Erin Welsh (00:00) [Firsthand account]
“The cold was so intense, one constantly found men who, overcome by the cold, had been forced to drop out and had fallen to the ground, too weak or too numb to stand. Ought one to help them along, which practically meant carrying them? They begged one to let them alone. There were bivouacs all along the road. Ought one to take them to a campfire? Once these poor wretches fell asleep, they were dead. If they resisted the craving for sleep, another passerby would help them along a little farther, thus prolonging their agony for a short while, but not saving them. For in this condition, the drowsiness engendered by cold is irresistibly strong. Sleep comes inevitably, and to sleep is to die. I tried in vain to save a number of these unfortunates. The only words they uttered were to beg me, for the love of God, to go away and let them sleep. To hear them, one would have thought sleep was their salvation. Unhappily, it was a poor wretch's last wish. But at least he ceased to suffer, without pain or agony. Gratitude and even a smile was imprinted on his discolored lips. What I have related about the effects of extreme cold and of this kind of death by freezing is based on what I saw happen to thousands of individuals. The road was covered with their corpses.”

Erin Updyke (01:31)
What Erin is that from?

Erin Welsh (01:35)
~ that is from Napoleon's close advisor Armand de Calcaincourt about the retreat from Moscow. And I'll talk a little bit more about it, but it is. It is horrific, yeah. Words can't adequately describe. ~ yeah. Hi, I'm Erin Welsh. And this is This Podcast Will Kill You.

Erin Updyke (01:44)
~ my gosh. Horrific. Ugh. And I'm Erin Allmann Updyke. Today's very uplifting episode is going to be about hypothermia.

Erin Welsh (02:09)
It is about hypothermia. ~ And it's one of two parts because as we kind of were talking about hypothermia and the effects of cold and we thought, it's unfair to paint cold in just one light as this bad thing and hypothermia. So this is a two parter. Part one is cold is bad and part two is cold can be good. Right?

Erin Updyke (02:23)
Exactly. Yeah.

Mm-hmm.

Are those our titles? Because I love it.

Part one, hypothermia. Cold is bad. Part two, cold is not always bad.

Erin Welsh (02:39)
I think I. Go home is that. Yeah, yeah.

There's nuance even to cold. How about that? I am excited. There's I feel like this is a topic that we have not really. I mean, I guess we've done fever, but it's like so related to infection, whereas this is just like what happens when your body is stretched beyond its physiological limits?

Erin Updyke (02:48)
~ wow!

I know,

and it's interesting because especially like, well at least you live somewhere where you probably are, people are seeing hypothermia more than like where I live. I'm like, how come we didn't choose heat stress as our first temperature, temperature related thing? But I know.

Erin Welsh (03:18)
Well, especially because it is July. We're recording this

quite early. It is July. Like the heat, the heat is so strong. I am in a long sleeve wool sweater with skiers on it. You've got some deer. ~ I can't are they elk? Not sure. ~ On your sweater. They're sweaty. Yeah, we are sweaty sweaters. ~ But it also like reading about hypothermia now and about

Erin Updyke (03:27)
It is.

Mm-hmm. Mm-hmm. Mm-hmm. Also wool.

They're sweaty is what they are.

Erin Welsh (03:47)
cold was kind of like, yeah, there is another temperature besides 91 degrees. Yeah. Yeah.

Erin Updyke (03:54)
Besides heat, yeah, yeah.

Well, we'll get into all of it, but first, it's quarantine-y time.

Erin Welsh (04:02)
But first,

What are we drinking this week?

Erin Updyke (04:06)
The Uncommon Cold.

Erin Welsh (04:10)
I mean, hypothermia is, I'm sure you'll have stats later. It's not that uncommon, but it's... Okay.

Erin Updyke (04:13)
You know, I don't have that many stats, honestly, but it's not that...

it just very much depends on where you live. But... yeah. It's not that uncommon. Yes, definitely.

Erin Welsh (04:19)
Right, right, yeah. It's more uncommon than the common cold. Okay.

And we thought in light of the fact that ~ cold can be bad and good, we're gonna do a cold blended drink, but that also has heated elements as in spicy, yeah. So it's like a habanero margarita blended.

Erin Updyke (04:32)
huh.

spicy to it.

Yeah, blended.

Which is not my favorite kind of margarita, so if you don't want that, don't do that.

Erin Welsh (04:46)
Yeah, you do whatever you want.

Erin Updyke (04:47)
Listen, we'll post the full recipe on our website, thispodcastwakilie.com and all of our social media channels, so make sure you're following us there. Yeah.

Erin Welsh (04:50)
you

Please do, please

do. On our website, thispodcastwillkillyou.com, you can find all sorts of things. You can find transcripts, you can find sources for each and every one of our episodes, links to bookshop.org affiliate account, links to our Goodreads list, links to music by Bloodmobile, links to a Contact Us form, ~ links to a Submit Your First Hand Account form, Patreon, merch, other things. Check it out.

Erin Updyke (05:21)
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Erin Welsh (05:28)
It might be, it might be.

of podcast.

You can't bring myself to say that, but yes, we are. Go to the exactly right YouTube channel and you can subscribe so you never miss an episode. OK.

Erin Updyke (05:38)
I can't not say it that way.

Moving

on, Erin, tell me about the history of hypothermia. What? mean, listen, I'm assuming we've always frozen. Okay, tell me.

Erin Welsh (05:58)
Yeah, that's true. But

we'll get into a little bit more of that right after this break.

Humans have existed, thrived even, on the farthest reaches of the earth for tens of thousands of years. The earliest evidence of humans in the European Arctic, for example, dates back 40,000 years. Yeah, there were, it is a long time, there were mammoth tusks with human-made cuts, sliced wolf bones, stone artifacts, and other animal bones with like clear human...

Erin Updyke (06:21)
Wow, that's a long time.

Erin Welsh (06:33)
you know, manipulation or whatever found above the Arctic Circle. Pretty cool. That means that like only a few thousand years after humans reached Europe, they just kept right on heading north. Why?

Erin Updyke (06:38)
I love it.

~ Okay. Just looking

for something new, I guess. Following the mammoths.

Erin Welsh (06:50)
Basically,

but I feel like if you have spent a winter in or close to the Arctic, it might be like, but why? I have, yeah, it's a natural question to ask. Even if you absolutely love the winter and you long for the days to get shorter so that you can break out your favorite pom-pom wool hat and cozy sweaters, or even if you get to see the Southern or Northern lights in the winter and you love to snowshoe or ski,

Erin Updyke (06:57)
which you have.

