Webinar Series

Advancing Sleep Diagnostics Through Home Sleep Testing

Introduction

The healthcare industry was challenged by the global pandemic, but ultimately, it took a giant leap forward toward advancing at-home and telehealth solutions to meet patient demand. Sleep diagnostics are no exception — sleep diagnostics are ripe for disruption and among the best suited for the changes ahead. In fact, providers have already begun to shift from in-hospital to home-based sleep tests and to provide telemedicine solutions along the patient journey.

Throughout the past decade, sleep diagnostic providers have been torn between whether to conduct a full polysomnography (PSG) in the hospital or to send patients home with a home sleep apnea test (HSAT). The hesitancy to rely on an HSAT lies in the historically inconsistent measurements and standards recognized across the world. Traditionally, HSAT is considered to be still somewhat far away from PSG, but modern innovations to the technology pose a new outlook.

In what was originally a three-part webinar series, *Advancing Sleep Diagnostics Through Home Sleep Testing*, we looked at the challenges facing home sleep testing, the reactions from diagnostic technology providers, the metrics to measure accurate sleep diagnosis, and how artificial intelligence (AI) in sleep diagnostics has taken the field by storm. The webinar series attracted more than 1,000 registered attendees from various professions within the sleep industry, including sleep physicians, sleep researchers, sleep technologists, sleep center directors, dentists and other professionals.

During the live Q&A session, Nox Medical's Product Marketing Manager, Snorri Helgason interviewed both experts from Nox Medical along with experts in the field of sleep to focus on the urgent challenge we all face – to increase accessibility to good sleep diagnostics, ultimately supporting healthy sleep for all.

Now available in a written insight paper format, we have summarized the webinar series and expanded on the subject beyond the contents of each session.

Webinar Session 1

Balancing Clinical Accuracy and Simplicity in Home Sleep Testing

Dr. Erna Sif Arnardottir, Director of Reykjavik University Sleep Institute

Throughout the past decade, sleep tests have progressively shifted to the home setting due to the increasing number of patients in need of a proper sleep diagnosis. This is the result of both an increased awareness of sleep disorders among the general population and the demand for feasible diagnostic options without hospitalization. Often, sleep diagnostic providers have focused on comfort and simplicity in home sleep testing but have excluded important data to do so. According to Dr. Erna Sif Arnardottir, Director of the Reykjavik University Sleep Institute, one of the challenges in today's sleep diagnostics is the industry's mis-diagnosing of patients — whether that means under- or over-diagnosing. Furthermore, the entire procedure is too labour intensive and time-consuming for practitioners to manage the enormous demand from patients.

Dr. Erna Sif Arnardottir is the Director of the Reykjavik University Sleep Institute, President of the Icelandic Sleep Research Society, board member of the European Sleep Research Society, and Project Leader of The Sleep Revolution. The Sleep Revolution, a project that aims to change the way sleep diagnostics are performed, to better predict who will develop adverse consequences due to sleep disordered breathing, to predict this in a much earlier manner that is currently done, and to get patients into relevant treatment with milder disease.

Dr. Erna Sif Arnardottir

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During the live webinar, Dr. Erna Sif Arnardottir started by explaining how and why the industry has bridged the gap between in-lab polysomnography (PSG) testing, considered the "gold standard," and home sleep apnea testing (HSAT) in recent years.

"There is a reason why we're talking more about home sleep testing now than we would have been a year ago. There's a huge need for home sleep testing and for having simpler ways of doing diagnostics because we appear to be in a sleep apnea pandemic as well. Nearly 1 billion people worldwide have sleep apnea, and that's only accounting for adults."

Once patients reach the point of undergoing sleep diagnostic testing for obstructive sleep apnea (OSA), it's standard practice to pre-screen patients with a questionnaire. Dr. Arnardottir warns of simplifying the process:

"We need to be careful when we do sleep diagnostics that we don't simplify it to such a manner that we only do an objective sleep study or a home sleep study and don't actually talk to the patient and get the subjective patient data, such as daytime sleepiness,

sleep hygiene, comorbidities, etc. In our oversimplification to try and work faster and to do things better, we also need to make sure that the questionnaires and the patient experiences are recorded. This can be done for telemedicine and conducted online."

While discussing why the gold standard is still so ineffective and what can be thrown out without jeopardizing quality, Dr. Arnardottir shares **Sleep Revolution's** ongoing efforts to move diagnostics from the hospital to home in order to combat challenges facing PSG studies, such as long waiting lists and uncomfortable in-lab sleep settings.

