

Envenomations: Snakes, Lizards, Marine Life, and Arthropods

Episode 1 – Evidence-Based Treatment of Snakebites

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Guest

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- His research interests include envenomations, salicylate poisoning, antimuscarinic toxicity, anticonvulsant overdoses, and alcohol withdrawal.
- He has authored more than 50 book chapters and scholarly articles and is the recipient of multiple teaching and clinical awards.
- Dr. Greene has directed the Houston Venom Conference since 2013.
- He serves as the Co-Chair of the newly established American College of Medical Toxicology (ACMT) Toxinology section and directed the ACMT Natural Toxins Academy.

Host

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- With 15 years in nursing, she has worked at the bedside, in management, and in nursing education
- She has demonstrated expertise and scholarship in innovation and design thinking in healthcare and education and collaborative efforts within and outside of healthcare.
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Transcript

Episode 1 – Evidenced-Based Treatment of Snakebites

DR. CANDACE PIERCE, HOST: Hello, everybody. This is Dr. Candace Pierce with Elite Learning by Colibri Health Care. And you are listening to our Elite Learning podcasts where we share the most up to date education for health care professionals. Today, I'm joined by Dr. Spencer Greene, a board-certified emergency physician, medical toxicologist and addiction medicine specialist.

We will be discussing all things and then a nation specific to the U.S. to include snakes, spiders, insects, marine life, and lizards. Dr. Greene, thank you for taking time to share your expertise with us today.

DR. SPENCER GREENE, GUEST: Thanks for having me.

PIERCE: Yes, you have a very extensive and impressive bio, which can be viewed in this podcast show notes. But to show that you are the expert. Like I said, you're a board-certified emergency physician, medical toxicologist, and addiction medicine specialist, but you're also a clinical professor at the University of Houston College of Medicine and director of toxicology at HCA Houston Health Care Kingwood, which I've heard or read, is one of the busiest snakebite services in the U.S.

GREENE: That's right. We see a lot of bites and this year is even busier already. I've already had 13 bites.

PIERCE: Oh, wow. Well, I'm not sure how you do all that you do, but I know you also continue to find time to be active in research with over 50 publications to include articles, books and chapters, and the recipient of multiple teaching and clinical awards. And didn't you just have an article published this year?

GREENE: I've had about five articles published this year. I'm not sure which one you're referring to.

PIERCE: Well, my daughter really loves black Mamba. Mamba is not sure how to say that. And so didn't you just have one publish on those?

GREENE: I did, yes. I took care of a friend of mine who was envenomed by a black mamba. And he's good now. But it was ah it was scary for all of it.

PIERCE: I bet. Well, my daughter really loves all things snakes. I'm. I'm going to have to keep you on speed dial if that's okay.

GREENE: Absolutely.

PIERCE: Well, before we get into the discussion on envenomations, I'm really curious as to what drew you to this area in medicine.

GREENE: It's actually kind of a funny story. When I was really little, I wanted to be an ice hockey player. And then around the time I turned five, I'm like, you know, I want to be a doctor. And for about 13 years, I went to be an ophthalmologist, and I have no idea why. And that was the plan until I got into college, and I started thinking about some other specialty as I thought about neuropsychology, because I was reading all these Michael Crichton novels.

And I thought about surgery before I realized I'm clumsy and I can't stand still very long. I thought about other things. And then ultimately, I became involved with EMS [emergency medical services] and I decided, Oh, I'm going to do emergency medicine when I'm a physician. So throughout medical school, for all but 6 hours, I'm like, I'm going to do emergency medicine for 6 hours

I thought about anesthesia, but I'm like, I'm going to do emergency medicine. And I figured my future would be in EMS. And when I started residency, of all the three classes, I was really the only person that was interested in the EMS. So, I got involved teaching at the paramedic program at the local community college, even while I was an intern.

And I started teaching a class for medical students as an intern. And that's what I'm going to do. But then I met our toxicologist, Donna Cyr, who was already a world-famous toxicologist. She was president of the American Academy of Clinical Toxicology. And I realized she had this whole body of knowledge. It was just all this information that most doctors never learn.

She knew about the plants, the mushrooms, all the envenomations, the drug interactions. What happens if you overdose? What happens if you withdraw from them? All occupational exposure. That's what I want to do. And I had the option of doing a fellowship immediately after residency, but I decided to fulfill my military obligation because the Air Force was generous enough to pay for medical school.

So, I went on active duty. I was actually teaching toxicology for the Air Force even before my fellowship. I basically started out a few weeks ahead of the residence, but after a few years I learned a lot. But when I was deployed, I can't talk about what I did too much, not until 2031. I signed a 25-year non-disclosure statement, but I was involved with Special Ops and it was really cool from a military standpoint, but from a medical standpoint, it wasn't especially busy.

I had one patient every two weeks on average, so I did a lot of other things to occupy my time. And one day I found a snake on our property, and I became sort of fascinated with the local fauna. And I'm like, you know what? It's 135 degrees here. I love it. And snakes are cool, and I'm going to go somewhere where I can be warm and learn about snakes.

So, I did my fellowship at what was known at the time as Banner Good Samaritan Medical Center in Phoenix, which historically treats the most bites in the country, or certainly, you know, one of the top two or three places in the country. And they have snakebite experts there. And I love them. I realized that's what I want to do with my life.

You know, we saw tons of snake bites. We saw tons of scorpion envenomations like several hundred per year. We saw a spider bite, Gila monster. We saw everything. And that's what I have really devoted my career to since I left there.

PIERCE: Wow. Yes. I have a random fear of all the things you're about to talk about, and I don't know why. And but then there's also that weird fascination on the health care side of it, like how do you treat it when it happens? But to start off, I often hear the terms venomous and poisonous used interchangeably.

Can you kind of help us to understand the difference between those two terms?

GREENE: Absolutely. So, you know, in a lot of languages, a lot of cultures, the words are synonymous. And it's interesting. You go through a sort of an evolution when you know nothing about, you know, venomous critters. You use them interchangeably. Then when you to know a little bit, people get very fired up if, God

forbid, you use the wrong word, like if you referred to a snake as poisonous, you know, you go now, it's venomous and you act kind of like a jerk.

And then at some point you realize, you know, we know what they mean, so we don't bother correcting them, except for in the setting of a scholarly project or whatever. So technically and in venomous or a venomous animal is one that produces its own toxins and has a stinger or a fang some way of actively injecting the venom into the victim.

So, snakes are venomous because they have venom glands, they make the venom and then they have fangs through which they can induce the that poisonous is generally a passive phenomenon where usually they take up something from their environment, from their diet. And if you eat them, you know, if you actively ingest them, then you can get sick so they can introduce it into you, but rather you have to take it.

And then to complicate things, there's something called toxungens, animals where they actively provide a toxin that's either in, you know, produced indigenously or taken from the environment. They actively introduce it, but not through something that breaks the skin. So, they slime you, for example, or they spray you. So, it's not breaking the skin with something sharp, but they still actively do it.

So, there's really technically poisonous and venomous and toxungens. But most people are only familiar with poisons and venomous. But the simple answer is venom. They introduce it to you. Poison, you take it into yourself.

PIERCE: So, there is a ton of different species that can envenomate you throughout the U.S. So, I'm really it seems like it's common. It'd be a common occurrence. Why do you think health care professionals are not trained as well? Or maybe that's not brought in like it needs to be within health care curriculum for how to take care of people who've been envenomated, especially snake bites.

GREENE: I think there's a lot of reasons that most health care professionals aren't educated. First, realize in half the country they'll probably never see a snake bite. So that's already, you know, half your workforce. They're probably never going to see one. And in a lot of places, they may see so few, you know, even anything that I have one of the busiest services in the country and I see at the bedside 80 bites a year

Well, how many people do I see with belly pain per year in the emergency departments and I figure three a day and that's just me working part time. So, imagine you have eight people a day coming to the emergency department. Now multiply that by every emergency department in the country, where there's only like a few thousand bites in the country every year.

So, we're talking about hundreds of thousands, millions of cases of some complaints versus fewer than 10,000 cases per year in the whole U.S. So, it's just it's a matter of volume. You know, it's just not something that they're going to see very often and they're going to see it more in certain places than others. So, on top of that, most people and most specialists don't have envenomations as a formal part of their training.

So, like I looked at the emergency medicine curriculum, you know, the one put out by the ACGME and yes, you have to cover envenomations, but other specialties, they don't specifically have to cover it. And a lot of places

that do coverage, it's being the information being passed on from someone who doesn't know that much about it to someone else who doesn't know much about it.

And then he or she will pass it on to someone who doesn't know much more. So, we perpetuate a lot of misinformation. You know, there are very few people who really care about envenomations like I do. I'd estimate just 25 to 30 of us in the country who really have devoted a significant part of our careers to the proper management and education of snakebites and other envenomations.

PIERCE: Well, I know your patients thank you for that for sure. Can you share what types are when different venomous snake species are found in the U.S. and some of the statistics around them that would be meaningful?

GREENE: Absolutely. So, in the broadest terms, we have two types of snakes that are classically venomous. And I'll explain what I mean by that in a second. We have what we call pit vipers or crotalids, and those include copperheads, cottonmouths, and rattlesnakes. And then we have coral snakes, which are a Elapidae. So, copperheads, cottonmouths and rattlesnakes. I want to point out also that cottonmouths and water moccasins are the exact same thing.

Typically, if you're from the north, you refer to them as cottonmouth, and we tend to use cottonmouth a little more often in scholarly papers, but cotton mouths and water moccasins are the same thing. If you're from the south, you call them water moccasins. Early in my career before people realized who I was and like that, I really do know about this, some crusty old nurse in one of my hospitals, called me out.

