

TPWKY – Ep 212 – Burns Part 1

[00:00:00]

EW: This episode features descriptions that some listeners might find upsetting. Please listen with discretion.

Case 1: A lady, aged 20 years, in feeble health, was extensively burned by her mosquito curtains and calico bed cover being set on fire after she had fallen asleep. The flames enveloped her head, neck, and arms and were not extinguished for 20 or 30 seconds. Ardent spirits were first applied, then flaxseed oil, and lastly, a calcareous soap of the same oil and lime water. Laudanum was administered freely, both externally and internally.

Case 2: The Editor, while rescuing the patient described in Case 1, was severely burnt on both hands from compressing the burning clothes with his bare hands until the flames were extinguished. The cuticle exfoliated from nearly the whole right hand and the cutis vera sloughed in seven places. The left hand suffered much worse. The whole cuticle was separated and much of it was rolled up, especially that which covered the space between the wrist and hollow of the hand and extended up the inner side of the thumb as far as the middle of the second phalanx. Between these limits and the metacarpal bone of the little finger on one side, and the corresponding bone of the thumb on the other, the true skin was killed and turned black.

Immediately after the accident, he immersed both hands in whiskey, then in a liniment of flaxseed oil and lime water, after which the affected parts were wrapped in rags dipped in a painter's mixture of the same kind of oil and white lead, ground together. In 3 days, this was replaced by carrot poultices with yeast and Peruvian bark; the deeply burnt parts being stimulated at different times with tincture of myrrh, oil of turpentine, ammoniated alcohol, and other excitants. After a few days, suppuration was established and the dead skin sloughed off. Had the case presented nothing but what has been stated, a report of it would have been of little interest. There resulted, however, from this local injury a great constitutional disturbance. And to this I beg leave to direct the attention of the reader. Several causes seem to have conspired to depress the energy and disorder the sensibilities of his nervous system.

Number one: The acute sensibility of the parts injured. The pain for several hours after the accident was excruciating, notwithstanding the liberal use of laudanum.

Number two: The scene of concentrated horror under which the injury was inflicted, contributed not a little to overthrow the powers of the nervous system.

Number three: The immersion of both hands extensively denuded of cuticle, in a liniment of oil and white lead seems to me to have contributed largely to the same effect.

Number four: Two, three, or four days after the accident, when febrile symptoms were developed, the patient, by his own advice, lost about 10 ounces of blood. This was done under the apprehension that the fever and inflammation might run too high for healthy suppuration, but it manifestly did harm.

It would be difficult to set forth the variety of physical and moral suffering which were attendant on the protracted state of nervous or constitutional irritation which these causes generated. A great variety of applications were advised and employed for this formidable affection, but with little good. Time only has been efficacious, but even a period of nearly two years has not entirely overcome the effect.

EAU: I can't believe that they survived.

EW: Yeah. I know. Uh, so that It is, it is. It's horrible.

EAU: Really horrible.

EW: And it, it exhibits, I think there are some, it's, there's an entire paper actually that I, I found this in that was like discussing, uh, the, what this represents in terms of the history of burn treatment and where things stood.

EAU: Mm-hmm.

EW: The author of that was a medical doctor named, uh, Daniel Drake, who was actually one of a, like a famous doctor at the time. And he wrote this about his own experience

EAU: Hmm.

EW: the editor of a journal and he was like, I need to tell everyone about this,

EAU: Yeah.

EW: these. And, and I think the realization that he came to was like, all of these treatments, we have so many different treatments and none seem to have positive

EAU: Right. Like if anything, they might've made things worse. Yeah.

EW: The article if you're interested is titled History of Two Cases of Burn Producing Serious Constitutional Irritations by Daniel Drake. It was published in 1830 and the paper that I, uh, found this in was called Daniel Drake's Account of His Own Hand Burns by Eric Mooney. That was published in like 1998. I think so, um, yeah. Truly awful stuff, but

Hi, I'm Erin Welsh

EAU: And I'm Erin Allmann Updyke.

EW: and this is, This Podcast Will Kill You.

EAU: Welcome to burns[00:05:00]

EW: Yeah, part one.

EAU: Part one, two parts, because this is a big, this is a big one.

EW: I mean each, there are,

EAU: as

EW: I was working on the second episode and like the way that I split up the history for this is that I did like most of history, of

EAU: Most of right, right.

EW: everything. And then like the last 80 years basically, and like the various developments in the last 80 years, each one of those could be its own episode.

EAU: Not to mention

I know,

EW: burn centers being its

EAU: right?

EW: multidisciplinary be all like all these things. Anyway,

EAU: I know. There's so, there's so much, and like even in the newer, like the techniques and the, and the newer technologies and things that we have, like, there's so much more detail that we

EW: so much more

EAU: Listen, we've got a lot to cover though today and next week. Today is Burns part one. Should we tell people like kind of what we're covering today, what we're covering next week,

EW: Sure,

EAU: let 'em know a little bit what they're getting into. I don't know if you wanna know.

EW: Here's a preview.

EAU: Here's a preview. Today we're gonna talk about the biology of burns. What is happening in our bodies, to our bodies when we suffer a burn? And then Erin, you're gonna walk us through, like you said, the most of humanity's history.

EW: Mm-hmm.

EAU: With burns,

EW: Yep.

EAU: then next week we're gonna pick up with more modern history and how we actually treat and deal with burns today.

EW: Yeah.

EAU: So

EW: There's a, there's a lot.

EAU: There's a lot. Mm-hmm.

EW: And, uh, before we can do any of this, it

EAU: It's quarantini time.

