**Spectrum, clinical profile and outcome of animal bites and stings in a University Health Service in Southern Nigeria: a 10-year retrospective study**

**Abstract**

**Introduction**: Animal bites and stings constitute a significant environmental emergency worldwide. It involves an exposure to toxin from a venomous source, mainly snake bites and insect stings.

**Objective**: To evaluate the spectrum, clinical profile and factors influencing the outcome of patients with animal bites and stings seen in our University Health Service.

**Methodology**: Using a retrospective design, eligible patients were purposively recruited. Data collection was done using a structured form comprising sections on each participant’s baseline information, clinical history of bite/sting, severity of envenomation, treatments and outcomes. The data were extracted from patients’ files over a ten-year period. Descriptive and inferential analyses were done; p <0.05 was considered significant.

**Result**: A total of 15,290patients were admitted during the study period. Thirty-nine (0.26%) persons with bites and stings were recruited; their mean (*SD*) age was 28.8(13.2) years. On further analysis of 30 participants, snake bites were the commonest, 22(73.2%); followed by scorpion stings 3 (10.0%). Dog bites 2 (6.7%) and cat bite 1 (3.3%) were less common. Local site effects that frequently occurred were swelling, 11(36.7%) and bleeding, 7(23.3%). Most bites or stings were not provoked, as reported by 28(93.3%) of participants. Thirteen (43.3%) participants had moderate envenomation while 12(40.0%) were severe. Twenty (66.7%) participants were referred. Demographic factors did not influence the outcome of participants (p>0.05).

**Conclusion**: Animal bites and stings occurs in University community with variable severity. There is a need for health education on prevention and appropriate first aid care. Also, an enhanced capacity for envenomation treatment in University Health Services is desirable.

**Key words**: envenomation, spectrum, clinical profile, outcome, University community

**Introduction**

Envenomation is a significant environmental emergency worldwide, especially in South-east Asia and Sub-Saharan Africa (1); it refers to exposure to toxic substance from a venomous source, mainly animal bites and insect stings (2). Snakebite is a leading cause of morbidity and mortality in all age groups if appropriate treatment is not promptly administered, with the World Health Organization reporting around 5.4 million snake bites yearly, 2.7 million cases of envenomation from these bites, over 100,000 deaths annually, and around three times as may amputations and permanent disabilities (3). Meyers and Tadi(4) in 2022 noted that 7,000 snakebites occur in the United States yearly, notably contrasting with findings from Suraweera *et al* (5) in a national study, which discovered that about 1.2 million snakebites occurred between 2001 and 2014 in India, averaging about 58,000 per year. Several studies have found that snakebites due to Viperidae were the leading cause of death among affected individuals in Africa 5, 6, 7). Nduagubam *et al* (8) in Enugu, Eastern Nigeria and Fadare *et al* (9) in Kogi, Northern Nigeria reported a high incidence of complications among patients with snakebites, often worsened by late presentation to health facilities and harmful prehospital care of the patients (8, 9).

The clinical features of snakebite include local effects such as burning pain, ecchymosis, petechiae and bullae, as well as systemic toxicity like hepatoxicity and neurotoxicity (10). These manifestations have been adapted for grading the severity of envenomation from grade 0 (no envenomation) to grade 4 (severe systemic envenomation) (11). Low grade envenomation is commoner in the literature. Yang *et al* (12) reported that 81% of patients in their study had mild snakebites, as characterized by the snakebite severity scale, similar to findings by Gouda *et al*(13) in Egypt, which showed that 64% of snakebites were non-venomous. Ghasempouri *et al* (14) in India reported that only 13% of their participants had severe systemic manifestations that necessitated Intensive Care Unit admission. The progression in severity of envenomation is sometimes related to whether the bite is provoked or not, as well as inappropriate pre-hospital care and late presentation. Scorpion stings, bee stings and spider bites can also be palpably distressing to patients with attendant risk of anaphylaxis unless effective supportive and prophylactic therapies are promptly instituted (15, 16). Moreover, canine bites constitute nearly 1% of injury related emergency department visits especially among children; besides antibiotic therapy, they must be thoroughly assessed and offered booster tetanus and rabies prophylactic vaccination (17,18).

