Effects of snake envenomation: a guide for emergency nurses

Stephen McGhee and colleagues explain how practitioners should care for people bitten by snakes, including those not native to the UK, and how to recognise the effects of different forms of venom

Abstract

Only one species of venomous snake, the adder, is indigenous to the UK, but many people keep venomous snakes as pets and others travel to places, such as the United States, where a wider variety of venomous snakes can be found. Emergency nurses should therefore be prepared to treat bite wounds caused by venomous and non-venomous snakes. This article offers an overview of the most common forms of envenomation in the UK and makes recommendations for the clinical care of people who have sustained snake bites.

Keywords

Snake bite, adder bite, venom, envenomation

Snakes have a reclusive nature and prefer a rural habitat, and usually bite humans only when they sense they are under threat (Klug et al 2010, Evans and Nelson 2013). Nevertheless, venomous snake bites are associated with significant morbidity and mortality worldwide (World Health Organization (WHO) 2010). There have been 14 fatalities from snake bites in the UK since 1876 and the most recent of them, in 1975, involved a child in Scotland (Reid 1976). However, there were 510 cases of snake bite reported to the National Poisons Information Service between 2004 and 2010. Snakes are not indigenous to Northern Ireland.

The European adder, or Vipera berus, is responsible for 52% of snake bites in the UK, with exotic species accounting for 26% and the European grass snake for 4%. The causes of the remaining 18% of snake bites are unidentified (Coulson et al 2013). While life-threatening envenomation is rare in the UK, people who have been bitten can experience long periods of pain and distress (Warrell 2005).

Although the adder is the only venomous snake indigenous to the UK, many pet enthusiasts keep snakes that pose a risk of life-threatening envenomation (Persson 2001). Significant envenomation by any of these snakes is considered a medical emergency requiring anti-venom therapy.

Every year around the world there are about five million snake-bite envenomations (Girish and Kemparaju 2011), of which about 125,000 result in death and another 375,000 cause pain, loss of function or both (WHO 2010).

Some people, including members of the military, farm workers and children who live in isolated rural areas, are especially at risk of envenomation due to their occupations or geographic locations (Johnson et al 2013). Most snake bites are inflicted on the feet and ankles (WHO 2010), with envenomation often causing neurotoxic and haemotoxic effects accompanied by tissue necrosis (Heiner et al 2013).

Members of the British armed forces are often deployed to areas where there is a significant risk of snake bite (Wall 2012), although since 1990 there has been only one published case of non-fatal snake-bite envenomation involving a British soldier (Krysta-Clark et al 2004). Although envenomation has occurred among US forces taking part in combat operations in Afghanistan and Iraq, there are little data about the magnitude of the problem.

In a voluntary cross-sectional survey of 390 US military personnel leaving Afghanistan, Shiau et al (2007) found there had been seven incidents of snake bite, and that military personnel there were at greater risk of snake bite than those in Iraq. In a more recent case review conducted in Afghanistan,
Heiner et al (2013) reported on 17 snake bites involving 15 Afghan nationals and two members of the US military who had been bitten mainly on the fingers, hands, feet, ankles or lower legs. Because these are common locations for snake bites, troops in jungle locations must wear boots and gloves, and should exercise appropriate caution when lifting items from the jungle floor (Kasturiratne et al 2008).

Envenomation from snake bites is also an important public health issue in tropical countries. In Sierra Leone, for example, nearly 7,000 people are bitten by snakes every year and almost 500 die due to lack of timely access to anti-venom (Kasturiratne 2008).

Venomous snake species

The two types of venomous snakes discussed in this article are the Viperidae and Elapidae. Snakes of the Viperidae family include many of those found in the south-eastern US. They include the copperhead (Agkistrodon contortrix), water moccasin or cottonmouth (A. piscivorus), eastern diamondback (Crotalus adamanteus) and European adder (V. barus) (Evans and Nelson 2013).

Snakes of the Elapidae family are also found in north America, as well as Africa, Asia, Australia and South America. They include cobras (genus Naja), the common krait (genus Bungarus), coral snakes (genus Micrurus) and mambas (genus Dendroaspis) (Evans and Nelson 2013). Some of these snakes are pictured in Figure 1.

The European adder can be found in most of mainland Britain. Adder bites usually occur between February and October, with the number of bites peaking during the summer months (Warrell 2005), a seasonal pattern that is thought to be associated with the adder’s hibernation periods (Coulson et al 2013). Meanwhile, about 75 different types of non-native snakes are kept as pets in the UK and envenomation from these occurs most often when they are being fed, their cages are being cleaned or their venom milked, or their owners handle them while intoxicated (Warrell 2005, Evans and Nelson 2013).

Viperidae inject venom into their victims and leave painful, deep puncture wounds (Ferri 2012), although about 25% of Viperidae bites do not cause envenomation and are termed dry bites (Ashton et al 2011, Evans and Nelson 2013). Viperidae inject a haemotoxic venom, while snakes of the Elapidae family inject a neurotoxic venom that attacks blood and nerve tissue (Juckett and Hancox 2002).