EW: time. What are

EAU: Sure is.

EW: week?

EAU: We're drinking by degrees.

EW: degrees.

EAU: That is technically still how we measure burns ish.

EW: Okay.

EAU: ish. We'll get there, but kind of, yeah.

EW: Okay.

EAU: still all over the literature.

EW: It is.

EAU: Yeah.

EW: when, when I was like, oh, degrees and you were like, no, we don't talk about that

EAU: Yeah. It's like,

EW: fine,

EAU: it's fine. We're going to,

EW: we're going. Okay. Okay. Okay. Well, by degrees is the name of the quarantini. And the

EAU: yeah.

EW: is a non-alcoholic bees knees, basically.

EAU: Mm-hmm.

EW: Uh, some non-alcoholic gin. Lots of different varieties out there.

EAU: Mm-hmm.

EW: lemon juice, honey. Um,

EAU: Which is a great antiseptic for wounds.

EW: It is, it is historically, used as well as today.

EAU: as well as today. Yep.

EW: Yeah,

EAU: You can find the full recipe for that on our website. This podcast will kill you.com and all of our socials. We are on this podcast. Will kill you most places.

EW: just search. This

EAU: Just find us. You'll find us. We're there.

EW: us. And if you, if that searching lands you on our website, other things that you can find include bookshop.org affiliate

EAU: Mm-hmm. Mm-hmm.

EW: list links to music by blood mobile, uh, a firsthand account form a contact us form, links to merch, Patreon, transcripts, et cetera.

EAU: There's a lot there, isn't there?

EW: there.

EAU: Yeah. This podcast will kill you.com. Uh, thank you for rating and reviewing and subscribing to this podcast on your favorite pod catcher. Um, and or on YouTube. Hello

EW: YouTube.

EAU: YouTube

EW: to

EAU: watchers,

EW: Yep.

EAU: the end. Shall we?

EW: we

EAU: We've got a lot to cover, so let's get into it. Okay.

For today's episode, I wanted to take us through how exactly we classify burns in medicine and what this classification means for how our body responds to a burn injury. Because although a burn is a type of trauma to our skin, and there's a lot of other traumas that we could get to our skin, right, scrapes, cuts, et cetera, our body's response to burn injuries is actually fairly unique, even though it is still the same inflammatory response. It is also unique. It's kind of interesting.

EW: Huh. Okay.

EAU: And what I really think and what I took away from digging really deep into this, is that what burns really show us is just how incredible and how important of an organ our skin is,

EW: truly, truly.

EAU: how severe damage to that skin has life-threatening consequences and long lasting consequences. So I'm gonna walk us through the types of burns that we can see, burn severity and how we actually determine severe versus minor or major versus minor burns and what is happening to our whole entire body as a

result of a burn injury. And then save the, like what do we do about these burns for next week's episode? Okay.

EW: Sounds good.

EAU: So a lot of different things can actually cause the type of damage that we would refer to as a burn. And the source of a burn really does matter a lot because the pattern of injury that you see can be really different depending on the source of that burn. So as an [00:10:00] example, electrical burns, which we've talked about in our lightning episode, we talked a lot about electric burns.

EW: We

EAU: They can cause really severe deep damage to like our internal structures with very minimal visible surface injury. But those are still gonna be burn injuries, but deeper, a burn from a chemical, like say a strong acid might cause coagulation necrosis. So your blood vessels are all clotting and all your blood, blood is clotting. While a burn from an alkaline chemical might actually liquefy your tissues completely.

EW: Whoa.

EAU: Yeah, so burns from chemicals are going to act a little bit differently, and they might differ in how we need to treat them. You can think of frostbite as a type of cold burn and those need to be rewarmed and watched. See our two episodes on cold and cold injuries. Hypothermia, is that what we called them? Yeah.

EW: so, yeah.

EAU: I was like, what did we call this? whereas a heat burn is going to be different. And so most of what I'm going to talk about though, it probably applies to most all burns. They're really, I'm talking mostly about thermal burns, so burns as a result of heat injury.

EW: Did you

mention radiation burns?

Okay.

burns?

EAU: I didn't, but those are yet another type of burn that might be more like, more similar to maybe a chemical burn or, or somewhere in between. A little bit different. Yeah. So yeah, there's a lot of different kinds of burns. but, so I'm focusing mostly on thermal burns. These are the most common types of burns worldwide and these can be flame burns, so from a fire as well as scald type burns. So think hot, liquid and those sorts of things. And those are the two most common types of burns worldwide. once we know what caused the burn, then the next thing that we need to know is the severity of that burn. And the severity is a combination of the body surface area that's affected. So how much of your body got burned and the depth of that burn. And then of course, we also need to look for whether there was any additional injuries or traumas, especially in the case of something like a flame burn.

EW: Mm-hmm.

EAU: have inhalational injuries

EW: Yeah.

EAU: a chemical burn, you might have other toxin exposures. Um, you could even have like blunt trauma injuries, right? Depending on how, how the burn was sustained. Um, and then there's patient factors that might make someone more susceptible to severe outcomes from a less severe burn. Like say a very young child or a very old person, um, et cetera.

EW: Underlying health issues, so

EAU: Exactly. Diabetes that might interfere with wound healing, things like that.

EW: So

EAU: So let's go through how we kind of get to the severity we already mentioned, and a lot of us have heard of the idea of a first, second, and third degree burn. And that is like classically how we classify burns. And I say that we don't quite use it as much today because we now get a little bit more specific based on the thickness or the depth of the burn in our skin. Um, but colloquially we still use first second, third degree. So we'll just go a little bit more detailed. Okay?

