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General Medicine

SNAKE BITE ENVENOMATION IN EAST DISTRICTS OF SIKKIM DEMOGRAPHIC, CLINICAL PROFILE AND OUTCOME

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ABSTRACT **Background:** Snake bite envenomation represents a significant public health challenge in subtropical and tropical regions, with India bearing the highest mortality burden globally, estimated at 35,000-50,000 deaths annually. This prospective observational study examines the demographic, clinical profile, and outcomes of snake bite cases in East Sikkim, a biodiverse Eastern Himalayan state harboring 71 snake species. **Objectives:** To determine the epidemiological and clinical characteristics, severity assessment, management outcomes, and prognostic indicators of snake envenomation cases presenting to healthcare facilities in East district of Sikkim. **Methodology:** A prospective observational study was conducted from October 2018 to September 2020 at Sikkim Manipal Institute of Medical Sciences, Gangtok. All confirmed snake bite cases from East Sikkim district fulfilling inclusion criteria were enrolled. Demographic data, clinical presentations, laboratory investigations including 20-minute whole blood clotting test, snake bite severity score assessment, anti-snake venom administration, and outcomes were systematically recorded and analyzed. **Results:** Fifty-one snake bite cases were documented with mean age 39±14.88 years and male predominance (58.9%). Rural cases constituted 66.7%, with farmers and housewives equally affected (25.49% each). Maximum incidence occurred during monsoon season (56.86%) and daytime (78.4%), predominantly affecting lower extremities (52.95%). Non-toxic bites comprised 52.9% of cases, vasculotoxic envenomation 41.2%, and neurotoxic 5.9%. Fang marks (88.24%) and local swelling (56.86%) were predominant clinical features. Prolonged 20-minute whole blood clotting test was observed in 25.5% cases. Anti-snake venom was administered in 49.02% cases. Snake bite severity score correlated significantly with hospital admission duration (r=0.381, p=0.006). Mortality rate was remarkably low at 1.96% with only one death recorded. Early hospital presentation within two hours (74.5% cases) and prompt treatment initiation contributed to favorable outcomes. **Conclusion:** Snake bite envenomation in East Sikkim predominantly affects rural agricultural populations with vasculotoxic manifestations being most common. Early hospital presentation, prompt anti-snake venom administration, and snake bite severity score assessment are critical prognostic determinants ensuring excellent outcomes with minimal mortality.

KEYWORDS : Snake bite envenomation, Vasculotoxic, Anti-snake venom, Snake bite severity score, Sikkim

INTRODUCTION:

Snake bite represents a significant public health problem globally, particularly in subtropical and tropical regions. Approximately 5 million people are bitten by snakes annually worldwide, with the true burden of envenomation remaining unclear despite extensive research[1,2]. India bears the highest mortality burden, with an estimated 35,000–50,000 deaths annually. As an agriculture-predominant nation with rich biodiversity, India faces heightened human-snake exposure[3].

Sikkim, spanning 7,906 sq km in the Eastern Himalayas (latitude 27.5–28.9°N; longitude 87.59–88.56°E), is one of India's smallest yet most biodiverse states. It harbors 156 mammal species and 550 bird species, establishing it as a global biodiversity hotspot[3]. The state exhibits diverse vegetation patterns, with alpine predominance and seasonal variations: low-lying areas experience hot summers and pleasant winters, while higher altitudes show cold winters and temperate summers.

Sikkim contains 88 confirmed reptile species, though earlier reports varied between 26–75 species due to geographic confusion (particularly regarding Darjeeling hills classification), incomplete field surveys, and taxonomic nomenclature changes. Among these, 71 are snake species—19 venomous and 52 non-venomous. Snakes are categorized into five families: Colubridae (58%, the largest family), Boidae (2%, the smallest), Elapridae, Viperidae, and Typholopidae[4].

Snakes hold profound cultural, religious, and folkloric importance across Sikkim's three major communities-Lepcha, Bhutia, and Nepali-simultaneously evoking fear and fascination. Biologically, despite widespread public perception of universal danger, only a small snake proportion poses genuine human threats. Most snakes are non-aggressive and actively avoid human contact, biting only defensively when threatened. Such defensive bites, termed "death bites," are typically fatal[5].

