ORIGINAL RESEARCH ARTICLE

Predictors of Antivenom Administration and Dose Requirement among Snakebite Patients: A Prospective Observational Study from a Tertiary Government Hospital in Tamil Nadu, India

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ABSTRACT

Background: Snakebite envenoming is a neglected tropical disease-causing significant mortality and morbidity globally. Considerable variability exists in antivenom administration practices. This study aimed to identify predictors of anti-snake venom (ASV) administration and dose requirements among snakebite patients.

Methods: A prospective observational study was conducted at a tertiary government hospital in Tirunelveli, Tamil Nadu, over two months (October–November 2022). A total of 139 patients admitted to intensive care units with snakebite history were enrolled using consecutive sampling. Bivariate and multivariate logistic and linear regression analyses were performed to identify predictors of ASV use and dosing.

Results: ASV was administered to 82 (58.9%) patients. Snake identification (AOR=4.95; p=0.007) and pain at bite site (AOR=2.81; p=0.017) were independent predictors of ASV administration. Bleeding at the bite site (β=0.592; p=0.021), lymphadenopathy (β=0.544; p=0.037), and neurotoxic envenomation (β=-0.861; p=0.005) were significant predictors of higher ASV dose requirements. Mortality was nil and adverse reactions were mild (9.7%).

Conclusion: Snake identification and pain at bite site predict ASV administration, while bleeding, lymphadenopathy, and envenomation type determine dose requirements, enabling rational, protocol-driven antivenom use.

Keywords: Snake bites, Antivenins, Envenomation, Venom, Tropical medicine, Neglected Diseases

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Introduction

Snakebite is an acute, life-threatening, time-limited medical emergency. It is a preventable public health issue that occurs in tropical and subtropical nations during times of excessive rainfall and humid weather.[1] Approximately 4.5-5.4 million snake bites are recorded globally every year of which 1.8-2.7 million accounting to snake envenoming, 81000 to 138000 deaths and triple the number of amputation and permanent disabilities.[2] Snake bite envenoming was officially classified as a neglected tropical disease by the World Health Organization in June 2017, highlighting its substantial global burden and the need for improved prevention, treatment, and resource allocation.[2] The South East Asia (SEA) region comprising of Bangladesh, India, Nepal, Pakistan, and Sri Lanka together constitute nearly 70% of global snakebite mortality.[3] It is estimated that 58,000 deaths occur of an estimated 3-4 million snakebites annually in India which accounts for half of all snakebite deaths globally.[4] In Tamil Nadu, snakebite remains a pressing health issue with a prevalence of 36.4 in 100,000 population. Despite relatively low mortality rates (0.91-1.24 per 100,000), the burden persists underscoring the need for better surveillance.[5] The state has snakebite a notifiable disease, mandating all hospitals to report cases and deaths. This decision reflects ongoing underreporting, the potential for preventable mortality, and the need for evidence-based treatment protocols in both urban and rural settings. [6]

Anti snake venom (ASV) is the only specific way to prevent or treat manifestations of venomous snake bites when administered in adequate therapeutic dose. In 2022, the initiative "National action plan for prevention and control of snakebite envenoming (NAPSE)", a strategic approach to reduce the mortality and morbidity due to snakebite envenoming was launched by Centre for One Health, Government of India. It details the recommendations of ASV administration for use by medical officers.[4] Despite its critical role, considerable variability persists in clinical practice regarding both the decision and the dose to be administered.[7] These inconsistencies in ASV administration and dosing may result in either overtreatment with increased risk of adverse reactions and resource wastage or undertreatment leading to poor clinical outcomes and increased morbidity.[8] There is therefore a need for systematic evaluation of predictors of ASV use to improve evidence-based management of snakebite cases. The present study aimed to identify predictors of ASV administration and to determine the factors influencing the total ASV dose required.

Methodology

Study Design and Setting: This prospective observational study was conducted by Department of Pharmacology at Government Medical college and Hospital in Tirunelveli District of Tamil Nadu, India. Data collection was done over a period of 2 months during October and November 2022.

