Talking Sleep Season 4
Episode 2
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Home Sleep Apnea Testing in Children
Dr. Shannon Sullivan, guest

Episode Transcript

**DR. KHOSLA**: Thank you for joining us for Talking Sleep, a podcast of the American Academy of Sleep Medicine. I'm your host, Dr. Seema Khosla, medical director of the North Dakota Center for Sleep here in freezing Fargo, North Dakota. Advances in home sleep apnea testing have made it a useful diagnostic tool, but when is it best to use?

Today, we're talking with Dr. Shannon Sullivan, a pediatric sleep specialist at Stanford University, about home sleep apnea testing in children. Thanks for joining us, **DR. SULLIVAN**.

**DR. SULLIVAN**: Thank you very much for having me, Seema. It's great to be here.

**DR. KHOSLA**: So let's dive into what the current guidelines say. What are the current guidelines on using HSAT in children?

**DR. SULLIVAN**: Well, Seema, the American Academy of Sleep Medicine did release a position paper for the use of home sleep apnea testing for the diagnosis of obstructive sleep apnea in children in 2017. And in that position paper, it is stated that the use of home sleep apnea tests is not recommended for the diagnosis of obstructive sleep apnea in children, and there have been no further position papers released since that time.

But what's interesting is that slowly but surely, we're starting to see more reports, in particular settings and in particular cases of potential uses for home sleep tests or pediatric sleep polygraphy in the literature.

**DR. KHOSLA**: So tell me what's been happening in the world of pedes with respect to this testing, I mean, is it something pandemic related with pediatric practices having to adapt?

**DR. SULLIVAN**: Well, good points point, Seema, for sure. I think top of mind for everybody in sleep medicine over the last two years has been how to adapt practice to best meet the needs of patients, all patients, but including pediatric patients since the beginning of the pandemic.

And some of these, I mean, in a glass half full kind of way, I think the pandemic has challenged our dogma and allowed for us to think about new opportunities within the practice of sleep medicine, and that includes in pediatrics, and that certainly can include thinking about ways to be able to introduce some of these methods of care at distance for our pediatric patients. And you know, there's an interesting paper out in the middle of last year called uncharted territory about some of these challenges and opportunities in the world of sleep medicine and among them is, is, you know, thinking about the use of home sleep studies for selected groups of children or adolescents. And there's other things as well that we can talk about.

**DR. KHOSLA**: So are there actually devices that have been FDA approved for pediatrics?

**DR. SULLIVAN**: There are. An example would be the WatchPAT, which is approved for individuals aged twelve and up or the Nox T3, for example. There are others, but I would like to point out that just because there may be FDA approval for the use of these devices in a certain age group that doesn't necessarily translate to, for example, payor requirements. And so that doesn't necessarily mean that payers will pay for these or necessarily that it's a good idea, depending on the clinical situation, to use them.

**DR. KHOSLA**: So when might you consider utilizing HSAT and kids, I mean, you kind of talked about a resource limited situation. When do you think we might consider utilizing this testing in children?

**DR. SULLIVAN**: Well, that's very interesting. So first, let's go back to that 2017 position paper I mentioned before. There is a line in that position paper that states that the ultimate judgment regarding any specific care must be made by the clinician, and the clinician ought to do this in light of individual circumstances, as well as available diagnostic tools and or accessible treatment options or other resources. So nothing has brought this into better focus than the circumstances of the pandemic. So, for example, you know, we have to think about what are the available resources and then in that space and what clinical situations might this be something to consider? I think, you know, and we can talk about specific clinical situations, but I think one

really interesting thing to do is to keep in mind, what are the limitations of this type of technology? Because from there, you can start to think about, OK, in what situations might I be able to manage those limitations in a reasonable way clinically? So, you know, when I think about the limitations of home sleep testing in children, you know, the first thing that comes to mind is that very often these are more limited evaluations. So especially in the case of the level three home sleep apnea tests, these are lacking EEG, so it is not possible to score arousals in most cases, according to the standard definitions. And as you know, in pediatric sleep, arousals are needed for the to score hypopneas in some cases and also for the definition, one of the definitions for central apnea. Another really important thing about EEG is that you aren't measuring sleep if you don't have a measure of EEG in most cases. And so the denominator against which the AHI or REI is calculated is a recording time rather than a sleep time. Now that's a big deal in pediatrics because, as you know, an AHI of 1.0 events per hour, anything above that level could be considered sleep-disordered breathing. We'll talk about different thresholds in a little while, but that's a big deal in pediatrics.