EW: Okay.

EAU: And first I wanna take us through our skin. And we've talked about our skin on a number of episodes before, including like our retinoids episodes.

EW: yes.

EAU: But our skin is an incredibly important organ, and it's a layered organ, the largest organ in our whole entire body. and it's made up of several different layers. The top layer, the outside, what you're touching, and what you see is called the epidermis. And this is very, very thin layer, and it differs in thickness depending on where on your body. So it's a lot thicker in places like the soles of our feet and our back. And it's a lot thinner in places like, say your eyes or you know, the backs of your hands or things like that. underneath the epidermis is the dermis, and this is the layer that has, a lot of structure to it. It's a little bit thicker still only on the order of millimeters. but the dermis is underneath that. And then underneath the dermis is a layer of subcutaneous tissue. So this is like fat and things like that. And then below that is when we get to muscles and bones.

EW: okay?

EAU: So. The degree of a burn depends on how far through that skin layers, through those layers of skin, we actually get a superficial burn, or a first degree burn is one that burns only the uppermost layer, the epidermis. This you can think of as a bad sunburn.

EW: Right. a blister, type of a thing?

EAU: Well, no, not a blister type of a thing. So a bad sunburn, your skin is red, it's angry and it's painful. But beyond that, it's generally does not blister

EW: okay.

EAU: and it does not need any kind of specialized treatment, and you're not going to get a scar or any residual defects or anything. These type of superficial or first degree burns generally heal within a week or so. But no blistering.

[00:15:00] That is when we get into second degree burns

EW: Okay.

EAU: what used to be just lumped as second degree burns is now split into two different types. So the first is a superficial partial thickness burn. This is the one Erin that will blister.

EW: okay.

EAU: so this is a burn that burns completely through the epidermis and then into the first part of the dermis, but does not go like deeply into the dermis.

EW: Okay,

EAU: so this is something that you might get if you burn yourself on a pan or the oven or like really hot, you know, liquid that spills on you or something. These burns are very, very painful. they might be red, they might be blistered, they might be very wet and kind of weep, and you have to take care of these wounds, but you're not going to need surgery to fix these wounds. Because the layer of the dermis has not been completely burned through, and so your skin is going to be able to, it's called re epithelialize. It's going to be able to make new skin to cover up this wound without a lot of additional help. most of the time you're not going to get a scar from these types of burns. If you do, it might just be pigmentation changes because of losses of like the melanocytes that are in more of the epidermal layer.

EW: Okay.

EAU: Okay? Next is, again, within this considered second degree burn is called a deep partial thickness burn. And. The deep partial thickness burns actually tend to hurt a little bit less than the first two, and that's because they burn deeply enough that they're actually destroying our pain receptors in our skin. These burns tend to be a lot drier than a superficial partial thickness burn, so you don't necessarily have blisters, or if you do, they're just not quite as wet as a superficial burn. They often look either very dark pink or sometimes almost white, where they just look like it doesn't really look like there's anything there. It's just like completely white regardless of your skin color.

EW: Right.

EAU: And they're almost kind of pearly looking, rather like, or like waxy looking a little bit.

EW: Yep.

EAU: these generally do need surgery. Very often these are deep enough that the skin is not going to be able to completely heal over this without some kind of surgical intervention, and that means that they're at much higher risk of some kind of scar formation. There's not a huge leap then from a deep partial thickness to a full thickness burn or a third degree burn, and this is one that extends completely through the dermis. So the epidermal layer and the dermis are completely burned through all the way down into that subcutaneous tissue.

EW: Mm-hmm.

EAU: some cases, it a burn can extend all the way down into our deeper tissues, which is sometimes called a fourth degree burn, or sometimes it's just lumped under this third degree, and that means that there's damage to the muscles or the bones, depending on how deep it goes. These full thickness burns are not painful because all of our nerve endings have been destroyed. And I asterisk that Erin, because. That just means that at the time of the injury, that specific area that sustained a full thickness burn, if you touch it, you will not feel that the way that if you touch a burn blister, it really hurts. but that doesn't mean that they're not painful in the long run.

EW: or that you only have a third degree burn and that

EAU: Exactly.

EW: are not experiencing first and second degrees.

EAU: Exactly. Exactly. Very, very often, almost always, if someone has severe burns,

EW: Mm-hmm.

EAU: every part of the burn is the same degree. Right. You have a mix of burns, of varying degrees or varying thicknesses, um, on different parts of that burn, which means yes, things are likely going to be very painful, even if parts of those burns have completely destroyed the nerve endings and everything.

EW: Okay,

EAU: Um,

EW: about like surface area and degrees because it's a big, like, like we just talked

EAU: Mm-hmm.

EW: a mixture of different degrees or severities of the burn

EAU: Mm-hmm.

EW: parts of your body. So how is that calculated or how does that get incorporated into total body surface area?

EAU: That's a great question. So total body surface area is the next thing that we have to look at. So once we know, and, and I say it as if these are separate things, they're really not like, we're, we're looking at all of this at the same time, if someone comes into a hospital with a burn, but total body surface area is how much of your body surface is covered by this burn, regardless of the degree. So you don't need to separate it by, oh, you know, this much surface area was the first degree versus second versus third. Here we're just looking at how much of your skin got burned. And this is actually the most important part in looking at mortality is surface area.

EW: area,

EAU: So how we classify something as a so-called [00:20:00] minor burn. This is actually a lot more. I won't even say contentious in the literature 'cause I don't think anyone's fighting over it. But it really depends on the situation, whether something is considered a severe or a minor burn. In general, most people don't require hospitalization for burns that cover less than 10% of their body surface. But that's a huge generalization because a burn on the face, a burn on the groin, a burn on the hands, even if it's significantly less than 10%, might still require hospitalization. Um, as well as depending on the thickness or the, the degree of that burn.

