

# Fire Engineering®

By Dena Ali

On June 28th, 2023, I had the privilege of sitting with Dr. Matthew Walker, a neuroscience and psychology professor at the University of California, Berkeley, and founder and director of the school's Center for Human Sleep Science. I am happy to share his responses to some of our most pressing concerns surrounding sleep health for first responders. The conversation was a breath of fresh air. While Dr. Walker has concerns with shift work, on several occasions, he expressed gratitude for our work and his understanding of the need to have responders available 24/7.

**What are your thoughts on our schedules? Currently, many departments mandate a 56-hour workweek; which schedule is optimal?**

The optimal shift is the one that has a longer duration of recovery to gain some flexibility to get back at least some of the sleep that was lost. Additionally, you want a schedule that limits transitions, so of the ones described, 24/72 is optimal, followed by 48/96, 24/48, and finally, the On/off/on/off/on/4-off. The goal is to find something as consistent as possible.

**What is the role of REM sleep? How is it maximized?**

We often think that sleep is sleep and it doesn't matter what time of night or day we get it, but that's not entirely true. In a typical normal night of sleep, the first half of that night will be dominated by deep, non-rapid eye movement (NREM) sleep. As you push through to the second half of the night, those sleep cycles, which last about 90 min in humans, will keep repeating, from NREM to REM and then again. However, the ratio of NREM to REM changes in the 90-minute cycle as you move across the night. Specifically, the second half of the night, especially those last two hours, is where you get almost all of your dream sleep. So if you want to get a jump start on your workday and wake up after 6 hours, rather than 8, you have lost 2 hours out of your 8, only 25% total sleep. But the problem is that you may have lost up to 80% of your REM sleep, dream sleep.

So coming back to your first question and PTSD, there is, firstly, I can tell you, in the past 20 years of researching sleep and mental health, there is no single psychiatric condition that we have discovered in which sleep is normal, and I think that tells us a

huge amount about this relationship between our emotional wellness and our sleep health. What we've certainly discovered is that in people with PTSD, sleep is profoundly disrupted. You cannot receive a diagnosis, a clinical diagnosis of PTSD, without either having sleep disruption or repetitive traumatic nightmares.

What we discovered is that sleep, particularly dream sleep, and rapid eye movement sleep, offers a form of overnight therapy, and dream sleep acts almost like a nocturnal soothing Balm that takes these difficult, painful, traumatic experiences and just starts to shave off the sharp edges, so that you come back the next day and those memories are no longer as emotional. They don't feel like they've got that painful sting anymore. So in that sense, it's not time that heals all wounds; it's time, during dream sleep, that provides this emotional convalescence.

And by the way, what makes a memory emotional and a traumatic memory is that at the time of the experience, that memory encoding event was wrapped in a blanket of visceral emotion that was elicited by the trauma, and envelopes it almost like the bitter rind around an informational orange. That bitter rind is the traumatic emotional wrapper around the core of the experienced memory, and what dream sleep will come in and do is essentially strip away the emotion from memory, and by divorcing the emotion from memory, that's why you come back the next day, and you have now a memory of an emotional event. But it's no longer emotional itself. You don't get that same visceral reaction that you had at the time of the experience that made it emotional.

What we started to discover is that that process was failing in patients with PTSD, and we were working with an amazing psychiatrist just outside of Seattle, Murray Raskind, and he discovered that his patients would have these problematic, traumatic nightmares, and he couldn't understand why. Until he discovered the link between dream sleep and a brain chemical called noradrenaline which is the same stress-related fight-or-flight chemical as adrenaline, it's sister chemical is adrenaline, but in the brain, noradrenaline. When you have a traumatic experience, that chemical is dumped into the brain, and it creates this visceral emotional memory. As you go into REM sleep, the brain shuts off that stress-related chemical, so you get the chance, in a neurochemically safe environment during dream sleep, to reprocess and strip away and soften those emotional memories. But in patients with PTSD, we discovered that that chemical, noradrenaline, was staying too high. They had chronic levels of stress-related noradrenaline that was disrupting their dream sleep, and so what was happening was that they couldn't strip away the emotion from the trauma memory.

Murray Raskind and I discovered that he, at the time, was treating his patients in the VA. These were largely war veterans, with a cheap generic drug for their blood pressure called Prazosin. An issue with this medication was that it crosses what we call the blood-brain barrier so it doesn't just affect your body it also goes up into the brain, and reduces noradrenaline in the body so that it relaxes your cardiovascular system, hence it's good for blood pressure, but upstairs in the brain, what was happening is that his patients were coming back and saying, look, I, "my blood pressure isn't that much better, but it's the strangest thing, all of those repetitive trauma nightmares that I was

having, have started to go away, and I'm starting to feel better." Prazosin is one of the first-line approved treatments in the VA for repetitive nightmares.

