

An update on epidemiology and management practices of Scorpion envenomation in India

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ABSTRACT

Introduction: Scorpion envenomation is a life-threatening condition, particularly for children. Therefore, it is essential for primary care health providers to suspect, identify, and manage this condition early to prevent death and minimize morbidity. **Objective:** To identify the key epidemiological characteristics of scorpion envenomation and update the primary care health workers regarding the latest management practices of scorpion envenomation. **Methodology:** A non-systematic review was performed by searching the key terms on databases such as PubMed, Medline, Scopus, Google Scholar, and ResearchGate. **Results:** Worldwide, over 2.5 billion people are living at risk of scorpion stings. Every year, over 1.2 million are stung by scorpions leading to the death of at least 3,250 people globally. The most vulnerable group includes farmers, laborers, and those living in rural areas. Adults are most frequently stung but envenomation is more severe among children. Prazosin is a key drug to prevent death due to cardiovascular complications. **Conclusion:** Most of these stings and deaths could be preventable with proper awareness, safety precautions, and timely access to treatment. Government and local hospitals should ensure the availability of key drugs such as prazosin.

Keywords: Epidemiology, prazosin, scorpion envenomation, scorpion sting

Introduction

Scorpion envenomation is a life-threatening public health hazard of tropical and sub-tropical regions of the world.^[1] However, very little attention has been given to morbidity and mortality due to venomous animal bites or stings in developing countries including India. This is reflected in the lack of a systematic reporting system on venomous bites or stings. Every year, thousands of human deaths occur due to bites or stings of snakes, scorpions, spiders, scorpions, etc., Dandona *et al.*^[2] reported that deaths due to the bite/sting of a venomous animal in the Bihar state of India accounted for 10.7% of all deaths due to all unintentional injuries, with an adjusted annual mortality rate of 6.2 per 100,000

population. For scorpions, the adjusted mortality rate reported was 0.9 per 100,000 populations.

A vast population of the world, nearly 2.5 billion is living at the risk of scorpion sting. Every year, over 1.2 million are stung by scorpions leading to the death of at least 3,250 people globally.^[1] The most vulnerable group includes farmers, laborers, and those living in rural areas.^[3] Though adults are most frequently stung, envenomation is more severe among children causing high mortality among them.^[1] Children constitute most of the hospitalized and fatal victims of scorpion stings. Most of the scorpion stings among children occur during playing (50%) and sleeping (33%).^[2] The most common reason for high mortality among them is a delay in seeking treatment. Those children who received treatment after 6 hours of being stung are at high risk of complication and death.^[4,5] There is a paucity of epidemiological data on scorpion stings mainly because of the reduced severity of scorpion envenomations among adults and poor organization of health services. Apart from this, many patients resort to

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traditional medicines to treat scorpion stings.^[1] Even qualified health providers lack sufficient skills to recognize and manage scorpion envenomation. Lack of standard management guidelines for scorpion envenomation at the hospital level and the absence of a comprehensive national program on animal bites or stings further jeopardize the situation.

Distribution and characteristics of scorpions and their venom

Scorpions are one of the most venomous animals, mostly found in the hot and dry climate of tropical and sub-tropical regions. There are around 1,500 species of scorpions, of which 30 are dangerous to humans.^[1] Different regions of the world have different species of prevalent scorpions.^[1]

They can sting with or without inoculation of venom that results in a wide range of clinical manifestations.^[1] *Mesobuthus tamulus*, an Indian red scorpion, and *Palamnaeus swammerdami* (black scorpion) are poisonous species found in India. However, *M. tumulus* is most lethal and widespread in the Indian subcontinent.^[3,6]

Venoms of scorpions are very toxic for humans. The venom distributes rapidly in the extravascular compartment leading to an early appearance of symptoms.^[1] Nature and potency of venoms, the behavior of the scorpion and varies according to the species. The main active components of the venom from dangerous scorpions are neurotoxic peptides. Because of the structural, antigenic, and functional variations among these neurotoxic peptides, it is always a challenge to prepare an effective antivenom. This venom activates the sodium and calcium channels of the neuromuscular system.^[7] The major mechanism of action of scorpion venom toxins involves the release of endogenous acetylcholine and catecholamines (autonomic storm) by acting on ion channels.^[8] It leads to transient cholinergic symptoms of vomiting, abdominal colic, diarrhea, incontinence, profuse sweating, piloerection, and priapism. This is followed by late and sustained adrenergic effects such as hypertension, shock, tachyarrhythmia, and bradyarrhythmia, evidence of myocarditis, and pulmonary edema.^[1]

