



Snake bite: a current approach to management

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Summary

Snake envenoming is uncommon but potentially life-threatening. It is characterised by systemic effects including coagulopathy, neurotoxicity, myotoxicity and renal impairment. Pressure immobilisation bandaging is safe and appears to be effective first aid if applied correctly soon after the bite. Each Australian snake causes a characteristic clinical syndrome which can be used with information about the geographical distribution of snakes to determine which snake is involved when a patient is envenomed. Snake venom detection kits are available to help identify the causative snake. Antivenoms are available for the five major groups of snakes and are the mainstay of therapy in patients with systemic envenoming. Antivenom should be administered by slow intravenous infusion in a critical care area. Serious adverse reactions to antivenoms are uncommon.

Keywords: antivenom, coagulopathy, envenoming, venom.

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Introduction

Australia has a unique snake fauna including snakes with highly potent venoms. The major Australian snakes are the brown snakes, tiger snake group, mulga/black snakes, taipans and death adders. Estimates suggest that there are between 500 and 3000 snake bites annually. In about 200 to 500 cases antivenom is required.^{1,2} Snake envenoming is an uncommon but potentially life-threatening medical condition.³ Between one and four deaths occur each year with most resulting from brown snake bites. Bites occur in the warmer months and are more common in regional and rural areas. Exotic snakes are kept legally in zoos and illegally by collectors so bites by non-Australian snakes sometimes occur.

Clinical effects

In many snake bites only local effects occur because insufficient venom is injected or the snake is non-venomous.

With more significant envenoming there may be local or systemic effects. These range from non-specific effects (nausea, vomiting, headache, abdominal pain, diarrhoea, dizziness and collapse) to major organ effects (coagulopathy, neurotoxicity, rhabdomyolysis or renal damage).⁴

Local effects

Brown snake bites have minimal local effects, whereas local pain, swelling and occasionally tissue injury can follow black and tiger snake bites. Bites from some snakes such as whip snakes (*Demansia* species) can cause immediate significant local swelling and pain.

Coagulopathy

The majority of dangerous Australian snakes cause a procoagulant coagulopathy. The venom contains a prothrombin activator that leads to consumption of major coagulation factors including fibrinogen, resulting in a defibrination coagulopathy which should be referred to as venom-induced consumptive coagulopathy. This is characterised by very high d-dimers, undetectable fibrinogen, and unrecordable prothrombin time and activated partial thromboplastin time. Recovering from this takes many hours after venom neutralisation has been achieved with antivenom.

Some black snakes (mulga and Collett's snake) cause an anticoagulant coagulopathy, probably due to an inhibitor, that is rapidly reversed with antivenom. It is not associated with consumption of clotting factors, so fibrinogen and d-dimer levels are normal.

Neurotoxicity

Paralysis is a classic effect of snake bite and is due to presynaptic or postsynaptic neurotoxins in the venom. Presynaptic neurotoxins disrupt neurotransmitter release from the terminal axon. This takes days to resolve and does not respond to antivenom. Postsynaptic neurotoxins competitively block acetylcholine receptors but the effect can be reversed by antivenom.

Neurotoxic envenoming causes a progressive descending flaccid paralysis. Ptosis is usually the first sign, then facial and bulbar involvement progressing to paralysis of the respiratory muscles and peripheral weakness in severe cases.

Myotoxicity

Some Australian snakes, such as the mulga snakes and tiger snakes, have venom containing myotoxins that cause rhabdomyolysis with muscle pain, tenderness and weakness, a rapidly rising creatine kinase and myoglobinuria.

Renal damage

Renal impairment or acute renal failure can occur secondary to severe rhabdomyolysis, in association with microangiopathic haemolytic anaemia (reported with brown snakes) or can occur rarely in isolation.

Major types of Australian snakes: clinical syndromes

The five major groups of medically important Australian snakes which cause characteristic clinical syndromes are included in Table 1. Identifying the snake is important for diagnosis and determining the appropriate antivenom to be administered, but is not always possible. Venom detection kits are available to assist with identification.