The other thing about this, this testing equipment, is that very often they cannot readily identify hyperventilation or CO2 retention. And again, we really don't know how these devices perform in terms of what is the AHI or REI cut off that's that really should be used depending on the characteristics of the child. Now in pediatrics or a whole range of considerations around limitations of the data that's collected.

**DR. KHOSLA**: So when I think about this, the first patient population that I think of and I'm an adult sleep person, I don't see kids at all. But I, you know, immediately I would think of sort of the older adolescent who, you know, we think has sleep apnea like obstructive sleep apnea, but are there, you know, so A, is that correct? And B, are there other, you know, other groups that maybe would just do better by virtue of being at home? You know, like maybe a neuro atypical kid or something like that?

**DR. SULLIVAN**: Yeah, great points, Seema. So first of all, I think for post pubertal adolescence, you get out of one of the other considerations around sleep apnea testing, which is around feasibility. So in younger children in particular, there may be concerns around adequate signal acquisition and even safety of the equipment for younger children. And I think with older

patients, older children and adolescents, sometimes feasibility considerations are easier to manage.

But you're right, the I think among, I mentioned before, there are an increasing number of small studies that have been published looking at potential applications for level three home sleep apnea tests. And often we see that performance characteristics and actually diagnostic category pencils out reasonably well in and certain populations of adolescents. But I agree with you. What about a sort of school age child who might have four plus tonsils and witnessed apnea as in whom you think a clinical diagnosis of sleep apnea is pretty apparent? Who maybe has a surgeon who desires a positive sleep test before, before and no tonsillectomy? That might be a case in which if the wait for in lab testing is excessively long or your lab is closed down related to pandemic concerns, you might think about that as a layer of your approach now. It's very important to know that even in that clinical scenario, you're really needing to consider the individual circumstances and deciding, well, OK, what's going to happen if I don't get data on that particular night? Would I repeat it? Am I going to wait for the lab test? What if the test is negative? You know, it's probably important to think about, OK, what's the next step if a test is going to be negative in that scenario?

Another interesting one, you mentioned adolescents. I mean, I think a really interesting application is in children who may have delayed sleep-wake disorder, who may have a habitual sleep-wake schedule, which is really not aligned with the local sleep lab. Because, as you know, waking that individual up at 6 a.m. because the lab is, you know, getting ready to close for the day might miss very valuable episodes of REM. And in that individual, they may not be ideally served by truncating the sleep period in such a fashion.

And then again, you can think about children who may have developmental delays, who have come into the lab and failed related to the number of wires or the intensive nature of in lab polysomnography, but in whom, as a clinician, you would like to get some sense of what might be going on for them in terms of breathing during sleep? That might be a situation where you might consider deploying a home sleep apnea test.

And I want to point out that I think that degree of clinical decision making and bootstrapping, if you will, that that all clinical providers do we sometimes find especially is needed in pediatrics

to really stay patient, focused and patient centered. And this kind of thing is included in in that 2017 position paper, I think it's acknowledged that that's part of the practice of medicine.

**DR. KHOSLA**: Well, that's exactly it, right? There's the art and then there's the science. So can you get a measurement of carbon dioxide at home?

**DR. SULLIVAN**: There are devices to do that, Seema, but I wouldn't say that at this moment, those are standard as part of level three sleep apnea tests.

So but I think as we move forward and we stretch ourselves to think about how can we really take care of our patients effectively, incorporating those types of devices into practice in certain situations and for the right patients could be could be something worth considering. We're learning.

**DR. KHOSLA**: We're always learning, aren't we?

**DR. SULLIVAN**: Mm hmm.

**DR. KHOSLA**: So how do the parents feel about this?

**DR. SULLIVAN**: You know, this is really interesting, I think. So if I if you don't mind if I if I pull in a little bit of data on that one, I think this is an interesting space. I think it varies. It depends. How about that as an answer?

So there's an interesting study that was recently released. It's a retrospective analysis of actual practice and a pediatric study in the UK following the COVID-19 pandemic. And actually, the title of that study is the feasibility and parental perception of home sleep studies during COVID-19, and this was a report from a tertiary care center. So this was a group of very experienced pediatric sleep medicine providers, and they take care of patients with a number of comorbid conditions and a couple of things about this. They reported on about 100 children who underwent home sleep apnea testing. These children tended to be younger. So unlike some of the other case reports of kind of mainly adolescents, these were children who ranged in age from one to about twelve years old, and their overall success rate was 56%. So meaning that they were able to collect adequate data. Now, their patient population includes children with ADHD, autism spectrum disorder, achondroplasia, other developmental delays, epilepsy,

neuromuscular disease and children who are typically developing but being evaluated for sleep apnea. So again, this is kind of a classical pediatric tertiary care sleep population, but with substantial comorbidities.

