BioClinix: Journal of Medical and Pharmaceutical Sciences
www.bioclinixjournal.com | VOLUME-2 ISSUE-1 | JANUARY-MARCH 2026 | BI001
DOI : https://doi.org/10.65713/biov2i101

VENOM-INDUCED LETHALITY: A REVIEW OF THE FORENSIC APPROACH

Divyanshu Chandra*, Khalida Nazeer, Ekta Singh Yadav**, Namrata Singh, Asim Ameen, Roomi Parveen**

***Author, Student, Integral Institute of Allied and Healthcare Sciences, Integral University, Lucknow, U.P. India**

****Corresponding author, Faculty, Integral Institute of Allied and Healthcare Sciences, Integral University, Lucknow, U.P. India**

Faculty, Integral Institute of Allied and Healthcare Sciences, Integral University, Lucknow, U.P. India

*divyanshuchandra40@gmail.com ,**khalidan@iul.ac.in , **ektas@iul.ac.in

ABSTRACT: Death resulting from toxic exposure remains a significant concern in both clinical medicine and forensic science. Envenomation by venomous organisms including snakes, spiders, scorpions, and various marine species, constitutes a major cause of toxin-related mortality worldwide. Venoms produced by these species contain complex mixtures of neurotoxin, hemotoxic, cytotoxic, and organelle destructive substances that can lead to rapid systemic failure and death. The medical and forensic dimensions of deaths caused by envenomation with particular emphasis on forensic diagnostics, therapeutic interventions, and investigative methodologies. It underscores the critical role of timely antivenom administration in improving clinical outcomes and differentiating envenomation related deaths from other causessuch as drug overdose, sharp-force injuries, or homicidal poisoning. Accurate diagnosis is essential to avoid misinterpretation of the cause and manner of death. This review explores the forensic value of muscle tissue analysis including the detection of venom remnants and toxin-related biochemical changes in muscle homogenates, which may enhance the precision of postmortem diagnosis. Integrating the clinical findings, toxicological analysis, and forensic pathology, this multifaceted review highlights the importance of interdisciplinary collaboration among the medical practitioners, toxicologists, and forensic experts. Such collaborative strategies are essential for addressing otherwise unexplained deaths associated with surgical wounds, sharp-force trauma, or suspected toxic exposure, and for improving the accuracy of death investigations involving venom and other toxins.

Key Words: envenomation, epidemiology, homogenates, toxins, drug overdose, sharp force injuries

1. INTRODUCTION

Death is defined as the permanent cessation of the biological and physiological processes necessary to sustain life and is medically determined by the irreversible failure of the heart, lungs, or brain(1). The brain death is the complete and irreversible loss of all brain and brainstem function, recognized as the most definitive criterion in modern medicine. Following death, cellular breakdown processes such as autolysis and putrefaction begin, accompanied by postmortem changes including rigor mortis, livor mortis, and algor mortis,

BioClinix: Journal of Medical and Pharmaceutical Sciences
www.bioclinixjournal.com | VOLUME-2 ISSUE-1 | JANUARY-MARCH 2026 | BI001
DOI : https://doi.org/10.65713/biov2i101

which are central to forensic pathology for estimating the time since death and determining its cause and manner(2). Legally death must be certified by a qualified medical professional, as it's classified into the criteria's that is defined as natural, accidental, suicidal, homicidal, or undetermined that has significant implications for criminal investigations, civil liability, inheritance, insurance, and public health records. Among specific causes, venomous death refers to fatalities resulting from envenomation, a form of death caused by the injection of biologically active toxins from venomous animals such as snakes, spiders, scorpions, fishes, insects, and certain marine species(3). These venoms are complex mixtures of proteins, enzymes, and bioactive compounds that exert neurotoxic, cytotoxic, hemotoxic, or myotoxic effects, often acting simultaneously(4). Neurotoxic venoms disrupt neuromuscular transmission leading to paralysis and respiratory failure, hemotoxic venoms interfere with coagulation and damage blood vessels, causing hemorrhage and shock; cytotoxic venoms induce severe local and systematic tissue necrosis; and myotoxic venoms cause muscle breakdown that may progress to acute renal failure(4). Death in envenomation cases commonly results from shock, paralysis, or asphyxia. In forensic practice, accurate recognition of venomous deaths through crime scene investigation, physical examination of dead body, clinical history, autopsy findings, and toxicological analysis which is essential to distinguish them from other forms of natural or unnatural death and to ensure precise determination of the cause and manner of death.