I mean, like crusty, an old old like she had been practicing nursing for 470 years. And I walked in one day said, Hey, where's the cotton mouth bite? And she's like, it's a water moccasin bite. If you don't even know what species is, how can we trust you to manage the patients? I was like, whoa, okay, you're nuts.

So anyway, copperheads there are 2 species of copperheads in the United States, they used to have one species and five subspecies, but the taxonomy changed six years ago. So, there's two species of copperheads, two species of cottonmouths, and there's roughly 20 to 21 species of rattlesnakes. And collectively they're pit vipers, and they account for 98% of the bites nationwide... venomous bites and then coral snakes.

There's three species of coral, six native to the U.S. and they account for about 2% of the native bites. Now, there are some snakes that are technically venomous, but they don't tend to cause serious problems very often. And then there's a school of thought that all snakes are venomous to some degree, but most of them are not medically significant.

So, an example of a venomous snake that rarely causes problems, but not never would be a hog nose. And you'll hear people say, oh, you know, they're not venomous or, you know, if you get a reaction to them, you're allergic and that's not true. It's a venom effect. It doesn't happen often. But I've definitely treated and seen plenty of, you know, people who've had envenoming from a hog nose.

But classically we have our pit vipers, and we have our coral snakes. And like I said, of course things account for only 2%. And there's two reasons for that. One, they're just, you know, not many of them. You have three

coral snake species. There's the Arizona one found in and around Arizona. There's the Texas one found in and around Texas.

And then there's the Eastern or Harlequin, which is found primarily in Florida and surrounding states. So, there's not many of them. And these guys are like the laziest animals ever. It's really hard to get envenomed by a coral snake. And that's why, of course, they, unlike most think. And I'll talk about how most snake bites happen in a second. Unlike most snake bites, these guys are so mellow that you pretty much, with rare exception, have to mess with them to get bitten.

And that's not true with the other snakes. So that that's probably a good way to segway into that. So how do most bites occur? There's this popular opinion among herpetologists and maybe some other outdoorsy people, or maybe people who just don't know. They assume that most bites occur when someone's intentionally messing with the snake, and that's simply not true at all.

We did a study using data from the North American Snake Bite Registry, and we found that only 19% of bites were the result of intentional interaction. The overwhelming majority of bites occur when someone doesn't see the snake, isn't aware of the snake's presence, and they step on or near the snake and they get bitten on the foot or the ankle where they reach into a bush or they reach under a log or something and they get bitten.

So the overwhelming number of bites happen when you're not aware of the snake, not when you're messing with a snake. And it's not just our study that showed that the Arizona Poison and Drug Information Center, they did a study and they found that only 12.6% of bites were the result of intentional aggression, meaning that over 87% of bites were the result of just being unlucky and not paying attention to surroundings.

So that's how most bites happen. You're just not aware of the snake, which is why I always tell people, you know, when you're walking at night outside in areas where snakes are common, wear the appropriate footwear, I would say 50% of my bites, even more, probably like 6% of bites, could be avoided if people were wearing sneakers outside instead of being barefoot or wearing flip flops at night when they're walking their dog or taking off the trash or whatever.

PIERCE: Makes sense. I've even seen where my family grew up. We grew up in the South, and so they would go fishing and you have the snakes start coming up the back of the motor while they're fishing and they're unaware because they're fishing and they're not paying attention to the snakes coming up the motor. But once, once a bite happens, I've always heard in the south you're supposed to kill the snake, bring the snake in in a bucket.

I don't necessarily know if that's really what you want us to do, because that's going to risk somebody else getting bit. But is there a way to decipher when you have a bite come in without them knowing exactly what that snake was, that bit them, what it was.

GREENE: Yeah. So let me as a but yeah, please. I don't want people killing the snakes for two reasons. One, I love snakes. And two, you're not eliminating the threat so people can be envenomed by decapitated snakes. There was a case in Texas of years ago that made national attention where someone got really sick after being bitten by a decapitated snake.

Interestingly, the case that didn't get a lot of attention was a guy in South Dakota, probably because there aren't a whole lot of people in South Dakota. But a guy who actually died after he was bitten by a decapitated prairie rattlesnake, he died after being bitten by a decapitated snake. So, they're still dangerous for some amount of time after you kill them.

So don't do that. Yeah, we don't actually have to know the species in order to treat the patients. That said, most people have phones. So, if you can quickly and safely take a photo, great. But the reality is we don't have to know because when someone comes in, they either have no findings or they have clinical findings consistent with a pit viper bite, or they have clinical findings consistent with a coral snake bite. We don't actually have to see the snake in order to treat the patient.

And one of my many I have a lot, but one of my many pet peeves is when someone goes to a hospital and the doctor's like, well, we don't know what snake it is so we can't treat you. That's preposterous. If they have a pit viper bite, you treat them for a pit viper envenomation. If they have a coral snake, you know, of course you treat them for a coral snake. You don't have to know the species because all pit viper bites kind of look the same.

They're characterized by the swelling and the bruising and the sheen to the skin. And they may or may not have systemic toxicity or a hematologic lab abnormality, but clinically their hand or their foot or whatever was bitten, it looks the same. And you can easily distinguish a pit viper bite from a coral snake bite, which doesn't have the swelling, the bruising.

Coral snakes. They have a minimal swelling. They actually have more redness than I typically see with the pit viper bite. But what's characteristic of a coral snake is they have these painful paresthesia. It's like this numbness or tingling, and it's often very painful. In fact, they're more painful, I think, than most pit viper bites. They're among the most painful things I treat second only to widow spider envenomations.

So, it's pretty easy for someone who knows just a little bit of that snake bites to distinguish a pit viper bite from a coral snake bite. And if it's a pit viper bite, you treat it with a pit viper antivenom and there's two of those. If it's a coral snake bite you determine do, they need the antivenom or not.

And typically, we reserve coral snake antivenom for people who have objective weakness. When it's just pain or power as we treat the symptoms.

PIERCE: Well, while you're talking about antivenom, I, I know that one of the main treatments for snakebite that that is venomous is going to be antivenom. But there there seems to be a lot of questions around antivenom such as what is antivenom even made of, how is it made, and is it safe? It seems like a lot of health care providers think it's kind of scary to give. So, there's kind of a give and take of when to give it and if to give it.

GREENE: Yeah. Okay. So let me talk about sort of the history of an animal for the last 25 years. Before 2000, we had one anti-venom for pit vipers. It was called YFACP. And it was very effective, but it also had a really high incidence of side effects. Like acutely 25 to 56% of people would have an adverse reaction.

And if you had gotten 10 more vials, 100% of people got what was called serum sickness sort of a delayed response after the anti-venom. And that can be really painful. And the pain in their joints, fever, rash, itchiness. So, a lot of people were reluctant to use it unless it was absolutely necessary. Well, in 2000, Crofab came out. And Crofab had a much, much, much better safety profile.

You know, the acute the instance of acute adverse reactions depending on the study ranges from like 1.4% to 8%. And the incidences of serum sickness is negligible. And even when people have symptoms, it's much more mild compared to what we had with YFACP. And then in 2018, ANAVIP came on the market here in the United States. And again, it has a good safety profile.

We don't have the exact numbers. It's not been around as much, but it's probably under 10%. Same thing. The incidence of serum sickness is lower. And when they do have it, it's less intense than it was with the YFACP. So, the products we have today either cover and are much safer, much better tolerated than what we use before the year 2000.

So, when people are reluctant to use anti-venom for safety concerns, it means they simply don't understand, you know, the safety of anti-venom. They're just not up to date. Let's talk about how they're made. So antivenom is a basically a form of passive immunity. So, I'm more familiar with Crofab, and I should say I am a consultant for the company that makes them. Basically, they take venom from several snake species.

They have labs in two parts of the country and they have a Mojave rattlesnakes and they have Western Diamondbacks, they have Eastern diamondbacks and they have both types of Cottonmouths. They extract the venom, and it gets shipped down to Australia eventually where they immunize flocks of sheep, each species as snake as its own flock. And they slowly over several months immunize the sheep.

You know, they the infuse these venom components and the sheep develop antibodies. You know, it's a slow, long process. It's safe for the sheep and they get great benefits. You know, they have a great retirement package, and they get two weeks of vacation. They go poolside and drink their little drinks or whatever. And so, they collect these antibodies made to the venom components that are being infused and then the antibodies are processed. With CroFab, there's one extra step that's done in another continent to make it especially pure.

And then ultimately the antibodies are purified. And with CroFab it's called fab fragments because they process the antibodies in such a way that they have only what's called the FAB portion. And that's the part that can bind the venom component and neutralize it. And it doesn't have the part of the antibody that causes most of the adverse reactions. And then additively, they use two snake species, one from, you know, from basically Central and South America.

And again, they infused horses. So, CroFab comes from sheep and it comes from horses and they infuse these venoms, these two venoms into horses and then they process the antibodies and they make what's called Fab two fragments. So, it's a larger molecule. They clean the antibody, a different site, so it's a much larger molecule. But again, they're eliminating the part that causes most of the adverse reactions.

So basically, after the antivenoms are passive immunity that you can infuse into someone when he or she has, you know, evidence of an envenomation.

PIERCE: So, I have actually only taken care of one snake bite in my career. It was in Okinawa, Japan. It was a Habu bite. And there were a lot of rumors that were swirling around about having to use antivenom for this particular bite. And one of the rumors was, oh, you can't go around horses anymore. You're going to be allergic to horses.

And also, that you can never have antivenom again if you've already had it. So, if you get that again, they're sending you to the States. Is there any truth to these rumors? As far as I know now?

