

Prevention and Treatment of Venomous Animal Injuries

by FINDLAY E. RUSSELL

Laboratory of Neurological Research,
Los Angeles County-University of Southern California Medical Center,
Los Angeles (California 90033, USA).

Snakebite is of common occurrence in many parts of the world. It has been estimated that as many as one million people are bitten by venomous snakes each year, while the number of deaths from snakebite is thought to be between 30,000 and 40,000. Generally overlooked, however, in epidemiology studies on snakebite, is the problem of morbidity. For example, in the United States there are about 45,000 bites by snakes each year of which approximately 8,000 are inflicted by venomous snakes, and although there are only 15 deaths the incidence of morbidity is not known and, indeed, may be quite high in untreated, under-treated or mistreated cases. In a series of 100 patients in which antivenin was not used following bites by rattlesnakes, there were 37 cases in which there was significant tissue loss, including 11 where amputation of a digit or part of a digit, or a larger area was necessary. In all, there were 58 contractures or tissue defects causing some decrease in the range of motion of a joint or of a function¹⁻⁴.

Stings and bites by arthropods are of such common occurrence that no statistics have been kept. In the United States, estimates ranging from 1 to 5 million persons are noted for envenomations by arthropods each year. There are 3 times as many deaths from bee stings as from rattlesnake bites. In 1 year, while the author was working in Mexico, there were approximately 70,000 stings by scorpions and 1,200 deaths. Deaths from spider venom poisoning, particularly *Latrodectus*, *Loxosceles* and *Phoneutria* occur each year, though fortunately the number of fatalities is relatively small^{3,5}.

Stings and bites by venomous marine animals occur frequently in many parts of the world. Approximately 40,000 injuries by marine animals are said to occur each year, while poisoning following the ingestion of various poisonous fishes accounts for some 20,000 cases. Fortunately, deaths attributable to the stings or bites of marine animals and the ingestion of poisonous fishes, or shellfishes, probably number less than 300. Among the most often implicated poisonous and venomous marine animal entities are paralytic shellfish poisoning, cnidarian stings, stings by the various venomous fishes, particularly the stangyris, scorpionfishes and weeverfishes, and poisoning following the ingestion of Tetraodontidae species and ciguateric fishes. Of lesser concern are envenomation by sea urchins, sponges, cone shells and octopuses⁶⁻⁹.

Prevention

The old proverb that 'an ounce of prevention is worth a pound of cure' may have been written by someone who had just been stung by a bee. The best measure for assuring not being bitten or stung by venomous animals is to stay away from them. More than 40% of all bites and stings seen by the author, some 6,000 cases, could have been prevented had the victim exercised more care in his encounter with the offending animal. Rather than seeing how far a snake can strike, keep 5 meters away from him and read about his striking ability from a good book when you get home. When bees swarm around you, do not try to bat them away; and when you see an ant hill, walk around it, even if you are a fast walker. It is not always possible, of course, to avoid being bitten or stung, particularly by spiders, scorpions, ticks and certain marine animals, but several bits of advice bear consideration.

Snakes

When in areas where snakes are highly endemic (a) do not put your hands or feet in places you cannot look and do not put them in places without first looking, (b) do not turn a rock or fallen tree without making sure your hands are out of striking distance of any snake that might be underneath, (c) do not gather firewood after dark, (d) do not crawl beneath fences without first looking under them carefully, and (e) do not sleep near wood or rubbish piles, or at the entrance to a cave. Of course, do not disturb snakes, do not try to kill them, do not try to capture them unless you are very skilled at this, and do not handle freshly

¹ S. A. MINTON, JR. and M. R. MINTON, *Venomous Reptiles* (Charles Scribner's Sons, New York 1969).

² F. E. RUSSELL, *Current Therapy* (Ed. H. F. CONN, Saunders, Philadelphia 1969), p. 873.

³ H. M. PARRISH, Publ. Hlth. Rep., Wash. 81, 269 (1966).

⁴ F. E. RUSSELL, Med. Arts Sci., in press (1974).

