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Brandy has a passion for writing and has written several papers for *Veterinary Technician* magazine including 'Recognizing and Treating Diabetic Ketoacidosis', 'Diabetic Ketoacidosis', 'Canine Parvovirus', 'Heatstroke in Dogs', 'All Things Considered: Thromboelastography', and 'Osteoarthritis'.

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# Pit viper envenomation in the United States

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**ABSTRACT:** Pit viper envenomation is commonly seen throughout the world, including the United States. The majority of cases seen by the author involve rattlesnake envenomation in dogs. The prompt recognition and initiation of treatment are important to get these patients back home again. This paper will focus on the pathophysiology, progression, and treatment of pit viper envenomation in dogs.

Pit viper envenomation is the most common envenomation seen in dogs in the United States. Approximately 150,000 cases are reported yearly (Armentano and Schaer, 2011.) There are two families of venomous snakes in the United States: Crotalidae (pit vipers: rattlesnakes, copperheads, and cottonmouths) and Elapidae (cobras: coral snake)(Gold et al., 2004).

This paper will focus on the pathophysiology, clinical signs, and treatment of pit viper envenomation in dogs.

Pit vipers are so named because of the foramen (or pit) found between the eye and nostril. The foramen is used to sense the heat coming from prey and allows the snake to be more accurate with its strike (Gold et al., 2004). Non-venomous snakes are often mistaken as venomous pit vipers. There are several distinct differences including the elliptical pupils and triangular head of the venomous snake, versus the round pupils and rounded head of the non-venomous snakes (Gold et al., 2004).

## Pathophysiology

Not all snake bites result in envenomation. Although there have been no studies conducted in dogs (Armentano and Schaer, 2011), in humans 20 to 25 per cent of bites by pit vipers are dry bites (Hackett et al., 2002, Gilliam and Brunner, 2011). This occurs when the victim is bitten but no venom is injected and there are no clinical signs of envenomation.

The venom of pit vipers contains a variety of proteins, which directly or indirectly affect a multitude of systems, including the cardiac, respiratory, hematologic, muscular and nervous systems (Armentano and Schaer, 2011, Ashton J., 2001, Gold et al., 2004). The coagulatory system is affected more than any other (Ashton J., 2001).

Studies have shown snake venoms to have a variety of effects on the coagulation of blood, including:

- those that cause pro-coagulation by activation of factors V, IX, and X, prothrombin (factor II), and fibrinogen clotting
- those having anticoagulation properties through binding of

☑ **Figure 1.** Swelling present 1 hour



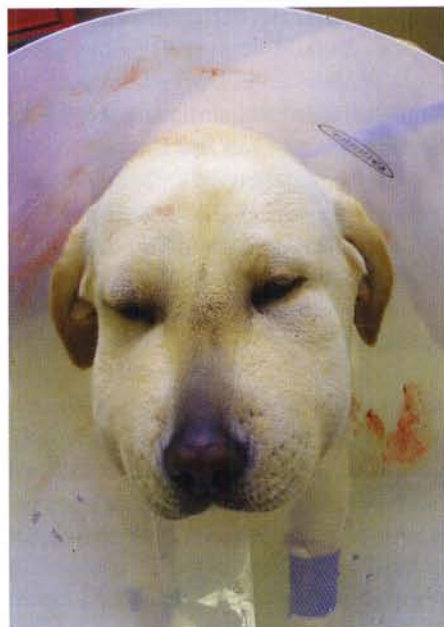


Figure 2. Swelling 24 hours after rattlesnake envenomation

factor IX/X, inhibition of thrombin, activation of protein C which in turn causes degradation of Va and VIIa, and the presence of phospholipase A which inhibits the formation of prothrombinase

- those with fibrinolytic properties that degrade fibrin and fibrinogen, and through the activation of plasminogen; and
- those that interact with platelets and inhibit or induce platelet aggregation (Markland, 1998).

## Clinical signs

Clinical signs usually become evident within 30 minutes of envenomation but may be delayed (Figures 1 & 2). Because of this, patients showing no clinical signs should be kept in the hospital and observed for 24 hours (Armentano and Schaer, 2011) (Figure 3).

Dogs are most commonly bitten on the face; although they can present with bites to a limb (Hackett et al., 2002, McCown et al., 2009). Puncture wounds may be evident and marked by active bleeding but sometimes are hard to find. There may be almost immediate swelling around the bite wound and the area can be shaved and cleaned to make it easier to find any wounds.

The first clinical sign of pit viper envenomation is tissue damage at the site of the bite, including pain, swelling, and ecchymosis (Gilliam and Brunner, 2011). Damage to endothelial cells results in swelling and rupture allowing for the

movement of fluid into the extracellular space causing oedema.