Brown snakes

Brown snakes occur widely throughout mainland Australia. They are fast moving and easily alarmed snakes that strike readily. However, they have a high rate of dry bites with envenoming occurring in less than half of bites. Bites cause minimal local effects and non-specific systemic effects are uncommon. Severe envenoming is characterised by an early collapse, within an hour of the bite, usually with spontaneous recovery within 5 to 10 minutes. Collapse appears to occur at the time of onset of the coagulopathy, but the mechanism is unclear. The major clinical feature is a venom-induced consumption coagulopathy.⁴ Renal damage and microangiopathic haemolytic anaemia have been reported and neurotoxicity is rare.

Tiger snake groups

Tiger snakes occur in southern and eastern Australia. The major clinical effects are a venom-induced consumption coagulopathy, presynaptic neurotoxicity and rhabdomyolysis. An early collapse can occur and initially the only detectable effect may be a coagulopathy.

Rough-scaled snakes are closely related to tiger snakes and cause similar effects. Copperheads are less well characterised, but appear to cause neurotoxicity and coagulopathy. The *Hoplocephalus* genus (Table 1) cause coagulopathy and are clinically similar to brown snakes except that tiger snake antivenom is used for treatment.

Mulga and black snake groups

Mulga snakes occur across Australia except the south and east. They cause severe rhabdomyolysis and anticoagulant coagulopathy associated with non-specific symptoms. Collett's

snake causes a similar clinical picture, but only bites in snake handlers have been reported due to its isolated distribution.

The red-bellied black snake is common in southern and eastern Australia, but only causes non-specific systemic effects, mild rhabdomyolysis and local effects which are usually managed without antivenom.

Taipans

Taipans occur in northern Australia and are very dangerous with a high envenoming rate. The mortality rate is high in untreated cases. Clinical effects include a venom-induced consumption coagulopathy, presynaptic neurotoxicity and mild rhabdomyolysis. Thrombotic microangiopathy, haemolytic anaemia and renal failure have been rarely reported.

Death adders

Death adders are widespread but secretive ambush predators that have a characteristic 'viper-like' appearance. The major clinical effect is a postsynaptic neurotoxicity associated with non-specific systemic features.⁴

Diagnosis

In the majority of cases there is a history of a snake bite or suspected snake bite. History, examination and investigations focus on whether the patient is envenomed or not and by which snake so that the correct antivenom can be given. Occasionally the diagnosis is not obvious if a snake is not seen or the patient presents with coagulopathy or neurotoxicity and no history of a bite.

A careful history is required to determine the circumstances of the bite and what first aid has been applied. Early symptoms suggest severe envenoming. The examination should include the bite site, and palpation of the lymph nodes draining the site for tenderness. In addition to standard observations, the examination includes looking for signs of paralysis (ptosis, bulbar palsy, respiratory effort and peripheral weakness), any evidence of coagulopathy (bleeding) or evidence of rhabdomyolysis (muscle tenderness and weakness).

Investigations should include a full blood count, coagulation studies including d-dimer, and biochemical tests including creatine kinase. A urine analysis is helpful for detecting blood or myoglobin.

A whole blood clotting time may be useful if coagulation studies are not available. Blood is collected in a clean glass tube and the time to clot is measured. The normal clotting time is less than 10 minutes. If the clotting time is greater than 20 minutes, this is highly suggestive of a procoagulant coagulopathy. If the clotting time is between 10 and 20 minutes, the result is indeterminate, but may be consistent with an anticoagulant coagulopathy.⁵ This test may be useful in remote situations to determine if a patient has significant coagulopathy.

