- Primary assessment of airway, breathing, and circulation takes precedence.
- Few studies have evaluated the utility of most first aid.
- The utility of negative pressure extraction devices has not been evaluated for scorpion stings.
- Perform endotracheal intubation and vascular access as needed.

Emergency Department Care

Supportive care in all cases and antivenom in severe cases are used for the treatment of scorpion envenomation.

- Grades of *Centruroides* envenomation
- Grade I - Local pain and/or paresthesias at the site of envenomation
- Grade II - Pain and/or paresthesias remote from the site of the sting, in addition to local findings
- Grade III - Either cranial nerve/autonomic dysfunction or somatic skeletal neuromuscular dysfunction
- Cranial nerve dysfunction - Blurred vision, roving eye movements, hypersalivation, tongue fasciculations, dysphagia, dysphonia, problems with upper airway
- Somatic skeletal neuromuscular dysfunction - Restlessness, severe involuntary shaking or jerking of the extremities that may be mistaken for a seizure

- Grade IV - Combined cranial nerve/autonomic dysfunction and somatic nerve dysfunction

- *Androctonus australis* Hector Hospitalization Score
- Priapism: +3
- Vomiting: +2

- SBP >160: +2
- Corticosteroid PTA: +2
- Temperature >38ºC: +1
- Heart rate >100 bpm: +1

Total ≥2 = Hospitalization

- Although grading and scoring systems have been developed, they are limited due to species specificity and low-degree symptoms that would lead to hospitalization or therapy.

Medical care

Because the clinical manifestations and severity of the symptoms vary among patients, individualize management of scorpion stings. Furthermore, frequent patient monitoring allows earlier recognition of the life-threatening problems of scorpion envenomation. Treatment generally consists of moving the patient away from the scorpion and stabilizing the patient's airway and vital signs, followed by administration of antivenin and institution of symptomatic and local treatment.

- Local treatment is discussed as follows:
- A negative-pressure extraction device (ie, the extractor) may be useful, although the benefit is unproven. The extractor creates a negative pressure of 1 atm. Apply it to the sting site after incision. Oral extraction is contraindicated.
- Use ice bags to reduce pain and to slow the absorption of venom via vasoconstriction. This is most effective during the first 2 hours following the sting.
- Immobilize the affected part in a functional position below the level of the heart to delay venom absorption.
- Calm the patient to lower the heart rate and blood pressure, thus limiting the spread of the venom.
- For medical delay secondary to remoteness, consider applying a lymphatic-venous compression wrap 1 inch proximal to the sting site to reduce superficial venous and lymphatic flow of the venom but not to stop the arterial flow. Only remove this wrap when the provider is ready to administer systemic support. The drawback of this wrap is that it may intensify the local effects of the venom.
- Apply a topical or local anesthetic agent to the wound to decrease paresthesia; this

tends to be more effective than opiates.

- Administer local wound care and topical antibiotic to the wound.
- Administer tetanus prophylaxis.
- Administer systemic antibiotics if signs of secondary infection occur.
- Administer muscle relaxants for severe muscle spasms (ie, benzodiazepines.)

- Systemic treatment is instituted by directing supportive care toward the organ specifically affected by the venom.
- Establish airway, breathing, and circulation (ie, ABCs) to provide adequate airway, ventilation, and perfusion.
- Monitor vital signs (eg, pulse oximetry; heart rate, blood pressure, and respiratory rate monitor).
- Use invasive monitoring for patients who are unstable and hemodynamic.
- Administer oxygen.
- Administer intravenous fluids to help prevent hypovolemia from vomiting, diarrhea, sweating, hypersalivation, and insensible water loss from a tropical environment.
- Perform intubation and institute mechanical ventilation with end-tidal carbon dioxide monitoring for patients in respiratory distress.
- For hyperdynamic cardiovascular changes, administration of a combination of beta-blockers with sympathetic alpha-blockers is most effective in reversing this venom-induced effect. Avoid using beta-blockers alone because this leads to an unopposed alpha-adrenergic effect. Also, nitrates can be used for hypertension and myocardial ischemia.
- For hypodynamic cardiac changes, a titrated monitored fluid infusion with afterload reduction helps reduce mortality. A diuretic may be used for pulmonary edema in the absence of hypovolemia, but an afterload reducer, such as prazosin, nifedipine, nitroprusside, hydralazine, or angiotensin-converting enzyme inhibitors, is better. Inotropic medications, such as digitalis, have little effect, while dopamine aggravates the myocardial damage through catecholaminelike actions. Dobutamine seems to be a better choice for the inotropic effect. Finally, a pressor such as norepinephrine can be used as a last resort to correct hypotension refractory to fluid therapy.
- Administer atropine to counter venom-induced parasympathomimetic effects.