1.1 Table 1: CLASSIFICATION OF VENOMS PRODUCED BY ANIMALS

Animal Type	Body Parts Affected	Fatal Dose	Fatal Period	Toxins Released	Venom Characteristics	Forensic Significance
SNAKES						
King Cobra (Ophiophagus hannah)	Nervous system, respiratory center	12 mg (dried venom)	0.5-24 hours	Neurotoxins, phospholipase-A, fibrinolysin, proteolysin	Neurotoxic; yellow/black coloration; most potent snake venom	Largest venomous snake; forest habitat limits human contact
Common Krait (Bungarus caeruleus)	Nervous system, respiratory muscles	2.5-6 mg (dried venom)	0.5-24 hours	Neurotoxins (paralysis only), no convulsions	Highly neurotoxic; painless bite; nocturnal hunter	Often bites sleeping victims; delayed symptom recognition
Russell's Viper (Daboia rusellii)	Blood vessels, kidneys, blood coagulation	40 mg (dried venom)	1-4 days	Hemolysins, proteases, hemorrhagins, coagulase,	Hemotoxic; white/yellow venom; coagulation disorders	Causes 80% of venomous bites in India; agricultural exposure

BioClinix: Journal of Medical and Pharmaceutical Sciences
www.bioclinixjournal.com | VOLUME-2 ISSUE-1 | JANUARY-MARCH 2026 | BI001
DOI : https://doi.org/10.65713/biov2i101

				thromboplastin		
FISHES						
Pufferfish (Tetrodotoxin)	Nervous system, sodium channels	1-2 mg (oral)	4-6 hours	Tetrodotoxin (TTX)	Blocks sodium channels; causes paralysis	Food poisoning; illegal consumption as delicacy
CANTHARIDES (Spanish Fly)						
Cantharis vesicatoria	Kidneys, genitourinary system, skin, GI tract	15-30 mg cantharidin or 1.5 g powder	24 hours	Cantharidin	Vesicant; nephrotoxic; readily absorbed from all surfaces	Used as aphrodisiac/abortifacient; accidental poisoning from hair oils
INSECTS						
Bees (Apis mellifera)	Respiratory system, cardiovascular system	Variable (multiple stings)	2-15 minutes	Melittin, phospholipase-A, hyaluronidase, histamine	Hemolytic; causes mast cell degranulation	Anaphylactic reactions; occupational exposure
Wasps/Hornets	Respiratory system, cardiovascular system	Variable (multiple stings)	2-15 minutes	Kinins, serotonin, phospholipase-A, histamine	Vasodilatory; causes immediate pain and swelling	Seasonal outdoor activities; nest disturbance
Fire Ants (Solenopsis)	Skin, respiratory system (severe cases)	Variable (multiple stings)	Minutes to hours	Solenopsin-A, alkaloids, proteins	Cytolytic; causes pustule formation	Geographic distribution expanding; agricultural workers
SPIDERS						
Black Widow (Latrodectus)	Nervous system, neuromuscular junction	Variable by bite	1-8 hours	Alpha-latrotoxin, latroinsectotoxin	Neurotoxic; blocks presynaptic calcium channels	Accidental bites; dark, undisturbed areas
Tarantula (Theraphosidae)	Skin, respiratory system	Rarely fatal	Hours	Histamine, enzymes, cytolytic compounds	Mildly toxic; urticating hairs	Pet trade exposure; handling accidents

CC BY NC

BioClinix: Journal of Medical and Pharmaceutical Sciences
www.bioclinixjournal.com | VOLUME-2 ISSUE-1 | JANUARY-MARCH 2026 | BI001
DOI : https://doi.org/10.65713/biov2i101



Figure 1: Venomous animals (snakes & scorpion)
(https://researchmatters.in/sites/researchmatters/files/styles/large_800w_scale/public/Bigfour%20snakes.jpg?itok=H49dIobj)

1.2 SCOPE OF VENOM

Forensic autopsy plays a vital role in establishing the definitive cause of death in cases involving venomous bites or stings(5). A through evaluation begins with analysis of the victim's medical history and the circumstances surrounding death, including environmental exposure and possible contact with venomous animals, as well as any available information aiding species identification. Toxicological analysis is central to the investigation and involves the detection of venom, specific proteins or enzymes in postmortem blood, urine, or tissue samples, which can help confirm envenomation, assess venom concentration, and estimate the severity and timing of exposure(6). Autopsy findings may reveal characteristic local and systematic effects of venom, such as puncture or fang marks, hemorrhage, tissue necrosis, muscle breakdown, inflammation, nerve damage, internal bleeding, and evidence of organ failure, particularly in the lungs, heart, liver, or kidney(6). Advanced techniques, including immunoassays and molecular testing, may further support species identification through venom markers.

From a legal and forensic standpoint, accurate interpretation of these findings is essential to determine the manner of death- most commonly accidental, but occasionally suicidal or homicidal in rare cases involving intentional administration of venom. Forensic experts must carefully correlate autopsy results, toxicology, and circumstantial evidence to rule out foul play. While forensic investigation focuses on postmortem diagnosis, medical management of venomous injuries emphasizes rapid administration of species- specific antivenom, supported by critical care measures such as mechanical ventilation, fluid resuscitation, and symptomatic treatment(7). Preventive strategies, including public education, use of protective equipment, and first-aid awareness in high-risk areas, remain crucial in reducing venom related mortality. Collectively, venomous deaths represent complex medico-legal events requiring close collaboration between clinicians, toxicologists, and forensic pathologists to ensure accurate diagnosis, effective prevention, and proper administration of justice.

