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A comprehensive epidemiological study of Snake bites in a tertiary care hospital in Bhubaneswar, India

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Abstract
This prospective hospital-based study spanned from September 2015 to September 2017, encompassing all patients, regardless of age or gender, presenting with a history of snake bite. Among the 169 recorded cases, comprising 116 males (68.7%) and 53 females (31.3%), with a mean age of 32±12 years, the male-to-female ratio stood at 2.2:1. Predominantly hailing from rural locales (67.5%), individuals engaged in agricultural pursuits formed the most susceptible occupational group (48.5%). Outdoor incidents accounted for the majority of bites (62.7%), with over half of the incidents (52.1%) involving unidentified snake species. Among identified venomous snakes, Elapidae and Viperidae constituted 15.4% and 13.0%, respectively. The third quarter of the year saw the highest incidence of cases (67.4%), with peak occurrences between 6:00 PM and 12:00 midnight (30.2%). Lower limbs were the most frequent site of bites (69.2%), with common manifestations including fright (85.2%) and localized pain (57.9%). Treatment predominantly involved anti-snake venom (ASV) administration (81.1%), resulting in a high survival rate (92%).

Keywords: Poison, death, snake, snake bite, epidemiology, venom

Introduction
Snakebite poses a significant public health challenge worldwide, particularly in tropical and sub-tropical regions. Snake venom, one of the oldest known poisons to humanity, has been documented in ancient medical texts and myths, evoking both fascination and fear since ancient times. Across various mythologies, snakes have been depicted as symbols of both good and evil, revered as deities or feared as demons. In Greek mythology, for instance, snakes were associated with Goddess Hygeia and worshipped alongside Asclepius, the God of Health. This symbolism persists to this day, with the snake occupying a prominent place in the universal symbol of the medical profession.

Despite numerous efforts to gauge the global impact of snakebite envenoming, an accurate measure of its burden remains elusive. Globally, over 5 million snakebites occur annually, resulting in an estimated 20,000 to 125,000 deaths [1-3]. India bears the highest burden of snakebite fatalities, with 35,000 to 50,000 deaths reported annually, particularly in rural areas where access to healthcare and antivenoms is limited [3]. India has the highest number of deaths due to snake bites in the world with 35,000–50,000 people dying each year according to World Health Organization (WHO) direct estimates [3]. This is especially true in rural areas where snakebites are common but there is limited access to health care and anti-venoms. Further, delay in seeking medical care or lack of knowledge among primary care physicians about the correct treatment of snakebite increases morbidity and mortality [4]. But unlike mortality from snakebite poisoning the true incidence of snakebite cannot be ascertained as large number of cases goes unnoticed, treated by local quacks, or ignored considered as bites by non-poisonous snakes.

In India, land is infested with snakes ranging from 12,000 feet altitude above sea level of the Himalayas down to Cape Comorin; however, but different areas have different species preponderance. India is inhabited by more than 60 species of venomous snakes – of which only four have been popularly known to be dangerously poisonous to man; Spectacled cobra (*Naja naja*), common krait (*Bungarus caeruleus*), saw-scaled viper (*Echis carinatus*) and Russell's viper (*Daboia russelii*) [5]. The most common poisonous snake among them is common krait [6]. Bites may be inflicted in the confines of home by peri-domestic species such as cobras (*Naja)* which may live in roof spaces or under the floor and by kraits

(*Bungarus)* which enter human dwellings at night in search of their prey and may bite people walking along paths in the dark. It is difficult to ascertain the correct incidence of snake bites as large numbers of cases are not reported at health care facilities and people still believe in traditional methods as first line of treatment. It is agonizing to note that some of the cinema and television serial stories breed unscientific ideas on snakes and snakebites, and relish displaying traditional treatment to accommodate the theme of the story [7].

