Antivenin dosage is determined by the severity of envenomation and the patient's response. Children frequently require 50% more antivenin than adults because of the higher concentration of venom relative to body mass. Patients receiving antivenin need to be monitored closely for signs of anaphylaxis. Allergic reaction to antivenin can be severe and usually is evident within minutes of initiating the infusion. Premedicating the patient with antihistamine and epinephrine lowers the incidence of adverse reactions.

Approximately 5% of patients receiving antivenin will develop serum sickness, even if no allergic reaction initially is noted. This serious reaction may occur for up to 2 weeks after treatment, and the risk increases with the quantity of antivenin received. Signs and symptoms include arthralgia, skin rash, nephritis, and lymphadenopathy. In severe cases, encephalitis or pericarditis may occur. The treatment of serum sickness is based on the type of symptoms experienced. Anti-inflammatory doses of systemic steroids may be required.

Summary

Crotalid envenomation may be life-threatening within a very short time frame, especially for children. Treatment is based on the severity of symptoms experienced. Antivenin is a major component in the medical management of moderate and severe cases of envenomation. In children, the severity of envenomation is increased because of high concentrations of venom relative to body mass.

In all moderate and severe envenomations, prompt assessment and supportive treatment are key to survival. Rapid transport to an appropriate medical facility is essential for definitive care. Advance notification gives the receiving hospital staff time to mobilize the required resources and expertise. When available, assistance should be obtained from those knowledgeable about this type of injury.

References

1. Simon MW. Venomous snakebite of a child. J Ky Med Assoc 1998;96(2):56-8.
2. Kitchens CS, Van Mierop HS. Mechanism of defibrination in humans after envenomation by the eastern diamondback rattlesnake. Am J Hematol 1983;14:345-53.

Bibliography

Kitchens CS. Hemostatic aspects of envenomation by North American snakes. Hematol Oncol Clin North Am 1992;6:1189-95.

Lister B. Anaphylaxis and envenomation. In: Macrae A, Macrae D, Henning R, editors. Care of the critically ill child. New York: Churchill Livingston; 1999. p. 408-13.

Sitprija V, Gopalakrishnakone P. Snakebite, rhabdomyolsis and renal failure. Am J Kidney Dis 1998;31(6):I-Iii.

Ron Cordasco, RN, PM, and Wade Jones, PM, fly with ShandsCair at the University of Florida in Gainesville. Wanda Liddell, RN, ARNP, is the nursing coordinator for ShandsCair and a family nurse practitioner at Doctors Medical Center in Old Town, Fla.

Reprint orders: Mosby, Inc., 11830 Westline Industrial Dr., St. Louis, MO 63146-3318; phone (314) 453-4350; reprint no. 74/1/114425
doi:10.1067/mmj.2001.114425

COMMENT

The Role of Air Medical Services in Envenomation: An International Perspective

Blair Munford, BMedSci, MB, ChB, FANZCA, Alan Garner, MB, BS, FACEM

This case report highlights some of the problems that can be encountered in severely envenomated patients after snakebite and the role air medical services can play in facilitating their medical management.

Problems of snakebite and the medical management of envenomation differ significantly in various parts of the world. Venomous snakes belong to three main families: the vipers, made up of the old world vipers of the Eastern Hemisphere and the pit vipers (crotalids, including rattlesnakes, cottonmouths, and American copperheads) of the Americas and Asia; the elapids (such as cobras, mambas, kraits, the North American coral snake, and all poisonous Australian snakes); and the sea snakes.[1] The venoms of vipers tend to have more localized toxicity (necrosis, hemolysis, and rhabdomyolysis) but generally have far less neurotoxic and paretic effects than most elapid venoms. Absorption of both viper and elapid venom is usually predominantly or exclusively through the lymphatics.[1-3] This absorption can be extremely rapid and often may be confused with direct intravenous injection of venom, as is reported to have occurred in this case, but which is not nearly as common an occurrence as widely believed.

The most venomous snakes in the world (28 of the top 30 as measured by lethality of a typical yield of venom) are found in Australia.[4] To compare relative toxicity, if the venom yield of the common Indian cobra (*Naja Naja*) is used as a standard and rated as 1, such Australian species as the taipan (*Oxyuranus scutelattus*), eastern brown snake (*Pseudonaja textilis*), and the tiger snakes (genus *Notechis*) have ratings of 49.5, 12.4, and 4.25, respectively. By comparison, the most venomous U.S. snake (the eastern diamondback rattlesnake, *Crotalus adamanteus*) has a rating of 0.06.

However, many other factors contribute to mortality and morbidity from snakebite. These variables include the frequency of contact between humans and snakes and variations in behavior and aggression level of different snake species (and different people), all of which determine the incidence of snakebite. Once a bite has occurred, mortality and morbidity are influenced by the amount and toxicity of venom injected, the environment in which the snakebite occurred and how this relates to the employment of effective first aid measures, and the timely availability of definitive care, including antivenin.

In real risk terms, the most dangerous snakes in the world are probably the Indian cobras (*Naja* species)—ranked between 11 and 15—because of their frequent contact with humans, relatively aggressive behavior, and the limited availability of health resources and antivenin in much of India. Conversely, the mortality rate from snakebite in Australia (one to five deaths per year in a population of just under 20 million) does not greatly exceed that in the United States (10 to 20 deaths per year among 280 million people) despite the wide disparity in toxicity of snakes.[2]

Envenomation can be a particular problem in children. The case described s unusual in that witnessed envenomation by snakes in small children tends to be the exception rather than the rule, and the diagnosis consequently may not be obvious.[4,5] However, the case is more typical in other respects, such as the rural setting and consequently prolonged prehospital time that is common in snakebite worldwide.[1,6]

Recommended first aid measures differ in different areas of the world, partly reflecting the predominance of envenomation by either vipers or elapids.[6-11] The Australian-developed pressure immobilization method with crepe or elastic bandaging of the entire limb, combined with limb splints and an absolute requirement to stop the patient from walking, is now the standard of initial care for snakebite in this country and recommended for all elapid envenomation.[7,8] In contrast, measures for viper (particularly crotalid) envenomation remain controversial,[9] with incision of bites,[10] attempted venom extraction,[11] and use of a venous/lymphatic tourniquet[12] all having their advocates.

