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CLINICAL PROFILE, MANAGEMENT, AND OUTCOMES OF SNAKE ENVENOMATION IN PATIENTS PRESENTING TO A TERTIARY CARE HOSPITAL IN NORTHERN MAHARASHTRA: A PROSPECTIVE OBSERVATIONAL STUDY

Emergency Medicine

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ABSTRACT

Background: Snakebite envenomation is a major neglected tropical disease and an important public health problem in India, contributing significantly to preventable morbidity and mortality. This study evaluated the clinical profile, management, and outcomes of snakebite envenomation in a tertiary care hospital. **Methods:** A prospective observational study was conducted among 165 patients with snakebite envenomation presenting to the Emergency Department of a tertiary care teaching hospital in North Maharashtra. Demographic details, clinical features, laboratory findings, treatment, complications, and outcomes were recorded using a structured case record form and analysed using descriptive and inferential statistics. **Results:** Most patients were young adult males from rural areas, with bites occurring predominantly during the monsoon season and involving the lower limbs. Viper bites were the most common. Local pain and swelling were the predominant manifestations, while coagulopathy, neuroparalysis, acute kidney injury, and cellulitis were the major complications. Most patients received polyvalent anti-snake venom, and a smaller proportion required ventilatory support, blood transfusion, or renal replacement therapy. Early hospital presentation and timely anti-snake venom administration were associated with favourable outcomes, with recovery in most patients and mortality limited to severe systemic envenomation. **Conclusion:** Early recognition, prompt anti-snake venom administration, aggressive supportive care, and timely referral improve outcomes. Public awareness regarding early hospital presentation and avoidance of harmful first-aid practices is essential to reduce snakebite-related morbidity and mortality.

KEYWORDS

Snakebite, Snake Envenomation, Anti-snake Venom, Emergency Medicine, Clinical Profile, Outcome.

INTRODUCTION

The threat of snake envenomation remains one of the most significant and neglected public health concerns globally, particularly in tropical and subtropical regions. Despite advancements in healthcare infrastructure and antivenin therapy, snakebite envenomation continues to be a major cause of morbidity and mortality worldwide. [1,2] The World Health Organization (WHO) has officially known snakebite as a neglected tropical disease, emphasizing the need for increased awareness, data collection and improved accessibility to treatment.[3]

Globally, snakebites are estimated to affect nearly 5.4 million people each year, leading to between 81,000 and 138,000 deaths and leaving approximately 400,000 survivors with permanent disabilities such as amputations, blindness, chronic pain, and psychological sequelae. The highest burden of snake envenomation is observed in South Asia, sub-Saharan Africa, and Southeast Asia. India alone accounts for nearly 50% of global snakebite deaths, with an estimated 58,000 fatalities annually most of which occur in rural areas where immediate medical care is often inaccessible or delayed. [3,4]

The epidemiology of snake envenomation is heavily influenced by environmental, occupational, and socioeconomic factors.[5] Agricultural workers, gardeners, children playing in fields, and individuals residing in rural or semi-urban areas are at the highest risk. Seasonal variations also play a critical role in determining incidence rates, with peaks commonly occurring during monsoon and harvesting seasons due to increased human-snake encounters. [5,6]

The situation is further poor by a lack of awareness, traditional practices, limited public education, and insufficient access to trained expertise or antivenom at primary healthcare centres. [5,6] Snakebite-related deaths often occur within hours of the bite, and the chances of survival increase significantly with early administration of appropriate antivenom and supportive care.

However, poor outcomes are frequently linked to delays in transportation to tertiary care centres and reliance on traditional healers and snake charmers with their traditional remedial practices involving black pepper (Piper nigrum) and water for snakebites, mantra or a prayer used for protection against snake venom or for healing from a snakebite and/or treatment by untrained physicians in many parts of the world.

Venomous snakes can be broadly classified into three families:

- **Elapidae** (e.g., cobras, kraits, mambas, coral snakes, Australian elapids),
- **Viperidae** (pit vipers and old-world vipers, such as rattlesnakes, copperheads, and saw-scaled vipers), an
- **Hydrophiidae** (sea snakes and several venomous land snakes found in Australasia, including taipans, tiger snakes, brown snakes, and death adders).

