Original Article

Epidemiology of Snakebites from A General Hospital in Singapore: A 5-year Retrospective Review (2004-2008)

Hock Heng Tan,[1] *MBBS, FRCS A&E (Edin), FAMS*

Abstract

Introduction: This is a retrospective study on the epidemiology of snakebites that were presented to an emergency department (ED) between 2004 and 2008. Materials and Methods: Snakebite cases were identified from International Classification of Diseases (ICD) code E905 and E906, as well as cases referred for eye injury from snake spit and records of antivenom use. Results: Fifty-two cases were identified: 13 patients witnessed the snake biting or spitting at them, 22 patients had fang marks and/or clinical features of envenomations and a snake was seen and the remaining 17 patients did not see any snake but had fang marks suggestive of snakebite. Most of the patients were young (mean age 33) and male (83%). The three most commonly identified snakes were cobras (7), pythons (4) and vipers (3). One third of cases occurred during work. Half of the bites were on the upper limbs and about half were on the lower limbs. One patient was spat in the eye by a cobra. Most of the patients (83%) arrived at the ED within 4 hours of the bite. Pain and swelling were the most common presentations. There were no significant systemic effects reported. Two patients had infection and 5 patients had elevated creatine kinase (>600U/L). Two thirds of the patients were admitted. One patient received antivenom therapy and 5 patients had some form of surgical intervention, of which 2 had residual disability. One patient had heparin instilled in the eye for eye injury from cobra spit. Conclusions: Snakebite infrequently presents to the ED. Most of the patients developed local effects that do well with supportive treatment.

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Key words: Antivenom, Cobra, Envenomomation, Spit, Viper

Introduction

Snakes are present even in an industrialised country like Singapore.[1,2] A bite from a venomous snake can inflict much morbidity and occasionally, it can be fatal. In many countries with a large agricultural base, it poses a significant economic burden.[3] However, local epidemiological data on snakebites is lacking. Snakebite epidemiology from neighbouring countries like Malaysia[4,5] and Thailand[6] may not be applicable here. Besides the local native species, bites can occur from exotic snakes kept as pets and those kept in zoos. A bite from a local pet snake could result in significant bleeding tendency.[7]

The occurrence of snakebite locally is not common and clinicians may not be familiar with its management. Location specific protocols used in some regions have reduced the need for antivenom therapy and mortality from snakebites.[8] The aim of this paper is to characterise the type, frequency and severity of snakebites that were presented to the hospital's emergency department (ED). This would help in the development of a local management protocol as well as suggest optimum antivenom stocking.

Materials and Methods

This is a retrospective review of 5 years (January 2004 to December 2008) of ED records and in-patient case notes. The ICD code (E905 and E906) for bites and stings were manually searched for diagnosis that included definite, probable or possible snakebites. In addition, pharmacy records on the use of snake antivenom and records of patients referred to the ophthalmologist for eye injury from snake venom were searched.

Two trained reviewers independently double extracted the data into standard data collection sheets and any differences were resolved by consensus. The results were uploaded into excel files with pull down notes and analysed using the SPSS software.

[1] Department of Emergency Medicine, Changi General Hospital, Singapore.
Address for Correrspondence: Dr Hock Heng Tan, Changi General Hospital, 2 Simei Street 3, Singapore 529889
Email: hock_heng_tan@cgh.com.sg

Snakebites were considered definite if the snakes were seen and the patients claimed that the snake bit or spat at them. Snakebites were considered probable if the patients sustained a bite with definite fang marks and a snake was seen near the patient or if the patients had clinical effects of snakebites and a snake was seen although no fang marks were identified. Snakebites were considered possible if the patients were bitten and had definite fang marks although no snake was seen. However, the clinicians who saw the patient considered snakebite as a likely diagnosis. Fang marks are puncture wounds and usually occur in pairs (range, 1 to 4).

The results are expressed as percentage and average. No statistical analysis was performed. The study was approved by the hospital's institution review board and supported by the hospital research grant.

