

John Iliff

Good morning, Erins. Good morning, everyone, and thank you for the invitation to come and share a story that I went through in my career. In 2012 I was an intern back in Dublin in a large teaching hospital. It was six months after finishing my intern year, aged 23. And I was working in a busy surgical unit. It was January and I was woken up about 6 am to go and start my journey to work. As I've gone to work, bear in mind it's a Thursday, I've already undertaken about 36 hours of work within this work week from Monday and I'm about to go and start on another Thursday. I feel I'm relatively well rested but I know that I'm not feeling particularly good going in to start a very large shift which I'm going to elaborate on a little bit now. At 6:30 I arrive into work and I undertake results checking. We look at all the results of our patients from the day before, recent blood tests, recent scan results, and ultimately to prepare for the ward round when our surgeons and the consultants and the senior doctors will start undertaking looking at every patient on their list.

At 7 o'clock we start sharp and we finish about 8 o'clock. And at 8 o'clock those senior surgeons will head off to surgery. And also as the junior doctors, we'll then undertake the tasks of the day. We'll look at organizing consultations, we'll be writing letters, discharging patients, admitting new ones, and then deal with problems as they occur on the wards. It's fast paced, it's a busy unit but it's something that I thrive. I enjoy the challenges as they present. I really am passionate about the work and I'm very happy to work in such a busy environment, even though you might only be getting 20 minutes for a quick lunch break. You feel very valued, you feel wanted, and a key cog in that machine of the hospital. But there's very much a drive. You have to have the work done and it has to be done correctly. It's got to be done with precision because at the end of the day, patient care depends on it.

As the day continues we take over to about 5:45 in the evening and then the surgeons are starting to come out of theater and then we start doing a further round through the hospital again of all the patients that have been under the lists of the surgeons who have operated and those who are still waiting after their operations. These rounds then can finish about 7:15. So bear in mind I've been in the hospital since 6:30 and it's now 7:15 at night. I then start the next part of my shift. And back in 2012 we were routinely rostered to do 24 hours. So I will then move from my day job to then providing night cover in the tertiary hospital, of which there are only 4 interns. All of us have only done 6 months prior and we're all fresh out of college, maybe 23, 24, 25. We each cover in the region about 180 patients each with one senior doctor to call upon for assistance as we go through the night.

Now usually you would get a scattering of sleep here or there, a few hours and maybe hold each other's pagers. This particular night in question, that was not going to be one of those cases. We were dealing with sick patients across the hospital and in my particular area that I was looking after I know offhand I was dealing with a patient who was having an acute stroke on the middle of the ward, as well as a patient who was bleeding postoperatively on the ward and trying to get them back to theater for emergency surgery. Jobs kept creeping up as we went through the night and they did not stop. But then we were getting to 6:30 in the morning and I was then starting to get set for the next ward round which my team were getting prepared for.

It's at that point that I'd been notified that we have a sick doctor on and I'm going to be required to stay. And my boss has asked me to stay and conduct surgery with him. Now bear in mind I'm not a surgeon and I'm working under complete supervision of very senior surgeons at the time. I'm not putting any patient within risk because I'm simply holding a retractor, I'm not doing anything that's going to be compromising them. It is simply to be able to hold something in theater and provide that extra bit of support so the surgeon and their assistant can do their work under full supervision at that time. I finished and I wrapped up about 11:30 in the morning, I'm excused, at which point I've probably been awake for about 29 hours and scatterings of sleep here or there. I make the decision to drive home. And nobody forced me to make this decision, I took that completely on myself. And as I'm driving down the Grand Canal in Dublin, I fall asleep at the wheel.

And I wake up with a jolt and I've put my car into the back of a large Dublin bus. I get out of the car, looking at the smashed windscreen, completely obliterated bonnet and smoke coming off the engine, and I'm shaking. I'm uninjured but really fraught with anxiety and just fear of what's happened. I called my dad, who's been a fantastic wealth of advice and support for me over the years, who helps me to navigate the situation in relation to getting insurance, calling retrieval authorities, etc, to get cars off the road. He slowly makes his way to come and see me on the Grand Canal dock and as traffic starts to move on, we get the daggered looks of the frustrated drivers whose days have been interrupted by my accident. But my dad, who has sort of been a wealth of advice over the years, says to me that this has been a very valuable learning curve for you and you've gone through it without anybody being injured.

And for me that was what was really interesting was because now as I reflect back on that, my life could have taken a very different turn. Not only was I uninjured but I did not injure anybody else. And it's something that it really does strike fear in me that I didn't only put myself in a position of danger but I put others in danger. And it only cost me the price of my car and not the cost of someone's life or my own life and leaving a family, potentially having an injured family member or even my own family where they would have to deal with my death because of a decision I made. But in reality I was far too fatigued to make that decision correctly. And as I said, no one forced me to do this, this was something that I did on my own bat. And it's something I reflect on every day as I go to work, whether I'm making sure that I am not in a position where I can make an error like that again.

TPWKY

(This Podcast Will Kill You intro theme)

Erin Welsh

That is just a terrifying and very relatable story.

Erin Allmann Updyke

Yeah.

Erin Welsh

And I'm glad that you were okay, I'm glad everything turned out okay. And just thank you very much for sharing this story with us.

Erin Allmann Updyke

Yeah, thank you. We're so glad, like you said, that the accident wasn't worse than it was. And we really appreciate you sharing it with everybody here today. I think it's something that unfortunately a lot of us can probably relate to. So thank you so much.

Erin Welsh

Yes, thank you.

Erin Allmann Updyke

Thank you for having me. Thank you all.

Erin Welsh

Hi, I'm Erin Welsh.

Erin Allmann Updyke

And I'm Erin Allmann Updyke.

Erin Welsh

And this is This Podcast Will Kill You. And we are coming to you live with our very first recorded live episode from Perth, Australia, the lovely Perth. And we're here at the 2024 AIOH Annual Scientific Conference and Exhibition and we are just thrilled to be here.

Erin Allmann Updyke

We really are. Thank you all so much for having us. A huge thank you to Zach and Kelly and David and everybody who helped organize this conference. We are truly honored to be up here today speaking with you all.

Erin Welsh

Really. And in light of the fact that we are at the annual meeting of the Australian Institute of Occupational Hygienists and we just flew across 1 million time zones to get here, not an exaggeration, we decided to focus on a topic that is of central importance to pretty much every industry. And that is fatigue, specifically fatigue caused by disruption in our circadian rhythms in the context of shift work.

Erin Allmann Updyke

And because that alone is such a huge topic that there's no way that we could fit it all into a 90 minute plenary, we're not going to make you sit here for 100 hours, don't worry, we're going to take you through just a few parts of that. So first I'm going to focus on what do we mean by fatigue? How do we define that and what does that actually mean? How our circadian rhythms actually work and how disruption in circadian rhythms can lead to symptoms like fatigue, excessive daytime sleepiness, and so many other chronic health conditions.

Erin Welsh

And then I'll get into how our understanding of circadian rhythms has evolved over time, the changes that led to shift work becoming as widespread as it is today, and how we came to recognize those negative effects of shift work. And then we're going to bring on a subject matter expert, Dr. Ian Dunican, who will share some of the current exciting research that's going on on circadian rhythms and how to combat the negative effects of things like shift work and jet lag.

Erin Allmann Updyke

Yes. But first, no episode of our podcast, This Podcast Will Kill You, would be complete without a beverage that we call a quarantini or in our case a placeborita because we don't have any alcoholic spirits in it.

Erin Welsh

Nope.

Erin Allmann Updyke

But we are drinking one today. Erin, what are we drinking today?

Erin Welsh

We're drinking Tick Tock You Don't Stop.

Erin Allmann Updyke

Get it? Because it's like a clock.

Erin Welsh

Yeah.

Erin Allmann Updyke

It'll be funny eventually.

Erin Welsh

We love to explain jokes so that they're not funny anymore.

Erin Allmann Updyke

But what is in Tick Tock You Don't Stop, Erin?

Erin Welsh

It's a delicious beverage consisting of one ingredient which is Australian ginger beer.

Erin Allmann Updyke Thank you, thank you.

Erin Welsh It's delicious. And also easily modified, you can add whatever spirit you would like or just leave it with a little bit of lime in there. Delicious.

Erin Allmann Updyke Yeah. Yeah, sorry, we should have really had the foresight to make a drink for everyone.

Erin Welsh Yeah.

Erin Allmann Updyke Like under your seats you can find...

Erin Welsh Oh my gosh.

Erin Allmann Updyke I know.

Erin Welsh That would have been really fun.

Erin Allmann Updyke Very Oprah of us.

Erin Welsh Cheers?

Erin Allmann Updyke Cheers. To you all.

Erin Welsh Okay.

Erin Allmann Updyke Okay. Now drinks are drunk. Shall we? We'll get into the biology of our circadian rhythms.

Erin Welsh I can't wait. Yeah, tell me all about it.

Erin Allmann Updyke It's gonna be fun.

TPWKY (transition theme)

Erin Allmann Updyke So we decided to do this talk today on fatigue because it's kind of this universal experience that also happens to be an occupational hazard in so many different industries. Everyone has at some point been fatigued, experienced fatigue. But when we talk about this idea, what do we actually mean? Like how do we define fatigue?