Clinicians since pre-historic times have witnessed the tragedy of injury, disability, and death from snake bite that has been a customary sight in many parts of Africa, Asia, and Latin America. To hundreds of people living in these regions, including some of the world's most impoverished communities, snake bite is an ever present occupational risk, an added penalization of poverty. Like malaria, dengue, tuberculosis, and parasitic diseases, the risk of snake bite is always present. Unlike many of these other public health risks, however, the burden of human suffering caused by snake bite remains unrecognized, invisible, and unheard by the global public health community, forgotten by development agencies and governments alike. The problem is so underrated that it was only added to WHO's list of neglected tropical diseases in April, 2009 [8]. In this study, we have documented the epidemiology of snake bite poisoning in & around district Khurda region including incidence among various sex and age groups, the place of incidence, time and site of bite, seasonal variation, immediate manifestation, hospital stay, treatment received and final outcome. Also, suggested the measures to prevent the deaths from snakebite poisoning.

Materials and Methods

This hospital-based prospective study, conducted in collaboration between the Department of Forensic Medicine, Department of Medicine, and Department of Pediatrics at IMS and SUM Hospital, Bhubaneswar, Odisha, spanned from September 2015 to September 2017. All patients presenting with a history of snake bite, regardless of age or gender, were included in the study.

The study involved 169 patients, who were meticulously observed from their admission to the hospital until their final discharge. Patients with a history of scorpion bites, bee stings, and other insect bites were deliberately excluded from the study. Upon admission, essential demographic data including age, occupation, educational status, marital status, and domicile were recorded for each case. Additionally, details regarding the circumstances surrounding the bite, the time and location of the incident, observed symptoms and signs upon hospital admission, and the administered treatment were meticulously documented. In most instances, patients provided their own medical history, except in cases where severe symptoms compromised their ability to communicate, in which case, relatives provided proxy information. However, such information was later confirmed by the patient upon recovery.

Results were expressed as frequency percentages. A probability of $p<0.05$ was considered statistically significant. SPSS statistical software was used for evaluation. Chi-square analysis was carried out to assess the association between variables.

The study was approved by "Institutional Ethics Committee" of IMS and SUM hospital, Bhubaneswar. All the subjects were included after their written informed consent and parents/guardians provided consent on behalf of minors.

Results

A total n=169 snake bite patients, consisting of 116 (68.7%) male and 53 (31.3%) female [mean (SD) age 32±12 years] were admitted to the hospital during the period of study. Maximum number of cases i.e., 49 (29.0%) belonged to 30-39 years of age, and the least i.e., 3 (1.8%) belong to less than 10 years of age. The circumstances of snakebite and the demography of patients are described in Table 1.

Table 1: The Epidemiology of snakebites during the study period

Description	Male	Female	Total (%)
Total number	116	53	169
Age (mean)	32	30	32
Year			
2015	23	11	34
2016	66	30	96
2017	27	12	39
Occupation (χ^2=135.8, df=4, $p<0.05$)			
Agriculture	79	3	82 (48.5)
Student	15	3	18 (10.7)
Unemployed	8	0	8 (4.7)
Housewife	0	45	45 (26.6)
Others	14	2	16 (9.5)
Religion			
Muslim	11	7	18
Hindu	105	46	151
Marital status			
Married	78	46	124 (73.4)
Unmarried	38	7	45 (26.6)
Education (χ^2= 11.69; df= 3; $p<0.05$)			
Illiterate	46	35	81 (47.9)
Primary school	33	11	44 (26.0)
High School	31	7	38 (22.5)
Senior secondary	6	0	6 (3.6)

Domicile			
Rural	81	33	114 (67.5)
Urban	35	20	55 (32.5)
Location			
Outdoor	77	29	106 (62.7)
Indoor	39	24	63 (37.3)
Season			
Jan-Mar	10	3	13 (7.7)
April-June	24	13	37 (21.8)
July-Sept	79	35	114 (67.5)
Oct-Dec	3	2	5 (3.0)
Site of bite (χ^2=19.84; df= 9; p<0.05)			
Lower limbs	84	33	117 (69.2)
Upper limbs	26	18	44 (26.0)
Head & neck	5	2	7 (4.1)
Others	1	0	1 (0.6)
Time of bite (00:00-24:00 hr)			
00:01 - 06:00	27	15	42 (24.9)
06:01 - 12:00	21	18	39 (23.1)
12:01 - 18:00	30	7	37 (21.9)
18:01 - 24:00	38	13	51 (30.1)

Bulk of the population i.e., 82 (48.5%) was involved in agriculture and a significant association (p<0.05) was found between occupation and sex among the cases of snakebite poisoning. (Table 1) Majority of the subjects bitten were illiterate i.e. 81 (47.9%). A significant association (p<0.05) was established between education and sex among the cases of snakebite poisoning. (Table 1) Greater part of snake bite cases were from rural region i.e. 114 (67.5%) and mostly the bites occurred outdoors i.e. 106 (62.7%). Rural area indicates that snake envenoming affects largely the poor people depending on agriculture as source of livelihood. More than half the number of snakebite poisoning cases i.e., 114 (67.5%) reported between July to September, the peak time occurring from 18:00 to 24:00 hours.