GREENE: No. No. So, people can get treated with antivenom more than once. I've treated more than two dozen people multiple times because I have a lot of friends who play with a lot of snakes. So, when they call me, I'm like, all right, what bit you this time? And there's this awesome case report written by my colleague Eric Margolis years ago.

It describes someone who's been treated at least 19 times with antivenom. We know he's been treated more than that, but we couldn't you know, they couldn't document all the other areas. But yeah, you can get antivenom more than once. Now can people develop an allergy eventually? Yes, it's possible. Highly unlikely. And you know, if you are treated with antivenom it doesn't mean you can't be around horses or sheep anymore.

Similarly, if you have a horse or sheep allergy, it doesn't mean you cannot receive antivenom. Now, if someone had a horse allergy, I'd probably prefer to use the sheep products and vice versa. But you can get it because you're not necessarily to have a reaction. And here's the most important thing. Even if you've had adverse reactions to an antivenom before, if you're envenomation is severe enough that you warrant antivenom, we give antivenom.

What you do is you just watch for any allergic reaction where if you want, you can pre-treat them for an allergic reaction. But ultimately, if someone needs antivenom, he or she should get antivenom because it's the definitive treatment for envenomation. You can always treat allergic reaction but there's nothing else you can do for the envenomation besides antivenom.

I mean, there's supportive care that may help and sometimes it is sufficient. But for a bad envenomation with systemic toxicity within hematological lab abnormalities with a lot of significant local injury, you know, you want to get antivenom. So, it's a lot safer than people have been led to believe. And it's frustrating when you have a patient who clearly needs antivenom and his or her doctor is like, oh no, I'm too afraid to use it.

Then they need to ship them somewhere where there's an expert. And that's one of things I constantly emphasize. Going to the closest hospital isn't always the best thing. Yeah, you know, if you're not having any systemic toxicity like trouble breathing or low blood pressure, dizzy, sometimes it makes much more sense to drive 30 minutes or even an hour to go to the definitive care, because then you're going to get treated by an expert.

Someone who's familiar with snakebites. It's better to drive an hour and get treated within an hour of arrival than to go to your local hospital and sit there for 5 hours and not get treated.

PIERCE: Absolutely. Is there a time limit for when you are bitten as to when you can no longer receive antivenom?

GREENE: Well, yes and no. There have been two studies that I'm aware of. One, I coauthor looking at timing of antivenom, and we found that it's most helpful in the first 6 hours. In one of our studies, 5.47 hours. But 6 hours. That said, we often give antivenom even days after the envenomation. In fact, if someone has what's called hematologic recurrence where the labs were abnormal, then they got better and then they get better again like a week later.

Then we'll redose the antivenom even a week after the bite. And it's helpful. Now, you know, if someone were to come in a month after a bite, we're not going to start antivenom. That wouldn't make a whole lot of sense. But you can definitely give it several days later. And it's so frustrating again, when we hear about these doctors saying, oh, well, you got bit 10 hours ago, there's no point giving antivenom.

And of course, there is. If there's ongoing venom effects, you give them antivenom. It works.

PIERCE: So, I want to just kind of talk a little bit about the separate species of snakes. I want to start with the pit vipers. What's important for us to know about the pit vipers? And one of the questions that I really have two is there's 20 different species or so of rattlesnakes. So, is their venom going to be different?

And do they have different effects when the antivenom is used?

GREENE: So, there are certain clinical features that we see with most pit viper medications. Again, we see local tissue swelling in more than 95% of cases and about three quarters of cases. That's all we see. That's why so much of what we do is designed to minimize the local swelling. But there are certain venom components that may be found in one or several species that can cause different effects.

For example, there is a phospholipase A 2 called Mojave toxin, you know, found in some but not all Mojave rattlesnakes. Those that have the toxin are generally located in like California or New Mexico, not as much as Arizona. They get less of the bleeding abnormalities. They get less of the local swelling, but they can get neurotoxicity, which can manifest in its worse form as respiratory paralysis.

But usually, it's more like weakness or eye drooping or something like that. Several other species have Mojave toxin. The Southern Pacific Rattlesnake, for example has that. And then there's some other species that can cause some neurotoxicity. We see it on rare occasions for Western diamondbacks and really rare occasions from sidewinders. We can see it from timber rattlesnakes.

We're not going to see that with most of the vipers. Like you just don't see that with Cottonmouth, you don't see that with copperheads. And then there are some toxins found, especially in the timber rattlesnake, that cause a lot of bleeding or cause platelets to drop and often not respond to antivenom. We see sometimes refractory low platelets with southern Pacific.

And again, it's not something that we see with most pit vipers. Luckily, the antivenoms we use are designed to cover a variety of snake antigens. That's why, you know, we don't have to tailor a specific antivenom for a specific species. That would be sort of cost prohibitive and would just be very difficult. So, by using multiple

species, you know, like I said, Crofab really uses five species and ANAVAP uses two species, we can cover for a variety of snake antigens so we can treat the envenomations irrespective of what snake is actually responsible.

PIERCE: So, I've always been told that the separation between fangs tells you how big the snake is, because I remember the Habu bite. That was one of the things that everybody talked about was how wide the fang marks were. But does that really help you determine the size? And when it comes to a dry versus wet, the bigger the snake, the more venom they release, so to say.

GREENE: Yeah. So, let me talk about two things there. First, let's talk about the biggest misconception there is when it comes to snake bites. It is literally the question I'm asked most commonly, and it's the first thing I mention on my website. You'll hear people say that baby snakes are more dangerous than adult snakes. This is 100% unequivocally false.

Okay, look, you'll hear people say that baby snakes are more dangerous because they can't control how much venom they release, that they just shoot everything at once. First of all, that's completely untrue. That's 100% untrue. Juveniles are born with the ability to regulate their venom just as well as adults can. So, I will say in some species, the composition of the venom does evolve over time, and you may see more bleeding early, you know, with a juvenile snake's venom versus an adult.

And it makes sense. It's how they kill their prey and what their diet is. But that's actually not as big of a component in determining how bad an envenomation is as the amount of venom. And adults make more venom. So even if even if they only, you know, injected a percentage of their venom and a baby did in fact inject all of it, adults have so much more that they're going to give more venom on average.

And again, I say on average, because every bite is unique. On average, an adult bite is way more serious than a juvenile. A bite from any snake has the potential to be mild, moderate, serious, or even fatal. So that's one misconception. Now, you asked about the size of the snake and the space between the fang marks. Well, there's a few things to understand.

First, you often don't see any fang marks. The swelling often obscures the fang marks. Secondly, a lot of times envenomations are due to a single fang. You know, the fangs are very mobile for pit vipers as opposed to coral snakes. Coral snakes have fixed-point fangs, whereas pit vipers have mobile front fangs. So, you may get, you know, jammed with one fang or you may get jabbed, you get injected with one and the other one sort of scrapes.

So, you have one fang mark and a scrape. So, you can't really measure the distance when there's not two fang marks. But the other thing to consider is because these fangs are so mobile, they can move inward. And then you have a small space between the two fang marks, which would suggest incorrectly that it's a small snake or they can move outward.

And then you have a larger distance, which may lead to believe that it's a bigger thing. Now, I will say if there's two fang marks that are really far apart, that's obviously a bigger snake, unless they got bitten two different times. But if it's, you know, a small distance or a medium distance, you really can't tell. Typically, the larger the snake, the more venom is delivered, so the worse the effects.

But really you can't tell, ultimately you don't have to know. It's nice to know. It's not a have to know or anything because you're going to treat the patient based on the clinical features you see in front of you right now.

PIERCE: Right. Now when you think that a bite is dry, do you have to watch it for so long in order to ensure? Is there kind of a time gap there?

GREENE: Yes. So, first of all, let's define a dry bite. A dry bite means there's no venom effects whatsoever. All too often I hear people say, oh, well, my doctor said, you know, that even though I've swelling and bruising because my labs are fine it must be a dry bite. That is so frustrating. Swelling and bruising are venom effects.

If you have venom effects, it's not a dry bite. And when it comes to pit vipers, the incidence of dry bites is less than 10%. Realize you know, if you're getting bitten by a pit viper, you're probably going to have venom effects. A dry bite is the exception, not the rule. So, a dry bite means there's no venom effects. Now, what you need to know is that sometimes these venom effects are delayed.

You can't make a diagnosis of dry bite an hour after the bites. You can't make it after 2 hours. The recommendations are to watch these people for a minimum of 8 hours because snake bites are dynamic. What looks really innocuous at first can be really bad 6, 7, 8 hours later. Now, if you have no effects after 8 hours, you can safely say alright it's a dry bite and that's for pit vipers. Technically for coral snakes,

We always watch these people for 12 hours while those symptoms often appear early especially in southeast Texas, where they have pain and palpations right away. Sometimes you won't manifest signs and symptoms until, you know, a delay of half a day or more. So, we always recommend watching those for 12 hours. But if you have no symptoms at all, no findings, we still watch it for at least for 8 hours for a pit viper. And if you have any signs you know, any bruising, any swelling the recommendations should watch for a minimum of 12 to 24 hours, even if they don't need antivenom.

We still watch to see if it gets worse because a lot of bites that look really not that big a deal at first gets worse and then they need antivenom. And it's even happened to me where I discharge someone after about 6, 7 hours thinking yeah, they're probably fine and they came back, you know, 8 hours later with way more swelling, bruising.

And I regretted not watching them longer not you know.

PIERCE: Right. What is recovery? What is the treatment and recovery look like for pit vipers?

GREENE: So, if you get treated appropriately, you know, you get timely antivenom and they don't do anything stupid like unnecessary surgery, you know, as long as they elevate appropriately and they don't try to, you know, RUSH your recovery too fast. Most people recover fully.