Elapid venoms are primarily neurotoxic, affecting neuromuscular transmission and potentially leading to respiratory paralysis and death. [7,8] In contrast, viperid venoms are predominantly hemotoxic and cytotoxic, damaging the coagulation system, vascular endothelium, and soft tissues [9,10]

These effects can result in hemorrhage, acute kidney injury, disseminated intravascular coagulation (DIC), and localized tissue necrosis. [9,10,11,12,13] Sea snake venoms possess both neurotoxic and myotoxic properties, often resulting in rhabdomyolysis and acute renal failure.[14]

In India, the "Big Four" venomous snakes "**Russell's viper"** (*Daboia russelii*), "**saw-scaled viper"** (*Echis carinatus*), "**Indian cobra"** (*Naja naja*), and "**common krait**" (*Bungarus caeruleus*) are responsible for the majority of serious envenomation and deaths.[15] The cornerstone of snakebite management in India is the early administration of multivalent antivenom, which is crucial for neutralizing circulating venom and reversing systemic effects.[18] However, antivenom therapy carries risks such as anaphylaxis and serum sickness especially in settings lacking adequate monitoring and emergency care resources.[19] Additionally, geographic variations in venom composition (venom variability) affect the efficacy of antivenoms, underscoring the importance of region-specific antivenom development. Supportive measures, including airway management, fluid therapy, blood transfusion, dialysis, and surgical debridement, are essential in managing complications and improving patient outcomes.

In tertiary care settings, the management of snake envenomation requires a multidisciplinary approach involving emergency physicians, intensivists, nephrologists, hematologists, and surgeons. Thorough clinical assessment and routine investigations are vital for determining the severity of envenomation and anticipating complications such as coagulopathy, renal failure, and respiratory paralysis. Diagnostic parameters including whole blood clotting time (WBCT), prothrombin time, serum creatinine, urine output, arterial blood gases, and muscle enzymes are routinely observed to guide treatment plan.

Despite the availability of these diagnostic and therapeutic resources in

tertiary centers, the outcomes still depend heavily on pre-hospital care, the time taken to reach the facility and the presence of comorbid conditions.

In tertiary care hospitals, there is an urgent need for studies examining the clinical profile and outcomes of snake envenomation. In this background, we conducted this study to assess the clinical profile and outcome of patients admitted with Snake bite in a tertiary care centre of North Maharashtra

MATERIAL AND METHODOLOGY

- **Study design:** It is a prospective observational study.
- **Source of data:** Tertiary care hospital in North Maharashtra.
- **Sample size:**

P=proportion of most common category of snake bites = 70%
q= 100-p = 30%
Z1 – α/2 = 1.96 at 5% level of significance
L= Margin of error 7%
N= sample size = $[\{Z - \alpha/2\}^2 * p * q]/L^2 = 165$

Study variables:
1. Gender.
2. Age.
3. Any interventions done from PHC.
4. Occupation.
5. Residence.
6. Time of bite and patient received at hospital.
7. First aid methods used.
8. Type of snake.
9. Number of vials Of ASV given in total.
10. Complications associated

Inclusion criteria:
All age group patients and all genders with at least one of the following criteria were included in the study:
1. Patient or relative has seen the offending snake.
2. Definite fang marks are noted.
3. Features of local or systemic envenomation.

Exclusion criteria:
1. Unknown bite.
2. Suspected bite.
3. People with bleeding diathesis, chronic liver disease, chronic alcoholics and those who are on anti-coagulant therapy.

Apparatus:
1. Case record format.
2. Intravenous catheter.
3. Intravenous drip set.
4. Syringe with needle.
5. Multicolored vacutainers.
6. Multipara monitors with Pulse, BP, SpO2 and ECG readings.
7. Anti snake venom (ASV).
8. Injection neostigmine, Injection Atropine.
9. All emergency drugs and equipment's needed to manage airway, breathing and circulation.

METHODOLOGY

Data Collection Procedure:
This prospective observational study enrolled 165 patients who presented with snakebite to the Emergency Room (ER) of a tertiary care centre in North Maharashtra. Patients were selected based on predefined inclusion criteria, and informed consent was obtained before enrolment.

At the time of admission, each patient was initially assessed and stabilized following the standard primary survey protocol involving the Airway, Breathing, Circulation, Disability, and Exposure (ABCDE) approach.

This was followed by a detailed history and complete clinical examination as part of the secondary survey.

Patients were categorized based on several parameters, including age, gender, type of primary health center (PHC) intervention, first aid measures taken, occupation, place of residence, and time of the snakebite.

