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Reality Bites

Rattlesnake Envenomation an Evolutionary Perspective

The phone rang and I was driving to the hospital ten minutes later. As I slowly cruised down my street, I was careful to avoid the dozen or so large male desert spiny lizards (Sceloporus magister) camped on the road every fifty feet or so. They seem ever present during the monsoon season in Tucson. Little kings staking out their territories, hoping to mate with the not so obvious females I knew to be around.

I arrived at the hospital at six-thirty PM. Knowing I was one of the only doctors around who liked to treat rattlesnake envenomation, Tucson Medical Center emergency room had called me with just such an event.

I got a quick rundown of the situation from the attending emergency medicine physician. I then went and took a quick medical history and did a brief physical examination of the victim. This turned out to be a typical rattlesnake envenomation. The patient, a 22-year-old male, had been driving

home from a friend's house after watching the University of Arizona lose its final four basketball game and drinking most of a six-pack. He spotted a two-foot long western diamondback rattlesnake (Crotalus atrox) on the road. He stopped, pinned the snake with a nearby stick and got back in the car with the C. atrox griped behind the head in his left hand. He then proceeded to drive home. Shortly after capturing the rattlesnake he attempted to make a left turn. His right hand gripping the steering wheel moved directly into the snake's mouth.

This scenario represents what is known as an illegitimate bite; meaning, the victim attempted to capture or molest the snake. A legitimate bite, on the other hand, is more or less accidental. More than 50% of the bites I see are illegitimate. These usually occur in young males (as you might expect). Illegitimate bites usually occur on the hand or forearm. Alcohol is almost always involved, showing that testosterone, alcohol, and rattlesnakes are a dangerous combination. Legitimate bites are more evenly spread among the sexes, and occur more often on the lower extremities.

My patient was not feeling well at all. Not only had the University of Arizona lost the game, he was also in excruciating pain and scared to death. There were two fang marks in the dorsal (back) aspect of his right hand. There was a wave of swelling that was almost visibly moving proximally (toward the

center of the body). This swelling had already reached the middle of his forearm. In medicine we use the extent and rate of spread of swelling as the most important initial factors in determining the severity of an envenomation. If there is no swelling within a few hours then significant envenomation is doubtful.* If the swelling is localized and not spreading it is considered a mild envenomation. Swelling that involves part of an extremity is moderate. Involvement of an entire extremity or more is severe.

Other factors also help us grade an envenomation. The presence of any systemic symptoms (symptoms other than local effects) portends a moderate or severe envenomation. Systemic symptoms include such things as hypotension (low blood pressure, tachycardia (rapid pulse), nausea, diaphoresis (cold sweats), confusion, numbness or tingling, paralysis (very rare), and many other effects. Blood test abnormalities can also be detected. These are mainly alterations in the bodies clotting ability. Clotting abnormalities are usually not dangerous in themselves but also portend a more severe envenomation.

Attesting to the ability of rattlesnake venom to effect blood clotting, the fang marks on my patient’s hand were oozing a red tinged straw colored fluid. The pain was spreading into his arm. He also complained of nausea, looked diaphoretic (cold sweat), and had a pulse of about 100 (normal is 60 to 90). Due

to the fact that within one hour of the bite he had swelling that seemed to be progressing and the presence of systemic symptoms, I deemed that this was either a moderate or severe envenomation. Thus the use of antivenom was appropriate.

Crotalid Polyvalent Antivenom® produced by Wyeth Pharmaceuticals is the only non-experimental antivenom for rattlesnake envenomation available in the United States. It is not very potent and is very antigenic (any substance, that when introduced into the body, stimulates the production of an antibody). This essentially means you need to use a lot of it and it has a lot of adverse affects. I instructed the pharmacy to begin mixing ten vials of the stuff in 500cc of D5W (5% Dextrose in water). It takes quite a while to prepare this, as the antivenom powder doesn’t dissolve easily.