Sample size and Sampling: All patients admitted in Intensive Medical Care Unit (IMCU) and Paediatric Intensive Care unit (PICU) with a history of snake bite with or without objective signs or symptoms of envenomation were included in the study. The study excluded the patients with preexisting systemic illness (diabetes, hypertension, hepatic, renal, cardiac, etc.), declined consent or left the hospital against medical advice. Systemic illnesses could influence clinical presentation, lab parameters and treatment response thereby affecting the accuracy of identifying the predictors pertaining only to snake bite envenomation. A total of 139 eligible patients admitted during the study period were included using a consecutive sampling technique. The sample size was based on all cases meeting the inclusion and exclusion criteria within the defined timeframe, thereby reflecting a real-world clinical scenario.

Data collection and Tools: All patients underwent a detailed history, physical and laboratory workup. Patients were observed from the time they were admitted until they were discharged from the hospital. Data collected included a detailed history (pertaining to identification of snake, location of the bite, time of bite, application of Tourniquet, local remedies such as incising the bite wound, sucking venom from bite site or applying herbs, time to reach the hospital, treatment and referral history) and clinical examination. Identity of biting snake was assessed by reliable history from victims, bystanders and signs of local and systemic envenomation as hemotoxic or neurotoxic.[9] Local envenomation includes pain at the bite site, often immediate and severe, bleeding from the fang marks, rapidly progressive swelling across a joint pain, redness (erythema), warmth, ecchymosis, blistering and local tissue necrosis in the absence of Tourniquet. Systemic envenomation includes evidence of coagulopathy primarily detected by prolonged 20-minute whole blood clotting time or presence of clinical bleeding such as haemoptysis, GI bleed, haematuria or evidence of neurotoxicity such as presence of ptosis, ophthalmoplegia, neck holding weakness, respiratory or limb paralysis.[10] Patients with envenomation were initiated on polyvalent ASV in recommended dose according to standard treatment guidelines.[1] Patients were observed for emergence of any complications and treated accordingly. Patients were checked after receiving the initial dose of ASV and then every 6 hours, or more frequently until they were completely asymptomatic.

Data analysis: Data were expressed as number (percentage) for categorical variables and mean ± standard deviation (SD) for continuous variables, as appropriate. Statistical analyses were performed using Jamovi version 2.7 for Windows. Descriptive statistics were used to summarize the epidemiological and clinical characteristics of the study population. Bivariate analysis (Chi square and Independent T test)

was done to determine the association between ASV administration and dose with other variables of interest. Variables that showed statistical significance (p-value <0.05) in the bivariate analysis were included in the multivariate logistic and linear regression to account for potential confounders. Assumptions of linear regression, including linearity, normality of residuals, homoscedasticity, and multicollinearity were checked before model fitting. Odds ratio, Adjusted Odds ratio, Standardized beta coefficients (β), 95% Cis and p-values were reported.

Ethical considerations: The study was approved by the Tirunelveli Medical College Institutional Ethics Committee (TIREC-Ref no: 20222396, dated 28-09-2022) before the commencement. The study procedures were followed in accordance with the Declaration of Helsinki and the National Ethical Guidelines for Biomedical and Health Research involving Human Participants by the Indian Council of Medical Research (ICMR). Written informed consent was obtained from all the study participants, and confidentiality was maintained.

RESULTS

A total of 139 snake bite cases presented to our hospital during the study period. They were analyzed as follows.

Table 1: Epidemiological profile of the patients with snake bite

Parameters	Cases (%)
Age	
0-16 years	14 (10)
17 - 30 years	25 (17.9)
31-45 yrs	42 (30.2)
above 45 yrs	58 (41.7)
Gender	
Male	83 (59.7)
Female	56 (40.3)
Time of bite	
Early morning (4.01 AM to 7 AM)	19 (13.6)
Daytime (7.01 AM to 5 PM)	80 (57.5)
Evening (5.01 PM to 8 PM)	11 (7.9)
Nighttime (8.01 PM to 4 AM)	18 (12.9)
Not sure	11 (7.9)
Time of onset of treatment in IMCU	
<1 hour	36 (25.8)
1 - <3 hour	52 (37.4)
3 - 6 hours	35 (25.1)
> 6 hours	16 (11.5)
Traditional therapies	
Herbal application	34 (24.4)
Urinating on the bite	6 (4.3)
Incising the bite wound	4 (2.8)
Suction at bite site	3 (2.1)
Nil	103 (74.1)
Tourniquet Application	
Yes	70 (50.3)
No	69 (49.6)