And what was interesting is that the parents of children who had developmental delays had a greater preference for home study, so 74% of them would prefer to do the home test, whereas the parents of typically developing children who were referred for a straightforward OSA evaluation had a greater preference for in lab testing. So 53% of them. So you know, what's interesting about that is that I think that's a really important consideration. Because when you look at sort of these small series, case series type studies that kind of evaluate performance testing for level three HST against PSG, it's very often in children with few comorbidities, who are mainly being evaluated for obstructive sleep apnea. And I think we still have a lot to learn about what the acceptance will be for deploying measurements in the field in that population.

**DR. KHOSLA**: Do you want to kind of wonder is it going to be like telemedicine, where at first it was really clumsy in patients, you know, we're very unfamiliar with it, whereas now they're, you know, they're really good at it now.

**DR. SULLIVAN**: You know, that's a great point. Seema, I mean, actually one of the other learnings that came out of that particular study and has been reported elsewhere as well, that it's not so much that you just give someone a suitcase with some equipment inside and kind of give him a thumbs up and say, good luck with that. There are probably a lot of supports that can be developed that could be helpful. For example, you know, YouTube videos or like a video that you could deploy that could demonstrate how to attach the equipment or, you know, helpful dos and don'ts, or even a real, real time video chat with a technologist who might be able to help troubleshoot on any questions and make sure that the leads were picking up signals correctly in the beginning of the night. And as you may know, there are studies showing higher success rates in even younger children when a technologist visits the home to help set up equipment. Now that may not be generalizable or scalable, but there are different methodologies that that could be explored again, depending on their clinical circumstance.

**DR. KHOSLA**: Well, and I think you're right. one of our colleagues, her team, Dr. Amy Bender, they won the Sleep Change Agents competition, and they talked about how to deploy, you know,

type two PSG into the home. And so that, you know, that's a consideration with the tech setting it up and you're right with the educational piece.

I kind of want to hit on something you mentioned earlier about how the threshold rate that you know, that AHI of 1 in the lab is where you sort of decide if a child has sleep apnea or not. How does that compare to the REI? Is it a different cutoff, maybe for HSAT? Or is it the same number?

**DR. SULLIVAN**: Well, that's a great question. And the answer is we really need more data. I mean, I think that's one of the reasons the field is there's many reasons, but that, you know, we're just there's just we're just not at the point of being able to say it's time to mainstream this as an option across the boards. There's just so much more work that needs to be done as we start to think about how to best fit this into our practice. Now, to that end, you know, there's a study actually from 2017 that looked at the performance of one type of type three home sleep apnea test.

And how did the AHI or REI threshold reported by the home sleep apnea test, how did that compare to the AHI I derive from polysomnography? And in fact, a couple points in the mild range are quite different so that the best sensitivity and specificity for that, the level three HSAT unit, if you wanted to identify a child who had an AHI greater than one was actually 3.5 on the home test. Now, as the severity level increased, so that if your goal was to identify children who had an eye on PSG of greater than five, then you would use a threshold of 5.5 on the home sleep apnea testing equipment.

And then the other thing that plays into that, Seema, is age, so that it looks like the performance of these home sleep apnea tests, which again, are really kind of for the adult world or developed for the adult world, that that that performance probably varies depending on age. And in that study, the performance improved when children were in the double digits if they were age ten or greater.

**DR. KHOSLA**: That's a really good point. Let's take a quick break, and when we come back, we'll talk more about diagnosing sleep disorders in children. You're listening to Talking Sleep from the American Academy of Sleep Medicine.

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**DR. KHOSLA**: Welcome back to Talking Sleep. We're talking with Dr. Shannon Sullivan, a pediatric sleep specialist, about home sleep apnea testing for children. So is it time to update the guidelines?

**DR. SULLIVAN**: I don't think we're there yet, Seema. I think, you know, and we've been talking about a lot of, you know, this kind of starting to be the emergence of some data to help us better framework around where we might start to think in various clinical situations where something like home sleep apnea testing could be appropriate or could be deployed as part of an overall approach, not as a standalone, you know, one and done type thing. But among the other unknowns, we really don't know their best age range, although we spoke a little bit about, you know what our judgment is on that or what our thinking is on that, what the what the case series published on this are. I still think we don't know both for utility and for safety. We really need to think about missing signals. Again, that's something we deal with even in the lab. But the big advantage there is that these are attended studies. And so when an important sensor falls off, we have someone there to replace it. So how can you think about trying to minimize missing signals? And we spoke a little bit about that. But I think developing pathways for parental training and to get greater involvement in how sensors are placed is really important.