As an advancement in the industry, she also references Nox Medical's Self Applied Somnography (SAS) System* which allows the patient to self-apply the diagnostic technology using an instructional video in the comfort of their home. To obtain optimal amounts of data, the patient wears the technology for three consecutive nights, rather than one.
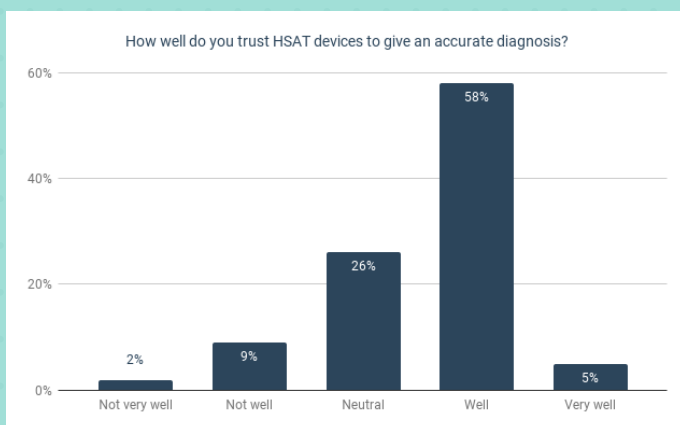
How well do you trust HSAT devices to give an accurate diagnosis?

Halfway through the webinar session we launched a poll asking attendees questions about the featured topic. 100 people participated in the poll.

We asked attendees how well they trusted Home Sleep Apnea Testing devices to give an accurate diagnosis. 11% of participants did not trust HSAT devices to give an accurate diagnosis while the majority (58%) trusted them well to give an accurate diagnosis.

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The Shift to Home Sleep Testing

With the shift in diagnostics from a hospital to home setting, at what point in home sleep testing are we sacrificing too much data for simplicity? And how accurate is the data that is gathered from home sleep testing? To answer these valid questions, Dr. Arnardottir compared PSGs to Type III and Type IV devices and explained their limitations.

Type III Sleep Diagnostic Devices

Type III devices are typically used for patients with high pretest probability of OSA and utilize the same sensors as a PSG. However, the technology doesn't record sleep itself or assess hypopneas causing arousals only. When using these devices, it's imperative to gather subjective patient data to know whether or not a Type III device is a good fit or not.

"We need to remember that with these types of devices (Type III), that we do not have the actual sleep information. So the index time for the apnea-hypopnea index can lead to both over and underestimating sleep since it doesn't distinguish between awake and asleep. For people with milder disease, this could have a huge impact and may instead require a PSG."

Type IV Sleep Diagnostic Devices

Dr. Arnardottir sees a bigger issue for simplicity with Type IV devices (that some may consider to be Type III devices) that only use an oximeter or a Peripheral Arterial Tonometry (PAT) device. She references a **meta-analysis** on how PAT technology works to diagnose OSA. As of 2014, the analysis included 14 studies and over 900 subjects.

"In comparison to PSG, the AHI was quite high. Meaning, on average, if you use this [PAT] technology, you can have pretty good diagnostic accuracy. However, there are a lot of potential confounders."
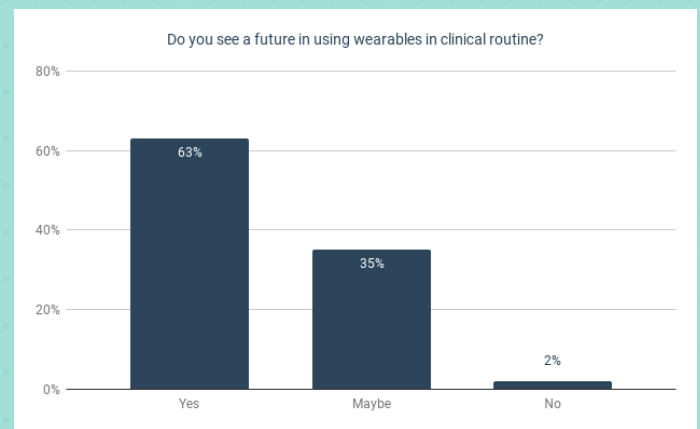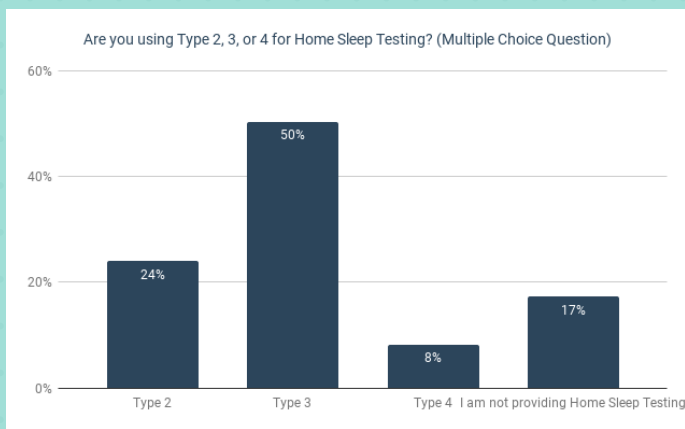
She explained that although PAT technology shows good performance measured against PSG on average, it may not work well for an individual patient as it excludes large patient populations, such as people with hypertension, which is typically half of the sleep apnea patients coming in for a diagnosis. Furthermore, it may not work well for younger people, and there are issues with comorbidities, etc., resulting in the likelihood of either under-or over-diagnosing sleep apnea. Also, since these devices do not measure the actual sleep signal, they result in a black box analysis — meaning there is an input and an output but no data to evaluate in between the two, she adds.