EW: Or other injuries. Sustained or

EAU: Exactly.

EW: that it is. Yeah.

EAU: Exactly. So that, that is really an overgeneralization. Most of the time if we're thinking about what is going to cause, um more likely to cause systemic symptoms. Then we're looking at burns that are maybe more than 15 or 20% of your body surface area, depending on the person and their age and like how big they are, right? Like a kid might have a less body surface area to cause severe

effects, but all of that is really like, it's, it's so depends on the person, right? so there's not like a clear cut definition of like, this is a, a major burn versus a minor burn or a severe burn versus a non-severe burn. But calculating that body surface area is a really important part of the care of a person and understanding like how severe their outcomes are going to be. And the way that we do that is, there's a couple different ways. There's a fast and ready way kind of, that is called the rule of nines, and that is that we just split up an adult body area into areas that are about 9%. So our head is about 9% of our body surface. Um, our chest, the front side of our chest and the front side of our abdomen are each 9%, and same thing with the back. So that's like 18 and 18. and then the front of our legs are 9%. The back of our legs are 9%, and our two arms put together are 9%, and then an extra 1% for the genitals.

EW: Okay.

EAU: The other way that you can do it though, um, because that calculation does not hold true for children. Because children, their head is a significantly larger body surface than especially for babies.

EW: Mm-hmm.

EAU: Um, so there's different calculations that we use for children and babies, but you also could use, a person's hand. So not my hand to calculate your burn area, but your hand to calculate yours.

EW: Yeah.

EAU: to calculate mine, um, our palm, so the entire surface of our hand, including our fingers on our palm, is about 1%. So that's considered about 1% total. So you can use that to kind of estimate. if, if it's less than 9% or something, you're trying to get a rough estimate. So that's how we sort of calculate and estimate how severe a burn is. And of course, like I said, at the very top, our skin is the largest organ in our body.

EW: Mm-hmm.

EAU: So damage even to a small portion of that organ has the potential to cause a whole body response and the response that we see. Really depends on the depth of that burn, the surface area of that burn, and the person who sustained that burn and what their underlying conditions is.

EW: Right.

EAU: But we can kind of understand how this process is going to go if we understand our basic inflammatory response and how our body responds to wounds in our skin, which we've talked about on previous episodes. I think on our maggots episode, we talked about this like inflammatory response because anytime that our skin is wounded from a burn or a scrape or a scratch, our body follows a very predictable series of responses to try and repair that wound. The very first thing is hemostasis, right? We have to stop the bleeding because most of the time wounds bleed. Very often they don't in the case of burns, and we'll get to why that is, but the second thing that's going to happen is inflammation, and this is to bring helpers to the area in order to start the repair process. The third step is proliferation. We need to start making new cells to fill in the gaps that are left by this wound. And finally, we have maturation or remodeling. That's the finishing up that is really scar formation because our skin pretty much always heals by scarring. So in the event of a burn, our body is going to attempt to heal by this similar process.

However, because of some specific things that happen, especially in the case of a thermal burn, so a heat related burn, as well as the potential for a very large portion of our skin to be affected, the end result is often a pretty dysregulated body response that can be really severe. So unlike say, a cut or a scrape that just has damage, wherever that [00:25:00] scrape actually happened, a burned wound actually has several different zones of injury.

In the very center, or like where the burn was actually sustained is what's called a zone of coagulation. You can think of this as not necessarily the deepest part of the burn, but like the part that actually had contact with the hot liquid or the flame or whatever it was that caused the injury. And in that area, the tissue is dead. The blood cells are coagulated, so there's no bleeding in that area because of the, the strong heat that was applied and that tissue in that area cannot be completely salvaged. Okay.

EW: Okay.

EAU: Immediately around this,

EW: Mm-hmm.

EAU: is a zone of stasis, and in this area there is a lot of inflammation, so our body is trying to respond to that central area. It knows that there's something wrong here, but there's very low levels of blood flow. There's a lot less perfusion in this zone because of damage that was sustained and our body's response of kind of clamping down to try and protect that area,

EW: Okay.

EAU: has the effect that if that area is not addressed, then the damage from the burn can actually extend out over the next 24 to 48 hours

EW: How can it do that?

EAU: because that area, that zone of stasis is not getting enough blood flow.

EW: Mm-hmm.

EAU: that blood flow is not restored to that area, then that area is also going to die because of a lack of blood flow. Does that kind of make sense?

EW: Yeah.

EAU: And then outside of that zone is called the zone of hyperemia, and this is non damaged tissue where perfusion hasn't been affected. And this is all like viable tissue essentially. So in the first 48 hours, it's important to be able to find those areas and see how much tissue can be salvaged, especially, and I'm talking really in the case of deep partial thickness, so like those more severe second degree burns or third degree or full thickness burns, right?

EW: Okay.

EAU: This isn't necessarily happening in a superficial burn where it's just the epidermis.

EW: Okay, so just so I, I wanna go over this, so I think I, I make sure I understand this. So

EAU: Yeah.

EW: experience a second degree burn, let's say it's like on your leg,

EAU: Mm-hmm.

EW: the area that is like the most severe

EAU: Mm-hmm. Mm-hmm.

EW: things are. Bad.

EAU: Yes.

EW: has happened directly there, and then surrounding that area, there's sort of the, the area that has also been kind of affected, but not directly by the thermal injury,

EAU: Mm-hmm.