Mm-hmm.

Erin Welsh (07:18)
You have to admit that the polar regions are not an easy place to live. And they don't let you forget it. Grabbing the wrong jacket before you step outside, losing a glove, a window that's lost its insulating ability, these things don't go unnoticed, at least not for very long. Whether immediately or eventually, the cold makes itself known.

It insinuates itself into the nooks and crannies of your jacket, of your body, the tips of noses, toes, fingers, and it settles into your bones until you feel like you'll never be warm again.

Erin Updyke (07:56)
That is the exact way that I would describe living in Illinois.

Erin Welsh (08:00)
Will I ever be warm again? Yeah, get it.

Erin Updyke (08:05)
Just so many,

like, ~ so many memories of that feeling of like your bones being so cold, which I know they're not really, but your bones being so cold that you don't, it is impossible to remember warmth. Ugh.

Erin Welsh (08:12)
Mm-hmm.

Yeah.

Right now it's impossible for me to remember cold, even though I'm talking about it. I'm so, so warm. I'll have to try to remember this moment come February. Yeah. But I think that many of us lower latitude dwellers have kind of a sense of awe, at least I do, for those living in the Antarctic and Antarctic regions of the world. Because even with the warmest of jackets and the most insulated of shelters,

Erin Updyke (08:25)
So sweaty.

Yeah, exactly.

Erin Welsh (08:48)
Polar life exists on a knife edge where even the tiniest thing can tip the scales, turning a minor mistake or a minor accident into a fatal outcome. I cruised the Wikipedia page for hypothermia-related deaths, which is quite morbid, I know. ~ And the one thing that really stuck out to me was just how easily it can happen. I went through and I read different people's stories and it was just like, and then...

Erin Updyke (09:04)
gosh. Yeah.

Erin Welsh (09:18)
one wrong step. And that was it. That was it. And how powerless you are when the cold really sets in. And yet, many species call these polar regions their home, not just humans. Why would an animal live in a place that is so brutal, so unforgiving, although not all the time, as we'll see?

Erin Updyke (09:32)
Mm-hmm.

Erin Welsh (09:41)
There are all sorts of reasons. Maybe it's more available habitat, less competition for resources, escape from predators, escape from parasites, a combination, or something else entirely. But for this episode, the why isn't as interesting to me as the how. Like, how can species live at the ends of the Earth? Not just like eking out a meager existence, but flourishing despite the deadly cold.

Humans have innovated incredible clothing, shelter, transportation, and tools to help protect from freezing temperatures. And animals have evolved a vast array of strategies, anatomical, physiological, behavioral, to resist hypothermia and other harmful consequences of cold, like frostbite. Would you like to learn about some of these strategies?

Erin Updyke (10:31)
Erin, I am thrilled, thrilled

to learn about these.

Erin Welsh (10:36)
~ One way is just to avoid it. Just migrate the heck out of there. Birds love this. They're big fans of the migration. And some bats and other things, like big for birds, yeah. And then there's torpor, which includes hibernation and dormancy. So basically an animal just turns down the dials on body temperature, activity, and metabolism to get through the winter. Bears, ground squirrels, bats, some frogs.

Erin Updyke (10:41)
Yeah, birds. Hundo. Yep.

Butterflies.

one of my favorite words.

Erin Welsh (11:05)
And then there's cold resistance. So like you keep operating mostly as normal during the cold months, but you just bump up your resistance, your defense against. And that would be something like Arctic foxes, polar bears, and so on. And these strategies, they're not mutually exclusive. You can have a little bit of this and a little bit of that.

Erin Updyke (11:13)
Your own metabolism. Yeah.

Erin Welsh (11:27)
And there's also great variation within some of these. like hibernating black bears only drop their body temperature by a few degrees Celsius, while some mammals, small mammals drop temperatures 20 to 30 degrees Celsius body temperatures. ~ it gets, it gets better.

Wood frogs. Do you know about wood frogs? Yeah. Who doesn't? But no, lots of people don't. I had to, I had to refresh my memory because the stats are, I was like, this can't be, I was like, I need to fact check this.

Erin Updyke (11:39)
my gosh.

I love it. yeah. yes, I know about wood frogs.

Ha ha ha!

Right.

I love it.

Erin Welsh (11:56)
multiple places. Is this

real? They're the hall of famers for dormancy. They survive freezing temperatures below minus 20 Celsius for months on end, like seven months, by nearly freezing solid. 50 to 65 % of their body water is frozen, is ice, just frozen. Yeah. These are frogs that live above the Arctic circle. What?

Erin Updyke (12:00)
Yeah.

Seven months.

Wow. Ice.

Erin Welsh (12:26)
Like, I just can't get over it. And then you've got the fish that avoid freezing in Antarctic waters by using antifreeze proteins that let them keep swimming around. Other animals like polar bears, ptarmigan, wolves and hares make simple burrows in the snow to help with insulation, which is, It's a bird. Yeah, they're really cute. ~ Yes.

Erin Updyke (12:44)
Question, what's a ptarmigan? Okay, thank you.

Erin Welsh (12:55)
Or sometimes they'll employ bagel formation, which is not the technical term, but I love this. It's like where you make yourself into a tiny ball, like a little ball to trap heat. Yeah, exactly. You just tuck your little nose and you're in bagel formation. Yeah. And then other animals that live in colonies like walruses and penguins, they'll huddle together for warmth, especially baby emperor penguins. Yes.

Erin Updyke (13:01)
Okay.

like the doggies do. Okay.

Bagel formation.

~ yes, they're very cute.

Erin Welsh (13:25)
They're very cute. ~ Thick fur and blubber help to reduce heat loss as do changes in the circulatory system or even the type of hemoglobin that an animal has. So

Erin Updyke (13:36)
Huh?

Erin Welsh (13:37)
Pretty cool. ~ Because of, and then there's like circulatory changes. So because there are these specialized changes in blood flow in paw pads of Arctic wolves and foxes that allows them to stand on the ground that has a temperature of minus 50 Celsius, but their feet don't freeze or become damaged. I don't know. and then nasal cavities. I didn't realize that like,

Erin Updyke (13:38)
Yeah.

What?

Erin Welsh (14:00)

The shape of a nasal cavity could be so important, but it is.