Most scorpion stings are a problem in rural areas due to the peculiar habitat of scorpions that live in the crevices of dwellings, underground burrows, under logs or debris, paddy husk, sugarcane fields, coconut and banana plantations.^[9] Most stings are reported at night as the scorpions retreat in the crevices of dwellings during the day and only emerge out at night.^[5,9] Scorpion stings are more common during the summer season.^[5,9] Several human habits and activities such as walking barefoot, sleeping on grounds, and doing activity in the dark, increase the risk of exposure to a scorpion sting.^[9] The most common site of the sting is the extremities, mainly over the lower limbs, followed by the upper limb and the face.^[5]

Natural history and clinical manifestations

In adults, scorpion sting is generally harmless and produces local symptoms only, whereas it is a medical emergency in

children, with life-threatening complications such as myocarditis and encephalopathy.^[8] Clinical manifestations depend upon scorpion species, region, the dose of venom, age of the person, the season of the sting, and the time-lapse between sting and hospitalization.^[6] In adults, most of the time, excruciating and persistent pain remain the only symptoms. The appearance of digestive symptoms within the first few hours (in 5% of the cases) marks the entry of the patient in a serious stage of the envenomation, which can consequently evolve into pulmonary edema or hypotension, arrhythmia, or cardiac ischemia. The death can occur early due to cardiovascular collapse (in less than 1% of the cases).^[1] Some species such as *Centruroides* sp. produce predominantly neurotoxic effects such as erratic eye movements, fasciculations, muscle spasms, and respiratory distress. Other manifestations of different species in different regions are ptosis and dysphagia from *Parabuthus* envenoming (South and East Africa), thrombotic strokes from *Nebo hierichonticus* stings in the Middle East, acute pancreatitis from *Tityus trinitatis* in Trinidad, and local necrosis, hemolysis, and acute kidney injury from *Hemiscorpius lepturus*.^[10]

In the Indian subcontinent, refractory pulmonary edema is the major cause of death among the cases of severe scorpion envenomation.^[3] In rural India, early warning signs of impending life-threatening cardiac manifestations of scorpion envenomation are vomiting, sweating, cold extremities, and priapism in males.^[11]

Among children, scorpion sting envenomation is a life-threatening emergency condition and may cause severe neurological, cardiac, respiratory system involvement, anaphylactic shock, and death.^[6] Major factors associated with the poor prognosis of scorpion sting envenomation among children are the presence of metabolic acidosis, myocarditis, priapism, encephalopathy, and acute pulmonary edema.^[6] The mortality rate varied from 1 to 10.7% in different studies conducted in different regions of India.^[3,5,6] A higher mortality rate in some studies is mainly due to late presentation (beyond 6 hours of sting) of cases to the hospital for treatment.^[4-6] A higher mortality is also observed among children who received steroids and anti-histamines.^[4-6] Mahadevan *et al.*^[9] is of opinion that deaths in children are mostly due to irrational therapy or failure to monitor closely and effectively treat pulmonary edema. In reality, because children have a healthy myocardium, they should recover fast and tolerate the autonomic storm of venom well if they receive timely and effective treatment.

Management of scorpion envenomation

All patients with an exposure history of scorpion sting after quick initial assessment and preliminary treatment at peripheral health facilities should be promptly referred to tertiary hospitals with intensive care unit (ICU) beds, oxygen, and antivenom facilities. Particularly for children, scorpion envenomation should be treated as an emergency with early therapy with prazosin followed by a timely referral.^[6]

Alleviation of excruciating pain is an important part of the management of scorpion stings. The most effective analgesia is a local anesthetic, which is administered by digital block in stings on fingers and toes.^[10] At the referral center, early detection of cardiopulmonary complications such as myocarditis, left ventricular failure, and cardiogenic shock based on clinical manifestation, electrocardiographical abnormality, biomarkers, and echocardiography can help in the risk assessment of patients and facilitate decision-making in the management of scorpion envenomation cases.^[12]