EW: it's that area that needs to be like looked after

EAU: Mm-hmm.

EW: it's at risk of dying. And so that's where a lot of the inflammation comes into there,

EAU: Yes, yes.

EW: necessarily the central point of the burn itself, because there's nothing left. There's no more tissue left to go to that is alive and

EAU: Right, right, right, right, right. Exactly.

EW: first. Okay.

EAU: Exactly. So yes. In, in that tissue that is completely dead. Our inflammatory response can't kick in there. We don't have blood flow there.

EW: There's no blood flow.

EAU: no blood flow in that.

EW: for anything, so then okay, everything

EAU: Exactly.

EW: Got it.

EAU: has to be restored. So that's the first challenge, is identifying those areas that that need restoration, that we need to do something. Otherwise, that repair

process is not going to be able to start. That's the first challenge. The second challenge is that all of the surrounding tissue will have a lot of inflammation,

EW: Mm-hmm.

EAU: right? Because our body knows that something is going on and they're trying really hard to send in all the troops. That means in the surrounding areas, we have a lot of vasodilation. That means our blood vessels are getting larger, and that's to accommodate more flow. We see an increase in vascular permeability, so that means that our blood vessels are more leaky, and that is to allow all of the plasma that has our white blood cells and the inflammatory markers and the cytokines and all these things into the area to try and help. But unfortunately, what that ends up resulting in is a lot of edema, so a lot of fluid in the area. Because the degree of inflammatory signals is so high, and this can be in and of itself very dangerous, especially in the event of like a circumferential burn. So think like a burn that goes around your entire arm, for example. basically the fluid has nowhere to go and so that's going to increase pressure in that area. Does that make sense?

EW: How, how does blood pressure overall play? Like what happens to your blood pressure?

EAU: Yeah. So the, the pathophysiology of burns, severe burns, especially, is divided into two phases. The first phase is in these first 24 to 72 hours, and that's called the hypodynamic phase. And that is when all this inflammation is happening, our bodies kick into high gear. [00:30:00] Inflammatory markers are going everywhere. Vascular permeability is up. So we are at very high risk of going into shock. And shock, as we learned in our sepsis episode, means a drop in your blood pressure enough so that all of your other organs are not getting enough blood. So this is incredibly dangerous. It can result in multi-organ failure. kidney failure, liver failure. Your heart is not pumping out enough blood. and really it's because you're, you, you're not losing blood. So you're not bleeding out, but you are losing so much fluid from this process that your blood pressure just can't keep up. Um, we can also see really bad fluid imbalances and electrolyte imbalances as well.

EW: Mm-hmm.

EAU: So in this period, what's really important is fluid resuscitation as well as like management of these wounds to try and prevent all of this stuff from getting worse. And in the case of those, like if we have circumferential burns and things, there has to be like pressure relief. So you have to do some kind of

surgical intervention, even if it's something small, to literally release that pressure so that you don't cause further damage to the tissue or the tissue downstream from that,

EW: Okay.

EAU: after that initial 24 to 72 hours. Um, after a burn, your body enters a new phase that's called the hyperdynamic and hypermetabolic flow phase.

EW: Yeah.

EAU: And you can kind of think of this as your body, like releasing all the stress hormones that it has. So you are still alive. Your body has kept you alive for this first few days, and now it's recognizing that without a portion of your largest organ, being able to thermoregulate, being able to regulate the water in your body, being able to protect you from infection, your body is going to have to compensate in a huge, huge way.

EW: Mm-hmm.

EAU: So what we see are blood vessels actually clamping down, so a real decrease in vascular permeability. We see your heart rate going up.

EW: Hmm.

EAU: We see the like small blood vessels or the micro vasculature of the area around that wound starting to heal and redistribute blood to these areas to actually promote healing rather than just like kind of freaking out like they were at first.

EW: right?

EAU: And then we also see huge increases in our basal metabolic rate. So our body literally starts burning way more energy than it has in the past.

EW: Right.

EAU: And what is so wild about burns are that these changes in metabolism and total body functioning, like changes in cardiac output, changes in insulin and glucose regulation, changes in heat production last for years following a severe burn.

EW: really?

EAU: Yes. So if we see body surface area burns of 20% or greater than these changes in metabolism can last for two or more years. Yeah,

EW: and this is okay, I have so many questions

EAU: know. Yeah.

EW: and that's like, at that point what does the burn, like what does the burned skin or tissue look like? Has it been healed?

EAU: Yeah,

EW: Is it scar? Why? Yeah.

EAU: it really, so it's really, really going to depend on what kind of, um, treatment you have access to.

EW: Okay. Yeah.

EAU: If you don't have access to any treatment, especially if this was a deep burn, then the tissue that has died is going to form what's called an eschar. I think that's how you say it. Um, and that's basically like, you can think of it as a really, really bad scab. So something that's completely black, completely necrotic, um, can be very thick and it will take a very long time, if ever, for that wound to heal completely. Because again, if the burn extends all the way through the dermis, so a deep partial thickness burn or a complete thickness burn, so a late second degree, two B or a third degree burn or greater, there aren't any. Like dermal cells left to re epithelialize. And so that wound has to heal like from the bottom up and it's really a slow process and in some cases it just never completely makes new skin again without some kind of wound management. So that wound might never heal and it might become a chronic wound

EW: Okay.

EAU: if, if you don't have any access to essentially surgical debridement and then treatment for it.

EW: Mm-hmm.