Erin Updyke (14:04)
feel

like I remember learning this at some point. Tell me about it, Erin.

Erin Welsh (14:08)
Okay, okay, so reindeer have nasal cavities that warm the air before it enters the body, and it sort of like warms it, and then there's like water condensation, right? But then instead of losing that heat and water to the environment, they also somehow cool the air before it leaves. And so you're basically conserving heat and water because of the way that their nasal cavities.

Erin Updyke (14:28)
What?

that's fascinating.

Erin Welsh (14:33)
are.

Babies of Arctic animals are born well equipped with extra warm fur or feathers or brown adipose tissue that keeps them super warm. And mom will also often provision them with super fatty milk. One of my go-to fun facts to share at a cocktail party is that some whale milk is so fatty, like 30 to 60 % fat.

Erin Updyke (14:51)
Mm-hmm. Delish.

Erin Welsh (15:02)
that it has the consistency of toothpaste.

Erin Updyke (15:04)
toothpaste

as one of my favorite things too. Just imagine baby whales lapping up toothpaste in the ocean.

Erin Welsh (15:07)
Yeah, I love it.

I mean, I think it also must help with like not just diluting into the environment. Yeah. Yeah. Yeah. But for comparison, human breast milk is like 4 % fat compared to 30 to 60 for some whales. Love it. my. I mean, it's already whipped. It's like solid. Like, what do you do? It's like butter basically. Yeah.

Erin Updyke (15:15)
Exactly. Yeah, it has to be thicker so they can kind of like get it.

Mm-hmm.

Right. It's like, imagine the whipped cream you could make.

Right. Right. It's just butter. Yeah, it's actually just butter.

Erin Welsh (15:40)
Okay, so one last fun fact before I get to humans. One of the major challenges with living in polar regions is food availability. It's not always reliable. And in those times of scarcity, you're not only expending energy trying to find food, you're also using more energy staying warm. And some Arctic species deal with this by cashing food. So like one Arctic fox horde had 136 seabirds and just like in a little pile.

Erin Updyke (16:07)
my, he's like, listen,

they're frozen, they're gonna keep, don't worry about it. I will eat them through the winter.

Erin Welsh (16:11)
Yeah, yeah, this is my chest

freezer. This is my Costco. Yeah. And and an ermine was found to have hidden over 150 lemmings. Just.

Erin Updyke (16:25)
Also, you know, still,

like I know that a lemming is an animal, but I have no idea what they look like. I cannot picture a lemming. I only, do you remember that game? The lemmings going over a cliff? You don't remember this game?

Erin Welsh (16:30)
They're like little rodent-y things.

No, was, it was on what device? Phone? Computer?

Erin Updyke (16:44)
computer, computer, it

was a computer game where there was, I think they were called Lemmings, but they were like little people looking things and they just were going over a cliff and you, ~ no, I'm gonna need to look this up. feel great. feel, yeah.

Erin Welsh (16:53)
Yikes.

Wow, was it

like Ski Free era? You remember that game with the abominable snowman that would come in? Okay, yeah. Okay, okay. Well, we'll have to find it and get some sort of emulator. You just pictured tiny humans just, my God. Yikes, yikes. Yeah, I don't think they look like miniature humans. ~

Erin Updyke (17:02)
I know that game, yes. I don't know if it was same era. I have no idea. Sorry, that was a real tangent. But that's what I think of when I think of lemmings and that's why I can't picture that there's an animal called lemmings. Going over a cliff is what I picture. Okay. With little gnome

hats on. Okay.

Erin Welsh (17:27)
No, I don't believe

that they have constructed gnome hats. IRL. ~ OK, so another besides cashing food and lemmings, not with gnome hats. Another approach is storing extreme amounts of fat. So seal pups undergo something called catastrophic molting, which sounds a lot scarier than it actually is. They just lose all their fur at once and then they have to wait a while to grow back a new layer.

Erin Updyke (17:33)
Okay, moving on.

Erin Welsh (17:57)
And so during that time, they can't go in the water for food because they'll get hypothermia, so they don't eat. They can go 52 days without food or water.

Erin Updyke (18:08)
Wow, that's a really long time.

Erin Welsh (18:10)
Isn't that wild?

It's a really long time. And so my point with all of this, besides being able to share with everyone the whale milk toothpaste fun fact so that you have something to share at like, you know, the next round table icebreaker type thing, Wood Frogs. Oh my God, icebreaker would also have been a good quarantine name anyway. Yeah.

Erin Updyke (18:25)
Yeah, and the Wood Frogs

Wow, it really would have.

Erin Welsh (18:35)
that animals have evolved, my whole point is that animals have evolved an incredible array of ways to deal with the cold. And unfortunately, humans lag behind in this respect. And so under the right set of circumstances, our body struggles to warm itself, our temperature drops, and we slip into hypothermia, which is something that we've been doing for as long as we've been human.

So even though I just spent a good deal of time in the polar regions with polar animals, you can get hypothermia anywhere on Earth. Some of the earliest references to hypothermia

come from ancient Greece, which is certainly not Arctic. Hippocrates, of course, noted the benefits of cold, but also the dangers. Quote, cold is bad for the bones, teeth, nerves, brain, and the spinal cord.

Erin Updyke (19:07)
Mm-hmm.

Mm-mm.

Erin Welsh (19:25)
In 450 BCE, the Greek historian Herodotus wrote about soldiers dying in a sea expedition. Quote, "some were seized by these sea monsters and so perished while others were dashed against the rocks and some of them did not know how to swim and perished for that cause. Others again by reason of cold." End quote. War has always been a bad spot for hypothermia.

Erin Updyke (19:46)
Mm-mm. Sea monsters.

Erin Welsh (19:52)
In fact, most historical records of hypothermia come from various wars throughout history. In 218 BCE, Hannibal's army of 12,000 cavalry, 90,000 infantry, and 40 elephants was cut down to 19,000 men and some uncertain number of elephants during their march over the Alps with many of them dying of cold.

Erin Updyke (20:15)
Hmm.

Erin Welsh (20:17)
During the American Revolutionary War, countless soldiers suffered frostbite and hypothermia, especially during the winter of 1777, 1778, when nearly a fifth of the 11,000 men who retreated into Valley Forge did not have shoes or boots at all. Just imagine that in the winter, yeah.

Erin Updyke (20:35)
no,

I can't imagine that.

