Getting to the Heart of Sleep Health: Defining and Evaluating Sleep Health

Konrad Sawicki (00:00):

Hello, everybody. Welcome to the podcast on defining and evaluating sleep health. My name is Dr. Konrad Sawicki. I am a second year cardiology fellow at Northwestern University in Chicago in the physician scientist track. I'm delighted to be joined today by two experts in sleep science, Dr. Dayna Johnson who's an assistant professor in the Department of Epidemiology at Emory University. And also Dr. Anne Fink, who's an assistant professor in the Department of Bio-behavioral Nursing Science at the University of Illinois in Chicago. And we'll be referring to each other by our first names today. Before we begin, I would just like to say that these American Heart Association podcasts entitled Getting to the Heart of Sleep Health are made possible through sponsorship through Jazz Pharmaceuticals, though it's important to note that all the program material was developed independent of the sponsor. Well, let's get started.

Konrad Sawicki (01:08):

So humans spend about a third of our lives sleeping, or at least attempting to sleep. And we know that sleep is important for our health and particularly our heart health, but we often take it for granted and it can feel like an overlooked and forgotten third of our lives. Unfortunately, sleep is usually the first thing to go when we're pressed for time. The average American now sleeps less than seven hours at night, which is about two hours less than just a century ago. What are the implications of this for our cardiovascular health? Well, in order to understand poor sleep, we first need to understand healthy sleep and fortunately, Anne is an expert in the neurobiology of sleep. Anne, what are some of the characteristics of healthy sleep?

Anne Fink (01:57):

Most importantly, healthy sleep should involve a sufficient amount of deep restful sleep, as well as what is called rapid eye movement or REM sleep. These different types of sleep are controlled by neurons in various parts of the brain, including the basal forebrain, thalamus, hypothalamus, and brainstem. Multiple neurotransmitters released in these brain regions influence the brain's electrical activity as a person, transitions from wakefulness through the different stages of sleep. As people sleep, they go through cycles of the different sleep stages. Each sleep stage has distinctive brain activity patterns. These patterns can be measured by conducting sleep studies with an electroencephalogram, also called an EEG. This is a test that measures the brainwaves. When someone is awake, for example, the electrical activity in the cortex will appear fast and highly variable depending on what activities the person is engaged in. As the person relaxes and prepares for sleep, their brain activity begins to slow.

Anne Fink (03:02):

The pattern shifts to a slower, more synchronized rhythmic pattern in brain activity. Neurons in the cortex and thalamus begin to produce bursts of oscillatory activity, which appear as peaks in the EEG recording. And these peaks indicate that someone is transitioning to the second stage of non REM sleep. Next, the brain activity becomes progressively slower as the depth of sleep increases. The person then enters the deepest stage of non REM sleep, which is often called slow wave sleep, due to the distinctive pattern of large and slow EEG waves. Sustaining periods of slow wave sleep is important because this is the deep restful restorative phase of sleep. Throughout the sleep period, non REM sleep will alternate in cycles with shorter periods of REM sleep. REM sleep appears very differently on the EEG compared with what we see during slow wave sleep.

Anne Fink (04:02):

REM sleep is characterized by a high frequency, low amplitude desynchronized brain activity pattern. REM sleep also involves muscle atonia. Essentially your skeletal muscles are going limp and cannot be moved. And as the name suggests, there are rapid movements of the eyes. Although, the physiologic purpose of REM sleep is not completely clear, there is evidence supporting a role for REM sleep in learning and memory, and in immune and metabolic functions. Typically the duration of REM sleep, as well as the frequency of REM sleep episodes increases as a person's sleep period progresses. People tend to experience the most REM sleep in the early morning hours. And there's also more transitions among the sleep stages in the early morning hours in most people.

Dayna Johnson (04:54):

So, Anne, how would you describe pathological sleep?

Anne Fink (04:58):

Healthy sleep may involve frequent awakenings, reduced time spent in slow wave sleep and reduced REM sleep. When the total sleep duration is short, meaning less than six hours, it's difficult to obtain sufficient, slow wave and REM sleep.

Dayna Johnson (05:15):

Interesting. So how does the time of day influence sleep?