Table 1

Clinical effects of envenoming by Australian snakes and initial dose of antivenom required

Snake genus	Early collapse	Local effects	Non-specific systemic features	Coagulopathy	Neurotoxicity	Myotoxicity	Renal impairment	Antivenom dose
1. Brown snake	++	+/-	+/-	+++	+/-	-	+ ^e	2-5 vials ^f
2. Tiger snake ^a Hoplocephalus species ^b	+	++	++	+++	++	++	+/-	4 vials
3. Black snake: Mulga snake/Collett's snake Red-bellied black snake ^c	-	+++	+++	++	-	+++	+	1 vial
4. Taipan	+	+	++	+++	+++	+	+	3 vials
5. Death adder	-	+/-	+	-	+++	-	-	1 vial
Whip snake ^d	-	++	+/-	-	-	-	-	nil

^a Includes rough-scaled snake and copperhead snake

^b Includes broad headed, pale headed and Stephen's banded snakes and is treated as tiger snake

^c Includes blue-bellied and spotted black snake

^d Not one of the 5 major types of snakes but a common snake causing mild envenoming

^e Renal failure usually occurs in the setting of microangiopathic haemolytic anaemia

^f Recent research suggests that the previously recommended larger doses of brown snake antivenom are unnecessary, and further research is required. The Poisons Information Centre (phone 13 11 26) should be contacted for current recommendations.

+++ major feature of envenoming that almost always occurs

++ common feature

+ reported but uncommon, absence does not exclude this snake

+/- rarely reported

- not reported

Significant systemic envenoming has been defined as any of the following:

- neurotoxic paralysis
- coagulopathy (confirmed by laboratory)
- myotoxicity
- renal impairment/failure.

Determination of the snake involved and more importantly the selection of the appropriate monovalent antivenom is based on:

- knowledge of the local snake fauna
- clinical syndrome
- snake venom detection kit.

Snake venom detection kit

The snake venom detection kit is a useful diagnostic test to confirm which of the five major snake groups is responsible for the envenoming. This will determine which antivenom is needed. The test is therefore only useful in healthcare facilities that have antivenom supplies. It should be done in a laboratory. The test has no value in non-envenomed patients because of false positives and it cannot be used to confirm or exclude snake envenoming. In many cases the determination of the snake involved can be made on geographical and clinical grounds, and results from the venom detection kit should always be interpreted in the context of these. It is prudent to collect and store bite site swabs for venom detection in all suspected snake bite cases and only do the test in cases where envenoming is confirmed and antivenom is required.

Management of snake bite

Many snake bites do not result in envenoming. The rate of envenoming varies depending on the species of snake. Whether envenoming has occurred cannot be immediately determined when the patient presents. This means all suspected snake bites must be triaged as a medical emergency and observed for a sufficient period of time in a hospital with adequate supplies of antivenom and laboratory facilities. Immediate expert advice can be obtained from the Poisons Information Centre network (phone 13 11 26).

First aid

The bite site should not be washed so that the area can be swabbed for venom detection. Pressure immobilisation is the recommended first aid treatment for all snake bites.⁶ It has been effective in animal studies and case studies, but has not been tested in clinical trials.

A broad (15 cm) bandage is applied at the same pressure as for a sprained ankle over the entire limb. The patient must then remain completely immobilised, not just the bitten limb. For bites on areas other than limbs the patient should be immobilised to slow the spread of venom.

Pressure immobilisation should only be removed once the patient is in a hospital stocked with antivenom. If the patient is envenomed, pressure immobilisation can be removed once antivenom therapy has commenced. If the patient has no clinical or laboratory signs of envenoming, the bandage can be removed if antivenom and resuscitation equipment are available.

General management

Initial management includes basic resuscitation and assessment of the patient. Once airway, breathing and circulation have been assessed and stabilised, the diagnosis can be made and specific management undertaken.