Erin Welsh (20:39)
And then there's Napoleon's army, this retreat from Moscow in 1812. he this is like where this is infamous. And we've talked about this in several other times of the podcast. Napoleon and his army started out in June with nearly half a million soldiers. By the time they had gotten to Moscow in late fall, numbers had dwindled pretty substantially by at least 10000.

But when they arrived, they found a burned out abandoned city. No opportunity to restock, to refuel, no food, nothing. The Russian forces had adopted this like scorched earth tactic and that would prove to be Napoleon's downfall. So he waited around a bit just trying to figure out, well, here, what do I do here? Do we stay? Do we go? And then was like, you know what? We should just get back to France. So a retreat to France, that was the move. The army started back in October.

still dressed in their summer uniforms. And they pushed through the snow and ice and frozen rivers in November through December and even into January. Count Philippe Paul de Ségur, a brigadier and aide to Napoleon wrote, quote, "Russian winter in this new guise attacked them on all sides. It cut through their thin uniforms and worn shoes, their wet clothing froze on them.

and this icy shroud molded their bodies and stiffened their limbs. The sharp wind made them gasp for breath and froze the moisture from their mouths and nostrils into icicles on their beards." quote. By the time they got back to France, all that remained of Napoleon's 500,000 troops was 10,000.

Erin Updyke (22:21)
my gosh.

Erin Welsh (22:23)
Yeah. Some died in battle, others from their injuries or infections. If you remember back to our typhus episode, that was a major, major killer, but many succumbed to the cold. frost-bitten and constantly waterlogged foot turned gangrenous with the infection spreading to the rest of the body.

Erin Updyke (22:30)
Mm-hmm.

Erin Welsh (22:44)
A raid on a liquor store allegedly killed 800 soldiers who imbibed a bit too much and fell asleep in the snow. At the time, was thought that alcohol was warming and helped stave off the negative effects of the cold, although I'm not sure they were drinking it as medicine. And by the way, it is not warming. It is not what you should use to treat someone suffering from hypothermia.

Erin Updyke (22:51)
Mm.

No, alcohol

actually can, there's actually thought that not just the like the risk of, know, drowsiness or falling asleep or, you know, making decisions about what clothes you might wear that are impaired because of the effects of alcohol. There's actually thought that the alcohol, the effects of alcohol itself also contribute to hypothermia. So exactly, yeah.

Erin Welsh (23:14)
Right.

Yeah, more heat loss. Yeah,

yeah, yeah. And then there was also just poor nutrition and grueling conditions that took many others just after they drifted off to sleep. One of Napoleon's surgeons wrote, quote, "the first hours of sleep offered deceptive delight, precursor to the grave that yawned for them. Far from finding safety in the sweets of sleep, they were seized and benumbed by cold and never saw daylight more.

Along the road in the neighboring ditches of fields were perceived human carcasses heaped up and lying at random in fives, then fifteens and twenties of such as had perished during the night." quote. No one was spared, not even the surgeons who wrote how their brains had become so dulled by the cold that they could barely recognize one another. So many died or suffered permanent injuries from the cold on this retreat, not just because of

poor quality clothing and shoes or insufficient food, but also because no one really knew how to treat hypothermia or frostbite. Those words didn't even exist yet. A practical thermometer that could be used clinically was still decades away. Instead, the effects of

cold were kind of grouped together under the term asphyxia, ~ partial asphyxia, usually referring to frostbite, and general asphyxia, referring

to hypothermia. These were diagnosed from like subjective observation. So it was thought that like, basically there was ~ congealing in your body fluids were congealing and blood in starting at the the extremities. Yeah. And then as it grew your whole if you're so that was like frostbite. So you're like, OK, there's no it's all congealed. And then in hypothermia, was like your whole body. It's not that far off.

Erin Updyke (24:51)
Interesting.

Yeah.

huh.

Right at your flick fingertips and nose and then

Yeah, there's no blood flow. Yeah.

Not that off, yeah.

Erin Welsh (25:19)
Yeah, I was going to say it's

yeah. And so but because of this treatment usually took the form of slowly rewarming to get everything to reliquify. And you were supposed to start in reverse. So you start with snow, rubbing snow on your frostbitten fingers and then yeah, and then cold water and then cool water, then tepid water. You get the idea. Go slow. Yeah, earlier physicians had learned their lesson the hard way not to use extreme heat.

Erin Updyke (25:29)
Mm-hmm.

Okay.

Go really slow. Okay, interesting.

Erin Welsh (25:49)
And revival efforts were occasionally successful during Napoleon's retreat, but they often weren't even attempted if someone looked dead. And it wasn't widely known at the time how many of the signs of hypothermia, signs that mimicked death, could be reversed. One of the surgeons later learning of this wrote, how many resurrections might have been made on the retreat from Moscow? Probably lots.

Erin Updyke (26:14)
Yeah.

Erin Welsh (26:16)
And as later medical advancements in the late 19th, but especially the first half of the 20th century revealed, hypothermia did not always carry with it a death sentence, and doctors could more readily measure temperature thresholds beyond which recovery was unlikely. And as the term hypothermia came into more usage in the first decades of the 20th century, and it became a distinct clinical entity,

focused interest in prevention and treatment of the condition increased, especially during World War II. So I don't know when exactly, I tried to find when exactly the phrase, you're not dead until you're warm and dead originated, but it was likely in the last few decades of the 20th century, showing the huge amount of progress made in understanding hypothermia and reversing it. And so before I turn it over to you, Erin, to tell us,

Erin Updyke (26:55)
Mmm, yeah.

Okay.

Mm-hmm.

Erin Welsh (27:09)
what exactly is happening when our body temperature drops to dangerous levels and what we do about it. I want to end with one of the most amazing hypothermia revival stories that shows just how far we've come. Like Napoleon's surgeon's minds would have been absolutely blown by learning of this story. Okay. In 1999, a 29 year old Swedish woman named Anna,

Erin Updyke (27:21)

I love it.

huh.

Erin Welsh (27:33)
moved to a small town in northern Norway in the Arctic Circle to complete her medical residency or above the Arctic Circle. And part of the reason that she chose this location was because she was an avid and very experienced backcountry skier. In May, she and a couple of friends who also had medical training went out skiing for the day. At 6.20 p.m., Anna or Anna maybe lost her balance and fell head first into a waterfall gully.

where she became wedged in the ice and glacial water. Her friends couldn't get her out. They tried to pull her out and they couldn't get to her. And so they called for help. And unfortunately, help was slow to arrive. The only rescue helicopter available was on its way to transport a sick child, which was in the other direction from Anna. At 7 p.m., she stopped moving. It was 40 minutes in the ice. At 7.40, a ground rescue team arrived and extracted her from the ice.