Table 1 details the epidemiological characteristics of patients. The mean age of the subjects was 41.95 ± 17.4, with the majority (41.7%) being above 45 and 30.2% falling between 31 and 45 yrs. Males (59.7%) were more likely than females (40.3%) to have sustained snakebite. The majority of patients in our study (57.5%) suffered bites in the day time. Almost 63.3% arrived at the IMCU within 3 hours for treatment. Approximately 74.1% did not receive any traditional therapies. Among those who received traditional therapy, the most frequent method employed was applying herbs to bite site (72.3%). Tourniquet was applied in 50.3% of cases.

Table 2: Clinical profile of the patients with snake bite

Parameters	Cases (%)
Site of bite	
Lower limb	92 (66.1)
Upper limb	39 (28)
Head and neck	1 (0.7)
Not sure	7 (5)
Side of bite	
Right side	80 (57.5)
Left side	51 (36.6)
Not applicable	8 (5.7)
Local symptoms	
Local bleeding	60 (43.1)
Pain at the site of bite	85 (61.1)
Local swelling	54 (38.8)
Local signs	
Local rise of temperature	13 (9.3)
Discolouration	3 (2.1)
Tenderness	64 (46)
Blister	3 (2.1)
Lymphadenopathy	24 (17.2)
Cellulitis	38 (27.3)
Systemic symptoms	
Hematological	12 (8.6)
Hematuria	6 (50)
GI bleed	1 (8.3)
Hemoptysis	5 (41.6)
Neurological	13 (9.3)
Ptosis	11 (84.6)
Ophthalmoplegia	5 (38.4)
Respiratory paralysis	10 (76.9)
Loss of consciousness	6 (46.1)
Neck holding weakness	3 (23)
Limb paralysis	1 (7.6)
Complications	
Acute kidney injury requiring dialysis	3 (2.1)
Fasciotomy	1 (0.7)
Necrotic patch	1 (0.7)
Hematoma	2 (1.4)
Identity of snake	
Hemotoxic	53 (38.1)
Neurotoxic	13 (9.3)
Not made out	73 (52.5)
Total ASV dose	
1-10 vials	51 (36.6)
11-20 vials	14 (10)
> 20 vials	17 (12.2)
Not given	57 (41)
Reactions to ASV (n = 82)	
Mild	8 (9.7)
Nil	74 (90.2)

Table 2 summarises the clinical features of snake bite cases. The lower limb was the most common site of snakebite, accounting for 66.1% of cases. Identity of biting snake was made out in 47.4% cases. The most common symptom was pain at the bite site (61.1%) and tenderness was the commonest local sign (46.0 %) in the study population. Bleeding from other sites such as haematuria, GI bleed, haemoptysis was seen in 8.6% of patients. Neurological manifestation was observed in 9.3% of cases. Ptosis was present in 11 out of 13 (84.6%) patients who had any signs suggestive of neuro-paralysis. Complications were reported in 5.0% cases. Mortality was nil. Adverse drug reactions to ASV were mild in the form rigor, chills, vomiting and pruritus. These patients were managed with inj. Dexamethasone and Inj. Chlorpheniramine maleate and ASV was restarted.

Based on the clinical features, 82 (58.9%) patients were treated with anti-snake venom (ASV) and the remaining 57 (41.0%) patients were managed on supportive and conservative therapy. Table 3 and 4 depicts the bivariate and multivariate logistic regression regarding the predictors of ASV administration. On multivariate logistic regression analysis, identification of the snake (AOR = 4.95; 95% CI: 1.56-15.74; p = 0.007) and pain at the bite site (AOR = 2.81; 95% CI: 1.20-6.59; p = 0.017) were independently associated with increased odds of ASV administration. Patients in whom the snake was identified had nearly five times higher odds of receiving ASV, while those presenting with pain had approximately three times higher odds. In contrast, tourniquet application, bleeding from the bite site, and cellulitis were not independently associated with ASV administration after adjustment (p > 0.05). ASV recipients had significantly higher mean prothrombin time (PT) compared to non-recipients (19.61 ± 4.29 vs 16.36 ± 2.73; p = 0.001). [Table 5]