Results

Fifty-two cases of snakebites were identified: 51 cases from manual search of the ICD code and one case from cases referred to the ophthalmologists. There were 13 definite cases, 22 probable cases (18 with fang marks and 4 with no fang marks) and 17 possible cases. The definite and probable cases are analysed together as snakes were seen in these cases.

The circumstances of snakebite and the demography of patients are described in Table 1. Generally the patients were young with a mean age of 33 years (range, 13 to 69) and of the male gender (83%). Most of the patients presented within 4 hours of the bite (83%). The most common months when snakebite occurred were August and November (7 cases each), December (6 cases) and May and June (5 cases each). One third (37%) of the bites occurred while the patients were working and their occupations included army personnels (5), construction workers (4), security guards (2) and unknown (8). Most of those who tried to catch the snake probably did it while they were working – 2 army officers, 1 security officer, 1 train station master and the last patient was helping the police to catch the snake. In another one quarter (27%) of cases, the patients were simply walking along footpaths or grass patches when they were bitten. Most of the bites occurred outdoors in vegetated areas (42%). In cases where the snake was seen, most of the bites occurred on the upper limb (21/35 or 60%) while in patients where the snake was not seen, most of the bites were on the lower limb (11/17 or 65%). One patient was spat in his eye by a cobra.

In cases where the snake was seen (total 35 cases), none of the snakes were from captivity. The size of the snakes range from 12 cm to 100 cm with the average length around 30 to 50cm (no data in 14 cases). The most common colour was black (14), green (5), brown (3) and colourful (3). Data were not available in 10 cases. The snakes were identified in 17 cases (17/35 or 49%): 7 cobras, 4 pythons, 3 vipers, 2 grass snakes and 1 paradise tree snake. The cobras were all described as black in colour (colour not available for one case) and the 3 vipers were described as black, brown and green, respectively. Most of the snakes were identified by the patient, by people at the scene, by the poison information centre (via teleconversation) or by healthcare workers. The paradise tree snake (Chrysopelea paradisi) was the only snake identified by a snake specialist from the Singapore zoo. Seven of the snakes were caught but only 4 were brought to the ED for identification (3 cobras and 1 paradise tree snake).

The clinical effects of snakebites are illustrated in Table 2. The most common clinical presentation were local effects of pain (77%) and swelling (50%). There were a few patients with systemic complaints but these were self-limited and non life-threatening. Most of the abnormal vital signs recorded were mild (e.g. systolic blood pressure of 160 to 180mmHg and tachycardia <120 beats per min) and they resolved after a period of observation and symptomatic treatment (e.g. pain relief). Amongst definite and probable snakebite patients, 26 had fang marks identified. Of these patients, 7 patients had very minimal local signs around the fang marks. There were no systemic effects reported (except 1 patient with a heart rate of 105/min). Table 3 describes the clinical features from bites of snakes that were identified. Pain and swelling were seen in all cases bitten by suspected vipers while in patients bitten by cobras, all had some swelling (one patient reported swelling initially) and 3 patients had numbness at the bite site.

Investigations were not uniformly performed for all the patients. Five patients had creatine kinase (CK) levels (maximum) more than 600 U/L (range, 630 to 1130). The snakes involved were a cobra, a viper, 2 unidentified snakes and in one case, no snake was seen. All the patients reported pain but swelling was present in only 3 out of the 5 cases. There were no cases with systemic bleeding or clotting disorder, systemic neurotoxicity, renal failure and cardiotoxicity. Two patients had documented secondary infections. The first patient had thumb abscess after being bitten by a cobra and the second patient (possible snakebite case) had cellulitis of the lower limb.