Clinical Assessment: [20]
All 165 patients were assessed clinically for local signs and symptoms at the bite site such as swelling, tenderness, bleeding manifestations, and signs suggestive of necrosis or gangrene. Additionally, signs of neurotoxicity were systematically evaluated. These included single breath count <25, ptosis, paralysis, diplopia, dysarthria, dysphagia, dysphonia, and dyspnea.

To identify hematotoxic envenomation, a blood sample was collected from each patient for the 20-minute Whole Blood Clotting Time (WBCT) test.

Once a toxic snakebite was confirmed based on clinical findings and WBCT results, appropriate treatment was initiated without delay.

Therapeutic Management: [20]
For all three types of snake envenomation, anti-snake venom (ASV) administration was the mainstay of treatment. Each vial of ASV was reconstituted using 10 ml of sterile water, and 10 vials were diluted in 400 ml of normal saline in accordance with the National Standard Protocol (NSP).

In cases of hematotoxic envenomation, patients received 10 vials of polyvalent ASV administered intravenously over 30 minutes as a stat infusion, followed by 6 vials every six hours as bolus therapy until normalization of clotting time and resolution of local swelling. In patients with uncontrolled bleeding, fresh frozen plasma (FFP), fresh blood, and vitamin K were administered as needed.

For neurotoxic snakebites, 10 vials of ASV were administered as an infusion over 30 minutes.

If no improvement was observed within one hour, a second dose of 10 vials was given.

Adjunctive Therapy:
Supportive therapy for neurotoxic snakebites included administration of Injection Atropine (0.6 mg) followed by Neostigmine (1.5 mg) given intravenously as a stat dose. This was followed by Neostigmine 0.5 mg with Atropine every 30 minutes for a total of five doses, with dosing held in between if symptoms reversed.

For local wound management, dressing with Glycerin–Magnesium sulphate was applied at the bite site to alleviate edema and swelling.

Patient Monitoring and Follow-up:
Once patients were estimated vitally stable, they were shifted to their respective inpatient wards after a period of six hours. Follow-up was conducted to document the total number of ASV vials administered and to monitor for any delayed complications.

Statistical analysis:
Once the data entry was completed, statistical analysis was performed using SPSS version 21. The data were presented as number (percentage) or mean ± standard deviation (S.D.), wherever appropriate.

RESULTS

Table 2: Age-wise distribution

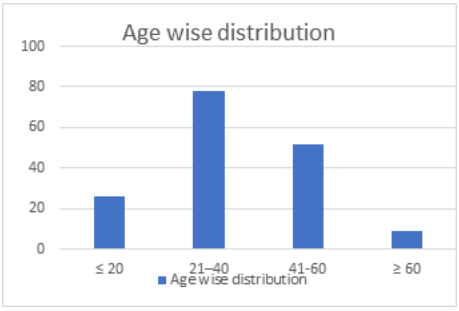
Age	No. of patients	Percentage
≤ 20	26	16%
21–40	78	48%
41–60	52	31%
≥ 60	09	5%
Total	165	100%

The age-wise distribution of snake bite patients is depicted in Table 2 .
The majority of patients (48%) were in the 21–40 years age group (n=78), followed by 31% (n=52) in the 41–60 years group. Patients aged ≤20 years accounted for 16% (n=26), while those above 60 years made up 5% (n=09) of the total. Thus, early adulthood population were the most commonly affected group in this study of 165 patients.

Table 3: Distribution according to gender.

Gender	No. of patients	Percentage
Male	94	57%
Female	71	43%

Total	165	100%



The gender-wise distribution of snake bite patients is shown in Table 3.

Out of 165 patients, the majority were males, accounting for 57% (n=94), while females comprised 43% (n=71). This indicates a male predominance among patients admitted with snake bite during the study period.

Table 4: Distribution according to residence.

Residence	No. of patients	Percentage
Rural	143	87%
urban	22	13%
Total	165	100%

The distribution of snake bite patients according to their place of residence is presented in Table 4.

The majority of the patients were from rural areas, accounting for 87% (n=143), while 13% (n=22) were from urban regions. This highlights a higher incidence of snake bites among individuals residing in rural settings.

Table 5: Distribution according to type of snake .

Type of snake	No. of patients	Percentage
Cobra	7	4%
Viper	29	18%
Krait	22	13%
Unknown	107	65%
Total	165	100%

The distribution of snake bite cases based on the type of snake is shown in Table 5.

