This was a retrospective case controlled study of 18 infants who were subsequently to die of SIDS (unex-plained deaths despite post-mortem studies) Sleep stages, cardiorespiratory parameters (apneas, QT in-tervals) and heart rate spectral analysis as an estimate of autonomic nervous system activity was analyzed and compared to 18 controls matched for age, sex, gestational age, birth weight and sleep position	Case control study Blinded study	Eligible: 18 Completed study: 18 % males:72 # controls:18 % males:72	Cases:8 wks (5-19) Controls: 8 wks (5-19) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Government funded	QT intervals and heart rate spectral analysis were examined	SIDS diagnosed post mortem (no other explanation)	Yes REM vs NREM vs movement or wakefulness Yes Apneas were 3 seconds in duration	Comprehensive PSG PSG duration = 8-9 hours Timing of PSG:Nocturnal	Overnight PSG utilizing cardiorespiratory recordings in addition to sleep staging can be helpful in establishing differences in these parameters in infants at risk for SIDS. However, a retrospective post-mortem study.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.3.1.1 Asthma												
180	Redline (1999)	3	This study examined risk factors for SDB in children; specifically quantifying risk associated with obesity, race, and upper and lower respiratory tract problems. Children were recruited from participants in the larger Cleveland Family Study, a genetic-epidemiologic study of sleep apnea. Children were classified as being from an index family if one family member had PSG-confirmed OSA and controls were recruited from a random sample (not specified how they did that or who was chosen) of names of friends and neighbors provided by the index family. There were 31 index families and 30 control families. From the 31 index families, 273 children participated in the present study; from the 30 control families 126 control children participated Children with AHI>10 classified as SDB. Children with AHI5-10 not included in analysis in which SDB was the outcome variable (n=35). This study was designed to assess risk factors for pediatric SDB using a genetic-epidemiological study	Prospective cohort Blinding not specified	Eligible: unknown; these data are of subjects participating in a larger study Completed study: 273 children from index families % males: 49% # controls: 126 children from control families % males: 47%	Cases: 11.1±4.3 yrs (range 2-18yrs) Controls: 10.7±3.9yrs (range 2-18yrs) Wide spectrum	Community referral Self-selected groups cases were children from index families (1 member with PSG-confirmed OSA); controls from neighbors/friends of the index family Government funded	NS	PSG criteria Other diagnostic criteria developed by authors	NA / Yes. Adult definitions were used (10 seconds) and AHI > 5 Comments: Respiratory scoring parameters developed by the authors which may limit comparison with other studies	Unattended ambulatory sleep study comprised of airflow, chest wall, pulse oximetry, and heart rate (edentrace I and II) Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG: Nocturnal	In this community based study, the findings are supportive of obesity, African American race, and upper- and lower-respiratory tract conditions being independent risk factors for SDB in children based on ambulatory sleep studies for defining SDB. Findings do not support a role for sex as a risk for SDB in children
301	Ramagopal (2008)	4	A retrospective analysis of polysomnography and questionnaire data from 236 children, referred for evaluation of snoring and suspected SDB, were completed to determine whether there was an association between OSA and asthma in children referred for PSG for nocturnal snoring.	Clinical series, observational study, case report Blinding not applicable	Eligible: 236 Completed study: 236 % males: 58% # controls: NA	Cases: 7.2+/- 3.7 years (range 2-15 years) Narrow spectrum	Academic center and community referral Expert assigned or selected groups Funding not specified	Medical History of Asthma	PSG criteria Medical history of asthma	Yes / Yes	Comprehensive PSG PSG duration = Overnight Timing = Nocturnal	The main finding of this study is that a history of asthma, reported by a snoring child's guardian decreases the likelihood of OSA, but is associated with a mild sleep disturbance (e.g. increased arousal index and decreased TST.)
4.3.1.2 Cystic Fibrosis												
302	Villa (2001)	4	1. To investigate whether children with CF, <3 yrs have SDB. 2. Results suggest that children with CF and airway inflammation (rhinitis, cough, red throat) have desaturations during sleep.	Case control study Blinding absent	Completed study: 19 infants % males: 9 M: 10 F # controls: 20 controls % males: 10 M: 10 F	Cases: Mean 13.1 months Range 3-36 mo Controls: Age-matched Patient Spectrum: Narrow spectrum	Academic center Random selection Pharmaceutical or equipment company	Not specified	Not stated	Yes / yes	Comprehensive PSG Duration not specified 16 overnight, 3 nap	1. PSG may be helpful in diagnosing SDB in CF infants, especially symptomatic infants. 2. Desaturations are the most common PSG abnormality.
303	Gozal (1997)	4	1. Aim of the study was to examine the effect of nocturnal nasal BiPAP on SaO2, RDI and sleep architecture during sleep in patients with CF and severe lung disease (mean FEV1 = 29% predicted). 2. Subjects were evaluated on 3 separate nights. First night was a control night to establish baseline ventilation and confirm SDB. Second night was with supplemental oxygen. Third night was to initiate nasal BiPAP.	Clinical series, observational study, case reports Blinding absent	Eligible: 8 patients Completed study: 6 patients % males: 3 M: 3 F	Cases: Mean 22.3+4.7 yr Range 13-28 yr Narrow spectrum	Academic center Expert assigned or selected groups Blinding not specified	Not specified	Not stated	Yes / yes	Comprehensive PSG PSG duration = Studied for 8 hours TST = 378 + 49 min Timing of PSG: Nocturnal	1. PSG is useful to initiate and titrate BiPAP in CF patients with SDB. 2. PSG documents improved oxygenation and ventilation in these patients.
4.3.2.1 Kyphoscoliosis and other chest wall abnormalities												
268	Yuan (2004)	4	This retrospective review looked at medical records of children undergoing surgery for scoliosis and aimed to determine whether PSG or infant PFTs could predict the need for prolonged mechanical ventilation post-op (>3 days). PFTs appear to predict the need for prolonged ventilation but this group of children were unable to perform PFTs, hence why infant PFTs and PSG were evaluated. 66% of children had daytime nap studies and the rest had overnight PSG	Clinical series, observational study, case reports Blinding not specified	Eligible: 110 Completed study: 110 % males: 56/110 = 51% No controls	Cases: 10.8±4.9 yrs (range 1.6-20.5yrs) Wide spectrum	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria Other diagnostic criteria developed by authors	No / Yes	Comprehensive PSG (34%) or Daytime nap studies 66% of subjects) PSG duration = at least 6 hrs for both nocturnal and daytime PSG Nocturnal or daytime naps	Findings not supportive of PSG parameters predicting prolonged mechanical ventilation in children undergoing scoliosis surgery
241	Kirk (2000)	4	The charts were reviewed on 73 patients with myelomeningocele and moderate to severe SDB seen at seven peds centers. 27 came from McGill University, the others had 1-13 patients. All centers used lab PSG with EEG and several used home studies for f/u, but details about the studies are not given, including technical details. This paper is essentially reporting types of successful treatment in the PSG-diagnosed major categories of SDB in these patients. OSA, CSA hypoventilation	Clinical series Blinding absent; This study was done to look at identification and treatment of SDB in patients with myelomeningocele in a variety of academic centers	Eligible: 73 ots Completed study: 73 % males: 53	Cases: 15 pts (20%) <1 yr; 23 pts (31%) 1-5 yrs; 20(27%) 6-12 years 11(15%) 13-18 yrs 4 (5%) greater than 18 years Narrow spectrum	Academic center 35 peds sleep centers contacted 7/22 responding centers had adequate clinical and lab data to participate Expert assigned or selected groups Pts included by participating centers if they had moderate to sever e SDB (would require close f/u or treatment) Privately funded (non-p)	Not specified	PSG criteria	No / No	Not stated	1) Pts. with meningomyelocele should undergo early PSG to diagnose multiple potential types of sleep disordered breathing. 2) Oximetry alone is insufficient in the evaluation of children with meningomyelocele because they are at risk for multiple types of SDB including obstructive sleep apnea, central sleep apnea, central hypoventilation, and sleep-exacerbated restrictive lung disease.. 3) Treatments of SDB are variably effective and physicians should have a low threshold to do a follow up study to assess treatment efficacy
4.3.2.2 Restrictive Parenchymal lung disease, including diaphragmatic hernia - NO PAPERS												
4.3.2.3 Neuromuscular Weakness and progressive respiratory insufficiency												
4.4.1 PSG for Positive Airway Pressure (PAP) titration												
305	Downey (2000)	3	18 patients under age 2 with OSA documented by PSG who failed surgery or who were not surgical candidates and not felt to be surgical candidates were given trial of CPAP. Divided into four groups: Group 1 = 6 pts with tracheostomies; only 2 used CPAP Group 2= 2 pts Post T&A with residual OSA; OSA resolved over time Group 3=4 patients did not tolerate CPAP Group 4=6 pts used CPAP until f/u PSG showed resolution of OSA (used CPAP 1-5 yrs)	Clincal series Blinding not applicable; The primary objective of this paper was to study CPAP efficacy in pts <2 y/o with OSA	Completed study: 18 % males: not specified	Cases:11 pts <1 yr 7 pts between 1-2 yrs Controls:N/A Narrow spectrum Age <2. They did include a wider variety of pathology than some studies (ie Down syndrome, craniofacial anomalies)	Community referral The last 18 patients studied with diagnosis of OSA by PSG Not specified	Pre CPAP PSG compared to CPAP titration PSG Variables compared: Awakenings AI OAI HI Lowest O2 sat Min <90% O2	PSG criteria	Yes / Yes **Used OSA scored by absence of airflow for 6s rather than 2 breaths duration	Comprehensive PSG PSG duration =overnight, time not specified Timing of PSG: Nocturnal	1. Findings suggest that PSG should be repeated in patients after successful CPAP treatment of OSA 2. PSG used to diagnose OSA in children <2 years 3. PSG used to titrate CPAP in children <2 years 4. Findings suggest that PSG should be repeated in patients after successful CPAP treatment of OSA as symptoms may resolve over time.
151	Uong (2007)	4	This study was a retrospective chart review of 46 patients aged 7-19 yrs who had persistent sleep apnea despite T&A; Initial diagnostic study was performed to diagnose OSA, then repeat PSG with PAP titration. The goal of this study was to determine the rate of compliance of PAP use, both hours nightly and nights per week.	Clinical series, observational study, case report Blinding absent	Eligible: 46 Completed study:46 % males:56.5	Cases: 13.6 +/-3.1 (7-19) Wide spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 8 or more hours Timing = Nocturnal	1) In children s/p T&A, PSG is useful in diagnosing persistent OSA, and in PAP titration useful in determining optimal treatment of residual symptoms 2) Construct validity of PSG is demonstrated in that children treated for OSA with PAP and who were adherent to PAP demonstrated improvement in nocturnal symptoms, daytime sleepiness, and school performance.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
204	McNamara (1999)	4	24 infants with various diagnoses (FH of SIDS, ALTE, anatomic abnormalities including Pierre Robin, micrognathia, choanal atresia, laryngomalacia, other syndromes Beckwith Wiedemann, SLOS, Moebius) were diagnosed with OSA by PSG and then had repeat PSG with nCPAP titration. Additional f/u PSGs at 2–4 month intervals until age one, and then q 6 months were done to determine continued need for CPAP	Clincal series Blinding absent; This study looked at the effectiveness of long term nasal CPAP therapy for OSA in infants	Eligible: 24 Completed study: 24 % males: 62.5	Cases: 37.6 +/-.7 weeks (30-42 week) Wide spectrum	Community referral Expert assigned or selected groups Government funded	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG PSG duration = 9-11 hrs Timing of PSG:Nocturnal	1) PSG can be used successfully in infants with a wide range of suspected etiologies for OSA, both diagnostically and therapeutically with nasal CPAP 2) Serial PSG is helpful in determining ongoing need for CPAP as well as retitrating pressures in this population.