Sub-optimal management of envenomation can lead to severe systemic complications. Some previously practiced first-aids for persons with snakebites and scorpion bites have been shown to be ineffective and potentially deleterious to patients’ health (19). Use of tight tourniquets, pressure bandaging, incisions, suctioning, native herbs, alcohol application and elevation of affected limbs can lead to tissue damage and dissemination of snake venom (20). Russell *et al*(21) in Ohio found that scarification and tourniquet use were poor prognostic factors in patients with snakebites. In addition, such ineffective therapy can lead to a delay in the administration of antivenin and other effective care. Abhulimen-Iyoha *et al* (22) in Benin City opined that patients with snakebites who presented late to the Children Emergency Room were more likely to develop severe complications such as disseminated intravascular coagulopathy, necrotizing fasciitis and compartment syndrome, usually requiring surgical interventions. Other severe systemic complications associated with envenomation include rhabdomyolysis, neurotoxicity and respiratory failure but they can be averted by specific antivenom therapy and relevant supportive care (1, 10).

Considering the foregoing and the thought that general education does not always translate to health awareness and prevention of environmental hazards, we evaluate the burden of envenomation seen in the health services of our University campus. We hypothesize that prehospital care and first-aids received by the patients may impact their outcome.

**Methods**

**Study Area and Participants**

The study took place at the University of Benin, Department of Health Services, Ugbowo campus, Benin City, Edo State, Nigeria. The study involves reviewing the clinical data of all patients with envenomation managed in the preceding ten-year period, January 2014 to December 2023 at the University of Benin Health Centre. Benin City is the Capital of Edo State in the South-South geopolitical Zone of Nigeria. It is a cosmopolitan city, situated in the rainforest belt 122 metres above sea level with an estimated population of 1,147,188.

**Subjects:** All patients who presented with complaints of bites and stings at the University health centre during the period under review (January 2014 – December 2023).

**Inclusion criteria**: Presenting complaints of animal bites, snakebites, scorpion sting, hymenoptera (bee, wasp, fire ant) sting and other features of envenomation.

**Exclusion Criteria**: Patients without a clinical diagnosis of animal bites or envenomation.

**Study design**: This study adopted a retrospective design.

**Sample size and Sampling Techniques**: The is a total population study of all eligible patients seen at the University Health Centre during the 10-year period under review. Participants were purposively selected from the clinical record of the Health Centre.

**Data Collection**: This was done using a structured data collection form comprising sections on each participant’s baseline information, clinical history of bite/sting, severity of envenomation, treatments and outcomes. This form was used to extract data from patients’ case notes.

**Statistical Analysis**: The data was analyzed using SPSS version 26.0 statistical software for Windows (*IBM, Armonk, N.Y., United States*). Frequencies and percentages of types and severity of envenomation, socio-demographic features and other categorical variables was calculated. Chi-square was done to detect significant difference between proportions. Multivariate analysis was done where applicable. The level of significance of each test was set at *p < 0.05*.

**Ethical consideration**

Ethical clearance was obtained from the Research and Ethical Committee (REC) of the College of Medicine, University of Benin (CMS/REC/2024/606). Data collection form was coded (*without names*) to ensure confidentiality.

**Results**

**Baseline Characteristics of the Participants**

Altogether, 15,290patients including 39 (0.26%) persons with envenomation were admitted at the University Health Centre during the study period. Among the 39 patients with bites and stings, 9 persons were excluded from further analysis due to grossly incomplete data on their clinical-demographic features and outcome. The baseline information of the remaining participants (n=30) reveals that there are more females than males, 23 (76.7%) and 7 (23.3%) respectively. The age distribution indicates that the largest group of participants falls within the 21-30 years age range, comprising 13 (43.3%) of the total. This is followed by those aged over 30 years at 9 (30.0%), and those under 20 years at 8 (26.7%). The mean age of the participants is 28.8 years with a standard deviation of 13.2 years. The Bini ethnic group is the most represented, making up 13 (43.3%) of the participants. This is followed by the Yoruba at 11 (36.7%) and the Igbo at 6 (20.0%); Table 1.