⁵ F. E. RUSSELL, Med. Arts Sci., in press (1974).

⁶ B. W. HALSTEAD, *Poisonous and Venomous Marine Animals of the World* (U.S. Government Printing Office, Washington, D.C. 1965, 1967, 1970), vol. 1-3.

⁷ F. E. RUSSELL, *Advances in Marine Biology* (Ed. F. S. RUSSELL, Academic Press, London 1965), p. 255.

⁸ F. E. RUSSELL, *Fish Physiology* (Ed. W. S. HOAR and D. J. RANADL, Academic Press, New York 1969), p. 401.

⁹ F. E. RUSSELL, in *International Encyclopedia of Pharmacology and Therapeutics* (Ed. H. RASKOVA; Pergamon Press, Oxford 1971), section 71, chapter 15, p. 3.

killed snakes. Always carry snakes on a stick, if you must transport them for identification purposes. Finally, do not panic if you see a snake; and remember, snakes are probably more afraid of humans than humans are of snakes. Treat them kindly by always giving them the right of way¹⁰.

Arthropods

Most spider bites can be prevented by wearing gloves when handling plants, rubbish or ground cover. Fortunately, very few people pick up spiders to examine them and other than encounters under houses or in picking up ground cover or in gardening, in which cases gloves should always be worn, bites are relatively uncommon. It should be remembered, however, that all spiders, with the exception of two small groups, are venomous, but fortunately for man the fangs of most species are too small or too fragile to penetrate the human skin. Nevertheless, at least 50 species, in the United States alone, have been implicated in bites on humans¹¹.

Most scorpion stings occur at night or in the evening hours, such as in Mexico where large numbers of these arthropods are found in and around human dwellings¹². I have had 5 to 8 scorpions every year in my shower at Portal, Arizona and only when I screened off all the roof vents did they tend to disappear, but not entirely. It is essential to screen off all vents and openings into a home and to pursue a household eradication program in those areas where these animals are highly endemic. In some areas they are frequent visitors to sleeping bags and they are so often found in one's camping gear in the southwestern United States and Mexico that packs, clothes, food and camping gear are always put in well-tied plastic bags at night. Never place clothing, gloves or shoes on the ground by your sleeping bag or bed roll in a desert or tropical forest, unless you wish to collect scorpions.

Marine animals

As most stingrays with which humans are likely to come in contact are species found in shallow water, and ones which often burrow in the sand and thus escape being seen, it is a wise procedure to shuffle one's feet when walking through the surf or mud flats where these animals may abound. This generally scares up the stingray, or will at least minimize the chances of stepping directly on top of one. Scorpionfishes and weeverfishes should be handled with great care, when removing them from a hook or net. We generally employ gloves and long-nose pliers in removing these fishes from our hooks. Stonefishes should be handled with even greater care, and when walking about reefs where these fishes are found, always wear shoes or protective foot covering^{7, 13}.

Whenever possible in shallow water, try and see where you must put your feet down, particularly in rocky or reef areas. Most of the sea urchin injuries seen by the author have occurred while the patient was climbing over rocks, failing to watch for these animals. Again, it is wise to wear protective foot covering whenever collecting on reefs or on rocky shores. Never swim in areas where coelenterates abound. Many swimmers are stung by jellyfishes without ever seeing the offending species. Broken tentacles floating in the water may sting, as well as freshly detached segments lying on the beach. Never pick up such tentacles, or coelenterates, except with gloved hands. Be particularly watchful after storms when these animals tend to be washed inshore and sometimes broken up. In handling cone shells, always pick them up by the large posterior end of the shell, and preferably with gloves.

In those parts of the world where fish poisoning, or ichthyotoxism, occurs, never eat fish you have caught yourself until you have checked on the edibility of the fish with a knowledgeable local inhabitant. When in areas unfamiliar to you, exercise extreme care in purchasing fish from anyone except reputable fish dealers. If you wish to eat a puffer, be sure to remove all visceral organs and the skin, irregardless of the species. Then take your chances. Frying, baking, boiling or stewing do not significantly alter the toxicity of most poisonous fishes. Paralytic shellfish poisoning usually occurs in persons who fail to observe public health warnings against eating molluscs at certain times of the year. Almost all areas of the world, where paralytic shellfish poisoning is a problem, are posted. However, a recent outbreak in Europe demonstrates that such cases can occur distant to the source area, and because of inadequate public health supervision.