EAU: So that's mostly burns. and kind of how severe they can be, what damage they can cause There's obviously a lot of complications that can arise during the treatment of these burns. You are at very high risk of infection because your skin is the main barrier from infection. and depending on what caused the burn, you might have additional, like inhalational injuries and smoke [00:35:00] inhalation deserves its whole own episode because that can cause a really severe injury. it, it deserves its whole entire own episode. But that's kind of like the main, how we deal with burns in terms of how our body is responding to that burn. And the management is going to really vary depending on what you have access to and depending on how severe that burn is. But Erin, I have to assume that we've been. Subject to vulnerable, to burns ever since, I don't know, forever, since we lost our fur, like furry animals can still burn. What? Tell me,

EW: Uh, I'll, I will get there. I do have one other question for you though, and that's

EAU: Okay.

EW: like general, you know, so much of what I encountered in the history of Burns is that burns were. V could be very, very

EAU: fatal. Mm-hmm.

EW: they're, they're not as much now today if you have access to all these top of the line treatments and burn centers, but what is behind or driving that mortality.

EAU: It really depends. it depends on the total body surface area. There's actually like a calculator that you can use based on someone's age and their body surface area, , to like predict essentially whether someone is likely to die from it. In the case of severe burns, then it's that first like 24, 48 hours that you really need access to resuscitation or somebody could die from shock and organ failure and then after that it's more likely to be infection, um, or potentially other complications like if there was an inhalation injury or something like that at the same time,

EW: gotcha.

EAU: yeah,

EW: Okay. Uh,

EAU: it is grim, erin.

EW: is grim and I, I will say that the, the history is, uh, for a large part is, is quite grim as well. But this is why I'm so glad that we're doing these two episodes is because it really does exemplify how far we have come

EAU: Yes.

EW: to treat and manage burns. It's

EAU: Yeah, it really is.

EW: revolutions.

EAU: incredible.

EW: but let's let's see where,

where things came from. Right.

EAU: okay.

EW: Do you, do you remember your first bad burn?

EAU: I remember some really, really bad sunburns when I was a kid. Um, probably that came close to a second degree. They were so bad. That's it. That's what I can remember. Really bad. Sunburns.

EW: Yeah. Yeah. probably like hot stove when you were a child, I'm sure.

EAU: Pro

EW: kind

EAU: probably. Yeah.

EW: I, I am sure that I burned myself earlier than this, but seared into my memory is the summer of 1997.

EAU: Mm.

EW: I was running around my friend's yard, Kathleen, she lived down the street from us in Kentucky, and we had a bonfire going, you know, it was classic. Got a bunch of neighbors there, hot dogs, s'mores, the whole, the whole nine

EAU: Uhhuh.

EW: And I see a marshmallow on the ground near the

EAU: Oh, no. Oh.

EW: never wanting a marshmallow to go to waste.

EAU: Uh

EW: i pick it up. and itt takes a few seconds to register that what I was holding was not in fact a delicious marshmallow, but it was a white hot ember that had shot out of the fire and into the grass. It was looked just like a marshmallow

EAU: Uh

EW: and I had a rough time for a few days, but ultimately it was a very minor burn, like very minor, right? I iced my fingers, I covered them in aloe, I soaked them in water, cold water overnight like and, and I was fine. This story is not unique, and I'm sure everyone has a story just like this or one much, much more severe because I was extremely lucky. Hundreds of millions of people are burned every year, which

EAU: mm-hmm.

EW: I would guess a conservative estimate, and nearly 200,000 lose their lives around the globe every year due to burn injuries. Burns are a routine feature of our lives as human beings. And that's been the case for a very long time. My story of picking up a white hot ember, not only is that a common story today, it's been a common story for hundreds of thousands of years.

EAU: Wow.

EW: least

EAU: Okay. Okay.

EW: many a paper that describes the history of burn treatment starts off with some variation of, ever since man discovered fire he's had to deal with burns.

EAU: Yeah.

EW: So many of them start just like that. And it's the truth, like

EAU: Yeah.

EW: the truth. I mean, sure there may have been some, you know, hot springs accidents or, uh, severe sunburns, lightning strikes, wildfires maybe that caught up with early humans. and in this, we're no different than the other animals that have suffered the same fate for the 400 million years that fire has been possible on this planet.

EAU: Whoa,

EW: It wasn't possible before that. It was

EAU: because No oxygen or why?

EW: Oxygen and land plants. Okay.

EAU: Okay. Okay.

EW: Yeah.

EAU: Fascinating. Erin?[00:40:00]

EW: fascinating? Yeah, but it's the domestication of fire

EAU: Yeah.

EW: us apart. Controlling and creating fire, making fire gave us warmth. It protected us from predators. It provided a means of cooking, giving us access to higher quality and more easily digestible foods, which provided the energy needed to fuel bigger brains. It helped us to make tools, weapons, and ceramics. Fire is a fundamental essential step in hominin evolution, second in importance only to language, which may have been encouraged by fire.

EAU: Hmm.

EW: Without fire, we would not have developed into the humans that we are today.

EAU: Wow.

EW: At all.

EAU: Wow.

EW: Burns are a consequence of fire domestication for the

EAU: Thanks a lot, Prometheus. Just kidding. Sorry.

EW: Deep cut. I like it. But as, as our hominin ancestors learned to use fire first by controlling wildfires, then making fires from scratch, they were sure to suffer burns.

EAU: Mm-hmm.

EW: Just last year, a paper came out that pushed back the estimate of fire making to like actually originating fire okay to 400,000 years.

EAU: Wow.

EW: yeah So researchers found compelling evidence of fire making in Eastern England, in Neanderthal sites. And

EAU: Wow.