"When we are not measuring the actual signal, breathing or brainwaves, and if it is a black box analysis, we should always be careful. We need to think about all of the potential limitations of these devices."

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Are you using Type 2, 3, or 4 for Home Sleep Testing? (Multiple Choice Question)

- Type 2: 24%
- Type 3: 50%
- Type 4: 8%
- I am not providing Home Sleep Testing: 17%

Do you see a future in using wearables in clinical routine?

- Yes: 63%
- Maybe: 35%
- No: 2%

During the webinar, we asked attendees what level of diagnostic devices they were using for Home Sleep Testing (multiple choice question). The majority of participants (50%) mentioned Type III devices. A total of 17% of participants answered that they were not providing home sleep testing.

We also asked attendees whether they saw a future in using wearables in clinical routine. The majority (63%) of participants reported that they did see a future for wearables in clinical routine.

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Going Beyond the AHI

When validating such devices, Dr. Arnardottir explains the need to evaluate the temporal overlap of events with an epoch-by-epoch comparison of the device to a PSG to note its accuracy. She also states that in order to go beyond the apnea-hypopnea index (AHI), the industry must work towards engaging with more than just Type III or IV devices and strive for high diagnostic accuracy and reliability despite the diagnostic tool.

"So even if we have so much to do, and there are so many patients waiting, we shouldn't move to such simplistic ways of doing things that we actually lose all of our diagnostic accuracy and good way of doing things."

Dr. Arnardottir ends by referencing the ongoing efforts of the Sleep Revolution, a four-year horizon project among 37 centers in Europe and Australia, to revolutionize sleep diagnostics and home sleep testing.

The session wrapped with a Q&A with Dr. Arnardottir where she answered compelling questions, such as the following:

- Do you feel like the link between diagnosis and treatment is clear?

- How do you prioritize who should go into the lab and who shouldn't?

- How do you feel about the general trust of the sleep diagnostic industry with artificial intelligence (AI)?

*Self Applied Somnography System (SAS) is available for research purposes only.

Watch the full session with Dr. Erna Sif Arnardottir.

Watch the session here ▶

Webinar Session 2

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Artificial Intelligence in Sleep Medicine

Dr. Jon Skirnir Agustsson, Director of Analysis, Data and Research at Nox Medical

In recent years, artificial intelligence (AI) in medicine has gained traction and sparked ongoing conversations around the role of this new technology in diagnosing and treating patients. For sleep professionals, AI has shown tremendous potential to improve patient outcomes and to increase predictability through diagnostics. If developed properly, AI could be a significant player in helping people with sleep disorders throughout the world. In this session, Dr. Jon Skirnir Agustsson, Director of Analysis, Data and Research at Nox Research, led conversations around AI in sleep medicine to collectively discuss the artificial technology itself and how industry leaders can leverage it to help people with sleep disorders around the world.

Dr. Jon Skirnir Agustsson, PhD.
Dr. Agustsson holds a masters degree in electrical engineering from the University of Iceland and a PhD in physics from Basel University in Switzerland. During his training and career, Dr. Agustsson has focused on metrology, the science of measurements, and data science. His career has spanned the measurements of the electrical properties of individual molecules, to developing novel technology to monitor pollution in water. Now he is a Director of Analysis, Data and Research at Nox Research, leading a team focused on developing novel methods of analysing data recorded during a sleep study. Nox Research is an interdisciplinary team of scientists working on advancing sleep medicine by collaborating with medical scientists, doctors, and other sleep researchers. Nox Research is a part of Nox Medical with a focus on supporting sleep researchers with the goal of improving sleep medicine in the future.


Dr. Jon Skirnir Agustsson

In the live webinar session, Dr. Jon Skirnir Agustsson started by sharing his thoughts on how to best use new AI machine learning technologies in diagnosing and treating patients

"I think there is a lot we can achieve by applying AI and machine learning to sleep matters and sleep diagnostics, particularly with regards to efficiency and repeatability," said Dr. Agustsson. *"Hopefully we can use AI and machine learning to derive new and more robust information from the data we record in sleep studies to ultimately provide better care to the patient. I believe this is the underlying goal we all share in the sleep industry."*

He mentions the term *"AI-boosted humans"* used internally among his colleagues at Nox Medical.