Treatment

Probably no discipline in the practice of medicine has been more trespassed by fables, folklore, myths and superstitions than that involving the treatment of venomous animal injuries. Up until 1964, some 300 papers are noted to have been published on folklore, myths, superstitions and primitive treatments of snake venom poisoning alone¹⁴. This number does not

¹⁰ H. G. DOWLING, S. A. MINTON, JR. and F. E. RUSSELL, *Poisonous Snakes of the World* (U.S. Government Printing Office, Washington, D.C. 1968).

¹¹ F. E. RUSSELL, J. WAINSCHEL and W. J. GERTSCH, *Current Therapy* (Ed. H. F. CONN, Saunders, Philadelphia 1973), p. 868.

¹² L. MAZZOTTI and M. A. BRAVO-BECHERELLE, *Rev. Inst. Salubr. Enferm. trop. (Mex.)* 21, 3 (1961).

¹³ F. E. RUSSELL, T. C. PANOS, L. W. KANG, A. M. WARNER and T. C. COLKET, *Am. J. med. Sci.* 235, 566 (1958).

¹⁴ F. E. RUSSELL and R. S. SCHARFFENBERG, *Bibliography of Snake Venoms and Venomous Snakes* (Bibliographic Associates, West Covina, California 1964).

include those measures which were not based on obvious myth and practiced at the time (and even now) nor those measures which have been demonstrated to be useless or of little value, even though used by a segment of the medical profession. Since 1964 the number of articles involving the use of folklore measures has decreased, fortunately for the patient, but even as late as the present year, articles have appeared in reputable journals which deal with concepts based in folklore and found to be useless or dangerous.

The line between folklore and fact is often difficult to determine, for it is apt to change with the passing of time and with experience. Nor can one say that ineffectiveness automatically places a remedy in the folklore class, since until quite recently, nearly all measures for venom poisoning have been largely ineffectual, including many of those favored by the medical profession. There is one last reason to be very concerned with folklore cures in medical practice beyond their historical curiosity, and that is, whatever their source, they are hazardous: firstly, because they often involve dangerous methods, and secondly, because they delay the use of really effective therapeutic measures¹⁵.

With these thoughts in mind it might be best to put down some general considerations for the first aid of venom poisoning and the subsequent medical care of the patient. These suggestions have, for the most part, been presented by the author elsewhere, where they have been discussed in some detail. Here they will be presented in brief form. They represent the author's experience with 482 cases of snakebite 1,652 cases of arthropod envenomation and more than 2,000 injuries by marine animals.

Snake venom poisoning

Snake venom poisoning is an emergency requiring immediate attention and the exercise of considerable judgment. Delayed or inadequate treatment may result in tragic consequences. On the other hand, failure to differentiate between the bite of a venomous and a nonvenomous snake may lead to the use of measures that cannot only cause discomfort to the patient but may produce deleterious results. It is essential that a diagnosis be established before any treatment is instituted. In making the diagnosis it must be remembered that a venomous snake may bite a person without injecting venom, and that such bites are best treated as simple puncture wounds. It should also be borne in mind that some persons bitten by nonvenomous snakes become excited and even hysterical, and that these emotions may give rise to disorientation, faintness, dizziness, hyperventilation, a rapid pulse and even primary shock¹⁶.

First aid. 1. Make every effort to identify the snake before initiating treatment. 2. Place victim in recum-

bent position. 3. Allay any apprehension and keep patient at rest, and warm. 4. Immobilize injured part in a physiological position and keep slightly below heart level but not in a completely dependent position. 5. Transport victim to nearest doctor or hospital. If victim is alone, he should walk slowly and rest periodically.