This study examines the epidemiological and clinical profiles of snake envenomation patients in East Sikkim's district—the first such investigation in this region. Sikkim comprises nine protected wildlife areas (seven wildlife sanctuaries, one National Park, one conservation reserve) and is administratively divided into four districts: East (headquarters: Gangtok), West (headquarters: Gyalshing), North (headquarters: Mangan), and South (headquarters: Namchi)[6].

MATERIALS AND METHODS:

The present Prospective and observational study was conducted by Department of Medicine, Sikkim Manipal Institute Of Medical Sciences, Gangtok between October 2018 - September 2020. All the Snake bite cases registered in East district of Sikkim fulfilling the inclusion and exclusion criteria in the study period was taken for the study.

Patients with definitive H/o recent Snake bite attending ER of CRH, STNM, DHS and 7 PHCs of East Districts of Sikkim, with or without presence of fang marks, with or without presence of swelling, cellulitis, bleeding, blister formation at the local site and patients willing to give consent were included. Patient with doubt of other animal/insect bite and patient / NOK not giving consent were excluded.

Data was collected after obtaining approval from the Institutional Research Protocol. Evaluation committee and Institutional Ethics committee in the proforma attached within. Written informed consent was taken from the patient or patient party. Relevant general clinical examination and examination of bite site, use of pressure bandage, local swelling and symptoms (vomiting & neurotoxicity) was done. Relevant laboratory investigations - 20 minutes whole blood clotting test was noted. Review of first aid received in location of bite and peripheral health centre was done.

After obtaining approval from Institutional Research protocol

Evaluation committee and Institutional Ethics committee and a written informed consent from the patients satisfying the inclusion criteria, data was recorded by Patient/attendant interview using predesigned questionnaire. Various potential prognostic factors like age, sex, duration of bite to hospital time was recorded. Relevant general clinical examination and examination of bite site, use of tourniquet, local swelling and symptoms(vomiting & neurotoxicity) was done. Relevant laboratory investigations-20 minutes whole blood clotting test, urine albumin, serum creatinine, LFT, platelet count, Hb%, CBC, Routine urine test., SSS Review of first aid received in location of bite and peripheral health centre. Treatment given to the patient in the referral hospital. ASV, noting SSS every 4 hourly for 24 hours, clinical investigations to be done every 24 hours. Classifying severity based on SSS. Outcome of the cases. Till Recovery/ Death/ Discharge.

Demographic and epidemiological data was summarized using descriptive statistics. Normality of the data was ascertained using Shapiro wilks test. Accordingly, the test of comparison was used to compare variables. Test of correlation was based on scale of measurement and relationship was observed between indicator of morbidity, clinical parameters and use of ASV.

RESULTS AND OBSERVATIONS:

Table 1. Demographic Profile Of Snake Bite Cases:

Demographic Parameters		Frequency	Percent
Age Groups (Years)	13-29	17	33.3%
	30-49	20	39.2%
	50-70	14	27.5%
Gender	Male	29	58.9%
	Female	22	41.1%
Type of Dwelling	Rural	34	66.7%
	Urban	17	33.3%
Socio-economic status	Below poverty line	9	17.6%
	Above poverty line	42	82.4%
Occupation	Farmer	13	25.49
	Driver	04	7.843
	Govt. employee	05	9.80
	Business	03	5.88
	Student	05	9.80
	Housewife	13	25.49
	Others	08	15.68
Total		51	100.0

The mean age of the cases was 39±14.88 years. Majority of cases were in age group 30-49 years and majority, 58.9% were males. 66.7% cases were more from the rural areas in comparison to the urban region (33.3%).

42 cases (82.4%) were above poverty line while only 9 cases (17.6%) were below poverty line. Majority of the cases comprised of farmer (25.49%) and Housewife (25.49%), Government employee comprised of 9.80%.