Anne Fink (05:20):

Well, our bodies are hardwired to sleep during the night and to be active during the day. The propensity for being asleep or awake is controlled by our circadian rhythms. The term, circadian, refers to biological processes that show a cyclical pattern occurring every 24 hours. Exposure to light determines the timing of circadian rhythms and a group of light sensitive neurons in the hypothalamus are responsible for tying our sleep behaviors to the time of day. These neurons also have a role in controlling the release of

melatonin, a hormone that regulates the sleep wake cycle. The interactions amongst sleep, wakefulness and circadian rhythms are described by a framework called the Two Process Model, which was developed by Alexander Borbay and colleagues. According to this model, two processes control when we sleep, the first is our circadian rhythm. The second is the length of time that we have been awake. Our circadian clock drives us to naturally want to sleep at night and to wake up with the sunlight.

Anne Fink (06:27):

It is possible, however, to resist our natural circadian rhythms and to stay awake all night. Prolonged wakefulness will result in a natural and powerful drive to sleep after approximately 16 hours of being awake. About a third of the population reports problems with sleeping, particularly the inability to fall and stay asleep. The Two Process Model suggest potential interventions to alleviate these problems such as maintaining consistent sleep wake times and avoiding bright light exposure before bed time. The model also suggests that increasing light exposure during the daytime may help relieve excessive daytime sleepiness. The timing of our sleep in a manner that is consistent with our circadian rhythms is also important for cardiovascular health. A healthy cardiovascular system demonstrates variability that correlates with sleeping and waking times. Blood pressure for example, is highest during the day, during periods of wakefulness, but during sleep blood pressures should decline by approximately 10 to 20%. The absence of a dip in blood pressure during sleep has been identified as a risk factor for cardiovascular disease.

Dayna Johnson (07:42):

Konrad, I think you're supposed to prompt us to the public health piece.

Konrad Sawicki (07:46):

Very interesting Anne. Now let's talk about sleep from a public health perspective. Dayna, what are some of the dimensions of sleep health?

Dayna Johnson (07:56):

That's a great question. I'd like the definition that was proposed by Dan Bice in 2014, which really talks about sleep health as a multi-dimensional concept, and it can be characterized according to five dimensions. The first is sleep duration. This corresponds to the total amount of sleep that's obtained per 24 hours. And then there's sleep continuity or efficiency. Now this is the ease of falling asleep and returning to sleep. And then we have sleep timing. This is the placement of sleep within a 24 hour day. Next is alertness or sleepiness, which means the ability to maintain a tentative awakefulness. And then lastly is sleep satisfaction or quality. And this is the subjective assessment of good or poor sleep, which you can ask a patient or participant how they feel about their sleep. So those are the five dimensions that characterize sleep health.

Konrad Sawicki (09:03):

And at a population level, is sleep a public health concern?

Dayna Johnson (09:08):

Absolutely. So unfortunately sleep health or adversely health is highly prevalent and it is definitely considered a public health concern and it's a public health burden. So sleep disorders as well as insufficient sleep, which can be defined as a short sleep duration or poor sleep quality, tends to be expensive to the medical system as well. So we're bringing a lot of attention to this in the public health arena. And we can see this by the goal of healthy people, 2030, which is stated to improve health, productivity, well-being, quality of life and safety by helping people get enough sleep. So there is increased national intention to improve sleep for both children, adolescents, as well as adults. Now, if we talk a little bit more about the public health burden of sleep.

Dayna Johnson (10:06):

So about one in three adults and even more in adolescents do not receive the amount of sleep that they should. So that's [inaudible 00:10:15] that aspect of sleep health that I discussed earlier, and we know that these sleep problems can affect health as well as wellbeing, and also adversely health as well as circadian misalignment is associated with a higher prevalence of poor health outcomes, particularly cardiovascular risk factors, such as obesity, also associated with diabetes, heart disease, stroke, dementia, cancer and all cause mortality. So a number of core health outcomes. Also short sleep duration or undiagnosed sleep disorders, particularly sleep apnea are associated with increased sleepiness, which is also associated with increased risk of accidents, both occupational as well as driving. And so drowsy driving is as detrimental as drunk driving. So there are severe consequences for not getting the amount of rest that our bodies need.

Konrad Sawicki (11:19):

Wow. And what are the determinants or causes of adverse sleep health as well as factors that affect our sleep?

Dayna Johnson (11:27):

Great question. And so Anne mentioned some of these in her description of healthy sleep. And so I like to think about this within multiple levels. And so there are individuals as well as contextual factors that can affect our sleep. So in really thinking about poor sleep hygiene, there are different behaviors that we can engage in, in our bedrooms that can delay or interrupt our sleep. So things like watching television or listening to the radio in bed, and then there's other factors like our exposures to stress. Stress is known to be associated with poor sleep. And then there's also screen time exposures, which we see particularly among children and adolescents that has an effect on our sleep, particularly the initiation of sleep, and then also our social demands. So having a schedule that requires us to be awake at a certain time, that's different from weekdays and weekends. And we call this social jet lag, when

there's a discrepancy between our demands on weekdays and weekends, and that tends to have an effect also on poor health outcomes.