Other recommended first aid measures will depend upon the snake involved. In viper bites, excluding those by small European vipers and the small copperheads of North America, longitudinal incisions of 3–8 mm in length should be made though the fang marks, except in those cases where there is an abnormal amount of bleeding or an obvious defect in coagulation. The incisions should be made as deep as the fang penetration. Suction should then be applied and continued for the first hour following the bite. Oral suction should not be used if other means of suction are available. Multiple incisions over the involved extremity or in advance of progressive edema are not advised. To be effective, suction must be applied within the first few minutes following the bite. It is of little value if delayed for 30 min or more. Incisions through the fang marks without subsequent suction are of questionable value. Always apply a constriction band immediately above or proximal to the wound; this should not impede arterial or deep venous flow¹⁷.

In envenomations by elapids, and African and Asian vipers, we have found incision and suction to be of little value, probably because in the former case the more deleterious fractions of the venom appears to be absorbed directly into the blood stream rather than lymph system, while with the African and Asian vipers the fang wounds are usually much deeper than with the rattlesnakes (which tend to bite rather superficially) thus precluding the possibility of moving the venom by negative pressure. In elapid bites, the time to doctor or hospital may be a more important factor than in crotalid bites and thus the first aid may need to vary considerably with the species of snake and the time before antivenin or definitive treatment can be given. Perhaps it would be wisest to suggest what I, personally, would do if envenomated by a large cobra. I would wash off the fang punctures immediately and irrigate the punctures, if possible. I would weigh carefully whether or not to excise the fang wounds and I would not hesitate more than 3–5 min to do this. If excision did not seem practical, I would place a tourniquet immediately proximal to the wound or above the joint proximal to the wound and leave it in place, releasing it for 60 sec every 10 min. I would then get to the nearest physician with the least possible

¹⁵ F. E. RUSSELL, *West. Med.* 2, 101 (1961).

¹⁶ F. E. RUSSELL, *Cyclopedia of Medicine, Surgery and the Specialties* (Ed. G. M. PERSOL, F. A. Davis, Philadelphia 1962), vol. 2, p. 199.

¹⁷ F. E. RUSSELL, *Toxicon* 4, 285 (1967).

effort. I would also lay down and remain quiet for 2 min each time before releasing the tourniquet.

Medical Treatment. It is not possible in this short review to detail the various forms of treatment for the different kinds of snake venom poisoning. The reader is referred to the fine papers of REID et al.¹⁸, MINTON¹⁹, CHAPMAN²⁰, EFRATI and REIF²¹, SAWAI et al.²² and others²³⁻²⁵ for specific therapeutic measures. A general compilation of their works and medical advice on various problems relating to snakebite will be found in the text *Poisonous Snakes of the World*¹⁰.

(A) Constriction Band and Incisions and Suction

1. If patient seen within 30 min of bite, and there is evidence of envenomation, place constriction band 5-10 cm proximal to area or above first joint proximal to bite.
2. Band should be tight enough to occlude lymph flow but not to impede venous or arterial flow.
3. Incise through fang marks in appropriate plane. Incisions should be no longer than 5 mm and no deeper than 4 mm. They are of no value if delayed more than 30 min. Apply suction.
4. Do not make cuts anywhere but through fang marks.

(B) Immobilize affected part and place at heart level, and in a physiological position.

(C) Keep patient at rest and give reassurance.

(D) Under no conditions should the injured part be placed in ice, the bite area excised, or a fasciotomy performed.

(E) Antivenin

1. Conjunctiva or skin test (See antivenin brochure). If positive get consultation stat.
2. Give i.v. in continuous saline drip, if possible, and in all cases of shock.
3. 2-12 vials may be necessary during the first 6 h, depending on severity.
4. If necessary to give i.m., give in buttocks, and give small amount s.c. proximal to bite. Do not give i.m. if you can give i.v.
5. Never inject antivenin into a toe or finger.
6. Measure circumference of extremity 10 cm proximal to bite and at a second area proximal to that every 15-30 min as a rough guide to antivenin administration.
7. Have tourniquet, oxygen, adrenalin, and shock drugs available during antivenin administration.