Erin Welsh Right. It's super easy to define, right?

Erin Allmann Updyke Yeah, right. There's not a definition. There is not a single definition of fatigue but there are a lot of different definitions. Most of them use a lot of synonyms, things like tiredness or exhaustion. Most of the definitions include something like the decreased ability to function at your normal capacity.

Erin Welsh Okay.

Erin Allmann Updyke Or some kind of decreased capacity for mental or physical work.

Erin Welsh: Okay.

Erin Allmann Updyke: So overall we're looking at fatigue as this generalized lack of energy that overall has some kind of impairment on your ability to function, be that your physical function or your cognitive function.

Erin Welsh: All right.

Erin Allmann Updyke: Makes sense?

Erin Welsh: All right, I'm following.

Erin Allmann Updyke: But in that definition, what's important about it is that we then have to intentionally separate fatigue from sleepiness.

Erin Welsh: Right.

Erin Allmann Updyke: Right?

Erin Welsh: And how does one do that?

Erin Allmann Updyke: How does one do that? By defining sleepiness.

Erin Welsh: Okay, more definitions.

Erin Allmann Updyke: More definitions. So we can do this by defining sleepiness as directly related to the physiologic phenomenon that is the act of falling asleep.

Erin Welsh: Okay.

Erin Allmann Updyke: Because that means that it's something that we can measure, okay, at least to a better degree than we can fatigue which is so nebulous.

Erin Welsh: Right.

Erin Allmann Updyke: And we do this, we can measure sleepiness with a couple of different tests. There's one called the multiple sleep latency test, which is I'm gonna put you in a dark room and you're going to lay down and fall asleep. How long does it take you?

Erin Welsh: Wow. Okay.

Erin Allmann Updyke: Sounds not stressful at all, right?

Erin Welsh: No.

Erin Allmann Updyke: And then there's also the maintenance of wakefulness test, which is how long can you stay awake if we sit you in a dark room and ask you to not sleep?

Erin Welsh: Sit, you have to be sitting for this one. Okay.

Erin Allmann Updyke: Just sitting with your thoughts in a dark room.

Erin Welsh: Oh no, I don't like that idea.

Erin Allmann Updyke: Now sleepiness itself, like falling asleep, it's not a bad thing inherently. We have to sleep. It is required.

Erin Welsh: Yep.

Erin Allmann Updyke: Of all humans. And as humans are a diurnal species, we have evolved to sleep at night when it is dark and be awake when it is light. So being sleepy at night time itself is not a bad thing. But if that sleepiness is happening when we shouldn't be asleep, then it can lead to what's called excessive daytime sleepiness or this inability to stay awake during hours when you should be awake. And that can be bad, or as we heard in our firsthand account, even downright dangerous.

Erin Welsh: Yeah.

Erin Allmann Updyke: Both excessive sleepiness and fatigue, though they are different and these definitions are important, they're also kind of two halves of a story and they both contribute to the kinds of accidents and workplace events like we heard about in our firsthand account. And while circadian rhythm disruptions themselves are by no means the only things that can cause excessive daytime sleepiness or fatigue, these are two of the most immediate consequences that we see from circadian dysfunction. So having a basic understanding of what our circadian rhythms are and how they work can go a really long way to understanding what happens if they get pushed out of sync, which then can lead us to better anticipate the hazards that might be inherent to some professions or recognize these symptoms when they start to crop up during certain phases of life. Hello, newborns. Gotta love them. And then evaluating and understanding these consequences of this type of circadian disruption can help us to actually implement strategies in the future to help mitigate some of these hopefully. We'll get there.

Erin Welsh: Yeah. Can it be done?

Erin Allmann Updyke: Can it? So then first we have to start with what really is circadian rhythm. And I think most people probably have a sense of what this means in their mind, right. It comes from the Latin, 'circa' means 'about' and 'dies' or 'diem' means 'day'.

Erin Welsh: Stole my line.

Erin Allmann Updyke: Thank you. I try. So when we talk about a circadian rhythm, we're talking about cycles that are happening in our bodies on an about 24 hour time frame. And Erin, I know later you're going to talk about why we have these rhythms.

Erin Welsh: Yeah, yeah.

Erin Allmann Updyke: Like from an evolutionary perspective.

Erin Welsh: Yep.

Erin Allmann Updyke

What are they doing for us?

Erin Welsh

They're important, they're important.

Erin Allmann Updyke

Are they? Let's find out.

Erin Welsh

Yeah.

Erin Allmann Updyke

But I want to focus first on how they actually work. And everyone is probably most familiar with the circadian rhythm in the context of sleep and our sleep-wake cycle. Because our sleep-wake cycle is one of the most classic examples of our circadian rhythm in action. So we can see a few different things that oscillate in our sleep-wake cycles. One of them is something like melatonin secretion. So our melatonin peaks in the couple of hours before we go to sleep and then we'll go to sleep. Our cortisol levels will peak in the morning right about the time that we tend to wake up. We also see oscillations in our body temperature, with the lowest body temperature happening in the wee hours of the night while you're still asleep.

Erin Welsh

I just want to ask why for each one of these.

Erin Allmann Updyke

I don't have great answers. But I can tell you like the why is that these processes together are what are driving our drive for wakefulness-

Erin Welsh

Okay.

Erin Allmann Updyke

And our pressure for sleep.

Erin Welsh

Okay.

Erin Allmann Updyke

So these three things, they're not the only things that are involved in what's literally keeping us awake during the day-

Erin Welsh

Right.

Erin Allmann Updyke

And telling our bodies we need to go to sleep at night. But these are three of the big drivers of that drive for wakefulness that happens during the day-

Erin Welsh

Yeah.

Erin Allmann Updyke

And that pressure for sleep that happens like towards the night.

Erin Welsh

But what's the deal with temperature?

Erin Allmann Updyke

Oh I don't know, Erin.

Erin Welsh

And also what is that... So the body temperature changes by how many degrees?

Erin Allmann Updyke

I knew you were gonna ask that and I meant to like look it up again to try and get it. I don't know. I don't know the answer to that.

Erin Welsh

Not like 20. It's just a few.

Erin Allmann Updyke: No! Yes. Like proportions of a degree.

Erin Welsh: Yeah, yeah, okay.

Erin Allmann Updyke: Yeah. Little changes. But it's enough that it's sort of in that period when we're close to waking up, that drop in temperature is what helps our body stay asleep essentially, right.

Erin Welsh: Okay.

Erin Allmann Updyke: Like it's colder, stay asleep, etc.

Erin Welsh: Yeah.

Erin Allmann Updyke: Right?

Erin Welsh: Okay, all right. It explains why I don't sleep well when I have that heavy comforter.

Erin Allmann Updyke: It gets too hot!

Erin Welsh: Yeah.

Erin Allmann Updyke: We're going off track.

Erin Welsh: Yep.

Erin Allmann Updyke: So as humans, because we're diurnal, we see these particular cycles again on this 24 hour clock where sleep is happening at dark and awake time is happening during the light. So this is what we all think of when we think of circadian rhythm. But it is not just this. Our circadian rhythm, like literally every single function and process in our bodies from the cellular level, like the genes that are controlling which cells are going to divide when, the genes that are controlling DNA repair, does it happen, in what cells, and when? Things like our immune system, our metabolism, our hunger cues, our bowel movements, our libidos. Every function in our body is controlled to one degree or another by circadian processes.

Erin Welsh: It's like the ultimate 'but wait, there's more'.

Erin Allmann Updyke: Right, exactly.

Erin Welsh: It's not just sleep-wake, it's everything. Yeah.

Erin Allmann Updyke: It's everything. And these all are our circadian rhythms. It's not just sleep but sleep is a big part of our circadian rhythm. And these circadian rhythms are mechanized internally in our bodies by what's called an intrinsic circadian clock. But not just one clock, we have multiple clocks. We have a main clock in the part of our brain that's called the suprachiasmatic nucleus.

Erin Welsh: I'm really glad that you pronounced this because I just wrote SCN over and over again.

Erin Allmann Updyke: Yes.

Erin Welsh: I don't even know if I talk about SCN but no, no, no.

Erin Allmann Updyke: Now you know.

Erin Welsh: Now I know how to pronounce it.

Erin Allmann Updyke: The SCN or the suprachiasmatic nucleus. And this region in our brain functions as like a master regulator of our internal clock. But all of our peripheral cells and tissues, they all have clocks of their own. And together all these clocks drive our many, many circadian rhythms, in large part by the build up and then the breakdown of specific proteins whose literal job it is to be made, build up, and then break down on a 24 hour cycle to keep these clocks all in sync with each other.

Erin Welsh: Okay.

Erin Allmann Updyke: Does that make sense?

Erin Welsh: Yeah.

Erin Allmann Updyke: It's like pretty basic, right?

Erin Welsh: Yeah. Super simple. I'm sure it took no time at all to figure that out.

Erin Allmann Updyke: No, no, no. So that's how these circadian clocks are working on like a cellular level. And I said that these are intrinsic and we know that these are intrinsic because these cycles will persist on an about 24 hour basis. In humans it's a little long, we tend to run about 24 hours and 10 minutes.