I also had the nursing staff begin giving the patient intravenous fluids (normal saline solution at a rate of 200cc per hour). This is standard procedure for me as it helps prevent shock (low blood flow to organs). Shock is the most common cause of death in rattlesnake envenomation. It occurs due to large amounts of fluid being sequestered in a severely swollen extremity. This fluid comes from the blood, lowering blood pressure.

One way to understand the effects of rattlesnake envenomation on a human patient is to examine it from an

evolutionary perspective. Rattlesnake venom evolved with several evolutionary selection pressures. Selection pressures are aspects of the environment in which an animal resides. They favor certain traits over others in an animal's makeup. Venom in snakes initially evolved as a means of killing prey. It worked so well that venomous snakes could obtain prey that was larger than they were. This presents a substantial problem with digestion. This is particularly true in many rattlesnakes, which inhabit a cool northern environment. Digestion, which involves chemical reactions, occurs slower in cooler climates. An analogy would be a human trying to digest a watermelon that it had somehow swallowed whole. In order to help facilitate the digestive process, rattlesnake venom has evolved potent digestive properties. This allows the rattlesnake to begin the digestive process from the inside via venom and the outside via gastric chemicals. The evolution of rattlesnake venom may also explain why many snakes less evolutionary advanced than rattlesnakes possess venom far more fatal to humans. If rattlesnake venom killed too rapidly, then the prey animal's own circulatory system would not be available to help spread the venom around to help with digestion. Thus there may have been a lessening of the lethal properties of the venom in favor of digestive effects.

In a human envenomated by a rattlesnake, the large dilution of the venom in a person as opposed to a small prey animal is such that the lethal properties have little effect. The main clinically important symptoms are due to the digestive effects, local tissue destruction and swelling. However, in certain situations, such as the injection of large quantities of venom, intravascular injection of venom, and the venom of certain sub-populations of various species of rattlesnakes, systemic symptoms can be severe.

In addition to the IV fluids I instructed the nursing staff to use small doses of morphine to help control the patients pain. He also received a dose of lorazepam (an anti-anxiety agent), as he was very frightened. We got the antivenom from the pharmacy about an hour after it was ordered. The infusion was begun slowly. It is important to observe the patient for signs of acute serum sickness, a type of allergic reaction to the antivenom. After 15 minutes he seemed to be tolerating the medication without problems. I then increased the flow to a rate that would get the antivenom into the guy over about one hour. The quicker the antivenom is received after a bite the more effective it is.

I had the patient’s arm elevated by resting it on several pillows. This decreases swelling and helps the venom to spread away from the site of the bite. Again, this is the opposite of

more traditional thinking. We are neutralizing the venom with antivenom and giving IV fluids to prevent shock. So diluting the venom in a larger part of the body will hopefully decrease local tissue damage.

The victim was transferred to the intensive care unit where he could receive one to one nursing care. This also allows for constant monitoring of his blood pressure, respiration, level of consciousness, pain level, swelling, urine output, and general well being. Taking frequent measurements of the affected extremity assesses the swelling. Blood tests are preformed every six hours to look for clotting abnormalities and other metabolic parameters.

He did develop some mild clotting abnormalities during the night. The low platelet count and the mildly lowered fibrinogen level resolved with an additional 5 vials of antivenom. This patient’s swelling peaked by the next morning. It had progressed to his elbow and no further. His pain, though still significant, had improved. With all his systemic symptoms resolved. I transferred him out of the intensive care unit. He remained in the hospital for another day.

Upon discharge from the hospital the patient still had significant swelling. I told him this would probably resolve over 1 to 2 weeks. I would need to see him in 2 or 3 days to see if there was any severe tissue necrosis (death of tissue).

Necrosis occasionally results in the need for skin grafting or even amputation of a damaged finger--or worse.

I also gave him a prescription for prednisone, an oral synthetic corticosteroid. This powerful anti-inflammatory medication was to be taken at the first sign of delayed serum sickness. Delayed serum sickness occurs in about 80% of people who receive antivenom. It usually appears as a diffuse itchy rash. It also frequently causes joint pain, malaise, headache, and fever.