In the majority of cases (65%, n=107), the type of snake could not be identified. Among the identified species, viper bites were the most common, accounting for 18% (n=29), followed by krait bites at 13% (n=22) and cobra bites at 4% (n=7). This indicates that a significant proportion of patients were unable to recognize the offending snake species at the time of the bite.

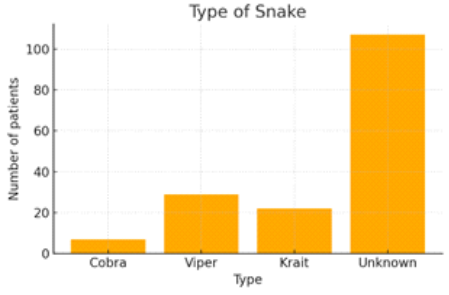


Table 6: Distribution according to time of bite.

Time of bite	No. of patients	Percentage
6am-12pm	46	28%
12 pm-6pm	39	24%
6pm-12am	65	39%
12 am- 6 am	15	9%
Total	165	100%

The distribution of snake bite cases according to the time of bite is presented in Table 6.

Most bites occurred between 6 PM and 12 AM, accounting for 39% of cases (n=65). This was followed by 28% (n=46) of bites occurring between 6 AM and 12 PM, and 24% (n=39) between 12 PM and 6 PM. The least number of bites, 9% (n=15), were reported during the early morning hours from 12 AM to 6 AM. These findings suggest that snake bites were more frequent during the evening and early night hours.

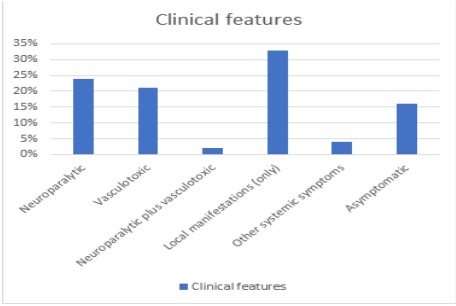


Table 7: Distribution according to place of bite.

Place of bite	No. of patients	Percentage
Indoor	84	51%
Outdoor	81	49%
Total	165	100%

The distribution of snake bite cases according to the place of occurrence is shown in Table 7.

Of the 165 patients, 51% (n=84) were bitten indoors, while 49% (n=81) experienced the bite outdoors. This indicates a nearly equal distribution between indoor and outdoor settings, with a slight predominance of indoor bites.

Table 8: Distribution according to site of bite.

Site of Bite	No. of patients	Percentage
Lower limb	92	56%
Upper limb	49	30%
Other	24	15%
Total	165	100%

The distribution of snake bite cases according to the site of bite is detailed in Table 8.

The lower limb was the most commonly affected site, accounting for 56% of cases (n=92), followed by the upper limb in 30% of patients (n=49). Other body parts, including the trunk, face, or neck, were involved in 15% of cases (n=24). These findings suggest that the extremities, particularly the lower limbs, were the most vulnerable sites for snake bites.

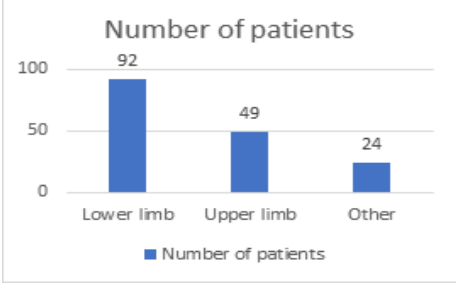


Table 9 Distribution according to time lag.

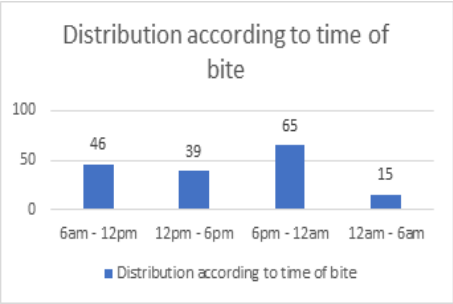
Time lag	No. of patients	Percentage
< 6 hrs.	129	78%
6 to 24 hrs.	19	12%
>24 hrs.	17	10%
Total	165	100%

The distribution of snake bite cases based on the time lag between the bite and hospital presentation is shown in Table 9.

The majority of patients (78%, n=129) sought medical care within 6 hours of the bite. About 12% (n=19) presented between 6 to 24 hours, while 10% (n=17) reported to the hospital after more than 24 hours. These findings indicate that most patients received early medical attention, which is crucial for better outcomes.

Table 10: Distribution according to outside hospital.