Over the years, several treatment options, such as lytic cocktail (pethidine + promethazine + chlorpromazine), insulin glucose drip, beta-blockers, digoxin, diuretics, rotating tourniquets to the extremities, and nifedipine have been experimented with, but with little success.^[3] Bawaskar, through his careful observation, experimentation, and close monitoring, has successfully treated several cases of scorpion envenomation among children initially with sodium nitroprusside and later on with oral prazosin.^[13]

Antivenom has proved effective in several studies in Arizona and India.^[10] However, its non-availability, high cost, and ineffectiveness in severe envenomation limit its use for most of the cases.^[6] Antivenom will not be effective once severe envenomation develops, and the parasympathetic effects of venom are over.^[3]

Cardiovascular symptoms respond well to vasodilators such as alpha-1 blockers like prazosin.^[10] Prazosin is considered a physiological and pharmacological antidote to scorpion venom action. It antagonizes the after-effects of venom-liberated catecholamines.^[3] Early administration of prazosin helps arrests the development of severe systemic features and thereby prevents mortality.^[5] As compared to the pre-prazosin era, the mortality rate due to scorpion envenomation has reduced from 30% to 1% after routine use of prazosin.^[14]

Currently, simultaneous use of prazosin and scorpion anti-venom is considered as the mainstay of treatment of scorpion envenomation.^[14] This regimen has reduced the case fatality rate to less than 1%.^[14] Early administration of scorpion antivenom and prazosin within 4 h of sting along with timely referral can reduce cardiovascular morbidity and mortality. Close monitoring in an ICU during the treatment is essential as nearly 10% of children may develop marked tachycardia, hypotension, pulmonary edema, and shock and may require treatment with intravenous dobutamine, nitroglycerine, and ventilator support for 24 to 96 h.^[3] Dobutamine is particularly effective for left ventricular failure that evolves despite early prazosin therapy.^[10]

Steroids, antihistamines, calcium channel blockers, and diuretics should be avoided in the management of scorpion envenomation as they can worsen cardiac complications by their negative effects on the heart.^[3,4]

Prevention and Control

Simple preventive techniques, such as wearing protective clothing and checking the absence of scorpions in clothes, shoes, or bedding before use, clearing debris, and trash from areas one inhabits, using a flashlight at night are of paramount importance to reduce the risk of venomous bites and stings. Houses should have a row of ceramic tiles at the base of outside walls and the doorsteps should be at least 20 cm high to prevent the entry of scorpions.^[9,10] Scorpion can also be controlled by using indoor residual insecticides such as 1% lindane or dieldrin. However, the use of insecticide poses the problem of pollution and toxicity for non-targeted fauna and humans.^[1,9]

Government has a very important role in controlling and management of this potentially life-threatening condition. They can help by creating awareness and sensitizing the community about the dangers of scorpion sting, particularly among children, and the importance of receiving early treatment can save lives and also improve the reporting of cases to health facilities.^[1] Capacity building of health providers and ensuring availability and access to key drugs such as antivenoms, prazosin, and local anesthetics will help manage this scorpion bite effectively. Better organization of the care system with proper linkage to the referral facility for the management of complicated cases can help minimize the preventable death due to scorpion stings.

Emphasis should be given to venomous animal control programs,^[1] which should include a surveillance system to facilitate better reporting of bites or stings cases. Data generated through improved should be used to plan the region-wise and facility-wise requirements of antivenom and prazosin. These measures will help prevent death by ensuring access to timely treatment.

Conclusions

Most of these stings and deaths could be preventable with proper awareness, safety precautions, and timely access to treatment. Government and local hospitals should ensure the availability of key drugs such as prazosin.

Key messages

1. Children are at the risk for severe complications of scorpion envenomation sometimes even causing death.
2. Common complications of Indian red scorpion include cardiovascular complications such as pulmonary edema and myocarditis.
3. Timely detection of pulmonary edema and administration of prazosin can help prevent death due to scorpionism.
4. Capacity building of primary care providers, educating the general population, a robust referral system, and better reporting of animal bites or stings through a surveillance system should be the key components of the government program for controlling animal bites and stings.

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Conflicts of interest

There are no conflicts of interest.

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