Clinical features

The first clinical manifestation of a snake bite is anxiety. Patients, even those who have sustained dry bites, may therefore report anxiety-associated autonomic arousal symptoms, including breathlessness, dizziness, numbness in the fingers, palpitations, sweating, tightness in the chest and tingling (Bates 2001). When practitioners attend to, transfer and treat patients, therefore, they must...
offer them reassurance at all times. There follows a checklist of good practice in managing snake bites:

- Keep calm, ensure you appear and sound confident, and maintain good eye contact with the patient.
- Place patient in a comfortable sitting position.
- If the patient is hyperventilating, encourage him or her to take deep and slow breaths, and praise their efforts. If the patient has a dry mouth, give him or her water.
- If the patient is panicking, explain that this is a normal reaction.
- Explain what the treatment involves but do not overwhelm the patient with information. Avoid using jargon or clinical terms unless you are sure the patient understands them.
- Explain that pain does not necessarily mean harm.
- Be positive about outcomes but keep to the facts. Avoid negative messages and do not speculate.
- Provide the patient with an opportunity to ask questions and acknowledge his or her concerns.
- After you have explained the treatment, ask the patient to confirm that he or she understands what has been said.

The presenting signs and symptoms of envenomation depend on the variety of snake responsible for the bite. Snakes such as the spitting cobra and South African rinkhals (*Hemachatus heamachatus*) spit a form of venom that can cause venom ophthalmia if it enters the eyes. Venom ophthalmia can cause painful chemical conjunctivitis, sometimes leading to corneal ulceration and anterior uveitis, with the potential for secondary infection (Warrell 2005).

Practitioners in Australia often use the enzyme-linked immunosorbent assay-based rapid snake venom detection kit (SVDK), which involves taking a swab of the patient’s bite area or a urine sample to identify the correct anti-venom to administer. SVDKs are not used in the UK or US, however.

A summary of the localised and systemic effects of Viperidae and Elapidae venom is listed in Table 1.

### Recommendations

Most emergency department (ED) nurses in the UK will lack experience in treating patients who present with snake bite (Bates 2001). When someone with suspected snake bite presents to or contacts the ED, clinicians’ most important task is to identify the type of snake involved. There are recorded cases of envenomation in people handling the dead bodies or severed heads of snakes (Suchard and LoVecchio 1999), so anyone who has been bitten should be discouraged from bringing these to an ED. Instead, they should be asked to take a photograph of the snake (Warrell 2005), ideally by smartphone or digital camera so that the photograph can be shared easily.

The National Poisons Information Service has a list of herpetologists who can give expert advice on snake species and the actions of their venom.

### First aid

Initial first aid should involve safe transfer of the patient to hospital as quickly and with as little movement as possible (Gold and Barish 1992). Any delay in administering anti-venom can lead to significant complications or even mortality (Sharma *et al* 2004, Narvencar 2006). Reassurance must be given at all times when moving or transferring patients and during the treatment process.

Rings and other tight-fitting jewellery should be removed from the patient in case of local swelling (Bates 2001), while a splint or sling can be applied to the affected limb area for immobilisation during transfer (Warrell 2005). For some Elapidae species, immediate pressure immobilisation is advocated due to the rapid action of neurotoxic venom (Bates 2001, Warrell 2005, Wall 2012). However, pressure immobilisation is not advocated for a patient bitten by a Viperidae species, such as the adder.

Figure 2 shows the British armed forces method of pressure immobilisation adapted from Ministry of Defence (2012) clinical guidelines for operations.
Emergency management A patient who is thought to have been bitten by a poisonous snake requires maintenance of airway, breathing and circulation, and should be monitored for at least 24 hours or until a diagnosis of venomous snake bite has been excluded (Bates 2001, Evans and Nelson 2013). If the patient is to be transferred by ambulance, intravenous access must be achieved and a 0.9% sodium chloride infusion commenced (Pittman 2008). Envenomation symptoms can develop between 30 and 60 minutes after a bite so it is important to monitor the patient’s vital signs, and to obtain a detailed clinical history that includes the type of snake and time of bite (Peterson 2006).

A top-to-toe examination should then take place to assess for signs of coagulopathy, and nurses should assess for any puncture-type wounds that have been inflicted by fangs or small teeth. Treatment includes marking the border of swollen and tender areas with a view to skin reassessment every 15 minutes so that extension of the bite can be assessed (Ferri 2012).

Lymphatic obstruction, swelling and blister formation can be ameliorated by immobilisation and extension of the limb with a simple splint (Lavonas et al 2011). Tetanus immunisation will have to be considered because cases of Clostridium tetani infection have been reported following snake bite (Ferri 2012). If the patient has been bitten by a snake of the Viperidae family, anaphylactoid symptoms can be treated early with oral or parenteral H1 blockers (Bates 2001).