Table 2. Details Of The Snake Bite:

Details of the Snake bite		Frequency	Percent
Time of bite	Day (6 am – 6 pm)	40	78.4
	Night (6 pm- 6 am)	11	21.6
Site of Bite	Foot	19	37.3%
	Leg	08	15.7%
	Hand	19	37.3%
	Forearm	04	7.8%
	Others	01	2.0%
Home to hospital time	<2 hours	38	74.5%
	2-4 hours	7	13.7%
	4-6 hours	5	7.9%
	> 6 hours	2	3.9%
Centre of admission	CRH	34	66.66
	STNM	9	17.64
	Rhenock CHC	1	1.96
	Pakyong PHC	2	3.92
	DH Singtam	5	9.8
Seasonal Incidence	Monsoon (June-Sept)	29	56.86
	Winter (Oct-Feb)	05	9.8
	Summer (March-May)	17	33.33
Total	51	100.0	

Most of the bite occurred during the daytime (78.4%) while it was 21.6% during the night. Most commonly involved site was foot (37.3%) and hand (37.3%) followed by leg (8%) and forearms (4%). All the bite occurred outside of the house. Most of the patient reached hospital within 2 hours (74.5%). The mean being 1.89±1.88 while 25.5% patient took more than two hours to reach hospital.

Majority of the cases were recorded in Central Referral Hospital (66.66%), followed by STNM (17.64%) and District Hospital Singtam (9.8%). Maximum number of cases 56.86% were recorded in monsoon season which ranged from June to September. Summer season recorded 33.33% cases while winter season had 9.8% cases.

Presenting Symptoms Of Snake Bite Cases:

Most common symptom was presence of fang mark (88.24%), Local swelling (56.86%), local pain (29.41%).

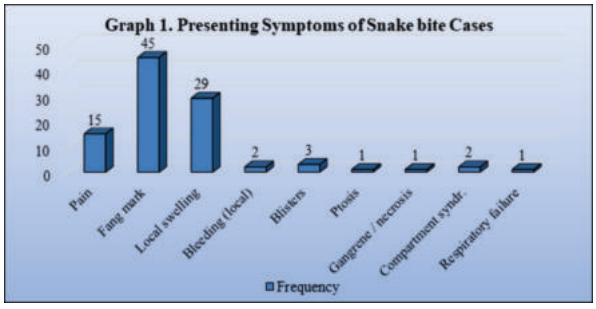


Table 3. Laboratory Parameters:

Variables	Total (n=51)
Mean blood urea	30.72±11.85
Mean serum creatinine	0.92±0.22
Mean hemoglobin (Hb%)	13.31 ±1.8
Mean prothrombin time	12.18±1.3
Mean international normalized ratio	1.0±.19
Mean respiratory rate	19.20±2.9
Mean systolic blood pressure	132.15±22.18
Mean diastolic blood pressure	84.58±13.56

20 Min WBCT was prolonged in 25.5% cases while it was normal in 74.5% cases.

Table 4. Types Of Snake Bites And Number Of Vials Used:

Snake types		N	Percentage(%)	No of vials used
Toxic	Vasculotoxic	21	41.2	366
	Myotoxic	0	0	00
	Neurotoxic	3	5.9	50
Nontoxic		27	52.9	0
Total		51	100	416

Most of snake bite case registered were nontoxic (52.9%), vasculotoxic accounted for (41.2%) and neurotoxic (5.9%). No myotoxic bites was recorded.

Anti Snake Venom (ASV):

ASV was used in 49.02% cases (n=25) bitten by toxic snake bites. In majority of the cases less than 30 vials of ASV were used, more than 30 vials were used in only two cases.

Snakebite Severity Score:

Most of the cases had low snakebite severity score 0- (21.6%), 01- (35.3%), 02- (27.5%). Only 3.9% had severity score of 5 and 6 respectively. Median Snake bite severity score in the study was 1 (1-2). Majority of the patient (88.2%) had received first aid.