2. REVIEW OF LITERATURE

Ennik.**F.*et al*.(1980),**Suggested that "Deaths from Bites and Stings of Venomous Animals" analyses mortality data in California from 1960 to 1976, finding that Hymenoptera (bees, wasps, and ants) caused 56% of deaths, followed by snakes at 35%. The average annual death rate was 0.01 per 100,000 population, with a higher incidence in males.Vulnerable groups included children under five for snake bites and older adults for insect stings, often leading to

anaphylaxis.The study highlights the need for better identification of venomous species in medical records and improved public health policies to prevent fatalities.

White.J.*et al.*(2000),Researched on Venomous and poisonous animals pose significant health risks globally, with a particular focus on Australia, where elapid snakes cause over 3 million bites and more than 150,000 deaths annually. These snakes have potent venoms containing neurotoxins and myotoxins, while lacking local necro toxins. Australia has developed specific antivenoms and a venom detection kit to improve treatment accuracy. Additionally, dangerous spiders like the funnel-web and redback contribute to antivenom use. The marine environment also contains various toxic species, highlighting both health risks and research opportunities. Understanding these animal's clinical impacts is essential for effective treatment and public health strategies.

Gold.B.*et al.*(2002),Emphasized that the medical and forensic literature defines death as the irreversible cessation of vital functions, with brain death accepted as the most definitive criterion, while postmortem changes such as rigor mortis, livor mortis, and algor mortis are essential for estimating the time since death and determining its cause. Venomous deaths represent a distinct category of chemical fatalities resulting from envenomation by animals such as snakes, insects, spiders, and marine species. Studies consistently report that snake envenomation, particularly by neurotoxic and hemotoxic species, is a leading cause of venomrelated mortality, producing fatal outcomes through paralysis, coagulopathy, shock, and respiratory failure. Insect stings, especially from bees and wasps, are frequently associated with fatal anaphylaxis, while marine toxins like tetrodotoxin cause rapid neuromuscular paralysis. Forensic investigations emphasize the integration of scene findings, autopsy evidence, and toxicological analysis to confirm envenomation and distinguish venomous deaths from other causes. Overall, the literature underscores the medico-legal complexity of venomous deaths and the need for accurate forensic diagnosis and preventive strategies.

Gwee.M.*et al.*(2002),Enlightened that venoms consist of complex mixtures of bioactive compounds, including those that target ion channels and the autonomic nervous functions. The findings indicate that the venom of medically important scorpions, particularly of the family Buthidae, is highly neurotoxic, can modulate the functions of both sodium and potassium channels, and thereby causes an over-release of autonomic neurotransmitters with severe cardiovascular, respiratory, and neurological symptoms and usually fatal results. However, studies related to the Asian black scorpions suggest that the venom does not exhibit potent neurotoxicity, and the symptoms are driven mainly by the action of certain neurotransmitters, including acetylcholine and noradrenaline; thus, there are more local rather than highly toxic outcomes. In general, the salient feature of the reviewed articles is the importance of interspecies variability in terms of the composition and potency of scorpion venom, a consideration that is highly relevant to clinical and therapeutic use of antivenoms.

Singh.B.*et al.* (2006),Researched thatPoison is a big world health worry. Each year, over one million cases are told. But the true count may be way more. This is true in places that grow fast. Many cases do not get told there. More poisons, life changes, & wide use of bug sprays & drugs up the poison cases. On plan, some harm with OP bug spray. This is a big worry in poor spots. It leads to lots of deaths, up to 20%due to slow & weak care. The World Health

Group says over 200,000 die each year from bug spray. OP stuff alone makes up 3 million cases and 300,000 deaths all over, each year. A study at Govt. Wenlock Hospital, Mangalore, India (2001-2003) saw that sharp poison made up 1% of those who came in. Most were young adults (21-30 years), with a lot more men than women (2.4:1). This shows we need data & info for each place to find & treat poison fast. This will cut the harm & deaths from poison.

Warell.D.(2010),Said thatvenom envenoming deaths are significant and well documented in medical and forensic literature, mostly in tropical regions. Animal venoms are intricate compounds of bioactive proteins and enzymes displaying neurotoxicity, hemotoxicity, cytotoxicity, and myotoxicity, resulting in fatal respiratory distress, shock, hemorrhage, or organ collapse. Snake bite envenoming is more extensively documented, but cobras, kraits, and vipers are responsible for the highest number of fatalities, whereas the autonomic toxicity of scorpion venom stands out for its ion-channel modulating toxins. Insect stings, especially those of bees and wasps, can lead to fatal anaphylactic shock, whereas the neurotoxicity of certain marine toxins, such as tetrodotoxin, generates immediate neuroparalytic symptoms. The forensic literature stresses that in any of these reported deaths, particular attention must focus on the scene investigation, necroscopic data, and toxicological assays in the identification process. Generally speaking, the current data emphasize the medico-legal significance of fatalities due to venom exposure, requiring an ipsilateral forensic assessment.

