Management of Poisonous Snake Bites in Southern Taiwan

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Snake bite envenomation is not uncommon in Taiwan. This study focuses on the pattern of poisonous snake bites and their management in southern Taiwan over a 5-year period. The case histories of 37 patients with poisonous snake bites admitted to the Kaohsiung Medical University Hospital between June 2001 and July 2005 were analyzed retrospectively. Three patients, bitten by unknown species of venomous snakes, were excluded from this study. The frequency of snake bites from each species of snake, the local and systemic manifestations of snake bite, treatment of complications and final outcomes were analyzed. Of the remaining 34 patients, 11 (32.4%) were bitten by bamboo vipers, 10 (29.4%) by Russell's pit vipers, 8 (23.5%) by Taiwan cobras and 5 (14.7%) by Taiwan Habu. The majority of snake bites (28) occurred between May and November. Those affected were mainly outdoor hikers (14) and workers (9). The antivenin requirements for treatment in the emergency room were in accordance with standard procedures. No mortality was noted among those envenomed by poisonous snakes. Although poisonous snake bite is not a common life-threatening emergency in the study area, we observed both an environmental risk and a seasonal incidence of snake bite. Keeping the varied clinical manifestations of snake bite in mind is important for effective management. Ready availability and appropriate use of antivenin, close monitoring of patients, institution of ventilatory support and early referral to a larger hospital when required, all help reduce mortality.

Key Words: acute renal failure, envenomation, snake bite
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Venomous snakes have been held responsible for more deaths than all other venomous and poisonous animals added together. They exist in a wide range of habitats throughout the world, with the exception of Antarctica.

The majority of snake bites are caused by nonvenomous snakes, and in clinical findings, very few cases of venomous snake bites appear. Despite this, estimates suggest that there are more than 2.5 million venomous snake bites annually, resulting in more than 125,000 deaths. Snake bite is also one of the major causes of morbidity and mortality in developing countries, with the risk being highest among the local populations of rural tropical areas. Venom injected into local tissue causes local and systemic reactions. Clinical findings may vary according to the species and age of the snake, the depth of the bite, the amount of injected venom, and the age, gender and general health status of the victim. The purpose of the present study was to analyze data on snake bites in southern Taiwan, in order to consider the problems created by venomous snakes in tropical countries.

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Materials and Methods

A total of 37 patients with histories of snake bite were admitted to Kaohsiung Medical University Hospital between June 2001 and July 2005. Data from chart records were summarized in this retrospective series. This study evaluated factors concerning the severity of skin necrosis in local bite sites and systemic symptoms resulting from venomous toxins among snake bite patients in southern Taiwan. We studied 37 victims retrospectively. Three were excluded because they had been bitten by unknown species of snakes. Data collected from the remaining 34 patients included: gender, anatomic location of the bite, where the attacks took place, and predisposing factors that might have affected the clinical course. Renal function studies included measurement of serum urea nitrogen and serum creatinine concentrations. Hematologic studies consisted of bleeding time, partial thromboplastin time, platelet count, plasma fibrinogen and fibrin degradation products, and urinary hemoglobin. Patients were treated either conservatively or aggressively by dialysis and intubation. All 34 were treated with antibiotics, and received standard antivenin treatment, which is discussed later in the article.

Results

Most patients were asymptomatic or mildly symptomatic, except for local skin lesions. Of the 34 patients, 11 (32.4%) were bitten by bamboo vipers, 10 (29.4%) by Russell's pit vipers, eight (23.5%) by Taiwan cobras and five (14.7%) by Taiwan Habu. The majority of snake bites (29) occurred between April and September, with the peak in June (10), which is the early part of the rainy season in Taiwan (Figure 1). The majority of snake bite victims were males (73.5%), with an age range of 20 to 71 years. However, there were two children (5.9%) under 10 years of age in our series. Most bites were on the toes and fingers (44%), with bites on the lower and upper limbs representing 38.2% and 14.7% of bites, respectively. Interestingly, one child suffered a snake bite on the upper lip while playing.