EW: Before this, the earliest evidence was like 50,000 years. Which didn't mean that people thought it wasn't older, but like this was

EAU: That was the only evidence they had.

EW: Yeah.

EAU: Wow.

EW: But it's likely that our hominin relatives had been controlling fire for much longer than that, perhaps as far back as like one and a half million years. They

would've had to in order to migrate to regions with colder climates in the first place

EAU: Hmm. Okay.

EW: All this is to say, this is my long, in my long-winded way of saying, ever since man discovered fire that he's had to deal with burns, right? We've been dealing with burns for hundreds of thousands of years in the quest to harness fire,

EAU: Okay.

EW: and throughout all that time, humans have attempted to treat the burns that they experienced. And of course, we can only guess at the variety of remedies used before the invention of writing, but it's likely they were plant-based, like there is some evidence for that, including a ghost citation I couldn't track down, so I'm not gonna even reference it. But

EAU: Okay.

EW: earliest doc confirmed insight into the treatment of burns comes from the medical texts from ancient civilizations that we're used to encountering, you know, the ebers papyrus, the hippocratic texts, medical treatises from China, writings by Shushruta and so on. The majority of these treatments for burns were centered on the application of like a goo or an ointment or a cream to the burn itself, to the actual location of the burn with a little bit on pain relief and maybe early like debridement type of approaches.

EAU: Okay.

EW: Yeah. Ancient Egyptian physicians seem to favor recipes that included resin and honey, or oil soaked linen wraps. But milk also made an appearance, uh, specifically goat milk or milk from women who had given birth to a son.

EAU: Interesting.

EW: I don't know if

EAU: Highly specific

EW: Right. Only sons if

EAU: sons.

EW: is okay. Do you

EAU: Okay.

EW: and daughter? You know, I dunno.

EAU: Fascinating

EW: other

EAU: riff. Like you had a son before, but now you just had a daughter. Like, does that, is that okay too?

EW: I, it, I don't, yeah, you'll have to

EAU: We need more detail.

EW: the author of the

EAU: Okay.

EW: Yeah. might not be, um, reachable, but the other, other remedies called for a sequence of different ointments to be applied. So like day one, black mud, day two, boiled cow dung, and so on and so forth. products feature prominently in many of the recipes from ancient Egypt, Greece, Rome, and India. Not just milk like for instance, bulls fat. Boiled with papyrus is one treatment.

EAU: Okay.

EW: text recommend that for a burn, you should quote, "take melted fat of old pigs. Mix it with resin and beum, spread it out over a cloth, warm it at the fire and apply it as a plaster." End

EAU: Okay.

EW: dung was, uh, also a popular choice, specifically hare's dung and she goat dung.

EAU: She goat.

EW: She goat.

EAU: She goat?

EW: She goat,

EAU: Okay. She goat. She goat. Okay.

EW: uh, eggs here and there were mentioned, you know, hardboiled yolks mixed with rose oil as an

EAU: Interesting.

EW: There were also many plant-based remedies as well. So in ancient China, tea leaf extract was applied to burns. In ancient India, you might get an ointment made from butter mixed with the bark of a fig tree. to quote from a 1977 paper by Thompson on the history of burn treatment, quote, "it would be tedious and not a little revolting to detail all the hundreds of variations on this theme" end quote.

EAU: Okay. Fair enough.

EW: Fair enough. But hopefully I've given you a small taste of the variations

EAU: [00:45:00] Yeah.

EW: and I think that there are two main takeaways with this foray into ancient burn treatment. First, there are a lot of treatments which suggests, of course, that this was a problem, encountered frequently enough to keep trying new things.

EAU: Right. And everywhere. So everyone's got their own version of a treatment.

EW: got their own

EAU: Mm-hmm.

EW: because there was no clearly single reliable remedy, people were constantly inventing new recipes. And second by and large treatments were topical, aimed at promoting healing and providing relief. when you think of these in comparison to the full scale, multi-specialty approach that we use

today, it's barely a drop in the bucket. I mean, they were doing the best that they could with the knowledge that they had, and as that knowledge grew, so did their approaches, but not necessarily with success.

EAU: Mm-hmm. Mm-hmm.

EW: sort of, there were limitations, uh,

EAU: Yeah.

EW: for thousands of years

EAU: Yeah.

EW: by the Middle Ages, the list of options for treating a burn had grown tremendously. So sure. Still plenty of people were opting for raw onion slices, which remained popular for long, like a really long time actually with

EAU: Okay.

EW: Ambrose Pare employing onions and salt allegedly effectively in the 16th century. But there was one sizable shift in focus over that time, and that was sort of towards temperature.

EAU: Hmm.

EW: physicians found that topical treatments that invoked a cooling sensation or were themselves cooling, like melted snow, provided relief to those with burns, especially with superficial burns. Others suggested that treating like with like, so applying heat to the burn would yield more positive results, especially for those with deep wounds.

EAU: Okay.

EW: Yeah.

EAU: Ooh.

EW: The first book dedicated to Burns, uh, *de Combustionibus* was written by Fabricius Hildanus in 1607, and it warned that if cooling were applied to burn

skin, it would quote, "harden like fat when it is cooled and thus shut in the moisture"

EAU: How fascinating. Okay.

EW: keep things warm,

EAU: things warm.

EW: keep things flowing is kind of like their idea.

EAU: Okay.

EW: but this book also was among the first to, to propose treatments for contractures,

EAU: Okay.

EW: but um, which did you, did we talk about contractures? No,

EAU: but I'll talk more about it next week.

EW: Okay. So we'll get there, stay tuned.