306	Nakra (2008)	2	51/55 children with metabolic syndrome screened with PSQ and 93% were positive. 42 agreed to PSG and 31 had SDB (74%) 25 of those with SDB were included, 11 used CPAP, 14 did not. Study assessed children with metabolic syndrome who screened positive for SDB as determined by the Pediatric Sleep Questionnaire (PSQ). 34 children completed PSG, yielding 25 with OSA (AHI>1.5) and 9 without OSA (used as the control group for subsequent analysis). Metabolic markers and other data were compared for the children with OSA compared to those without. Children with OSA proceeded to 3 months of home CPAP treatment followed by repeat PSG and metabolic tests.	Prospective cohort Blinding not specified	Eligible: 25 Completed study: 25 % males: 48% # controls: 9 % males: 52%	Cases: 13.1 ± 3.o Controls: 12.3 ± 3.4 Narrow spectrum	Academic center Expert assigned or selected groups Government funded	1. Pediatric Sleep Questionnaire (PSQ) 2. Metabolic markers: houlrly catecholamines and leptin during PSG	PSG criteria	Yes / Yes	Multiple PSG types: Subjects without OSA (AHI < 1.5 during first 4 hours) received full-night PSG; Subjects with OSA (AHI > 1.5 during first 4 hours) had split night PSG with conversion to CPAP trial Full night duration Timing = nocturnal	1. 93% of children with metabolic syndrome had a postivie screen for SDB using the PSQ. 74% of those agreeing to PSG, had SDB confirmed. 2. PSG is indicated for confirmation of SDB in children with metabolic syndrome 3. PSG has a role in the identification of optimal PAP pressures needed to eliminate respiratory events in childrwn with SDB 4. Twenty-five of 34 children (73.5%) testing positive on the PSQ were found to have OSA on PSG. 5. Presence of PSG-defined OSA was significantly correlated with increased catecholamine and leptin levels. 6. Leptin levels declined significantly following treatment with CPAP, although follow up PSG data were not reprted in this manuscript.
241	Kirk (2000)	4	The charts were reviewed on 73 patients with myelomeningocele and moderate to severe SDB seen at seven peds centers. 27 came from McGill University, the others had 1-13 patients. All centers used lab PSG with EEG and several used home studies for f/u, but details about the studies are not given, including technical details. This paper is essentially reporting types of successful treatment in the PSG-diagnosed major categories of SDB in these patients. OSA, CSA hypoventilation	Clinical series Blinding absent; This study was done to look at identification and treatment of SDB in patients with myelomeningocele in a variety of academic centers	Eligible: 73 ots Completed study: 73 % males: 53	Cases: 15 pts (20%) <1 yr; 23 pts (31%) 1-5 yrs; 20(27%) 6-12 years 11(15%) 13-18 yrs 4 (5%) greater than 18 years Narrow spectrum	Academic center 35 peds sleep centers contacted 7/22 responding centers had adequate clinical and lab data to participate Expert assigned or selected groups Pts included by participating centers if they had moderate to sever e SDB (would require close f/u or treatment) Privately funded (non-p)	Not specified	PSG criteria	No / No	Not stated	1) PTs. with meningomyelocele should undergo early PSG to diagnose multiple potential types of sleep disordered breathing. 2) Oximetry alone is insufficient in the evaluation of children with meningomyelocele because they are at risk for multiple types of SDB including obstructive sleep apnea, central sleep apnea, central hypoventilation, and sleep-exacerbated restrictive lung disease.. 3) Treatments of SDB are variably effective and physicians should have a low threshold to do a follow up study to assess treatment efficacy
309	Mellies (2003)	4	The aim of the current study was to investigate the long-term impact of nocturnal noninvasive (positive-pressure) ventilation (NIV) on sleep, sleep-disordered breathing (SDB) and respiratory function in children and adolescents with progressive neuromuscular disorders (NMD).	Clinical series, observational study, case reports Blinding absent	Eligible:38 Completed study: 30 % males: 47%	Cases: 12.3±4.1 yrs, range 6–19 yrs Narrow spectrum	Source not specified Expert assigned or selected groups Academic grant (U of Essen) and manufacturer grant as well as a foundation	Lung and respiratory muscle function (IVC) Arterial blood gas tensions Carbon dioxide arterial tension	Neurologist assessment that was confimed at the histopathological and molecular level where applicable	Yes Standards and indications for cardiopulmonary sleep studies in children. American Thoracic Society. Am J Respir CritCare Med 1996; 153: 866–878. ASDA. Recommendations for syndrome definition and measurement techniques in clinical research. Sleep 1999; 22: 667–689. Yes SDB was considered present if the respiratory disturbance index was>10 events per hour, nocturnal hypoventilation was defined as Ptc,CO2 w6.7 kPa (w50 mmHg) for w50% of total sleep time	Multiple PSG types, specify: Comprehensive PSG (n=22) and cardiorespiratory polygraphy (n=8) PSG duration = overnight Timing of PSG:Nocturnal	This paper demonstrates the clinical utility of PSG for evaluation of respiratory function during sleep in this population and it demonstrates usefulness of PSG to initiate and titrate positive airway pressure.
308	Young (2007)	4	Records were reviewed on fourteen patients with various neuromuscular diseases who were placed on noninvasive ventilation (13/14 BiPAP, one CPAP) .Patients and parents were asked to fill out quality of life questionnaire after NIV, and recall QOL data prior to initiation (retrospectively) . Symptoms related to SDB were elicited (headache, sleepiness, anorexia, dysphagia, cough, attention problems, learning problems) and compared pre and post-NIV (also retrospectively determined) Health care costs were compared, and PSG data from 11 patients before NIV, and 6 patients done pre/post NIV were examined.	Clinical series, observational study, case reports Blinding absent	Eligible: 17 Completed study: 14 ONLY 11 had PSGs % males: 35	Cases: median 7.7 yrs (1.5 – 16 yrs) Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Outcomes measures (quality of life or academic)	PSG criteria	Not completely: RDI is defined, but does not specify definition of hypopnea	Comprehensive PSG Duration not specified Timing = Nocturnal	1) PSG does not appear to adequately predict neuromuscular patients who may decompensate with respiratory infections and require non invasive ventilation when obtained in the absence of intercurrent illness. 2) PSG indices are not related to patient symptoms
231	Mellies (2004)	3	Aim: characterize SDB and associated symptoms in SMA-patients and to verify our hypothesis that in SMA NIV as treatment of SDB is beneficial.	Case control study Blinding absent	Eligible: 15; 10 with SDB and 5 without. Completed study: 7 % males: 3 males # controls: 5 % males: not stated	Cases: 8.1±1.6 yrs (range=6-11 yrs). 6 with SMA type I and one type II Controls: 7.8±1.9 yrs; one with SMA type I and four with type II Narrow spectrum	Academic center Self-selected groups Other, specify: funded by University of Essen and Vitalaire and Foundation support	None	PSG criteria Comment: also used a questionnaire to evaluate sleep disturbance, nocturnal sweating, morning headaches, nausea, fatigue, impaired concentration – not validated questionnaire.	Yes / Yes (used the two breath rule for defining respiratory events, RDI > 5/hr and hypoventilation as CO2> 55 mmHG or saturation < 90%	Comprehensive PSG standard but not specified, including CO2 PSG duration = in minutes – not specified Timing of PSG:Nocturnal	1) patients with SMA may develop SRBD before reported symptoms or obvious abnormalities detectable on pulse oximetry or blood gas 2) children with SMA should be systematically evaluated with PSG to look for evidence of SRBD. The optimal timing and frequency of PSG is not known. 3) Initiation of NIV and continuation of NIV use can be monitored using PSG, but optimal timing is not known.
233	Suresh (2005)	4	Evaluate the spectrum of SDB in all DMD patients. Found younger boys more likely to have OSA and older boys more likely to have hypoventilation.	Clinical series, observational study, case reports Blinding not applicable	Eligible: 34 Completed study: 32 % males: 100%	Cases: 10 yr (1-15 yr) Narrow spectrum	Academic center Random selection Funding not specified	Most of the patients had PFTs.	PSG criteria	Yes / yes	Comprehensive PSG Timing: nocturnal	1. PSG identifies SDB in boys with DMD. Younger boys had OSA. The incidence of OSA seems higher in this patient population (30% compared to the incidence of 2% in "normal healthy" children). So emphasizes need to do PSG on all these boys. 2. PSG identifies hypoventilation in older boys, many of whom where asymptomatic. Symptoms and PSG abnormalities improved with NIV. Again emphasizes need to do PSG on these older boys.
492	Tan (2007)	4	Retrospective chart review of children seen at their sleep center who were using respiratory support when sleeping. All children done within 12 months who had been using respiratory support >3 months. 61 sleep studies (1/3 comprehensive PSG, 2/3 cardiorespiratory monitoring, a few autoPAP titrations) were done in 45 children (median age 8.3 y) over a 12-month followup period among children who had been using respiratory support (RS) at least 3 months. Children had a myriad of conditions requiring them to use CPAP or BPAP, autoPAP, or NIPV. Authors examined how often adjustments in PAP were needed in children receiving long-term PAP or other respiratory support when sleeping. No blinding, judgment to alter PAP or RS settings made by one person, perhaps empirical, not then tested by repeat unattended sleep study. Used peculiar definitions and standards to grade abnormalities found. No titration of respiratory support during sleep studies, single clinician reviewed sleep studies, prescribed empirical adjustment, no documentation of the efficacy of this recommendation save no major complaints reported by caregivers or patients after adjustments made.	Clinical series, observational study, case report Blinding absent	Eligible: 45 children/no controls/60% boys Completed study:45 % males:60% # controls:0	Cases:45 (median age 8.3 y range 0.4-18.6 y) Controls: none Patient spectrum unclear	Community referral Expert assigned or selected Funding not specified	Not specified	Other diagnostic criteria developed by authors	Yes but unique; only 1/3 of studies were comprehensive PSG then scored using R& K, for cardiorespiratory studies, scored 30-s epochs as awake if contained >50% movement artifact on respiratory channels or digital video. Yes: Unique definition of apneas or hypopneas lasting 3 or more seconds.	1/3 of PSG were comprehensive in-hospital unattended PSG using Compumedics. 2/3 were inhospital unattended cardiorespiratory monitors; 5(8%) were autoPAP titrations, 3 of these done at home: CPAP flow measured at mask or pressure at tracheostomy done. Piezo belts used to monitor respiratory effort; Based on diagnostic studies, sleep pediatrician recommended adjustments in CPAP or BPAP or IPV settings, efficacy of these confirmed by feedback from patients or their caregivers. Duration not given Timing = nocturnal	Children using respiratory support when sleeping be it CPAP, BPAP, tracheostomy with NIV or autoPAP often need adjustment of the pressure settings . No clinical features identified children more likely to require changes in respiratory support settings. The authors said their data and findings did not enable them to make recommendations on timing of followup sleep studies. PAP needs change with time and growth and children. Prospective studies are needed to determine how often sleep studies should be repeated in children using respiratory support when sleeping. Documentation of respiratory status during sleep while on respiratory support; they did not do titrations/adjustments in pressure during the PSG study