Table 3: Predictors of ASV administration in patients with snake bite

Predictors	ASV recipients (n = 82) (%)	ASV non recipients (n = 57) (%)	Odds ratio (95% CI)	P value
Sex – Male (Ref Female)	47 (57.3)	36 (63.1)	0.783 (0.391 - 1.57)	0.49
Site of bite (n = 132)				
Above waist	28 (35.8)	12 (22.2)	1.96 (0.889 - 4.32)	0.09
Below waist	50 (64.1)	42 (77.7)	Ref	
Tourniquet applied@	47 (57.3)	22 (38.5)	2.14 (1.07 - 4.26)	0.03*
Traditional therapies@	23 (28.0)	13 (22.8)	1.32 (0.602 - 2.89)	0.48
Identity of snake identified@	56 (68.2)	10 (17.5)	10.1 (4.43 - 23.1)	< 0.001*
Pain at bite site@	63 (76.8)	22 (38.5)	5.28 (2.52 - 11.1)	< 0.001*
Bleeding from site@	43 (52.4)	17 (29.8)	2.59 (1.27 - 5.30)	0.008*
Cellulitis@	34 (41.4)	4 (7.0)	9.39 (3.10 - 28.4)	< 0.001*
Bite to needle time ≤3 hrs@	49 (59.7)	36 (63.1)	0.866 (0.432 - 1.74)	0.68
Day Time of bite (n = 128)				
Day time	53 (72.6)	42 (76.3)	0.820 (0.366 - 1.84)	0.63
Night time	20 (27.3)	13 (23.6)		

*Statistically significant at p value < 0.05
@Ref category - negative reply

Table 4: Multivariate logistic regression analysis of Predictors of ASV administration

Predictor	P value	Adjusted Odds Ratio	95% Confidence Interval
Tourniquet applied	0.599	0.783	0.315 - 1.949
Identity of snake	0.007*	4.947	1.555 - 15.743
Pain at bite site	0.017*	2.811	1.199 - 6.590
Bleeding from site	0.240	1.665	0.711 - 3.899
Cellulitis	0.220	2.420	0.590 - 9.926

*Statistically significant at p value < 0.05

Table 5: ASV usage and coagulation profile in patients with snake bite

Parameters	ASV recipients (n = 82) (mean & SD)	ASV non recipients (n = 57) (mean & SD)	P value
Activated Partial Thromboplastin time (APTT)	28.6±5.54	26.1±5.24	0.07
Prothrombin time (PT)	19.61±4.29	16.36±2.73	0.001*
International Normalized Ratio (INR)	1.5±0.4	1.3±0.35	0.25

*Statistically significant at p value < 0.05 in independent sample T test

Predictors of ASV dose requirements: Table 6 and 7 depicts the bivariate and multivariate linear regression regarding the predictors of ASV dose requirements. The overall regression model was statistically significant, F (5, 50) = 5.52, p < .001, explaining 35.6% of the variance in ASV vial requirement (R^2 = .36, Adjusted R^2 = .29). Consequently, bleeding from the bite site (β = 0.592; p = 0.021) and lymphadenopathy (β = 0.544; p = 0.037) were significant independent predictors of increased ASV dose re-

quirement, showing a positive association with the number of vials administered. Type of envenomation was also a significant predictor (β = -0.861; p = 0.005), demonstrating a negative association, indicating that hemotoxic envenomation required significantly fewer vials compared to the neurotoxic group. In contrast, pain at the bite site and cellulitis were not independently associated with ASV dose requirement after adjusting for other variables (p > 0.05).