"This is where AI can shine in sleep diagnostics. Rather than replacing humans, we use AI to really allow humans to do better work and to service their patients in a better way."
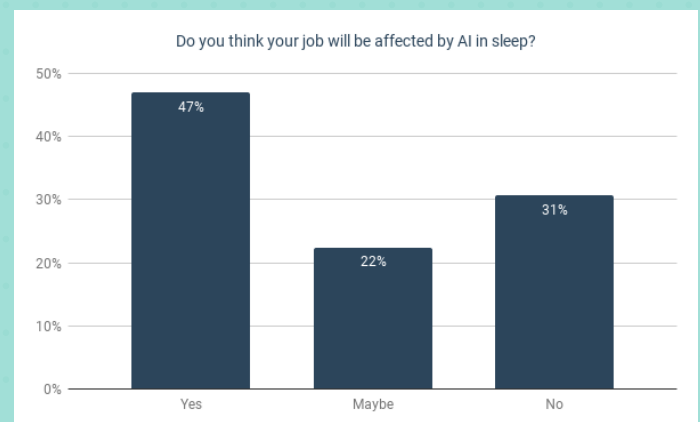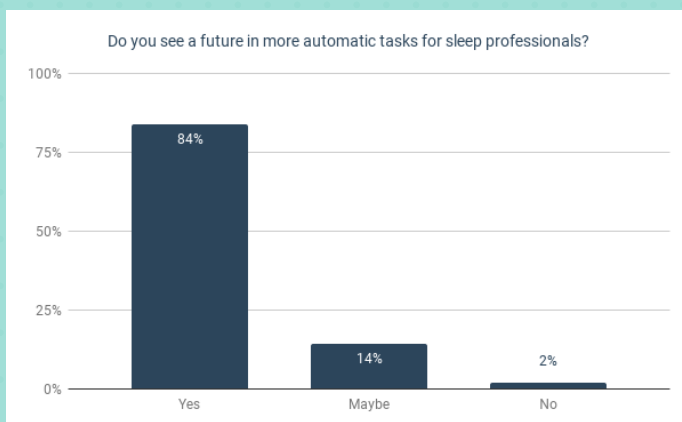
Half-way through the webinar session we launched a poll asking attendees questions about the featured topic. 98 people participated in the poll.

We asked attendees if they saw a future in more automatic tasks for sleep professionals. The great majority of participants (84%) were certain that there will be more automatic tasks for sleep professionals in the future.

Furthermore, we asked if people thought their job would be affected by AI in sleep. Most participants (47%) thought their job would be affected, while 31% of participants thought it would not be affected and 22% were undecided.

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Untangling Artificial Intelligence

Before broaching more complex topics in AI and machine learning, Dr. Agustsson breaks down the basics.

He first explains the difference between conventional programming and machine learning.

"In conventional programming, you typically have a software engineer write a program, and the program is a set of rules. You can then apply the rules to data to generate answers. However, with AI and machine learning, the rules are so vague or complicated that it's not practical to write a program to capture the rules."

With AI and machine learning, Dr. Agustsson says instead of writing a program, users must collect large amounts of labeled data, such as manually scored sleep studies, and present the data and scoring results to algorithms, which are called artificial neural networks or deep learning. The data and answers are then presented to the algorithm, which adopts and adjusts to infer rules

Are you currently using automatic analysis while scoring a sleep study?
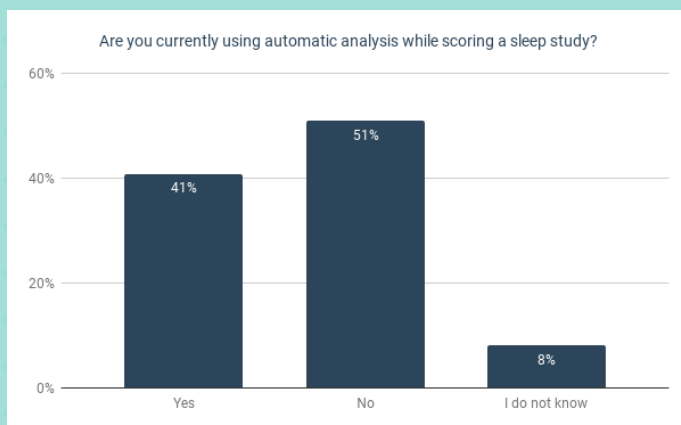
During the live webinar we asked if people were currently using automatic analysis while scoring sleep studies. Just more than half of participants (51%) answered that they were not using automatic analysis, while less than half (41%) are users of automatic analysis. A total of 8% did not know whether or not they were using automated scoring.

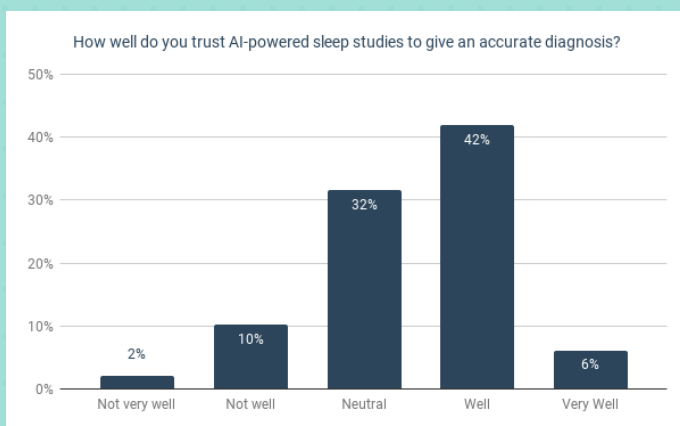# Applying Artificial Intelligence to Sleep Scoring

The AASM Manual for the Scoring of Sleep and Associated Events tells industry professionals the rules and data in scoring sleep studies.