She was clinically dead. The helicopter arrived around 8 p.m. and she was loaded onto it for transport to Tromso Hospital, which is about an hour's flight away. And with the adage, you're not dead until you're warm and dead in mind, resuscitation efforts were started in transit and continued along with rewarming at the hospital. When she got there, doctors found that she was not breathing.

She had no pulse. Her pupils were widely dilated and unresponsive to light. Her EEG was flatlined. Nurses and doctors continued their chest compressions and ventilation as they prepped to put her on a heart-lung machine. At 9.52 PM, so this is three and a half hours after she went into the ice, her temperature, her body temperature, was measured at 13.7 degrees Celsius or 56.6 degrees Fahrenheit.

Erin Updyke (29:24)
Wow.

Erin Welsh (29:24)
At

that point, yeah, she'd been three hours without a heartbeat. But then, I guess I kind of spoiled it at the beginning by saying revival story, but I mean, you know where this is going.

But then at 10, 15 p.m., something on the monitor, a heartbeat, then another, then a steady rhythm. She woke up 10 days later and spent another couple of weeks in the intensive care unit.

Erin Updyke (29:29)
Mm-hmm.

Okay, yes, uh-huh.

Erin Welsh (29:52)
And initially she showed signs of paralysis below the neck and struggled with various organ dysfunctions. But over time she made an almost complete recovery. After five months, she was like basically back to normal, back to skiing. It's an amazing story that shows what both the human body and modern medicine are capable of. And that being said,

Every year, many people, especially those who are unhoused or struggle to keep their homes warm in the winter who can't afford to do so, die of hypothermia. And most of these deaths are, they represent a failure, not of modern medicine, but of our society in providing a safety net to prevent death in this way. Because like stories like Anna's show us, it is possible.

And it can sometimes be reversed, but in a lot of these cases, it should never have happened in the first place. Yeah, so. But now, Erin, I'll turn it over to you to tell me more about how we deal with hypothermia today.

Erin Updyke (30:48)
100%. 100%.

I would love to. That's

you mentioned at the top, Erin, the last time that we talked about human body temperature was in relation to fevers. And we learned in that episode, and maybe everyone forgot, and that's fine, I'm gonna tell you again, but we learned that a fever is what happens when our temperature set point gets moved, right? Our brain, specifically our hypothalamus,

Erin Welsh (31:07)
Mm-hmm.

Erin Updyke (31:26)
controls our temperature set point. And so a fever is what happens when our hypothalamus is like, mm, mm, we need to get hotter, right? But most of the time, outside of a fever, we as humans seek to exist at about 37 degrees Celsius, 96 or so Fahrenheit, right? And that particular temperature is what our body is constantly

Erin Welsh (31:45)
Mm-hmm.

Erin Updyke (31:55)
maintaining. And because we are endotherms, like all mammals, we maintain this temperature by physiologic mechanisms within our own body, right? We don't rely on the sun or our environment to warm us or cool us. ~ And I, and all of this, like all of these processes are basically coordinated in our brain by our hypothalamus because this is controlling our temperature set point. So hypothermia is

Erin Welsh (31:59)
Mm-hmm. Mm-hmm.

Mm-hmm.

Erin Updyke (32:23)
like the easiest way to look at it is just that this is what happens when we can no longer do that. When all of the mechanisms that we have to keep our bodies warm and at the right temperature fail us. And that happens mostly when the environment is either just way too cold or it's just a little cold, but for way too long.

for us to generate enough heat via our metabolism and all the things going on inside of our bodies. Okay? And the external trappings that we use, of course, as humans. So we can pretty well maintain our body at a constant temperature without our bodies having to work very hard to do it, even if we were totally naked, if we exist between like 25 and 30 Celsius, which is like 77 to 86 Fahrenheit.

Erin Welsh (32:52)
Mm-hmm.

Mm-hmm. Yeah.

Erin Updyke (33:19)
That's our like thermo neutral zone. Once you get above this or below this, our bodies are gonna have to work harder to maintain our temperature. Now that's 77 Fahrenheit, 25 Celsius. That's not cold.

Erin Welsh (33:29)
Mm-hmm.

No, it's quite warm in fact. Yeah.

Erin Updyke (33:36)
is quite warm, but below

around that temperature means that our body is having to do something to generate heat, right? If you were totally naked, but we're gonna put clothes on too. So that's another thing, behavioral adaptations. So what I wanna talk about is less about the behavioral adaptations, because those are obviously important, but I'm really gonna focus on our bodies. How do we typically deal with temperature stressors? What are we doing inside of our body

Erin Welsh (33:49)
If you were totally naked, yeah. Right, right, right. Yeah.

Erin Updyke (34:06)
to generate heat when we're exposed to cold so that then we can understand what happens once those start to fail us. And then next week, we're gonna talk about kind of building off of that story that you told, Erin, and what we know about what cold does to our bodies once it kicks in, and the ways that people have thought to maybe use this to their advantage to treat various conditions.

Erin Welsh (34:21)
Yeah.

harness one of nature's elements.

Erin Updyke (34:35)
Ooh, that's a good one, Erin.

OK, so

two big body compartments to think about when we think about temperature management. We have our core body, which is our brain and our internal organs. And then we have all the rest of it, or our peripheral body. That's our skin, our subcutaneous tissue, our fat, our limbs. It's not the important stuff, right? When you think about your body existing.

Erin Welsh (34:50)
Mm-hmm.

Okay.

Yeah, I mean you can lose a pinky, but if your heart freezes, the devastation, yeah. Yeah.

Erin Updyke (35:07)
You're done. Right, exactly. And so, and our

body knows this, and our hypothalamus knows this. And so, because our hypothalamus knows this, our body regulates our temperature by regulating heat loss and essentially kind of sacrificing the things that are less important, as well as finding ways to keep heat in the core of our bodies, okay? To keep our internal organs warm.

Erin Welsh (35:36)
Yes, yeah.

Erin Updyke (35:38)
So one of the first

Erin Welsh (35:38)
Right.