The management and outcome of the patients are illustrated in Table 4. Antibiotics were prescribed in two thirds of the patients (mainly for prophylaxis). Tetanus toxoids and analgesics were routinely given when needed. The patient with the longest length of stay of 6 days was bitten by a 50 cm long unknown green snake while playing soccer. Fang marks were present with mild redness and pain but there was no swelling. He was otherwise asymptomatic. His creatine kinase rose to 1130 U/L on the second day. Four patients stayed between 3 to 4 days: 2 had surgical

Table 1. Epidemiology of Snakebites

	Definite or probable snakebites	Possible snakebites	Total (%)
Total number	35	17	52
Age (mean)	34	29	33
Gender			
- Female	30	4	9 (17)
- Male	5	13	43 (83)
Race			
- Chinese	14	10	24 (46)
- Malay	11	4	15 (29)
- Indians	7	3	10 (19)
- Others	3	0	3 (6)
Year of presentation			
- 2004	7	3	10 (19)
- 2005	5	1	6 (12)
- 2006	8	1	9 (17)
- 2007	6	8	14 (27)
- 2008	9	4	13 (25)
Time when bite occurred			
- Day (0600-1800hrs)	21	4	25 (48)
- Night (1800-0600hrs)	13	12	25 (48)
- Not available	1	1	2 (4)
Time from bite to presentation			
- <1hr	19	5	24 (46)
- 1-4hrs	10	9	19 (37)
- 4-24hrs	5	2	7 (13)
- >24hrs	1	0	1 (2)
- Unknown	0	1	1 (2)
Circumstances			
- While working	12	7	19 (37)
- Walking	6	8	14 (27)
- Recreational activities	3	1	4 (7)
- Catching snake	5	0	5 (10)
- Others/unknown	9	1	10 (19)
Location			
- Indoor	3	1	4 (8)
- Outdoors (vegetation)	11	11	22 (42)
- Outdoors (non or minimal vegetation)	10	5	15 (29)
- Unknown	11	0 11 (21)	
Site of bites			
- Upper limb	21	5	26 (50)
- Lower limb	13	11	24 (46)
- Trunk	0	1	1 (2)
- Head/eyes 1	0	1 (2)	
Pre-hospital treatment			
- Tourniquet	6	2	8 (15)
- Sucking	3	0	3 (6)
- Cutting	1	0	1 (2)
- Others	2	1	3 (6)

Table 2. Clinical Symptoms and Signs from Snakebite

	Definite or probable snakebites	Possible snakebites	Total (%)
Symptoms			
- Pain	23	17	40 (77)
- Swelling	12	14	26 (50)
- Bleeding from bite site	5	3	8 (15)
- Numbness at bite site	6	2	8 (15)
- Local necrosis	0	0	0
- Nausea and vomiting	3	1	4 (8)
- Shortness of breath	0	0	0
- Giddiness	5	0	5 (10)
- Weakness	3	0	3 (6)
- Bodyache	1	1	2 (4)
- Loss of consciousness	1	0	1 (2)
- Fever	3	0	3 (6)
Signs			
- Abnormal vital signs	13	8	21 (40)
- Fang marks present	26	17	43 (83)
- Swelling	14	15	29 (56)
- Erythema	8	13	21 (40)
- Tenderness	7	9	16 (31)
- Bruising	2	2	4 (8)
- Abrasion/Laceration	7	1	8 (15)
- Bleeding from wound	2	2	4 (8)
- Lymphadenopathy	1	0	1 (2)
- Paralysis	0	0	0

operations, 1 had elevated CK (943 U/L) and the last patient was observed until the redness subsided. The majority of patients made uneventful recovery although there were 2 patients with residual disability.

Polyvalent snake antivenom (Haffkine) was given to one patient. He was bitten on his thumb by a 100 cm long green snake with a triangular head (identified as a viper by the poison centre). He presented to the ED 7 hours after the bite and the swelling had progressed to his wrist and the pain had increased and radiated to his arm. Investigations were unremarkable and there was no systemic toxicity. He was given 2 vials of antivenom (uneventfully) in the ED as advised by the poison centre and was discharged the next day. On review one week later, he had recovered. One patient sustained left eye injury after a cobra spat venom into his eye. He complained of pain and blurring of vision and was noted to have decreased visual acuity with an opacity on the left corneal. Immediate water irrigation was performed and a toxicologist was consulted and heparin drops were instilled for 2 hours. His visual acuity improved and he was then seen by an ophthalmologist who noted that there was an abrasion on the left corneal. There was no systemic toxicity and he was discharged. He recovered uneventfully when reviewed the following week.