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
4.4.2 Repeat PSG in Children on Chronic PAP Support												
307	Tan (2007)	4	Retrospective chart review of children seen at their sleep center who were using respiratory support when sleeping. All children done within 12 months who had been using respiratory support >3 months. 61 sleep studies (1/3 comprehensive PSG, 2/3 cardiorespiratory monitoring, a few autoPAP titrations) were done in 45 children (median age 8.3 y) over a 12-month followup period among children who had been using respiratory support (RS) at least 3 months. Children had a myriad of conditions requiring them to use CPAP or BPAP, autoPAP, or NIPV. Authors examined how often adjustments in PAP were needed in children receiving long-term PAP or other respiratory support when sleeping. No blinding, judgment to alter PAP or RS settings made by one person, perhaps empirical, not then tested by repeat unattended sleep study. Used peculiar definitions and standards to grade abnormalities found. No titration of respiratory support during sleep studies, single clinician reviewed sleep studies, prescribed empirical adjustment, no documentation of the efficacy of this recommendation save no major complaints reported by caregivers or patients after adjustments made.	Clinical series, observational study, case report Blinding absent	Eligible: 45 children/no controls/60% boys Completed study:45 % males:60% # controls:0	Cases:45 (median age 8.3 y range 0.4-18.6 y) Controls: none	Community referral Expert assigned or selected Funding not specified	Not specified	Other diagnostic criteria developed by authors	Yes but unique; only 1/3 of studies were comprehensive PSG then scored using R& K, for cardiorespiratory studies, scored 30-s epochs as awake if contained >50% movement artifact on respiratory channels or digital video. Yes: Unique definition of apneas or hypopneas lasting 3 or more seconds.	1/3 of PSG were comprehensive in-hospital unattended PSG using Compumedics. 2/3 were inhospital unattended cardiorespiratory monitors; 5(8%) were autoPAP titrations, 3 of these done at home. CPAP flow measured at mask or pressure at tracheostomy done. Piezo belts used to monitor respiratory effort; Based on diagnostic studies, sleep pediatrician recommended adjustments in CPAP or BPAP or IPV settings, efficacy of these confirmed by feedback from patients or their caregivers. Duration not given Timing = nocturnal	Children using respiratory support when sleeping be it CPAP, BPAP, tracheostomy with NIV or autoPAP often need adjustment of the pressure settings . No clinical features identified children more likely to require changes in respiratory support settings. The authors said their data and findings did not enable them to make recommendations on timing of followup sleep studies. PAP needs change with time and growth and children. Prospective studies are needed to determine how often sleep studies should be repeated in children using respiratory support when sleeping. SUMMARY: Level 4 evidence, even then weak. I agree…the usefulness of PSG in this paper is limited to documentation of respiratory status during sleep while on respiratory support…they did not do titrations/adjustments in pressure during the PSG study
4.4.3 Clinical Utility of PSG for Therapeutic Intervention												
60	Villa (2007)	3	16 children were nonrandomly selected to participate in an observational cohort to evaluate the benefits of an orthodontic device called a Rapid Maxillary Expander (RME) in children with PSG documented OSA. To meet inclusion criteria for the study, children must have signs/symptoms of OSA along with AHI>1 and a high/narrow palate with malocclusion (deep bite, reclusive bite or crossbite). 78% of the children had enlarged tonsils. The RME device widens the maxillary bone by distraction osteogenesis at the suture level, widening the maxilla, and increasing the cross-sectional and volumetric space of the nasal cavity. It can also improve orophraryngeal spaceby modifying the resting position of the tongue. All patients underwent a Brouillette questionnaire and PSG prior to treatment, and at 6 and 12 month follow up.	Prospective cohort Blinding not specified	Eligible:16 Completed study:14 and 2 lost to follow-up % males: not stated	Cases: children aged 4-11 Controls: no control group Narrow spectrum; none were obese	Academic center Expert assigned or selected Funding not specified	Behavioral scales Brouillette questionnaire was performed before and after surgery Orthodontic assessments and measurements	PSG criteria	Yes Not applicable; apneas defined as lasting > 5 seconds.	Comprehensive PSG no nasal pressure transducer tracing, no End-Tidal CO2 tracing used. Used thermocouples PSG duration = "standard overnight" polysomnogram Nocturnal	1. Polysomnography in children shows face validity when compared to clinical scores (Brouillete Scale) and objective assessment of airway space improvements in this group of children with high arched palate and obstructive sleep apnea using a rapid maxillary expander device. 2. Though the RME does improve PSG results, as well as the symptoms and signs of OSA, residual disease is seen. It is reasonable to pursue PSG after maximum treatment results are obtained from RME, particularly if adenotonsillar hypertrophy is present. RME was limited to only a select group of children who were of normal height and weight.
310	Pirelli (2004)	4	All eligible children in an orthodontics clinic were referred for PSG, cephalometry and ENT evaluation before, during (4-6 weeks) and after rapid maxillary expansion (RME)	Prospective cohort study Blinding not applicable	Eligible:31 Completed study:31 % males:29	Cases:8.68 (range 6-12) years Controls: NA Patient Spectrum=NA	Academic center Other, specify: All children in the clinic who were eligible were approached Pharmaceutical or equipment company	Not applicable	PSG criteria	Yes / yes	Comprehensive PSG Duration and timing not specified	RME may be a useful approach in dealing with abnormal breathing during sleep.
52	Villa (2002)	4	To investigate the clinical usefulness of a personalized oral appliance for treatment of OSA with malocclusion. - 19/32 children randomly assigned to oral appliance for 6 months then post appliance PSG, questionnaire, and physical exam compared between these children and the non-intervention children (n=13) - note that oral appliance used corrects occlusal anomalies rather than provides mandibular advancement To assess clinical usefulness and tolerance to a personalized oral jaw positioning appliance for the treatment of OSA with malocclusion	Perhaps a methodological study; Clinical series, observational study, case reports; Blinding not specified	Eligible: 32 children initially enrolled, 19 randomly assigned to treatment, 13 acted as controls Completed study: 23 (9 controls) % males: 20/32 = 62.5% enrolled; treated 53% males, controls 77% males; sex unknown of those who dropped out	Cases: 6.86±2.34 years Controls: 7.34 ±3.1 years, Narrow spectrum	Academic center Expert assigned or selected groups Assigned groups according to AI>1 and clinical signs of dysthagnia Blinding not specified	Brouillette questionnaire of OSAS symptoms Physical exam incl tonsil size	PSG criteria: Initial Dx reached by AI>1 but no more details given. Subjects had to have initial Dx of AI>1 with associated clinical signs of dysgnathia before entry into study Follow up PSG included only 2 EEG channels and airflow measured by thermocouple	No Just stated that they were scored according to R&K Were respiratory scoring methods clearly defined? No repiratory inductive pleth, saturation and thermistor used Comments: PSG included 2 EEG channels and scored in accordance with R&K and ATS. No further details given	Comprehensive PSG PSG duration = not reported Timing of PSG: Nocturnal	"- use of personalized jaw positioning device for 6 months in the presence of AI>1 and dysthagnia was associated with an improvement in AHI and AI - also associated with reduced adenotonsillar hypertrophy (? Possibly due to enlarged pharyngeal space rather than reduced hypertrophy per se) - enlarging the pharyngeal space was associated with improvement in AHI and AI in the expected direction - findings support use of PSG in characterizing respiratory parameters following treatment intervention