**Table 1: Baseline Characteristics of the Patients with Envenomation at the University Health Centre (N =30)**

|  |  |  |
| --- | --- | --- |
| **Baseline Information** | **Frequency, n** | **Percentage (%)** |
| **Gender** |  |  |
| Male | 7 | 23.3 |
| Female | 23 | 76.7 |
| **Age (Years)** |  |  |
| <20 | 8 | 26.7 |
| 21 – 30 | 13 | 43.3 |
| >30 | 9 | 30.0 |
| Mean Age ± S.D = 28.83 ± 13.2 | | |
| **Ethnic Group** |  |  |
| Bini | 13 | 43.3 |
| Yoruba | 11 | 36.7 |
| Igbo | 6 | 20.0 |

**Spectrum of Envenomation and Clinical Features**

Snake bites are the most common type of envenomation among the participants, accounting for 22 (73.2%) of cases. Scorpion stings are the next most frequent at 3 (10.0%), followed by dog bites at 2 (6.7%). Cat bites, and others were rare (3.3% each). The leg was part of the body most commonly affected among the participants (73.3%); see further details on Table 2. Regarding site swelling, 11 (36.7%) of participants experienced swelling, while 19 (63.3%) did not. Of those with swelling, the majority, 9 (81.8%), had localized swelling, and 2 (18.2%) had generalized swelling. Site pain was reported by 21 (70.0%) of participants, with 20 (95.2%) experiencing localized pain and 1 (4.8%) having generalized pain. Bleeding was reported by 7 (23.3%) of participants, while 23 (76.7%) did not experience bleeding

**Table 2: Spectrum of Envenomation and Clinical Features of the Participants (N =30)**

|  |  |  |
| --- | --- | --- |
| **Envenomation/Clinical Features** | **Frequency** | **Percentage (%)** |
| **Spectrum of Envenomation** |  |  |
| Snake bite | 22 | 73.3 |
| Scorpion sting | 3 | 10.0 |
| Dog bite | 2 | 6.7 |
| Cat bite | 1 | 3.3 |
| Centipede | 1 | 3.3 |
| Unknown | 1 | 3.3 |
| **Part of the Body Bitten /Stung** |  |  |
| Leg | 22 | 73.3 |
| Foot | 4 | 13.3 |
| Arm | 1 | 3.3 |
| Eyes | 1 | 3.3 |
| Finger | 1 | 3.3 |
| Both upper and lower limbs | 1 | 3.3 |
| **Site Swelling** |  |  |
| Yes | 11 | 36.7 |
| No | 19 | 63.3 |
| **Site Pain** |  |  |
| Yes | 21 | 70.0 |
| No | 9 | 30.0 |
| **Bleeding** |  |  |
| Yes | 7 | 23.3 |
| No | 23 | 76.7 |

.

**Setting and Pre-Hospital Care of the Bites and Stings**

Concerning the setting of the bites and stings, 16 (53.3%) of the incidents occurred at school, 11 (36.6%) at home, 2 (6.7%) on the road, and 1 (3.4%) at work; Table 3. The time of occurrence was most frequently in the morning, accounting for 13 (43.3%) of cases, followed by night at 11 (36.7%) and afternoon at 6 (20.0%). Most bites or stings were not provoked, as reported by 28 (93.3%) of participants, while 2 (6.7%) indicated that the bite or sting was provoked. First aid was given to only 2 (6.7%) participants, whereas 28 (93.3%) did not receive any first aid.