Table 6: Predictors of ASV dose requirements in patients with snake bite

Predictors	Frequency (n = 82) (%)	Mean ± SD of ASV vials used	P value
Age			
≤ 30 yrs	22 (26.8)	16.7 ± 8.36	0.50
> 30 yrs	60 (73.1)	15.3 ± 8.96	
Sex			
Female	35 (42.6)	14.2 ± 7.52	0.191
Male	47 (57.3)	16.7 ± 9.55	
Site of bite (n = 78)			
Above waist	28 (35.8)	18.3 ± 9.8	0.05*
Below waist	50 (64.1)	14.2 ± 7.90	
Tourniquet application			
Yes	47 (57.3)	16.1 ± 8.89	0.6
No	35 (42.6)	15.1 ± 8.73	
Pain at bite site			
Yes	63 (76.8)	17 ± 9.21	0.011*
No	19 (23.1)	11.2 ± 5.28	
Cellulitis			
Yes	34 (41.4)	17.9 ± 9.35	0.05*
No	48 (58.5)	14.1 ± 8.09	
Bleeding at the bite site			
Yes	43 (52.4)	18.2 ± 9.81	0.006*
No	39 (47.5)	12.9 ± 6.55	
Lymphadenopathy			
Yes	23 (28.0)	20.81 ± 11.11	0.001*
No	59 (71.9)	6.80 ± 8.23	
Type of envenomation (n=66)			
Haemotoxic	54 (81.8)	16.3 ± 9.06	0.041*
Neurotoxic	12 (18.1)	22.5 ± 9.65	
Bite to needle time ≤3 hrs			
Yes	49 (59.7)	14.5 ± 7.49	0.155
No	33 (40.2)	17.3 ± 10.3	
Adverse drug reactions			
Yes	8 (9.7)	15.3 ± 9.13	0.89
No	74 (90.2)	15.7 ± 8.81	

*Statistically significant at p value <0.05 in independent sample T test

Table 7: Multivariate linear regression analysis of Predictors of ASV dose requirements

Predictor	t value	P value	Stand. Estimate (β)	95% Confidence interval
Pain at bite site	1.20	0.237	0.383	-0.2598 - 1.027
Bleeding from bite site	2.39	0.021*	0.592	0.0937 - 1.091
Cellulitis	1.26	0.214	0.305	-0.1816 - 0.792
Lymphadenopathy	2.14	0.037*	0.544	0.0335 - 1.055
Type of envenomation	-2.97	0.005*	-0.861	-1.4425 - -0.279

*Statistically significant at p value <0.05

DISCUSSION

Our study comprised 139 snake bites, both with and without evidence of envenomation regardless of snake species. Our research revealed a male preponderance working as farmers, which is consistent with findings observed by Pradhan J et al[11] and Patil A & Patil LS[12]. Males are more likely to be bitten by snakes than females since they engage in more outdoor agricultural activities. The mean age of the study population was 41.95±17.46 years and this was comparable to the study findings of Mandal A et al[13] (40.06 ± 15.24 years) whereas the mean age was slightly less in Chandrakumar A et al[14] (36.86 ± 17.99 years). These observations indicate that snakebite predominantly affects individuals in the economically productive age group. Majority of bites happened during the day which was concordant with study by Bhelkar SM et al[15] and discordant with study by Pradhan J et al.[11] The majority of bites occurred in the lower extremities, with right foot being the most prevalent site. This was concordant with similar oth-

er study.[16] This could be attributed to the prevalence of barefoot walking in agricultural lands.[17] All of this corresponded to snake bites being an occupational hazard for farmers and a serious public health issue. Hence this study assumes significance.

Nearly 50% of the patients had applied Tourniquet s adjacent to bite sites in our study which was quite alarming when compared to studies by Chilakala P et al[18] and Patil A & Patil LS[12] where only 34.6% and 10.1% reported with Tourniquet indicating a regional pattern of harmful practices. Recently, a meta-analysis reviewed that the use of Tourniquet were the highest in Asia (55.7%).[19] But, in multivariate analysis, there was no association between Tourniquet use and ASV administration and dosing. Targeted community education programs should be done to discourage Tourniquet use which when applied inappropriately can worsen tissue damage and to promote evidence based first aid practices.[1,10]

The proportion of patients who reached IMCU in less than 3 hours was 72%. Thus, early arrival to point of care would have played a crucial role in contributing to nil mortality. Also, ASV requirements did not differ in patients with treatment time difference. This finding was in concordance with a study conducted by Patel S et al[20] which indicated that a positive prognosis in ASV treated patients were related only to bite severity at presentation and not the treatment time. In contrast, a study by Jayaraman T et al[21] and Narvencar KP et al[22] found that the number of ASV needed significantly correlated with the bite to needle time, with a 6-hour cutoff period.