PIERCE: Antibiotics. No.

GREENE: No, we'll get to antibodies. No, no, no, no, no, no. Most people can recover just fine. But people, especially if they're under treated or go untreated. Some people have prolonged or even permanent disability

is estimated that even with copperheads, which on average are the least serious. Even with copperheads, it's estimated that untreated about 20% of people will have prolonged or even permanent disability.

That's why I'm so aggressive in treating these patients. I don't want people to have prolonged swelling. I want people to have prolonged disability. You know it is life altering. And one of the take home points from the randomized clinical trial for which I was one of the investigators and one of the authors, we found that even mild bites, they got better in a statistically and clinically significant way at two weeks. The people who got treated were better off than those who did not get treated and get treatment.

PIERCE: And is there a correlation between how soon they get anti-venom to that disability that you've seen?

GREENE: I think, you know, 6 hours is probably better, but I don't know specifically beyond that. But yeah, if they get appropriate treatment, they should do fine. It's the ones who don't get appropriate treatments. So, what is inappropriate treatments? There's two things, you know, well there is three big mistakes I see. Not giving anti-venom. One is indicated giving antibiotics unnecessarily and surgical intervention.

Let me talk about this. The incidence of infection following snakebite is less than 1%. Fewer than 1% of these envenomations are going to get an infection. And typically, infection occurs when someone's manipulating the bite site, they're licking it or they're cutting and sucking, or are they scratching it. Or when, God forbid, they get a scalpel, you know, they cut into it.

That's when we see most of our infections. If you just manage it conservatively, you know, with appropriate care, antivenom, elevation, you know, soap and water, they're not going to get infected. So, no, you don't need antibiotics. Antibiotics just cause side effects. They contribute to resistance. They can cause allergic reactions. And ironically, there's actually some antibiotics that can potentially contain certain snake venom components.

So, in theory, certain antibiotics could actually make an envenomation worse. How's that for a, you know, kick in the pants? And then the other thing, of course, and this is a battle we constantly fight, those of us who are treating these, these are medical emergencies. These are not surgical emergencies. These are not trauma emergencies. These are best managed medically.

We don't cut into snake bites. You know, there's no benefit in debriding these wounds, and there's no benefit in doing a prophylactic fasciotomy for potential compartment syndrome. And even if someone has compartment syndrome which is exceptionally rare, the initial treatment is not surgery, it's actually more antivenom. So, these things really do not require acute surgical intervention. And we try to make sure everyone understands these are medical, not surgical things.

The only time surgery is really necessary is if someone has full thickness necrosis. I don't mean a little superficial hemorrhagic bleb. Those are going to heal just fine as long as you leave them alone. Only if the entire finger or toe or whatever it is completely necrose, then they need an amputation. But that's exceptionally rare. Maybe once every few years, these things are best managed medically and we don't want people holding sharp objects to get near them.

PIERCE: So, what I heard you saying earlier is that the snakes do a really good job of keeping their fangs clean. So, no antibiotics.

GREENE: Yeah, you don't see infection and antibiotics are just it's not helpful and it's potentially harmful.

PIERCE: Yes, because most bites that I am familiar with, especially like dog bites and things, that's one of the things they talk about is how dirty their mouth are. So, this is one of the first bites I've heard with no antibiotics.

GREENE: Mammals are the worst for bites. You know, for infections than snakes are. I can recall antibiotics to two patients. I've treated over 1000 snake bites. I've given antibiotics to two patients. One, he was immunocompromised, and I and he didn't have anything worrisome on exam. And I remember I debated, and I finally gave it to him, and I got teased by my colleagues the other time as a kid who was actually like basically cutting into it.

He kept playing with his bite, he was cutting into it, and he developed the secondary infection and I put him on antibiotics literally other than that I'd never given antibiotics. And I follow up with all my patients, you know, for a long time after the bite to know if there's any delayed stuff and they don't get infected. Just leave them the heck alone.

They don't get infected.

PIERCE: That's really good to know. Now moving from pet vipers to coral snakes, what's the difference in their treatment from pit vipers and corals.

GREENE: All right. So coral snakes again, there's no tissue injury, there's no swelling, there's no bruising. We don't see any hematologic toxicity. What's characteristic of coral snakes, neurotoxicity. And as you go from West to east in the country, they get a lot more serious. Like in Arizona, they cause a little bit of pain, very rarely do they cause any systemic complaints.

There's no deaths. There's no respiratory or skeletal muscle paralysis. In fact, oftentimes we don't even need to admit them to the hospital. In Texas, there is some sort of geographic variation I'm sort of studying right now. In south and east Texas, we see a lot of pain and paresthesia, but I really don't see any objective weakness. Whereas in North and central Texas, we see some objective weakness, but nothing life threatening, no skeletal or respiratory muscle paralysis.

And that's why there are literally no human fatalities attributed to Texas coral snakes. But as you get farther east, you get to the eastern coral snake and those have the potential to be serious. There was one death in the last 50 years. It was in 2006. It was somebody who did not seek medical attention. What we see with the eastern coral snakes are again pain and paresthesia, although sometimes the pain's actually less intense, but they can also have objective weakness.

It doesn't happen all the time. And I think in the past a lot of people would give antivenom even prophylactically. And now we know that's not necessary, but they can get objective weakness. So, one of the things we have to do for coral snakes is constantly reassess their respiratory muscle strength and their skeletal muscle strength. And we can do that a variety of ways, including negative inspiratory force and dynamometry.

But if they have any complaints of weakness, then we consider giving anti-venom. But pain and paresthesia is mainly what you have to worry about. And that's what you get with coral snakes. You don't get anything else. Locally, you get a little bit of redness and minimal swelling and it's nothing like a pit viper bite. And anyone who's ever seen any snake bite should be able to distinguish one from the other.

PIERCE: It's really interesting that you're talking about the statistics of how many people have actually died or how bad the bite is, because I thought that the coral snakes had one of the deadliest venoms.

GREENE: So coral snakes again. There's. Sorry, I got distracted for a second. There's three coral snake species and yes, the East coral snake has potent venom, but potency is only one determinant. Like I said before, the volume of venom is a much, much bigger factor in how bad an envenomation is going to be. There's been one death from a coral snake in the last 50 years, and really there are a lot fewer coral snakes.

But even percentage wise, it's a lower percentage because most of it is just pain and paresthesias. Yeah. And the other thing is most of the potencies are not studied in humans. They're studied in host animals in, you know, subject, you know, animals that aren't perfect models for humans. Now, we do mice studies, rat studies, sometimes pig studies.

And while they're good, they're not perfect. The bottom line is coral snakes are a lot less worrisome than pit vipers. And that and again, among pit vipers, rattlesnakes tend to be the worst. The timber rattlesnake actually kills the most people. But I would argue the most dangerous when you consider both the volume of venom and the potency, I would consider the Mojave Rattlesnake the most dangerous and there are estimates that untreated, maybe even a third of these people would die if they got no medical treatment whatsoever.

Whereas with like a timber rattlesnake, it's probably closer to 10%. And with a copperhead less than 1%.

PIERCE: Wow. I can't imagine not having treatment. I want to move really quickly. I want to ask about some areas where we have non-native snake bites that will come in that will need to be treated by a health care provider. What should a health care provider know if a non-native bite comes in, what to do?

GREENE: Okay, I'm glad you asked, because here in Texas we see tons of non-native bites because it's really easy to own these snakes. A \$20 permit at Walmart. You have to know a few things. First, you have to know that you probably don't know. And, you know, I think one of the common themes of health care professionals, especially my physician colleagues, is this hubris where I can manage this.

I'm a doctor. Well, no, you can't. And you have to admit that to yourself. You have to acknowledge that you don't know how to manage these bites and you have to call an expert. We hear all these horror stories where, you know, someone tries to treat a non-native bite using our native antivenom, for example, and those are not appropriate.

You know, they're not going to help whatsoever. So, you have to know whom to call. And, you know, there are people like me and my colleagues, you know, involved with the National Snakebite Support. And people involved with the American Academy of Clinical Toxicology, the American College of Toxicology, who have a lot of experience with non-native snakes. So, you have to know that you should reach out to someone.

And then there's things to watch for. You know, with some of our non-native states, we're not going to see a whole lot of tissue injury, but we'll see a lot of neurotoxicity and things that we wouldn't do for our native snakes, such as pressure immobilization maybe indicated, for example, with an exclusively neurotoxic cobra bite or, you know, maybe a mamba bite or the Australian elapids.

So, we're going to do things differently. We may use different medications, not even counting antivenom. And of course, we have to use the specific antivenoms. The American Academy of Clinical Toxicology is putting out a paper how to treat non-native bites here in the U.S. And then my colleagues and I, we actually wrote something for the Department of Defense.

It's available online. It's the global snake envenomation management guideline and it talks about how to manage snakes from around the world. It's for troops that are deployed. But the same lessons apply if you have that kind of species here in the United States. So, for example, let's say this antivenom or this antivenom are recommended for, say, a bite from a mamba, whereas this antivenom was recommended for a bite from monocled cobra.

And this anti-venom is recommended for a bite from a Brazilian lancehead. So, it tells you what antivenoms to use and it tells you how to prepare the antivenom because sometimes you are going to use different volumes. You wash for different side effects. So, the big thing with the non-native is knowing what snake it is and then getting an expert involved so he or she can tell you what to do and what not to do.

I'm lucky I treat a lot of these. I've written a bunch of case reports. They're all in the Journal of Emergency Medicine, including the mamba bite and previously a white lipped tree viper bite. I've got a thing on cobra bites, specifically the monocled cobra. So yeah, the most important thing is to acknowledge that you don't know what to do and don't try to wing it.