**The big lesson for first responders is developing good routines, because once you're in poor sleep, you're gonna be more likely to struggle, and more likely to have PTSD. If early in our career, we can develop good habits and make sure after difficult calls, and difficult events, we are sleeping and getting a full night of sleep, we will be more likely to be able to process trauma, and I think that's the biggest message to get across, especially as we're bringing younger people into the fire service and other emergency services.**

Start emphasizing the importance of sleep in your young trainees, because, based on the evidence, everything I know, sleep is perhaps your greatest immunization against mental ill health that will come by way of the types of experiences and challenges that all of you face. Investing in sleep as best you can, by building sleep in as one of the priorities in your life, of course, there are lots of other things, like kids, relationships, working out, staying healthy, being with friends, having a social life, all of those things are critical. But, we often forget that sleep is non-negotiable. Sleep gets squeezed like vice grips and becomes the neglected stepsister in the health conversation. We need to change that. So, I love that mentality of impressing it early on, even if you think you're just invulnerable and you're a superhero.

**I'm grateful specifically for your work, because around the time your book was published, Jocko became huge for emergency responders, and everybody was reading his books. Every morning, he posted a picture at 03:45, and first responders felt they had to start getting up early. Then, your book came out with a different view.**

Firstly, I completely respect the gentleman, my goodness, what a human being. The second thing is that there is an alternative perspective to his, which would be mine. It's at the polar end. The third thing I note is that he is very clearly an extreme morning type, and to argue that everyone should be that way is a total fallacy.

Here's why. There are different chronotypes, morning, evening, or somewhere in between. You can go online and take the morningness-eveningness questionnaire (M-E-Q). It's about a three-minute test that will tell you which of the three types you are. You don't get to decide, you can't just simply say, "Well, Jocko says, wake up at 04:00 a.m, I'm an evening type, but I'm gonna become a morning type."

Why?

Because it is genetically hardwired. 22 different genes dictate your chronotype, and you cannot change them. It's gifted to you at birth. But there's a terrible stigma around being an evening type, that you're lazy, you're slothful, and this is absolute nonsense. When you sleep against your chronotype, there are marked deleterious ill health

consequences. So he is an extreme morning type, and that works for him. I suspect he is one of the tiny fraction of people who may be able to survive on probably around six hours of sleep. There are genetic mutant short sleepers. The likelihood that you are a genetically short sleeper is so low that you are far more likely to be struck by lightning in your life than you are to be one of these genetically short sleepers. Still, I suspect that he is, and the reason is that when he was on a podcast, he said while one of his daughters needs 9 or 10 hours of sleep, the other daughter doesn't seem to need so much sleep. That gene is genetically inherited, so I suspect he may have the short gene.

But, it isn't responsible to promote short sleep. To put that in context, if you're normal and you're on 6 hours of sleep, you're about 30 % more likely to get into a car crash. Let's Say you can't take your kids to school in the morning, and you order an Uber. Two Uber cars turn up, and one of them says, "Okay, I'm 30 % more likely to get into a car crash taking your kids to school versus the other guy". Which Uber are you going to select?

### **Can you describe how sleep flushes the brain of toxins?**

Now, everyone knows that your body has a cleansing system, and it's called the lymphatic system, but we didn't think the brain had one.

About 8 years ago, a research scientist, Maiken Nedergaard, from the University of Rochester, made three stunning discoveries:

- First, the brain has a cleansing system. It's called the glymphatic system, named after the glial cells in the brain that make up this sewage network.
- She also discovered that the brain's sewage system is not always switched on in high flow volume across the 24-hour period. She found that it's specifically during sleep, and deep, NREM sleep, that it kicks into high gear and flushes the brain of all metabolic detritus. In other words, wakefulness is low-level brain damage from a biochemical perspective, and sleep is your sanitary salvation.
- The third thing that she discovered, and she found all of this in mice, is that two pieces of metabolic detritus that sleep will wash out of your brain are two toxic proteins. Those two proteins are the culprits that underlie Alzheimer's disease.

We discovered that people who reported short sleeping, 6 h or less across their lifespan were far more likely to develop Alzheimer's Disease. We also understand that people with insomnia, untreated sleep apnea, and heavy snoring also had a far greater risk of Alzheimer's. Now, those are simply associational studies, they don't prove causality. We decided to test this relationship causally, and we deprive people of sleep for, a single night. Then the next day, we were able to measure circulating in your bloodstream, circulating in the cerebral spinal fluid that bathes your brain, or even measuring directly in the brain itself, using a special PET scan, we were able to see an immediate accumulation of Alzheimer's Disease toxic proteins after just one night of short sleep.