Most of the time people could not identify the snake i.e., 88 (52.1%), and among identified poisonous snakes Elapidae and Viperidae type constituted 26 (15.4%) and 22 (13.0%) respectively. Out of 169 cases, majority of persons i.e., 117 (69.2%) were bit in the lower limbs, among them the peak time of bite was between 18.00 to 24.00 hours. Significant association (p<0.05) was found between site and time of the bite Table 1.

Fright was the most common distinguished subjective symptom found in our study i.e., 85.2% (144) followed by pain at the local site i.e., 57.9% (98). Majority of the patients i.e., 137 (81.1%) were administered anti-snake venom (ASV) and most of them i.e., 126 (74.6%) recovered without sequelae (Table 2). Patients with features suggestive of non-poisonous bites were not administered anti-snake venom (ASV). Out of 169 cases, 13 (7.7%) expired, among them the major cause of death was respiratory failure. The signs/symptoms, management, hospital stay and outcome of the patients are illustrated in Table 3.

Table 2: Relationship between treatment and outcome.

Treatment (ASV)	Outcome					
	Cured		Expired		Total	
	No.	Percent	No.	Percent	No.	Percent
GIVEN	126	74.6	11	6.5	137	81.1
NOT GIVEN	30	17.8	2	1.2	32	18.9
TOTAL	156	92.3	13	7.7	169	100.0

Table 3: Characteristics of snakebites.

Type of snake	No. of cases	Total (%)
Non poisonous	33	19.5
Poisonous		
Elapidae	26	15.4
Viperidae	22	13.0
Unidentified	88	52.1
Interval between bite & hospital admission (hr)		
0-6	82	48.5
7-12	40	23.7
13-18	20	11.8
19-24	17	10.1
≥25	10	5.9
ICU admission		
Needed	52	30.8
Not needed	117	69.2

Duration of hospital stay (days)		
<3	43	25.4
3-7	112	66.3
≥7	14	8.3
Symptoms & Signs		
Fright	144	85.2
Pain at the local site	98	57.9
Swelling at the local site	84	49.7
Difficulty in speech	38	22.4
Difficulty in breathing	37	21.8
Ptosis	42	24.8
Altered sensorium	27	15.9
Cellulitis	18	10.6
Difficulty in swallowing	30	17.7
Vomiting	48	28.4
Abdominal pain	54	31.9
Hematuria	3	1.7
Oliguria	8	4.7
ASV		
Given	137	81.1
Not Given	32	18.9
Final Outcome		
Cured	156	92.3
Expired	13	7.7
Cause of death		
Respiratory failure	7	53.8
Septicemia	1	7.6
Shock	2	15.2
Renal failure	3	23

Discussion

A total of 48.5% of snakebites occurred in agriculture industry and farming activities, [4, 9-12]. Attributed to unshod farmers which makes them prone to the risk [4, 9]. Rural inhabitants form the biggest chunk of casualties (67.5%) attributed to the labour they are generally engaged in and this collaborates with inference drawn from other studies [4, 9-13]. The study shows that most of the snakebite victims were male (68.6%) as compared to females (31.4%). The predominance of male victims suggests a special risk of outdoor activity. This is comparable to the studies done by other authors [4, 11-14].

In the present study, about 47.9% of study population was illiterate, as majority of people living in rural areas do not have access to education. Females as compared to males were more educationally backward and further access to higher education was limited to either sex.

62.7% of the study group victims were bitten while being outdoors forming the ratio of 1.7:1 of outdoor to indoor bites. This ratio is completely in alignment of facts deducted in similar studies done elsewhere [4, 14-16].