143	Buchenau (2007)	2	This study used a randomized crossover design to evaluate the usefulness of an oral device (Pre-Epiglottic Baton plate) in 11 children with isolated Pierre Robin Sequence and upper airway obstruction on initial PSG. Half the group was assigned to the PEBP and half to a conventional palatal plate (only closes cleft, has no effect on opening hypopharynx), restudied, then crossed over to the other device and studied again. Infants received appliance for at least 36 hours before sleep study was done. Infants were up to 3 months of age, most of whom had been referred after prone positioning to sleep had failed.	Clinical series, observational study, case report Blinded study	Eligible: 11 Completed study:11 % males:27	Cases: 3 days (0-60) GA 39 weeks (36-41) Narrow spectrum	Academic center Expert assigned or selected Privately funded (non pharma) - German Foundation	Not specified	PSG criteria	No / Yes	Limited sleep study - No EEG was used; sleep determined by video and behavioral analysis PSG duration =at least 8 hours Timing: Nocturnal (began in the evening)	1) PSG is can be useful in determining the effectiveness of orthodontic treatment of upper airway obstruction in selected populations. 2) Test-retest validity of PSG is demonstrated in that AI improved in the expected direction when infants were using the appliance.
207	Sirois (1994)	4	To assess incidence of OSA post pharyngeal flap surgery for velopharyngeal insufficiency. All children underwent pre (1-2 days before surgery) and post operative (1-15 days, mean 5 days) respiratory recordings	Clincial series Blinding absent; Designed to assess incidence of OSA following pharyngeal flap surgery	Eligible: 41 Completed study: 40 % males: 23/40 = 57.5% # controls:none	Cases: 6.7 yrs (range 2-22yrs) Controls: n/a Wide spectrum	Academic center Self-selected groups ? all children undergoing pharyngeal flap surgery. Not sure if this is self-selection or not Not specified	Abbreviated studies Apnea monitor and pulse oximeter used post-operatively	PSG criteria Other diagnostic criteria developed by authors	Not completely: No EEG recorded	Heart rate, arterial saturation, airflow (thermistor), abdominal and thoracic movements Post-op only apnea monitor, pulse ox and clinical obs made Limited sleep study (describe parameters) PSG duration = not reported Timing of PSG:Nocturnal	"- findings support OSA as a complication of pharyngeal flap surgery at least in the immediate post-op period - limited follow up beyond immediate post-op period (timing not stated) suggests that OSA not apparent later on - findings do not support routine use of PSG in children with velopharyngeal insufficiency prior to pharyngeal flap repair - Test-retest reliability of PSG is demonstrated in that 13/14 children had change in obstructive AHI in the expected direction (increased) following VP repair.
138	Morita (2004)	4	16 patients with velopharyngeal insufficiency due to various causes (6 after cleft palate repair, 8 with submucous cleft palate, 2 with short palate) underwent two preoperative PSGs, one normal and the following night with nasal occlusion with tampon gauze. This forced the patient to breath orally, assuming this is the main route of breathing after pharyngeal flap due to increased nasal resistance. Based on pre-op occlusion studies,one patient did not undergo surgery. This study was done to see if it is possible to predict preoperatively the risk of OSA after pharyngeal flap surgery for velopharyngeal insufficiency	Clincal series Blinding absent	Eligible: 16 Completed study: 16 (14 had post-op PSGs) % males: 62.5	Cases: 7.3 yrs (4.7-12.9) Narrow spectrum	Academic center Expert assigned or selected groups	Not specified	PSG criteria	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	1) This study suggests that PSG with nasal occlusion may be helpful in prediciting post-operative OSA in patients undergoing pharyngeal flap surgery 2) Children with normal AHI (<5/hr) prior to undergoing surgery for velopharyngeal insufficiency also had normal AHI 2 weeks postoperatively, demonstrating test-retest reliability for the AHI obtained during PSG. 3) In children with VP insufficiency, there was a strong correlation between AHI with nasal occlusion pre-operatively and postoperatively. This correlation is in the expected direction and provides further test-retest reliability for the AHI obtained during PSG.
208	Liao (2003)	4	This study evaluated 10 patients with VPI who were to undergo palatoplasty. A PSG was done one day prior to surgery, and then repeated at one week, and approximately 3 and 6 months after surgery for a total of 4 studies per patient. Abnormal RDI was defined as >1, symptoms consistent with OSA (snoring, dyspnea, fragmented sleep, witnessed apnea, nocturnal awakening) were ascertained	Clinical series, observational; Blinding absent; This study was designed to determine the incidence and severity of OSA in children with velopalatal insufficiency (VPI) before and after a procedure to correct this (Furlow palatoplasty)	Eligible: 15 Completed study: 10 % males: 60 # controls: None	Cases: 5.1 +/-1.1 yrs Narrow spectrum	Academic center Expert assigned or selected groups Not specified	Not specified	Diagnosis reached using PSG criteria	Yes / yes (no CO2 or NP)	Comprehensive PSG Duration not specified Timing = Nocturnal	If there are concerns for OSA in pts with VPI after palatal surgery, PSG should be performed 6 months or more AFTER surgery, as there may be transient abnormalities on PSG in the first 3-6 months. Very small numbers. Snoring did not really seem to predict abnormalities in RDI, as we know..this may be due to the general poor correlation between history and PSG findings, or due to the inability of the testing to identify subtle forms of SDB or both,
137	Zafereo (2008)	4	This study was a retrospective review of 10 patients who had polysomnography pre (4 weeks) and avg 11 weeks post surgery (supraglottoplasty) for laryngotracheomalacia. Patients were 1-9 months old, 8 had GER, two had unilateral vocal cord paralysis and one had mild subglottic stenosis. Surgeries included division of aryepiglottic folds alone (n=4) And division of aryepiglottic folds plus unilateral excision of the cuneiform cartiliage and redundant mucosa	Clinical series, observational studies, case report Blinding absent	Eligible: 10 Completed study:10 % males:60	Cases: 4 months (range 1-9 months) Narrow spectrum	Academic center Expert assigned or selected Funding not specified	Not specified	PSG criteria Laryngomalacia diagnosed on clinical grounds	No / No	Polysomnography details not given PSG duration = TST mean 6.5 – s hours Timing = Nocturnal	1) PSG is helpful in identifying OSA in infants with laryngotracheoamalacia and documenting their improvement after supraglottoplasty 2) Test-retest validity of PSG is demonstrated in that OAHI and oxygenation improved in the expected direction following surgery.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
311	Marcus (1990)	4	Evaluation of patients (n=6) with severe laryngomalacia with nap PSG pre and post epiglottoplasty. 2 infants required intubation, 1 needed CPR, 2 had failure to thrive, 2 had cor pulmonale. one child not dxd with laryngomalacia till age 3 yrs.	Clinical series, observational study, case reports Blinding absent	Eligible: 7 Completed study: 6, because one had a normal PSG % males: 2/6	Cases: 9.4 ± 4.6 months (range 2-32 mos) at surgery: 10.3 ± 5.3 months Narrow spectrum	Academic center Self-selected groups Funding not specified	Multiple comparators, specify: hx, physical exam and endoscopic evaluation	PSG criteria	Yes / no: - not typical criteria an episode of obstructive apnea central apnea > 15 seconds, or desat end tidal > 45 sat < 90% or r/a or <95% on oxygen	Limited sleep study (describe parameters) ECG, EOG, respiratorSy effort using RIP, oxygen saturation, endtidal CO2 monitoring, PSG duration = daytime naps (1-2 hrs of sleep recorded), either daytime or evening – if no spontaneous sleep, sedated with chloral hydrate Timing of PSG: Daytime naps	This study looked at the most severe cases of laryngomalacia pre and post intervention. Most of the infants required sedation, but number or specific infants not specified. Some infants with severe laryngomalacia may still have abnormalities on their PSG post-surgery. This is a very small sample and it appears that every infant with severe laryngomalacia should be evaluated post-operatively.