"Anyone who scores sleep studies knows it's not enough to just read the manual. You need a lot of training first. This is also the reason why software engineers can't simply write the AASM manual rules into our programs because there is a lot of interpretation that needs to take place to score sleep stages accurately."

He explains the easiest way to accurately score sleep stages using machine learning models is to manually score the sleep study and to present the EEG data and the scored epochs to the algorithm. This lets the neural network learn what the different sleep stages look like by showing it a lot of examples.

"We (Nox Medical) use an algorithm called a convolutional neural network," said Dr. Agustsson. *"This is where we feed the recorded EEG signals directly into the artificial neural network. The model learns to predict the output, which is REM, wake or NREM 1, 2 and 3, from the sleep data we present to it."*

With the trained neural network, you'll want to measure its performance. *"The AASM has already given us answers to how you measure performance through a chart called a confusion matrix,"* said Dr. Agustsson. The matrices compare individual mistakes to those of the majority and of manual PSG studies to measure the algorithm's performance.

How well do you trust AI-powered sleep studies to give an accurate diagnosis?

Not very well	2%
Not well	10%
Neutral	32%
Well	42%
Very Well	6%

During the live webinar we asked attendees how well they trusted AI-powered sleep studies to give an accurate diagnosis. Most participants (42%) trusted them well, while many (32%) remained neutral in their opinion.

Building Confidence in Artificial Intelligence

Dr. Agustsson continued, *"It's important to understand how the algorithm is performing and what kinds of mistakes it can make. This helps us to build confidence that the machine learning models are capturing the same rules and essence as humans would from the data."*

After building confidence in using AI and machine learning to classify sleep from EEG data, Dr. Agustsson and the Nox Medical team sought to gather even more information from a simpler study, like a Type III. The company developed **Nox BodySleep™***, a novel and clinically validated method that uses an AI algorithm to analyze respiratory and actigraphy signals to estimate the sleep states of wake, REM and NREM for more accurate Apnea-Hypopnea Index (AHI) estimation by including an estimate of sleep epochs and the total sleep time.

"When you start doing something new like this (the Nox BodySleep) in AI and machine learning, you have to be extra careful that the results you get in the lab can be replicated in the real world. To be successful in AI and machine learning, you have to have access to a lot of data to validate the performance and to make sure you're as certain as you can be that it will fare well with various patient populations,"

said Dr. Agustsson. For the Nox BodySleep, Nox Medical had an external lab validate the algorithm using their own resources to establish confidence in the product.

Dr. Agustsson ends by briefly talking about another ongoing Nox Medical project. *"This is one of the biggest, most challenging AI and machine learning projects we've taken on. Projects like these could have a huge impact on improving efficiency and consistency in the scoring of sleep studies."* The project, which recently placed second in a global competition by PhysioNet.org, has the potential to detect cortical arousals which are rare events in EEG data.

The session wrapped with a Q&A with Dr. Agustsson where he answered compelling questions, such as the following:

- How do we as an industry address criticisms that AI cannot see the whole context, patient, study, etc.?

- Will AI positively or negatively impact sleep medicine and related industry jobs?

- Do you feel like the industry should've done a better job at making AI an assisting tool? And why are people not trusting these models?

- Do you anticipate any shifts in the landscape of medical reliability with a future increased reliance on machine learning models?

- Is there a way we can see arousals with non-EEG signals using air

*Nox BodySleep is not available in the United States.

Watch the full session with Dr. Jon S. Agustsson.

Watch the session here ▶

"When you start doing something new like this (the Nox BodySleep) in AI and machine learning, you have to be extra careful that the results you get in the lab can be replicated in the real world. To be successful in AI and machine learning, you have to have access to a lot of data to validate the performance and to make sure you're as certain as you can be that it will fare well with various patient populations,"

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Sleep Healthcare Trends from an Industry Perspective

Ingvar Hjalmarsson, Chief Product Officer at Nox Medical

The sleep industry is going through an enormous amount of change. Technology advancements are emerging with digital tools and telehealth solutions that can help scale sleep health care to diagnose and treat large patient populations. Providers have already begun to shift from in-hospital to home-based sleep tests and to provide telemedicine solutions along the patient journey. Furthermore, machine learning and AI technologies have shown tremendous potential to improve diagnostic accuracy, increase efficiency and provide cost-effective home sleep testing for patients with suspicion of sleep disordered breathing. It is important for sleep industry professionals to understand some of the key industry trends in order to ensure they are ready to keep up with the changes ahead. In this session, Ingvar Hjalmarsson, Nox Medical's Chief Product Officer, facilitated a conversation on today's sleep healthcare trends and shared his perspective as an industry player in sleep diagnostics.

"We at Nox Medical try to stay ahead of the curve by consistently tracking and identifying trends that can have an impact on our field," said Hjalmarsson. *"We've been innovating in this field for 20 years and have a clear mission of advancing sleep medicine to help everyone sleep better."*

Ingvar Hjalmarsson
Ingvar Hjalmarsson is the Chief Product Officer at Nox Medical. He is an accomplished executive with more than 15 years of experience in leadership roles in technology, marketing and sales, thereof more than 10 years in the field of sleep health.