(F) Supportive Measures.

1. Broad spectrum antibiotic in all but trivial cases.
2. Tetanus antitoxin/toxoid.
3. Fresh whole blood p.r.m. if hemorrhage or in children severely envenomated.
4. Aspirin or codeine for pain.
5. Limit i.v. fluids during period of acute edema.
6. Mild sedation.
7. Liquid or soft diet, if tolerated.
8. Maintain airway.
9. Oxygen p.r.n.; positive pressure breathing p.r.n.
10. Splint injured extremity in Orthoplast cast in physiological position at heart level.
11. Antihistamines or steroids to treat allergic reactions to antivenin or venom. Do not use steroids during acute phase of poisoning - first 4 days, except for severe allergic reactions.

(G) Laboratory tests

1. Type and cross match on admission in all but trivial cases.
2. CBC, platelet count stat and ESR and red cell fragility.
3. Lee-White, clot retraction, prothrombin time.
4. Urine analysis.
5. Sodium, potassium, chloride, calcium and CO₂ combining power, when necessary.
6. BUN, creatinine and bilirubin, when necessary.
7. ECG when necessary

Always try to obtain offending snake for species identification.

The following is the protocol for rattlesnake bites, posted in the Main Admitting Room of the Los Angeles County-University of Southern California Medical Center. Although lacking in detail it gives the admitting physician adequate guidance in the emergency care of the snakebite victim. Similar directions are posted for other kinds of snake venom poisoning.

Spider venom poisoning

There are no local first aid measures of value for most kinds of spider bite. Placing a small piece of ice or cold pack over the injured area recedes pain and causes some desirable vasoconstriction, but ice should never be used for extended periods of time. Specific antivenin, as in the case of black widow spider (*Latrodectus* sp.) bites, is usually used in children, while muscle relaxants, sedatives or calcium gluconate are generally employed in adults²⁶. In brown spider (*Loxosceles* sp.) bites, excision of the lesion area is advised if the patient is seen within 8 h of the bite. Thereafter, steroids, given intravenously, and in relatively high doses, appear to be the drugs of choice^{11, 27-28}.

Scorpion venom poisoning

As with spider bites, there are no first aid measures to recommend, other than rest, assurance and maintenance of body warmth, and perhaps ice locally. Again, specific antivenin is the therapeutic measure of choice. Although much has been written about the use of atropine, spark shocks, local procaine, neostigmine, potassium permanganate, calcium gluconate, and other measures, none of these have appeared of value in controlled studies at this Medical Center, nor in field trials in Mexico. Since some scorpion venoms (as does black widow spider venom) cause an increase in blood and cerebrospinal fluid pressures, it is wise to treat this specifically. Antivenin should always be used in children stung by one of the 'lethal scorpions', since the time from sting to death in a child may be very short, and once the terminal period is reached the antivenin may not be effective.

¹³ H. A. REID, P. C. THEAN, K. E. CHAN and A. R. BAHARAM, *Lancet* 7, 617 (1963).

¹⁹ S. A. MINTON, JR., *Cecil-Loeb Textbook of Medicine* (Ed. P. B. BOESON, W. B. SAUNDERS, New York 1971), p. 76.

²⁰ D. S. CHAPMAN, *Mem. Inst. Butantan* 33, 213 (1966) (publ. 1968).

²¹ P. EFRATI and L. REIF, *Am. J. trop. Med. Hyg.* 2, 1085 (1953).

²² Y. SAWAI, M. MAKINO, I. TATENO, T. OKONOGI and S. MITSUHASHI, *Jap. J. exp. Med.* 32, 117 (1962).

²³ F. A. SHANNON, *Ariz. Med.* 22, 968 (1965).

²⁴ N. C. MCCOLLUGH and J. F. GENNARO, JR., *J. Fla. med. Ass.* 49, 959 (1963).

²⁵ F. E. RUSSELL, *Toxicon* 7, 33 (1969).

²⁶ F. E. RUSSELL, *Am. J. med. Sci.* 243, 159 (1962).