241	Kirk (2000)	4	The charts were reviewed on 73 patients with myelomeningocele and moderate to severe SDB seen at seven peds centers. 27 came from McGill University, the others had 1-13 patients. All centers used lab PSG with EEG and several used home studies for f/u, but details about the studies are not given, including technical details. This paper is essentially reporting types of successful treatment in the PSG-diagnosed major categories of SDB in these patients. OSA, CSA hypoventilation	Clinical series Blinding absent; This study was done to look at identification and treatment of SDB in patients with myelomeningocele in a variety of academic centers	Eligible: 73 ots Completed study: 73 % males: 53	Cases: 15 pts (20%) <1 yr; 23 pts (31%) 1-5 yrs; 20(27%) 6-12 years 11(15%) 13-18 yrs 4 (5%) greater than 18 years Narrow spectrum	Academic center 35 peds sleep centers contacted 7/22 responding centers had adequate clinical and lab data to participate Expert assigned or selected groups Pts included by participating centers if they had moderate to sever e SDB (would require close f/u or treatment) Privately funded (non-p)	Not specified	PSG criteria	No / No	Not stated	1) Pts. with meningomyelocele should undergo early PSG to diagnose multiple potential types of sleep disordered breathing. 2) Oximetry alone is insufficient in the evaluation of children with meningomyelocele because they are at risk for multiple types of SDB including obstructive sleep apnea, central sleep apnea, central hypoventilation, and sleep-exacerbated restrictive lung disease.. 3) Treatments of SDB are variably effective and physicians should have a low threshold to do a follow up study to assess treatment efficacy
135	Miller (2007)	4	This study reported on a series of micrognathic infants undergoing mandibular distraction using a curvilinear device.	Clinical series, observational study, case report Blinding absent	Eligible: unknown Completed study: 12 % males: not specified No controls	Cases: median age 3.5 months (range 9 days – 8 months) Controls: n/a Narrow spectrum	Academic center Expert assigned or selected groups Funding not specified	Not specified	PSG criteria (No details given re: PSG: just stated that AHI improved)	No / No (No details given)	Not specified Duration not specified Timing = Not specified	Not enough details given although it appears that this study is supportive of an improvement in severity of SDB following distraction in micrognathic infants. Test-retest validity of PSG-determined AHI is possibly supported by this study in that the mean AHI improved in the expected direc-tion postoperatively.
4.4.4 Consideration of decannulation of tracheostomy												
312	Tunkel (1996)	3	1. To determine whether PSG is useful in the evaluation of readiness for decannulation in children with long-term trachs. 2. Variety of indications for trachs including craniofacial anomalies, subglottic stenosis, OSA, respiratory failure, BPD.	Clinical series, observational study, case report Blinding not specified	Completed study:24 patients	Cases: Mean 37 mo Range 16 mo-11 yr Narrow spectrum	Academic center Random selection Pharmaceutical or equipment company funded	Not specified	Not stated	Yes / Yes	Comprehensive PSG Duration not specified Timing = Nocturnal	PSG is a useful supplement to airway endoscopy in the evaluation of readiness for decannulation in children.
4.4.5 PSG for management of mechanical ventilator settings or weaning from ventilator support												
307	Tan (2007)	4	Retrospective chart review of children seen at their sleep center who were using respiratory support when sleeping. All children done within 12 months who had been using respiratory support >3 months. 61 sleep studies (1/3 comprehensive PSG, 2/3 cardiorespiratory monitoring, a few autoPAP titrations) were done in 45 children (median age 8.3 y) over a 12-month followup period among children who had been using respiratory support (RS) at least 3 months. Children had a myriad of conditions requiring them to use CPAP or BPAP, autoPAP, or NIPV. Authors examined how often adjustments in PAP were needed in children receiving long-term PAP or other respira-tory support when sleeping. No blinding, judgment to alter PAP or RS settings made by one person, perhaps empirical, not then tested by repeat unattended sleep study. Used peculiar definitions and standards to grade abnormalities found. No titration of respiratory support during sleep studies, single clinician reviewed sleep studies, prescribed empirical adjustment, no documentation of the efficacy of this recommendation save no major complaints reported by caregivers or patients after adjustments made.	Clinical series, observational study, case report Blinding absent	Eligible: 45 children/no controls/60% boys Completed study:45 % males:60% # controls:0	Cases:45 (median age 8.3 y range 0.4-18.6 y) Controls: none	Community referral Expert assigned or selected Funding not specified	Not specified	Other diagnostic criteria developed by authors	Yes but unique; only 1/3 of studies were comprehensive PSG then scored using R& K, for cardiorespiratory studies, scored 30-s epochs as awake if contained >50% movement artifact on respiratory channels or digital video. Yes: Unique definition of apneas or hypopneas lasting 3 or more seconds.	1/3 of PSG were comprehensive in-hospital unattended PSG using Compumedics. 2/3 were inhospital unattended cardiorespiratory monitors; 5(8%) were autoPAP titrations, 3 of these done at home. CPAP flow measured at mask or pressure at tracheostomy done. Piezo belts used to monitor respiratory effort; Based on diagnostic studies, sleep pediatrician recom-mended adjustments in CPAP or BPAP or IPV settings, efficacy of these confirmed by feedback from patients or their caregivers. Duration not given Timing = nocturnal	Children using respiratory support when sleeping be it CPAP, BPAP, tracheostomy with NIV or autoPAP often need adjustment of the pressure settings . No clinical features identified children more likely to require changes in respiratory support settings. The authors said their data and findings did not enable them to make recommendations on timing of followup sleep studies. PAP needs change with time and growth and children. Prospective studies are needed to determine how often sleep studies should be repeated in children using respiratory support when sleeping. The usefulness of PSG in this paper is limited to documentation of respiratory status during sleep while on respiratory support; they did not do titrations/adjustments in pressure during the PSG study
4.4.6 Titration of supplemental oxygen - NO PAPERS												
4.4.7 PSG in relation to use or discontinuation of Infant Apnea Monitor												
47	Rosen (1983)	4	26 infants with unexplained life-threatening apnea underwent clinical and PSG examination	Clinical series Blinding not applicable	Eligible: 26 Completed study: 26 % males: 65	Cases: 2.14+/- 1.25 weeks; Narrow spectrum	Academic center Self-selected groups Government Funded	Physical examination	PSG criteria; other criteria: clinical examination and GER data.	Yes / Yes	Comprehensive PSG Duration = 8-12 hours Nocturnal (12 hour recordings in 22 pts; 8 hour daytime recordings in 4 pts.)	1) Although subtle abnormalities may be detected by comprehensive PSG, they are not predictive of recurrent apnea or death. 2) Due to the absence of a control group in this study, differences between normal infants and infants with parent-observed apneas could not be determined. 3) GER episodes were not associated with apnea, bradycardia, or other respiratory changes during PSG.
4.4.8 PSG for assessment and monitoring of children with Prader-Willi syndrome being considered for or receiving growth hormone supplementation												
313	Haqq (2003)	2	Primary Aim - To determine whether GH administration in children with PWS improves: 1) pulmonary function; 2) behavior; 3) cognition; 4) sleep quality; 5) fasting serum gherlin level Secondary Aims – Confirm the effects of GH administration on : 1) Gh velocity; 2) Biomarkers of weight regulation and metabolism; 3) Body composition; 4) Resting energy expenditure Each subject was evaluated at 0,6 and 12 months with follow up at 3 and 9 months to ensure no side effects.	Prospective cohort study Blinded	Eligible: 14 Completed study: 12 % males: 6 (50%) # controls: each patient served as his/her own control	Cases: 9.7 ± 3.3 yrs Narrow spectrum - didn't specify how subjects chosen except that those with other health problems were excluded	Academic center Strategy not specified Government funded - NIH but also industry funded for the inactive ingredients	Not specified	PSG criteria	No - although sleep study – EEG not specified and carbon dioxide levels not reported No	Comprehensive PSG - EEG not reported not end tidal or carbon dioxide levels. PSG duration = recording of 10 hr throughout each night Nocturnal	GH administration for 6 months in children with PWS seemed to trend towards reduced number and frequency of apneas and hypopneas but were not statistically significant. None of the patients had normal sleep studies before or after administration of GH. Hypoventilation was not evaluated. T is presumed that lesser number of events are a function of improved respiratory muscle strength but actual respiratory muscle strength was not measured, just lung function. It is not reported whether the patients under-went intervention because of the very abnormal sleep study results. Actual sleep data (EEG, % REM etc) was not documented. In this small sample, GH administration does not seem to worsen SDB. None of the patients died.