Outside hospital	No. of patients	Percentage
Yes	91	55%
No	74	45%
Total	165	100%



The distribution of patients according to whether they received initial treatment at an outside hospital is presented in Table 10.

A total of 55% of patients (n=91) had received some form of management at another healthcare facility before being referred or admitted, while 45% (n=74) presented directly to the tertiary care hospital. This suggests that over half of the patients first sought care at peripheral or local centers before reaching the tertiary facility.

Table 11: Clinical features

Clinical features	Number of patients	Percentage
Neuroparalytic	39	24%
Vasculotoxic	34	21%
Neuroparalytic plus Vasculotoxic	4	2%
Local manifestations (only)	55	33%
Other Systemic symptoms	7	4%
Asymptomatic	26	16%
Total	165	100%

The clinical features observed among snake bite patients are summarized in Table 11.

Among the clinical features, local manifestations were present in 33% of patients (n=55), followed by Neuroparalytic symptoms 24% (n=39), then Vasculotoxic 21% (n=34), 16% of patients were asymptomatic (n=26), 4% of patients had systemic symptoms (multiorgan dysfunction, disseminated intravascular coagulation, acute renal failure etc), 2% of patients exhibited both Neuroparalytic and vasculotoxic features (n=4)

These findings highlight that a notable proportion of patients experienced local effects.

Note: A total of 76 patients had local manifestations, out of which 55 patients had only local manifestations and 21 patients had local manifestations with other systemic features.

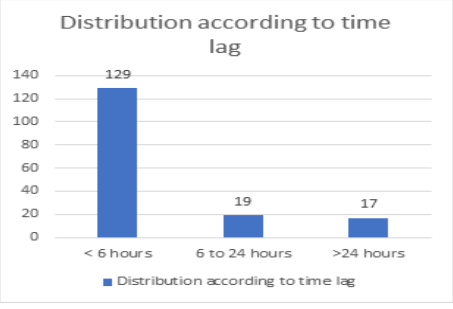


Table 12: Clinical features among the local manifestations.

	Number of patients	Percentage
Pain and swelling	59	77%
Cellulitis	13	19%
Compartment syndrome	3	4%
Total	76	100%

The clinical features related to local manifestations of snake bites are outlined in Table 12.

Out of the 76 patients with local manifestations, Pain and swelling were the most commonly reported symptoms, observed in 77% of patients (n=59).

Cellulitis was present in 19% of cases (n=13), while 4% (n=3) had compartment syndrome. These findings indicate that localized pain and swelling were the predominant features at the site of the bite.

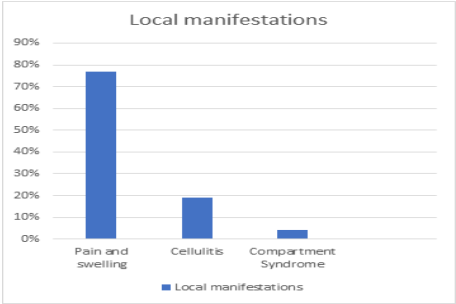
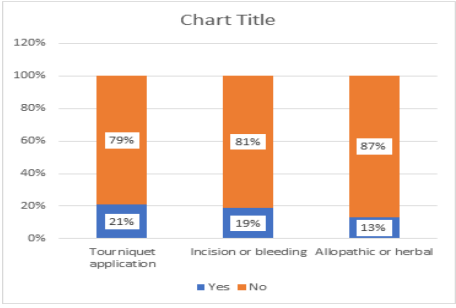


Table 13: First aid treatment measures adopted

Treatment of snake bite	Yes (%)	No (%)
Tourniquet application	34(21%)	131(79%)
Incision or bleeding	31(19%)	134(81%)
Allopathic or herbal	21(13%)	144(87%)

The treatment measures adopted by patients prior to or during hospital care are detailed in Table 13.

Tourniquet application was reported in 21% of cases (n=34), while 19% (n=31) of patients had undergone incision or bleeding at the bite site. Additionally, 13% (n=21) of patients reported using either allopathic or herbal remedies before presenting to the hospital. These findings indicate that a significant number of patients practiced potentially harmful first-aid measures before receiving proper medical treatment.



14: Patient requiring critical care – Life threatening / limb threatening

	Yes (%)	No (%)
Ventilator support	10 (6%)	155 (94%)
Anaphylaxis to ASV	8 (5%)	157 (95%)
Hemorrhagic shock	3 (2%)	163 (98%)
Hemodialysis	4 (2.5%)	161 (97.5%)
Limb amputation	5 (3%)	160 (97%)

The distribution of patients requiring critical management is presented in Table 14.

