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Occupational Snake Bites: a Prospective Case Series of Patients Reported to the ToxIC North American Snakebite Registry

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Abstract

Introduction In the developing world, occupation has been identified as a risk factor for snake bite. Such an association has not been described in the USA. The objective of this study was to describe the epidemiology and clinical manifestations of occupational snake bite in patients reported to the ToxIC North American Snakebite Registry (NASBR).

Methods This was a prospective case series of patients reported to the ToxIC NASBR between January 1, 2014 and November 5, 2015. Variables collected included snake species, patient demographics, date and location of exposure, occupation, bite location, clinical manifestations, and management.

Results Of 180 adult snake bites reported, 25 (13.9 %; 95 % CI 9.2–19.8 %) were occupational in nature. Rattlesnake envenomations were common (80 %). Most snake bites (96 %) occurred in men. Occupations most associated with snake bite were landscaping (28 %) and working directly with snakes (24 %). Fifty-six percent of bites occurred in an outdoor work environment. Seventy-six percent of envenomations were to the upper extremities. Intentional interaction occurred in 40 % of cases, all of which sustained finger envenomations. No cases presented with apparent acute ethanol intoxication.

Conclusions The majority of occupational snake bites occurred in men working outdoors and were unintentional injuries. Bites involving the upper extremity tended to result from intentional interactions. Acute ethanol intoxication did not appear to be involved with occupational envenomations.

Keywords Snake bite · Occupation · Envenomation · Risk factor

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Introduction

In the USA, nearly 10,000 snake bites are treated in the Emergency Department (ED) each year resulting in significant morbidity and rare mortality [1]. Both native and non-native snakes are implicated in these bites. In the USA, the *Viperidae* family (rattlesnakes, cottonmouths, and copperheads), and the *Elapidae* family (coral snakes) are responsible for native snake envenomations. Viper envenomations typically cause tissue and hematologic toxicity, although neurologic symptoms can occur with some species. Anaphylaxis and shock also rarely occur [2]. Elapid envenomations, conversely, are characterized by neurologic toxicity [3]. Serious envenomations also occur after exposure to captive non-native snake species [4].

Characteristics of individuals sustaining snake envenomations in the USA have been previously described [1, 5—8]. Men are over-represented, frequently comprising approximately 70–80 % of patients [1, 6, 8]. Extremity bites are common, and intentional interaction with snakes is often associated with upper extremity bites [6]. Rattlesnakes are responsible for the majority of venomous bites [1]. Young adults are more frequently affected than children and the elderly [7]. Ethanol intoxication has often been associated with snake bites, particularly when interaction is

intentional [6]. Envenomations are more common between March and October, peaking in the summer and fall when human outdoor and snake activities are highest [6].

Worldwide, occupational exposure has been identified as a significant risk factor for snake bite. Although the epidemiology and clinical manifestations of such exposures has been described in other parts of the world [4], data for this population in the USA is lacking. Despite the paucity of data, occupational snake envenomation in the USA does appear to play a significant role. In a recent review, 30 % of venomous snake bites occurred in the workplace [1]. Another review of non-native snake bites reported 11 % occurring in the workplace setting [4]. This study aims to describe the epidemiology and clinical manifestations of occupational snake bites in the USA using data reported to the Toxicology Investigators Consortium (ToxIC) North American Snakebite Registry (NASBR).

Methods

This was a prospective case series. Data reported to the ToxIC NASBR between January 1, 2014 and November 5, 2015 were reviewed.

The ToxIC Registry was established in 2010 by the American College of Medical Toxicology (ACMT) as a novel, prospective toxico-surveillance and research tool. It records all cases cared for at the bedside by medical toxicologists at each of more than fifty sites across the USA that actively contribute cases to the Registry. The Registry allows for pooling of detailed, de-identified clinical information from across all Registry centers.

The Registry is Health Insurance Portability and Accountability Act (HIPAA) compliant and no patient identifiers are available on the database. Participation in the Registry is done in accordance with local institutional and Western Internal Review Board (IRB) policies and procedures.