Dayna Johnson (12:41):

Additionally, mood is associated and can affect our sleep, particularly if we think about depression, there's a bi-directional relationship. And then also among older populations, we see that medications can affect the sleep of older individuals. And then there are certain behaviors that we can engage in that can affect our sleep. So for example, people that tend to take naps later in the day, it has a direct effect on their sleep at night and then also consuming caffeine or alcohol close to bedtime. And then if we think about those contextual factors, so at a neighborhood level, there's different exposures that can affect our sleep. So things like excessive noise, inopportune light exposure, which can have an effect on our circadian rhythms and then there's social and physical aspects of our environment that affect our sleep. So things like air pollution, neighborhood violence, neighborhood disorder, and even the socioeconomic status of both individuals and at a neighborhood level, can affect resources that have an indirect path to affecting our sleep health.

Dayna Johnson (13:58):

And then what's also important to think about is that these factors can vary across the lifespan, which also sleep patterns vary across the lifespan. And so we can see that these different factors that we're exposed to across our life can affect sleep in different ways. And then also critical points can affect our sleep. So for example, during pregnancy, we see that sleep tends to be affected and then also sleep patterns, they vary by race, ethnicity, socioeconomic status, particularly occupation, as a measure of socioeconomic status. We see among shift workers that they tend to have core sleep then those who work a day shift, for example.

Konrad Sawicki (14:45):

That's really interesting Dayna. So would you say that healthy sleep is equitable in society?

Dayna Johnson (14:50):

Unfortunately not. They're actually quite striking racial and ethnic disparities and also socioeconomic disparities that we see in sleep health. And so just to go into a bit more detail, we have data that shows that racial minorities. So those that are particularly African-American, LatinX, Asian, native Hawaiian Pacific Islander, and also Alaska natives tend to have shorter sleep duration, worse sleep continuity and more sleep disorders in comparison to non-Hispanic whites. And in general, we see that individuals of lower socioeconomic status are also disproportionately affected by poor sleep. And I use the term in general because we see that a gradient between socioeconomic status and sleep also varies by ethnicity. And so what I mean by that is that we see that among African-Americans in particular, that social economic status tends not to be protective in terms of good sleep health. And so what that means is

that we see worse sleep among higher income, African Americans, then lower income African Americans and this a very different gradient among non-Hispanic whites.

Dayna Johnson (16:17):

We see what we would expect, so that income is protected. And those that are of higher income in professional occupations have better sleep. But again, unfortunately that is not the case for African Americans. We also see this sexual minorities are disproportionately affected by poor sleep. Now these differences very largely, but in general, if we're thinking about racial minorities and non-Hispanic whites, there tends to be about an hour difference or more in sleep duration. And that's both among adolescents as well as adults. And then also we see that the sleep disparities, they occur across the lifespan. So in utero, there are certain exposures, early childhood, as well as in adulthood. And so the idea is that there could be a trajectory. So being exposed to poor sleep early in life, that is particularly more common among racial minorities or lower socioeconomic status individuals tend to be on this trajectory to have worse sleep among adults as well. So when they become adults. So it's really a critical point for us to address these sleep disparities, particularly among adolescents and address this generational pattern.

Konrad Sawicki (17:41):

And Dayna, what are some of the reasons for these sleep disparities?

Dayna Johnson (17:46):

Yeah. So there's a host of reasons why we're observing some of these sleep disparities and contributing factors to sleep disparities. And so mainly it's social determinants that are contributing to sleep disparities. And so when we're talking specifically about race, we're thinking of race as a social construct, and what that means is race is serving as a proxy for different experiences and it's really racism or discrimination that's contributing to these different sleep health disparities. And outside of the sleep field, it's known that racism or discrimination are fundamental determinants of health disparities. And again, we're seeing the same thing in sleep. And then there's also other stressors that tend to be more common among racial minority. So such as acculturation stress, and then there's also residential segregation. And so there are historical policies that were discriminatory that contribute to the way our environments are shaped.