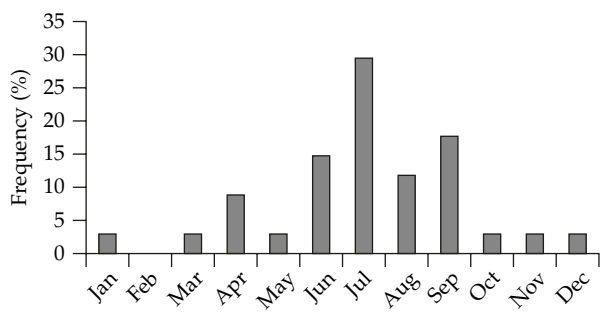

Figure 1. *Frequency of snake bites by month.*

Most bites occurred in rural areas, outdoors, and in dark places. Those affected were mainly outdoor hikers (14) and outdoor workers (9). Times between being bitten and arrival at our hospital ranged from 30 minutes to 30 hours. The amount of time that elapsed between being bitten and hospitalization did not result in significant differences in whether or not patients had severe tissue necrosis. Only one patient was treated first with an unknown traditional regimen (Chinese herbal or folk medicine treatment) before undergoing medical therapy. The antivenins used in all patients were in accordance with the standard protocols for each species. Hospitalization generally lasted from 2 to 7 days, but one case required a stay of 30 days. We found that the length of hospitalization was related to the severity of tissue necrosis.

One patient was found to have acute renal failure (ARF) during hospitalization. The delay between the bite and the onset of oliguria was 72 hours. Hemodialysis was then initiated, but respiratory failure developed and intubation was performed. The patient received three hemodialysis treatments, and intubation time was 7 days. Another patient also received intubation for 3 days, due to acute pulmonary edema. Almost all victims showed some degree of tissue necrosis at the bite site. Four victims required fasciotomy due to compartment syndrome, and three out of these four patients required more than one surgical debridement. Skin grafting was carried out in these three cases. In our series, there was no mortality due to venomous snake bites.

Discussion

Snake bites in southern Taiwan are still a public health problem, although the number of victims has decreased due to rapid urbanization and the degradation of snake habitats. The incidence of snake bite is highest in rural areas, with farmers and visiting urban dwellers at greatest risk.

Taiwan is home to 37 species of snakes, a dozen of which are poisonous. The six most commonly-encountered indigenous venomous snakes in Taiwan (Figure 2) are the Taiwan cobra (*Naja naja atra*), the Taiwan banded krait (*Bungarus multicinctus*), Russell's pit viper (*Vipera russellii formosensis*), the sharp-nosed pit viper (*Deinagkistrodon acutus*), the Taiwan Habu (*Trimeresurus mucrosquamatus*), and the bamboo viper (*Trimeresurus stejnegeri*). Apart from their different appearances, there are some specific local symptoms of bite wound, as listed in Table 1.

The first step in treatment is triage first aid. Good first aid can be life-saving, but bad first aid still predominates. Most of the once fashionable first aid