Most bites in our study were instigated by venomous snakes with hemotoxic envenomation predominating (54%), which may explain the greater incidence of local complications such as bleeding and pain at the bite site, cellulitis, and lymphadenopathy. This was similar to a study by Biju AP et al.[23] Multivariate analysis showed that lymphadenopathy and bleeding are independent risk factors for ASV dosing rather than cellulitis. Thus, ASV use is driven by progressive clinical features rather than local symptoms. ASV recipients had significantly higher PT levels than the non-recipients reflecting coagulopathy in patients requiring ASV. Research by Kolli B et al[24] found a statistically significant correlation between prolonged PT with severity among snake bite patients but study by Moriarty RS et al[25] failed to find a significant difference in the number of vials administered and observed PT.

In our study, approximately 47% of patients were able to tell the identity of snakes and knew their local names. This, could have prompted them to seek medical assistance immediately. This was further substantiated by multivariate regression analysis which showed that identification of snake was independent predictor for ASV use. In a study by Bolon I et al[26] concluded that biting snake identification could enhance snakebite management. Out of the 82 patients in our study who received ASV, about 51 (62%) required only 10 vials indicating adequacy of standard initial dosing.

The mean number of ASV vials required for neurotoxic bite was statistically significant than hemotoxic bites. Higher dose of ASV requirements in neurotoxic bites has been reported in other studies as well.[27,28] ASV may not adequately neutralize presynaptic toxicity, which is rather dependent on the regeneration of motor nerve terminals, resulting in insufficient recovery and greater dose requirements. Venoms of snakes from the Elapidae family consist of small low molecular weight toxins with greater diffusivity and neutralisation by antivenom administered during the post distributive phase is dependent on redistribution of tissue bound antigen from the extravascular space to central compartment resulting in varying ASV doses.[29]

Our study found a low incidence (approximately 10%) of mild adverse reactions to ASV, indicating that it should not be a major concern for treating snake bites. The most common reactions were urticaria, chills and rigors which resolved with antihistamines and corticosteroids. The severity of reactions was mild and occurred within in 10 - 180 mins of initiating ASV which was similar with the study done by Mer RJ et al.[30] Antivenom reactions happened in vasculotoxic snake bite cases in similar proportions to the study by Deshpande RP et al.[31]

Limitations

The major limitation is small sample size. Patients were enrolled without proper sample size estimation. The study was conducted only for a short period. Patients with comorbidities were excluded from the study leading to potential selection bias. All these can affect the generalisability of the study results. Identification of snake was based on patient or bystander reports introducing potential recall bias. Finally, the use of linear regression for count-type outcomes may not fully account for the actual ASV vial requirements.

Conclusion

In conclusion, identification of biting snake and presence of pain at bite site were the independent predictors of ASV administration while lymphadenopathy, bleeding at the bite site, and type of envenomation were key determinants of the total ASV dose required. These findings emphasize that early identification of clinical predictors and species identification can guide rational and protocol-based ASV use, particularly in resource-limited settings and optimize patient outcomes.

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Availability of Data: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Non-use of Generative AI Tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