All cases of suspected snake bite should be observed for sufficient time to exclude delayed envenoming. Close observation is needed to look for early signs of neurotoxicity such as ptosis.³ There has been significant controversy over the appropriate duration of observation and this is highly dependent on regional snake fauna and healthcare facilities. The current recommendation is that patients should be observed for a period of at least 12 hours and if this period extends into the night the patient should remain overnight. The duration of observation may be longer in regions where delayed envenoming occurs, for example the delayed neurotoxicity following death adder bites in northern Australia.⁴

The patient is unlikely to be envenomed if they have normal laboratory tests on admission, 1–2 hours after pressure immobilisation removal and before discharge.

Wound site infection is rare and only requires treatment if there is clear clinical evidence of an infection. Local swelling often resolves without treatment so antibiotics are not recommended. Tetanus prophylaxis is recommended for all bites.

Antivenom

Antivenom is the mainstay of treatment in patients with systemic envenoming (see Table 2). It is not recommended in patients who only manifest non-specific features as these may be misleading. Antivenom should always be administered intravenously after 1:10 dilution with normal saline or Hartmann's solution. The degree of dilution may need to be modified for large volume antivenoms and in young children. Premedication with adrenaline, antihistamines or corticosteroids is not recommended, but the patient must be monitored in a critical care area with adrenaline and resuscitation equipment readily available.

After the first dose, further doses and the intervals between them are dependent on the type of snake, the reversibility of the clinical effects and the time it takes the body to recover once the venom has been neutralised. The response to antivenom differs for the various clinical and laboratory effects. The postsynaptic neurotoxicity seen with death adder bites is reversed by

Table 2

Potential benefits of antivenom

Clinical effect	Benefits
Procoagulant coagulopathy	Neutralises toxin effect allowing clotting factors to be resynthesised and clotting to recover over 6–12 hours
Anticoagulant coagulopathy	Neutralises a toxin inhibitor of coagulation with immediate improvement in coagulation studies
Presynaptic neurotoxicity	Neutralises toxin in the intravascular compartment and will prevent further development of neurotoxicity but not reverse already present neurotoxic effects
Postsynaptic neurotoxicity	Neutralises toxin in the intravascular compartment and reverses neurotoxicity
Rhabdomyolysis	Neutralises myotoxins and will prevent further muscle injury but not reverse myotoxic effects
Local effects	Unlikely to reverse any local effects that have already developed
Renal damage	Unlikely to have any discernible effect because this is usually secondary to other toxin-mediated effects
Generalised systemic effects: nausea, vomiting, headache, abdominal pain, diarrhoea and diaphoresis	Rapidly reverse non-specific effects. This is a useful indication of antivenom efficacy

antivenom, but presynaptic neurotoxicity seen with taipan and tiger snakes is irreversible once it has developed and antivenom will only prevent further progression. Procoagulant toxins are neutralised by antivenom, but recovery of normal coagulation takes 6–12 hours on average. Anticoagulant coagulopathy is rapidly reversed by antivenom. Development or progression of rhabdomyolysis can be prevented by antivenom but it cannot be reversed.

There continues to be debate about initial doses, further doses and the dosing interval⁷ and discussion with an expert is often safest. The Australian Snakebite Project is a multicentre prospective study of snake bite where serial samples are being collected for quantification of venom and antivenom concentrations. This study should help to address the questions of initial dose and appropriate laboratory and clinical end points for antivenom treatment. (Patients can be enrolled by contacting the Poisons Information Centre or the author).

Adverse effects

Early and delayed allergic reactions can occur with any antivenom, but are uncommon with Australian antivenoms. Early allergic reactions occur in less than 5% of cases and are thought to be due to complement activation. True hypersensitivity reactions are rare except in snake handlers who have had previous exposure to antivenom.

Serum sickness is a delayed reaction that develops 5–10 days after antivenom administration and is characterised by fever, rash, arthralgia, myalgia and non-specific systemic features. This should be treated with a one-week course of corticosteroids. When greater than 25 mL of antivenom is administered it is advisable to give a prophylactic course of oral corticosteroids.

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Further reading

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For images of snakes: see Clinical Toxicology Resources website. <http://www.toxinology.com/> [cited 2006 Sep 12]

Conflict of interest: none declared