After one bad night of sleep, you're not going to wake up with Alzheimer's Disease, but notice what this cycle means, which is that if you're not getting sufficient sleep and not getting your deep sleep, your brain is gradually, over time, iteratively, just a small percentage, night by night, going to start potentially accumulating more Alzheimer's protein. We also discovered that these toxic Alzheimer's disease proteins target the brain's sleep centers and not all over your brain homogeneously.

So the less you sleep, the more of this Alzheimer's protein builds up in your brain. Because it builds up in the deep sleep-generating regions, it will cause you to get less deep sleep. The less deep sleep that you get, the more Alzheimer's protein builds up, and the more Alzheimer's protein, the less deep sleep. This becomes a vicious cycle, and it's almost like compounding interest on a bad loan that just escalates.

That's why we can see people who say I'm fine to survive for 5 or 6 Hours of sleep, I'm free of cancer, never had a heart attack, and I'm 66 years old, And then five years later, the family takes them to the doctor because they're starting to have memory problems. And so you've got to be very careful, the elastic band of sleep deprivation usually can stretch only so far before it snaps. Margaret Thatcher and Ronald Reagan were very vocal heads of state who said I can survive on four or 5 hours of sleep. I don't think it's coincidental that both of them, in their later life, succumbed to the disease of Alzheimer's.

### **Does the specific time matter concerning NREM and REM sleep?**

It is based on your chronotype. So if you're a night owl and you're going to bed at 01:00 a.m., that's perfectly normal and natural for you, and you will start your sleep cycle naturally and get your deep sleep appropriately.

But if you're an extreme morning type who normally goes to sleep at 09:00p, and then wakes up at 05:00 a.m., then, you will lose some of your deep sleep because your brain is already naturally further in its sleep cycle preference. There is no one greater stage of sleep. Some people ask how can I get more REM sleep or how can I get more deep sleep. My question to them is, why? They say, "Well, isn't that the good stuff?" I say, it's all good stuff.

Different stages of sleep do different things for your brain and your body at different times of night. When you think about it, sleep is so truly idiotic from an evolutionary perspective, you're not finding a mate, you're not reproducing, you're not foraging for food, you're not caring for your young, and worse, you're vulnerable to predation. So on any one of those grounds, and especially all combined, Mother Nature should have strongly selected against this thing called sleep, and in fact, we've often said that if sleep doesn't serve an absolutely vital function, it's the biggest mistake the evolutionary process has ever made. Now, it didn't make a spectacular blunder, and, my point is that if there was any one stage of sleep that wasn't necessary, trust me, during the course of evolution, we would have stripped out that stage of sleep because it's so deleterious.

We have all of these stages of sleep because all of them are non-negotiably necessary.

## **How does sleep contribute to learning and memory?**

Sleep is critical for learning and memory in three different ways.

1. You need sleep before learning to prepare your brain. The memory structures in your brain are almost like a dry sponge ready to initially soak up that information, and if you have not slept sufficiently, your brain cannot effectively imprint those memories into the circuits of the brain, so you need sleep before learning.
2. You need sleep after learning. Deep sleep takes those individual memories, and it's like hitting the save button on those memories. It just takes a lot longer than in your Word document because it's a biological process, but deep sleep helps fixate those memories into the brain. Sleep sets those memories like a fly in amber, sort of trapping it there forever. It makes those memories more permanent. And it future proofs the information that we've learned during the day, preventing you from catastrophic forgetting.
3. Deep sleep strengthens individual memories, but during dream sleep, during REM sleep, the brain starts to stitch and associate all of that new information with your back catalog of stored information. Consequently, due to dream sleep, you wake up the next day with a revised mind-wide web of associations capable of solving previously impenetrable problems. This is the reason no one has ever told you you should stay awake on a problem. They tell you to sleep on a problem. And I would argue that deep sleep and REM sleep strengthens those individual memories. Deep sleep is the difference between knowledge, which is learning the individual facts, versus REM sleep, which is wisdom, knowing what it all means when you put it together. So during dream sleep, we go to sleep with the pieces of the jigsaw, but we wake up with the puzzle complete.

**The next question is two-part question. For first responders, we will run a call in the middle of the night and when we get back, we can't fall back asleep, so how do you fall asleep?**

**Another problem for a lot of us, on our days off at home, we wake up at 02:30 or three and toss in turn and cannot go to sleep.**

What you described in the first situation is what happens when you're adrenalized, which is your heart rate is jacked up, and you've got a large amount of adrenaline that's released from your adrenal glands. At that point, your nervous system is shifted over it into what we call the fight or flight branch, and it's actually called the sympathetic nervous system, which is terribly named. It's anything but sympathetic. It's agitating, it's aggravating. When you are in that state, it's almost impossible to sleep.

Sleep happens when we switch over from the fight or flight branch over into the parasympathetic nervous system, which is very difficult to just get into. I see a lot of people in the clinic with work anxiety, and we've described it as the wired but tired phenomenon where they come to me and say look doctor, I am so tired, but I'm so wired, I just can't fall asleep. It's tough to combat that, but you need to find a wind down routine. And here are some of the things that will help.