And I think that, along those lines, it's important to think about how to best support individuals before leading up to the task. So is that in-person support at tech and in the home is that is that more remote type support that could be developed? And like you said, we are just learning about and it's not just a matter of sensitivity and specificity, it's also a matter of identifying optimal cutoffs. And identifying how would you handle not just false negatives, because maybe we can think through how what we would do with false negatives, but what is the possibility for false positives and what kind of clinical consequences can come out of that as well?

Now I will say I was delighted to see a methods paper published last year in 2021 that is describing a trial, a Spanish trial, looking at validity and cost effectiveness of pediatric home respiratory polygraphy or home testing for the diagnosis of obstructive sleep apnea in children.

And that paper goes through the rationale, the study design and the methodology. But what's interesting about this is their plan is to randomized 320 children to either home testing or to polysomnography. And one of the things we haven't talked about is that in either group, the children will also undergo a careful medical history and standardized questionnaires, and we didn't talk about this. But as you know, clinical medicine doesn't boil down to just the test results. And we need to think a lot about how children are presenting. And I think questionnaires can help this. A careful medical history can assist with this, and we need to take the broad picture and look at all of the pieces of the puzzle.

And then finally, what I like about this study, because I think this is important in the field, is that we need to focus on outcomes equivalence. It's not just a matter of how does one AHI compare it to another AHI, it's how are we serving our patients? What is their journey in pediatric sleep-disordered breathing? What are the therapies that are available to them after these evaluations? And what are their outcomes and how might their outcomes be the same or different? And so I I'm very excited for that. I think we need much more work like this, and I don't think we're ready as a field to simply accept wholesale that that, you know, we're ready for moving into the ambulatory space primarily in pediatrics.

**DR. KHOSLA**: Well, and it's interesting that you talk about these other things, right? Questionnaires and clinical acumen. What about consumer sleep technology? I almost imagine that you have an advantage because, you know, the adolescents are already very tech savvy, right, compared to the adult population. Is this something you routinely use in your clinic?

**DR. SULLIVAN**: Well, first, a comment about teens being tech savvy. Yes and no. I mean, in my own case, with children going to remote learning over the last two years, I mean, it's, you know, yes and no. I think I do think that there is an increased acceptance for wearables among certain patient populations. And that's a really interesting question that you raised because again, as you know, the American Academy of Sleep Medicine has a clinical practice guideline around the use of actigraphy to evaluate certain sleep disorders like insomnia and circadian rhythm sleep-wake disorders. And they're in that in that clinical practice guideline they do suggest the use of actigraphy in pediatrics for those categories of disorders. And so one really interesting question is how well do consumer wearables, which basically have black box

algorithms, how do those algorithms compare to classic research actigraphy, something like the ActiGraph or Active Watch 2?

We have seen a number of papers come out that compare these wrist worn devices to take actigraphy. There's a number of papers in JCSM looking at a sort of performance testing and comparing these. Now, let me first start out with some caveats. I think one really important thing to keep in mind, Seema, is that when you're looking at these performance testing papers, very often, the wrist worn device is not being validated in clinical populations or performance tested in clinical populations. It's being tested in generally healthy sleepers. Now the thing about generally healthy sleepers is that they tend to be sleeping for a very large percentage of the time when they are in bed. And that means that it's not as difficult to generate high sensitivity for sleep, because most of the time that person is sleeping. The other thing I'll say is that even training data sets that are used to develop the algorithms that are used and these wrist worn wearables don't necessarily include children. So even if there are sleep disorders they're not sleep disorders in children.

These wrist worn devices are not usually cleared by the FDA, and as I mentioned before, they cannot be manually scored. So the algorithm that's used to judge sleep or wake or in many cases, sleep staging, is really a black box and there are biases that exist, proportional biases that exist that can alter the performance of these devices. That said, I think it's our my experience anyway clinically that there's been pretty widespread adoption of consumer wearables of a variety of different kinds, and these things are walking into our clinic. And it is I think it is useful to be able to have a framework to understand how they these wearables that your patients may already be utilizing, how they might be able to assist in the management of certain disorders, the same that actigraphy can. And I do think that they have certain advantages over sleep logs, in children and especially in adolescents who may forget to fill out their sleep logs. And then they may be trying to fill out multiple days later, which of course, introduces a lot of recall bias and there might be missing this. So there is something to be said for that.

Now, if you look at the individual publications that have come out in the past two or three years that, for example, compare different iterations of Fitbit or the Oura Ring or the Polar wrist worn device, there are studies in children again, typically healthy children, although at least in one publication, this included children who had obstructive sleep apnea, and you compare that to

sort of standard research grade actigraph or actiwatch type devices, and in studies that include a ground truth measure of sleep-wake such as polysomnography, you see that the performance is about equivalent. So in general, these wrist worn devices tend to underestimate total sleep time, and they tend to overestimate wake after sleep onset.