A total of 6% of patients (n=10) required ventilator support, while 5% (n=8) developed anaphylactic reaction to ASV and 2.5% (n=4) patients developed acute tubular necrosis which required hemodialysis.

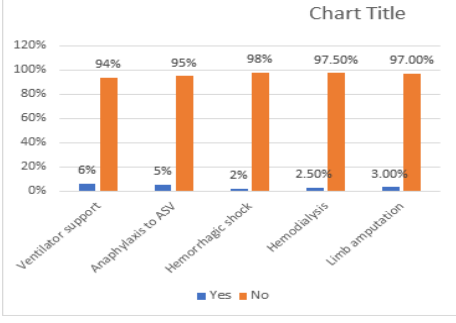
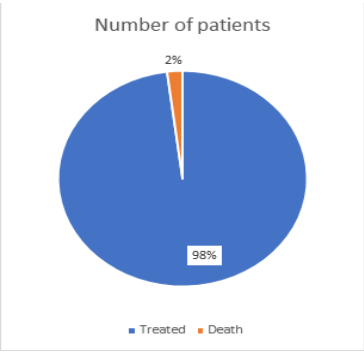


Table 15: Outcome

Outcome	Number of patients	Percentage
Treated	162	98%
Death	3	2%

The distribution of patient outcome in cases of snake bite is presented in Table 15.

Out of total 165 patients, 98% of patients (n=162) were successfully treated and 2% of patients (n=3) succumbed.



DISCUSSION

In this prospective observational study conducted in a tertiary care hospital in North Maharashtra, 165 patients with snake envenomation were analysed to determine their clinical profiles and outcomes.

Demographic Patterns:

The majority of patients were males (57%), predominantly in the 21-40 years age group (48%). This is consistent with previous studies by **Bawaskar HS et al., (2014) [19]; Kumar S, et al., (2021) [28]** and **Sasidharan P, et al., (2025) [22]** which demonstrated higher incidence among males due to occupational exposure, outdoor activities, and farming-related work.

The predominance of young adult males highlights the socio-economic burden, as this age group forms the major workforce in rural settings.

Residence and Occupational Risk:

A significant proportion (87%) hailed from rural areas, emphasizing the higher risk in regions with dense agricultural activity and poor access to healthcare.

Similar findings were reported by **Suryawanshi P, et al., (2025) [25] and Ingle V, et al., (2022),**[26] who stressed that agricultural workers remain the most vulnerable group due to frequent exposure to fields, water bodies, and wood storage areas where snakes are common.[26]
Out of 165 patients, 4 patients were snake rescuers who had history of multiple episodes of snake bite. This indicates

Lack of Proper Training and Handling Techniques:

- Most of the snake rescuers are self-trained. They lack any scientific knowledge.
- They still continue to use primitive methods for handling snakes mainly due to over confidence and for attention seaking

No usage of personal protective equipments:

- Rescuers often operate without proper safety equipment (e.g., snake hooks, tongs, gloves, boots).

Risky Rescue Environments

- Rescues often occur in dense vegetation, forest areas, water bodies where visibility is poor and escape routes are limited.

Type of Snake and Identification Challenges:

In the present study, the offending snake species could not be identified in **65%** of cases. Among identified species, vipers (18%) were most common, followed by kraits (13%) and cobras (4%).

These findings align with Indian epidemiological data, which identifies Russell's viper and krait as major contributors to envenomation-related morbidity and mortality. It has been also reported in studies by **Nallathambi M, et al., (2024) [24]** and **Pore SM, et al., [66] (2017).**

The high proportion of unidentified bites indicates the need for better community education on snake identification for timely syndromic management.

Time and Site of Bite

Most bites occurred between 6 pm and 12 am (39%), consistent with nocturnal behaviour of kraits and increased human outdoor activity during evening hours. The lower limb (56%) was the most common site, followed by upper limb (30%), reflecting accidental stepping over snakes, as reported in earlier studies by **Pore et al., [31] (2017)** and **Kaushik et al. [30] (2018).**

Indoor and Outdoor bites

In this study, it was found that there was unusually higher incidence of indoor bites (51%). Many such occurred when people were sleeping, especially at night or early morning hours. This is supposed to be due to majority of the study and sample size being completed during the monsoon season when the rains drive snakes into home in search of dry ground. Especially in rural India where people stay near the agricultural fields with poor housing design and sleeping on the floor.