Adukauskiene.D.*et al*.(2011),Suggested thatVenomation due to venomous animals has long been acknowledged within the literature as a significant medical and forensic issue, with the venom described as a ‘complex mixture of enzymes, peptides, and biologically active toxins, which have neurotoxic, hemotoxic, cytotoxic, and myotoxic actions. Adukauskiene et al. (2011) indicated that the venomation due to snakes is responsible for the ‘greatest number of venomation deaths’, which is due to the venom comprising phospholipases and metalloproteinases that cause paralysis, coagulopathy, hemorrhaging, tissue necrosis, and organ failure’, and the ‘venom of scorpions and insects is primarily known for its strong neurotoxic and autonomic actions, which are followed by cardiovascular and respiratory failure’. However, within the literature, it has been acknowledged that various factors contribute to the severity of venomation, including the species of the venomous animal, the ‘dosage and point of venomation’. In the context of forensic medicine, the correct postulation and determination of death due to venomation is subject to proving, within the context of clinical history, ‘at the crime site, autopsy, and toxicological analysis, that the venom is the cause of death’.

Parkinson.Z.*et al*.(2012),Implied thatVenomous snake bite accidents are not rare in Europe. They have been a concern for both medical professionals and forensic experts. There were documented instances of over 1,600 snake bite patients treated in Spanish hospitals from 1997 to 2009 by SazParkinson et al. (2012). Most such cases were identified to have been contributed by indigenous vipers. However, the death rate was low but considerable. Various biological constituents of viper venom have been explained by medical journals. Proteolytic enzymes and phospholipases have been identified to contribute to tissue damage, ·coagulopathy, systemic toxicity by such medical professionals. Studies also indicate increased vulnerability of the male genders of every age group along with the elderly.

Forrester.J.*et al*.(2012),Reviewed thatBetween 1999 and 2007, there were 1,802 fatalities due to animal encounters, averaging 200.2 deaths annually. The number of deaths varied from 167 in 2001 to 230 in 2005.

- Venomous vs. Nonvenomous Animals: Venomous animals caused 713 deaths (79.2 per year), while nonvenomous animals accounted for 1,089 deaths (121.0 per year). Notably, hornets, wasps, and bees were responsible for 28.2% of fatalities among venomous animals.
- Gender Disparities: Males represented 73.2% of all animal-related deaths, with 80.9% of fatalities from hornets, wasps, and bees. Males were also predominantly killed by "other mammals" (76.9% of deaths). In contrast, females accounted for the majority of fatalities in "other reptiles" (50.6%) and scorpions (60.0%).

This data highlights the need for targeted safety measures and awareness programs, particularly for highrisk groups. Further research is essential to understand the factors contributing to these fatalities and to develop effective prevention strategies.

Goswami.P.*et al*(2014),Emphasized thatSnake envenomation is a major public health problem, particularly in the tropical countries like India due to a few venomous species of snakes like cobras, kraits, and vipers, which are responsible for nearly all the lethal cases. The literature reports that the venom in snakes is a complex mixture of enzymes, peptides, and toxins like phospholipase A2, neurotoxins, hemotoxins, and cytotoxins, which give rise to multiple systemic symptoms such as neuroparalysis, coagulopathy, hemorrhage, tissue necrosis, and impairment of organs. In neuropa-ralytic venoms, respiratory paralysis is caused while in hemotoxic venoms there is disturbance in blood coagulation and vascular integrity resulting in shock and death. Antivenom is still the cornerstone in the treatment of envenoming, though their use is limited by unavailability and potential immunogenicity. In later years, increasing attention has been paid to the possible applications of snake venom in the treatment of cardiovascular diseases, cancers, and thrombotic diseases along with the utilization of medicinal plants in mitigating the action of the venom. The whole matter as reported in the literature, illustrates the dual role of venom in snakes, contributing to major lethality and utilization as a potential drug.

Forrester.J.*et al*.(2018),Reviewed thatBetween 2008 and 2015, animal-related encounters resulted in 1,610 fatalities, primarily from nonvenomous animals such as farm animals and dogs, as well as stings from hornets, wasps, and bees. The epidemiology of these fatalities mirrors findings from 1999 to 2007, indicating a persistent risk without significant improvements in treatment accessibility, particularly for anaphylactic reactions due to Hymenoptera stings. This underscores the urgent need for effective public health policies and prevention strategies to address the morbidity and mortality associated with animal encounters, especially in agricultural and residential settings.

Dandona.R.*et al*.(2018),Claimed thata study in Bihar, India, found that snakebites and other venomous animal encounters accounted for 10.7% of unintentional injury deaths, with a snakebite mortality rate of 4.4 per 100,000 population, particularly affecting rural areas and females. The highest fatalities occurred among children aged 10-14 years, often during common activities. Many victims did not receive timely medical treatment, highlighting the urgent need for improved public health interventions and preventive measures to reduce mortality and enhance outcomes for snakebite victims in the region.

Feola.A.*et al.*(2020), Suggested thatSnakebite is a bad but oft missed hot day sick. It mostly hits the poor in small spots of not rich lands. The World Health Org (WHO) says that each year 5.4 million snakebites hit, leading to 1.8–2.7 million sick folks, 81,000–138,000 deaths, & near 400,000 hurt for life. More than 600 of the 3,000 snake kinds all over are full of venom, with over 200 seen as key to fix. The worst bites are most from snakes in the Viper & Elapid groups, whose venom brings hard bad changes—big in blood, nerve, & cell harm—that hurt many parts & tools in us. Late fix, small reach to the right serum, & old fix tries oft lead to bad ends. Bad bites also show signs like tight guts, head & lung swell, small red leaks, key tube harm, wide blood mess, & at times, heart fail or brain leak. Spotting it stays hard due to broad spot of death signs, so looking at sad tales, bite marks, & venom tests is key to be sure. Even with new tools like ELISA, PCR, & big mass checks, their use is low in many hot spots. We need more know of venom acts & better dead body fix rules for right look at death causes & to build sharp health moves.