Erin Welsh: I got 11 in here, 11 minutes.

Erin Allmann Updyke: 11 minutes? 9-11 is what the literature says, we can have a range.

Erin Welsh: Anywhere from 9-11 minutes and 24 hours.

Erin Allmann Updyke: And our clocks... And 24 hours and 11 minutes, 9-11. And our clocks keep doing this even if we put someone in a dark room with absolutely no external environmental cues.

Erin Welsh: Yeah.

Erin Allmann Updyke: Like in absence of the environment, our clocks still run. However these environmental cues are in fact an essential part of our circadian rhythm because a lot like clocks, old-timey clocks, not newfangled watches which work by magic is how my watch works-

Erin Welsh: Magic. Yeah. Okay.

Erin Allmann Updyke: Old-timey clocks, mechanical ones, you used to have to wind in order for them to keep correct time. Our circadian clocks also have to be wound in order to keep them on as close to a 24 hour cycle as possible. And this happens through a process called entrainment. And the environmental cues that we use for entrainment in our circadian clocks are called zeitgebers, which is my attempt at German, and that is German for 'time giver'.

Erin Welsh

How did she do?

Erin Allmann Updyke

Did I... Anyone speak German? Not great, I can tell. I tried really hard. Zeitgebers. In humans it is light, predominantly light from the sun that acts as our number one zeitgeber or time giver. And the sun, light from the sun is detected by these specialized cells in the back of our eyeballs that project directly to that SCN, the suprachiasmatic nucleus. And that part of our brain, again, is this pacemaker that coordinates the cycles in all of the rest of our body. And they do this, they coordinate the timing of like so many different processes, right, through direct and indirect pathways, to keep us on this 24 hour cycle in sync with the sun or the light around us. Now light is by no means our only zeitgeber. Food can be a powerful one.

Erin Welsh

Okay.

Erin Allmann Updyke

Especially for other mammals other than humans. We also can see exercise, social activity, other things can serve as zeitgebers. But light is by far the primary one that our particular clocks use. Which means that although these rhythms are generated internally, they do require entrainment, mostly via light, in order for so many of our biological processes to match our environment. So when our environment changes, like when we travel across exactly nine time zones, I counted between California and Western Australia, to come to a conference-

Erin Welsh

10 for me.

Erin Allmann Updyke

Suffice to say, our internal clock no longer matches our external environment.

Erin Welsh

I'm feeling okay though, I will say.

Erin Allmann Updyke

Yeah. Thank you, caffeine.

Erin Welsh

Yeah, that's a big part of it.

Erin Allmann Updyke

Right. And we all know this particular phenomenon very well. This is jet lag. And with jet lag, because of this discrepancy between your external environment, the timing of light exposure, and where your internal circadian clock was set before you left, you end up feeling pretty terrible, right?

Erin Welsh

Not myself.

Erin Allmann Updyke

Not today right now, we feel great. But you can end up feeling pretty terrible. You might have symptoms like a really hard time falling asleep when it's time to fall asleep or maybe you simply cannot keep your eyes open for like an afternoon meeting when you get to where you're going. And because, again, this maladjusted timing is affecting every body system that we have, not just sleep, it's not just being fatigued or being excessively sleepy. You might also have GI upset, mood changes, brain fog, and so much more. Now in addition to regular old jet lag, there's also a phenomenon called social jet lag.

Erin Welsh

Oh yeah.

Erin Allmann Updyke

We'll separate it.

Erin Welsh

All right.

Erin Allmann Updyke: And social jet lag is basically this idea that we all, as like a society at large, not us in this room here, we have all decided that our day starts at like 8 am, right. Or whatever.

Erin Welsh: Sure. Yeah, roughly.

Erin Allmann Updyke: We can say 8. And that is when the day is supposed to start for everyone across the board. But a lot of us maybe end up relying on like our alarm clocks to wake us up on the weekdays to be able to get ready for work on time.

Erin Welsh: A lot of us.

Erin Allmann Updyke: A lot of us.

Erin Welsh: I mean who doesn't? That would be-

Erin Allmann Updyke: Impressive?

Erin Welsh: Amazing, yeah.

Erin Allmann Updyke: And then when that happens, many of us might perhaps on weekends when our schedule permits it, sleep in later, go to bed later, stay up later. So we have this shift in what our schedule looks like between weekdays and weekends. And it turns out that different people might feel differently, some of you might be like oh yeah, I do that, and others are like nah dude, 6 am, I'm ready to go. That's because we all have different chronotypes. And a chronotype is like different natural tendencies to either sleep early or sleep late, like early bird, night owl. It's a real thing.

Erin Welsh: Yeah. Which are you?

Erin Allmann Updyke: I'm an early bird.

Erin Welsh: You're an early bird.

Erin Allmann Updyke: Very early bird.

Erin Welsh: Okay so what is the threshold?

Erin Allmann Updyke: Oh what a fun question.

Erin Welsh: Yeah.

Erin Allmann Updyke: I don't know. I don't know.

Erin Welsh: Okay.

Erin Allmann Updyke: I don't know if there's like a specific thing.

Erin Welsh: Can you be neither?

Erin Allmann Updyke

Yes.

Erin Welsh

Or can you be like a light early bird?

Erin Allmann Updyke

You can be neither.

Erin Welsh

Okay.

Erin Allmann Updyke

You can be whatever you want to be.

Erin Welsh

Okay.

Erin Allmann Updyke

Are you an early bird?

Erin Welsh

I think I'm a mild early bird.

Erin Allmann Updyke

A mild early bird.

Erin Welsh

Yeah.

Erin Allmann Updyke

Like a not too early bird.

Erin Welsh

Yeah, yeah, yeah.

Erin Allmann Updyke

I don't want the first worm.

Erin Welsh

No, I want like the second or third.

Erin Allmann Updyke

The third one would be fine.

Erin Welsh

As long as they're still left at the buffet.

Erin Allmann Updyke

As long as they're not all all gone?

Erin Welsh

Yeah. I love that.

Erin Allmann Updyke

I'm an early.

Erin Welsh

Very early?

Erin Allmann Updyke

Like that first... No, no, probably not.

Erin Welsh

Okay.

Erin Allmann Updyke

Maybe I wish I was that early.

Erin Welsh

Yeah, yeah.

Erin Allmann Updyke

It's too much. But for people especially who veer more night owl, then they might have an especially hard time waking up for that 8am start every day, right. This is especially true for teenagers and that's not just a stereotype. Teenagers actually we see shifts in their intrinsic circadian clocks during the teen years.

Erin Welsh

And like most teenagers, at least in the US, start their days at like before 7.

Erin Allmann Updyke

Right, we force them into it.

Erin Welsh

Which like why do we do that? It's miserable.

Erin Allmann Updyke

It wasn't my idea. And so this system of forcing these early wakings on some days and then maybe seeing a shift in what your patterns are like on the weekends, it can end up causing chronic sleep deprivation. And so that's what we see in this phenomenon of social jet lag. And that's something that a lot of us have probably experienced to one degree or another. But we also then have even more severe or persistent disruptions in our circadian cycle that can result from a more chronic forced mismatch between our environmental cues and our intrinsic clocks. And this is what we can see in shift work. So across the globe, it's estimated that anywhere between 10%-30% of all adults in industrialized countries, which is a lot-

Erin Welsh

That's a lot.

Erin Allmann Updyke

Work in shift work. And often if you work in shift work, then you might end up working outside of a traditional 8-5 of like a regular old job. And that might mean you're working night shifts. And night shifts of course are going to require a complete flip of your circadian cycle where you have to adapt to working entirely during the dark hours and being asleep during the light hours, right. But it might not just be night shift. It can also mean rotating shifts.

Erin Welsh

Right, right.

Erin Allmann Updyke

It can mean late afternoon shifts that bleed into nighttime or it can mean early, early morning shifts that require you to start your day before the dawn.

Erin Welsh

My mom was an afternoon night shift worker, or afternoon worker as a nurse but she loved it because she would just lay out at the pool until 3 pm.

Erin Allmann Updyke

Oh my god, that's hilarious.

Erin Welsh

That's what she said. She was like I loved it and then I would go home and have a drink at the bar.

Erin Allmann Updyke

Well maybe is she a night owl?

Erin Welsh

Not anymore.

Erin Allmann Updyke

Maybe she was.

Erin Welsh

Maybe at 30, yeah.

Erin Allmann Updyke

Because that would track.

Erin Welsh

Yeah.

Erin Allmann Updyke

But so all of these and any of these scenarios can serve to end up disrupting our circadian clock because they're disrupting the typical timing of our light-dark exposure.

Erin Welsh

Right.

Erin Allmann Updyke

In a lot of cases it might be exposing our eyes and thus our brains to light essentially 24 hours a day. And while sometimes people can adjust the timing of when they're asleep and when they're awake, like maybe they sleep just fine during the day, they like sleeping in late and then laying out in the sun or whatever. What we do see is that the vast majority of shift workers do not show a complete shift in all of their circadian rhythms. Meaning things like their melatonin secretion, as an example, will still happen at nighttime and in some cases can be up to 12 hours out of phase from when they're actually sleeping.