Dayna Johnson (18:55):

And then racial minorities are more likely to live in these neighborhoods. And then also those of lower socioeconomic status. They're also more likely to live in these environments where they're exposed to inopportune light exposure, excessive noise, and other factors that are known to affect sleep health. And also can increase risk for different sleep disorders such as sleep apnea. So living in an environment that is safe or [inaudible 00:19:24] which is then associated with obesity and also increased the risk for sleep apnea, for example. And then if we think about different occupations, racial and ethnic minorities,

as well as those of lower socioeconomic status are more likely to be shift workers. And they are at increased risk for circadian disruption or circadian misalignment. And this can also alter their sleep as well as health trajectories.

Dayna Johnson (19:52):

Now I mentioned the neighborhood environment having various features that can affect sleep, but what's important to also think about is, is it the place or is it raised, this is a common discussion in the sleep disparities literature. And it's important to understand that it's placed that is exposing individuals to these different exposures. So it's the factors in these environments that are affecting the sleep of various individuals. And it's that racial minorities are more likely to live in these adverse neighborhood environments.

Dayna Johnson (20:29):

Now sleep disparities are likely driving overall disparities in health outcomes and particularly in cardiovascular outcomes. And so there's a number of studies and this data is emerging over time. So we definitely need more research in this area, but we do have some evidence that shows that sleep partially mediates racial differences and cardio-metabolic health. There's a study from the Midas Cohort. And then also, that sleep mediates, partially mediates the racial disparity and diastolic blood pressure. And this was seen in the Cardia Study.

Anne Fink (21:10):

I've noticed that many people have an interest in monitoring their own sleep using wearable devices. Are these devices useful and reliable?

Konrad Sawicki (21:19):

That's a great question Anne. I think before we talk about wearables, we need to talk about what the most accurate way of tracking sleep is. And that's polysomnography, it's the gold standard, it's a type of formal sleep study that's recorded in the lab with sleep technicians and it records multiple parameters, including your brain waves, oxygen levels, heart rate, breathing rate, as well as your movements in your eyes and your legs. However, it's not the most convenient method. It requires a night in the hospital, it's expensive. There are now many personal sleep tracking devices on the market. And there are two major categories of personal sleep tracking devices: wearables and non wearables.

Konrad Sawicki (22:09):

Wearables track your body health, essentially 24 hours of the day, 7 days a week. They can either be devices that you put on your wrist or rings that you can put on your finger or even their headbands. In terms of non wearables, these track data only while you're sleeping and they're typically placed under the mattress. But regardless of the type, most of these devices use some proprietary algorithm that tracks your heart rate, your heart rate variability, respiratory rates, and movements in order to generate

sleep data. So these devices can not only track your sleep, but they can also give you an objective idea of how environmental factors in your life may be affecting your sleep. Various factors like alcohol, diet, drugs, stress exercising, late in the day, checking your phone before bed, even the temperature of your room. They can all have effects on your sleep. And this sleep tracking data can help you find good habits and improve your overall sleep hygiene.

Konrad Sawicki (23:19):

However, it's important to keep in mind that these devices are not 100% accurate. Most of these devices have not been clinically validated. They're quite good at detecting when you're asleep, they're less sensitive at detecting the various stages of sleep, like light sleep, deep sleep and REM sleep. And also all the data from these devices can be overwhelming and anxiety provoking. Just like checking your blood pressure at home 10 times a day is not useful, over-interpreting this personal sleep data can also be harmful. So it's important to trust yourself because how you feel is ultimately more valuable than all of this data.

Anne Fink (24:06):

That's interesting. So it sounds like these devices can be useful, but don't necessarily replace the diagnostic value of a polysomnography.

Konrad Sawicki (24:15):

Exactly. It helps to compliment that.

Anne Fink (24:18):

In your practice, how do you see short sleep duration, having an effect on the nervous system and on metabolism and inflammatory processes?

Konrad Sawicki (24:28):

That's a great question. We know that lack of sleep increases the risk of all of these diseases like hypertension, coronary artery disease, obesity, and we're just starting to unravel some of the mechanisms that link sleep to disease. Sleep deprivation has been shown to disrupt many of the same biological processes that are altered in cardiovascular disease. For example, cardiovascular disease can be associated with changes in the nervous system. And one of the most important systems for cardiovascular function is the autonomic nervous system. It's responsible for many physiological functions, including the contraction of the heart, the resistance of the blood vessels and the heart rate. And the autonomic system has two components, the parasympathetic or rest and digest, and the sympathetic, or fight or flight.

