Articles

Poisonous Snakebite in Utah

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A retrospective study was done of poisonous snakebite in Utah to determine the current epidemiology and scope of treatment, reviewing emergency department logs and other sources statewide for a 69-month period. Of 61 cases of poisonous snakebite identified, 13 occurred in snake hobbyists or venom laboratory personnel and were considered nonaccidental, and 48 were inflicted by native noncaptive snakes. These bites were considered accidental, and all were presumed to be from rattlesnakes. Nearly three fourths of the victims were male, ranging in age from 2 to 56 years (mean, 22 years). Most accidental bites occurred in areas of high human populations, during the summer months, in the afternoon or evening hours, and during recreational activities. Of the 48 bites, 11 (23%) were provoked. Two thirds of bites were on the upper extremities, and a third were on the lower extremities. More than half of the victims had no first-aid treatment recorded. Of those who did receive first aid, many were subjected to possibly harmful treatments, including tourniquets and ice application. The median time to a hospital was 68 minutes, with a range of 15 to 440 minutes. Swelling and discoloration were the most common signs and pain and paresthesia the most common symptoms. Half the bites resulted in minimal or no envenomation, 17 (35%) produced moderate envenomation, and 6 (12%) severe envenomation. Most patients with moderate or severe envenomation received antivenin, but the dosages given were usually less than recommended dosages. Five patients received surgical treatment based on clinical findings. One child died in a snake-handling incident. Long-term morbidity was unknown due to lack of follow-up. The Utah Poison Control Center was poorly utilized as a reporting and informational resource.

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Poisonous snakebite is an uncommon emergency in the United States, even in states with large populations of indigenous poisonous snakes.[1] Despite many reports of different successful treatments, guidelines for the general management of poisonous snakebite in this country are not universally accepted.[2-6] In Utah, 20 poisonous snakebites were estimated to occur annually, based on a 1959 survey.[1] Despite this limited opportunity for clinical experience, various practitioners in the state have advocated a wide variety of first-aid measures and hospital treatments. To better define the epidemiology of poisonous snakebite in Utah and to examine the scope of prehospital and hospital care provided for these injuries, we did a retrospective study of snakebite in the state over a five-year period.

Cases and Methods

The emergency department logs of all Utah hospitals identified by the Utah Hospital Association as having 20 beds or more (21 total) were examined by diagnosis for the period January 1985 through September 1989. The hospital records of all patients with a diagnosis of poisonous snakebite or related diagnoses—snake venom poisoning or envenomation—were reviewed. In addition, names of snakebite victims were obtained from the Venom Research Laboratory at the Veterans Affairs Medical Center and the Utah Poison Control Center (UPCC) in Salt Lake City. Data were obtained pertaining to geographic location, type of snake, time of bite, victim activity, bite location, first aid, signs and symptoms, laboratory values, hospital treatment, complications, and outcome. The severity of envenomation was graded as none, mild, moderate, or severe based on presenting signs, symptoms, and laboratory values using the method described by Wingart and Wainschel (Figure 1).[7] The prevalence of bites was calculated using a mean population of 1,675,000 for the state over the study period (source: State of Utah, Population Estimates Committee). Linear regression was performed when appropriate, with $r > .8$ considered a good correlation.

Results

We identified 66 cases of poisonous snakebite or envenomation. Of these, 54 were found through the

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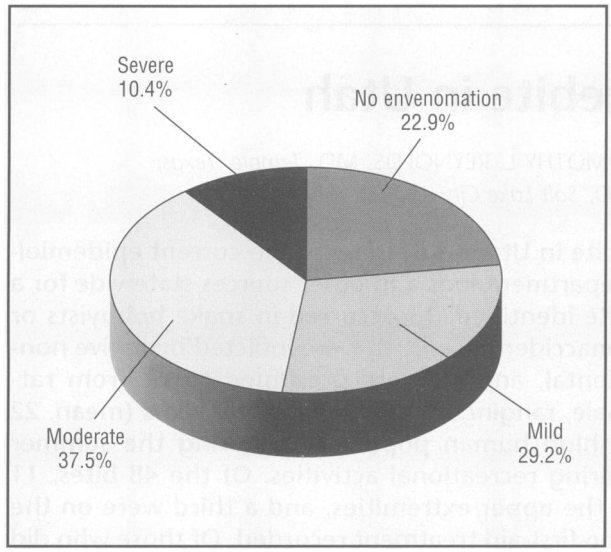