Erin Welsh

Wow, okay.

Erin Allmann Updyke

Right?

Erin Welsh

Yeah.

Erin Allmann Updyke

There was one paper I read that estimated that only about 25% of people who work night shift long term actually show evidence of having a lot of these circadian rhythms actually being shifted in line with their real life.

Erin Welsh

Wow.

Erin Allmann Updyke

Right? It's a pretty low percentage.

Erin Welsh

Okay. And this is like continuous night shift work, not like rotating shift work.

Erin Allmann Updyke

Right.

Erin Welsh

Or like two weeks on, two weeks off.

Erin Allmann Updyke

Exactly.

Erin Welsh

Okay.

Erin Allmann Updyke

This was in people who were like night shift for the long term.

Erin Welsh

Yeah, yeah.

Erin Allmann Updyke

And so this can unsurprisingly result in what's called shift work disorder which is a disorder that can be characterized by things like insomnia, which is difficulty falling asleep or staying asleep, or it might be excessive sleepiness, like falling asleep when you shouldn't be at work or micro napping. But it can also lead to increased irritability, it can lead to mood changes like depression or anxiety, and it overall can lead to this mental fog that can lead to increases in mistakes because of all of this fatigue and sleepiness. So some studies suggest that working during the night alone increases the risk of workplace accidents by 40%-100%.

Erin Welsh: Whoa.

Erin Allmann Updyke: Which is huge. It's a huge range also.

Erin Welsh: Yeah.

Erin Allmann Updyke: But it's also huge, like very significant. And shift work disorder alone is not that uncommon. Some papers estimate up to 27% of shift workers meet the formal definition of shift work disorder.

Erin Welsh: Okay.

Erin Allmann Updyke: But on a practical level, everyone who has worked shift work has probably experienced to one degree or another the negative effects of this circadian disruption.

Erin Welsh: Yeah.

Erin Allmann Updyke: But again, it's not just fatigue and sleepiness at work or outside of work. Because especially what we see with time spent working night shifts having really significant impacts on long-term health. Shift workers are at about a 20%-35% increased risk of breast cancer, prostate cancer, colorectal cancers, but also type 2 diabetes, coronary artery disease, and depression, and many other chronic health conditions as well.

Erin Welsh: Erin, but like what is the mechanism for that? Like why?

Erin Allmann Updyke: Yeah.

Erin Welsh: What do we know about that?

Erin Allmann Updyke: We don't know everything. Which is a classic one.

Erin Welsh: Yeah.

Erin Allmann Updyke: And I will say that there has in the literature been some like pushback as to like how causal is this relationship? Because a lot of these disorders also have a lot of other lifestyle factors that influence them as well.

Erin Welsh: Okay.

Erin Allmann Updyke: And so sometimes you might see difference in lifestyle between people who work shift work or night shift work specifically compared to day shift workers and things like that. But the evidence especially for cancers in animal studies is so significant that circadian rhythm disruption in animal studies leads to cancer formation, tumor growth. And it is such overwhelming evidence that the International Agency for Research on Cancer named night shift work a probable carcinogen all the way back in 2007.

Erin Welsh: Wow, okay.

Erin Allmann Updyke: This is isn't new information.

Erin Welsh

No.

Erin Allmann Updyke

But then if we dig even deeper on like what is the mechanisms, we know that our circadian rhythms are affecting so much of our overall body functions and what we see is that dyssynchrony of our sleep-wake cycles and our endogenous circadian rhythms ends up leading to things like increases in blood pressure, reduced insulin sensitivity, elevated lipid concentrations. And so all of these might put us at risk for things like diabetes, hypertension, cardiovascular disease.

Erin Welsh

Right.

Erin Allmann Updyke

There's also some evidence between like timing of and amount of melatonin secretion and the effects on oncogenesis or cancer formation.

Erin Welsh

That's interesting.

Erin Allmann Updyke

Exactly. So at like a basic level, what it's thought to be is that all of these increases in risk are a result of the fact that so many of us working night shifts, our endogenous circadian rhythms do not adapt to this forced pattern of being awake at night and being asleep during the day. So it's a mismatch between our internal cycles and the environment. So that was the best answer I've got.

Erin Welsh

I mean I think that's a pretty good answer.

Erin Allmann Updyke

Decent enough, thank you.

Erin Welsh

A lot of moving parts.

Erin Allmann Updyke

It is.

Erin Welsh

Yeah.

Erin Allmann Updyke

And probably a lot of specific mechanisms that go into each of the different disorders and things like that.

Erin Welsh

Right.

Erin Allmann Updyke

But on the whole, I think I've convinced you all that it's abundantly clear that our circadian rhythms are very, very integral not just in our sleeping and our weakness and our alertness or fatigue but also in so much of our health. So circadian rhythms are an important thing to consider in the context of a lot of our stages of life, a lot of our professions. So I have a question for you, Erin.

Erin Welsh

Ask, go ahead.

Erin Allmann Updyke

If this thing, these things, these circadian rhythms that seem today to be it's so easy for us to disrupt them, to get them messed up.

Erin Welsh

Oh yeah.

Erin Allmann Updyke

You just hop on a plane, just change your clocks back.

Erin Welsh

Just go into a grocery store at night.

Erin Allmann Updyke

Right. If it's so easy for them to get disrupted and when they get disrupted they can cause so much trouble, why do we have them? What do they do for us as humans or creatures?

Erin Welsh

Yeah.

Erin Allmann Updyke

And how did we know all of this? Tell me everything.

Erin Welsh

Okay, I'll tell you as much as I can tell you.

Erin Allmann Updyke

Okay.

Erin Welsh

Maybe not everything.

TPWKY

(transition theme)

Erin Welsh

Wherever you are, whether you're here in this room in Perth, Australia at this conference or you're tuning in from across the world, I want you to imagine yourself as a dot on the globe; as a pin on the map. I've marked Perth here. Now let's rewind time, let's say 200 million years or so, keeping that pin in its original coordinates. And I want you to picture a time lapse of the continents shifting, colliding, separating; oceans expanding and shrinking, mountains forming and crumbling. What is your pin witnessing in all of this? Has it mostly been adrift in a vast ocean? Or has it been at the center of continental action, witness to collisions and separations? Or maybe your pin has seen it all.

As our time lapse comes to an end eventually and the continents have settled into their familiar positions, let's take a minute to marvel at the incredible dynamic changes that our planet has seen over those 200 million years, which is just a fraction of the Earth's 4.5 billion year existence. Grasslands turned to deserts, rainforests turned to freshwater lakes, and temperature, rainfall, and atmospheric composition shifting tremendously over these millennia. Life on Earth has had to deal with a lot of change, even just over those 200 million years. But throughout those transformations, there has remained one near constant. The sun always rises and the sun always sets.

Erin Allmann Updyke

I love that. It's so profound.

Erin Welsh

And while the time between sunrise and sunset varies across latitudes and seasons, the existence of a day has always been a feature of life on Earth. So let's go back to your pin in the map, the 200 million years ago. The day you'd experience, outside of like having to fight and hide from dinosaurs, is nearly identical to the one that you'll experience today. Just about an hour shorter thanks to the Earth's gradual slowdown. In a world filled with so much uncertainty, it can be reassuring to have that one constant. And this sentiment is shared across much of life on Earth. Most organisms have evolved to anticipate these daily changes. Plants, animals, fungi, algae, even cyanobacteria all possess internal clocks that control the timing of biological, physiological, and behavioral responses.

Erin Allmann Updyke

I love that we see it even in bacteria.

Erin Welsh

I know. Me too.

Erin Allmann Updyke

Like it's unbelievably fascinating.

Erin Welsh

It's so cool. I also love that someone looked for that.

Erin Allmann Updyke

Right? They're like we've gotta find it here. It's not just us.

Erin Welsh

It's not just us. It's everyone. Or is it?

Erin Allmann Updyke

Is it?

Erin Welsh

That I don't know. Rhetorical question. But these behavioral responses or these biological responses, things like sleep, like the release of certain hormones or like feeding that occurs at certain times of day or night. And we call these rhythms that are these responses that repeat over a roughly 24 hour period of course are circadian rhythms. The ubiquity of these rhythms across all or almost all of life, I guess I don't know what's going on in like the worms that live in the deep sea vents, whether they have circadian rhythms-

Erin Allmann Updyke

Oh yes, they always mess things up.

Erin Welsh

I don't know. They could have.

Erin Allmann Updyke

They probably still do somehow.

Erin Welsh

They could have something, yeah.

Erin Allmann Updyke

We'll find out.

Erin Welsh

Yeah, we'll look into it. But it just speaks to how important these rhythms are. But why? Why would it be so crucial to partition our activity or our physiology across a 24 hour period?

Erin Allmann Updyke

That's my question.

Erin Welsh

Why does it matter?

Erin Allmann Updyke

Yeah.

Erin Welsh

In a word, optimization. Our external environment changes in many ways every day. Food availability, predator activity, temperature, when other members of your species are also out and about. You want to spend your energy where it counts. If you're a bird who relies on color vision for foraging for berries, you probably want to do that during the day when the light actually helps you pick out those colorful berries.