With a B.Sc. degree in Computer Science, Hjalmarsson has built his career from a strong technology background into a business and commercially focused leadership role where he is recognized for identifying and translating market opportunities, building strong brands, and product management.

Ingvar Hjalmarsson

Large-Scale Trends Facing Sleep Healthcare

Before addressing the top sleep trends in the industry, Hjalmarsson touches on macro trends that have a huge impact on the world as a whole related to sleep healthcare.

"Let's start with the obvious one—we're living in an age of sleeplessness. Almost half of people report poor sleep that affects their daily activities. It is starting to have an economic effect as well and is putting sleep on the economic radar in many countries," said Hjalmarsson.

According to research by the **Rand Corporation** in 2017, Hjalmarsson shares poor sleep is costing the United States more than $400 billion and Japan nearly $140 billion per year. *"This age of sleeplessness is costing us,"* he said.

"The second big macro trend is increased awareness," said Hjalmarsson. "**Early Bird**, a mattress company, reports more than 5 million monthly Google searches on sleep issues in the United States alone. *"People are frantically searching for answers to their sleep troubles,"* he said.

Hjalmarsson rounds out the top three macro trends by explaining that knowledge on sleep healthcare is concentrated. **Watson NP** et al reports that the numbers of physicians passing the American Board of Medical

Specialties (ABMS) board exam has been steadily decreasing since 2009. *"We as a field of sleep medicine certainly sit on quite a bit of knowledge, but we need more people to help us out,"* said Hjalmarsson.

He went on to say, *"If you combine these macro trends together, it is a trademark sign of disruption. One thing's for certain—our field will be disrupted. By whom? We don't know. How? We don't know. All we can do is support the disruption because an avalanche of people are coming, and they will certainly find a solution. Let's help them get there."*

To stay ahead of the disruption and to support the forthcoming influx of patient demand, Hjalmarsson suggests industry professionals use industry trends to stay enlightened and to influence short- and long-term decision making.

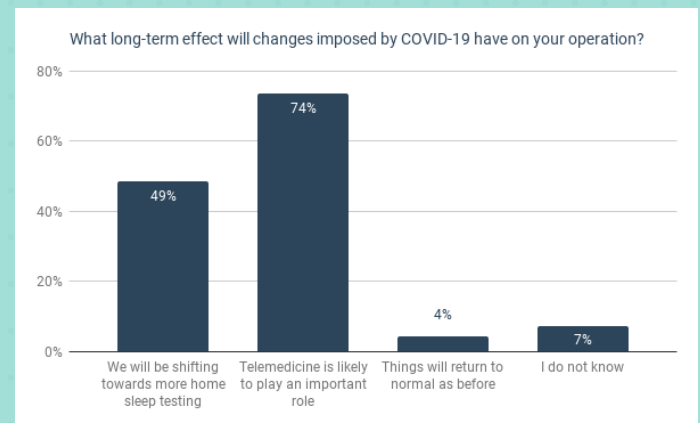| Top Trends Facing the Sleep Healthcare |
| --- |
| Telemedicine is Here to Stay |
| New Biomarkers and Individualized Patient Pathways |
| Big Tech's Entry to Sleep |
| Artificial Intelligence and Data Digitization |

Telemedicine is Here to Stay

Hjalmarsson proceeds to discuss the top trends he and his colleagues see in the sleep industry, starting with telemedicine. He said, *"Telemedicine is here to stay. In the wake of COVID-19 and distance working, we have seen the technology is ready for us. People already know how to use this technology, regulations are flexible enough to support it and it sets the stage for huge efficiency gains. In fact, payers are starting to take notice."*

Hjalmarsson explains sleep health is perfect for telemedicine, as it does not require huge machines, complicated biopsies, etc. It will ultimately make access to sleep health easier for patients.

"We're also seeing telemedicine accelerating the push from hospitals to homes, as biomedical technology allows location-independent sleep testing," said Hjalmarsson. *"The opportunity that telemedicine provides also helps in the management of chronic diseases and is being more recognized by physicians and technology providers. Telemedicine creates an opportunity for physicians worldwide to collaborate, offer second opinions and to enlist expert advice."*

Half-way through the webinar session we launched a poll asking attendees questions about the featured topic. 68 people participated in the poll. We asked what long-term effect changes imposed by COVID-19 would have on the operations of attendees (multiple choice questions). The great majority of participants (74%) mentioned that telemedicine is likely to play an important role. Close to half of participants (49%) mentioned that their operations would be shifting towards more home sleep testing.

What long-term effect will changes imposed by COVID-19 have on your operation?

Response	Percentage
We will be shifting towards more home sleep testing	49%
Telemedicine is likely to play an important role	74%
Things will return to normal as before	4%
I do not know	7%

New Biomarkers and Individualized Patient Pathways

The second trend is that sleep healthcare is about more than just sleep apnea. *"As we know, there are more than 80 sleep disorders. The industry now seems to be understanding better how a holistic view on patients seems to lead to better outcomes. We can see this from facts like behavioral sleep medicine is on the rise and where the evaluation and treatment of sleep disorders are addressed partly by behavioral, psychological and physiological factors that interfere with sleep,"* he said.