If the patient is in pain, non-steroidal anti-inflammatory drugs (NSAIDs) should be avoided because of the risk of bleeding and renal dysfunction (Pittman 2008). Instead, the patient should be given paracetamol or opiate-based medication according to local guidelines. The recommended laboratory tests and other assessments are listed in Table 2, page 28.

Anti-venom Snake bites do not always result in envenomation so the use of anti-venom is not always indicated (Evans and Nelson 2013). However, its use...
The use of anti-venom is indicated when there is all of the following:

- Incocoagulable blood or spontaneous systemic bleeding.
- Neurotoxicity or myotoxicity.
- Renal failure.
- Shock.
- Sustained fall in blood pressure.

The NHS has access to a wide range of anti-venom preparations (Warrell 2005). Some clinicians have been reluctant to use anti-venom following adder envenomation due to the risk of severe allergic reaction (Coulson et al. 2013). This is because in the late 1950s a child with mild viper envenomation died as a result of an anaphylactic reaction, and it was assumed thereafter that ‘the bite is less dangerous than the anti-serum’ (McKiddie 1979). The risk of anaphylactic reaction, which usually occurs between ten and 18 minutes after administration, can be mitigated by ensuring adrenaline is available during anti-venom administration (Theakston and Reid 1976, Bates 2001).

Today the most commonly used anti-venom in the UK is the Zagreb anti-venom, which is an F(ab')2 antibody used primarily for viper envenomation. Between 2004 and 2010, 85 patients in the UK required anti-venom. No anaphylactic or anaphylactoid reaction or signs of serum sickness were reported during this period (Coulson et al. 2013).

For people bitten by the more exotic snakes of the Viperidae family, many of which are popular with snake enthusiasts, Crotalidae Polyvalent Immune Fab (Ovine), or CroFab, is the anti-venom of choice (Pittman 2008). Obtained from sheep serum following injection of pit viper venom, CroFab is used widely in the US (Evans and Nelson 2013).

Most patients given anti-venom show a rapid improvement in hemodynamic status and level of consciousness (Bates 2001). Any bleeding should stop within 30 minutes of administration and coagulation profiles should return to normal within six hours.

Supportive care Secondary hypovolemia as a result of haemorrhage and vasodilation should be treated with a transfusion of whole blood and plasma expanders (Bates 2001). Inotropes, such as dopamine, should be administered to support patients with hypotension as a result of increased capillary permeability (Bates 2001, Warrell 2005). In cases of envenomation that has led to neurotoxicity, endotracheal intubation with intermittent positive pressure ventilation may be required (Warrell 2005). Anticholinesterase drugs can be used to improve prognosis in patients with neurotoxic envenomation by reversing the effects of the neurotoxic venom (Watt et al. 1986).

Elapidae envenomation produces a ‘curare-type effect’ in patients by blocking postsynaptic nicotinic acetylcholine receptors at the neuromuscular junction (Evans and Nelson 2013). These patients appear flaccid and are in severe respiratory depression or arrest.

Anticoagulants and corticosteroids should be avoided in all cases of envenomation due to the risks of haemorrhage (Pittman 2008). Antibiotics may be required if there are signs of bacterial infection, but there is no evidence to support administration of prophylactic antibiotics following envenomation (Jorge et al. 2004). Fasciotomy, a surgical procedure that relieves pressure on the fascia, can treat loss of circulation to some areas of tissue or muscle and is useful for decompressing raised compartment pressures, signs of which include the ‘five Ps’: pain, pallor, paresthesia, pulselessness and paralysis. Fasciotomy is justified only if there is a compartmental pressure of more than 45mmHg, which can result in ischemic necrosis, but can take place only after normal coagulation has returned (Bates 2001).

Care and follow up All patients administered anti-venom will require follow up because they are at risk of developing serum sickness, an allergy-type disease (Pittman 2008). Patients given anti-venom should be advised to look for signs of fever, joint pain and malaise, all of which are typical of serum sickness (Evans and Nelson 2013). Further blood testing that includes coagulation assay should be undertaken a few days after patients'
initial discharge and they should be reviewed about three weeks later (Lavonas et al 2011).

Patients who develop serum sickness should be administered prednisolone orally until the signs and symptoms have resolved (Gold and Barish 1992). During follow-up care, patients should be asked to report any signs of further bleeding and infection (Evans and Nelson 2013), and advised to avoid aspirin, NSAIDs, and all types of contact sports and dental work due to the risk of haemorrhage (Pittman 2008). 

Summary
All snake bites must be assessed by clinical professionals so that the patients concerned receive the correct treatments for the specific snakes that bit them. Photographs taken by smartphone can be useful for identifying the species of snake and increase the likelihood of correct management.

Early assessment and effective first aid reduce the chances of significant envenomation, and triage staff must be aware of the signs and symptoms of haemotoxic and neurotoxic envenomation to provide effective assessment. ED staff should be prepared to initiate measures to reverse hypovolaemia, bleeding and respiratory sequelae associated with venomous snake bites.

Further studies of patients with venomous and non-venomous snake bites are needed to advance clinical care and develop best practice for assessment, thereby increasing patients’ chances of survival.

References


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