But in general, if you look at the performance in terms of sensitivity for sleep or specificity for wake or accuracy, they tend to perform about the same. So it's not the case that they that these wrist worn devices correctly assign sleep or correctly assign wake in all cases, but they do perform about they seem to in these studies, perform about as well as actigraphy. So if we think that actigraphy has a role for the management of insomnia or management of circadian rhythm disorders, we might be able to deploy some of these wearables as a useful tool in the same way.

Now, does that obviate the need for clinical judgment? You know, and careful history and following your patient? Of course not, but it is a tool that can be used for sure.

**DR. KHOSLA**: So you mentioned something earlier and for those of us who are not in research, can you explain what proportional bias means?

**DR. SULLIVAN**: Sure, I'll attempt to. So you can you can think about proportional bias is as being that the, for example, the wearable that you might be using to measure or to estimate your gold standard measure that the performance of that wearable changes based on the how much of the gold standard based on the rating of the gold standard. So let's take total sleep time, for example. So an example of proportional bias would be that if the wearable device tended to underestimate total sleep time for very short sleep times and it tended to overestimate total sleep time if you had a very long ground truth total sleep time so that the relationship between the wearable and the gold standard measure varies depending on the amount of the gold standard measure.

**DR. KHOSLA**: Cathy Goldstein was talking about that, about actigraphy used for nighttime and actigraphy used for naps, and I thought that was just kind of a cool way of looking at it.

**DR. SULLIVAN**: That's exactly right. Yeah. And glad you brought that up, because that's a great example in pediatrics in particular, where napping is par for the course.

**DR. KHOSLA**: This is true and not necessarily, you know, something that we are worried about, obviously right for kids.

**DR. SULLIVAN**: That's right. That's right. Although, you know, and that's another interesting thing is that you know it as I as I would say in clinic, it's a sign of something. If you're having an adolescent who's napping on a regular basis, there's a lot more questioning that needs to. Why is that? So it can be an important sign of something. And again, you know, these wearables, are they perfect? No, they're not. But they are agnostic to circumstance. They tend to measure things in the same way across time and biases that we were just discussing notwithstanding, I think they do provide a picture that can be useful and can be integrated into clinical thinking.

**DR. KHOSLA**: Well, and I love how you always bring it back to that, right? You always bring it back to the patient and the clinician. And these are all just tools in our toolbox, right? You know, whether it's PSG or HSAT or wearables or what have you, but they do come down to, well, what makes sense for this patient, right? You know, because sometimes it's not necessarily what stage of sleep are you in at home, it's well, are you asleep or awake? Right?

**DR. SULLIVAN**: That's exactly right. And I do think about these things as potential tools in the toolbox rather than the end all, be all. And you happen to mention, Seema, something else. And I don't know if you were fishing there. But in fact, a lot of these consumer wearables do presume to categorize sleep into light sleep, deep sleep, sometimes REM sleep. And I, you know, the studies that have been that have been published to the extent that they have been in pediatrics and in my own practice, I tend not to focus on those details.

I think they for me, the utility is around sleep-wake patterns and not so much about some of those other details. And that's an interesting thing because as you know, I see adults and children. And one of the interesting things is that I do think that our patients do tend to get concerned depending on what their wearable is telling them about their sleep. So I guess I do have the occasional chief complaint of, you know, my wearable tells me I don't have any deep sleep. You know, what's going to happen to my health now? And I do think we have to be aware of that danger. And that's particularly important I think in pediatrics, these things should not be translated directly into clinical practice without adequate vetting and research to understand what the meaningfulness of the data really is.

**DR. KHOSLA**: So any final thoughts?

**DR. SULLIVAN**: I just want to thank you for inviting me on this program and having the chance to talk about these things with you.

**DR. KHOSLA**: Well, thank you so much for joining us today and really helping us understand when HSAT could potentially be appropriate for our younger patients.

**DR. SULLIVAN**: And thank you, Seema, so much for having me today. It's been a pleasure.

**DR. KHOSLA:** Thanks for listening to Talking Sleep brought to you by the American Academy of Sleep Medicine. For more podcast episodes, please visit our website at aasm.org. You can also subscribe through your favorite podcast service. And if you enjoyed this episode, please take a moment to leave a rating or review. For more feedback or suggestions, email us at podcast@aasm.org. I hope you'll join us again for more Talking Sleep. Until next time, this is Seema Khosla encouraging you to sleep well so you can live well.