- Warm bath or warm shower, hot shower.
- Surround yourself in darkness, we are a dark deprived society in this modern era, darkness signals to your brain that it is time to try to fall asleep. Artificial light is fooling your brain into thinking that it's daytime, and so you're stimulated for wakefulness, you're not driven toward sleep, and you're not releasing melatonin to help you time your sleep. Dim down 50 to 75% of the lights when you get home to start to tell your brain it is darkness.
- Try relaxing exercises. Breathing techniques are fantastic. Meditation. I'm a big advocate. I'm a hard-nose scientist, and when I was researching for the book, I would read all of these articles about meditation and how amazing it was for insomnia. I just thought this is woo woo nonsense. I thought, I'm just gonna try it. That was seven years ago and I meditate for 10 min every night before bed, so I try meditation or breathing related techniques.
- Other ways to wind down are reading a book, listening to a podcast, or anything that does not activate your mind.

In terms of your second question, middle of the night awakenings are hugely difficult, and it's a big problem as we get older, but it's a huge problem in a career where you're trained to be what we call hyper-vigilant throughout the night. I mean, whether you can sleep like a log, when you get the chance, there is some part of your nervous system that stays in a heightened state of awareness. That makes your sleep more shallow, and it makes your sleep more fragile, and you learn that almost as a behavioral state. So then you go back home, you're off shift, but you've kind of developed this mechanism of always being slightly on edge. Now, you're not conscious of this, you're asleep, but your brain isn't quite as deep sometimes and in that case, your sleep is much more vulnerable to being fragmented by an awakening. If you do wake up since you're in that slightly heightened state, it can make it harder for you to fall back asleep.

The common sleep recommendation is that after 20 to 30 min of being awake, don't stay in bed, because quickly your brain learns that this thing called my bed is this place where I'm awake. That's a bad association to make, so you need to break that association. The recommendation is, get up, get out of bed in dim light, just do something relaxing, and only when you're sleepy and there's no time limit, should you return to bed. It's miserable for the first couple of nights, but gradually your brain relearns, as it did as a child, that this thing called the bed is the place where I am always fast asleep. The analogy would be, we never sit at the dinner table waiting to get hungry, so why would you lie in bed waiting to get sleepy, the answer is you shouldn't.

That said, I understand because I'm not immune to bad nights of sleep and I've had two bouts of insomnia in my life. When it's dark and cold I don't want to get up and get out of bed. So what do you do then?

Well, one of the things I would say again, try meditation. I will meditate if I can't get back to sleep, and I'll stay in bed. The second thing is that I've learned to just let it go. And what I mean by this is sleep is a little bit like trying to remember someone's name. The harder you try, the further you push it away. And if I'm lying in bed and it's 30 min later,

and I think, i've got to wake up because I have a big day tomorrow, and anxiety builds, this becomes disastrous. Anxiety is the worst thing I can do.

Instead, I just say to myself, "well, tonight's not my night, and that's okay. One night of sleep is not the worst thing in the world, it's okay to just relax. I'm just gonna lie here with my eyes open." All of a sudden when you take that approach you stop trying to force sleep and typically the last thing that you remember is saying I'm just gonna rest before your alarm goes off and now it's 4 hours later because you've stopped trying. So that can sometimes help to.

If it's really problematic and you're having consistent middle of the night awakenings, this can be one of two flavors of insomnia. They're not mutually exclusive. You can have both. One is called sleep onset insomnia, difficulty falling asleep. The other is sleep maintenance insomnia. I can fall asleep fine, but I can't stay asleep.

While there are medications that help, I'm not a big fan of things like Ambien and Lunesta etc. Those drugs are sedative hypnotics. There is a time and place for them in medicine, but they are principally suggested to be short term across, weeks, but many people have been taking them for years if not decades. There are some alternative medications that people can use.

This is not me giving medical advice. I'm not here to provide that, this is me giving scientific, descriptive advice, not medically prescriptive advice.

You can always explore these medications with your doctor. The two most common that are prescribed, are not your classic sedating, ambien-like drugs. One is Trazodone, it works to simply dial down wake promoting chemicals. The other drug is called doxepin and Doxepin can also help with middle of the night awakenings as well. There's lots that you can try before you ever get to medication, because I would really prefer you not to be pharmacologically dependent, but for some patients, it is necessary.

### **What are your thoughts on supplements like magnesium sulfate, especially for the tactical athletes, zinc, and tart cherry juice.**

I've researched a lot about supplements and the first thing I would note is that anything online that suggests it is the Holy Grail of perfect sleep, is absolute nonsense, because if there was some special supplement out there that promoted exceptional sleep, I will guarantee you that the pharmaceutical companies would have discovered it 20 years ago, and would be making billions of dollars of profit from it.