Patients commonly present with a normal attitude but will become quieter as time passes. Systemic signs include tachycardia, tachypnea, and hypotension.

## Laboratory evaluation

Initial evaluation should include a biochemistry profile, electrolytes, and complete blood count (CBC). It is also important to perform a manual differential count to look for echinocytosis, as well as carrying out a manual platelet count.

In the light of the major effects venom has on coagulation, a prothrombin time (PT) and activated partial thromboplastin time (aPTT) should also be evaluated on presentation. This will allow for evaluation of the severity of any coagulation abnormalities. If these are elevated, care of the patient will differ in that it will require more intensive monitoring for bleeding.

An initial complete blood count (CBC) is likely to show thrombocytopenia. The exact cause of the thrombocytopenia is unknown, but several possibilities include platelet consumption, aggregation or sequestration at the site of the bite (Hackett et al., 2002, Odeleye A.A., 2004).

Echinocytes (red blood cells with evenly spaced, uniform projections on the membrane) are another common finding in rattlesnake envenomation. The

Figure 3. Continued bleeding from the bite of a rattlesnake several days after initial presentation



presence of echinocytosis will confirm envenomation; although its absence does not mean that envenomation did not occur.

Echinocytosis can be secondary to other disease processes and it must be considered in combination with the history and other clinical signs. One study found the presence of echinocytes to resolve within 48 hours with no subsequent drop in the packed cell volume, showing echinocytosis to be a reversible change when caused by rattlesnake envenomation (Brown et al., 1994).

## Therapy

### Antivenin

Therapy is geared towards preventing progression of the clinical signs, as well as the treatment of the symptoms already present. Antivenin is the 'gold standard' treatment for rattlesnake envenomation in human medicine.

There are two antivenin products available in the United States: Antivenin (Crotalidae) Polyvalent (ACP) [Boehringer Ingelheim Vetmedica], and Crofab Crotalinae Polyvalent Immune Fab (ovine) [Therapeutic Antibodies Inc] (Armentano and Schaer, 2011).

Antivenin is most effective if given within four hours of envenomation; but has been shown to be effective if there is circulating venom present (Gilliam and Brunner, 2011). People may receive anywhere from 10 to 20 vials of antivenin depending on the severity of their clinical signs (Gold et al., 2004). Although dogs may benefit from the same dose, antivenin is expensive and, while recommended, is not always administered.

Currently, at the author's hospital, the dispensing and administration of a vial of antivenin costs the client \$936.10 (£583.48).

The antivenin is available in powder form and must be reconstituted before administration. Care must be taken to prevent foaming of the product as this will increase the amount of time required to fully reconstitute the antivenin.

A recent study showed the reconstitution of Crofab with 18ml of 0.9% Sodium chloride rather than the standard 10ml of sterile water for injection, decreased the amount of time required for



Figure 4. Severe bruising secondary to rattlesnake envenomation

reconstitution as well as the amount of foam that was produced. Reconstitution times were decreased from 30 minutes to three minutes (Gerring et al., 2013). This is a significant finding because of the importance of administering antivenin as quickly as possible.

#### Pain management

In mild cases, antivenin may be enough to control pain (Peterson et al., 2013). If this is not the case, there are several options for analgesia including lidocaine, buprenorphine and fentanyl (Armentano and Schaer, 2011).

If morphine is used it should be done so with caution owing to the possibility of histamine release which can worsen hypotension (Armentano and Schaer, 2011). It is also important to avoid excessive sedation, so that the patient's mental status can be accurately assessed (Armentano and Schaer, 2011, McCown et al., 2009).

#### Antihistamines

Antihistamines are often recommended but have no effect on the venom itself, nor do they alter the progression of the envenomation (Armentano and Schaer, 2011). They may be effective when given to counteract an allergic reaction to antivenin.

They may also be utilized to keep a patient calm but, if that is the case, should be used with caution since, as previously mentioned, excessive sedation should be avoided (Armentano and Schaer, 2011).

#### Glucocorticoids

The use of glucocorticoids is controversial in both human and animal envenomation cases.

One study showed no benefit from oral steroids with regard to decreasing the oedema secondary to envenomation by green pit vipers in children (Nuchprayoon et al., 2008). As is the case with antihistamines, steroids have no effect on the venom itself and are not beneficial if used to decrease swelling caused by venom (Armentano and Schaer, 2011).

Another study showed no significant benefits from the use of glucocorticoids, with the only change seen being an increase in the leukocyte count following therapy (Hackett et al., 2002).

#### Antibiotics

The use of antibiotics in treating pit-viper envenomation is highly disputed. Despite the variety of Gram positive and Gram negative bacteria that has been found in the mouth of a snake (*Enterobacter*, *Salmonella*, *Pseudomonas*, *Proteus*, and *Clostridium*) (Armentano and Schaer, 2011), infections are rarely seen in pit viper envenomation (Gold et al., 2004).