Figure 1.—The grade of envenomation on initial presentation in 48 patients bitten by native noncaptive snakes is shown. The initial grading system is based on the method described by Wingert and Wainschel[7]: No envenomation (11 patients) = no local or systemic reactions; mild (14 patients) = local swelling but no systemic reactions; moderate (18 patients) = swelling that progresses beyond the site of the bite, together with a systemic reaction or laboratory changes such as a fall in hematocrit; severe (5 patients) = pronounced local reaction, severe symptoms, and laboratory changes.

emergency department log review, and 8 were reported by the Venom Research Laboratory. Although 269 snakebite calls were handled by the UPCC during the study period, only 55 were thought to involve poisonous snakes, many were from adjacent states, and few resulted in hospital evaluation. Of 54 cases treated in Utah hospitals, only 9 had been reported to the UPCC.

Of the 66 confirmed cases, 5 were eliminated: 4 occurred in other states but were treated in Utah, and 1 person was not bitten but was squirted in the eye with venom while skinning a dead rattlesnake. This left 61 cases of poisonous snakebite occurring in Utah over the study period, for an overall incidence of 12.8 bites per year, or about 0.8 bites per 100,000 per year.

Of the 61 bites, 13 occurred when human-snake contact was planned. These bites were considered nonaccidental.

In nine cases, laboratory personnel were bitten at two different venom laboratories. Four of these laboratory bites were by exotic species, and five were by rattlesnakes indigenous to the United States, but not to Utah. One of these persons was bitten on five separate occasions and another twice. One bite by a cobra with ligated venom ducts showed no signs of envenomation. The other exotic bites showed signs of moderate to severe envenomation, but the grading scale described is specific only for pit-viper envenomation. The four rattlesnake bites resulted in mild to moderate envenomation. In only three instances did professionals seek medical treatment, despite signs of envenomation in eight bites. The bite by the "venomless" cobra required only tetanus immunization. A bite by one exotic snake resulted in a severe case of coagulopathy that was treated only with supportive care because specific antivenin was not available in this country. A mild case of rattlesnake envenomation was treated with antivenin, complicated by a mild allergic reaction. There were no deaths from snakebite in laboratory personnel.

Snake hobbyists accounted for four nonaccidental bites. All were by rattlesnakes, species unknown. One hobbyist was bitten while force-feeding a pet snake, two others while playing with pet snakes, and one child died after being bitten by a pet rattlesnake placed on her by a hobbyist. Two bites showed mild envenomation, one moderate, and one severe. This last case was the only death encountered during the study period.

The remaining 48 cases represent bites by native noncaptive snakes. These bites may be considered accidental because contact between humans and snakes in these incidents was not planned. We think that the data obtained from such accidental bites more truly reflect the epidemiology of snakebite by indigenous species occurring in their natural environment. The rest of the results will refer to these 48 patients unless otherwise noted.

The incidence of native, noncaptive poisonous snakebite was 11 bites per year (0.7 bites per 100,000 per year). Of the 48 bites, 45 were thought to be inflicted by rattlesnakes. Although species differentiation was not possible using information in hospital records, the geographic location of the bites suggests that the Great Basin rattlesnake (*Crotalus viridis lutosus*) was the culprit in about 90% of cases. The other three bites showed smaller or indistinct fang marks but no signs of envenomation. These bites may have been inflicted by other snakes, but were treated as rattlesnake bites based on the patients' histories.

Of the 48 victims, 35 (73%) were male. The ages of the victims ranged from 2 to 56 with a mean of 22 ± 10.9 years. There was no bimodal age distribution.