There is no magic bullet in the supplement world for sleep. Do not be fooled. It's big business. By the way, it took George Lucas about 30 years to amass 4 billion in profit from the Star Wars franchise. It took Ambien 22 months to amass 4 billion in profit, so



it's a big deal. So if there was a supplement out there that the drug companies could patent and augment, they would have.

That's not to say that there aren't some supplements that may help with sleep a little bit. Most of the magnesium that you take does not cross the blood brain barrier. So if people tell you magnesium is great for sleep, that's absolute nonsense, because sleep is by the brain, of the brain, and for the brain, principally. Magnesium, in almost all of its formulations, does not cross the blood-brain barrier. There is one formulation for which there are two studies in animal models coming from MIT, suggesting that this form of magnesium can cross the blood-brain barrier, and therefore the theory is that it may help with sleep. It can be found on amazon as Mag-T.

The original evidence found in patients who were deeply magnesium deficient struggled with sleep. When you normalize their magnesium with a supplement, they went from having bad sleep to having normal sleep. That is very different from saying, i'm someone who has normal sleep, and then if I supplement with magnesium, will that supercharge my sleep?

There are several other supplements with inconsistent findings. Such as valerian root and chamomile tea.

Additionally, we found that melatonin will only increase your sleep efficiency by 2.2 %, and it only increases the speed with which you fall asleep by about 3.9 minutes, which is not really much different from a placebo. Melatonin helps the timing of your sleep, it doesn't help the generation of sleep. That's why it's largely useless as a sleep aid for those with insomnia.

What is useful for folks here, if you are stressed out and you feel as though you're in that wired but tired phenomenon, there are two supplements that have been shown to reduce down the cortisol response. The first is called ashwagandha, while it hasn't been proven out as much as I would like, in sleep studies, there is some evidence. It's been shown to benefit sleep because it lowers your fight or flight response, and shifts you over into that more passive, quiet branch, which helps with sleep. The other compound that's got some evidence is glycine.

There's some interesting data starting to emerge that antioxidants can also have a beneficial effect with sleep. How and why that's the case, we don't yet know, I would say evidence is still way too early to describe that.

I'm not trying to be dismissive of supplements, but I don't want people to waste their money on them either.

**I found first responders like to supplement with melatonin, and for the men, they**

**like to supplement with testosterone, not realizing that their testosterone is low because they don't sleep enough.**

Certainly, as we get older, there is a time and a place for hormone replacement therapy. Embrace that, because when you have low T in mid to late life, lots of things don't go your way in terms of health, including sleep, so normalizing testosterone can certainly help that. But if you're young, and you should be in a state where you can produce plenty of natural testosterone, but it's low, you should ask yourself, what's going on with my sleep. A healthy, young male who limits their sleep 5 hours for five nights will have a level of testosterone which is that of someone ten years their senior. So I can take a healthy guy and I can age him by a decade in terms of his testosterone, just by limiting his sleep for one week.

In terms of supplements, you have to be careful because supplements aren't regulated by the FDA. You've got no idea how much is actually in the bottle. On the plus side, I would say that the placebo effect is the most reliable effect in all of pharmacology, so if you think it's working, in some ways, no harm, no foul.

The purity melatonin is a good example. A recent study demonstrated the following across 20 different brands of melatonin based on what it said was in the bottle versus what was actually in the capsule itself. When they tested them, it ranged from 83 % less than what it said on the bottle to 464 % more than what it said on the bottle. What was even worse is that even within any one vendor of melatonin, the variability from one batch, to the next, the next was almost as large. The reason this gets me concerned is that now if you go down the shopping aisle at the grocery store, there is one large section of supplements all dedicated to melatonin, and more than 50 % of that section is dedicated to pediatric melatonin. People are dosing their kids with huge amounts of melatonin in gummies.

Most people take way too much melatonin. Most people are taking, let's say, 5 mg to 20 mg, that's what we consider to be called a supra physiological dose, meaning it's a dose that is far larger than your body would ever naturally release. Why am I concerned about it in pediatric populations? Well, there's some evidence in rodents, that if you dose them with high levels of melatonin during development, it causes testicular atrophy and testicular regression, and poor development of the testes. We just unearthed reports of melatonin overdosing in the emergency room in pediatric populations which had risen by 500% over the past ten years.

**A lot of first responders are at more risk for concussion and traumatic brain injury. Any Thoughts about concussion insomnia?**

I would say there is very clear evidence that almost 80% of individuals with concussions will lead to some kind of short term sleep disruption. We don't know what the interaction is long term, certainly one of the things that we have found in stroke patients, which is obviously very different, but it's related because when you have, let's say, a concussion,

and if you have brain trauma that's associated with it, your brain needs to undergo some degree of reparative processing. Now, in a stroke, obviously a part of your brain is damaged because it's starved of oxygen, and what we found is that the amount of sleep that you're getting or not getting during the recovery period from stroke will predict the degree to which you regain some of that neural function. And this is the reason that we know from animal models that sleep is critical for brain plasticity. Now, you don't necessarily regrow new brain cells, there's only a few areas in your brain where you regrow brain cells. The reason that a stroke patient can start by being completely immobile on one side, and then two years later they've got 50 % mobility back is because the existing tissue around the damaged area sprouts new connections.