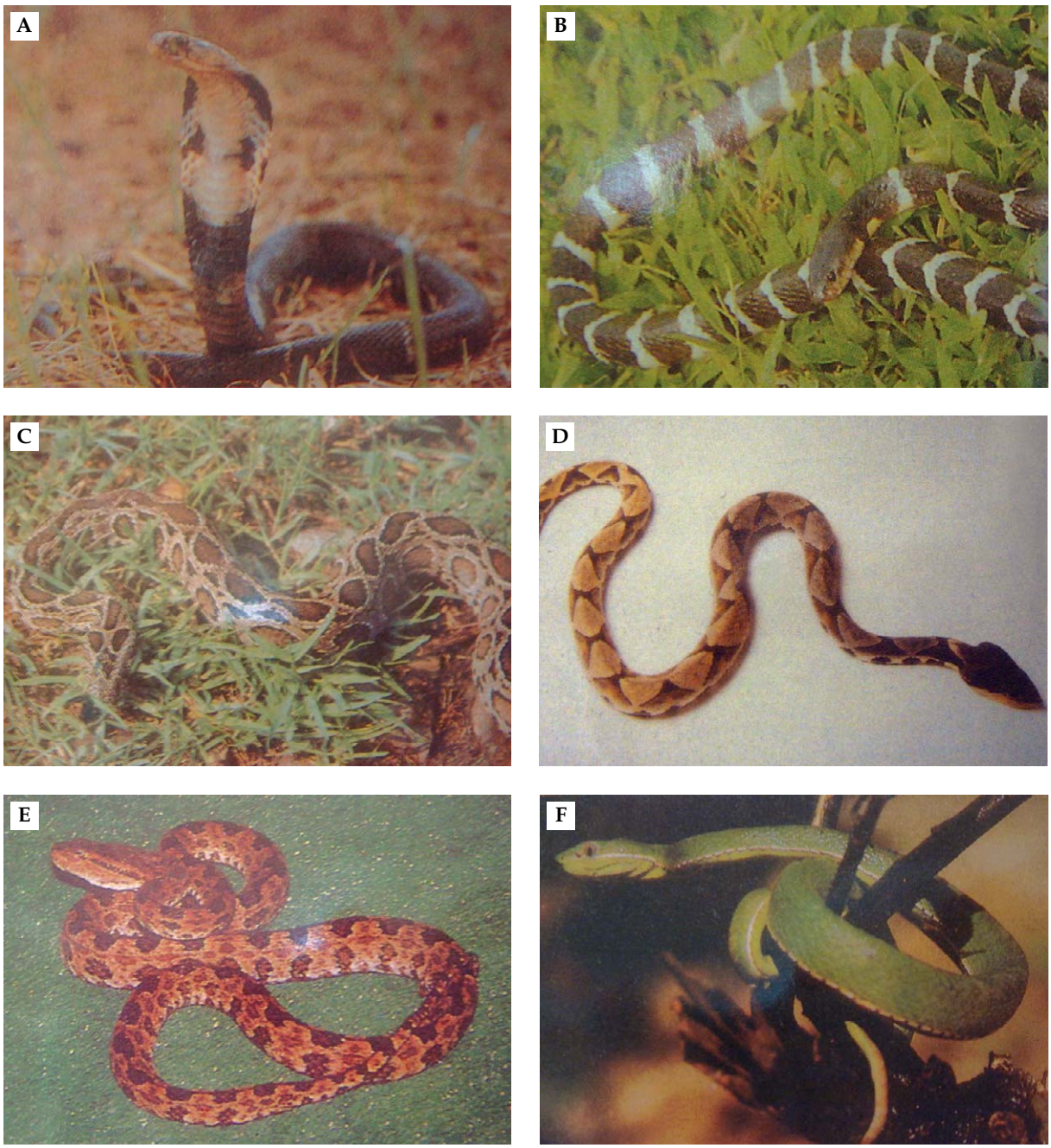

Figure 2. *The six most commonly encountered indigenous venomous snakes in Taiwan. (A) Taiwan cobra (Naja naja atra). (B) Taiwan banded krait (Bungarus multicinctus). (C) Russell's pit viper (Vipera russellii formosensis). (D) Sharp-nosed pit viper (Deinagkistrodon acutus). (E) Taiwan Habu (Trimeresurus mucrosquamatus). (F) Bamboo viper (Trimeresurus stejnegeri).*

Table 1. Local symptoms of bite wounds

Species of venomous snake	Local symptoms
Taiwan cobra (*Naja naja atra*)	Tooth marks appear shallow with slight bruising and trauma at the wound, which darkens quickly with ominous blistering
Taiwan banded krait (*Bungarus multicinctus*)	Difficult to detect needle-like tooth marks
Russell's pit viper (*Vipera russellii formosensis*)	Pin-like bite marks appear as black dots, marked by swelling around the tooth marks
Sharp-nosed pit viper (*Deinagkistrodon acutus*)	Blackened tooth marks become visible a few minutes after the bite
Taiwan Habu (*Trimeresurus mucrosquamatus*)	Visual pin-shaped tooth marks become imminently visible a few minutes after been bitten
Bamboo viper (*Trimeresurus stejnegeri*)	Bite marks appear with visible tooth marks that are darkish

methods, such as local incisions, suction, cryotherapy, potassium permanganate injections and electric shock have been proven to be of no value and have been abandoned. The two most important principles of first aid for snake bite are immobilization of the bitten limb and rapid transport to medical care. Immediately after a snake bite, the bite site should be immobilized to delay the spread of venom. Reassurance of the victim is also important.

The principles of medical care are identification of the species responsible for the bite, and close observation of the victim, especially during the first 24–48 hours after the bite. Asymptomatic cases, with no local swelling after 2 hours, may be discharged. However, symptomatic cases should be monitored for a minimum of 24 hours. Hospital management of snake bite hinges on neutralization of the venom with adequate quantities of intravenous antivenin, plus supportive treatments. Antivenins are recommended to be injected intravenously, with a dosage of one vial. Another dose may be given if symptoms/signs show no improvement. Supportive modality (such as ventilatory equipment if the victim is paralyzed) can be crucial, as antivenin does not always reverse paralysis. However, antivenins [1] are the only specific antidote to envenoming. A simple, rapid, whole blood clotting test has proven useful in many countries for diagnosis, both to indicate systemic envenoming requiring antivenin, and to control the dosage of antivenin. If the blood fails to coagulate by a standard time, a second dose of antivenin should be given and the test repeated at fixed intervals until coagulation has been restored. For complicated cases, close monitoring of blood and renal tests is necessary to prevent hemotoxic and renal complications.