Just call someone who does know what to do.

PIERCE: Another question. It just came to my mind that I want to ask really quick as we wrap this up is antivenom and pediatrics versus adults dosing. Do we lower it for peds?

GREENE: We do not lower the dosing for peds. If you think about it, a human of any size is a whole lot bigger than a snake. And the snake can't really distinguish a kid from an adult. So, the thing is going to be venom with how much venom, irrespective of the size adult. In a kid, the ratio of venom to body weight is actually going to be higher than the ratio of venom to body weight in adults.

So, we're definitely not going to lower the dose. We treat them the same because we're not only treating the patients so much, we're treating the venom and the venom is the same. So, we don't adjust dosing for pediatric versus adult patients. Now, if it were an infant, we may concentrate the antivenom in a little bit so there's less volume because typically you give 250ccs.

And for a tiny kid that might be a lot. But other than that rare exception, we just don't do anything differently.

PIERCE: Okay. It's good. It's good to know. Okay, so we are wrapping up episode one. I want to ask you one more question. A lot of health care providers will donate their time in the summer at camps for kids and youth, if a snake bite happens in the field, what should they do?

GREENE: First, don't panic, because, you know, if they get the appropriate treatment, they'll be just fine. Get away from the snake. You know, if you can quickly and safely take a picture of the snake then do so, but don't delay treatment. Don't delay transport. Because again, I don't have to know the species. I like to know the species, but get away from snake, don't do anything stupid.

So, things that were recommended in the past have been shown to be useless at best or dangerous at worst. So, we're not going to cut and suck. We're not going to use any sort of electrical therapy to denature the venom. You know, people think, oh, like if I can denature the venom, I can stop the envenomation. Well, yeah, but when you do that, you burn the patient and sometimes you denature the patient, and it kills them.

So don't do that. We're not going to wrap it with anything. We're not going to use any commercial, you know, extraction devices. Basically, what you do is remove any constrictive jewelry, any constrictive clothing. You're going to call 911 or arrange transport to the hospital, and then you can do something that is different from what was recommended 20, 30 years ago.

In the past, people said to position the affected limb below heart level because they didn't want to increase the systemic absorption of venom. We absolutely do not recommend that now. What we do is, well, I'll tell you where I am with copperheads and cottonmouths, where we know that systemic toxicity is much less likely than tissue injury, which is almost a guarantee we elevate immediately, you know, get it to about 60 degrees.

Don't bend the elbow or the knee. We elevate because that's going to minimize the local swelling and that's the thing we're trying to minimize. You know, we're worried about local when we're not worried about systemic. And so, in the past, we said keep it below heart level. Now most of the time we recommend elevation. If it's a rattlesnake and you're worried about systemic toxicity, it's reasonable to keep at heart level.

But even then, I think elevation helps. And we do have some evidence, at least with Copperheads, that elevation improves outcomes. Patients feel better, you know. And it's not really going to change the amount of venom absorption into the systemic circulation. It's going to help with the swelling, though, which again is seen in over 95% of our bites.

So don't do anything stupid. Call 911. We want to arrange for transport to a hospital and elevate. Don't wrap it. Don't do a tourniquet. Don't do pressure immobilization. Don't cut. Just get to the hospital where they can get definitive care.

PIERCE: Thank you That's really good.

GREENE: And another thing, don't pack it in ice. You know prolonged ice is actually bad for the tissue. And of course, finally, because it was on social media for so long Benadryl does absolutely nothing for a snake envenomation. It will not help the patients. And because of sedation, it makes it unable for them to provide a good history.

It can theoretically harm, so we don't use Benadryl for snakebites. And I don't even know where this nonsense came from in the first place.

PIERCE: That's very that's some very good information. Thank you very much. Well, that's all the time we have for episode one. We are so glad that you could join us for this first episode in our series of Common Envenomations. Dr. Greene, thank you for joining us and sharing your expertise. If you enjoyed this episode, we hope you will join us for episode two, where we will continue the discussion on envenomations.

I am Dr. Candace Pierce for Elite Learning by Colibri Healthcare.

Episode 2 – Spiders, Insects, Monsters and More, Oh My.

PIERCE: Welcome back to episode two of our podcast series on Common Envenomations. I'm Dr. Candace Pierce with Elite Learning by Colibri Healthcare and back with me to continue our discussion is Dr. Spencer Greene. Thank you, Dr. Greene, for joining us for episode two. If you missed that one, check it out. It's very insightful. We discussed venomous versus poisonous and common snake envenomations in the US.

We have so much left to cover in this episode, so we're jumping right in spiders. Let's start talking about some spiders. So, Dr. Greene, I know there's two, two big ones, widow spiders and recluse spiders. Tell us about those.

GREENE: All right. Yeah. So, there's two main types of spiders we think about in the United States. The widow spiders or recluse spiders. I can't speak. No, here. A lot of people talk about, you know, black widows. Well, technically speaking, there's no spider black widow. We have different types of black widows, and we also have a brown widow.

So here in the United States, we have five widow spiders. We have the southern black widow. We have the western black widow. We have the northern black widow. Although if you look at its geographic distribution, it really should be called the Eastern Black Widow. We have a red legged widow which is confined to Florida. And then we have the brown widow, which is actually widely distributed.

In fact, it's widely distributed around the whole world. And widow spiders, irrespective of species, cause a specific type of envenomation. Then we also have recluse spiders. Arguably the most famous is the brown recluse. And that has a pretty big distribution, although not nearly as big as the widow spiders. And there's a lot of parts of the country that don't have the brown recluse or any other recluse spider, and that has some important clinical implications.

And then we have a few other recluse spiders, which have a much narrower geographic distributions. So overall there's like six or seven species of recluse spiders in the US.

PIERCE: What are the statistic books on these bites as far as what are they doing when they get bit, who gets bit?

GREENE: Okay, so most people get bitten by either a widow spider or recluse spider when they're unaware and they sort of crush it or are threatened in some sort of way. You know, these spiders aren't going to attack

you. But if you sit down on them or you put your hand on them, they are going to bite in defense. As for statistics, I can tell you I have about 200 to 300 people a year who come in alleging recluse spider bite.

And of those 200 or 300 people, maybe one of them has a recluse spider. It's the biggest joke in toxinology if you will. Anytime someone has a rash or an abscess or some sort of soft tissue infection, they want to blame a spider. Guess what. It's almost never a spider. And this is especially true, you know, in people in the Northeast or northern United States where there are no recluse spiders.

They'll come in. Oh, I have a spider bite. No, you don't. You have an abscess. And it's important to distinguish because the treatments are diametrically opposed. What we do for an abscess is the worst thing you can do for a recluse spider. And what you do for recluse spider is the worst thing you can do for an abscess.

So, we get a few hundred spider bites reported to poison centers per year and we know that poisons data is incomplete. But I can tell you in my practice I see one to two widow spiders per year and one recluse spider bite per year. But I see hundreds of people who think they have a spider bite.

PIERCE: Yes. I thought they were more common than that because of what you're saying. I had no idea. How do you determine the difference when they come in? If you determine it is a spider bite, a recluse versus a widow.

GREENE: Well, widow bites and recluse bites look nothing alike. I mean, that's like confusing a Ferrari with a bicycle. Widow spiders are the most painful thing I treat. Widow spider envenomations are the most painful things I treat. And irrespective of species, what we see is sort of a sympathomimetic toxidrome. These people are hypotensive, they're tachycardic, they're diaphoretic, they're miserable, and they also have a lot of...

They get a massive release of acetylcholine, so they have a lot of profound muscle spasms and muscle cramping. So, they'll be double over in pain. They'll have really obvious muscle spasms. And oftentimes they're massaging the leg or arm, whatever is spasming because it's so painful. These people look like death, and they have the sensation that they're going to die.

But ironically, death is actually really uncommon fortunately. Even less common than recluse spider bites. So, it's really dramatic and they just look so, so miserable. They're pouring out sweat. It's hard to really confuse it with anything else. On the other hand, recluse spiders are, their envenomations is a lot more insidious. There are two types of things we worry about with recluse spiders. Locally, I think most people are familiar with the little eschar. They get the ulcer and that's more of a...

That's, you know, the bite often goes unnoticed and in the first few minutes may have like a little red bump. And over the course of hours to days, it's going to evolve and eventually you're going to have this central area of, you know, discoloration. They'll be bluish, blackish, brownish, surrounded by this white ring of ischemia, surrounded by this red ray.

And we call it the red, white, and blue pattern. And these things are flat. They're dry. They look nothing like an abscess or a soft tissue infection. They're not angry looking and they're not draining, you know, and that's why it's important to distinguish the two. With an abscess, we're going to drain it. We're going to cut into it.

You don't want to cut into a recluse spider bite. That actually impairs healing. And that's what we see primarily with recluse spider bites. But what's dangerous about recluse spider envenomations isn't the local stuff. It's the systemic toxicity making what's called Loxoscelism as a constellation of findings that develop anywhere from 24 to 72 hours after the bite.

Then they get fever, and they can get rash, which uncomfortable. But what's dangerous is they get really bad hemolysis, so all the red blood cells will get destroyed, which makes them profoundly anemic and can lead to cardiovascular collapse. And all the products of the hemolysis are going to clog the kidneys. So, they can get renal failure, which can also contribute to cardiovascular collapse.

So, we get a death every few years from a recluse spider that's almost always in a kid because they just have this systemic toxicity. But they don't look dramatically uncomfortable like a widow spider. So, it's really easy to distinguish one from the other using local or systemic. Oh, and locally I should mention for widow spiders, there's not much. Sometimes we see a little redness and swelling, but there's no big lesion.