References

1. National Health Mission, Ministry of Health and Family Welfare, Government of India. Management of snake bite: full background document. New Delhi: NHM; 2016. Available from: https://nhm.gov.in/images/pdf/guidelines/nrhm-guidelines/stg/Snakebite_Full.pdf [Accessed on 2025 Oct 10]
2. World Health Organization. Snakebite envenoming [Internet]. Geneva: WHO; 2023 Sep 12 [cited 2025 Nov 12]. Available from: https://www.who.int/news-room/fact-sheets/detail/snakebite-envenoming
3. Ralph R, Sharma SK, Faiz MA, Ribeiro I, Rijal S, Chappuis F, Kuch U. The timing is right to end snakebite deaths in South Asia. BMJ. 2019 Jan 22;364:k5317. DOI: https://doi.org/10.1136/bmj.k5317 PMid:30670457 PMCid:PMC6340368
4. Centre for One Health, National Centre for Disease Control, Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India. National Action Plan for the Prevention and Control of Snakebite Envenoming (NAPSE) [Internet]. New Delhi: Government of India; 2024 [cited 2025 Nov 12]. Available from: https://ncdc.mohfw.gov.in/wp-content/uploads/2024/07/NATIONAL-ACTION-PLAN-FOR-PREVENTION-AND-CONTROL-OF-SNAKEBITE-ENVENOMING-NAPSE.pdf
5. Salve PS, Vatavati S, Hallad J. Clustering the envenoming of snakebite in India: the district level analysis using Health Management Information System data. Clinical epidemiology and global health. 2020 Sep 1;8(3):733-738. DOI: https://doi.org/10.1016/j.cegh.2020.01.011
6. National Health Mission, Tamil Nadu. Integrated Disease Surveillance Programme (IDSP): Annual report on snakebite envenomation. Chennai: State Surveillance Unit; 2024.
7. Ojha A, Hadimani P, Anthony D, Raj V, Bhasker S, Mishra M, Johri S. Optimizing Anti-Snake Venom Strategies for Hemotoxic Envenomation in Northern India: Clinical Outcomes and Regional Challenge. Cureus. 2025 May 14;17(5):e84090. DOI: https://doi.org/10.7759/cureus.84090 PMID: 40519476 PMCID: PMC12164467
8. Pore SM, Ramanand SJ, Patil PT, Gore AD, Pawar MP, Gaidhankar SL, et al. A retrospective study of use of polyvalent anti-snake venom and risk factors for mortality from snake bite in a tertiary care setting. Indian J Pharmacol. 2015 May-Jun;47(3):270-274. DOI: https://doi.org/10.4103/0253-7613.157117 PMid:26069363 PMCid:PMC4450551
9. Saravu K, Somavarapu V, Shastry AB, Kumar R. Clinical profile, species-specific severity grading, and outcome determinants of snake envenomation: An Indian tertiary care hospital-based prospective study. Indian J Crit Care Med. 2012 Oct;16(4):187-192. DOI: https://doi.org/10.4103/0972-5229.106499 PMid:23559724 PMCid:PMC3610449
10. World Health Organization, Regional Office for South-East Asia. Guidelines for the management of snake-bites. 2nd ed [Internet]. New Delhi: WHO Regional Office for South-East Asia; 2016 [cited 2025 Dec 12]. Available from: https://www.who.int/publications/i/item/9789290225300
11. Pradhan J, Majhi C, Pradhan S. A study on the clinical profile and complications of snake bite among patients at a tertiary care centre in western Odisha. Medical Journal of Dr. DY Patil University. 2023 Mar 1;16(2):151-154. DOI: https://doi.org/10.4103/mjdrdypu.mjdrdypu_422_21
12. Patil A, Patil LS. A study to assess the clinical profile of patients with snake bites in a tertiary care hospital. MedPulse International Journal of Medicine. September 2021;19(3):96-99. DOI: https://doi.org/10.26611/10211933
13. Mandal A, Chakraborty M, Iyyadurai R, Gunasekaran K. Clinical Profile, Outcome, and Cost of Care in Snakebite Patients Requiring Admissions in a Single Medical Unit: A Retrospective Study from a Tertiary Care Center in South India. Archives of Medicine and Health Sciences. 2023;11(2):190-193. DOI: https://doi.org/10.4103/amhs.amhs_51_23
14. Chandrakumar A, Suriyaprakash TN, Mohan PL, Thomas L, Vikas PV. Evaluation of demographic and clinical profile of snakebite casualties presented at a tertiary care hospital in Kerala. Clinical Epidemiology and Global Health. 2016 Sep 1;4(3):140-145. DOI: https://doi.org/10.1016/j.cegh.2015.12.003
15. Bhelkar SM, Chilkar SD, Morey SM. Study of snake bite cases admitted in tertiary care hospital in Nagpur. Int J Community Med Public Health. 2017 May;4(5):1597-1602. DOI: https://doi.org/10.18203/2394-6040.ijcmph20171770
16. Satyanarayan B, Panda SK, Sunder A, Kumari S. Clinical and epidemiological profile of snakebite cases - A study from an industrial teaching hospital at Jamshedpur, Jharkhand, India. J Family Med Prim Care. 2022 Dec;11(12):7652-7656. DOI: https://doi.org/10.4103/jfmpc.jfmpc_890_22 PMid:36994007 PMCid:PMC10041039
17. Oktay MM, Al B, Zengin S, Gümüşboğa H, Boğan M, Sabak M, Can B, Özdemir N, Eren ŞH, Yıldırım C. Snakebites on Distal Extremities; Three Years of Experiences. Zahedan Journal of Research in Medical Sciences. 2022 Jan 1;24(24):e123972. DOI: https://doi.org/10.5812/zjrms-112107
18. Chilakala P, Sivapackiam M, Karmegam G, Janani J. A study on the clinico-epidemiological profile of snake bite cases in an emergency department of a tertiary care hospital in Chennai. Int J Acad Med Pharm. 2023;5(4):318-323.
19. 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: https://doi.org/10.1016/j.toxicon.2023.107582 PMid:38128838
20. Patel S, Patel A, Ganjiwale J, Patel D, Nimbalkar S. The study of clinical profile and outcome of patients with snakebite in a rural community. J Family Med Prim Care. 2021 Apr;10(4):1661-1665. DOI: https://doi.org/10.4103/jfmpc.jfmpc_1976_20 PMid:34123909 PMCid:PMC8144800
21. Jayaraman T, Dhanasinghu R, Kuppusamy S, Gaur A, Sakthivadivel V. Bite-to-needle Time - An Extrapolative Indicator of Repercussion in Patients with Snakebite. Indian J Crit Care Med. 2022 Nov;26(11):1175-1178. DOI: https://doi.org/10.5005/jp-journals-10071-24344 PMid:36873588 PMCid:PMC9983646
22. Narvencar KP, Favas TT, Dias A. Predictors of complications in venomous snakebites. Indian J Med Sci 2022;74:86-92. DOI: https://doi.org/10.25259/IJMS_328_2021
23. Biju AP, Krishnan J. Clinical and laboratory profile of snake bite envenomation: a crosssectional observational study at a tertiary care center. J. Evid. Based Med. Healthc.