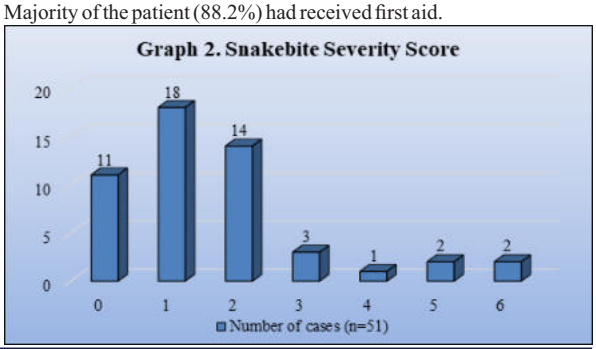


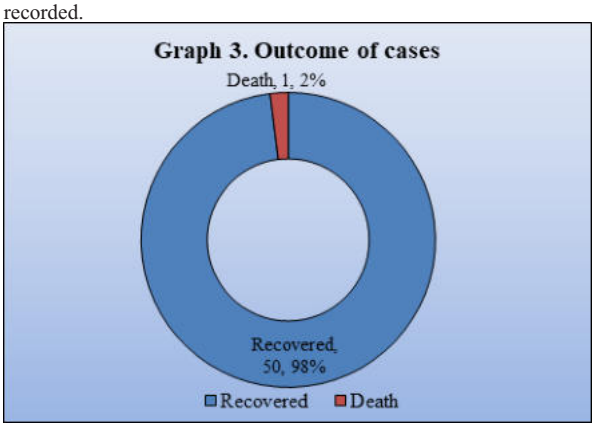
Table 5. Comparison Of Indicators Of Morbidity Between Toxic And Nontoxic Snakes

Variables	Toxic	Nontoxic	P value
N (%)	24 (47%)	27 (53%)	
Gender distribution M:F	14:10	15:12	
Age in years (mean±SD)	40.17±16.33	38.11±13.7	-0.642, 0.521
Median Home to hospital time in hours	1.5 (0.81 – 3)	1 (0.5 - 1.5)	-1.728, 0.084
Median days of admission	5 (3-6)	2 (1-2)	-5.232, 0.000
Median Severity score	2 (1.25 – 3)	1 (0-1)	-4.502, 0.000
Median no. of vials (n)	17 (10 – 21)	0	-6.527. 0.000
Prothrombin time (minutes)	12.3 (11 - 13.53)	11.8 (11 - 12.64)	-1.221, .222

There is association between snake toxicity and blood clotting time in 20 minutes as ascertained by Chi square test =14.34 (1), p=0.000.

Outcome Of Cases:

Majority of the case recovered (98.03%), while only one mortality was recorded.



Relationship Between Snake Bite Severity Score And Indicators:

Snakebite severity score corelated with number of days of admission r=0.381 (df 48), p=0.006 in all types of snake bites. There was relationship between prolongation of 20 min WBCT with number of days of admission which was ascertained using point bi-serial correlation where r=0.399, p=0.004. Partial correlation reveals that number of hospital admission days are proportional to snake bite severity score, r=0.456, p=0.001.

Respiratory system and CNS were affected in bites by toxic snakes (n=3). In cases of toxic snake bites snake bite severity score was related with number of days of admission, r=0.459 (df=21), p=0.024. In toxic snakes, the number of days of admission significantly correlated with number of ASV vials used. r=0.5, p=0.013, however but snake bite severity score is not related with number of vials p=0.069, nor the number of days of admission, p=0.184.

Snake bite severity score is an important indicator which can predict days of admission in cases of both toxic and nontoxic snake bites. In toxic snake bites number of days of admission can be estimated from no of ASV vials used.

DISCUSSION:

This study was done to know the demographical, clinical profile and predictors of severity of snake envenomation cases recorded in various health facilities in the East district of Sikkim as no similar study was done earlier in this region. Majority of patients were in age group 30-49 years and majority, the mean age in our study was 39 ±14.88. There were 58.9% were males.