All but five of the bites occurred along the front range of the Wasatch Mountains, which corresponds with the highest human populations. Half of the snakebites occurred during the months of June and July, with all occurring between March and October. More than half the bites occurred between 5 PM and 10 PM, with nearly all bites occurring between 12 noon and 10 PM. In all, 16 victims (33%) were bitten on a lower extremity, 31 (65%) on an upper extremity, and 1 was bitten on the trunk. Most snakebites occurred during recreational activities such as hiking, horseback riding, climbing, camping, fishing, and motorcycle riding. In 10 cases (23%), the victim admitted to handling or otherwise provoking the snake. Victims' use of alcohol was not reliably documented.

Nearly two thirds of victims (63%) had no first-aid treatment documented. In those cases in which first-aid measures were reported, 12 (25%) had tourniquets or

TABLE 1.—*Frequency of Occurrence of Symptoms and Signs in 48 Snakebite Victims*

Presentation	Frequency, No. (%)
Symptoms	
Pain	39 (81)
Paresthesia	23 (48)
Nausea and vomiting	15 (31)
Hyperesthesia	7 (15)
Weakness, "dizziness"	5 (10)
Taste changes	3 (6)
Signs	
Fang marks	48 (100)
Swelling	40 (83)
Discoloration	33 (69)
Bleeding	14 (29)
Bullae	7 (15)
Fasciculations	4 (8)
Tissue necrosis	3 (6)
Hypotension	2 (4)
Rigors and diaphoresis	1 (2)
Petechiae	1 (2)

ace bandages applied, 8 (17%) had ice applied to the wound, 3 (6%) had an incision, 6 (13%) had suction, 2 (4%) received elevation, and 1 (2%) had cleansing. The median time taken from the time of the bite to reach a hospital was 68 minutes, with a range of 15 to 440 minutes.

The frequency of reported signs and symptoms is shown in Table 1. Fang marks, swelling, and discoloration or ecchymosis were the signs present in most of the patients, and pain and paresthesias were the most common symptoms.

More than half (52%) the bites resulted in minimal or no envenomation, whereas 18 (38%) had moderate and 5 (10%) had severe envenomation (Figure 1). A variety of laboratory tests were done for 33 patients (Table 2). Although patients with moderate to severe envenomation were more likely to have abnormal laboratory results ($P < .05$), this observation is moot because laboratory values were used in determining envenomation severity.

Table 3 shows the incidence of antivenin administration and surgical treatment. Of the 48 patients, 27 (56%) received antivenin, although the number of vials received varied greatly (range, 1 to 15; mean ± standard deviation, 3.0 ± 3.8). Indications for antivenin administration or choice of number of vials given was not documented. There was no correlation between the severity of envenomation and the number of vials of antivenin administered ($r = .56$). An acute allergic reaction developed in one patient (whose horse serum skin test was negative), treated successfully with corticosteroids. A case of serum sickness was reported in a patient who received nine vials of antivenin for a moderate envenomation. His symptoms resolved after 12 days with corticosteroid treatment.

Two patients with severe and three with moderate envenomation received surgical treatment. Surgical treatment ranged from incision of the bite site to wound excision with fasciotomies and antibiotic perfusion catheters. Indications for any surgical approach were based on clinical findings. Compartment pressures were measured in only one of three patients undergoing fasciotomy.

Other supportive treatments given in the emergency department or hospital included antibiotics, immobilization of the extremity at the heart level, ice, antihistamines, analgesics, steroids, tetanus immunization, constricting bands, and wound cleansing with or without debridement.

Long-term morbidity was not documented in the medical records of any of the 48 victims of native, noncaptive poisonous snakebite. We did not have access to clinic or office records of physicians who might have provided subsequent care. There were no fatalities in this group.