Cutting across barriers of class distinction, education, income and social standing 52.1% of victims expressed inability to identify the offending snake, a fact accentuated further by unfounded superstitious belief of killing the snake and burning it to ashes immediately to avoid the female snake peeping into the dead snake's eye and registering the image of killer. Later this image helps in killing the victim (s) in retaliation [17]. This is supposed to be the hard core superstitious belief.

On the basis of signs and symptoms this study was able to establish neurotoxic (Elapidae) bites in 15.4% and hemorrhagic (Viperidae) in 13% cases. Few victims did bring the snakes- dead and captured alive-but they were too few and far between. Study done at Safdarjung hospital, New Delhi established the cohesiveness observed in this aspect in this study [18].

Highest numbers of bites (67.4%) were recorded in the months of July and September, which corresponds to the monsoon season in India and such incidences could be directly related to flooding of human dwellings in rural areas. A similar conclusion has been reached in studies conducted earlier [4, 9, 11, 12].

Lower extremities were the most observed bitten part of body (69.2%) commonly the feet, upper limb (26%), head and neck (4.1%) and least on other sites such as scrotum [17] in decreasing order. Bites on the head and trunk mostly occur when nocturnal species bite people while sleeping [19]. Lower extremity as the most common site for snake bite has been observed in similar other studies [9, 11, 14, 19, 20].

In the present study, the maximum incidence of snakebite occurred between 6:00 PM to midnight (30.2%), followed by midnight to 6:00 AM (24.9%). This is mostly because of poor visibility and accidental stepping on the snake. Similar studies conducted in other parts of country showed relatively higher incidence of snake bitten cases between 6:00 PM and midnight [9, 16, 21] as found in our series.

The most common symptom reported by the victim was fright (85.2%) followed by pain at site of snake bite (57.9%). This is consistent with findings reported by other authors [22, 23]. Majority of the cases were administered anti-snake venom (ASV) on admission i.e. 137 cases (81.1%) and most of them survived i.e., 74.6%.

Nearly half of the victims (48.5%) were admitted to the hospital within 6 hours of snake bite. Similar observation was also made by other authors [11, 18, 19]. The location of hospital and the means of transportation serve as the main limiting factor apart from the usual treatment from quacks for delay in arrival at hospital. The average duration of hospital stay varied from 3 to 7 days (66.3%). A parallel conclusion has been reported in studies conducted earlier [9, 16].

Majority of the cases were administered anti-snake venom (ASV) on admission i.e. 137 cases (81.1%) and most of

them survived i.e., 74.6%. Management must be started immediately to be effective. The mortality rate was 7.7% and the leading cause of death was respiratory failure (53.8%) followed by renal failure (23%). Mortality rates in similar other studies varied from 3-6% [4, 9, 14, 16]. Our apparently high mortality rate may be due to the delay in arriving at the hospital after the snakebite, since most patients came from 80 to 100 km away and perhaps due to patients initially seeking treatment from traditional healers and local practitioners. External factors that are not in control of the hospitals, which increase the chances of mortality in admitted cases, include not receiving first aid, unavailability of anti-snake venom (ASV) at health centres in rural areas, no transport facilities, and lack of public awareness about the urgency of treatment.

Conclusion

Snakebite continues to be a significant contributor to accidental deaths in contemporary India, yet its public health ramifications have often been overlooked. This perilous hazard poses a substantial occupational risk, particularly for plantation workers, construction laborers, and farmers toiling in fields. As evidenced by the aforementioned study, snake bites disproportionately afflict rural areas and individuals engaged in agricultural activities, with peak incidences occurring during the monsoon season. Lower limb injuries prevail, predominantly affecting males who are frequently bitten by venomous snakes. Preventive measures, especially during peak agricultural periods, are paramount in mitigating snakebite occurrences. Simple precautions such as wearing protective footwear, carrying a stick for probing, exercising caution near debris, and staying vigilant of the ground can significantly reduce the risk of snake encounters. Furthermore, it is imperative for primary health centers to be adequately equipped to administer prompt first aid and anti-snake venom when necessary. Dissemination of information regarding swift transportation, correct first aid procedures, and training for primary healthcare workers holds the potential to markedly reduce mortality rates associated with this neglected tropical disease.

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