Erin Updyke (35:39)
things that our body does in order to keep our core warm is vasoconstriction of peripheral veins and arteries in our skin. And what that does is it keeps our blood, which is warm, in our deeper circulation. This is going to reduce the amount of heat loss from all of our surface area of our skin, right? It's also going to reduce the temperature of our skin and our extremities.

Erin Welsh (35:46)
Mm-hmm. Yeah.

Mm-hmm.

Mm-hmm.

Erin Updyke (36:07)
which can lead to frostbite. ~ so a quick detour before we talk about hypothermia itself to talk about frostbite, which you can kind of think of as like extreme localized hypothermia. So frostbite is when you get tissue injury that's due really to freezing itself. And so frostbite, do tend to have to be in pretty cold conditions.

Erin Welsh (36:11)
Yes. ~

Mm-hmm.

Erin Updyke (36:34)
rather than the more mild conditions where you could still get hypothermia but without frostbite.

Erin Welsh (36:39)
like water versus snow.

Erin Updyke (36:43)
I mean, yes and no. Snow is like, if you are in a snowy environment, it's very likely that the air temperature and the wind chill and the snow itself is below freezing. So in some cases, you might be even more likely to get frostbite in those scenarios. In water, you could still get like freezing if the water was cold enough, but it's very easy to get.

Erin Welsh (36:53)
Mm-hmm.

Erin Updyke (37:07)
totally hypothermic in the water because you lose heat so much more rapidly in water because it's a really good conductor of heat. It just steals it away from us.

Erin Welsh (37:14)
Right, right.

So like snow, you would get frostbite first and then hypothermia potentially, whereas water, you're gonna get hypothermia first.

Erin Updyke (37:20)
Potentially. Yeah, potentially.

Yeah,

yeah, yeah, that's a good way to think about it. Love it. I was confused and thought you meant the opposite, but that totally makes more sense, Erin.

Erin Welsh (37:27)
Okay. ~

~

Erin Updyke (37:36)
So yes, and the degree of damage really varies, right? You have degrees of frostbite. The first degree, you might just have kind redness of the area. It might progress to kind of a white, almost waxy skin or blister formation. And then of course, the most severe, which is considered grade four, is black or necrotic tissue, where your entire tissue just dies. And all of this is going to depend on how...

Erin Welsh (37:51)
Mm-hmm.

Yeah.

Erin Updyke (38:04)
long you're exposed and to what degree of temperature you're exposed to, right? And the damage that you get is due to this vasoconstriction itself, right? It's also due to the effects of that cold on our blood, because our blood, you mentioned this in the, like what people thought happened to your blood way back when, they're not wrong. Our blood actually becomes thicker and kind of sludgy when it gets that cold.

Erin Welsh (38:09)
Mm-hmm. Mm-hmm.

Mm-hmm. Mm-hmm.

Yeah.

Erin Updyke (38:30)
And then you can also get blood clots in some of your small vessels, which might lead to more damage due to lack of blood flow there. And because of the actual freezing itself, the extracellular water freezes and that ice crystal formation can cause direct tissue damage. So it's very multifactorial. And in terms of treatment for frostbite,

Erin Welsh (38:47)
Right, right.

Erin Updyke (38:56)
the treatment is to rewarm that area to try and increase blood flow to that area but as likely happened during Napoleon's army if there is a risk that things will refreeze you cannot start to rewarm because freezing and then warming and then refreezing actually causes significantly more damage.

Erin Welsh (39:11)
Huh.

So is there a point, like, because you talked about the stages where there's red and then there's white and then there's black tissue, like necrotic, I guess. ~ Is there a point at which the point of no return, I'm guessing, is when there's necrotic tissue? Is there nerve, can you regain nerve sensation when the tissue becomes whitened or? Okay, okay.

Erin Updyke (39:25)
Yeah.

100%.

It depends. It totally depends. Yeah. So you

can obviously, like if it progresses all the way to the tissue completely dying, that's when you might lose limbs or lose fingers or lose the tips of noses, right? Where even after rewarming, that tissue will not come back to life. Prior to that though, even if the tissue itself can be saved, there can absolutely be permanent nerve damage and things like that. ~ It just, it totally depends on the, on the specific scenario. So that's frostbite. Done.

Erin Welsh (39:54)
Mm-hmm. Mm-hmm.

Mm-hmm.

Yeah.

Mm-hmm.

Erin Updyke (40:13)
But let's keep talking about cold, okay? All we've said so far is that we start with vasoconstriction in our peripheral tissues and in our blood vessels. Sometimes that's not enough to maintain heat. So the next thing that our body does is to increase the production of heat inside of our bodies. And there's two main ways that we do that. One is shivering. So our skeletal muscle activity

Erin Welsh (40:17)
Yeah.

Mm-hmm.

Erin Updyke (40:42)
involuntarily starts to shiver and you have these repeated contractions and that increases metabolism and so that increases heat production. But the downside of that is that it utilizes a lot of energy, right? It's costly. It's a very costly thing to do, but it can generate a lot of heat so that can help to keep our bodies warm in some scenarios. There's another mechanism that we use which is brown fat, brown adipose tissue. You mentioned this.

Erin Welsh (40:57)
Yeah, it's costly.

Erin Updyke (41:10)

And brown fat is so fascinating to me because it generates only heat. So metabolism in all of the other tissues of our body just generates heat as like a byproduct. doesn't, it does not mean to, but it happens to. But brown fat doesn't generate any energy. It only generates heat. That's the point. And it is the point. And newborns have quite a lot of it. And as adults, we have significantly less.

Erin Welsh (41:10)
Mm-hmm.

Right.

It's like, that's the point. Yeah, yeah.

They do.

Mm-hmm.

Erin Updyke (41:41)
And so you

have it, but just a little bit. So we can't use it all that much. But sometimes we might be exposed to cold. That continues. And our shivering and our brown fat and all of this increase in metabolism simply can't keep up. So what happens to the body if we cannot keep up? The first thing is that we see what's called a cold diuresis.

which basically means that because all of our blood has been shunted into our core, it's flowing very quickly through our organs, including our kidneys. And so our kidneys are furiously filtering all of this blood and we start to see an increase in urine production.

Erin Welsh (42:06)
Mm.