ACMT's ToxIC NASBR Sub-Registry is a database that gathers de-identified, detailed prospective information regarding snake bite, clinical manifestations of envenomation, and response to treatment for patients who receive bedside care from medical toxicologists across the USA. Occupational nature of snake bite was determined by the treating clinician for each case and was a mandatory field in the Sub-Registry.

Inclusion criteria were: age ≥ 18 years and occupational exposure leading to snake bite. Data collected included patient demographics, date and location of exposure, occupation, bite location, snake species, clinical manifestations, outcomes, and management. Method of identification of snake was not specified. Data for late bleeding events were obtained from direct patient contact or telephone interview.

Statistical Analysis

Descriptive statistics were used to report results. The Clopper Pearson method [9] was used to determine 95 % confidence intervals (CI).

Results

Cases

Between January 1, 2014 and November 5, 2015, 180 snake bites in adult patients were reported to the ToxIC Registry. Nine US states were represented. Twenty-five (13.9 %; 95 % CI 9.2–19.8 %) cases occurred during an occupational exposure to the snake and all occupational exposures identified were included in analysis. All occupational envenomations took place in seven US states (Table 1). The majority (52 %) of occupational snake bites occurred in Arizona. The greatest number of cases were reported between May and September, a pattern similar to that of the larger NASBR population. See Fig. 1.

Types of Snakes

There were 20 native rattlesnake, three copperhead, and two non-native pit viper (*Crotalus durissus terrificus* and *Trimeresurus albolabris*) snake bites reported. Rattlesnakes were not consistently identified by species. Four (16 %) occupational snake bites occurred after exposure to captive snakes, and the remainder (84 %) were secondary to wild native snakes. Captive snakes included the two non-native snakes, the South American rattlesnake (*Crotalus durissus terrificus*) and the green pit viper (*Trimeresurus albolabris*), as well as two native snakes, the Arizona black rattlesnake (*Crotalus cerberus*) and the western diamondback rattlesnake (*Crotalus atrox*).

Table 1 Occupational and total snake bites by state

US state	Total cases	Occupational cases (% total)
Arizona	79	13 (17)
Texas	37	4 (11)
California	21	3 (14)
North Carolina	15	1 [7]
Missouri	9	1 (11)
Colorado	7	0
New Mexico	6	2 (33)
Utah	4	1 (25)
Pennsylvania	2	0

Fig. 1 Occupational and total snake bites by month
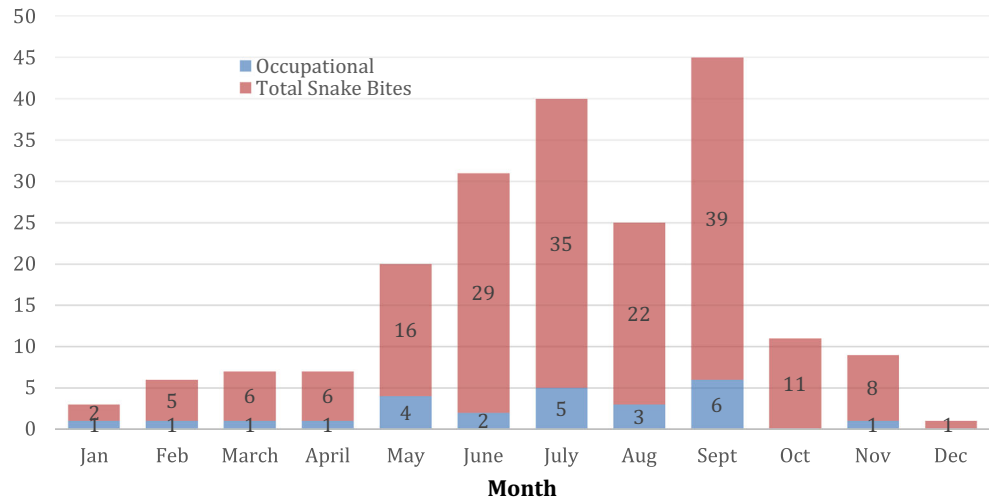
Demographics and Occupation

Twenty-four (96 %) patients were men and one was a woman. The average age was 40.3 years (range 18–66 years). One patient was aged over 65. Two (8 %) patients had sustained previous snake bites. This was the fourth envenomation for one patient, employed as a venomous animal educator.