Erin Allmann Updyke

Right. And see them.

Erin Welsh

You can actually see them.

Erin Allmann Updyke

It helps.

Erin Welsh
But if you're a small prey mammal species like this flying squirrel, maybe running around at night is your best bet to escape predators or flying around. You also don't want to be active all the time, that would be exhausting. Our sleep is incredibly important for housekeeping tasks that our body can't do while we're running around. And circadian rhythms help us optimize how we spend our energy and when it's safe to get the rest that we need to recuperate. Anyone who has pulled an all-nighter or who has had to run on a few stolen hours of sleep after welcoming a newborn knows the pain of being out of sync with the world. But for the most part we can easily recover from these one-time or short term disruptions. But what happens when there is a constant mismatch between your internal clock and the external environment?

Erin Allmann Updyke
Not great.

Erin Welsh
Well we know from what you just told us, Erin, that it's really not great.

Erin Allmann Updyke
Not great.

Erin Welsh
Not good for humans at the least, not good for most if not all of the animals we've studied.

Erin Allmann Updyke
Yeah.

Erin Welsh
And decades of research have shown that it's not great for really anything. So let's take a minute to get into the story of how we came to understand these rhythms of our lives and the consequences of their disruption. Humans have recognized circadian rhythms in ourselves and other creatures for millennia. Aristotle in the 4th century BCE noted that bees slept.

Erin Allmann Updyke
Wow. Bees.

Erin Welsh
Bees slept. How cute is that?

Erin Allmann Updyke
In the 4th century BCE.

Erin Welsh
4th century BCE.

Erin Allmann Updyke
I love that. They're just cutting open hives, being like oh, that one's asleep.

Erin Welsh
Oh yeah, I'm sure, yeah.

Erin Allmann Updyke
Sorry for disturbing you.

Erin Welsh
Tucked up like this. It's very cute.

Erin Allmann Updyke
Aw, so cute.

Erin Welsh
And around the same time, Androstheneas observed the leaves of the tamarind tree curling and uncurling over a day. The famous Ancient Greek and Roman physicians Hippocrates and Galen described fevers that peaked at certain times of day. What do we think that might be?

Erin Allmann Updyke
I love this. It's malaria.

Erin Welsh
It's malaria.

Erin Allmann Updyke

It's my favorite.

Erin Welsh

It's probably malaria, yeah. And one of the leading hypotheses for why these cyclic fevers exist is that the parasites match the circadian rhythm of their host or their mosquito vector for more likely transmission.

Erin Allmann Updyke

Right.

Erin Welsh

Like do they go into the bloodstream at certain times of day, so that that's when the mosquitoes are biting? It's really fascinating.

Erin Allmann Updyke

That's the part that's my favorite, not malaria, it's horrible.

Erin Welsh

Yeah.

Erin Allmann Updyke

But the stuff that they know and the parasites are like going to be active at certain times to maximize transmission-

Erin Welsh

I know.

Erin Allmann Updyke

That's mind blowing.

Erin Welsh

Evolution, man. It's pretty cool.

Erin Allmann Updyke

Really.

Erin Welsh

But for centuries all of these observations remained just that, observations. No one attempted to answer the question of why until the 1720s when a French scientist by the name of de Mairan decided to take a closer look at a plant, specifically *Mimosa pudica*, which also goes by the adorable common name of sensitive plant.

Erin Allmann Updyke

Or shy plant.

Erin Welsh

Or shy plant.

Erin Allmann Updyke

That's what I used to call it.

Erin Welsh

And anyone who has interacted with this plant can see where it got its nickname. When you touch its delicate leaves, they fold in on themselves like ah, don't touch me! And then a few minutes later they'll open back up, they calm back down. But it turns out that the plants also do this folding and unfolding routine throughout the day, folding up at night. De Mairan, observing this, thought to himself what if? The two words at the heart of every scientist. What if they aren't exposed to light? Then what happens?

Erin Allmann Updyke

Yeah.

Erin Welsh

And so he plopped the plant into a dark cupboard and saw that it still opened and closed its leaves over that 24 hour period.

Erin Allmann Updyke

Wow.

Erin Welsh

Even in complete darkness.

Erin Allmann Updyke

Wow.

Erin Welsh

And so if light wasn't driving this pattern, what was? In 1832, about 100 years after de Mairan's experiments, Swiss botanist Augustin de Candolle took this question further, placing Mimosa plants under continuous light. Initially the plants still showed their daily leaf movements but as the days went on, de Candolle watched as this pattern grew out of sync with day and night. Something internal, like an internal clock perhaps, seemed to be driving these movements, governed by a cycle slightly shorter than a day, around 22 hours compared to 24. De Candolle's experiment was the first to demonstrate the concept of a free running rhythm where an organism's internal clock is slightly longer or shorter than a full 24 hour day and in the absence of external cues, their rhythms will eventually decouple from that 24 hour cycle and instead be guided by their internal ones. Humans for instance, 24 and-

Erin Allmann Updyke

10?

Erin Welsh

24 hours and 9-11 minutes.

Erin Allmann Updyke

9-11 minutes.

Erin Welsh

But as it often goes, de Candolle's conclusion that organisms are guided by an internal clock, as opposed to responding solely due to external stimuli, was not immediately embraced.

Erin Allmann Updyke

Shock.

Erin Welsh

Imagine that.

Erin Allmann Updyke

We learned something new and not everyone believes you.

Erin Welsh

The debate on whether these daily patterns were directed by internal or external forces continued basically up to the middle of the 20th century, coinciding with the peak of the nature vs nurture debate. But while nature vs nurture seemed to be only increasing in contentiousness, research on rats, plants, birds, bees, even humans demonstrated clear evidence for an internal clock. Cut off from external cues, mice and rats kept running on their wheel or sleeping right on schedule. Chickens who had been incubated at constant conditions still hatched with an innate biological rhythm. Bees demonstrated a keen sense of time and an ability to communicate that time. Bees are just an amazing example of circadian rhythms.

Erin Allmann Updyke

They're so cute.

Erin Welsh

Yeah.

Erin Allmann Updyke

And their flower timing. They're really good at it.

Erin Welsh

I know! You have to like have a little schedule calendar-

Erin Allmann Updyke

Yeah!

Erin Welsh: For oh, I need to this flower then because that's when it's producing nectar.

Erin Allmann Updyke: Right. They have it all in a little notebook.

Erin Welsh: I just imagine getting there a little early and they're like oh my gosh.

Erin Allmann Updyke: Ugh, I have to wait.

Erin Welsh: The wait. Where's the nectar?

Erin Allmann Updyke: Yeah.

Erin Welsh: Got places to be.

Erin Allmann Updyke: Next one opens in five!

Erin Welsh: And humans turned out to be no exception to this as a series of cave, arctic, and underground bunker experiments demonstrated. The first of these took place in 1938 when physiologist Nathaniel Kleitman called his graduate student, Bruce Richardson, into his office one day. At least this is how I'm imagining how it went.

Erin Allmann Updyke: Yeah.

Erin Welsh: And said hey, Bruce, can I interest you in an all expenses paid 32 day trip to Mammoth Cave, Kentucky, where we'll hang out in a cavern and try to adjust our bodies to a 28 hour day? The nearby hotel will take care of our gourmet meals, you can bring whatever books you'd like, I've got a deck of cards to play Bridge. It'll be great.

Erin Allmann Updyke: One deck of cards, 32 days.

Erin Welsh: Yeah.

Erin Allmann Updyke: Cool.

Erin Welsh: Well that's all you need really.

Erin Allmann Updyke: Yeah, really.

Erin Welsh: But Bridge? Just Bridge?

Erin Allmann Updyke: I don't even know how to play Bridge.

Erin Welsh: Me neither. Two conditions though, you've got to record your sleep movements and your temperature at regular intervals. Richardson said yes, I mean who wouldn't? Like I would do this, that sounds fun. I tried to do it-

Erin Allmann Updyke: That's also his advisor. He's like well I can't say no.

Erin Welsh: That's true.

Erin Allmann Updyke

Yeah.

Erin Welsh

I tried to do it with ticks. Do you remember this?

Erin Allmann Updyke

Nope.

Erin Welsh

I was sampling in Panama and I tried to measure to see if there was like a diurnal pattern of tick abundance.

Erin Allmann Updyke

Ooh, I do remember that.

Erin Welsh

And then the rainy season started at like 3 am and I got rained out and I had to leave.

Erin Allmann Updyke

Yeah. And this is over.

Erin Welsh

Yeah, it was exhausting.

Erin Allmann Updyke

New experiment.

Erin Welsh

Yeah, I never did it again though. Oh well, opportunities for the future. But while the scientific conclusions drawn from this n^2 experiment, just Kleitman and Richardson, they were a little vague, right. Richardson apparently readjusted to 28 hours but Kleitman did not. It made quite an impact on the budding field of chronobiology, drawing the attention of journalists who sketched the story of scientific adventure, as well as researchers who wanted to try it for themselves. Like Michel Siffre, who spent two months in a cave in the Italian Alps in 1962, waking and sleeping when he felt like it. Ultimately when he emerged, he was shocked to find that he had lost two weeks. He thought it'll be exactly where I think but no.