²⁷ F. E. RUSSELL, W. G. WALDRON and M. B. MADON, *Toxicon* 7, 109 (1969).

²⁸ H. SCHENONE, *Mem. Inst. Butantan* 33, 207 (1966) (publ. 1968).

Marine animal poisoning

In the various works by HALSTEAD⁶ and the author⁷⁻⁹ the problem of the therapeutics for venomous and poisonous marine animal injuries covers more than 300 pages. In the present short review the author will need to limit remarks to two of the more common types of poisoning, those by venomous fishes and those by cnidarians. The standard procedure for treatment of most fish stings is well established. Injuries to an extremity should be irrigated with the salt water at hand, since some of the venom can be washed from the wound by this step. In the case of stingray injuries, an attempt should be made to remove the integumentary sheath if it can be seen in the wound. The extremity should then be submerged in hot water, at as high a temperature as the patient can tolerate without injury, for 30-90 min. The addition of sodium chloride, magnesium sulfate or mild ammonia to the hot water is optional. The wound should then be further examined for foreign bodies, debrided, sutured if necessary, and the appropriate antitetanus agents administered. Infections of these wounds are rare in properly treated cases. Elevation of the injured extremity is advised.

In some cases, where the initial first aid measures have been delayed, some physicians have found it necessary to block the injured area with procaine, although this affords only limited relief, and relief of short duration. Meperidine hydrochloride appears to be the drug of choice in controlling pain. The primary shock sometimes seen immediately following these injuries usually responds to simple supportive measures. Where secondary shock develops, as a result of the direct effects of the venom, the physician must direct his efforts toward maintaining a satisfactory circulating blood volume. Oxygen should always be given in such cases.

Treatment of wounds produced by stonefishes must be instituted immediately following envenomation. Immersion of the injured part in hot water, as described, should be tried. According to WIENER²⁹ injection of emetine hydrochloride directly into the wound (s) is of value if it can be done within 30 min of the stinging. In one case seen by the author, a soap solution was injected directly into the wound area 15 min after the hot-water treatment had been initiated. There were no untoward effects and no local tissue changes developed. An antivenin is now prepared by

the Commonwealth Serum Laboratories of Australia and should be used where conditions warrant.

The treatment of cnidarian stings has been subject to considerable variation, and success. In some parts of the world no treatment is advised except the local application of ammonia. In other parts the local application of vinegar is considered to be the best and only necessary measure. In the U.S., the local application of meat tenderizers is now enjoying considerable popularity, for the third time around. Sodium bicarbonate, boric acid, lemon juice, gasoline, alcohol and many other agents have also been advocated from time to time, and with some fervor. It may be that by merely changing the pH of the skin some of the symptoms and signs of the poisoning can be alleviated. In the author's experience, however, none of these agents by themselves have been highly beneficial following moderate or severe stings by cnidarians. The following procedures have been used with considerable success by lifeguard services:

-
1. Pour ocean water over the injured parts. Do not use fresh water. Do not rub with sand.
 2. Remove tentacles, preferably with a glove.
 3. Pour alcohol over the wounded areas.
 4. Apply flour, baking powder or shaving soap to the injured areas. Use dry sand only if none of the above are readily available.
 5. Scrape the above material from the wounded part with a sharp knife or instrument. Do not use a razor.
 6. Wash the areas again with salt water.
 7. Apply a corticosteroid-analgesic balm, preferably by aerosol.
 8. Transport victim to a physician if condition warrants.
-

In the more serious cases, other therapeutic measures are necessary. Oxygen, positive pressure or mouth-to-mouth resuscitation may be required. Intravenous fluids and epinephrine may be needed in shock or near-shock conditions. 10 ml of i.v. calcium gluconate has been used in relieving painful muscle spasms. Meperidine hydrochloride is the drug of choice for pain. In stings by some of the lethal chirodopid medusae of Australian waters, the immediate use of a tourniquet is warranted, and the patient may need to be digitalized. An antivenin has been prepared for the treatment of stings by certain Australian coelenterates.

²⁹ S. WIENER, Med. J. Aust. 2, 219 (1958).