Five patients had surgical interventions: 2 patients had toilet and suture done for finger lacerations due to python bites. The third patient was possibly bitten by a snake over the wrist and had definite fang marks. There was pain with limited range of movement of his wrist but there was no swelling or numbness. The decision for wound exploration could not be ascertained. These 3 patients recovered uneventfully. Long-term morbidity was identified in the remaining 2 patients. The first patient was bitten by a black cobra on the tip of his index finger. The finger was swollen and tender but the sensation was intact. He underwent decompression surgery for suspected abscess 20 hours after the bite. No necrotic tissues were found and no culture was done. He had secondary suture subsequently. Six months later, he was found to have decreased sensation of his finger and slight decreased range of movement and was assessed

Table 3. Clinical Symptoms and Signs from Bites by Identified Snakes

	Cobra (6)*	Viper (3)	Paradise tree snake (1)	Python (4)	Grass snake (2)
Symptoms					
- Pain	4	3	0	2	1
- Swelling	3	2	1	1	0
- Bleeding from bite site	2	0	0	1	0
- Numbness at bite site	3	0	0	0	0
- Local necrosis	0	0	0	0	0
- Nausea and vomiting	0	0	0	0	0
- Shortness of breath	0	0	0	0	0
- Giddiness	0	0	0	0	0
- Weakness	0	0	0	0	0
- Bodyache	0	0	0	0	0
- Loss of consciousness	0	0	0	0	0
- Fever	0	0	0	0	0
Signs					
- Abnormal vital signs	4	1	0	2	1
- Fang marks present	4	3	1	2	2
- Swelling	5	3	0	1	0
- Erythema	1	0	0	0	1
- Tenderness	2	0	0	0	0
- Bruising	1	1	0	0	0
- Abrasion/Laceration	0	0	0	2	0
- Bleeding from wound	1	0	0	1	0
- Lymphadenopathy	1	0	0	0	0
- Paralysis	0	0	0	0	0

*One patient who was spat by a cobra was excluded.

to have developed permanent disability on further review. The second patient was bitten by a cobra on his thumb at the base of the terminal phalanx. He developed swelling to the thenar eminence. Although the swelling was subsiding, he was noted to have new fluctuance with blister formation near the bite site on the 3rd day. Deblistering was done but no pus was seen. The culture from the wound site grew Morganella morganii. He was discharged well with antibiotics but one week later, there was increased pain and swelling over the bitten site again. He was readmitted and had debridement of the left thumb abscess. The culture then grew the same organism. Five months later, he was found to have decreased range of movement of his thumb from scarring but he declined further operations.

Discussion

This study showed that snakebite is not a frequent presentation to the ED but morbidity can occur. On average about 10 cases of snakebites were seen a year in this ED which had a census of about 130,000 to 150,000 per year.[9] Snakebite epidemiology is location specific and varies from region to region. The most common venomous snakes in India are the Indian cobra, common krait, Russell's viper and Saw-scaled viper.[10] In Malaysia, venomous snakebites were reported from cobras, vipers, kraits and sea snakes.[4,5,11] In Thailand[6] and Taiwan,[12] various species of vipers, cobras and kraits were described. The most common venomous snake identified in this series was the cobra (most likely the common black cobra) followed by the viper. However, only half of the snakes which were seen were identified and mostly by amateurs.