We're now interested in evaluating people with concussions and learning if the amount of sleep that they get after the concussion is going to be predictive of how much recovery they get, or is the sleep disruption that they suffer then deleteriously predicting a failure of recovery? If we can prove that, then we can start to institute a priority of sleep, in terms of either augmenting it clinically with medications, or helping at least impress the importance of sleep to the clinician during the recovery period. It may be that sleep, even in the first week, is ultimately critical.

Don't forget, the hospital is the last place that you ever get a good night of sleep. 80% of all hospital alarms in the ICU are largely useless, and I've railed against the medical system for this. Think about this, when you go on a long haul flight, you get a free pair of earplugs and a free eye mask. But when you go into the hospital, they don't consider sleep or sleep chronotype.

Sleep is the single most effective thing you could do in a hospital setting to reset the health of your brain in your body. But, why aren't we thinking about that? Same is true for concussion.

### **How detrimental is it to stare at your phones at night?**

A study comparing people who read on an iPad compared to those who read a book in dim light found that the people who read the iPad had significantly less total sleep, significantly less dream sleep in particular, and third, the peak levels of melatonin, were delayed by somewhere between two to three hours. So if I'm in California and I'm reading an iPad before bed, that would put my melatonin rhythm closer to Hawaii time than California time. What was also interesting about that study is that when they stopped using the iPad, sleep disruption continued for several days later. There was a blast radius. It's almost like a drug that you have to wash out of the system.

More recent studies have pushed back against this idea that it's the blue light, and what they've discovered is that the blue light is not as delicate as we thought. However, the sleep disruption caused by those devices is still profound. The other explanatory mechanism is that these devices that we have in our pockets are attention-capture devices. They are in the market for your attention, and they will capitalize on it, ruthlessly. And again, this comes back to the idea of when you are active and engaged,

these devices keep jacking your brain up with wakefulness. This is especially true for kids on their phones. It's not necessarily the blue light, it's that you're too activated by your phone, and that's the reason that you can't sleep.

I put my phone in the bathroom and when I wake up, I don't check my phone until I've sat down in the morning and I'm having my first cup of tea. That's just me, but here is the rule of thumb for people. I would say, if you're taking your devices into the room, you can only use your phone in the bedroom if you're standing up. What happens is after about 7 or 8 min of standing up you, you want to sit down.

### **Can you elaborate a little bit more on those strategies for shift workers?**

I'm so sympathetic to this audience. Again, I want to re-emphasize how much I appreciate what you do and the suffering that you go through by way of your circadian rhythm disruption and your sleep.

What's the ideal shift? There is no ideal shift. We're not a nocturnal species, and we can't train ourselves to deal with that biologically. Psychologically, you may be able to think that's true, but don't forget, it took Mother Nature about 3.6 million years to put this thing called a circadian rhythm in place in human beings, to make us sleep nocturnally at night. And to think we're going to come along and say, I've trained myself to be able to work throughout the night. That's hubris. You're fighting against 3.6 million years, it's not gonna work. So, what do you do about that in terms of shifts? What I would say is the evidence would favor avoiding flipping shifts frequently, don't flip flop back and forth.

Try not to flip back and forth every 24 hours, on for 24 then off for 23 and so on. You don't want to confuse your circadian system. If you can have slightly longer stretches of time when you're on and then slightly longer stretches of time when you're off, that's one model that is adapted and useful. Nighttime shift work is another thing that we must do, and instead of flopping we should slowly move to a rotating shift, where to gradually move around the clock, that's, a, little, bit, better, for, your, circadian, system, to gradually adapt.

If you work at night, and you have to sleep during the day, I would say it's okay to strategically use caffeine if you must. Dose yourself with caffeine only in the first half of the night shift, start to cut yourself off in the second half. When you get home, try to make your bedroom much like the night or a cave. It has to be cold and dark. You want to fool your brain into realizing it's not 11:00 in the morning, but instead it's 11:00 p.m. At night, and you could do that using darkness.

Then create a wind down routine, with a warm bath or shower. This doesn't just relax your brain but during the day time, your circadian rhythm ramps up your core body temperature. The opposite has to happen at night for you to fall asleep. You need to drop your core, brain, and body temperature by about two to three degrees Fahrenheit, to not only fall asleep but to stay asleep. This is why you'll always find it easier to fall

asleep in a room that's too cold, because a room that's too cold is taking you in the right direction for good sleep.