The people who sustained bites during sleep had a delayed presentation to the hospital because they were initially not aware of the bite and they might have waited till the development of some symptoms.
In pediatric population, there were incidence of kids who were sleeping, later on reporting with neuroparalytic symptoms without parents giving history of snake bite. On physical examination, were found to have bite marks.

Most of the patients sustaining outdoor bites had reported to the hospital within the golden period and had better outcome.

Clinical Presentation

1. Local manifestations such as pain and swelling (77%) were the predominant symptoms, particularly in viper bites, followed by development of cellulitis (19%).

4% of patients developed limb threatening injuries like compartment syndrome, gangrene of fingers / toes.

2. Neuroparalytic symptoms were observed in 24% of patients, highlighting the prevalence of elapid bites in this region.
Out of the 2Ps (Ptosis, Paralysis) and 5 Ds (Diplopia, Dysarthria, Dysphagia, Dysphonia, Dyspnoea),

Ptosis was the most common presenting symptom, followed by diplopia. Many patients complained of development of diplopia preceding to ptosis. 90% of patients with Ptosis and diplopia could be managed with Atropine, Neostigmine and Calcium gluconate injections.

Impaired neck holding was the next common sign observed. Only 20% of patients responded to Atropine, Neostigmine and Calcium gluconate and most of them had to be prophylactically intubated and had to be started on mechanical ventilation.

Hence, poor neck holding was found out to be a red flag sign in neuroparalytic snake bite cases.

3. Vasculotoxic features were seen in 21% of cases.

Local swelling crossing more than 2 joints were the most common sign, followed by bleeding from gums.

Similar patterns were described by **Keshava MM, et al., (2018),** where neurotoxicity was characteristic of cobra and krait envenomation, and hemotoxicity with coagulopathy was typical of viper envenomation.[32]

First Aid Practices

Alarmingly, 21% of patients used tourniquets, 19% underwent incision or bleeding, and 13% used herbal or unverified remedies.

The patients who developed either compartment syndrome or gangrene of toes / fingers were retrospectively asked regarding the use of any tight tourniquet.

Around 80% of patients gave a positive history These harmful first aid practices continue despite public health education and have been associated with delayed presentation, increased local complications, and worsened outcomes (WHO SEARO Guidelines).

This highlights the need for a proper community education regarding the Do's and Don'ts in a case of snake bite.

Treatment and Outcomes

In this study, 78% of patients presented within 6 hours, which is encouraging compared to previous data indicating delays in rural regions.

Early administration of polyvalent anti-snake venom (ASV) was effective in most cases. Even though 65% of patients could not identify the species correctly, the offending category (neuroparalytic v/s vasculotoxic) could be identified from the symptoms and appropriate intervention could be done.

Early recognition of warning signs and immediate intervention like airway protection and ventilatory support, treatment of coagulopathy lead to 98% survival, and only 2% mortality (n=3).

Out of the 3 deaths occurred during the study period, Case 1: Krait bite followed by development of myocarditis – patient went into refractory ventricular tachycardia, and could not be revived even after all resuscitative efforts.

Case 2: Delayed presentation of vasculotoxic snake bite – after 3 days, and patient went into disseminated intravascular coagulation with altered coagulation profile, bleeding from all orifices.

Case 3: Suspected anaphylaxis to ASV – patient reported within 2 hour of bite, but was given 3 vials of ASV in primary health centre, and developed itching and angioedema on the way to tertiary care centre. No intervention could be done for around 1 hour during the transit time.

This mortality rate is comparable to **Mandal RK, et al.,** [27] (2022), who reported 5.17% case fatality, and Kumar et al. (2021), who documented 3.7% mortality in venomous bites.

Early assessment and timely intervention in ER were instrumental in the high success rate in the treatment of snake bite.

Complications

Critical care requirements were seen in a minority:

- 6% required ventilator support due to neuroparalysis,
- 5% patients developed anaphylactic reaction to ASV
- 3% required limb amputation due to severe local tissue necrosis.
- 2.5% required hemodialysis for acute kidney injury
- 2% patients developed hemorrhagic shock, requiring extensive fluid resuscitation, blood or blood products
- 0.6% patients developed snake bite induced myocarditis. These findings underscore the importance of early and prompt ASV therapy to prevent systemic complications.