Discussion

Notification of poisonous snakebite in Utah is not required, and the true incidence is not known. This review is based on cases of patients who sought medical care for snakebite at Utah hospitals. Those who consulted a private physician or small hospital or clinic or who did not seek care are not represented, with the exception of a few laboratory personnel. Despite this limitation, the calculated incidences of 12.8 per year for all poisonous snakebites in Utah and 11 per year for poisonous bites by native, noncaptive snakes are probably as accu-

TABLE 2.—*Laboratory Results in 33 Snakebite Victims*

Laboratory Test	Normal Values	Mean ± SD	Patients With Abnormal Values and Moderate or Severe Envenomation, No.*	(%)
Platelet count, × 10^9/liter	140-440	227.2 ± 95.3	6/33	(18)
Prothrombin time, seconds	13.5-17.0	15.1 ± 5.9	3/26	(12)
Partial thromboplastin time, seconds	25-36	67.3 ± 98.9	13/27	(48)
Fibrinogen, grams/liter†	1.5-3.5	1.74 ± 0.08	4/17	(17)
Fibrin degradation products, μg/ml	0-5	52.3 ± 106.3	6/11	(54)

SD = standard deviation

* Not every patient had every laboratory test.
†To convert to conventional units (mg/dl), multiply by 100.

TABLE 3.—*Treatment in 48 Snakebite Victims*

Surgery (5 patients)				*Antivenin Administration (37 patients)**			
						No. of Vials	
Patients, No.	*Envenomation Grade*	*Type of Procedure*	*Indications Given*	*Patients, No.*	*Envenomation Grade*	*Range*	*Mean ± SD*
1	Moderate	Finger "fasciotomy" skin graft	No capillary refill	14	Minimal	0-5	1.4 ± 1.8
1	Moderate	Wound incision	"To allow drainage"	17	Moderate	0-15	5.4 ± 4.6
1	Severe	Volar and dorsal hand fasciotomies, carpal tunnel fasciotomy	"Black" hand with decreased sensation and capillary refill	6	Severe	2-9	5.0 ± 2.4
2	Severe	Wound excision, hand fasciotomies, perfusion catheters	Elevated compartment pressures >15 mm of mercury (1 patient); clinical findings of decreased capillary refill and pulses, contracture	37	All	0-15	3.0 ± 3.8

SD = standard deviation

*$r = .56$.

rate as can be practically obtained. This is considerably less than the incidence of 20 poisonous bites per year in Utah previously reported.[1] The previous estimate, however, was based on a 1958-1959 survey of selected physicians and hospitals and was extrapolated from 20 bites reported over a two-year period.

Poison control centers would seem an ideal resource for tracking poisonous snakebite data. Although many snakebite calls were received during the study period by the UPCC, only a few could be confirmed by hospital records. Some of these patients may have been treated in other states or by private physicians or clinics. Some may have decided not to seek medical care, for unknown reasons.

Conversely, most of the cases found in emergency department logs had not been reported to the UPCC, indicating a reluctance of Utah physicians to use this valuable resource. Other states have instituted snakebite registries on local or statewide levels, but reporting remains voluntary.[6] Even a well-utilized reporting system may not reflect the actual incidence of poisonous snakebite, as some bites result in little or no envenomation, and medical care may not be sought.

The descriptive statistics regarding victims' age, sex, activity, month, time of day, and anatomic site of bites do not differ greatly from those reported for rattlesnake bites in other series.[2,4,8] Young men and children engaged in outdoor recreational activities during summer afternoon and evening hours have been reported to be the most likely to be bitten. All but one of our victims was bitten on an extremity, the most commonly reported bite site, but there was no predilection for lower extremity bites in children, as reported by others.[2] Bites were preventable in at least 11 of our cases (23%) when victims admitted to handling or provoking the snake. In another report, bites were preventable in more than half of 282 cases.[4] We were unable to document alcohol use in our retrospective study, but others have noted intoxication in 16% to 28% of patients.[4,8]

Likewise, the use of first-aid measures in the field appears similar to that reported elsewhere. Most of our patients had no first aid documented, whereas in a previous report, various first-aid treatments were given in two thirds of 282 patients.[4] Many treatments that have been discouraged, such as tourniquets, ice, and incision and suction, continue to be used in Utah and other states.[4] Considerable morbidity of many of these well-intentioned measures has been documented.[6] There remains a lack of scientific evidence for the efficacy of measures such as suction and constrictive bands. Suction has been shown to remove a portion of injected venom in animal models only if applied within five minutes of the time of the bite.[9] Likewise, it has been shown in a swine model that a constricting band limited venom absorption without increasing swelling.[10] Neither of these findings has been confirmed in humans. Those measures which seem to have some validity are avoiding excessive activity, immobilizing the bitten extremity, and transporting the victim to the nearest hospital.[4,6]

Hospital treatment of poisonous snakebite remains even more controversial than first-aid measures. No universally accepted approach exists for the use of antivenin, surgical treatments, or other modalities. Even a uniform system of grading envenomation severity is not agreed on.