2018;5(40):2860-2864. DOI: https://doi.org/10.18410/jebmh/2018/585

24. Kolli B, R M Shinde. Study the role of coagulation markers to evaluate the morbidity and mortality of snake bite victims. MedPulse International Journal of Pathology. 2023;27(3):1-5.
25. Moriarity RS, Dryer S, Replogle W, Summers RL. The role for coagulation markers in mild snakebite envenomations. West J Emerg Med. 2012 Feb;13(1):68-74. DOI: https://doi.org/10.5811/westjem.2011.6.6729 PMid:22461925 PMCid:PMC3298204
26. Bolon I, Durso AM, Botero Mesa S, Ray N, Alcoba G, Chappuis F, et al. Identifying the snake: First scoping review on practices of communities and healthcare providers confronted with snakebite across the world. PLoS One. 2020 Mar 5;15(3):e0229989. DOI: https://doi.org/10.1371/journal.pone.0229989 PMid:32134964 PMCid:PMC7058330
27. Kavitha S, Nalini GK, Sahana GN. Evaluation of optimum dose of anti-snake venom required and its outcome based on severity of envenomation in snakebite case. Asian Journal of Medical Sciences. 2024 Mar 1;15(3):201-206. DOI: https://doi.org/10.3126/ajms.v15i3.60323
28. Panwar S, Dang A. A retrospective analysis of snake envenomation in the intensive care unit of a tertiary care hospital in Delhi. Journal of Acute Disease. 2019 Jul 1;8(4):165-169. DOI: https://doi.org/10.4103/2221-6189.263710
29. Gamulin E, Mateljak Lukačević S, Halassy B, Kurtović T. Snake Antivenoms-Toward Better Understanding of the Administration Route. Toxins (Basel). 2023 Jun 15;15(6):398. DOI: https://doi.org/10.3390/toxins15060398 PMid:37368699 PMCid:PMC10302821
30. Mer RJ, Kakasaniya GG, Mehta DS. Anaphylactic Reactions After Administration of Anti Snake Venom for Envenomation: A Case Series. International Journal of Pharmaceutical and Clinical Research. 2023Oct30;15(10):503-506.
31. Deshpande RP, Motghare VM, Padwal SL, Pore RR, Bhamare CG, Deshmukh VS, Pise HN. Adverse drug reaction profile of anti-snake venom in a rural tertiary care teaching hospital. J Young Pharm. 2013 Jun;5(2):41-45. DOI: https://doi.org/10.1016/j.jyp.2013.02.003 PMid:24396245 PMCid:PMC3828666