Coagulopathy, acute renal failure, and neuroparalysis remain the leading complications, as also highlighted by **Nallathambi M, et al., [24] (2024).**

Strengths and Limitations

The strengths of this study include its prospective design and detailed clinical assessment.

However, limitations include:

- Single-centre data limiting generalizability,
- Lack of species confirmation due to dependence on syndromic identification,
- No long-term follow-up to assess delayed complications such as chronic kidney disease or neuropathy.
- Lack of documentation on the number of vials of ASV given in primary health centres before being referred to tertiary care centre. So, it was not feasible to calculate the total ASV required per case and the mean total in each category also could not be calculated.
- A retrospective study of 6 months or 1 year (before March 2022) could have been done to find out if there has been any improvement in patient care and outcome once Emergency Medicine department was established in the institute.

Importance of Primary Prevention [33]

Reducing the incidence of snake bites in agricultural populations—especially in rural India and similar regions—requires a multi-layered approach involving

1. Usage of Personal Protective Measures
Protective Clothing

Encouraging the use of rubber boots, thick socks, and long pants while working in fields, especially early morning or evening.

Use of gloves while handling crop stacks, hay, firewood, or stones.

2. Habitat Modification
Clean Surrounding
Remove clutter, trash, rocks, wood piles, and dense vegetation near homes and field borders.

3. Rodent Control
Reducing rodent population helps, as rodents attract snakes.

4. Alteration of work pattern
Avoid working in fields early morning, after dusk, or during the monsoon without light or visibility.
Always use a torch/flashlight at night when walking outdoors.

5, Avoid sleeping directly on the floor.
Ensuring adequate seal in doors and windows.

Secondary Prevention [33]

- The **critical importance of early hospital presentation and ASV administration** in reducing morbidity and mortality.
- The **need for community education** on avoiding harmful first aid measures.
- Training of **primary healthcare providers** in early recognition and referral.
- Ensuring adequate vials of **ASV at peripheral centres** to prevent treatment delays.

SUMMARY AND CONCLUSION

This prospective observational study titled *"A Clinical Profile of Snake Envenomation and Outcome in a Tertiary Care Hospital"* was conducted in North Maharashtra to evaluate the demographic patterns, clinical presentations, management, and outcomes of snakebite cases. A total of **165 patients** were studied, with the majority being **males (57%)** in the **21–40 years age group (48%)**, reflecting the occupational exposure of young adults in rural settings.

Most patients (**87%**) hailed from rural areas, and bites predominantly involved the **lower limbs (56%)**, occurring more frequently during **evening hours (39%)**. Among identified species, **vipers (18%)** were the most common, followed by **kraits (13%)** and **cobras (4%)**, while in **65% of cases**, the snake species remained unidentified.

Clinically, **local manifestations** such as pain and swelling were the most common presentations, observed in **77%** of local manifestation cases. **Neuroparalytic symptoms** were present in **24%** and **vasculotoxic features** in **21%** of patients.

Despite public health efforts, harmful first aid practices like tourniquet application (21%) and incision or bleeding (19%) were still used by some patients, indicating a need for better community education.

Importantly, **78% of patients presented within 6 hours**, enabling timely administration of **polyvalent anti-snake venom (ASV)**, resulting in a **high survival rate of 98%**.

However, **2% mortality** was observed, mainly due to complications like respiratory paralysis and acute kidney injury secondary to delayed presentation. A small percentage required **ventilatory support (6%)**, **hemodialysis (2.5%)**, or **limb amputation (0.6%)**, indicating severe systemic involvement in advanced envenomation.

This study concludes that **snake envenomation remains a major medical emergency** with significant morbidity and mortality in rural India.

Early hospital presentation and prompt ASV administration are critical for favourable outcomes.

The findings emphasize the need for:

- **Community awareness programs** on prevention and appropriate first aid,
- **Training healthcare providers** in early recognition and management,
- **Ensuring adequate number of ASV availability** at peripheral health centres, and

- **Developing region-specific treatment protocols** to reduce the burden of snakebite envenomation.

Strengthening these aspects can significantly **reduce complications, disability, and mortality**, thereby improving public health outcomes and reducing the socio-economic burden of snakebite in endemic regions.

FUTURE DIRECTIONS

- **Developing region-specific treatment protocols.**
- **Conduct multi-centre, species-specific venom studies.**
- **Optimize ASV dosing protocols.**
- **Study long-term outcomes post-envenomation.**
- **Develop rapid venom detection kits.**
- **Enable species-specific (monovalent) ASV therapy.**

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