I feel like I came across that somewhere and I don't know where. If it was like, yeah, I read the Shackleton's expedition book for this and I was, it's great. I mean, it's like, it's unbelievable. And the pictures, the fact that there are pictures is wild to me. But anyway, I don't remember if that's where somebody was talking about peeing a lot or if it was because they're like freezing at night and no one wanted to go outside. And so it was like,

Erin Updyke (42:26)
Mm-hmm.

Yeah, that's one of my husband's favorite books

Yeah.

peeing a lot.

~

Erin Welsh (42:53)
who didn't wanna play the one or who didn't wanna play the game where was like the last person who fills the pot has to empty it. So you just hold it anyway. Sorry.

Erin Updyke (42:58)
Huh.

Well, yes, you do start to have a cold diuresis. This is not a good sign. It means that things are not going well. And on top of that, not only is it just not a good sign, but what it means is that you can end up getting dehydrated, right? Because you're losing all of this fluid through your urine, you could end up with acid-base disturbances. You can end up with electrolyte issues. And eventually, our body really cannot keep up with

all of this loss and our core body temperature will start to decrease. And as our core body temperature decreases, our energy expenditure also starts to decrease and pretty dramatically actually. I think for every one degree Celsius decrease in core body temperature, our energy expenditure decreases by like 13%.

Erin Welsh (43:44)
Mm-hmm. Mm-hmm.

So there's no more shivering. Or is there?

Erin Updyke (43:55)
A lot of times, a

lot of times shivering will stop, yeah, because things are just sort of slowing down and all of our cellular functions start to slow down. And this eventually results in our central nervous system slowing down so much that we lose consciousness. Usually that doesn't happen until our central, like our core body temperature drops to around 30 degrees Celsius. Should have looked up what that is in Fahrenheit, but I didn't. It's cold.

Erin Welsh (44:21)
Yeah, it's cold.

Erin Updyke (44:23)
But what is usually lethal is not the effects on our central nervous system, but actually the effects on our heart. Because first you can get those acid base like an electrolyte disturbances from all of this diuresis that can affect the contractility of your heart and it can lead to arrhythmias. And as our heartbeat is slowing down and all of this metabolism is slowing down in our heart, the time between beats can

Erin Welsh (44:41)
Okay.

Erin Updyke (44:51)
prolong, so we get what's called bradycardia. Your heartbeat is slowing down and then the time that it takes for the electric signals to actually be conducted through the heart also gets affected. So you end up with arrhythmias. There's a bunch of different types that you can get but most often it's ventricular fibrillation which is your heart just kind of quivering instead of contracting and then eventually it stops completely.

Erin Welsh (44:56)
Mm-hmm.

Mm-hmm.

Erin Updyke (45:19)
And that is how death usually happens with hypothermia.

Erin Welsh (45:23)
It's so, it's, am, this makes me really look forward to next week, because I'm trying to figure out, is this, there seems to, there are clear costs to hypothermia. And so there must be

enough of a benefit, or is there enough of benefit? But that's a question, I guess, for next week.

Erin Updyke (45:28)
Mm-hmm.

Clear costs, yes.

for next

week, yes.

Erin Welsh (45:43)
~ Okay, I feel like I have some questions. what about, are you gonna talk about like rewarming and how, okay, okay. So yeah, so I guess the rate at which hypothermia occurs is dependent upon the individual, upon the environmental conditions, upon clothing, upon too much to even go into. ~ And so are there thresholds? Are there established thresholds?

Erin Updyke (45:46)
Give them to me.

Mm-hmm. Yeah.

For like the risk or something? No, I knew you were gonna ask and no, it's what's really, think, it's one of the things that's very interesting about hypothermia, right? There's not like ~ a textbook that's like below this temperature, you are at risk of hypothermia because it depends, like you said, on so many different things. We do know that ~ extremes of age are more susceptible to hypothermia. So newborn babies,

Erin Welsh (46:14)
yeah yeah okay.

Erin Updyke (46:36)
and small babies and infants in general have a much greater surface area to volume ratio. So even though they have that great brown fat and everything, they just lose a lot more heat. And so they're at higher risk of core temperature drops and hypothermia. People who

are elderly, so as you get older, you have less efficient, we think, thermoregulatory mechanisms.

Erin Welsh (46:47)
Mm-hmm.

Okay.

Erin Updyke (46:59)
We also often see changes in like body mass composition during aging. And so that makes it so that you're less able to regulate your temperature. If you think about like your grandparents are cold all the time, right? They're just not as able to maintain their heat. You mentioned being unhoused, right? Not having access to the behavioral mechanisms that we as humans rely on to maintain our temperature, like adequate clothing and shelter, fires, or other forms of heat to keep us warm.

Erin Welsh (47:11)
Mm-hmm. Mm-hmm.

Mm-hmm.

Mm-hmm.

Erin Updyke (47:29)
And then

also substance use like alcohol and other central nervous system medications like opioids or any kind of thing that's affecting your central nervous system and depressing your central nervous system function is going to put you at higher risk of hypothermia ~ hugely. yeah, but there's not like you can certainly see, we see hypothermia here in San Diego even in the winter and it doesn't get very cold here. Yeah.

Erin Welsh (47:53)
Yeah. Right.

Right.

Erin Updyke (47:56)

In terms of how we treat it, it really depends on how severe it is ~ and then the specifics of the person and the scenario themselves. But across the board, it's rewarming. It is rewarming that person's body back to a normal temperature. ~ But whether that means just insulating them against any more heat loss, like if they're just mildly hypothermic, ~ or if you need to actively rewarm somebody. And that might mean.

Erin Welsh (48:13)
Mm-hmm.

Mm-hmm.

Erin Updyke (48:24)
externally, like putting them in warm water or using, we have in the hospital these things called bear huggers. I'm pretty sure that's a brand name, but it's like these forced air, it's like these blanket paper, blanket things that you put over someone. use them in surgery a lot too, but also in hypothermia and they just force hot air. So then you're like insulated with this blanket of hot air that's moving over you. They're quite cute.

Erin Welsh (48:27)
Okay.

Yeah, that sounds nice. Okay.

Hmm.

Erin Updyke (48:50)
Uh-huh, and then heated blankets. These are all external ways that you could warm a person's body if they're mildly hypothermic. ~ And then there's internal rewarming, which is, of course, much more invasive. And there's a, I'm sure you have. There's a lot of different ways that you can do it. You can do it with just heated IV fluids, so just in a peripheral line. You can do it via body, like,

Erin Welsh (48:59)
Okay.

Yeah.