Chakma.JK.*et al.*(2020),Said thatSnakebite envenomation remains an important public health problem in India, associated with substantial morbidity and mortality, especially in rural and farming communities. However, it has been asserted in literature articles in "Indian Journal of Medical Research" that despite being an important issue, it is still a "neglected tropical disease," further worsened by poor connectivity to medical facilities, delayed care, and an inefficient system of surveillance. It is asserted that most deaths due to snake bites are amenable to medical care, particularly antivenom administration within a short time frame, along with critical care facilities. Moreover, it is pointed out that underreporting of deaths due to snake bites, further inaccurately classified, leads to an underestimation of the true burden of the disease. Seasonal variations, occupational hazards, and socio-economic factors have proved to be significant in understanding "epidemiology of occurrences of snake bites." For "medico-legal investigations," literature articles have underlined that "recording, reporting, and integrating medical, epidemiological, and forensic components of a case lead to better case identification and mortality estimates."

Bolon.I.*et al.*(2020),Incorporated thatSnakebite bites (SBE) lead to over 81,000 deaths & 400,000 bad turns each year. To fix it right, we need to know the snake type (BSN). A big look at 150 studies in 35 lands showed lots of ways to ID the BSN. This can be checking dead or caught snakes, what the hurt one or others say, looking at sick signs, lab tests, & more and more, snaps. While 70% see the snake, only 38% take it to health spo3ts. Both hurt ones and health folks face trouble in right ID, which can lead to wrong calls & bad fixes. Old ways to think, no good guide, & more types of snakes add to the mess. The part of old health folks in this is not yet known. Snapping the snake, as WHO says, is turning out as a good & safe pick over killing or catching snakes. It makes way for pro checks & snake snap banks. Solid ID ways & more team work among town folk, health staff, & snake pros are a must to lift results & help good SBE fix all over.

Suraweera.W.*et al.*(2020),Reviewed thatIV snakebite is a rare but very deadly type. It means the snake puts its venom straight into a vein. This leads to fast and big health drops like heart fails, nerve harm, & blood issues in just a few mins. Most snake bites put venom in skin or muscle & show slow signs. But IV bites skip the main body blocks. They cause fast & most times deadly ends. We don't know the exact how much this happens. This is due to not

much data, hard to spot, & missed post-death checks. Some case talks point to bites on skin veins-like the ankle, wrist, or hand-as spots for IV bites. These move fast to shock, heart stop, or bad blood clots. Tests on critters back this up. They show more deaths & faster big impacts with IV ways. In the med world, fast see of this is based on quick signs & bite spots by skin veins. There are no true big check tools yet. To deal with this, a lot of anti-venom & strong care is key. Even then, many times, it ends bad. The small know, studies, & checking ways show we need more work to learn & help with this not often talked of but could kill state.

Pucca.M.*et al.*(2020),researchedthatDry bites from bad snakes, with no venom shot in, are hard to spot. They show signs that look like bites from non-bad snakes, such as red, sore skin, ill spread, & fear-linked signs like fast heart rate & fast breath. As venom acts can be slow, it is key to tell dry from wet (bad) bites. This is big for the right help, more so in the choice to use anti-venom. A wrong guess may lead to use of anti-venom when not needed or, on the other hand, bad waits in fixing true bad bites. The thing of dry bites ties to the snake's want to keep venom for hunt, more so since men are not much prey. To make health facts better, aid givers must be set to make sure varied guesses. This needs more grasp of both snake acts & how men react. This points out the need for more look & strong data on all snakebites. This is to help right guess, care plans, & teaching for health care.

Naik.S (2023),according to Naik (2023), intravenous snake bite envenoming takes place when there is a low incidence of systemic poisoning from direct venom introduction into the veins. There will also be limited local symptoms in this kind of snake bite compared to other kinds. The venom from vipers also takes center stage in this kind of poisoning because of its cardiotoxic and vasodilatory properties. Early diagnosis and administration of antivenom in this kind of poisoning have been strongly emphasized in most studies despite high mortality rates that accentuate medico-legal value in this area of snake bite poisoning.

Krizaj.I (2023), concluded thatThe snake venoms represent complex and dynamically evolving mixtures of bioactive peptides and enzymes, displaying neurotoxicity, coagulopathy, myonecrosis, and cardiovascular collapse. The literature stresses interspecific diversity of venom composition, making it difficult to predict clinical toxicity and cross-reactivity of antivenom. The biomedical importance of venom components, as well as the impact of snake envenomation on global health, have been emphasized in recent studies of this area.