Konrad Sawicki (25:21):

Now we see increased levels of sympathetic activity for the fight or flight after partial or total sleep deprivation, which can lead to increases in blood pressure and ultimately hypertension. In people who are sleep deprived, we see increased markers of inflammation like C-reactive protein or CRP, and these levels can remain elevated even after a few days of sleep recovering, suggesting that even just a few nights of restricted sleep can have a long impact on your health. And this is associated with increased production of pro-inflammatory molecules, like the interleukins and tumor necrosis factor alpha. And then this inflammation subsequently causes increased oxidative stress and damage to the blood vessel walls. And the release of prethrombotic factors, which can lead to atherosclerosis. Atherosclerosis is a narrowing of the arteries through the formation of plaques and commonly due to white blood cells that enter the artery wall and take up cholesterol and other substances from the blood, and then subsequently trigger inflammatory response. And atherosclerosis can occur in the hearts as well.

Konrad Sawicki (26:33):

And we are now understanding that sleep can regulate white blood cell production and can protect against atherosclerosis. At least in mice. An interesting study used genetically modified mice that were prone to developing atherosclerosis and subjected them to sleep disruption and found that these mice with persistently disrupted sleep had higher rates of atherosclerosis. And interestingly, they found that sleep deprivation caused the brain to release low levels of a neuro peptide that then signaled to the bone marrow to cause an increase in the production of white blood cells, particularly neutrophils and monocytes, which ultimately damage blood vessels and caused atherosclerosis.

Konrad Sawicki (27:15):

We're also seeing effects on the short sleep on metabolism. In animal models, such as mice and rats that are sleep deprived, we see increased rates of obesity and on a more molecular level, we see that hormones involved in appetite regulation are dysregulated in these animals. We see decreased levels of leptin, which is a hormone that normally inhibits hunger. And we see increased levels of ghrelin, which is a hunger hormone and increases food intake. So our lack of sleep actually causes our organs to secrete hormones that cause us to eat more than we really need. However, it's important to understand that we need more basic science research on sleep. We have a lot of studies that show that sleep deprivation or short sleep or sleep disruption is associated with various cellular changes, but there are far fewer studies showing that sleep deprivation or changes in sleep directly caused those changes. And also something important to note is that studies in mice don't often translate well to humans. So we need more human data as well.

Anne Fink (28:24):

That's very interesting. It sounds like we're just beginning to understand the effects of short sleep duration at the molecular and cellular level. The COVID-19 pandemic is likely to influence sleep health. What have patients been saying about their sleep quality during this pandemic?

Konrad Sawicki (28:42):

That's a great question Anne. We know that stressful events and anxiety affect your sleep hygiene and COVID-19 has been a stressful event for everybody. The Kaiser Foundation recently showed that over a third of Americans had difficulty sleeping this past summer due to the pandemic. And we're also seeing higher rates of insomnia as well. According to Google trends, the number of search queries for insomnia has increased by over 50% during this pandemic. And a lot of these queries are peaking around 3:00 AM, which is likely when people are having some difficulty falling asleep. And across the ocean in Finland, they did a dream crowdsourcing study during their COVID lockdown, which was one of the more strict in Europe and showed that participants who during the lockdown were experiencing more nightmares. And the majority of these nightmares were related to the pandemic.

Konrad Sawicki (29:36):

Now there's no data showing that short sleep or sleep disorders directly predispose to COVID-19. However we know that patients with sleep disorders like sleep apnea are more likely to be older and have comorbidities like hypertension, diabetes, heart failure, all of which do put you at an increased risk of contracting COVID-19. Additionally, sleep has an effect on your immune system. When they examined patients who were infected with the rhinovirus or the common cold, individuals who sleep less than seven hours a night were more likely to be symptomatic. And although we don't have the evidence that these findings directly apply to COVID, certainly short sleep probably is not helpful.

Konrad Sawicki (30:23):

Now, one of the patient populations that we're seeing more and more in the clinic are patients who had COVID that are having persistent symptoms or COVID long callers. And we see a variety of symptoms with these patients, including shortness of breath, palpitations, fatigue, and cognitive decline. But one of the most common symptoms are sleep difficulties and difficulty sleeping and insomnia, and we're still learning why this is all occurring so frequently in these patients. But I think putting this all together, it's important now more than ever to really optimize your sleep hygiene and treat any sleep disorders. And even simple strategies like regularly opening your blinds in the morning to let the sun in and help our bodies reset as well as meditation apps like Headspace and Calm can help us relax and rest. But it's also important to understand that if you're experiencing significant sleep problems, seeing a sleep therapist or a sleep medicine doctor could be very helpful and can ultimately improve your cardiovascular health as well.

Anne Fink (31:38):

Well, I'd like to thank everyone for listening. We hope that you all sleep well tonight. We'd also like to thank Jazz Pharmaceuticals for sponsoring today's podcast.