Ref ID	Author (yr)	Evidence Grade	Study Description	Study Design and Blinding	# Cases/ # Controls/ % Males	Mean Age/ Patient Spectrum	Recruitment Source, Strategy, and Funding	To What Alternate Diagnostic Measures was PSG Compared?	Diagnosis Reached Using…	Were Sleep Stage / Respiratory Scoring Methods Clearly Defined?	Type of PSG applied/ Duration /Timing	Study Conclusions Relative to PSG
197	Festen (2006)	3	Original study was a randomized controlled clinical trial of 6 months of GH Rx in prepubertal PWS children on growth, body composition, activity level, and psychosocial development. After start of study, a PSG was added so this is an analysis of a sub-group of the entire study. GH was dosed initially at 0.5 mg/m2-d for one month and then 1.0 mg/ m2-d for the rest of the study OSA and CSA	Case control Blinding not specified	Eligible: 53had initial PSG (57% male) Completed study: 35 (57% male) 39 (59% male) had second PSG but 4 had to be excluded because of concurrent URTI	Cases: 5.4 (2.1-7.2) Of the 35 who completed the study: 6.0 (2.4-8.6) at start of study Controls: none Wide spectrum All PWS without selection of those with resp sx's	Source not specified Random selection Pharmaceutical or equip	PSG's were performed before and after c. 6 months of Growth Hormone Rx	PSG criteria	Yes; R&K / Yes Comments: Apnea=decrease in A/F of > 90% for >=3 breaths; Hypopnea=decrease in A/F of >50% with a fall in oxy sat of >=4% for >=3 breaths; AHI>1/hr was considered ABNORMAL; OAI>1 was definition of OSA; Both central and obstructive events were noted	Comprehensive PSG 1. EEG 2. EOG 3. Submental EMG 4. EKG 5. RAT 6. LAT 7. Nasal pressure prong 8. Thoracic strain gauge 9. Abdominal strain gauge 10. Pulse oximeter Note, no CO2 data Nocturnal	1. PSG is likely indicated in children with Prader-Willi syndrome who are obese (BMI + 2SDS) as the prevalence of OSA in this study was high in obese PWS subjects (50%) although the number who were obese was small (8); 2. PSG may be indicated in children with Prader-Willi syndrome who are non-obese as the prevalence of OSA, although much smaller, was still 9% (n=45); 3. PSG is unlikely to change significantly in those children with PWS given growth hormone if there are no other clinical changes (e.g., no change in tonsil/adenoid size)
149	Miller (2006)	4	25 patients with PWS (17 with del'n of chr 15q11-13 and 8 with maternal uniparental disomy of chr. 15) agreed to stop GH or were naïve to GH therapy. They underwent PSG off GH, then 6 weeks after starting. PSG was repeted in 2 patients 6 months after GH was instituted This study was done to determine if growth hormone therapy in patients with Prader Willi Syndrome effects sleep disordered breathing	Clinical series Blinding absent	Eligible: 25 Completed study: 25 % males: 60	Cases: 6 months to 39 years Narrow spectrum	Academic center Expert assigned or selected groups Government funded	Not specified	PSG criteria	Yes / Yes but no definition of OSA	Comprehensive PSG Duration not specified Timing not specified, presumably nocturnal	Pts with PWS seem to have a high incidence of SDB; PSG should be considered prior to starting GH and within several months after starting, especially in patients susceptible to URIs and with adenotonsillar hypertrophy, although prevalence in PWS is unknown. Included subjects with OSA but did not define it.The administration of GH appears to change respiratory patterns in subjects with PWS on GH and suggest they undergo surveillance or follow-up PSG if they are taking GH