Afroz.A.*et al.*(2024), reviewed thatThe snakebite envenomation is documented in the literature as a significant yet underreported public health issue in South Asia, especially in rural areas. Afroz et al. described that delayed medical attention, reliance on traditional healers, lack of access to antivenom, and poor surveillance result in very high morbidity and mortality. Agricultural workers and young adults are the most affected, with seasonal and occupational exposures increasing the risk. Species-dependent variability in clinical outcomes includes respiratory failure due to neurotoxicity, coagulopathy, and death following hemotoxic envenoming. The literature reviewed stresses the importance of accurate reporting, improvement of healthcare facility access, and prevention to decrease snakebite-related mortality.

Sanci.A.*et al.*(2025)reviewed thatSnake bite envenoming has been well-documented as a serious medical and forensic issue, especially in rural areas, due to the resulting high

mortality associated with delayed treatment. Viperid snakes have been documented as the primary cause of death resulting from snake bite envenoming due to the hemotoxic, neurotoxic, nephrotoxic, and cardiotoxic effects of the venom that leads to coagulopathy, shock, and multi-organ failure. Autopsy reports have shown the presence of fang marks, hemorrhages, oedemas, and damage to vital organs such as the heart, lungs, and kidneys. The failure to use and the delayed use of antivenom have been established as the primary causal linkage for mortality following snake bite envenoming. Forensic analysis pinpoints the significance of investigating the crime scene and autopsy and toxicological analysis relevant for the confirmation of the cause and manner of death due to snake bites and differentiation from other natural and unnatural causes.

Vyas.N.*et al.* (2025) researched thatSnakebite harm is a big but not seen health problem in India. It causes near half of the world's snakebite deaths. This issue is worst in rural, farm areas when the rains come. Lots of studies show true troubles. Like low area know-how, trust in old healers, slow moves to get care, & not enough anti-snake venom (ASV). Bad first help, such as tight bands & cuts, is still in use. Many health help folk need new skills in how to deal with snakebites. Bad things like nerve harm, organ failure, & death can be stopped if help comes fast. The World Health Group's mark of snakebite as a lost warm land sickness in 2017 & India's own big plan in 2024 aim to fill gaps. They want to make better watch, teach, tell the public, & give ASV. The goal is to cut deaths & hurts by half by 2030.

Karunarathna.I.*et al* (2025),Suggested thatSnake bites hurt many, most in far places where help takes time. Books say that even with good meds & fast help, slow care, wrong calls, & not knowing well can harm a lot. This can cause shock, lost kid work, & tight spots. Right steps can bring good health, but docs need to know how to fix these fast. We must teach folks how to stay safe, use safe gear, & not do risky old ways. Good talk among help phones, quick help teams, & cut docs is key. Books say we need better snake meds, wide reach, & fair prices, with more teach & safe plans in towns to cut harm & death from bites.

Loria.S.*et al* (2025),Emphasised thatSnakebite envenoming is also cited extensively as a major contributor to mortality, especially in tropical countries, with its toxins exhibiting neurotoxicity, hemotoxicity, and cardiotoxicity that cause respiratory failure, coagulopathy, and shock. In most of these deaths, delayed treatment and inadequate antivenoms are noted to be major factors. In forensic analysis, autopsy analysis to distinguish wound marks from bites caused by the fangs of the snake, hemorrhages, and organ injury is deemed critical to determine that deaths result from snakebites. In general, accessible treatment and forensic analysis are critical to prevent avoidable deaths from snakebites.

3. METHODOLOGY

Verbal Autopsy(Population-Based Mortality Surveillance)

- Trained field workers conducted structured verbal autopsy interviews with relatives to record symptoms, circumstances, and events leading to death.
- ICD-10 Codes being the Cause of death Implied by doctors.
- Disagreements resolved via expert adjudication or reconciliation
- Data stastistically weighted and analyzed to estimate population-level cause specific mortatilty rate(eg.from posisonous animals to snakebites)

- Summarized and discussed Findings from previously published studies on snake venom science
- Comparative venomics research, transcription/protoeomic analysis, Pharmacological assays, clinical antivenom studies, and evolutionary genetics.
- Qualitative interpretation of existing literature to highlight methododlogical trends,and clinical implications.
- Toxicology screening combined with clinical history identified snakebite-related anaphylaxis/complications as cause of death; ruled out other causes and administered drugs

4. RESULTS AND DISCUSSION

Deaths due to snakevenom exposure remain significantly underreported, primarily because many affected individuals live in areas with limited or no access to nearby medical aids. Accurate estimation of mortality from snakebites and other venomous animal encounters is improved when physicians systematically review the circumstances surrounding each death and assign causes using standardised coding systems. These coding systems enable a clear understanding of the true burden of snake bite-related and other venom-induced deaths at the population level. Understanding the composition of venom has advanced significantly as a result of research on snake venom. Toxinologisthave shown that venom composition can differ significantly even between snakes of the same species from different geographic locations using methods like proteomic and genetic analyses. This variability contributes to the inconsistent efficacy of currently available antivenoms and causes varying clinical manifestation after envenomation. These results emphasise the critical need to increase snakebite victimsaccess to quality medical care and to integrate research findings into public health initiatives. In addition to improving the efficacy of snakebite treatment, ongoingresearch into snake venom is crucial for lowering mortality through improved envenomation case management, diagnosis and prevention.