Snake venoms are a mixture of complex toxins that may be independent, synergistic or antagonistic in action. There are several classification systems, but the most medically useful system lists them in terms of their clinical effects. The major groups are neurotoxins, myotoxins, coagulotoxins (hemotoxins), nephrotoxins and necrotoxins. In Taiwan, three venomous snakes, the sharp-nosed pit viper, the Taiwan Habu and the bamboo viper, produce hemotoxins. However, the Taiwan cobra and the Taiwan banded krait produce neurotoxins. Mixed toxins, combining hemotoxins and neurotoxins, are secreted by Russell's pit viper. It is important to keep in mind that the actual mix of toxins in the venom of a given species of snake will vary by individual, age, and season. Furthermore, the quantity of venom injected in a bite can be highly variable.

The clinical manifestations of venomous snake bites vary from mild local reactions to severe, life-threatening systemic reactions. Bites from species causing local tissue injury commonly result in rapid development of local swelling, blistering, or bruising; the rapidity of development mirrors the severity of the bite. If systemic effects occur, they may be general, such as headache, nausea, vomiting, abdominal pain, diarrhea, collapse or convulsions; alternatively, they may be specific, such as ptosis or progressive weakness (neurotoxins), muscle pain, myoglobinuria (myotoxins), oozing of blood from wounds or gums, extensive bruising (coagulotoxins), and oliguria or anuria (nephrotoxins). Death may occur early, usually because of shock or secondary myocardial effects of coagulotoxins, but is more usually delayed and caused by inadequate treatment of paralysis, myolysis, coagulopathy, renal failure, or extensive tissue injury. Thus, death is often preventable in many cases. If a significant amount of venom has been injected, then local and/or systemic envenoming will almost inevitably follow; however, the rate of onset of systemic envenoming may be hastened by physical activity or slowed by effective first aid.

Table 2. Species and sites of snake bite, delay for antivenins and treatment course

Patient no.	Age (yr)	Sex	Location	Bite area	Snake species*	Delay interval (hr)	Fasciotomy	Debridement	Skin graft	Intubation	Hemodialysis	Hospitalization (d)
1	45	F	Working	Right foot	B	7	+	+(2)†	+	+		34
2	61	M	Outdoor	Left leg	D	3						6
3	57	M	Outdoor	Right foramen	A	6						6
4	59	M	Indoor	Right hand	D	1						3
5	28	M	Indoor	Right thumb	A	0.5						5
6	61	M	Outdoor	Right dorsal foot	B	4				+	+	21
7	25	M	Outdoor	Left middle finger	D	22						5
8	48	M	Outdoor	Left 4th finger	D	3						7
9	61	F	Indoor	Right dorsal hand	A	6	+	+(2)†	+			28
10	71	M	Outdoor	Right 3rd toe	B	6						5
11	52	M	Working	Left hand first webspace	A	30						3
12	60	M	Working	Left thumb	D	1						4
13	20	M	Catching	Left upper lip	B	13						3
14	30	M	Indoor	Left index	B	2						4
15	39	M	Working	Right foot, dorsum	B	8						6
16	62	M	Outdoor	Right dorsal foot	C	20						9
17	60	M	Working	Right index finger	A	2	+	+	+			15
18	30	M	Outdoor	Right dorsal foot	A	3						6
19	9	F	Outdoor	Left dorsal foot	D	7						7
20	46	M	Outdoor	Right middle finger	B	1						4
21	64	M	Outdoor	Right lower leg	B	10	+		+			16
22	21	M	Working	Left 4th finger	D	3						4
23	28	M	Outdoor	Left 5th finger tip	C	9		+				11
24	20	M	Indoor	Right foot	D	17						7
25	51	F	Working	Right upper extremity	D	2						4
26	10	F	Indoor	Right hand	C	1						5
27	20	F	Indoor	Right foot	C	5						9
28	21	M	Indoor	Right middle finger	B	1						6
29	74	F	Outdoor	Right thumb	D	7						8
30	21	M	Outdoor	Right thumb	B	4						7
31	27	M	Working	Right index finger	A	3						3
32	44	M	Working	Right foot	C	2						6
33	38	F	Outdoor	Right lower leg	D	11						3
34	46	F	Indoor	Left dorsal foot	A	1						9

*Snake species: Taiwan cobra (A), Russell's pit viper (B), Taiwan Habu (C), and Bamboo viper (D); †more than one debridement.