**Table 3: Setting of the Envenomation and Prehospital Care** **of** **the Participants (N =30)**

|  |  |  |
| --- | --- | --- |
| **Setting/ Prehospital Care** | **Frequency** | **Percentage (%)** |
| **Location** |  |  |
| School | 16 | 53.3 |
| Home | 11 | 36.6 |
| Road | 2 | 6.7 |
| Work | 1 | 3.4 |
| **Time of occurrence** |  |  |
| Morning | 13 | 43.3 |
| Afternoon | 6 | 20.0 |
| Night | 11 | 36.7 |
| **Was the bite provoked** |  |  |
| Yes | 2 | 6.7 |
| No | 28 | 93.3 |
| **Prehospital care** |  |  |
| Yes | 2 | 6.7 |
| No | 28 | 93.3 |

**Severity of Envenomation and In-Hospital Care of the Participants**

Regarding the severity of envenomation, 12 (40.0%) of participants were categorized as severe, 13 (43.3%) as moderate and 5 (16.7%) as mild. Among those with complications, 9 (75.0%) had cellulitis, 2 (16.7%) had allergic reactions, and 1 (8.3%) had red eyes; see Table 4. Ten (33.3%) participants were admitted to the University Health Centre, while 20 (66.7%) were referred to a nearby tertiary health facility. Of those admitted at the health centre, 3 (30.0%) received anti-venom infusion, and 7 (70.0%) did not. All 10 (100.0%) received tetanus toxoid injections and anti-tetanus serum was given to 1 (10.0%) participant. All admitted participants (100.0%) received antibiotics, 9 (90.0%) received analgesics, and 6 (60.0%) received steroids. Blood transfusion and surgical procedures were both performed on 1 (10.0%) participant each; Table 5. None of the admitted participants received the anti-rabies vaccine.

**Table 4: Severity and Complications of Envenomation among the Participants**

|  |  |  |
| --- | --- | --- |
| **Severity/ Complications** | **Frequency (N)** | **Percentage (%)** |
| **Severity** |  |  |
| Mild | 5 | 16.7 |
| Moderate | 13 | 43.3 |
| Severe | 12 | 40.0 |
| **Complications\*** | **12** | 40.0 |
| Cellulitis | 9 | 75.0\* |
| Allergic Reactions | 2 | 16.7\* |
| Red eyes | 1 | 8.3\* |

\*Subsequent percentages denominated on n=12 patients with complications

**Table 5: Treatment Given to Participants with Envenomation Admitted at the University Health Centre (n=10)**

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Frequency** | **Percentage (%)** |
| **Anti-venom infusion** |  |  |
| Yes | 3 | 30.0 |
| No | 7 | 70.0 |
| **Tetanus toxoid injection** |  |  |
| Yes | 10 | 100.0 |
| No | 0 | 0.0 |
| **Anti-tetanus serum** |  |  |
| Yes | 1 | 10.0 |
| No | 9 | 90.0 |
| **Antibiotics** |  |  |
| Yes | 10 | 100.0 |
| No | 0 | 0.0 |
| **Analgesics** |  |  |
| Yes | 9 | 90.0 |
| No | 1 | 10.0 |
| **Surgical procedure** |  |  |
| Yes | 1 | 10.0 |
| No | 9 | 90.0 |

**Outcome and Prognostic Factors**

The overall outcomes show that 20 (66.7%) participants were referred, while 10 (33.3%) were managed and discharged at the Health Centre. Among those discharged, 9 (90.0%) were stable and 1 (10.0%) was unstable. The mean duration of admission was 1.73 days with a standard deviation of 0.78 days. Regarding prognostic factors associated with survival till discharge among participants, age (p = 0.79), gender (p = 0.37), site swelling (p = 0.99), complications (p = 0.65), and severity of envenomation (p = 0.78) were not statistically significant; Table 6.

**Table 6: Factors Associated with Survival till Discharge among Patients with envenomation at the University Health Centre**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Factors** | **Discharged** | | **Χ2** | **P-value** |
|  | **Yes** | **No** |  |  |
| **Age (Years)** |  |  |  |  |
| **<20** | 3 (30.0) | 5 (25.0) | 0.791 | 0.787 |
| 21-30 | 5 (50.0) | 8 (40.0) |  |  |
| >30 | 2 (20.0) | 7 (35.0) |  |  |
| **Gender** |  |  |  |  |
| Male | 1 (10.0) | 6 (30.0) | 1.491 | 0.372 |
| Female | 9 (90.0) | 14 (70.0) |  |  |
| **Site Swelling** |  |  |  |  |
| Yes | 4 (40.0) | 7 (35.0) | 0.072 | >0.999 |
| No | 6 (60.0) | 13 (65.0) |  |  |
| ***Site Pain*** |  |  |  |  |
| Yes | 3 (30.0) | 6 (30.0) | 0.000 | >0.999 |
| No | 7 (70.0) | 14 (70.0) |  |  |
| **Complications** |  |  |  |  |
| Cellulitis | 4 (40.0) | 5 (25.0) | 1.885 | 0.653 |
| Allergic Reactions | 1 (10.0) | 1 (5.0) |  |  |
| Red Eyes | 0 (0.) | 1 (5.0) |  |  |
| None | 5 (50.0) | 13 (65.0) |  |  |
| **Severity** |  |  |  |  |
| Mild | 1 (10.0) | 4 (20.0) | 0.798 | 0.776 |
| Moderate | 4 (40.0) | 9 (45.0) |  |  |
| Severe | 5 (50.0) | 7 (35.0) |  |  |