The argument against the pressure immobilization technique (and tourniquets) is based on the potential increase in local tissue damage from crotalid venoms.[6] However, this danger may need to be balanced against the increased risk of systemic envenomation without such measures. Pediatric envenomation well may be a relative indication for the use of tourniquet or pressure immobilization techniques, even with crotalid envenomation, because of the higher systemic toxicity (ie, the same dose of venom is injected into much smaller victim).

Of note in the case report is that apparently no attempt was made to reduce or delay the spread of venom by any method. Even if significant systemic envenomation already has occurred, there is still benefit from attempting to prevent further uptake of venom and deterioration until definitive antivenin therapy is available.

The roles of air medical services in the response to envenomation have been proposed.[13] These include response to remote areas (with hoist access and extrication where demanded by the terrain) and first aid and advanced resuscitation measures at the scene and en route to the hospital, including administration of antivenin (and any associated ancillary treatment) where indicated. The air medical service also may act as a resource multiplier to enable a single, more extensive stock of antivenin to supply a wide area. This role may be less important in the United States—where stocks of antivenin are relatively plentiful and a single type covers all (crotalid) envenomations—than in Australia, for example, where different species require different antivenins with antivenin selection on the basis of results from a venom detection kit. A polyvalent preparation that is a mixture of all the different antivenins is available, but the use of this carries a higher morbidity and is more expensive.[14] A similar situation exists in southern Africa, where significant envenomation may occur from either elapid or viper species.[1,15]

In the case reported, antivenin was administered at the referring hospital, and multiple further doses were required after arrival at the receiving institution, but none was administered during transport. Unless the flight was extremely short, this represents an unnecessary delay in the continuation of the definitive treatment. We would venture to suggest that air medical services responding to cases of envenomation should be prepared and capable of commencing or continuing antivenin therapy, including in flight. Administration of antivenin and adjuvant therapy technically is far less demanding than other procedures advocated in the flight environment, such as intubation and defibrillation. Supportive therapy, such as ventilation and circulatory resuscitation, obviously must be administered also, and the use of a mechanical ventilator is strongly recommended to provide more reliable and consistent ventilation and free the hands of another medical crew member to perform other tasks—such as mixing/administering antivenin.

In summary, although the scale and specifics of snake envenomation differ between regions, the role of air medical services should not differ greatly. The priorities are:

- Rapid response with a suitably skilled and equipped crew
- Prevention of further venom uptake or spread
- Resuscitative and support measures
- Administration of antivenin and adjuvant therapy as indicated
- Timely transport with continuing clinical care to the nearest appropriate definitive facility

The same priorities and principles also apply to envenomation by other creatures, such as spiders, scorpions, and many venomous marine species.

References

1. Read HA, Theakston RDG. The management of snakebite. Bull WHO 1983;61:885.
2. Norris RL, Auerbach PS. Wilderness and environmental medicine: envenomations. In: Grande CM, editor. Textbook of trauma, anesthesia and critical care. St Louis: Mosby–Year Book; 1993.
3. Sutherland SK, King K. Management of snakebite injuries. Royal Flying Doctor Service Monograph Series: No 1. Sydney: The Service; 1991.
4. Banner W. Bites and stings in the pediatric patient. Curr Probl Pediatr 1988;18:9.
5. Tibballs J. Diagnosis and treatment of confirmed and suspected snakebite: implications from an analysis of 46 paediatric cases. Med J Aust 1992;156:270.
6. Otten EJ. Venomous animal injuries. In: Rosen P, editor. Emergency medicine: concepts and clinical practice. St Louis: Mosby–Year Book; 1992.
7. Fisher M. First aid in envenomation. Med J Aust 1982;136:198.
8. Sutherland SK, Couter AR, Harris RD. Rationalisation of first aid measures for elapid snakebite. Lancet 1979;i:183-6.
9. Watt CH. Poisonous snakebite treatment in the United States. JAMA 1978;240:654.
10. Wingert WA, Wainschel J. Diagnosis and management of envenomation by poisonous snakes. South Med J 1975;68:1015.
11. Russell FE, et al. Snake venom poisoning in the United States: experience with 550 cases. JAMA 1975;233:341.
12. Burgess JL, Dart RC, Mayersohn M. Effect of constriction bands on rattlesnake venom absorption: a pharamacokinetic study [abstract]. Ann Emerg Med 1991;20:549.
13. Nocera A, Gallagher J, White J. Severe tiger snake envenomation in a wilderness environment. Med J Aust 1998;168:
14. Sutherland SK. Antivenom use in Australia. Premedication, adverse reactions and the use of venom detection kits. Med J Aust 1992;157:734.
15. Christensen PA. The treatment of snakebite. S Afr Med J 1969;43:1253.

Blair Munford, BMedSci, MB, ChB, FANZCA, is the senior flight physician and Alan Garner, MB, BS, FACEM, is a flight physician and the medical director of NRMA CareFlight/NSW Medical Retrieval Service in Sydney, New South Wales, Australia.