Six (24 %) patients were employed working directly with snakes and seven (28 %) were employed in landscaping. Fourteen patients (56 %) worked outdoors. See Table 2 for a full list of occupations. Acute ethanol intoxication was not present in any case.

Envenomation Details

Nineteen (76 %) snake bites occurred to the upper extremities, predominantly to the finger, and six (24 %)

occurred to the lower extremities, predominantly to the lower leg. See Fig. 2. Fifteen (60 %) cases were "legitimate bites," meaning the interaction with the snake was unintentional. Ten (40 %) cases involved intentional interaction with the snake, and all of these individuals sustained upper extremity finger bites (Fig. 3). All patients working directly with snakes also sustained finger bites. None of the lower extremity bites involved intentional interaction with the snake. The single woman was bitten on the finger after intentional interaction with a snake that had incidentally entered her animal care facility.

Outcomes and Management

Field therapy in the form of ice application was performed in one case. Time to presentation to health care was 3 h or less in all but one case in which there was a 48 h delay (average 3.4 h, range 20 min to 48 h). Antivenom (Crofab™, BTG International in 22 cases, Green Pit Viper Thai Red Cross Antivenom in 1 case) was given in 23 (92 %) cases, with an average total dose of 10 vials (range 2–24 vials) per case.
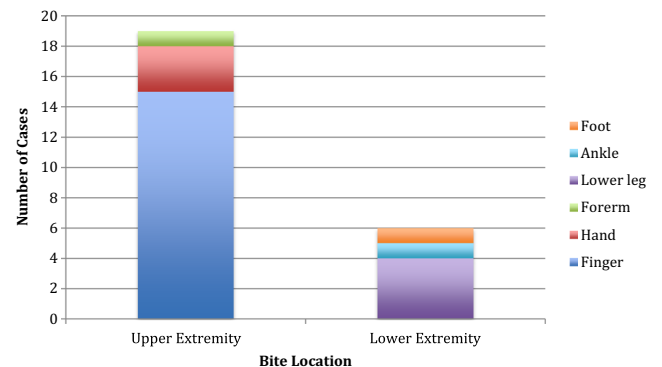
Table 2 Occupation of snake bite victims

Occupation	Cases
Landscaper	7
Snake handler/caretaker	3
Construction worker	2
Oil field worker	2
Snake remover	1
Venomous animal educator	1
Camp counselor	1
Mechanic	1
Engineer	1
Truck driver	1
Medicine man	1
Animal care facility manager	1
Biologist	1
Corrections officer	1
Professional mountain biker	1

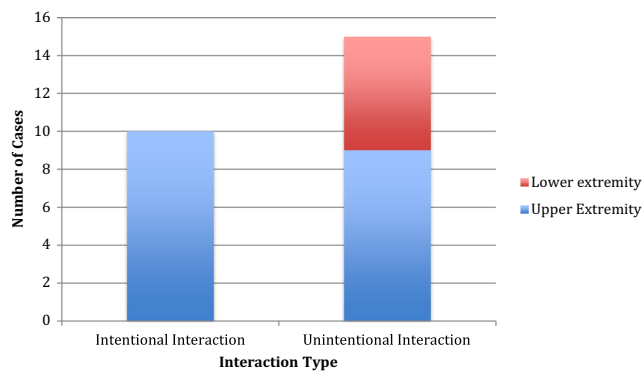**Fig. 2** Anatomic location of occupational snake bites

Fig. 3 Patterns of intentional and unintentional occupational snake bites

Mean time to antivenom administration after snake bite was 5.6 h (range 1–48 h). Clinical manifestations and laboratory results are described in Table 3 and Table 4, respectively. One patient was administered prophylactic antibiotics, and one underwent wound debridement. There were no fasciotomies. No patient was treated for late bleeding and there were no deaths.