Clinical observational and autopsy studies suggested that fatal envenoming is often complicated by systematic hemorrhage, coagulopathy, visceral injury, and hemodynamicshock. Histopathology and toxicological evidence supported the role of envenoming in causing mortality, while clinical evidence suggested that patient outcomes are largely dependent on early diagnosis, timely antivenom administration, and optimal treatment strategies.

5. CONCLUSION

Death is the irreversible end of the vital life functions of the organism and brain death is the clearest indication of it in the medical world today. The body goes through a number of changes after death such as autolysis (self-digestion), putrefaction and the changes that occur to the muscles causing rigor mortis (stiffening), livor mortis (blood settling), and algor mortis (body cooling). These are the main elements of forensic pathology in estimating the time of death and also determining the cause and manner of death. Venomous deaths are a unique and intricate group of chemical fatalities resulting from the poison of a diverse range of animals such as snakes, insects, spiders, and sea creatures. The animal toxins can have

various effects—neurotoxic, hemotoxic, cytotoxic, and myotoxic—which might work together to cause a very rapid and often lethal demise through respiratory failure, heart attack, shock, or choking.

The exact forensic analysis of venom-related deaths is an intricate process, including meticulous examination at the post-mortem site, autopsy analysis, and sophisticated toxin analysis to detect venom-specific compounds. It is always necessary to distinguish between venom-related deaths and other natural/death by unnatural causes in order to establish the exact cause of death. Although recent developments in antivenom treatment and critical care medicine have increased survival rates, the main attention should be focused on the preventative aspect in the form of education and safety measures.Suggest In essence, venom-related deaths today are in need of an interdisciplinary approach by forensic pathologists, physicians, toxicology experts, and law enforcement agencies to provide exact identification, proper prevention, and proper administration of justice.

REFERENCES

1. Nagel, T. (1970). Death. *Noûs, 4*(1), 73–80. https://doi.org/10.2307/2214297

2.Teo, C. H., Hamzah, N. H., Hing, H. L., & Hamzah, S. P. A. A. (2014). Decomposition process and post mortem changes: Review. *Sains Malaysiana, 43*(12), 1873–1882.

3. GBD 2019 Snakebite Envenomation Collaborators. (2022). Global mortality of snakebite envenoming between 1990 and 2019. *Nature Communications, 13*, 6160. doi:10.1038/s41467-022-33627-9

4. Hodgson, E. (2012). *Toxins and venoms.* In *Progress in Molecular Biology and Translational Science* (Vol. 112, pp. 373–415). Academic Press. doi:10.1016/B978-0-12-415813-9.00014-3

5. Langley, R. L., McFee, R. B., & Afzal, S. (2002). *An autopsy approach to bee sting-related deaths*. *Pathology*, *34*(3), 257–262. doi:10.1080/00313020220131327

6. Chen, L., & Huang, G.-z. (2013). *Poisoning by toxic animals in China: 18 autopsy case studies and a comprehensive literature review*. *Forensic Science International, 232*(1–3), e12–e23. doi:10.1016/j.forsciint.2013.08.013

7. Isbister, G. K., Graudins, A., White, J., & Warrell, D. (2003). *Antivenom treatment in arachnidism*. *Journal of Toxicology: Clinical Toxicology*, *41*(3), 291–300. doi:10.1081/CLT-120021114

8. Ennik, F. (1980). *Deaths from bites and stings of venomous animals*. The Western Journal of Medicine, 133(6), 463–468.

9. White, J. (2000). *Bites and stings from venomous animals: A global overview*. Therapeutic Drug Monitoring, 22(1), 65–68. https://doi.org/10.1097/00007691-200002000-00014-14

10. Gold, B. S., Dart, R. C., & Barish, R. A. (2002). Bites of venomous snakes. *The New England Journal of Medicine, 347*(5), 347–356. https://doi.org/10.1056/NEJMra013477

11. Gwee, M. C. E., Nirthanan, S., Khoo, H.-E., Gopalakrishnakone, P., Kini, R. M., & Cheah, L.-S. (2002). *Autonomic effects of some scorpion venoms and toxins*. Clinical and Experimental Pharmacology and Physiology, 29(9), 795–801. https://doi.org/10.1046/j.1440-1681.2002.03731.x

12. Singh, B., & Unnikrishnan, B. (2006). *A profile of acute poisoning at Mangalore (South India)*. *Journal of Clinical Forensic Medicine, 13*(3), 112–116. https://doi.org/10.1016/j.jcfm.2005.09.005

13. Warrell, D. A. (2010). *Snake bite*. The Lancet, 375(9708), 77–88. https://doi.org/10.1016/S0140-6736(09)61754-2

14. Adukauskienė, D., Varanauskienė, E., &Adukauskaitė, A. (2011). *Venomous snakebites*. Medicina (Kaunas), 47(8), 461–467.

15. Saz-Parkinson, Z., del Pino Luengo, M., López-Cuadrado, T., Andújar, D., Carmona-Alférez, R., Martín-Flores, R., & Amate, J. M. (2012). *Approach to the epidemiology of venomous bites in Spain*. Toxicon, 60(8), 1314–1324. https://doi.org/10.1016/j.toxicon.2012.03.021

16. Forrester, J. A., Holstege, C. P., & Forrester, J. D. (2012). *Fatalities from venomous and nonvenomous animals in the United States (1999–2007)*. Wilderness & Environmental Medicine, 23(2), 146–152. https://doi.org/10.1016/j.wem.2012.02.012

17. Goswami, P. K., Samant, M., & Srivastava, R. S. (2014). *Snake venom, anti-snake venom and potential of snake venom*. International Journal of Pharmacy and Pharmaceutical Sciences, 6(5), 4–7.