**Discussion**

This study shows that envenomation is fairly uncommon in the University community, accounting for less than one percent of patients managed during the study period; this may be partly due to the relatively high environmental safety and hygiene measures being practiced on campus, as Carter *et al* (23) identified clean and tidy environments as the most effective deterrent to snake bites. Nonetheless, prior hospital-based studies have reported reasonably low incidence of envenomation. Sanni *et al* (24) in Birnin Kebbi and Nduagubam *et al* (8) in Enugu reported that envenomation accounted for less than one percent of patients managed in their emergency departments. In contrast, Shah *et al* (25) in Sokoto found a higher incidence of envenomation in their series, with almost 3000 cases in a year, as compared to 126 cases over 12 years, as reported by Aghahowa and Ogbevoen in 2017 (26). Malik and colleagues in Benue also found that envenomation occurred frequently among farmers in their setting, especially during planting seasons (27).

Snakebite was the leading cause of envenomation among our participants similar to earlier reports. Deikumah *et al* (28) found that viperidae bites was particularly associated with severe envenomation in their study; however, snake species were not investigated in the index study. A significant proportion of our participants suffered bee sting which can be associated with potentially life-threatening anaphylaxis (16). However, this did not influence the outcome of our participants in this study, perhaps due to ease of access to healthcare within the campus. Animal bite was rare among our participants, highlighting the strict pet control measures within the University campus.

The severity of envenomation among our participants was significant with a majority of them graded as, at least moderate; this can be related to the volume of venom introduced into the victim during the bite (11). Also, complications especially cellulitis occurred in over one-quarter of the participants but only one participant required a surgical procedure, comparable to some earlier researches in West Africa (29, 30). However, there have been reports of complicated snakebite envenomation that led to limb amputation (30,31). Lower limb was the commonest site of envenomation in our study, similar to findings by Fadare *et al*(9) and Okumu *et al* (29) that over half of snakebites occurred on the leg in their studies. The largest proportion of the bites occurred at home reflecting the cold–blooded nature of reptiles, seeking shelter in homes especially during wet seasons (32). Few participants were bitten on the road perhaps due to inadvertent provocation of the snakes; one participant was bitten on multiple body parts but this is relatively uncommon.

The treatments given to our participants were based on the severity of their envenomation as per standard protocols (21). Few of the participants received first-aids before presentation at the health centre, but this did not significantly influence their clinical course in this study. Several studies (8, 9, 19, 20) found that inappropriate pre-hospital care was associated with complications in their series; such first aids often compromise tissue perfusion or increase toxin dissemination. Wound care, antibiotics and prophylactic anti tetanus vaccination were given to all our participants. Only participants with systemic symptoms or rapid progression of local envenomation effects were treated with anti-venom infusions to minimize the related risk of adverse reactions (33). Few participants received transfusion due to bleeding or evolving coagulopathy. Mubarak *et al* (34) and Osipov *et al* (35) opined that disseminated intravascular coagulopathy (DIC) is common in viperidae envenomation but neurotoxicity often occurs due to elapidae snakebites. Nevertheless, none of our participants had paralytic manifestations while on admission.