The common venomous snakes in this region falls into 2 main families: Elapidae and Viperidae.[13] Elapidae includes cobras, king cobras, kraits, coral snakes and sea snakes. Viperidae consists of the typical vipers and the pit vipers. Another less common venomous family are the colubrides. Snake venom contains proteins, enzymes and a variety of toxins. They cause a spectrum of clinical

Table 4. Management of Snakebites

	Definite or probable snakebites	Possible snakebites	Total (%)
Antivenom use	1	0	1 (2)
Antibiotics prescribed	21	13	34 (65)
Surgical interventions: operations	4	1	5 (10)
Outcome			
- Admitted	20	14	34 (65)
- Discharged with follow up	5	1	6 (12)
- Discharged – no follow up	9	1	10 (19)
- Others (AOR from ED)	1	1	2 (4)
Discipline of admission			(Total: 34)
- Medical	17	11	28 (82)
- Orthopedics	3	3	6 (18)
Admitted: Length of stay (days)			(Total: 34)
- 1	12	7	19 (56)
- 2	5	5	10 (29)
- >2 (3-6 days)	3	2	5 (15)
Final Outcome			
- Died	0	0	0
- Recovered with long term complications	2	0	2 (4)
- Good recovery	18	14	32 (62)
- Unknown (no follow-up records)	15	3	18 (34)

syndromes: neurotoxicity, nephrotoxicity, cardiotoxicity, bleeding and clotting disorders, myotoxicity and local swelling and necrosis. These clinical syndromes can overlap amongst the different families.[13] The most common elapid in Singapore is the black spitting cobra, Naja sumatrana.[14] Cobra bites can cause local pain and necrosis and the venom is capable of causing neurotoxic effects starting with ptosis and progressing to respiratory arrest. This cobra is able to spit venom up to a few metres distance and the venom can cause blindness. Patients with cobra bites in this series developed mainly local effects. They all recovered well except for 2 patients who had residual complications. Common pit vipers in our midst include the Shore pit-viper, Trimeresurus purpureomaculatus (purplish-brown), Wagler's pit-viper, Trimeresurus wagleri (green and yellow) and the Sumatran pit-viper, Trimeresurus sumatranus (green).[1,11] Vipers can cause much local swelling and bleeding, and clotting disorders. All 3 patients with suspected viper bites had mainly local swelling. Colubrides are hind fang minimally venomous snake but some species like red-neck keelback (Rhabdophis subminiatus) can cause significant coagulopathy.[7] The paradise tree snake is another example and the patient bitten by it did not have any significant effect. A bite by a nonvenomous snake like the python would cause local wound injury.

Snake identification is difficult as we do not have snakebite detection kits[15] and most clinicians are not trained to identify snakes. Herpetologists from the zoo and the National University of Singapore[1] are however, able to help in the identification of snakes. In cases where the snake is not seen, especially at night, the possibility of bites by other creatures like centipedes[16] and rats or a scorpion or insect sting need to be considered. Centipede bites tend to be small and associated with severe pain and local reaction.[17] They usually cling on to the victim for a while making identification easier. The diagnosis may not always be straightforward but snakebites should be considered in suspicious circumstances especially when they occur in children.[18]

The at-risk population appears to be those whose occupation is mainly outdoor and involves contact with vegetated areas. Construction workers, grass cutters and sweepers as well as army soldiers training in forested areas are at risk. As more people venture out into wildlife areas, the chance of a snake encounter also increases. Untrained personnel should not try to catch snakes especially if a venomous one cannot be excluded. Professional snake catchers are also at risk and their protective equipment should include goggles to protect them from snake spit.

Most of the snakebites documented in this series presented with local effects of pain and swelling. Systemic

manifestation were generally mild and not all the symptoms are due to systemic envenomation. There were a number of cases of definite and probable snakebites where there was minimal local injury and no systemic manifestation despite the presence of fang marks (7/26 or 27%). These could be cases of dry bites or bites by a non-venomous snake. Dry bites occur when there is no envenomation despite actual bite by a venomous snake. The rate has been noted to be as high as 30% to 40% in one report.[19] The diagnosis of a dry bite however, can only be made after excluding systemic effects as kraits and sea snakes are known to cause minimal local signs and symptoms. Secondary infection was identified in 2 patients, however, the need for routine prophylactic antibiotics is controversial. Some authors support its use for bites by some species[13] while others do not advocate its use.[20]