In one study involving 56 patients, no infections became evident, even when antibiotics were withheld. (LoVecchio et al., 2002). Yet antibiotics are still recommended and used in veterinary medicine probably as a consequence of the difficulty in keeping the wound clean, as well as the secondary bacterial

infections that can occur following tissue necrosis.

#### Non-steroidal anti-inflammatory drugs

The use of non-steroidal anti-inflammatory drugs (NSAIDs) is not recommended owing to their possible impairment of platelet function and, therefore, the worsening of any venom-associated coagulopathy.

The decrease in visceral perfusion seen in pit viper envenomation may also cause the patient to be more prone to NSAID-induced nephropathy and gastrointestinal ulceration (Armentano and Schaer, 2011).

#### Fluid therapy

Fluid therapy is essential in the treatment of pit viper envenomation. Hypovolaemia secondary to fluid shifts can be treated with crystalloids. In humans, an increase in the circumference of the thigh by two centimetres can incorporate one third of their total circulating volume (Peterson et al., 2013).

Synthetic colloids should be used with caution owing to their potential to impair platelet function (Armentano and Schaer, 2011). Blood products may be required if there is hemolysis, hemorrhage into the tissues or hemorrhage from the site of the bite itself (Armentano and Schaer, 2011).

The use of fresh frozen plasma (FFP) seems logical when considering the loss of coagulation factors and the ensuing coagulopathy; however, it is actually contraindicated in venom-induced coagulopathy (White, 2005).

FFP contains substrates that may worsen the coagulopathy and may actually increase the fibrinolysis process leading to further bleeding (Armentano and Schaer, 2011, White, 2005).

If a coagulopathy is present, the administration of antivenin is the recommended treatment. FFP should not be used until no venom remains, at which point it may not be necessary as the liver will replenish the clotting factors quickly (White, 2005).

#### Nursing care

Nursing care plays a large part in the recovery of these patients.

Close monitoring of any swelling and bruising is important, as the possibility

of marked swelling can be detrimental to the patient (Figure 4). Marking the edges of the swelling or bruising with a permanent marker when the patient presents will allow an objective observation of its progression.

It is important to remove any collars when the patient presents. They may cause constriction as swelling and oedema progresses and may be difficult to remove later.

The patient's comfort should be closely monitored. As previously mentioned, in some cases, antivenin may control pain (Peterson et al., 2013.) However, these patients should be watched carefully and most benefit from single agent analgesia. If the current pain management is not effective, the attending clinician should be approached and changes made.

Intravenous catheters should be monitored closely too. A catheter should be placed in a leg opposite the side the bite occurred since the swelling can progress down the leg on the same side. If swelling does progress down the catheterized leg, the catheter should be removed and placed in an unaffected leg.

## Summary

Pit viper envenomation is a life-threatening condition that is commonly seen in the United States. With prompt recognition and treatment, there can be a high survival rate. Several studies have shown survival rates in animal cases to be 70-99 per cent, while the reported survival rate in human cases is greater than 99 per cent (Armentano and Schaefer, 2011).

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## NEWS REVIEW by Jean Turner

### Call for nominations for hard-working managers and nurses

The Veterinary Practice Management Association (VPMA) and the British Veterinary Nursing Association (BVNA) have joined forces to call for nominations for managers and nurses for the Petplan Veterinary Awards.

While nominations for these categories have been growing in recent years, traditionally, it is the veterinary surgeon category which sees most of the action. VPMA president, Helen Sanderson, and BVNA president, Kirstie Shield, are working together to highlight the no-less deserving members of the practice team for the manager and nursing categories.

Helen said: "Whilst veterinary surgeons absolutely deserve credit for the hard work that they do, other practice staff do tend to be forgotten by the public in the nomination process. So together we are calling on practices to help us highlight the fantastic work carried out by veterinary nurses and managers."

Kirstie wanted to break down some of the barriers and misconceptions around the nomination process. "You don't need to produce a long, detailed testimonial," she said. "Although obviously the more information you can give to support your nomination, the more the judges have to go on. But a heart-felt simple paragraph or two entered online is absolutely fine, outlining why your nurse or manager deserves the award."

"If you have 10 minutes to spare, this is a fantastic way to boost your staff morale and just say thanks for their efforts. Every nominee receives a certificate that they can display in the practice."

Nominating someone for Nurse of the Year or Practice Manager of the Year is very easy. The whole process can be done online quickly and easily by visiting <https://www.petplanvet.co.uk/veterinary-practice-insurance/veterinary-awards/>.

The deadline for nominations is 31st January 2014.

Helen Sanderson



Kirstie Shield