EAU: Yeah, yeah,

EW: for explanation on contractures. But this idea of treating burns with heat, like it was Yeah, kind of like to keep things flowing, prevent fluid accumulation, and encouraging this like. Yeah. Just free flow

EAU: Free flow. Okay.

EW: Uh, Shakespeare even makes a reference to heat treatments in King John

EAU: Hmm.

EW: "And falsehood, falsehood cures as fire cools fire within the scorched veins of one new burned." I'm really great at reading Shakespeare.

EAU: Nailed it, Erin.

EW: I remember for a really long time we had to do Iambic pentameter or speak in Iambic pentameter in like 10th grade English, and I was just like, I don't get it. And it's, it's been a block for me ever since. So you go. I. But this debate, cold versus heat, it went on for hundreds of years, and it wasn't the only debate. There was an argument over whether open air exposure or covering a burn in dressing soaked with various substances was the better approach. Then there was a discussion over which substances and which dressings, you know, whiskey, linseed oil, olive oil, alkaline water, lead, silver linen, wool, cotton. you could argue over whether you should feed your patient and provide plenty of fluids or do some bloodletting and purging. Everyone had their favorite approach backed up by an anecdote, a gut feeling. Professional pride. Take your pick.

EAU: Mm-hmm.

EW: This lack of consensus on how to best manage burns. It plagued doctors throughout the Renaissance and into the 17 hundreds and 18 hundreds. Wars and industrial accidents and train crashes served as a painful reminder that in fact, medicine had not substantially advanced since the time of Galen and Hippocrates when it came to burns. What was needed to make any type of progress was consensus. First and foremost, on how to measure the severity of burns and the rate of healing,

EAU: Yeah

EW: Because only then could you compare treatments or approaches.

EAU: Mm-hmm.

EW: Only then could you pick lead ointment versus whiskey, ice water versus warming cloths. Only then could you have a hope of saving someone's life. How you get consensus? You gather data. In the early 19th century, Guillaume Dupuytren reviewed 50 cases of burn patients and followed their treatments and outcomes.

EAU: Okay.

EW: with this information, he put together a classification, uh, system for burns organized by depth, similar to the degree system that many people are familiar with today that we just went through. His was not the first burn grading system overall, but it was the first to relate burn severity, like depth and total area with mortality with [00:50:00] this system. Doctors were not just treating burns, they

were measuring them. Establishing this baseline was super important to compare different approaches. You know, again, turpentine versus linseed oil might look the same in a severely burned individual, but if you tried them out on a more moderate or a minor burn, you might see a difference in healing.

EAU: right, right, right.

EW: And it also opened the door to other kinds of treatments entirely, not just those based on topical ointments, such as surgical approaches, you know, skin debridement and skin grafts. Supportive therapies in the form of fluid replenishment, pain relief. By the end of the 19th century, many though not all, of the pieces were there to revolutionize burn care. They were just sort of like scattered all over the place, waiting for someone to put them together

EAU: Okay.

EW: up to this point. So around, I'm gonna say the early 19 hundreds. For pretty much all of human history burns had remained out of reach for physicians who could at most hope for the body's innate wound healing methods to kick in as they, the doctors provided some modicum of pain relief. Frankly speaking, medicine had made no progress in increasing survival or healing

EAU: Right. That's so wild. Even into the 19 hundreds.

EW: Into the 19 hundreds, and if this story so far feels unsatisfying or incomplete, then I've succeeded. That's what I, that, that was my aim here. Like, I wanted to spend this episode or this, my part of this episode, taking us through the desperate centuries and millenia in which medicine remained completely in the dark. So that next week when we get to share the story of how that changed, when we get to really take stock of how far we've come and stand a little bit in awe of scientific progress, what funding for research has helped us to achieve and how working across disciplines can make a huge difference. So that when we get there, we get to go, oh my God,

EAU: Oh my gosh.

EW: this is

EAU: actually come so far.

EW: we actually have, but that's where I'm gonna stop it here.

EAU: I love it. Erin.

EW: now, we can fill you in on where you can read more.

EAU: There's a lot there.

EW: There is a lot. There is a lot. Uh, so I'm gonna shout out just three sources in particular. There's 1986 History of burn care by Pinnegar and Pinnegar. 1977 Thompson Historical landmarks in the treatment of burns. And then by van he from 2007, from fat of old Pigs to fenestrated skin grafts.

EAU: Oh, ooh. I love that.

EW: more, lots more on the

EAU: I can't wait. Um, I, my absolute favorite paper that I read for this and next week's episode is by Jeschke I'm so sorry if I said that wrong et al. From nature Reviews disease primers. Love it when there's one of these, um, from 2020 called Burn Injury, and it was, I mean, it's so good, it's so comprehensive. It has everything, but you know that there's also more. So if you want way more in-depth information about the response and the pathophysiology and all of this biology, don't you worry because we have the list of all of our sources on our website. This podcast will kill you.com under the episodes tab.

EW: do you to Blood Mobile for providing the music for this episode and all of our episodes.

EAU: Thank you to Lianna and Tom, and Mark and Pete and everyone at Exactly right.

EW: Yes. Thank

EAU: There's probably people I forgot.

EW: and thank you to everyone. Uh, and thank you to you listeners, we and watchers, anyone who participates in this podcast in some way. We really do appreciate you tuning in and telling us what you think and just. Sharing this. I don't know everything. Thank

EAU: Thank you. Thank you. And a special shout out as always to our patrons. Thank you so much for your support over on Patreon. It really does. It really does mean so much to us.

EW: Until next time, wash your hands.

EAU: You filthy animals.