I've seen it on ER, yeah, many times.

Mm-hmm.

Erin Updyke (49:20)
~ body cavity lavage. So like any of your body cavities, you can flush warm fluid through those body cavities and then drain it out. I know. And then you also could use essentially like an ECMO machine. That's extra corp, extracorporeal rewarming machine that just takes your blood from your body, runs it through a machine, warms it up and oxygenates it and then returns it back to your body. Pretty darn incredible.

Erin Welsh (49:23)
Mm-hmm.

Mm-hmm.

Pretty darn cool, if you ask me.

Yeah.

Erin Updyke (49:50)
And that's it, Erin.

Erin Welsh (49:54)
Okay, so I have a question about something that you, don't know, I don't think you mentioned it, but like the, ~ your ability to make decisions kind of gets all funky too. So like that's one of the things there's this, what is it called where you disrobe? Like you start to take off your clothes.

Erin Updyke (49:59)
Okay.

Mm-hmm. It does.

Yep. Yeah, paradoxical

disrobing, I think, or something they call it. Yeah.

Erin Welsh (50:17)
That's what it is. Yeah,

Erin Updyke (50:19)
I mean, we don't really have a great understanding of why and how that happens, but it is something that you can see. And we think that it's just due to, even though you might not lose consciousness until your body gets quite cold, like a core temperature of around 30, the effects on your brain and your central nervous system can be pretty substantial, even at relatively mild hypothermia, which means that, people might not be.

Erin Welsh (50:25)
Okay.

Mm-hmm.

Erin Updyke (50:43)
And we don't really know. No one's, thankfully, today doing human experiments to figure out what are you thinking about when your body is getting to be that cold. And so we don't have great data on why do these types of things. But it can certainly complicate. I read a couple of forensic examiner-type papers where they were like, hypothermia deaths, if you're investigating them as a forensic medical person, can be really complicated because

Erin Welsh (50:53)
Mm-hmm.

Erin Updyke (51:11)
Sometimes it is just hypothermia, but it can look like there's a lot of foul play involved, or it can look like really complicated scenarios, and then it's ultimately determined that it's all just due to hypothermia. So it is really fascinating. Yeah. And what I think is also so fascinating about hypothermia are the kinds of stories like you told, Erin, of people actually being able to recover.

Erin Welsh (51:11)
Yeah.

Yes.

Mm-hmm. Mm-hmm. Okay. Okay.

Yeah.

Erin Updyke (51:40)
especially when you contrast it to heat stress, right? Like hyperthermia, the way that extreme heat induces damage to our proteins, to our cell structures itself, that has a pretty poor prognosis if your body temperature gets way too hot.

Erin Welsh (51:58)
Yeah, you're looking at like a degree of, a few degrees versus like tens of degrees people have come back from hypothermia. Yeah, yeah.

Erin Updyke (52:03)
Exactly, exactly. And

it's in part because hypothermia overall is reducing our cellular functioning and our energy demands, which means that we need less oxygen and our cells can therefore survive in absence of oxygen. And that is why people have thought to use this in medicine.

Erin Welsh (52:18)
Mm-hmm.

Erin Updyke (52:33)
as a therapeutic device. And that is what we're going to talk about next week.

Erin Welsh (52:38)
Loved that cliffhanger transition segue. Loved it. It was great. It was great. I am really looking forward to that because I want to know. I feel like I have made some assumptions about therapeutic hypothermia, so I'm ready to have those corrected if need be. Yeah. I don't know much, but I'll know more next week. And if you want to know more this week.

Erin Updyke (52:40)
Thank you. I tried really hard. Thank you. Thank you so much.

I can't wait, I'm excited about it. Maybe they're all correct, I don't know.

You will.

Right now,

so many.

Erin Welsh (53:08)
So many sources. Okay,

let me pull mine up. So for both of these episodes, I read a book that gave me a lot of different ideas called Out Cold by Phil Jaekl It's A Chilling Descent into the Macabre Controversial Life-Saving History of Hypothermia, book from 2021. And then if you want to read more, I absolutely loved this review paper about, it's called Adaptations to Polar Life in Mammals and Birds.

Erin Updyke (53:25)
Ooh.

I love

it.

Erin Welsh (53:36)
by ~ Blix from 2016. And it's just like such a fun, fascinating paper that talks about all the ways. Yes. Then there's for more of the history, especially the Napoleon stuff, there's a paper by Lankford from 2016 titled Dull Brains and Frozen Feet, a historical essay on cold. And finally, I want to just put a plug in for a short story by Jack London called To Build a Fire. ~

Erin Updyke (53:42)
just like full of fun facts. I love it.

gosh.

Erin Welsh (54:05)
and it's available, just search it, you can find a PDF, it's by the public domain. And it is, I mean, it's a story of hypothermia. It is chilling and good and yeah, I clearly should have thought of more, better adjectives before telling people to read it. But it is really, I think it does a really good job of kind of taking you through how, what hypothermia might feel like and sort of the,

Erin Updyke (54:32)
Hmm.

Erin Welsh (54:34)
one fault, like one false step, one misstep, one bad move.

Erin Updyke (54:40)
Yeah.

Erin Welsh (54:41)
Erin.

Erin Updyke (54:42)
I don't have really

fun recommendations like that, Erin. I have a paper called Body Temperature and its Regulation by Coote and Farmery from Anesthesia and Intensive Care Medicine. I've got Hypothermia by Turk in Forensic Science, Medicine and Pathology. That one was kind of interesting. Accidental Hypothermia from the New England Journal of Medicine, 1994. We got a few other papers. There is an update from 2022 on the accidental hypothermia one. So listen, you can find ...

all of the sources from this episode and every single one that we've ever done on our website, thispodcast.com.

Erin Welsh (55:18)
You can, you can. ~ Thank you to Bloodmobile for providing the music for this episode and all of our episodes.

Erin Updyke (55:25)
Thank you to Liana and Tom and Brent and Pete and Jessica and Mike and everyone else. I think there's more people I'm probably forgetting to say thank you to, but thank you also.

Erin Welsh (55:36)
everyone at Exactly Right and every one of our listeners, our watchers, anyone who participates in this podcast in some way, we really appreciate it. And especially to our

patrons, your support means it means the world to us. So thank you. Well, until next time, wash your hands.

Erin Updyke (55:42)
Mm-hmm. Yeah.

It really does so much.

You filthy

animals.