When I saw him 3 days later he was doing very well. His swelling and pain were almost gone. There was no sign of necrosis. His finger and wrist joints had good range of motion. He would have no lasting deficit from the envenomation. He was lucky. I've had patients loose fingers. Others have had long lasting pain, swelling, and loss of joint function. So far none of my rattlesnake envenomation patients have died. Unfortunately death occurs in about .25% (1 in 400) rattlesnake bites in the United States.

While driving home from the hospital the night I treated this patient, I encountered another large Western Diamondback on the street. I pulled over and got my ever-present snake stick out of the trunk. I gently urged the snake onto the hillside by the road. I was tired and didn't want to have to go back to the hospital for a second bite.

Sidebar 1

Antivenom

Crotalid Polyvalent Antivenom® is currently the only non-experimental rattlesnake antivenom available in the United States. It is produced by hyper-immunizing horses with the venom of the Eastern Diamondback Rattlesnake (Crotalus adamanteus), the Western Diamondback Rattlesnake (Crotalus atrox), the Tropical Rattlesnake (Crotalus durissus), and the Fur De Lance (Bothrops atrox). Small amounts of these four venoms are injected into horses. This stimulates their immune systems to produce antibodies against various components of the venom. Once a large amount of antibodies are produced, serum (blood minus all blood cells) is removed from the horses. The antibodies are then removed from the serum using chemical processes. This results in a powder, the antivenom.

Unfortunately, they’re several problems with this product. Since it is made by a horse’s immune system (equine) it is not completely compatible with the human body. Allergic reactions to the antivenom are common. Also, as these venoms

contain a wide array of chemical components, the resulting antibodies will not necessarily counteract all the toxic effects of the venom. Nevertheless, Crotalid Polyvalent Antivenom is effective to varying degrees in treating envenomation from all North American pit vipers.

A new antivenom is currently undergoing clinical trials (testing on people) in Tucson Arizona. It is an ovine (sheep) product. Initial reports are that it’s highly effective and much less antigenic. I’ve heard that it may be generally available soon.

Sidebar 2

First Aid

The only tools necessary for first aid in rattlesnake envenomation are a set of car keys. The old concept of “make an incision and suck out the venom” (see scene from Woody Allen’s Bananas) is obsolete. One study showed that an average of only 6% of the venom is removed by this method. Your are far more likely to damage underlying tissue (things such as blood vessels and nerves) with an incision than do any good. The use of the Extractor□, a device, which can be used to apply a large amount of suction to a bite site, may be helpful. If applied immediately and continued for 20 minutes it may remove up to 25% of the venom. However, whether this truly affects the course of envenomation is not known. Its use should not delay transport to medical care.

If you look at envenomation from an evolutionary perspective, current guidelines make sense. In human envenomation the digestive properties of rattlesnake venom predominate. Anything that helps to localize the venom at the

site of a bite will enhance local tissue destruction. Do not use a tourniquet, ice or cooling of any kind. These actions will localize the venom to a volume about the size of a rat. You don’t want to help digest your arm. To be fair, some medical personal do recommend a “constriction band”. This is a band placed above the bite site that is loose enough to only obstruct lymphatic flow. This may be appropriate in a bite of the more neurotoxic subset of the Mojave rattlesnake and other rattlesnakes with more neurotoxic venoms.

Do not use alcohol or drugs of any kind. Alcohol and caffeine increase urination, which can make shock more likely. Aspirin and non-steroidal anti-inflammatories (ibuprofen, naproxen, etc) can contribute to coagulation problems.

The only universally excepted first aid advice is to get to the hospital as soon as possible. I also recommend giving clear fluids to prevent dehydration and shock.

These recommendations apply only to rattlesnake envenomation. Other types of first aid such as pressure wraps are appropriate for elapid bites.