And there's you know, and oftentimes it's not even anything you know at all, you know, maybe a little shamrock, but there's no gross wound like and eventually get with recluse bites.

PIERCE: So, what's that treatment like?

GREENE: So, for widows supportive care you know in focus in their early being circulation, they're often hypertensive, not hypotensive. So, we may have to lower their blood pressure, especially if they're at risk for complications from high blood pressure, like if they have a history of stroke or if they're pregnant. We give them pain medicine; we give them muscle relaxants.

I like to use benzodiazepines because in addition to the muscle relaxation, they also provide some anxiolysis. And then if it's really bad, where the refractory to the adjuvants, we actually have antivenom for widow spiders. And again, it has the same bad reputation that snake antivenom has. Oh, it's so dangerous we shouldn't use it. It actually has a really good safety profile.

One big study estimated the incidence of adverse reactions, I think at 3.5%. So, it's not completely benign, but no drug is. But when used appropriately, it's actually very safe. It may be a little hard to get, but fortunately later this year we should have another antivenom on the market, which should be easier to access.

PIERCE: I was going to ask how easy it was to get your hands on the antivenom.

GREENE: It's hard to get the anti-venom for widow spiders right now. But you know, by the end of 2023, it should be something that hospitals should be able to purchase and stock if they're in areas where there's widow spider patients. So, pain control, good supportive care for widow spiders. For recluse spiders, the systemic toxicity, a good, good supportive care, fluid resuscitation. They may benefit from plasmapheresis. They may benefit from corticosteroids for systemic toxicity. For the local toxicity,

It's very simple. For the local findings of a recluse bite, just leave it the hell alone. That's what you do for a recluse bite. You don't cut into it. Most of the time, you know, at least 80% of the time they're going to recover

fully if you just leave it alone. There was a study by Donna Seeger and Keith Rand and Seth Wright and Lindsey Murray out of Vanderbilt years ago.

They found that 97% of the wounds from a recluse bite got better spontaneously even when just left them alone. So, you're not going to cut into it because that will actually increase the likelihood of impaired healing. The 3 to 20% that do not recover eventually will need skin grafting. But what you don't want to do is do it prematurely, so wait a few weeks, otherwise leave it alone.

You don't need antibiotics. These are not infectious. You don't use steroids. You don't use hyperbaric oxygen. Just leave it the heck alone. Keep it clean and dry and most of the time they will get better. So, you deal with the systemic stuff and the best thing you can do for the local stuff is don't let anybody cut into it or give unnecessary antibiotics.

PIERCE: What does that long term recovery look like for them? Sounds terrible in the acute phase.

GREENE: Anywhere from 80 to 97% will recover just fine over the course of a few weeks. The others get, you know, a skin graft and then they do fine. The recovery from widow spiders again, if you survive the initial insult, you should be fine. There are case reports of people getting cardiomyopathy, but they are really rare and generally resolved once the envenomation is over.

So, they both have great prognosis. Again, you just don't do anything harmful during the acute phase.

PIERCE: Those sound horrible. I didn't realize they were so bad in that initial bite. I've seen a recluse. I've seen the wound from a bite. But I remember it was when I was in high school, I didn't look pretty. It's the only one I've ever seen, though. I've never seen one in the hospital setting.

GREENE: A lot of people think they have a recluse bite. But again, almost everybody who alleges recluse bite, does not have a recluse bite?

PIERCE: I thought it was interesting. I was reading one of your articles when I was preparing for this, and one of the things you said is that there are many more species of spiders that are blamed for clinical effects for which they are not responsible.

GREENE: Is it just saying, you know, people always attribute signs and symptoms to spiders and it's not spiders? Yeah.

PIERCE: Tarantulas, are they?

GREENE: Okay, so tarantulas are cool.

PIERCE: I don't think so. They are so big.

GREENE: Their bites are ouches, but that's it. The only other thing to worry about with tarantulas is they can flick these hairs they have on their abdomen, and they can get in your eyes. And cause some damage to your eyes. If they're threatened, they can flick these hairs, but generally their bites are ouches at best.

PIERCE: Yeah. They are so big, I bet.

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GREENE

I think the biggest problem with tarantulas is arachnophobia and people having, you know, panic attacks when they see, you know, there's spiders bigger than their first car coming toward them.

PIERCE: Exactly. Yeah. I'm going to go the opposite direction. Yeah. Okay. Scorpions. I don't know why I have this fear of them being in my shoes. I don't know if they're here in Florida.

GREENE: I am assuming your talking about the arthropods and not the band from Germany. Because I'd be afraid if they were my shoe as well. But yeah. So, scorpions are found throughout the south and in other parts of countries. Well, not so much in the northeast or the northern part of the country, but sometimes in a lot of places. The good news is of the approximately 90 scorpion species in the U.S., most of them, their stings are not that serious.

There's only one species that consistently is worrisome, and that is the Arizona Bark Scorpion, *Centruroides sculpturatus*, which is primarily in Arizona. And then like the western part of New Mexico, the eastern part of California, the southern part of Nevada and the southern part of Utah. So, the rest of the country, they have scorpions, and their stings are ouches.

There have been some adverse reactions from the striped bark scorpion, which is found to actually have the biggest distribution of any scorpion species. We have it here in Texas. There have been at least two deaths attributed to that, but both times it was due to legitimate anaphylaxis. People who are previously sensitized to arthropod venom, who had legitimate, and laboratory confirmed anaphylaxis.

So, there's been two deaths with that. And again, that's not a lot. Most of the time scorpions are ouches. The Arizona Bark Scorpion is a unique animal that has a very unique clinical presentation, a sort of a grading system. You know, when you get stung by one of those and if it's a mild envenomation, you'll have pain or paresthesia at the site. If it's a little more serious, it will be called grade 2 and they'll have pain and paresthesia locally, but also in a site distant from where they were stung.

And then when you get a grade three and four, you can start getting cranial nerve involvements where they can have what's called opsoclonus, where their eyes are going different directions or they can have tongue fasciculations, or their larynx can spasm. They can have neuromuscular thrashing and those are really impressive and scary looking and potentially life threatening.

But fortunately, we can manage these people with either antivenom or with supportive care and the antivenom for the Arizona bark scorpion is very effective, very safe. It's actually a phenomenal drug. And I was one of the seven investigators back in 2007 and 2008. And it was just amazing to see these people who were so miserable in so much pain gets the antivenom in 35, 40 minutes later, they were totally fine and went home.

PIERCE: Wow. How easy is it to get that antivenom?

GREENE: So, I don't practice in Arizona anymore, but I can tell you when I was there, pretty much all the hospitals had it. Because scorpion envenomations are so common. You know, my first year in fellowship, we saw maybe 50 or 60 snake bites. I not sure. I mean, anywhere from 45 to 60. We probably saw several hundred scorpion stings.

And my first time ever on call, I remember I had five patients. My first patient ever was an oxycodone and acetaminophen overdose and two of the next four were scorpion envenomations. And because I had been teaching toxicology in Ohio, that was something with which I wasn't at all familiar. So, it was very eye opening for me to see how painful they were, but also how quickly they responded to appropriate treatments.

PIERCE: Where are you usually stung by a scorpion? Is there like a and they just walk barefoot.

GREENE: So sometimes, oftentimes the hand because you don't reach into something else yet. But often in kids, you know, the scorpions will fall on them like or whatever. So, you can get stung anywhere.

PIERCE: Yeah. My gosh.

GREENE: But yeah, see, hands are most common. With babies if there was one that fell into their crib, they could be anywhere on the torso.

PIERCE: Oh, gosh, that sounds terrible.

GREENE: Yeah.

PIERCE: Okay. Anything else I need to know about scorpions before we move into insects?

GREENE: Like I said, really painful. So, if you don't have antivenom, good, supportive care. I remember seeing years ago a lot of people were treating these with benzodiazepines because the patients were so agitated, but they were agitated because they are so painful. So, make sure you're liberal with the opioids as well. You know, these are painful, so give them pain meds.

PIERCE: All right. So, wasps, bees . Well, I'll start with bees. First of all, I didn't realize that a bumble bee and a honeybee were not the same thing. I thought it was the same. There are differences.

GREENE: There are differences. Yes, they are different species.

PIERCE: Yeah. I didn't know that.

GREENE: And so, you know, honeybees, they have their barbed stingers, and they sting you once and then they die. And, you know, with the other Hymenoptera, they don't have barbed stingers. So, they can sting you more than once.

PIERCE: But we also have the killer bees.

PIERCE: I was just going to say, what is there that that the treatment difference between honeybees and then killer bees.

Yeah. We call them hybridized. So, the bees themselves individually are not more dangerous than our domestic ones. And realize in the south, pretty much all the bees that are in the wild are these hybridized. You know, they entered America in Hidalgo, Texas, back in the nineties, and they have pretty much taken over the southern half of the United States.

GREENE: What makes them so dangerous isn't the individual venom or the individual bee. It is the fact that they have this mob mentality, this swarm mentality. They will defend the hive at all costs. They're like the Terminator. They're not going to go away until they complete their mission. So, if you disturb them, they're going to go after you and they're going to sting you.

And it is not going to be one or two stings. It is going to be hundreds or thousands of stings. I've treated two patients who each had over 2,000 stings. Individually, not a big deal. But when you get that many, it becomes a big deal. Because we start worrying about life-threatening signs and symptoms at about 20 to 40 stings per kilogram.

So, if you have someone who weighs 50 kilos and 20 stings, that's a thousand stings. Well, someone has 2000 stings. That's potentially really dangerous. And that's not even talking about the allergy stuff. Obviously, allergy to Hymenoptera is something different and even a single sting can cause life threatening symptoms. But even people who are not allergic, when you get that many stings, you can get systemic toxicity, you know, cardiovascular collapse and, you know, airway swelling, all sorts of things.