Erin Allmann Updyke

No.

Erin Welsh

He lost two weeks.

Erin Allmann Updyke

Because he's too long.

Erin Welsh

And this work helped to incite interest into the study of circadian rhythms. And by the early 1960s, the field of chronobiology was born with one of its leaders, Franz Halberg, introducing the term circadian rhythm in 1959.

Erin Allmann Updyke

I love that.

Erin Welsh

It seems so recent.

Erin Allmann Updyke

Recent? I know.

Erin Welsh

Yeah.

Erin Allmann Updyke

It is.

Erin Welsh

I mean internal clock I think was at least from the 1800s.

Erin Allmann Updyke

So just the term circadian rhythm.

Erin Welsh

Circadian rhythm, recent.

Erin Allmann Updyke

Okay.

Erin Welsh

And since then, researchers examined the process of entrainment which you described. And I was thinking about zeitgebers, again apologies for the pronunciation, as kind of like right now how you're giving a talk and you think oh, I'm right on time, I'm doing great, and then someone at the back holds up like a five minute warning. And you're like what?

Erin Allmann Updyke

Whoops.

Erin Welsh

I'm only halfway through my presentation, I feel like that sign is a zeitgeber.

Erin Allmann Updyke

Yeah. That's a good analogy. I like it.

Erin Welsh

Researchers have examined the mechanistic basis of how these external signals are received by the hypothalamus, eyes, pineal gland, or by some other means. They've attempted to decipher the genetic basis of biological clocks, identifying clock genes and observing how these genes synchronize across our body to orchestrate broad physiological and behavioral changes during a 20 hour period. They've done a lot.

Erin Allmann Updyke

Yeah.

Erin Welsh

A lot. And this research has been integral to understanding what drives the rhythms of our life, why they're important, and what happens when they're disrupted. Which brings me to shift work. Shift work has been around forever. Or at least for thousands of years. Standing guard, keeping the fire lit, watching over your flock of sheep, caring for the sick or wounded. The military and certain trades have long required irregular hours like shipbuilders who had to work with the tides or rope makers. I found a quote by a rope maker from 1742. "We cannot make ropes when the sun shines. We begin at 8 o'clock at night and work til 8 in the morning and sometimes we work all day if we can hold it." I don't know why.

Erin Allmann Updyke

Yeah.

Erin Welsh

I tried to look into it and I even asked like Bluesky and I got varied answers and some fun hypotheses. But if anyone knows or has an idea-

Erin Allmann Updyke

Why they have to work at night.

Erin Welsh

Please reach out, come find me. But until the late 1800s, shift work was a fairly uncommon occurrence. Then let there be light, specifically electric light. In 1892, just three years after the invention of the light bulb, the first power plant in New York opened, supplying continuous power to those who could receive it. The effect on industry was immediate. Factories that had to shutter their doors shortly after the sunset or who used lanterns or gas lights for overnight work could now operate around the clock, bathed in the glow of artificial light. For the heads of industry, the benefits of a round the clock operation were clear. Again, the word optimization comes to mind. Factories could be more efficient while maximizing production and a 24 hour workday broken down into shifts became the new norm for many industries, even those that had not previously required continuous labor. Shift work was not just something to give them a leg up but it was becoming necessary to survive the competition. It was apparent that industry was enjoying an economic boom from this increased productivity, but how were workers faring in this brave new well-lit world?

Erin Allmann Updyke

Doing great, I'm sure.

Erin Welsh

Doing wonderful. So interest in this question grew in earnest over the first couple of decades of the 20th century. And a new concept termed 'industrial fatigue' was introduced to describe the exhaustion caused by overexertion, too long working hours, and insufficient rest, often measured by a decline in productivity.

Erin Allmann Updyke

It's all about productivity, Erin.

Erin Welsh

Yeah. I mean so under this framework, human health was reimagined as or equated to the body's capacity for productivity. So in other words, if you're sick, that means diminished output. If you're exhausted, that means more mistakes which means diminished output. And this concern with worker health and productivity, especially when it came to industrial fatigue, led to the formation of committees such as the Health of Munition Workers Committee in Great Britain who sought to get a sense of the scope of the problem. One thing became clear. People working on night shift were especially prone to industrial fatigue. So I'm going to read you a quote from a 1918 report by the Health of Munition Workers Committee about night shift.

The objections to night shift may be shortly summarized as follows. Number one, it is uneconomical owing to the higher cost of wages, lighting, and heating. Number two, supervision at night is not always so good as by day owing to less effective lighting or to the employment of fewer or less experienced foremen. Number three, the inferiority of lighting may make work and especially fine work more difficult. Number four, the workers may be unable to obtain adequate sleep by day. This may be the result of the dislocation of the ordinary habits of life or of social causes, e.g. noises and disturbances or the care of children. Workers are tempted to curtail their period of sleep through rising to join the family midday meal or to obtain some recreation and enjoyment. Number five, social intercourse, recreation, and amusement may be seriously interfered with. And number 6, finally, it is not natural to turn the night into day and to deprive the body of the beneficial effects of sunlight. Not natural.

Erin Allmann Updyke

Not natural.

Erin Welsh

Not natural.

Erin Allmann Updyke

They're not wrong.

Erin Welsh

So as far back as 1918, people recognized the harm that night shift work could cause. But the next line in this report reveals the stark reality facing this kind of work. Under existing conditions, night work at any rate for men and women is inevitable. And those existing conditions that are referenced in that happen to be WWI. And then they happened to be WWII. And then night shift work and shift work in general stopped being discussed as something that was an exception to the rule and slowly became the rule, a normal part of many industries, from transportation to hospitality, logistics to entertainment, round the clock work became a fact of life. Many countries introduced pieces of legislature that limited the harsh working conditions, especially like long and irregular hours, that had become so widespread during the late 1800s and early 1900s. But shift work remained a staple of industry, growing in prevalence particularly through the mid-20th century. I can share a couple of old stats here if you'd like.

Erin Allmann Updyke

Yes, please. I love stats.

Erin Welsh

Okay, okay. So these are from a 1981 symposium. In France between 1957-1974, the percent of shift work across the workforce more than doubled from 10.3% to 22%.

Erin Allmann Updyke

Wow.

Erin Welsh

And in some industries that percentage shot up to 50% and over.

Erin Allmann Updyke

Okay.

Erin Welsh

In Great Britain, full-time night work was estimated to increase by 1% every year from the end of WWII to the late 1970s, which 1% doesn't sound like much but it adds up over time.

Erin Allmann Updyke

Every single year? Yeah, wow.

Erin Welsh

Yes, yeah. The bottom line is that over the course of the 20th century, we've got more people than we ever have doing shift work. And accompanying this growth in shift work was heightened interest in its health effects on shift workers, as opposed to solely the effects that it had on accidents, injuries, or lost productivity. Partly driving this change in research interest was the growing field of chronobiology. While researchers were uncovering the physiological basis of the internal clocks that guide circadian rhythms, they were also exploring what could happen if or when those rhythms were disrupted.

Erin Allmann Updyke

On purpose.

Erin Welsh

Intentionally. And as you might expect, this research held great interest to both industry as well as the military. Can a person ever truly adjust and switch from diurnal to nocturnal?

Erin Allmann Updyke

Spoilers, not so much?

Erin Welsh

Not so much.

Erin Allmann Updyke

Not so much.

Erin Welsh

And if so, how long does that switch take?

Erin Allmann Updyke

Right.

Erin Welsh

And how easy is it to reverse it?

Erin Allmann Updyke

Right. Go back to normal.

Erin Welsh

Can you switch?

Erin Allmann Updyke

Yeah.

Erin Welsh

Is it every 2 weeks? Is it every 3 weeks? Is it a month?

Erin Allmann Updyke

Okay.

Erin Welsh

Can it be done? Can it be done? How does shift work alter physiology of different systems in the short term and what are some potential implications for the long term? By the 1980s and the 1990s, some of these long term health effects of shift work were coming into focus. Digestion issues, which had long been recognized to be a part of shift work, cardiovascular disease, cancer, immune system issues, diabetes, mood disorders, and a host of social and lifestyle risk factors emerged as possible consequences of shift work or more generally a disrupted circadian rhythm and poor sleep. We have made great strides in our ability to evaluate the links between shift work, circadian rhythm, and health, from epidemiological, physiological, genetic, psychological, and sociological perspectives, all the perspectives.

We've also a long way towards understanding how we can control those risks in the workplace. Because everyone in this room, everyone listening can attest we've still got some ways to go to put what we've learned into practice for sustained improvement and prevention. We've recognized the negative effects of shift work for over 100 years since it became a feature of our everyday lives and there are some brilliant minds working on innovative solutions to address and reduce the impact of circadian rhythm disruptions at both individual and systemic levels.