The incidence of male cases (58.9%) were slightly more than the females (41.1%) in the study, with male to female ratio of 1.3:1, which may be due to the fact that males were more involved in field work, more active at night in comparison to females. **Kulkarni et al[7],** in their study had similar male to female preponderance with 433 (68.40%) male cases, while females were 200(31.60%). **Bawaskar et al[8],** had 114 males(63%) and 68 females (37%) in their studies.

Most of the cases in our study were from rural region (66.7%) while cases from urban region was 33.3%. Also, more people work in fields in the villages which predisposes them to more exposure to snakes. This finding is similar to the observation made by **Bhalla G et al[9],** where rural cases were around 78%. **Kaushik et al[10],** in their study had also found that majority were from rural region (88.46%).

As bulk of cases were farmers (25.49%), housewives (25.49%), Government employees (9.80%), students (9.80%) and others (15.68%). The study by **Pal et al[11]** recorded cases as farmers (42.31%), labourer (17.31%), Housewives (13.46), others (26.92%). Similar observation was seen in study of Arshad **Anjum et al[12]** where farmer comprised of 48.5%, housewives (26.6%), student (10.7%) and others (9.5%).

Most of the snake bite cases (56.86%) in were seen during monsoon season (June to September), summer season (March to May) witnessed (33.33%) cases. Our findings were slightly lower in comparison to findings of **Pandeya et al[13]** where (91%) of the cases was recorded between June –September, **Sarojini et al[14]** had maximum number of cases in April –July (50.3%). The monsoon and the summer season are the time for maximal agricultural activity in Sikkim and hence more exposure to the snakes during this period.

All of the 51 patients in the study were bitten outside of the house. **Pal et al[11]** had 71.15% of cases who were bitten outside the house, while **S.K. Sharma et al[15]** had 84% of cases bitten outside. In the present study more cases of snake bite were found during the daytime (78.4%). This can be due to the fact that most of the outdoor activities are carried during the daytime. 72.92% of bite was seen in daytime in study by **Laddhad et al[16].** Similar observations were made by **Pal et al.[11]**, **Chandrakumar et al[17].**

The most common site of bite in the study was lower extremity (52.95%), which included foot (37.3%) and leg (15.7%) while upper extremity bite was (47.05%) which included mainly hand (37.3). This fact suggests that interaction with the snake was merely an accidental tipping on them resulting in reflexive bite or purposeful contact during the work mostly in agricultural field which involved cutting grass, collecting wood etc., resulting in bite mostly on the exposed part of the body. Lower extremity bite (60- 80%) was also more in the study done by **Alirol et al[18].** Similarly in another study by **Krishnappa et al[19]** lower limb bites were present in 65% of the total cases.

The most common clinical manifestations found in our study was the presence of fang marks (88.24%), followed by local swelling (56.86%), pain (29.41%). **Bawaskar et al.[8]** had 72% of total cases who presented with local swelling. 20 minutes whole blood clotting test (20 WBCT) was prolonged in (25.5%) cases. These findings suggest more of the vasculotoxic nature of the snake venom than neurotoxic one in our study. The findings were quite similar to the findings of **Leon et al. [20]** and **Chandrakumar et al[17].** Two patients developed compartment syndrome and required fasciotomy.

Cases of myotoxic snake bite was not seen. **Kumar et al. [21],** in their study also had similar findings where vasculotoxic snake bite accounted for majority (61%) of the cases. While in contrary study done in rural Odhisa **by Mishra et al[22]**, 70.9% of the cases where having neurotoxicity. Similarly in the study done by **Rao et al. [23],** in Andhra Pradesh majority of the cases (59%) were of neurotoxic snake bite. Hence it will be prudent to say that snake envenomation in different regions can present with different manifestations depending upon the predominance of particular species whether vasculotoxic (Russell viper, saw scaled viper), neurotoxic (cobra, krait) or myotoxic (sea snake) in the concern regions.