PIERCE: Now, I learned this a few years ago. We have I have an anesthesiologist friend and they are he has beehives. So, I went out there with them a few times to check the hives. And reached down, and she got stung on her jeans by a honeybee. So, she went to hit it. And when she hit it, she said, "I can't get in the truck with you now" because I guess there's a pheromone that they release that says to the hive, because she was we were very close to the hive that there was danger.

So, they actually came and swarmed around her, but they didn't sting her anymore. She had to walk. She had to keep walking away from the hive and eventually they left her alone. But the difference between the honeybees, I guess, hybrid bees, would be that mentality that they would have come out stinging, they would have come out more aggressive versus that honeybee, probably.

GREENE: That's a little outside my area of expertise. I didn't know about that. Yeah, but I knew you had to walk them off eventually. I mean, it was like, But yeah, yeah.

PIERCE: She had to walk a long way away from the hive for she to get back in the truck with us. So that was very interesting. So, when I was in high school, I got stung by something in between my fingers. I went to pull a towel off air, off of a rope. That was where it was drying.

And I remember it hurt really, really bad. We had no idea what it was, but I was going to go to the lake and swim. I didn't think much about it, but I started to feel really, really nauseous. So, I went and sat down on the

steps and the nausea didn't get better. So, I stood up to go to the bathroom and I reached for the door handle, and I passed right out and I woke up on the couch.

What do you think caused that response? Just a vagal nerve response to the sting.

GREENE: So how old are you When this happened.

PIERCE: I was about 16. 17.

GREENE: Some people are going to have, you know, severe reactions because of the pain. You know, pain can cause people to pass out, no question about it. But one of the things that can happen with a Hymenoptera you can get vasodilation. So yeah, you can just be, you know, you stand up quickly, you get orthostatic, and you pass out.

It can also be a vagal thing where the blood vessels dilate, and your heart rate goes down. So, I don't know. I wasn't there. You probably don't remember all the details. So, there's a lot of explanations for it.

PIERCE: Yeah. Yellowjackets, hornets and wasps. What do we need to know about them?

GREENE: They're evil.

PIERCE: They are. They hurt.

GREENE: Those things hurt. I've been stung by hornets. I've been stung by wasps. They hurt. But again, unless there's a massive envenomation or you're allergic, it's more about pain control and local terror.

PIERCE: Well, I get a lot of health care providers, see how they work out there in the summer with the kids. And I get a lot of children that come to me with being stung. So usually what I do is just try to check and see if the stinger is still in the site. I give them some maybe some kind of topical numbing something to try to help the pain, depending on how it looks, maybe a topical antihistamine or cream.

But what I have also found is that popsicles work really good too for pain control.

GREENE: Popsicles work for the majority of pediatric emergencies. So, I do a lot of pediatric emergency medicine, and I always joke that I can treat, you know, a significant number of my patients with some combination of Zofran, I.V. fluid, and popsicles.

PIERCE: Yes.

GREENE: Oh, yeah. But for your non-life-threatening envenomations, it's good. You know, just good supportive care of pain control. And that includes topical stuff. You know, I like topical lidocaine. One you can use for swelling when it's itchy and swelling, you can use oral or topical antihistamines. Now, you mentioned the stinger. Every once in a while, I hear some talk about, oh, you have to remove the stinger immediately.

It's like so important. It's actually not that important in the scheme of things. You know, the venom sacs attached to the stingers empty all their venom in the first 30 to 60 seconds. So, after the first 30 to 60 seconds, there's no rush to remove the stinger. It's something that has to be done eventually because it's a foreign body, but it's not emergent.

Like if you're dealing with someone with low blood pressure or serious pain or, you know, airways, swelling, it is not a priority after 30 to 60 seconds. You get to it when you get to it. One of our patients who had several thousand stings, was flown to us. We didn't get around to the stingers until like the second day.

We had some medical students get a whole bunch of tape and just go, you know, inch by inch and get all the stingers out. It wasn't a priority because they're essentially inert after the first minute.

PIERCE: I can't imagine having to remove that many stingers. Now, as far as I know, you mentioned antihistamines. What about topical steroids. Is that beneficial?

GREENE: It may be for itchiness. You know, it's worth it if the other topical stuff doesn't work. Yeah. And if there are a lot of swelling, we will do oral steroids as well.

PIERCE: Right. So okay, anything else that our health care provider should know if they come in contact with somebody who's been stung. Carrying an EpiPen.

GREENE: Had an allergy, they should EpiPen. But that's I'm glad you brought that up for all in medications. You know, epi is also going to be used routinely if you have a documented allergy or if someone's having clear signs of anaphylaxis, you know, hypotension, airway swelling, you know, refractory vomiting, then epinephrine should be used, but it shouldn't be used routinely.

And that's true. Regardless of the envenomation, whether it's a snake or spider or a scorpion. Epinephrine is for someone who's having allergic, you know, severe allergic reaction. Not mild ones. Severe allergic reactions.

PIERCE: Okay. Yes. Very good to know. And that's something that we keep on hand at camp in the summer, too. We always have an EpiPen with a provider. And with that, the camp counselors, just in case. caterpillars and centipedes. Anything we need to know about those.

GREENE: Yeah. So, my favorite caterpillar is the puss caterpillar or the asp *Megalopyge opercularis*. And they're adorable. They look like little furry potstickers. The most important thing, though, is to avoid getting stung. So don't sit under oak trees in late fall. They like oak trees, and they'll just fall on people and they get stung. There is a local college where they get like half a dozen to a dozen these a day during peak season because they're just everywhere.

GREENE: Yeah, just because something looks cute and furry don't pick it up because, you know, they have these stingers under their hairs, and it hurts. It hurts a lot. You know, other caterpillars aren't quite as bad, but they can all sting. So, you know, don't mess with them and, you know, don't walk around barefoot in the grass. You know, throughout the country, there's sort of a bimodal distribution.

You see a peak in the late spring, early summer. And then you see one in late fall, early winter. Here in Texas where I am, we don't see them in the summer because it's too hot. So historically, from the end of September to the beginning of November, I guess it's all fall, late summer, we'd see them. This past year.

This past year everything was shifted by a few weeks because of the weather, so I didn't even start seeing them until the beginning of December and I saw them until January. So just watch where you step and don't hang out under oak trees for any length of time unless you're wearing a hat because these things can hurt. Can land on you and hurt.

And generally it's just local pain. Some people do get systemically ill. We published the case report of someone who was transferred for presumed appendicitis or peritonitis because she was so, so symptomatic. She was doubled over in pain. She was having abdominal pain, nausea, vomiting. And so, we numbed up her sting site. All her symptoms resolved. It was.

PIERCE: How do they release the hairs, when they fall on you or...

GREENE: There are stingers underneath their hair. So, if they touch you, if they make contact, you can get stung. Like when, when you touch their bodies, the stingers right below the hairs, we'll just inject the venom.

PIERCE: Oh okay. I thought they released their hair. I don't know if caterpillars do that. Centipedes?

GREENE: Yes. So, centipedes, there's some more. Some of them are really impressive. They're big and scary looking. And they bite. People have debated for a long time. Is it a stinger or is it a bite? It's actually a bite. They have these modified jaws and their bites hurt. You can get systemic toxicity, but mostly it's local.

You know, injury, but it can be an impressive local injury. I had someone in his nineties come in after getting bitten by one of these things and he was miserable. So, we don't see them a lot. But they're out there you know throughout the south. They're in Florida in the southwest. We have them in Texas. I don't see them a lot.

I think I've only seen one centipede in the wild ever.

PIERCE: So, with the caterpillars and the centipedes, really, treatment is going to be pain control.

GREENE: Exactly.

PIERCE: Okay. Marine life. I was reading through some of the different marine life that you were talking about. I did not realize catfish were venomous. That was a new one for me. And I've fished my whole life. But catfish, lionfish, rockfish, scorpion fish, stingrays are all venomous. When I was in Okinawa. Stone fish, I want to say the stone fish was a big one we had to watch out for. So, what do we need to know about these guys?

GREENE: All right, Let's start with the most obvious. There is no benefit in urinating on marine envenomations, whether it's a jellyfish or a stone fish, whatever. You know, if you got to go, you got to go. But don't you know use someone's envenomation as an excuse to urinate on them? It will not change anything.

PIERCE: Good to know.

GREENE: So, the most important thing to know about all marine envenomations is that they have heat labile venom. So, the definitive pain control treatment is immersion in hot water.

PIERCE: Now is it tap water or salt water? Because I have.

GREENE: Hot water and hot tap water's fine. So, But first. I'm glad you asked. The first thing you want to do, especially with jellyfish, you want to remove the tentacles and you want to use saltwater for that. You just pour it on and whisk it away. If you were to use tap water, which is hypotonic, it could exacerbate the firing of the nematocysts, which are the venom apparatus on these jellyfish.

GREENE: So, you want to wash them off with salt water. You can also use vinegar to inactivate the nematocysts. So once the nematocysts are gone or once the stinging apparatus is gone, then pain control. And of course, we can use traditional analgesics, opioids, or whatever. But because all these marine venoms are heat labile, you can also immerse the affected limb in hot water.

Now, how hot? If you have a thermometer, you know, 105 to 110 degrees, but most people don't have a thermometer. So, what you do is let's say you're stung in your right hand. You feel the hot water with your left hand and as hot as your left hand can tolerate, that's what you immerse your right hand and the affected limb.