And we are so excited to have with us here today one of those brilliant minds, Dr. Ian Dunican. Like Dr. Iliff, the provider of our firsthand account, Dr. Ian Dunican is also originally from Ireland but moved to Perth where he completed his many degrees, including his PhD in sleep and performance which he earned at the University of Western Australia. Dr. Dunican is the director and chief advisor of Melius Consulting, a scientific consultancy undertaking research, consulting, and education, and he also hosts and produces the Sleep 4 Performance podcast. Fellow podcaster. On top of all of that, Dr. Dunican is also an adjunct senior research fellow at the University of Western Australia and is involved in numerous research projects related to sport, shift work, nutrition, safety, death, and psychology. So please join me in welcoming Dr. Dunican. Thanks so much for coming.

Erin Allmann Updyke

We made this meme just for you.

Erin Welsh

Yeah.

Ian Dunican

It's the first time I ever heard my name and brilliant together so we can retract that afterwards at the end.

Erin Welsh

Don't worry, we can cut.

Erin Allmann Updyke

Thank you so much. We're really, really excited to chat with you. We're going to just pepper you with questions. Ready?

Ian Dunican

Fire away.

Erin Allmann Updyke

So like Erin kind of has described already, we've known for a really long time that work that disrupts circadian rhythms can be pretty detrimental to human health. So if we look first from a systems perspective, what measures can organizations or companies take to help reduce the impact of shift work?

Ian Dunican

Yeah, it's a good question. I think it's Really important to take a systematic view. Many companies tend to just chase one thing and go ooh, let's get technology, let's look at rosters. So we always advocate a system view and we have this paper that we published a couple of years ago in Safety and Health at Work, which has 14 elements and it's very holistic. Some of those key elements obviously include things like shifts and rosters; sleep disorders which many people really don't focus on. I know you spoke about sleep apnea earlier on. There's over 70 recognized disorders by the American Academy of Sleep Medicine that we follow here in Australia.

Erin Allmann Updyke

Right.

Erin Welsh

Yeah.

Ian Dunican

But typically many companies just administer a questionnaire like the-

Erin Allmann Updyke

The Epworth.

Ian Dunican

The Epworth Sleepiness Scale. And they think that's an actual sleep disorder program when it's not.

Erin Allmann Updyke

Okay.

Ian Dunican

So we need to look more holistically there. Other components include educating our workforce, and that's not just a few slides and an induction, that's actually spending 2-3 hours, like what you've done here today, in more detail about how to manage shift work at a personal level around sleep patterns, diet, nutrition, commuting to work, if travel's involved as well. So these are just some of the elements that we would take in a system view as well. But another crucial aspect not to be overlooked is actually staffing. Because if we don't have enough people to do the job, we're just going to lead to more overtime, more stress on the individuals, and more rework. And so it's very important at the first level that we have the staffing correct before we start trying to implement the system. And finally on this point, you don't actually have to have a system that stands alone. That system could be integrated in your health, your safety, or other sort of systems there in a business. So it doesn't have to be a standalone or a newly constructed system, it may exist in other ones as well.

Erin Allmann Updyke

Okay. That makes sense.

Erin Welsh

Yeah.

Erin Allmann Updyke

Yeah.

erin welsh

And so maybe you're lucky enough to work at one of these places that does incorporate a more holistic view of sleep and shift work, or maybe you're not, but what can anyone do at an individual level to kind of reduce the negative impacts of shift work?

Ian Dunican

Yeah. I think at the individual level, I think you've done a really good job today highlighting some of the negative impacts. But what a lot of studies haven't done is looked at what is the benefit of some of the interventions or case control studies where people are doing something going forward. The first thing I would say to anybody undertaking shift work is keeping your own physical fitness and mental health in check is number one.

Erin Allmann Updyke

Yeah.

Ian Dunican

So excessive alcohol consumption that we see, excessive nicotine, caffeine use that we see in shift workers, we need to bring that back into normal tolerable levels. When we start increasing our body weight, that's going to lead to things like sleep-related breathing disorders, it's going to lead to more of that generalized fatigue that you defined at the start as well. So it's really important that your own physical fitness and mental health and well-being is in check and in shape. And that's really key I would say for individuals. And also as well when you are away undertaking shift work, whether it's here in Western Australia or elsewhere like in the classic fly in/fly out, is having a routine. And that routine doesn't mean going to the pub every night and having drinks. That routine may involve some exercise, connecting with other people, family and friends back home as well. So it needs to be holistic in nature as well for the individual.

Erin Allmann Updyke

Yeah. Just being healthy, you mean?

Ian Dunican

Yes. Which is difficult when we're working 12-13 hour days.

Erin Allmann Updyke

It is. Yeah.

Ian Dunican

But you gotta make time. And I would say to people as well, don't think about going to the gym as a 1 or 2 hour exercise. Even 15-20 minutes of high intensity exercise can be really good for you.

Erin Allmann Updyke

Yeah.

Erin Welsh

And just having that routine.

Ian Dunican

Yeah.

Erin Allmann Updyke

Right, the routine.

Erin Welsh

Which is such a hard part to maintain but it's so important.

Erin Allmann Updyke

Especially if you're on those rotating shifts or things like that.

Ian Dunican

Yeah.

Erin Welsh

Right.

Erin Allmann Updyke

But that makes a lot of sense.

Erin Welsh

Yeah.

Erin Allmann Updyke

So a hot topic-

Ian Dunican: Yeah.

Erin Allmann Updyke: Hot button topic these days, why we made you this meme, is our screens, especially our personal devices and especially the use of those at night. So I want to ask you what do we actually know about how much these devices are disrupting our sleep or disrupting our circadian rhythms and contributing to things like fatigue? And how much of it is the light or the things that we're doing with our devices?

Ian Dunican: So do you want the scientific answer or do you want the clickbait answer?

Erin Allmann Updyke: I want your answer is what I want.

Ian Dunican: Because I won't give you a clickbait answer. It's really interesting because we did discuss this a few weeks ago. However over the last few days there has been a bill introduced in Australia to ban social media.

Erin Allmann Updyke: What?

Erin Welsh: Whoa.

Ian Dunican: Yeah, so this was passed the other day I believe. I'm not getting into politics, I'm not going, that's as far as I'll go. So if we look at electronic device use and its impact on sleep, there's two ways of looking at this. One is the subjective evidence. How do people report they feel with electronic devices? And two is the objective evidence. What's happening in laboratories with polysomnography, what's happening with actigraphy of wrist-worn devices? The subjective stuff is saying ooh, this is really impacting my sleep. The objective stuff is saying it's not. So the science and the data and the quantitative method actually is showing very little of what's out there. We're currently undertaking a systematic review and a meta-analysis. A few scientists are on there from around the world. Russell Foster, who you may know who actually discovered the SCN, he's on that paper with us as well.

And so what we're finding so far, self-reported stuff, very influenced I think by the media and the general population. I've run two studies in athletes, no impact onto sleep. However there's three mechanisms how electronic devices may be impacting sleep. One is the light emitting from these devices, that could be TV, iPad, social media, it could be anything or gaming. Two, The nature of the stimulating activity. And many of us in this room do this. We get home, put the kids to bed, do our exercise or wherever it might be, and then we go ooh, a bit of me time. I'll put on Netflix, open up my laptop, do some emails, I'll check Instagram as well while I'm having a glass of wine and healthy dark chocolate. And it's all this like stimulation plus alcohol plus caffeine. And then you wonder why you can't sleep.

Erin Welsh: I wonder why.

Ian Dunican: Yeah, I wonder why.

Erin Allmann Updyke: Not a single explanation there.

Erin Welsh: Yeah.

Ian Dunican: And as you've explained in your review earlier on, in the graph, is when cortisol is high, melatonin can't be released. So if we're doing all this stimulating activity, we cannot release melatonin or it delays the time of melatonin. But also it's that artificial light may have that impact as we said. And the final thing is that we're replacing sleep time with other time.

Erin Allmann Updyke: Yeah.

Ian Dunican: Classic example is I'll just watch one more and tonight Yellowstone is out as well. But the bad part about Yellowstone at the moment, which is also good, is there's no one more episode because it comes out weekly. Yeah?

Erin Welsh: That's the trick, that's why streaming services have ruined us.

Erin Allmann Updyke: Right?

Erin Welsh: Yeah.

Ian Dunican: Yeah.

Erin Allmann Updyke: So that's what we can actually blame is Netflix.

Erin Welsh: Yeah.

Erin Allmann Updyke: No?

Ian Dunican: No, we can't blame Netflix. Yeah. It's on Stan here in Australia anyway, so you can blame Netflix but not Stan. That's why I'm wearing my R. M. Williams boots and belt today for Yellowstone. I was gonna wear a hat but my wife said no. I recently bought a nice Akubra. So it's those three mechanisms, the light, the type of activity, and then replacing sleep time.

Erin Allmann Updyke: Yeah.

Ian Dunican: But so far we are not seeing a definitive link. A couple of weeks ago we had the Australasian Sleep Association conference in the Gold Coast and even a massive study looking at body motion cameras with kids, no results, no impact on sleep.

Erin Allmann Updyke: Yeah.

Erin Welsh: Wow.

Erin Allmann Updyke: It's so interesting because all of the like recommendations are still like no screen time, 1 hour, 2 hours before bed.

Erin Welsh: Right.

Ian Dunican: Yeah.