Search Terms

Original search in June 2007.

Limits: Humans, English, All Child.

Pediatric OSA Indications for PSG:

Infant	Polysomnography	Obstructive sleep apnea
Child	PSG	Sleep related breathing
Adolescent	Sleep	Breathing
Pediatric	Sleepiness	Respiration
	Sleep studies	Tonsillectomy
	Sleep Testing	Adenoidectomy
	Oximetry	Positive airway pressure therapy
	Multiple Sleep Latency Test	Autotitrating positive pressure
	MSLT	Autopap
	Maintenance of wakefulness test	Non-invasive positive pressure ventilation
	MWT	Tracheostomy
		Obesity
		Snoring
		Hypoventilation
		Down syndrome
		Craniofacial
		Tonsillar hypertrophy
		Oxyhemoglobin desaturation
		Nocturnal hypercapnia
		Upper Airway Resistance Syndrome
		Periodic breathing
		Hypoventilation
		Sleep-disordered breathing
		Sleep-related breathing disorders
		Central sleep apnea
		Apnea
		Sleep Apnea

Other Respiratory Indications for PSG:

Column 1 AND Column 2 AND Column 3

Infant	Sleep studies	PSG
Child	Sleep study	Sleep studies
Adolescent	Sleep testing	Oximetry
Pediatric	Polysomnogram	Portable screening
	Polysomnography	OSA

	NREM sleep	OSAS
	REM sleep	Sleep disordered breathing
	Sleep deprivation	Habitual snoring
	Diagnosis	UARS
	Sensitivity	Respiratory failure
	specificity	Respiratory insufficiency
	Reliability	Down syndrome
	Positive predictive value	Trisomy 21
	Negative predictive value	Prader Willi Syndrome
		Chromosomal Disorders
		Craniofacial malformations
		Pierre Robin
		Cleft lip/palate
		Chiari malformations
		Central apnea
		Brainstem lesions
		Respiratory control
		Cerebral palsy
		Hypotonia
		Spasticity
		Myotonic dystrophy
		Muscular dystrophy
		Duchenne’s muscular dystrophy
		Facioscapulohumeral dystrophy
		Congenital myotonic dystrophy
		Arthrogryposis
		Autism
		Pervasive developmental delay
		Rett syndrome
		Sickle cell anemia
		Sickle cell disease
		Pulmonary hypertension
		Idiopathic pulmonary hypertension
		Systemic hypertension
		Cystic fibrosis
		Hypoxemia
		CTFR
		Congenital heart disease
		Chronic lung disease
		Bronchopulmonary dysplasia
		Congenital diaphragmatic hernia
		Respiratory insufficiency
		Home apnea monitoring
		Laryngomalacia
		Tracheomalacia
		Bronchomalacia

		Apparent life threatening events
		Near miss SIDS
		Reflux
		Gastroesophageal reflux
		Heartburn
		Spinomuscular atrophy
		Central hypoventilation
		Congenital central hypoventilation
		Diaphragmatic pacing

Updates in March 2009 included the following additional terms:
Auto cpap
Cor pulmonale
Allergic rhinitis
Atopy
Asthma
Spina bifida
Reactive airways disease
Kyphoscoliosis
Scoliosis
Restrictive lung disease
Sudden infant death syndrome
Apnea of prematurity
Primary sleep apnea of infancy
Congential lung disease

Updates in March 2009 were arranged the terms by topic, for example (sleep test search terms linked by OR) AND (diseases of interest, for example sickle cell anemia) AND (the limits activated, for example search date and English and children)

The specific searches for the 2009 update were:

(polysomnography OR PSG OR sleep OR sleepiness OR sleep studies OR oximetry OR multiple sleep latency test OR mslt OR maintenance of wakefulness test OR MWT) AND (respiratory failure OR respiratory insufficiency OR cerebral palsy OR hypotonia OR spasticity OR myotonic dystrophy OR muscular dystrophy OR Duchenne's muscular dystrophy OR facioscapulohumeral dystrophy OR congenital myotonic dystrophy OR arthrogryposis OR Rett syndrome OR sickle cell anemia OR sickle cell disease OR pulmonary hypertension OR idiopathic pulmonary hypertension OR cystic fibrosis OR hypoxemia OR CTFR OR congenital lung disease OR chronic lung disease) AND ("last 2 years"[EDat] AND (Humans[Mesh]) AND (English[lang]) AND (infant[MeSH] OR (infant[MeSH] OR child[MeSH] OR adolescent[MeSH])))

(polysomnography OR PSG OR sleep OR sleepiness OR sleep studies OR oximetry OR multiple sleep latency test OR mslt OR maintenance of wakefulness test OR MWT) AND (bronchopulmonary dysplasia OR congenital diaphragmatic hernia OR laryngomalacia OR tracheomalacia OR bronchomalacia OR apparent life threatening events OR near miss SIDS OR reflux OR gastroesophageal reflux OR spinomuscular atrophy OR spino muscular atrophy OR central hypoventilation OR congenital central hypoventilation OR diaphragmatic pacing OR achondroplasia OR reactive airways disease OR kyphoscoliosis OR scoliosis OR restrictive lung disease OR sudden infant death syndrome OR apnea of prematurity OR primary sleep apnea of infancy)

(polysomnography OR PSG OR sleep OR sleepiness OR sleep studies OR oximetry OR multiple sleep latency test OR mslt OR maintenance of wakefulness test OR MWT) AND (obstructive sleep apnea OR sleep related breathing OR breathing OR respiration OR tonsillectomy OR adenoidectomy OR positive airway pressure therapy OR autotitrating positive pressure OR auto cpap OR non-invasive positive pressure ventilation OR tracheostomy OR obesity OR snoring OR hypoventilation OR down's syndrome OR craniofacial OR tonsillar hypertrophy OR oxyhemoglobin desaturation OR nocturnal hypercapnia OR upper airway resistance syndrome)