Discussion

Occupation as a risk factor for snake bite has been described in other countries. In South East Asia, farming is the occupation most associated with snake bite and farmers represent approximately 80 % of snake bite victims in India [10]. In such an environment, bites to the lower extremities predominate. This contrasts significantly from the results seen in this study, in which there was not a single reported case of occupational snake bite in a farmer. In this study, the majority of bites were to landscapers, followed by snake handlers and others whose employment places them in direct contact with snakes.

Also in contrast to data from South East Asia, the majority of bites in this study were to upper extremities, frequently accompanied by intentional interaction with the snake.

This data is in agreement with other modern studies of snake bites in the USA which also demonstrate an association between intentional interaction with snakes and upper extremity bites. The majority (60 %) of bites in this study involved unintentional interaction with the snake. These data, in contrast, differ from most modern snake bite studies in the USA in which the majority of bites result from intentional interaction with snakes [4, 6, 7]. Factors that may have contributed to an increased proportion of unintentional envenomations in this population are speculative but may include absence of ethanol intoxication and occupations exposing victims to snake habitats.

Similar to other snake bite series, male victims predominated. Perhaps the preponderance of men, rather than women, employed in landscaping contributed to the persistence of this trend in this series. Additionally, bites were most likely to occur in the summer and fall months in this group, months when snakes are more active. Overall, individuals are more frequently out of doors both recreationally and for employment purposes during these months, however this may not hold true for more southern states such as Arizona.

Uniquely, ethanol intoxication was not present in any case of occupational snake bite, a finding that differs significantly from other studies of snake bite victims. This is somewhat expected, as consuming ethanol or other intoxicants while working is typically discouraged. Although it would be expected that clinicians at the bedside would be able to detect ethanol intoxication in these patients, victims of occupational envenomations may have ulterior motivations to deny ethanol intoxication under such circumstances. Method of determination of ethanol intoxication (i.e., clinician judgment, patient report or laboratory confirmation) was not reported.

Limitations

This review of data reported to the NASBR Sub-Registry presents limitations inherent to voluntary reporting of data to a registry. Although the NASBR undergoes quality assurance

Table 3   Incidence of clinical manifestations in occupational snake bites

	Rattlesnakes (% total)	Copperheads (% total)	Non-natives (% total)
Swelling	19 (100)	3 (100)	2 (100)
Ecchymosis	7 (37)	1 (33)	1 (50)
Erythema	7 (37)	2 (67)	0
Emesis	2 (11)	0	1 (50)
Neurotoxicity	2 (11)	0	1 (50)
Hypotension	0	0	0
Minor Bleeding	3 (16)	0	0
Necrosis	1 [5]	0	0
Angioedema	1 [5]	0	0

Table 4 Mean laboratory results in occupational snake bites

	Rattlesnakes (range)	Copperheads (range)	Non-natives (range)
Platelet nadir (K/mm^3)	216 (51–310) $n = 20$	168 (104–214) $n = 3$	177 (169–184) $n = 2$
Fibrinogen nadir (mg/dL)	272 (153–415) $n = 20$	251 (227–274) $n = 2$	97 (<30–164)^a $n = 2$
Prothrombin Time peak (sec)	21 (11- > 120)^b $n = 19$	12 (11–12) $n = 3$	20 (16–24) $n = 2$

[a] For fibrinogen < 30, a value of 30 was used to calculate the mean

[b] For prothrombin time > 120, a value of 120 was used to calculate the mean

review to identify and correct errors or omissions in data entry, it is possible that all errors were not identified. Notably, the majority of cases took place in Arizona. Data reported for occupations and snake species are thus skewed towards those typical of this geographical region. Limited availability of follow up data in a large number of cases prevented accurate reporting of such outcomes. Lastly, the small number of occupational envenomations resulted in a small sample size. This limited conclusions that can be drawn from the data and limited generalizability of findings.

Conclusions

Occupational exposure represented 13.9 % of snake bites in adults reported to the ToxIC Registry. The majority of occupational snake bites occurred in men working outdoors and were unintentional injuries. Bites involving the upper extremity tended to result from intentional interactions. Acute ethanol intoxication did not appear to be involved with occupational envenomations. These findings need to be validated in a population with a large sample size.

Compliance with Ethical Standards

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