- Insulin administration in scorpion envenomation animal experiments has helped the vital organs to use metabolic substrates more efficiently, thus preventing venom-induced multiorgan failure, especially cardiopulmonary failure. Unfortunately, no human studies have been conducted.
- Administer barbiturates and/or a benzodiazepine continuous infusion for severe excessive motor activity.
- The use of steroids to decrease shock and edema is of unproven benefit.
- Antivenom is the treatment of choice after stabilization and supportive care. Because of the heterogeneity of venom composition between different scorpion species, one specie’s antivenom will have limited effect on another scorpion specie’s venom. Thus, correct scorpion species identification is a prerequisite for proper antivenom treatment.

- For newer scorpion antivenom, the exact dosing has not been established as animal studies treatment amount does not translate into human studies treatment amount. In addition, the quantity to be used is determined by the patient's clinical severity, symptom evolution, and treatment response. Unfortunately, predicting the patient's response treatment is difficult, which makes exact antivenom dosing difficult. Furthermore, underdosing will result in limited or no effect, while overdosing increases the side effects and hypersensitivity reactions.
- The antivenom significantly decreases the level of circulating unbound venom within a few hours. The persistence of symptoms after the administration of antivenom is due to the inability of the antivenom to neutralize scorpion toxins already bound to their target receptors or inadequate antivenom amount.
- General time guidelines for the disappearance of symptoms after antivenom administration are as follows:
- *Centruroides* antivenom: Severe neurologic symptoms reverse in 15-30 min. Mild-to-moderate neurologic symptoms reverse in 45-90 min.
- Non-*Centruroides* antivenom: In the first hour, local pain abates. In 6-12 hours, agitation, sweating, and hyperglycemia abate. In 6-24 hours, cardiorespiratory symptoms abate.

- While an anaphylaxis reaction to the antivenom is possible, the patient is at lower risk for this than with other antivenoms for other poisonous envenomations if there is a scorpion venom—induced large release of catecholamines. Also, animal-derived antivenom increases the risk of hypersensitivity reaction compared to human monoclonal-derived antivenom. Finally, the larger the dose of antivenom, the greater the change for serum sickness.
- In a prospective, randomized, double-blind study, Boyer et al compared scorpion-specific F(ab') $_2$ antivenom (Anascorp, *Centruroides* [scorpion] immune $F(ab)_2$ intravenous [equine], Instituto Bioclon) (n=8) with placebo (n=7) in children who developed neurotoxic symptoms following scorpion envenomation. [12]

Neuromotor abnormalities were present in all patients at baseline, and respiratory distress was present in 20%. Beginning 2 hours after treatment, symptom resolution differed significantly in the antivenom group compared with the placebo group. Plasma venom concentrations were undetectable and cessation of the neurologic syndrome occurred within 4 hours in 100% of antivenom recipients compared with 1 placebo recipient (p=0.001).

- Thus, the Boyer et al study suggests that scorpion-specific $F(ab')_2$ antivenom successfully treated the clinical syndrome, reducing the need for concomitant sedation and reducing circulating unbound venom levels for *Centruroides* envenomation. [12]

- For *Mesobuthus tamulu* envenomations, horse-derived antivenom has been developed. Natu et al compared the newer antivenom treatment versus the traditional

prazosin treatment in their open label study of 81 envenomated patients and found that antivenom decreased clinical recovery time to 4.14 hours +/- 1.6 hours compared to prazosin's clinical recovery time of 19.28 hours +/- 5.03 hours. [13]

- Natu et al also found that the antivenom plus prazosin combination group had a recovery time of 3.46 hours +/- 1.1 hours but felt it was comparable to the antivenom group recovery time and recommended that the combination therapy be reserved for patients presenting with pulmonary edema with hypertension.
- Bawaskar et al compared antivenom plus prazosin versus prazosin in their open label trial of 70 patients with only grade 2 envenomations (beginning of systemic involvement) and found that 91.4% of the combination treatment group had resolution of their clinical symptoms within the 10-hour mark compared to 22.9% in the prazosin treatment group. [14]

Both the Natu and the Bawaskar studies suggest the utility of the new *Mesobuthus tamulus* antivenom for systemic symptoms envenomations.

- A vaccine preparation was tried in experimental animals but was not pursued because of the need to prepare different antigens according to different geographical areas and to different species of scorpions living in the same area.
- In some cases, be aware that meperidine and morphine may potentiate the venom. Also, the concurrent use of barbiturates and narcotics may add to the respiratory depression in patients who have been envenomated.