Hjalmarsson references **the first session** in Nox Medical's *"Advancing Sleep Diagnostics through Home Sleep Testing"* series where Dr. Erna Sif Arnardottir discussed a push for new biomarkers and a drive to understand sleep apnea in more detail than just the single indicator— normally the apnea-hypopnea index (AHI). *"We're seeing 'beyond the AHI' becoming much more apparent than in the past,"* said Hjalmarsson.

He then asks the group how the industry can incorporate true, long-term circadian rhythm treatment modalities into regular clinical practice? How can the industry build better programs and technology to support patients long-term in their constant quest for better sleep?

"This is a huge opportunity," he said. *"The inclusion of other medical specialities is fundamental in the evolution of our field. Pediatricians, ENTs, dentists, primary care, cardiologists, mental health professionals and even allied health are headed into the field of sleep. Collaboration and inclusion should be our mantra as more people start to get an interest in sleep health."*

"As we know, there are more than 80 sleep disorders. The industry now seems to be understanding better how a holistic view on patients seems to lead to better outcomes. We can see this from facts like behavioral sleep medicine is on the rise and where the evaluation and treatment of sleep disorders are addressed partly by behavioral, psychological and physiological factors that interfere with sleep,"

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Big Tech's Entry to Sleep

The third trend is *"big tech"* is getting into sleep. *"Why shouldn't they get into sleep? We all sleep! These forward-thinking companies are all investing in initiatives that affect as many people as possible."* He acknowledges the expanding market of consumer wearables that track sleep and new relationships between big tech companies, such as Google and Amazon, and sleep professionals to either collaborate or invest in sleep-related technologies and initiatives.

Hjalmarsson said, *"Big tech's interest in the field will have a lot of impact moving forward. At Nox, we believe that the resources these companies have at their disposal, paired with the vast knowledge of sleep that the field has, sets the stage for some extremely interesting collaboration opportunities in the future. By working together, we will have the most impact."*
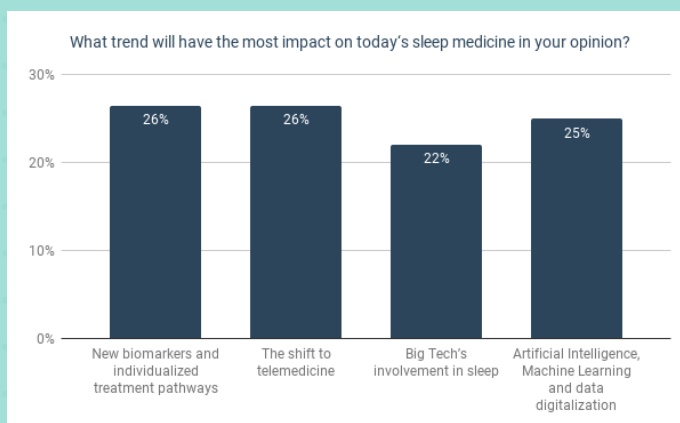
Artificial Intelligence and Data Digitization

The fourth and final trend discussed in the session is that the data-driven revolution is here. *"Sleep is a data-rich field. Even though we've made strides in the digitization of our field, we are just getting started,"* Hjalmarsson said.

In recent years, there has been an explosion in the development of multimodal sensors and technologies to promote and monitor physical activity, such as sleep and circadian rhythms. Vast amounts of sensor data is being generated with potential applications ranging from large-scale epidemiological research linking sleep patterns to disease, to wellness applications, including the sleep coaching of individuals with chronic conditions.

Hjalmarsson references an article from a **Nature Partner Journal** on digital medicine that discusses the digitization of sleep healthcare and offers a digital sleep framework. *"This framework shows how interconnected each step of a data-driven process for sleep is,"* he said. *"The digitization framework of sleep can facilitate a personalized sleep monitoring experience, empowering people to improve their sleep."*

What trend will have the most impact on today's sleep medicine in your opinion?

Trend	Percentage
New biomarkers and individualized treatment pathways	26%
The shift to telemedicine	26%
Big Tech's involvement in sleep	22%
Artificial Intelligence, Machine Learning and data digitalization	25%

How well is your operation prepared to adapt to new sleep trends?