A review of current reference materials available to clinicians and poison control centers shows a wide variation in indications for and amount of antivenin to be used.[6,11,12] Some authors have called for controlled studies to verify the efficacy of antivenin, but these have not as yet been done. One group chose to treat poisonous snakebite without antivenin and reported good results in ten cases of rattlesnake envenomation.[3] Most authors, however, insist that antivenin is the mainstay of the treatment of serious envenomation.[6,11,12] Russell has recommended administering from 5 vials of antivenin for minimal envenomation to 20 or more in severe cases.[6]

Others recommend withholding antivenin for all but moderate to severe envenomation, with doses ranging from 0 to more than 20 vials, depending on the clinical presentation.[4,12] It is not surprising, therefore, to note that there was no consistency in the amounts of antivenin used in our series of patients. Amounts used were generally less than those recommended by the manufacturer and by most authors.[11-13] We were unable to determine if any increased morbidity was associated with the failure to use recommended doses of antivenin in our small series. It is likely that consultation with a regional poison control center would have resulted in a more consistent use of antivenin.

Generally, most authors who advocate the use of antivenin in cases of poisonous snakebite recommend no antivenin for bites with fang marks only and no signs or symptoms of envenomation. Observation for as long as eight hours has been recommended for these patients to ensure that late-developing signs are not missed. For patients with mild envenomation, various authors recommend giving 0 to 8 vials as an initial dose. For moderate envenomation, 0 to 10 vials have been recommended, and for severe envenomation, 5 to 20 vials or more. Even greater doses of antivenin have been recommended in children and in those who do not respond to the initial dose with decreased progression of swelling in the first hour of antivenin treatment. All authors who use antivenin recommend skin testing before administering antivenin, but warn that allergic reactions may still be seen in those with negative skin tests, as was noted in the one patient in our series with an allergic reaction to antivenin. Prophylactic antihistamine administration has been recommended by some.

Likewise, indications for and type of surgical therapy are seldom agreed on. Some authors take a strong stand against any surgical intervention for poisonous snakebite, regardless of tissue pressures.[6] Others advocate excision of the bite site and early fasciotomy based on clinical indicators.[14,15] Many have taken a conservative approach, advocating the use of antivenin, with fasciotomy being done only if indicated by clinical signs and elevated tissue pressure measurements.[2] Unfortunately, none of these approaches is supported by controlled clinical studies. In our series, only five patients received surgical interventions, and long-term outcomes were not available, so we can make no conclusions.

Finally, the use of various supportive measures has been addressed by several authors. Many have recommended the prophylactic use of antibiotics, even though the incidences of infection in their series are low.[2,7,8] Steroids and antihistamines are of no value in envenomation, but their use is indicated for allergic complications when these occur.[6] Certainly, the application of ice has no place in the treatment of envenomation, and its use has been shown to result in gangrene in some cases.[6] Supportive measures were recorded infrequently in our series, with antibiotics, immobilization, and ice being those most often applied. No detrimental effects of ice application were recorded, but follow-up was not available.

The UPCC was an underutilized resource for snakebite reporting and treatment recommendations. We encourage Utah physicians to report all snakebites to the UPCC for continued epidemiologic study and assistance with current management guidelines. It is likely that a more consistent use of antivenin would have resulted from routine consultation with the UPCC on all snakebite cases. Although too few cases were treated surgically in our series to allow specific inferences, we support the approach that surgical intervention be based on clinical findings confirmed by elevated tissue compartment pressure measurements. Routine consultation with a poison control center is recommended for epidemiologic reporting of snakebite and consistency of antivenin treatment.

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