Erin Allmann Updyke: Even like all the sleep organizations still like recommend that blanket statement which is so interesting.

Ian Dunican: Yeah.

Erin Welsh: Right.

Ian Dunican: But it's not definitive.

Erin Allmann Updyke: Right.

Ian Dunican: But what I would say to people is if you're having trouble sleeping, shift work disorder, sleep onset insomnia, trouble winding down, eliminate that activity before bed.

Erin Allmann Updyke: Yeah.

Ian Dunican: Lessen that light. And just basically use that time to basically just wind down and calm down.

Erin Allmann Updyke: Wind down. Yeah.

Ian Dunican: Which probably leads into the recommendations on light.

Erin Allmann Updyke: Yep.

Erin Welsh: Yeah.

Erin Allmann Updyke: Exactly.

Ian Dunican: This is something that we're really seeing now.

Erin Allmann Updyke: Yeah.

Erin Welsh: Yeah.

Erin Allmann Updyke: That makes a lot of sense. That makes a lot of sense.

Erin Welsh: Yeah. And so this may or may not be a question of personal interest, seeing as we just traveled across 9 and 10-

Erin Allmann Updyke: 9 and 10 time zones.

Erin Welsh: Or a million time zones is what it feels like sometimes. But what can we do to minimize or escape the effects of jet lag? Like are there any tips or tricks or are we all just doomed to be sleep deprived and brain fog and groggy when we cross more than a couple of time zones?

Ian Dunican: Yeah, you really are but you can lessen that. You can, yeah, the answer is yes. But you're going to be impacted by jet lag. There's no escaping. There is no biohack. Regardless of who you listen to on a podcast-

Erin Welsh: Yeah.

Ian Dunican: You cannot biohack out of jet lag.

Erin Welsh	Makes sense.
Ian Dunican	And then people go what happened years ago and people came to Australia? They came on a slow moving ship, it took 6 weeks, so they slowly adjusted. But now we have this rapid transmeridian travel which leads to jet lag.
Erin Allmann Updyke	Yeah.
Ian Dunican	So you can do some pre-adaptation like with shift work but a lot of people can't do that because they're trying to work before they go.
Erin Allmann Updyke	Right.
Erin Welsh	Right.
Ian Dunican	And then you've got to really kind of use rapid adaption when you get there. And going east and west will have different effects, like switching from days to nights or nights to days in shift work. And so there's many things you can do. The number one thing I would say is light. Light is key. So for you two here today trying to get over jet lag, this is the worst environment you could be in. Nice and dark, nice and cool, artificial light, no zeitgebers, no time givers. It's a bit like a casino. And that's what they do in a casino, they use all those things against you to keep you in there.
Erin Welsh	Yeah.
Erin Allmann Updyke	So you have no idea what time it is.
Ian Dunican	No idea what's going on.
Erin Allmann Updyke	Yeah.
Ian Dunican	And now at 12 midnight that we are now, we've got no idea what time it is. And so that's what's happening there as well.
Erin Allmann Updyke	That makes sense.
Ian Dunican	But with that, I would say for people trying to overcome jet lag is light and natural light is key.
Erin Allmann Updyke	Okay.
Ian Dunican	So today I would recommend as much natural light as possible.
Erin Allmann Updyke	Okay.
Ian Dunican	That's the number one mechanism you can do.
Erin Allmann Updyke	We need to go outside.

Ian Dunican: So don't get off the plane and go straight to the casino, go outside, get some fresh air and get some movement.

Erin Allmann Updyke: Oh I love it. We have one last question for you. It seems like a very exciting time to be working in these fields in chronobiology and sleep science. What are you most excited about or most hopeful for in the future of this field of research?

Erin Welsh: Yeah.

Ian Dunican: I think some of the most interesting research is coming out of Flinders University in Adelaide at the moment and it's looking at light. Now I'm separating the word light from social media.

Erin Allmann Updyke: Yeah.

Ian Dunican: And I'm looking at the impact of light on our health, like you spoke about, artificial light, people working at nighttime and so on. Sean Cain and Andrew Phillips, Angus Burns, some of those guys there are doing some really interesting work around the long-term impact of light and they're using the UK Biobank data to show the impact on cardiovascular disease, mortality, all of these things as well. And as you said earlier on, in this research space, still lots lots to do but we know that so far that less than 3% of people can fully adapt to permanent night shift.

Erin Welsh: Yep.

Erin Allmann Updyke: Yeah.

Ian Dunican: And that's very, very few people.

Erin Allmann Updyke: Yeah.

Ian Dunican: But most people think they can. So you cannot biohack your way out of this. There is no free ride and you've really displayed that today. So what I would say is that sort of the light and the science is really key going forward. And the final part is I think using individual sleep tracking metrics is really key for the future because we have to individualize this. And we're starting to look at individualizing light as well because people have different sensitivities to light.

Erin Allmann Updyke: Yeah.

Ian Dunican: Some people can be in a brightly lit room and go straight to sleep, other people can't.

Erin Allmann Updyke: Yeah.

Ian Dunican: So looking at more an individual level of sleep and wake patterns and individual light sensitivity as well is the next phase I think we're going to get into.

Erin Allmann Updyke: Okay.

Erin Welsh: That's fascinating.

Erin Allmann Updyke: I can't wait.

Erin Welsh: I know.

Erin Allmann Updyke: Yep.

Erin Welsh: I have a million more questions.

Erin Allmann Updyke: Yeah.

Erin Welsh: But I know that we do have to wrap this up.

Erin Allmann Updyke: Yeah.

Erin Welsh: So thank you so much for sharing your expertise with us today.

Ian Dunican: No problem.

Erin Welsh: That was super fun.

Erin Allmann Updyke: Yeah.

Erin Welsh: Yeah.

Erin Allmann Updyke: We're really excited. If everyone here also got really stoked about this and wants to learn a lot more about circadian rhythms, about shift work, we have a very long list of the sources that we used to put together this episode.

Erin Welsh: There's another page.

Erin Allmann Updyke: There's a lot.

Erin Welsh: Just come and find us.

Erin Allmann Updyke: Yeah.

Erin Welsh: And I've got a ton of sources for this but we always shout out just a couple that we want to specifically highlight. So two in particular. One is a book by Russell Foster and Leon Kreitzman titled 'Circadian Rhythms: A Very Short Introduction' published in 2017. And on the history of shift work side of things, there was a great 1986 paper by Gordon et al titled 'The Prevalence and Health Impact of Shift Work' from the American Journal of Public Health.

Erin Allmann Updyke: And then I also had a number of sources, a couple really great overview papers about circadian rhythm that I loved. One was from The Lancet 2022 by Meyer had all titled 'Circadian Rhythms and Disorders of the Timing of Sleep' and that was part of a four-part series that was also really, really great. And then another one from the New England Journal of Medicine by Allada and Bass in 2021, 'Circadian Mechanisms in Medicine'. But we had a lot. We always post them on our website this thispodcastwillkillyou.com under the EPISODES tab, you'll be able to find this list of all of our sources.

Ian Dunican: Can I plug my book?

Erin Allmann Updyke I was gonna say, please.

Erin Welsh Of course, please. Yeah. And your session, yeah.

Erin Allmann Updyke Yeah.

Ian Dunican I just released a book today for pre-order.

Erin Allmann Updyke Ooh!

Ian Dunican Yeah. And it's called... Thank you very much, it's a ghost writer. And it's called 'A guide for Sleep Health and Shift Work'.

Erin Allmann Updyke Love it.

Erin Welsh Perfect.

Ian Dunican And it's got over 240 references in it and it's designed for people doing shift work, organizing sleep and shift work patterns. It's available for pre-order. It's up on LinkedIn. It's on our website, Melius Consulting.

Erin Allmann Updyke Fantastic.

Ian Dunican Please go over there and do it. And tomorrow we have a fatigue management symposium from 1:30-2:30 and we'll be delving more into this with five speakers in that session.

Erin Allmann Updyke Excellent.

Erin Welsh Amazing.

Erin Allmann Updyke That's gonna be great.

Erin Welsh Yeah. Thank you. Well and a big thank you again to Dr. Iliff and also you, Dr. Dunican, for sharing your experience and expertise with us. We really appreciate it.

Erin Allmann Updyke Yeah. And thank you again to Zach Bentley, Kelly Phypers, David Lowry, and everybody else here at AIOH. I can't say it well.

Erin Welsh I know.

Erin Allmann Updyke And I say the H wrong, I know.

Erin Welsh H.

Erin Allmann Updyke H. No? Thank you everyone for inviting us and for organizing this conference. We're really, really excited to be here.

Erin Welsh

And we've got a couple more of our usual outro episode thank yous, which is thank you to Bloodmobile for providing music for this episode and all of our episodes. Thank you to Lianna Squillace and Tom Breyfogle for their amazing audio mixing. Thank you to everyone at Exactly Right. And a huge thank you to our amazing listeners, including everyone here today.

Erin Allmann Updyke

Yay.

Erin Welsh

Thank you, thank you, thank you. And until next time, wash your hands.

Erin Allmann Updyke

You filthy animals. I've never said that to people in real life. Sorry. I'm so sorry.