You don't want to adjust the temperature using the affected limb because sometimes your sensation is altered, and you may not realize it's so hot you're actually causing damage to yourself. Or if it's numb, you may not realize it is not hot enough to do anything. You are just having continued pain. So, you use the unaffected hand to test the water and then immerse the affected limb in that hot water.

And usually after a few minutes, they feel a whole lot better.

PIERCE: What about vinegar?

GREENE: So, vinegar is good to inactivate the nematocysts for most jellyfish, but not all. For example, we use it for the man of war. The Portuguese man of war, which we have here in Texas. But there are some sea nettles where vinegar can actually exacerbate the nematocysts. So, what you should do is figure out where you live or figure out where you're traveling.

Find out if it's one of the species for which vinegar is indicated, and if it is, carry a little bottle with you on the beach and that can help inactivate the stuff. Other things to know about marine envenomations obviously, you want to get out of the water. You know, sometimes you can get serious systemic toxicity.

It's definitely happening with that Portuguese man of war, and they need good supportive care. There's only antivenom for a certain species of box jellyfish, which is not native to the U.S. and there's only antivenom for one venomous fish species, and that's the stone fish, which again, not native to United States. It's just good supportive care. And then when it comes to stingrays, there's a few things to consider.

Stingrays can cause not only an envenomation, but they can also cause actual trauma. And I think everyone remembers what happened to Steve Irwin. It wasn't the envenomation so much as that he got staked in the heart and then he pulled it out too. And he probably removed the one thing that was tamponade his bleeding. So, he bled to death after that.

So, with stingrays, you have to consider the concomitant trauma. The other thing is any time you have a marine envenomation where something is stuck deeply into your tissue, this in contradistinction to our terrestrial envenomations, these should be treated with antibiotics. Because marine water or, you know, whatever, it has a lot more bacteria. And especially in the brackish water we want to cover with antibiotics.

Now, you are not guaranteed an infection. I think the incidence of infection following stingray is about 14%, but that's a lot higher than the less than 1% it is for snakes, for example, or the less than 1% you'd see from spiders, etc., etc. So, with marine envenomations, if there's something that was embedded, whether it was a sea urchin or a stingray, especially a stingray, you want to cover those people with antibiotics as opposed to our terrestrial stuff.

PIERCE: Okay, Anything I'm missing on marine life that you think we should cover?

GREENE: Hot water. You know, talk to the locals, find out when the jellyfish can be bad. Like I was in Pensacola once and there was just one weekend where all the jellyfish were just washed up everywhere on the shore so you couldn't go swimming. There's just every foot you'd find a bunch of jellyfish. So yes.

PIERCE: Make sure you check the flags before you go. If you're visiting a beach, if it's purple, you probably should not go in the water.

GREENE: Okay. I didn't know that's what purple meant. I would have assumed royalty, but okay.

PIERCE: Now there are no purple flags at the beach, at least here in Florida. Mean we have Marine life right there in the water, usually jellyfish. I know there's some little sometimes when you get out in the water, you don't see jellyfish, but you feel things stinging. You also tentacles not attached to jellyfish. They can still sting, right?

GREENE: Completely. Yep. Yep. You can have a little tangle with all the nematocysts floating up. Yeah, both my kids got envenomed back in 2013 and 2012 in Pensacola. So yeah, we just we washed off in salt water and gave them some oral pain medication and they were fine.

PIERCE: Yeah. Yeah. It depends on how bad you want to swim in the ocean. Yes. All right. The last thing that I have on our list is lizards. Specifically. That is, it is called the Gila Monster.

GREENE: The Gilo Monster.

PIERCE

Well, I looked at the picture of it. It looks terrifying. Not going to lie.

GREENE: So, I think they're adorable. I can also tell you the worst envenomation I have ever treated came from a Gila monster.

PIERCE: Really?

GREENE: So, it's appropriate for you to choose to do this last. I don't think it was intentional, but yeah, the worst envenomation I've ever treated was a Gila monster bite. So, this was a guy who had had six previous snake bites. He actually lost his thumb to a snake bite, and he decided one morning after having his two pitchers of beer for breakfast, he decided he wants to be a Pirates.

Well, because he couldn't find a parrot, he put the next best thing on the shoulder, a Gila monster. The Gila monster bit him on the neck. One of the things we see with Gila monster envenomations, you get a lot of low blood pressure, a lot of hypotension. So, this guy's blood pressure dropped to 40 over 26. Gila monster venom also causes a lot of angioedema and a lot of diarrhea.

So, he had horrible diarrhea, which is actually redundant because there's no such a thing as good diarrhea. So, he had angioedema. He had diarrhea, his blood pressure is low, and his airway swelled up. This was at a tiny little hospital in southern Arizona. They forced a tube down his throat. They gave steroids, antihistamines, epinephrine, fresh frozen plasma, anything they could. And most of which don't actually work.

And they flew him to us. You know, they gave him lots of fluids and he had come in about an hour and 10 minutes after a snakebite. And I said something to my snakebite patient that I've said to no other snakebite victim before says, because, you know, I love snake bites. I said, "Excuse me, I'm going to go take care of something more interesting." In terms of a snake bite, it was a straightforward bite. And this guy was sick, and this guy spent eight days on the ventilator.

PIERCE: Oh, my gosh.

GREENE: Once again, the most impressive thing I've ever seen. So, Gila monsters are great, They're slow. They don't want to you know, we always discourage, you know, handling venomous critters, but especially venomous snakes. But I've had plenty of friends who've safely handled Gila monsters because they're slugs. You know, they're chill. You know. But don't mess with them. One of the big things we have to worry about if you get bitten by a Gila monster is their jaws are so tight it may be really hard to extract your body part from them.

So, you have to find safe ways, safe, effective ways to help open their mouths. So, some people use like a flat object like a fishing lure and stick it back. Or a sharp knife, but, you know, something that can sort of pry open. Some people pour, like alcohol down their mouths to have them open up. Some people will submerge the lizard attached to the limb underwater.

So, getting the lizard off is a one big thing.

PIERCE: It's like a snapping turtle.

GREENE: Yeah. And then you get a lot of local tissue injury. People have debated the need for antibiotics. I think with good irrigation you know the antibiotics shouldn't be prescribed prophylactically, but definitely watch for infection. But yeah, most would get bitten because they're messing with it because again, these animals are so lazy that they don't want to bite you, so don't mess with them.

And you will probably be fine but realized you could have systemic toxicity. Their venom may also help with diabetes because you know exenatide comes from Gila monster venom. So, if you're a diabetic and get bitten by a Gila monster, maybe they'll control your blood sugar.

PIERCE: Oh, my gosh. Okay. What did his recovery look like long term? Were there any lasting effects from this?

GREENE: So, the guy who was on the bed for eight days, he was lost to follow up. But again, he wasn't the greatest specimen to start with. He was already missing a thumb and he was old and chronically ill appearing, so he was lost to follow up.

PIERCE: We were okay. So, note to self. Don't mess with those. Are they seen like are they easy to see out and wherever they are? Did he just walk outside and find him.

GREENE: So, I was never able to find one in the wild. But there was a young lady that we treated for snakebites, and she was coming to our clinic for follow up. And I had mentioned to her that I, like Gila monsters, so she came in with like a box of Gila monsters that she had caught on her property.

So, they're definitely easy to spot. You know, you can find them in places where they're native.

PIERCE: And you kept all those, huh?

GREENE: Now, now they'd return to the wild.

PIERCE: Oh, good. Okay. Sounds terrible.

GREENE: I kept a nonvenomous snake in my office. And that was the only pet that I had in my office.

PIERCE: Okay. Anything else we should know about this lovely lizard.

GREENE: I'm like I said, I think it's really neat that exenatide, you know, Byetta comes from Gila monster venom. And I think it's bizarre that the research done on this was done in New York City, where I promise you, there are no native Gila monsters. So, I think that's bizarre, but I think they're awesome. Just don't mess with them.

And I can tell you that I am lecturing on Venomous Lizard envenomations in September at the Denver Venom Conference, which I encourage all listeners to attend. All the proceeds go to the Asclepius Snakebite Foundation, which is my friend's organization, and there's a great line of speakers covering a whole host of venomous topics.

PIERCE: All right. Well, we've talked about a lot of different creatures that can envenomate from slithering flying to crawling and swimming. Is there anything we missed or anything you want to make sure that you can share?

GREENE: I think we've covered everything and then some.

PIERCE: Hey, well, we have come to the end of episode two and our series on common creatures that envenomate, where we have discussed clinical presentations, interventions, and treatments. Dr. Spencer Greene, you're a rock star. Thank you so much for sharing your time with us and for all that you've done to help grow our body of research and treating patients with for things that not a lot of people study or know how to treat.

So, I know you have a really big following. So, thank you for taking the time. I also want to mention your Facebook page, if that's okay, where you can connect experts to people who have had snake bites, National Snakebite Support. Is that what it's called?

GREENE: Yes. So, we have about 200,000 members and we exist to answer questions for both patients and their representatives, as well as clinicians. You know, when someone comes with a snakebite and no one knows what to do, they contact us. We always have somebody moderating and monitoring the feed and they can connect us experts with the people who need the timely information.

And, you know, our purpose is to help people get the appropriate treatment and to avoid unnecessary stuff and we do a lot of educational posts. And we also have a great file repository with hundreds of articles that are relevant to the practice of toxinology.

PIERCE: Yeah. So, this is a great free resource. So, thank you so much, Dr. Greene, for having that for our listeners and for the people who are members. So, to our listeners, I hope you've gained insight through this series into how to care for envenomations and we encourage you to explore many courses we have available on Elite learning dot com to help you grow professionally in your career and earn CEs.

This is Dr. Candace Pierce for Elite Learning by Colibri Healthcare