18. Forrester, J. A., Weiser, T. G., & Forrester, J. D. (2018). An update on fatalities due to venomous and nonvenomous animals in the United States (2008–2015). *Wilderness & Environmental Medicine*, *29*(1), 36–44. https://doi.org/10.1016/j.wem.2017.10.004

19. Dandona, R., Kumar, G. A., Kharyal, A., George, S., Akbar, M., &Dandona, L. (2018). Mortality due to snakebite and other venomous animals in the Indian state of Bihar: Findings from a representative mortality study. *PLOS ONE*, *13*(6), Article e0198900. https://doi.org/10.1371/journal.pone.0198900

20. Feola, A., Marella, G. L., Carfora, A., Della Pietra, B., Zangani, P., & Campobasso, C. P. (2020). Snakebite envenoming a challenging diagnosis for the forensic pathologist: A systematic review. *Toxins*, *12*(11), 699. https://doi.org/10.3390/toxins12110699

21. Chakma, J. K., Menon, J. C., & Dhaliwal, R. S. (2021). *White paper on venomous snakebite in India*. *Indian Journal of Medical Research*, *152*(6), 568–574. https://doi.org/10.4103/ijmr.IJMR_3377_20

22. Bolon, I., Durso, A. M., Botero Mesa, S., Ray, N., Alcoba, G., Chappuis, F., & Ruiz de Castañeda, R. (2020). Identifying the snake: First scoping review on practices of communities and healthcare providers confronted with snakebite across the world. *PLOS ONE, 15* (3), Article e0229989. https://doi.org/10.1371/journal.pone.0229989

23. Suraweera, W., Warrell, D., Whitaker, R., Menon, G., Rodrigues, R., Fu, S. H., Begum, R., Sati, P., Piyasena, K., Bhatia, M., Brown, P., & Jha, P. (2020). Trends in snakebite deaths in India from 2000 to 2019 in a nationally representative mortality study. *eLife, 9,* Article e54076. https://doi.org/10.7554/eLife.54076

24. Pucca, M. B., Knudsen, C., Oliveira, I. S. de, Rimbault, C., Cerni, F. A., Wen, F. H., Sachett, J., Sartim, M. A., Laustsen, A. H., & Monteiro, W. M. (2020). *Current knowledge on snake dry bites*. Toxins, 12(11), Article 668. https://doi.org/10.3390/toxins12110668

25. Naik, S. S., & Naik, S. S. (2018). Profile of fatal snakebite cases in rural Mandya: A retrospective study. *Indian Journal of Forensic Medicine and Pathology*, *11*(4), 227–230. https://doi.org/10.21088/ijfmp.0974.3383.11418.4

26. Krizaj, I. (2023). Toxinology and pharmacology of snake venoms. *Toxins*, *15*(3), 212. https://doi.org/10.3390/toxins15030212

27. Afroz, A., Siddiquea, B. N., Chowdhury, H. A., Jackson, T. N. W., & Watt, A. D. (2024). Snakebite envenoming: A systematic review and meta-analysis of global morbidity and mortality. *PLOS Neglected Tropical Diseases*, *18*(4), Article e0012080. https://doi.org/10.1371/journal.pntd.0012080

28. Sancı, A., & Kaya, B. (2025). Death due to Artvin viper bite: A case report. *Genel Tıp Dergisi*, *35*(2), 393–397. https://doi.org/10.54005/geneltip.1596435

29. Saha, S., Behera, S., Kotekar, S. U., Hameed, S., & Vyas, N. (2025). A scoping review on epidemiological risk factors and treatment modalities for snakebites in India. *Indian Journal of Public Health, 69*(1), 203–210. https://doi.org/10.4103/ijph.ijph_824_24

30. Karunarathna, I., Jayawardana, A., Fernando, C., Vidanagama, U. S. G., Ekanayake, U. P. N., Hapuarachchi, T. M. B., Gunasena, P., Aluthge, P., Perera, N., Gunathilake, S., De Alvis, K., Gunawardana, K., Rajapaksha, S., Rathnayak, B., Warnakulasooriya, A., Athulgama, P., Abeyek, M., Dius, S., Ranwala, R., Rodrigo, P. N. (2025). Comprehensive management in venomous snakebite: Diagnosis, prognosis and complications. *Uva Clinical Anaesthesia and Intensive Care*, *2025*, 1–7. https://cmb.academia.edu/IndonilKarunarathna

31. Loria, S. F., Framenau, V. W., Harvey, M. S., & Rix, M. G. (2025). The world's most venomous spider is a species complex: Systematics of the Sydney funnel-web spider (*Atracidae: Atrax robustus*). *BMC Ecology and Evolution*, *25*(1), Article 2. https://doi.org/10.1186/s12862-024-02332-0

.