Indicators Of Severity And Clinical Profile:

20-minute whole blood clotting test was found to be prolonged on admission in 17 cases (25.5%). In 2 patients, 20 minutes whole blood clotting test was initially normal but it started getting prolonged from day two which even after receiving multiple vials of ASV, remained prolonged. This might be due to the fact that polyvalent ASV which was given to the patient was not effective in neutralizing the venom of that particular species of snake responsible or it can also be due to bleeding from some other cause or due to low potency of the ASV used which needs to be further analyzed. This finding is similar to the study done by **Kaushik et al.[10],** where 20 minutes whole blood clotting test was prolonged despite giving maximum amount of polyvalent ASV as most of the cases were bitten by green pit viper whose antivenom is not present in polyvalent ASV.

Snake bite severity score was quite low in our study. Maximum victims

had score of 0-2 (84.4%) with mean of 1.59±1.48. Lower the snake bite severity score better the prognosis while higher score is associated with bad prognosis. In a study of **Padhiyar et al.** [24] improved patient had the snake bite severity score of 4.76±2.46, patient who had significant morbidity had a mean score of 8.48 ±1.75 and among those who expired it was 8.5±0.707.

None of the snake bite victims in our study had features of vomiting, renal failure disseminated intravascular coagulation, shock which are the important predictors of mortality seen in snake envenomation cases. In contrary to our study 58 patients (22.3%) had died in the study of **Patil et al.** [25], out of it 87.9% cases had vomiting, 62.5% had decreased urine output, 6.9% had altered sensorium while 82.7% had systemic bleeding. In our study mean INR was 1.09±0.198 while mean prothromin time was 12.18±1.30.

Indicators Which May Have Reduced Morbidity And Mortality:

Majority of cases (88.2%) in the study had received first aid before coming to the hospital while only 11.8% did not receive first aid. These findings are contrast to findings of **Vaiyapuri et al.** [26] where 64.3% of the cases did not receive first aid in any form. First aid used in the field in the present study was mainly in form of tourniquet, arm sling, while some had used homemade remedy like turmeric paste. In cases of referral first dose of ASV and injection Tetanus Toxoid was received by the patients. The only recommended first aid method in the field as per WHO[27] is Do it R.I.G.H.T, which is reassurance, immobilization, get to hospital and tell the doctor of your symptoms.

As there was only one mortality in this study, we could not assess statistically significant predictors of mortality. Low mortality could be due to low toxicity of the venom of snake in the region, bite mainly by non-venomous snake, or more importantly the quick transport of victim to the hospital. As in our study most of the victim (74.5%) were brought to hospital within 2 hours, with mean of 1.8±1.88 hours, appropriate treatment could be started early. Similar findings were seen in study by **Menon et al**[28]. The study by **SK Sharma et al**[15] in Nepal had a similar observation, there was a decrease in the Case fatality rate when victims were quickly brought to the hospital.

Early use of ASV is a very important factor in reducing the mortality and morbidity due to snake envenomation. As in our study most of the patient reached the hospital within 2 hours, ASV was instituted early which resulted in better outcome. In the study conducted by **Patil et al.** [25] early initiation of ASV was found to be more useful in reducing the morbidity and mortality. Similarly, **Inamdar et al**[29]**.** found initiation of treatment within six hours was associated with lower mortality (4.4%) in comparison to the mortality rate of 8.4% when treatment was initiated after six hours.

CONCLUSION:

Snake bite envenomation in East Sikkim predominantly affects rural agricultural workers during monsoon season, with vasculotoxic manifestations being most common. The study demonstrates that early hospital presentation within two hours, prompt ASV administration, and appropriate first aid significantly contribute to favorable outcomes, as evidenced by low mortality (1.96%) and minimal severe complications. Non-toxic snake bites constitute 52.9% of cases, while toxic envenomations are primarily vasculotoxic (41.2%) with rare neurotoxic presentations (5.9%).

Snake bite severity score correlates strongly with duration of hospital admission and serves as a reliable prognostic indicator for clinical management. Community-based awareness programs emphasizing early hospital presentation and appropriate first aid techniques should be implemented across rural East Sikkim. Healthcare workers at primary health centers require training in snake bite management protocols, including proper ASV administration and severity score assessment.

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