In general, viper bites are often a significant cause of mortality in southern Taiwan because of their mixed toxins, and the severity of local and systemic reactions is usually greater than that of other species. However, hematologic changes caused by systemic envenoming, such as coagulopathy and hemolysis, are the most common pathologic manifestations [2,3]. ARF is the most common finding in cases of lethal envenomization, while coagulation abnormalities and shock are other key clinical features. ARF following snake bites has also been frequently reported [4,5]. Many investigators have shown that Russell's viper venom may have both direct and indirect nephrotoxicity, which might cause multifactorial effects on renal tubular cells [6] and the renal vasculature [7]. In cases of direct nephrotoxicity, all of the proximal tubules of the kidney are affected evenly, with a preserved basement membrane. The indirect (ischemic) type of renal injury that is caused by severe renal tubular and cortical necrosis is highly correlated with disseminated intravascular coagulopathy. Experimentally, viper venom causes mesangiolysis, and this may be a significant factor in the pathogenesis of viper bite-induced glomerular disease. Treatment with antivenin is commonly used. Dialysis and supportive treatment appear to be the mainstay of therapy in cases complicated by renal failure. In our study, only one victim bitten by Russell's pit viper developed ARF, and this patient made a full recovery after several dialysis treatments.

Antivenins are the only antidote to envenoming; species-specific antivenins neutralize circulating venom and reverse systemic symptoms. Neutralization of the venom's effect is sometimes difficult to assess, because it does not immediately release venom bound to binding sites at neuromuscular junctions. Therefore, additional doses of antivenin might be required if neurotoxicity or shock persists, or recurs within a few hours of the initial dose.

The primary local effect of venom is edema, which may be delayed or occur within minutes, but which is almost always present within 2 hours. Although the bite site is usually painful, pain may be minimal or absent. Snake bite commonly results in other local tissue injuries, such as blistering and bruising, and the rapidity of development mirrors the severity of the bite. In our study, there were no statistically significant differences in the severity of tissue necrosis among patients who received medical attention soon after being bitten, and those who did so only after a significant delay. A previous study showed that antivenin administration within 30 minutes of a bite did not prevent local tissue damage [8]. However, hospitalization was prolonged significantly for patients with local tissue necrosis and systemic complications. In our report, seven victims underwent surgical debridement for necrotic wounds due to snake bites. Although it varied depending on the amount of venom injected and the species of snake, the hospitalization times of these seven severely bitten victims was more than 10 days (Table 2). The more times that surgical debridements were required, the more necessary were longer hospitalizations.

In Taiwan, dawn and dusk are prime times for encounters with snakes. Many snakes tend to be nocturnal, or they are at least more docile during daylight hours. When walking at dawn or dusk, walkers must be particularly careful to avoid snakes. Slow walkers often do not make enough noise to frighten snakes away, but do cause sufficient vibrations for the snakes to "hear" them coming. Therefore, hikers and outdoor walkers must be alert while walking during peak snake bite times. However, in our series, there were nine cases of snake bite occurring indoors, by snakes that had entered their victims' homes.

It is not commonly known that not all snake bites are effective at injecting venom. Ineffective bites, or "dry bites", can be common in some species, accounting for more than 50% of bites. In many parts of the world, bites by nonvenomous snakes outnumber bites by venomous species, further reducing the chances of a severe, venomous bite.

Although the incidence of snake bites throughout Taiwan has decreased because of the reduction in the snake population as a result of hunting and degradation of their habitat, it is worth keeping in mind the priority of acute management of snake bites.

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南台灣毒蛇咬傷之醫療

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台灣是毒蛇咬傷好發率的地區，而本研究更針對在南台灣五年來的毒蛇咬傷作一完整統計分析。從 2001 年至 2005 年，高雄醫學大學附設醫院共收集 37 個毒蛇咬傷案例，排除 3 個案例是由不知名的毒蛇咬傷外，其餘均詳實分析毒蛇種類、所引發的局部及全身性症狀、併發症的治療以及治療結果。在這 34 位個案中，11 位 (32.4%) 是由青竹絲咬傷、10 位 (29.4%) 鎖鏈蛇咬傷、8 位 (23.5%) 是眼鏡蛇咬傷以及 5 位 (14.7%) 是龜殼花咬傷；大部份毒蛇咬傷多發生在 5 月及 11 月之間，所有個案中沒有死亡案例。經過分析結論，快速且正確的使用毒蛇血清、密切觀察毒性反應、重症照護設備的需求，以及及時轉診至教學醫院的可易性，都是降低毒蛇咬傷致死的因素。

關鍵詞：急性腎衰竭，蛇毒，毒蛇咬傷

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