A hot bath or shower forces all of the blood to the surface of your skin. You get a massive thermal dump of heat out of your body, so the warm bath or shower is almost like a snake charmer in that it's charming the heat out of the core of your body to the surface. When you get out of the shower, you get this huge dissipation, and the core body temperature plummets.

### **What should you do on your days off to help your sleep?**

Sleep is not like the bank, you can't accumulate a debt and then pay it off at a later point in time, in full. Let's say, I take you and I deprive your sleep for an entire night, you've lost 8 hours of sleep, and then I give you all of the recovery sleep you want. On the second and third night, or even a fourth night, how much sleep do you get back? That first recovery night, you're going to sleep longer than is normal, why? Because you've been awake for 24 hours, but ultimately what we found is that even across three or four nights, you will still only sleep back an extra 4 hours. So you will still carry a 50 % sleep debt.

In other words, sleep in that sense is not like the bank. You can't accumulate a debt and then start to pay it off. However, there is a different form of what I would call sleep banking. It was discovered by the Walter Reed Army Institute. They were looking at soldiers in the field and studying the errors sleep deprivation was causing in terms of missions, which was costing them both lives and also huge amounts of money. And what they realized is that we can do something called sleep banking. This means if you've got two days off, and you know that you're about to go into a 48 hour shift where you're maybe only gonna get 3 h of sleep on average, the best piece of advice I can give you is, in those two nights before you go into your shift, try to sleep as long as you possibly can. Instead of paying off debt, go to the bank and build up some sleep credit to begin with, and then use that accumulated credit to lessen the debt impact they're about to go into.

### **Afternoon Naps?**

Naps are wonderfully beneficial for both the brain and the body. Naps, however, are a double edged sword. There is a dark side to napping, and it's the following. If you're struggling with sleep at night, do not nap during the day. The reason is because during the day, we are building up this healthy sleepiness, and, from the moment everyone woke up today, the chemical adenosine has been building up in your brain. The more adenosine that builds up, the sleepier you will feel.

After about 16 hours of being awake, you accumulate what is called sleep pressure, that makes you feel tired and sleepy, and it helps you fall asleep. When you sleep, the brain

gets the chance to clear away some of that sleepiness chemical adenosine. Between seven and 9 hours of sleep, your brain is able to clear away all of the adenosine so you wake up feeling refreshed.

When you take a nap in the afternoon, you just release some of that healthy sleep pressure that you've been building, so then it can make it harder for you to fall asleep in the evening or even stay asleep soundly. If you can nap regularly and you're not struggling with sleep, naps are just fine. But if you are struggling with sleep, do not nap, stay awake, build up as much of that healthy sleepiness chemical as you can to try to guarantee a better night of sleep.

There is an art and skill of napping, firstly, try not to nap too late into the afternoon or in the early evening. Napping late in the day is a little bit like snacking before your main meal, it just takes the appetite off your sleep hunger for the evening. Next, try to limit naps to about 20 to 25 min. Because if you sleep more, you start going into the deeper stages of deep NREM sleep. You get some nice benefits there, but the problem is that when you wake up out of deep NREM sleep, you have what's called sleep inertia, otherwise, there is a sleep hangover, and you will feel almost worse after you wake up from the nap.

We've discovered that naps ranging from somewhere between about 15 to 25 min will still give you some nice brain benefits. It will boost your alertness, boost your reaction time, and boost your ability to focus and concentrate.

## Alcohol and THC?

Many people will say to me, "look, I have just a couple of drinks in the evening, or a couple of nightcaps, go to bed and it really helps me fall asleep". That's incorrect. What's happening is that you're simply knocking your cortex out, and sedation is not sleep. But when we have a few drinks in the evening, we mistake the former for the latter. That's the first problem. The second problem is that, if I want to show you the electrical signature of your sleep when you've had alcohol on board, it is not the same as naturalistic sleep. It's not the same type of deep, restorative sleepiness. Alcohol fragments your sleep, so you wake up many more times throughout the night. You don't remember it, but the next day you kind of feel lousy, and you don't feel refreshed by your sleep.

The final problem with alcohol is that it's pretty good at suppressing your REM dream sleep. REM is important for learning memory, it's also critical for emotional and mental health. So I would say alcohol is certainly not a sleep aid by any means. That said, though, again, I am just a scientist, and I have no right to tell anyone how to live their life. After all, for goodness sake, life, to a degree, is meant to be lived. You folks know that better than anyone. So what I'm saying is that, firstly, no one wants to be the healthiest person in the graveyard. Every now and again, have a drink in the evening. Just don't use it as a self medicating tool to help solve your sleep problems. If that's the

case, that you are dependent on alcohol to get to sleep, you need to see a doctor.