The outcomes of our participants were largely favourable, similar to a report by Sanni *et al* (24) in Birnin Kebbi. Those that were admitted survived till discharge with only one patient remained unstable at follow up. A large proportion of our participants were referred to an affiliated tertiary centre for multi-disciplinary care which is sometimes indicated in the management of envenomation (36). The long-term outcome of referred patients was not explored in this study but envenomation could lead to life-long sequelae such as blindness, limb loss or renal failure (37, 38).

The strength of this study includes the screening of thousands of in-patients’ records managed during the period; this allows the inclusion of participants from various temporal environmental changes that might have occurred on the University campus. Nonetheless the retrospective design was a limitation as well as the relatively small number of eligible participants; this hinders a complete investigation of potential risk factors of envenomation in the setting.

**Conclusion** : animal bites and stings with envenomation occur in University communities. This decade-long review highlights the need to upgrade the capacity to manage envenomation such as snakebites and hymenoptera stings as well as canine bites at the University Health Services. It will be helpful to network with relevant poison control centres in the country to facilitate easy access to specific antivenins at the University health centre. Moreover, a large multi-centre study evaluating the burden, treatment and outcome of envenomation on campuses is desirable.

**Ethical consideration**:Ethical clearance was obtained from the Research and Ethical Committee (REC) of the College of Medicine, University of Benin (CMS/REC/2024/606). Data collection form was coded (*without names*) to ensure confidentiality.

**Data availability**: Data is available from the corresponding author on reasonable request.

**Prior Presentation**: This study abstract has been presented in September 2024 at the Annual Scientific Conference of the College of Medical Sciences, University of Benin, Nigeria.