The antivenom available in this hospital includes the Haffkine polyvalent antivenom and the sea snake antivenom. The Haffkine antivenom is developed by the Haffkine institute in India[21] and is composed of horse antibody against 4 common Indian snake: Indian cobra (Naja naja), Russell's viper, common krait and Saw-scaled viper. From anecdotal evidence, it appears to be effective against our local common black cobra. However, its efficacy against local fauna remains to be verified. One to 2 vials can be given over 2 hours and further antivenom therapy should be guided by the clinical state of the patient.[21] However, this dosage may be inadequate in severe envenomation and 6 to 10 initial vials have been recommended.[22] The indications for antivenom therapy includes systemic toxicity example neurological deficits like ptosis, paralysis, renal failure, bleeding disorder and rapidly progressing local swelling especially when it crosses the wrist and ankle.[13] The complications for antivenom therapy include anaphylaxis, pyogenic reactions and delayed serum sickness. Antivenom therapy given for local swelling is only effective in the first few hours.[13] The optimum antidote stocking should take into account the type and severity of local snakebites. A reasonable stocking is to have at least 4 to 6 vials for use in the first few hours. The other antivenom that is stocked is the sea snake antivenom against the sea snake Enhydrina schistosa.[23] Complications of sea snake bites include myotoxicity, renal failure and neurotoxicity.[24] As sea snake bites were not identified in this series, no firm recommendation can be made regarding the stocking of this antidote.

Instillation of heparin for snake venom spit on the eyes leading to eye injury had been studied in rabbits.[25] The most important treatment when snake venom has entered the eyes is to wash the eyes thoroughly with running water[13] for at least 20 minutes. The patient should be referred to an ophthalmologist. Therapy with heparin drops appear quite safe but its safety and efficacy remains unconfirmed by human studies.

Generally, the need for surgical intervention in snakebite cases is limited to lacerations that occur with python bites, drainage of abscess and wound debridement for necrotic tissues. If wound debridement is indicated, it should be performed 4 to 5 days later.[26] The risk of compartment syndrome is relatively low. By elevating the limbs and using antivenom in a timely manner, the need for decompression is further reduced.[20,26-28]

Pre-hospital management of snakebite should include immobilisation of the affected limb and rapid transport to the hospital.[29] Treatments like sucking, cutting, electric shock and arterial tourniquet are not recommended.[13] When a snakebite case is presented to the ED, the first priority is to stabilise the patient. The wound should be inspected and cleaned. Swellings should be serially marked and timed to assess progression and the limbs should be elevated. Analgesia and tetanus toxoid should be given when indicated. If a venomous snakebite is suspected, blood and urine tests should be done to exclude coagulopathy, rhabdomyolysis, thrombocytopenia and renal failure. Radiographs should be performed in the case of a python bite to identify embedded tooth or fractures. Routine prophylactic antibiotics for snakebite is controversial but if infection is suspected, the patient should be given broad spectrum antibiotics. Snake identification should be attempted if the snake is brought along. Antivenom therapy should be started early if indicated and a physician experienced in managing snakebite consulted on its use. A patient with a possible dry bite can be safely discharged after a period of observation (at least 8 to 12 hours). If the snake is nonvenomous, the patient can be discharged after proper wound care.

The limitation of this study is that it is a retrospective study from one centre. There is a sizable proportion of unidentified snakes as well as possible snakebite cases. Most of the snakes were not identified by a herpetologist making it difficult to confirm the identity of the snakes and attribute clinical features to particular species of snake. However, this study gives a realistic picture of the spectrum of snakebite cases that could present to a local ED. A prospective multicentre study would provide a more complete epidemiology of snakebites in Singapore.

In conclusion, snakebite is an infrequent presentation at the ED. Most of the patients developed local effects and recovered uneventfully with supportive treatments. However, systemic effects should be looked for if a venomous snakebite cannot be excluded.

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