Response	Percentage
Not very well	3%
Not well	22%
Neutral	37%
Well	31%
Very well	7%

During the live webinar we asked which of the four trends mentioned above would have the most impact on today's sleep medicine. The answers were evenly distributed as can be seen in the graph below.
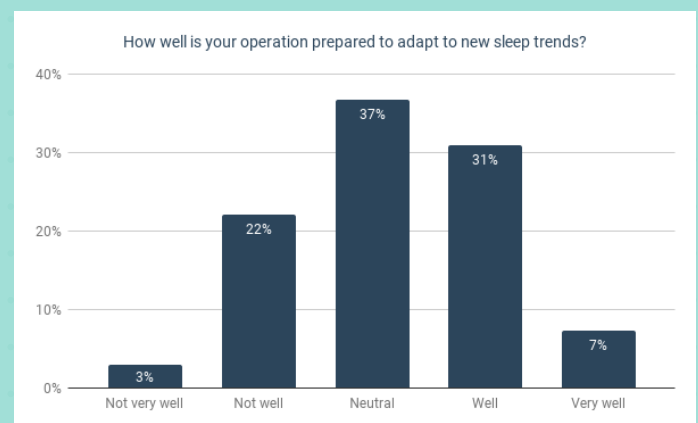
Furthermore, we asked how well attendee operations were prepared to adapt to new sleep trends. The majority of participants (37%) remained neutral, while 31% reported that their operations were well prepared. A total of 22% of participants considered their operation to be not well prepared for new sleep trends.

Nox Medical Reacts to Sleep Trends

Hjalmarsson wraps up the discussion by sharing the impact these trends have on the work at Nox Medical. He said, *"We (Nox Medical) create solutions that enable a seamless continuum of care in sleep healthcare. We use our capabilities to support and to participate in these trends."*

Nox Medical is investing in simplified, more accurate biosensors to use in mass for large populations, cloud technology to support scalable clinical pathways, and automation technology and data science to identify and present new biomarkers to make a clinical impact.

The company is also investing in important people-facing technology that will allow healthcare providers to implement telemedicine in their practice and to increase their reach. In addition, Nox Medical is investing in service initiatives to take the operational burden off clinicians and solutions for large-scale collection of objective longitudinal sleep data to better understand sleep and manage chronic disease.

"It's our obligation to the field of sleep healthcare to support it, help it grow and continue to impact millions of people and help them sleep better," he concludes.

The session wrapped with an engaging Q&A with Hjalmarsson where he answered compelling questions, such as the following:

- How will technology and services move more sleep testing toward the home rather than to specialized sleep clinics?

- Is there anything the industry should be doing to prepare for these sleep industry trends in a better way?

- How can we as an industry prove to payers the need to move to more home sleep testing and widespread sleep diagnostics?

- What would be in the near future for Nox Medical to go "beyond the AHI"? How do diagnostics relate to better treatment?

- Is there a concern with patients relying on a wave of unpublished technologies and apps and the industry losing control on the quality of diagnostics and therapy?

- Is technology always the answer to solving some of the problems facing the sleep industry?

Watch the full session with Ingvar Hjalmarsson.

Watch the session here ▶

Conclusion

Home sleep testing (HST) is emerging as a diagnostic tool, now more than ever. In this three-part webinar series **Advancing Sleep Diagnostics through Home Sleep Testing**, we looked at what has supported this shift to HST and how the industry is prepared for the changes ahead. The three sessions have covered the challenges facing home sleep testing, the reactions from diagnostic technology providers, how artificial intelligence (AI) has taken the field by storm, and the upcoming trends that are likely to affect how sleep diagnostics are currently performed.

Key takeaways include that balancing simplicity and diagnostic accuracy in home sleep testing is possible but we need to be careful of oversimplifications in diagnostic procedures. Furthermore, we need to be aware of the limitations of Type III devices, and more specifically Type IV devices using PAT technology, by paying close attention to potential confounding factors and what works for the individual patient.

We have also learned that there is a lot that can be achieved by applying artificial intelligence (AI) and machine learning (ML) to sleep diagnostics, particularly with regards to efficiency and repeatability. AI and ML can be applied to derive new and more robust information from recorded sleep data that ultimately should support better patient care. When developing and applying AI, we need to be mindful that lab results can be replicated in the real world and represent various patient populations.

We see that telemedicine is here to stay and that the sleep industry is well fitted for telehealth solutions. New research studies show that a number of other factors can be used to complement AHI, for a more comprehensive picture of patients' disordered breathing. We are seeing involvement of other medical specialties such as pediatricians, ENTs, dentists, primary care, cardiologists, and mental health professionals in the industry, which results in industry advancements. Furthermore, big tech's interest and collaborations with sleep professionals is likely to make a significant impact on the field of sleep.

Nox Medical strives to continue to advance the field of sleep medicine by supporting it, nurturing its growth and by impacting millions of people by helping them sleep better. The recent launch of the **Nox T3s** Type III diagnostic device has revolutionized home sleep testing. The Nox T3s is based on the world-renowned Nox T3, which launched in 2009 and quickly became, for many, the standard for home sleep testing and since then thousands of units have been sold globally. The Nox T3s maintains the brand's commitment to patient comfort and clinical accuracy, with the **Nox RIP technology** for more sophisticated sleep time estimation. By combining smart technology in a single device with disposable consumables, clinicians now have a more precise and safe way to test, analyze and treat their patients. The main feature of the Nox T3s is the Nox BodySleep* algorithm's ability to conduct sleep time estimation without EEG.

To learn more about the Nox T3 sleep diagnostic solution please contact us at sales@noxmedical.com or visit our website **www.noxmedical.com.**

*Nox BodySleep is not available in the United States

NOX T3s