**References**

1. Hamza M, Knudsen C, Gnanathasan CA, Monteiro W, Lewin MR, Laustsen AH, Habib AG. Clinical management of snakebite envenoming: Future perspectives. Toxicon X. 2021 Aug 8;11:100079. doi: 10.1016/j.toxcx.2021.100079. PMID: 34430847; PMCID: PMC8374517.
2. Ramirez-Cruz MP, Smolinske SC, Warrick BJ, Rayburn WF, Seifert SA. Envenomations during pregnancy reported to the national poison data system, 2009-2018. Toxicon. 2020 Oct 30;186:78-82. doi: 10.1016/j.toxicon.2020.07.029. PMID: 32771392.
3. World Health Organization. Snakebite envenoming. Updated September 12, 2023. Accessed August 3, 2024. https://www.who.int/news-room/fact-sheets/detail/snakebite-envenoming
4. Meyers SE, Tadi P. Snake Toxicity. 2022 Sep 19. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 32491497.
5. Dingwoke EJ, Adamude FA, Mohamed G, Klein A, Salihu A, Abubakar MS, Sallau AB. Venom proteomic analysis of medically important Nigerian viper Echis ocellatus and Bitis arietans snake species. Biochem Biophys Rep. 2021 Nov 2;28:101164. doi: 10.1016/j.bbrep.2021.101164. PMID: 34765747; PMCID: PMC8571701.
6. GBD 2019 Snakebite Envenomation Collaborators. Global mortality of snakebite envenoming between 1990 and 2019. Nat Commun. 2022 Oct 25;13(1):6160. doi: 10.1038/s41467-022-33627-9. PMID: 36284094; PMCID: PMC9596405.
7. Benjamin JM, Abo BN, Brandehoff N. Review article: Snake envenomation in Africa. Curr Trop Med Rep. 2020;17:198. doi:10.1007/s40475-020-00198-y.
8. Nduagubam OC, Chime OH, Ndu IK, Bisi-Onyemaechi A, Eke CB, Amadi OF, Igbokwe OO. Snakebite in children in Nigeria: A comparison of the first aid treatment measures with the world health organization's guidelines for management of snakebite in Africa. Ann Afr Med. 2020 Jul-Sep;19(3):182-187. doi: 10.4103/aam.aam\_38\_19. PMID: 32820730; PMCID: PMC7694701.
9. Fadare JO, Afolabi OA. Management of snake bite in resource-challenged setting: A review of 18 months experience in a Nigerian hospital. J Clin Med Res. 2012;4(3):39-43. doi:10.5897/JCMR11.044.
10. Centers for Disease Control and Prevention. Symptoms and First Aid. The National Institute for Occupational Safety and Health (NIOSH). https://www.cdc.gov/niosh/topics/snakes/symptoms.html. Last reviewed June 28, 2021. Accessed August 3, 2024.
11. Kim OH, Lee JW, Kim HI, et al. Adverse Cardiovascular Events after a Venomous Snakebite in Korea. Yonsei Med J. 2016 Mar;57(2):512-517. <https://doi.org/10.3349/ymj.2016.57.2.512>.
12. Yang Q, Gao Y, Fu W, Ma S. Impact of tourniquet use on severity of snakebite envenoming in Chongqing, China: a single-center retrospective study. J Int Med Res. 2024 Jan;52(1):3000605231225540. doi: 10.1177/03000605231225540. PMID: 38258738; PMCID: PMC10807319.
13. Gouda AS, Elnabarawy NA, Badawy SM. A study of snakebite envenomation cases admitted to Egyptian National Poisoning Center. Acta Med Int. 2017;4(2):34-40. doi:10.4103/ami.ami\_48\_17.
14. Ghasempouri SK, Sazgar M, Ranjbar S, et al. Evaluation of clinical features of snakebite in patients referred to Razi Hospital in Qaemshahr City. Medicina Clínica Práctica. 2023;6:100407. doi:10.1016/j.mcpsp.2023.100407.
15. Castillo A, Attaluri P. Acute respiratory failure following scorpion stings: Anaphylaxis or severe systemic envenomation? The Southwest Respiratory and Critical Care Chronicles 2018; 6(22):47–50.
16. Freeman T, Carlson JC. Patient education: Bee and insect stings (Beyond the Basics). UpToDate. https://www.uptodate.com. Updated April 3, 2024. Accessed August 3, 2024.
17. Morzycki A, Simpson A, Williams J. Dog bites in the emergency department: a descriptive analysis. CJEM. 2019 Jan;21(1):63-70. doi: 10.1017/cem.2018.2. PMID: 29490720.
18. Nadal D, Bote K, Masthi R, Narayana A, Ross Y, Wallace R, Abela B. Rabies post-exposure prophylaxis delivery to ensure treatment efficacy and increase compliance. IJID One Health. 2023 Dec; 1:100006. doi: 10.1016/j.ijidoh.2023.100006. PMID: 38152594; PMCID: PMC10752235.
19. Mahmood MA, Halliday D, Cumming R, Thwin KT, Myitzu M, White J, Alfred S, et al. Inadequate knowledge about snakebite envenoming symptoms and application of harmful first aid methods in the community in high snakebite incidence areas of Myanmar. PLoS Negl Trop Dis. 2019 Feb 15;13(2):e0007171. doi: 10.1371/journal.pntd.0007171. PMID: 30768596; PMCID: PMC6395000.