Right now we don't have evidence on CBD yet but the following is true of THC. It will speed the time with which you fall asleep up significantly. In other words, you fall asleep faster. The problem with THC is that like alcohol, but through a different biochemical mechanism, it will also block your dream sleep. This is why people tell me all the time, look, I've been smoking weed for years, and I never remembered my dreams. Why? Because you weren't getting any REM sleep, so you weren't dreaming. Then they say, "when I stopped smoking weed, I had all these crazy dreams, why"? Because your brain has been starved of dream sleep for so long that it's built up this debt, this pressure for dream sleep, and when you stop smoking, all of a sudden you get what's called a REM sleep rebound, and you get these intense dream episodes. And that shows you a very clear case in point that THC is blocking your dream sleep when you're taking it. The other problem with THC is that you become so dependent on it that if you stop smoking weed you get what's called rebound insomnia. The clinical diagnostic profile of cannabis withdrawal is insomnia syndrome, that's how reliable it is, and it's the principal reason that people remit and start reusing cannabis again, because they can't take the insomnia, so THC is really to be avoided.

The evidence may look somewhat promising with CBD. CBD is the non psychoactive component of cannabis and in some animal studies it seems to help with increasing the duration of sleep and increasing the amount of deep sleep that you get. Do we know that that's true in humans? Not with enough data for me to go on public record and say, yes, it's good. But I'm intrigued. And one of the interesting things about CBD, which is scientifically well proven, is that CBD seems to be very good at reducing your anxiety, and I can see this in your brain when we dose you with CBD. The emotional centers of your brain, called the amygdala, are dampened down in their activity. So if you were to ask me, in five years time, after we have the clinical, randomized control trials showing that CBD helps you with sleep, and you were to ask me, how do you think CBD could do that? My principle bet is that it reduces anxiety, and one of the principal underlying mechanisms for insomnia is physiological anxiety, it's that fight or flight range of the nervous system. One of the reasons that people can't sleep is not because you're not tired or your brain can't generate sleep, it's that there is a roadblock in place called anxiety, and when you remove that roadblock, you allow passage into this beautiful thing called sleep at night. Maybe that's how CBD is working.

### **Is polyphasic sleep healthy?**

As adults, sleeping like a baby is the most unwise thing that we can do, which is sleeping in these ultra short cycles. Now, that's not to say that when you're under extreme circumstances, when you're profoundly sleep deprived. In that case, sleep whenever you can, within reason, under those extreme circumstances, but don't adopt it as a lifestyle.

## How do we better help our population of first responders improve their sleep?

There is not much sleep education throughout the emergency services, and I feel sad about that. With even just a 15 minute lecture, or posters saying here are the five tips to help optimize sleep, you could be empowered. Why don't we have that simply in every fire station, so people can just look and, you know, take a picture of it and start to understand a little bit more about sleep, even that would go a long way.

The second thing is a slight change in attitude, certainly. There is the sleep machismo attitude that people are almost braggadocio about how little sleep that they need. And they wear it like a badge of honor on their arm. That is profoundly hurtful to you as the individual, and it's a profoundly poor signal if you're in a leadership position to then transmit to the next generation. Leaders should not be advocating for sleep neglect and sleep shame. While I am not familiar with your population, I've seen it elsewhere. If the toxicity of sleep shame and stigma is in your workplace, and you can push back against it, bravo, that would help too.

So I would say those are two things. How can we get education mass marketed to all of these employees, be it a simple poster that's generated, printed out, laminated, and slapped on a wall. Or when you first go through training, it's part of your training. I think trying to co opt a better attitude and mental transmission of celebrating sleep, instead of treating sleep as a cost.

We need to stop doing that. Instead, sleep is an investment in your health. If you don't want to live a shorter life, and you want to live a life that is largely free of disease and sickness, there is no better health insurance policy that I know of, other than this thing called sleep. And many of you have husbands and wives, many of you have kids, and they desperately want you around for as long as possible. We need to prioritize sleep.

**DENA ALI** is a battalion chief with the Raleigh (NC) Fire Department. She previously served as a police officer for five years. Ali has a degree from North Carolina State University and an MPA from the University of North Carolina—Pembroke, where her research focused on firefighter suicide. As a graduate student, she was awarded the 2018 MPA student of the year, and she has also received several other awards, including the NC Office of State Fire Marshal Honor, Courage, and Valor. Dena has also served as a subject matter expert at the National Fire Academy, where she assisted in curriculum review for their health and wellness curriculum. Dena is an advocate of awareness, education, and understanding of mental health disorders and suicidality. She speaks locally and nationally on these topics and is a QPR Suicide Prevention Gatekeeper Instructor. She is the founder and director of North Carolina Peer Support, where she helped to develop their statewide curriculum. She is also a founding member of the Carolina Brotherhood, a group of cyclists/firefighters in North Carolina who honor the fallen and their families annually.