(polysomnography OR PSG OR sleep OR sleepiness OR sleep studies OR oximetry OR multiple sleep latency test OR mslt OR maintenance of wakefulness test OR MWT) AND (periodic breathing OR hypoventilation OR sleep-disordered breathing OR sleep-related breathing disorders OR central sleep apnea OR apnea OR sleep apnea OR Cor pulmonale OR allergic rhinitis OR atopy OR asthma OR chromosomal disorder OR Chiari malformation OR Spina bifida OR cleft lip/palate OR Pierre Robin syndrome)

Limits Activated: daterange, 2007, 06, 01, 2009, 03, 27, Humans, English, All Infant: birth-23 months, All Child: 0-18 years

[Author, Year]

Indications for PSG in Children Task Force: Data Extraction Form

Primary Reviewer ID: Not specified	**Secondary Reviewer ID: Not specified**	**Paper meets inclusion criteria : Not specified**	**Reason for excluding paper: Not specified**
Was this study designed to address specific issues regarding this category or topic? Not specified	**If no, explain the primary purpose of this study and why data are relevant or useful in addressing this topic:**		

Category (topic) for extraction (same article may be extracted more than once on different topics)								
☐ **SRBDs**	☐ **Other respiratory**	☐ **Parasomnias, Epilepsies and characterization of arousals**	☐ **Sleep-related movement disorders**	☐ **Narcolepsy and other hypersomnias**	☐ **Insomnia with CRSD**	☐ **Insomnia or hypersomnia with depression or other mood disorder**	☐ **ADHD or other neurobehavioral problem**	☐ **Technical, procedural or methodological papers**
Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified

Study Methodology:

Study Design/ Blinding Methods	**# of cases/ # of controls/ % males**	**Mean Age ± SD (range)/ Patient spectrum**	**Recruitment Source and Strategy/ Funding**	**To what alternative diagnostic measures was PSG compared (if applicable)**	**Condition diagnosed by Check all that apply**	**Were sleep stage scoring methods clearly defined?**	**Describe type of PSG applied/ Duration of PSG (mins)/Timing of PSG**
Not specified	Eligible: Completed study: % males:	Cases: Controls:	Not specified and Not specified	Not specified	☐ Diagnosis reached using PSG criteria ☐ Diagnosis reached using ICSD criteria ☐ Diagnosis reached using other diagnostic criteria developed by authors ☐ Other, specify: Comment:	NA	Not specified
NA	# controls: % males:	Patient Spectrum[1] NA	Pharmaceutical or equipm			**Were respiratory scoring methods clearly defined?** NA	PSG duration =
						Comments:	Timing of PSG: Not specified

Study Overview:

Study Description (short narrative)	**Study Findings:** (describe each major outcome or finding, including mention of significant statistical issues; discuss methodological limitations, sources of bias, or other factor that may influence outcome):	**Study Conclusion(s) Relative to PSG**

Outcome variables:

% subjects having diagnostic test and appropriate independent outcome measure	Was a valid reference standard used to assess presence of disease? If yes, was it independent of the diagnostic test?	Reliability	Validity issues	Diagnostic Accuracy (Outcome variables)[3]	
% patients provided both the diagnostic test and diagnostic accuracy measurements:[2]	NA NA	☐ Reliability issues –Choose one or more: ☐ intra-reader reliability ☐ inter-reader reliability ☐ test-retest reliability ☐ Recording strategy issue: No If YES, choose one: Not specified	☐ History or structured history: Not applicable ☐ Questionnaire (specify): Not applicable ☐ Clinical: Not applicable	Not specified 95% CI = Relative Risk = Sensitivity = Specificity =	PPV = NPV = P = LR = Other:

[1]Studies with a wide spectrum of patients should include patients with mild forms of the disease and patients with clinical conditions that could easily be confused with the disease. Studies with a narrow spectrum of patients only include patients who clearly have the disease or clearly do not have the disease.
[2]A cohort study should be downgraded to level II if less that 80% of the subjects have both the test performed and the variables measured
[3]If pertinent outcome measures have not been calculated by the study authors, can they be calculated? If yes, see table below.

Quality Assessment:

Quality Assessment					Level of Evidence (Grading rubric)	
A1. Was the study prospective?	☐ **Yes**	☐ **No**	☐**Uncertain**	☐**NA**	☐ Level 1: A1+,B1+,C+,D1+, E+	
A2. Was the study retrospective	☐ **Yes**	☐ **No**	☐**Uncertain**	☐**NA**	☐ Level 2: [A1+, B2+] or [A2+, B1+] and C+,D1+, F+	
B1. Did the study use a broad spectrum of patients with the suspected condition in both the test and control groups?	☐ **Yes**	☐ **No**	☐**Uncertain**	☐**NA**	☐ Level 3: A2+, B2+, D3+	
B2. Did the study use a narrow spectrum of patients with the suspected condition in either the test or control groups?	☐ **Yes**	☐ **No**	☐**Uncertain**	☐**NA**	☐ Level 4: D3-, C-, D2+ ☐ Reviewer uncertain, provide comment:	
C. Was a control group present?	☐ **Yes**	☐ **No**	☐**Uncertain**	☐**NA**	Additional notes or comments:	

D1. Was the study blinded?	☐ **Yes** ☐ **No** ☐**Uncertain** ☐**NA**		
D2. Was the blinding in some way inadequate or absent?	☐ **Yes** ☐ **No** ☐**Uncertain** ☐**NA**		
D3. If retrospective, was the reference standard (if not objective) applied by someone other than the person interpreting the test?	☐ **Yes** ☐ **No** ☐**Uncertain** ☐**NA**		
E. Did all patients undergoing the diagnostic test also have the presence or absence of disease determined?	☐ **Yes** ☐ **No** ☐**Uncertain** ☐**NA**		
F. At least 80% of patients had both the test performed and the variables measured?	☐ **Yes** ☐ **No** ☐**Uncertain** ☐**NA**		

If sensitivity, specificity PPV, NPV, P value, likelihood ratios etc. are not provided, can a table be constructed and the values calculated? If yes, complete the table:

	PSG + (Disease present)	PSG – (Disease absent)	Total
Test +	A	C	
Test -	B	D	
Total			

Relative risk = [A/(A + C)] / [B/(B +D)]
Sensitivity = A/(A +B)
Specificity = D/(C + D)
PPV = A/(A + C)
NPV = D/(B + D)

Levels of Evidence:

Level I: Evidence provided by a **prospective** study in a **broad spectrum** of persons with the suspected condition, using a **reference (gold) standard** for case definition, where test is applied in a **blinded fashion**, and enabling the assessment of appropriate test of diagnostic accuracy. All persons undergoing the diagnostic test have the presence or absence of the disease determined. Level I studies are judged to have a low risk of bias.

Level II: Evidence provided by a **prospective** study of a **narrow spectrum** of persons with the suspected condition, or a **well designed retrospective** study of a **broad spectrum** of persons with an established condition (by **"gold standard**") compared to a **broad spectrum of controls**, where test is applied in a **blinded** evaluation, and enabling the assessment of appropriate tests of diagnostic accuracy. Level II studies are judged to have a moderate risk of bias.

Level III: Evidence provided by a **retrospective** study where either person with the established condition or controls are of a **narrow spectrum**, and where **the reference standard, if not objective, is applied by someone other than the person that performed (interpreted) the test**. Level III studies are judged to have a moderate to high risk of bias.

Level IV: Any study design where **test is not applied in an independent evaluation** or evidence is provided by expert opinion alone or in **descriptive case series without controls**. There is **no blinding or there may be inadequate blinding**. The **spectrum of persons tested may be broad or narrow**. Level IV studies are judged to have a very high risk of bias.

Description of study design (from AAN document):

Prospective cohort study: Investigators start with a group of subjects suspected of having the disease (cohort). The diagnostic test would be performed on this cohort. Some subjects would have a positive test, others a negative test. The cohort would then have the actual presence or absence of the disease of interest determined by an independent reference standard (the gold standard).

Case-control studies: Rather than starting with a group of subjects suspected of having the disease, investigators start by selecting a group of subjects who clearly have the disease (cases) and a group of subjects who clearly do not have the disease (controls). The test is then performed on both cases and controls and measures of diagnostic accuracy are calculated. Although the case-control study is easier to execute, its retrospective design introduces several potential biases, and at best, a case-control study can only be a Level II or lower.