20. Maduwage K, Kodagoda Gamage S, Gutiérrez JM. First aid and pre-hospital practices in snakebite victims: The persistent use of harmful interventions. Toxicon. 2024 Feb 1;238:107582. doi: 10.1016/j.toxicon.2023.107582. PMID: 38128838.
21. Russell JJ, Schoenbrunner A, Janis JE. Snake Bite Management: A Scoping Review of the Literature. Plast Reconstr Surg Glob Open. 2021 Apr 29;9(4):e3506. doi: 10.1097/GOX.0000000000003506. PMID: 33936914; PMCID: PMC8084039.
22. Abhulimhen-Iyoha BI, Oguejiofor C, Ogonor E. Venomous snake bite in children: A case report from Nigeria. Int J Med Pharm Case Rep. 2018;11(1):1-7. doi:10.9734/IJMPCR/2018/40082
23. Carter H, Glaudas X, Whitaker R, Chandrasekharun G, Hockings K, Nuno A. Venomous snakebites: Exploring social barriers and opportunities for the adoption of prevention measures. Conserv Sci Pract. 2024;6(2):e13063. doi:10.1111/csp2.13063
24. Sanni UA, Lawal TO, Musa TL, Alege A, Na'uzo AM. Prevalence and Outcome of Snake Bites Among Children Admitted in the Emergency Pediatric Unit, Federal Medical Centre, Birnin Kebbi, Nigeria. Cureus. 2021 Aug 24;13(8):e17413. doi: 10.7759/cureus.17413. PMID: 34589324; PMCID: PMC8459746.
25. Shah MM, Imam TS, Bala A, Tukur Z. Survey of Snakes Bites among Snake Endemic Communities in North Eastern Nigeria. In: Shah MM, Sharif U, Buhari TR, Imam TS, eds. Snake Venom and Ecology. IntechOpen; 2022:1-12. doi:10.5772/intechopen.105419
26. Aghahowa SE, Ogbevoen RN. Incidence of Snake Bite and Utilization of Antivenom in the University of Benin Teaching Hospital Benin City, Nigeria. Niger J Exp Clin Biosci. 2017;5(1):5-10. doi:10.4103/njecp.njecp\_27\_15
27. Malik R, Bukie JO, Oigocho JJ. Assessment of snake bite in some selected communities in Benue State, Nigeria. In: Proceedings of 6th NSCB Biodiversity Conference; 2018; Uniuyo. 61-64.
28. Deikumah JP, Biney RP, Awoonor-Williams JK, Gyakobo MK. Compendium of medically important snakes, venom activity and clinical presentations in Ghana. PLoS Negl Trop Dis. 2023 Jul 28;17(7):e0011050. doi: 10.1371/journal.pntd.0011050. PMID: 37506181; PMCID: PMC10411737.
29. Okumu MO, Patel MN, Bhogayata FR, Ochola FO, Olweny IA, Onono JO, Gikunju JK. Management and cost of snakebite injuries at a teaching and referral hospital in Western Kenya. F1000Res. 2019 Sep 4;8:1588. doi: 10.12688/f1000research.20268.1. PMID: 31824667; PMCID: PMC6892383.
30. Yakubu A-S, Abdul-Mumin A, Adam A. Clinical and demographic profile of patients with snakebite in a tertiary hospital in Ghana. Sahel Med J. 2019;22(4):194-199. doi:10.4103/smj.smj\_68\_18
31. Abubakar SB, Habib AG, Mathew J. Amputation and disability following snakebite in Nigeria. Trop Doct. 2010 Apr;40(2):114-6. doi: 10.1258/td.2009.090266. PMID: 20305111.
32. Pandey DP, Thapa NB. Analysis of News Media-Reported Snakebite Envenoming in Nepal during 2010-2022. PLoS Negl Trop Dis. 2023 Aug 28;17(8):e0011572. doi: 10.1371/journal.pntd.0011572. PMID: 37639403; PMCID: PMC10491300.
33. Tednes M, Slesinger TL. Evaluation and Treatment of Snake Envenomations. 2024 Sep 10. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 31985944.
34. Mubarak R, Mohapatra BN. Study of coagulation disorder following haemotoxic snake envenomation in a tertiary care centre. Int J Res Med Sci. 2021;9(6):1641-1647. doi:10.18203/2320-6012.ijrms20212230
35. Osipov A, Utkin Y. What Are the Neurotoxins in Hemotoxic Snake Venoms? Int J Mol Sci. 2023 Feb 2;24(3):2919. doi: 10.3390/ijms24032919. PMID: 36769242; PMCID: PMC9917609.
36. Mhd Yunin N, Singh K, Othman M, et al. Naja species bite injury- pathophysiology of envenomation and multidisciplinary approach in management. Malays J Med Health Sci. 2023;19(5):435-437. doi:10.47836/mjmhs.19.5.51
37. Kasturiratne A, Lalloo DG, Janaka de Silva H. Chronic health effects and cost of snakebite. Toxicon X. 2021 Jul 17;9-10:100074. doi: 10.1016/j.toxcx.2021.100074. PMID: 34355162; PMCID: PMC8321925.
38. Jayawardana S, Arambepola C, Chang T, Gnanathasan A. Long-term health complications following snake envenoming. J Multidiscip Healthc. 2018 Jun 26;11:279-285. doi: 10.2147/JMDH.S126648. PMID: 29983571; PMCID: PMC6027691.