NATIONAL GUIDELINE FOR THE MANAGEMENT OF SNAKEBITES (2024)

Zoonotic Disease Control Unit
Communicable Disease Division
Department of Public Health
Ministry of Health
Royal Government of Bhutan

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FOREWORD

Snakebite is a neglected tropical disease, causing medical emergencies in many parts of the world. There is a high incidence of snakebite morbidity and mortality particularly in South Asia although an accurate burden of snakebites is lacking in the region. However, most of the national estimates tend to rely on hospital-based data, which is generally underestimated.

The published information on snakebite is rare in Bhutan despite a significant number of cases with few deaths reported each year. One of the concerns is that victims present with complications due to delayed medical interventions because the majority of rural communities seek remedies from local healers.

In contrast to many serious health conditions, a specific and effective treatment exists. The prevention of mortality depends upon early identification and administration of antivenom at the right time with the right dose.

Therefore, the national guideline on the management of snakebites is developed based on the evolving evidence and international standards to enable our health professionals to manage snakebites as per this protocol efficiently and uniformly.

Karma Jamtsho
Director
Department of Public Health

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ABBREVIATIONS AND ACRONYMS

20 WBCT	: 20-minute whole blood clotting test
ABCDE	: Airway, Breathing, Circulation, Disability and Exposure.
AKI	: Acute Kidney Injury
ALT	: Alanine aminotransferase
aPTT	: Activated Partial Thromboplastin Time
AST	: Aspartate aminotransferase
ASV	: Anti Snake Venom
ATN	: Acute Tubular Necrosis
BUN	: Blood Urea Nitrogen
CMO	: Chief Medical Officer
CRRH	: Central Regional Referral Hospital
CT	: Computerised Tomography
CVD	: Cardiovascular Disease
DHIS II	: District Health Information System II
DoPH	: Department of Public Health
DVT	: Deep Vein Thrombosis
ECG	: Electrocardiogram
ERRH	: Eastern Regional Referral Hospital
FAD	: Forced Alkaline Diuresis
FEV-1	: Forced Expiratory Volume-1
FFP	: Fresh Frozen Plasma
FNPH	: Faculty of Nursing and Public Health
FoUGM	: Faculty of Undergraduate Medicine
FV	: Factor V
FVIII	: Factor VIII
GDMO	: General Duty Medical Officer

Hr	: Hour
ICU	: Intensive Care Unit
IgE	: Immunoglobulin E
IM	: Intramuscular
Inj	: Injection
INR	: International Normalised Ratio
IV	: Intravenous
IVF	: Intravenous fluid
KDIGO	: Kidney Disease Improving Global Outcomes
Kg	: Kilograms
KGUMSB	: Khesar Gyalpo University of Medical Sciences of Bhutan
Mcg	: Micrograms
Ml	: Milliliter
MoH	: Ministry of Health
MRI	: Magnetic Resonance Imaging
NS	: Normal saline
PO	: Program Officer
PT	: Prothrombin Time
RCDC	: Royal Center for Disease Control
SC	: Subcutaneous
SEA	: South-East Asia
SEARO	: South East Asian Regional Organization
SGOT	: Serum glutamic oxaloacetic transaminase
VICC	: Venom Induced Consumption Coagulopathy
WHO	: World Health Organization
ZDCU	: Zoonotic Disease Control Unit

INTRODUCTION

Snakebite is a neglected public health problem in many tropical and subtropical countries. Most of these occur in Asia, Africa, and South America. As per the WHO 2023 report, an estimated 5.4 million people worldwide are bitten by snakes each year with 1.8 to 2.7 million cases of envenomings. Around 81,410 to 138,000 people die each year because of snakebites, where nearly 70% of annual global snakebite deaths occur in South Asia alone. However, the true magnitude of mortality and morbidity from snakebite is not known because of inadequate reporting in almost every part of the region.

Snakebite is a common occupational hazard in the Bhutanese population as well. Some of the important occupational risk factors identified are agriculture workers, rearing livestock, and harvesting forest products. Likewise, children are also one of the vulnerable populations. Bhutan has recorded 1037 cases of snakebites in the last 5 years (as per the DHIS II). One of the primary challenges in managing snakebites stems from individuals turning to traditional, herbal, or ayurvedic remedies. These often lead to snakebite victims either not reporting the incidents or delaying treatment at the health centers.

In 2023, a total of 5145 bites and stings were reported (DHIS-II, MoH 2023). The District Health Information System gives combined reports on bites and stings including snakebites as well as the morbidity and mortality of snakebites as shown in Table 1. Four elapid species have been reported from lowland regions of Bhutan (less than 500 meters above mean sea level): cobra, king cobra, and two species of krait. Other venomous species such as N. kaouthia, Sinomicrurus macclellandi, Daboia russelii (“Bhutan Hills” according to MA Smith 1943), and several pit vipers may well occur there as well. There is limited published information on snakebites in Bhutan despite sporadic cases having been recorded in snakebite-endemic dzongkhags.

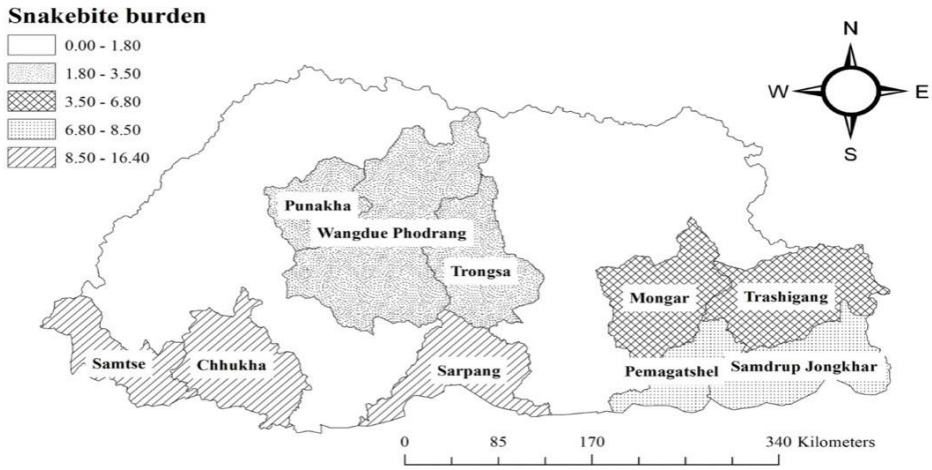


Figure 1: Map of Dzongkhags with average annual percent of snakebites cases in Bhutan

Sl. No.	Year	2019	2020	2021	2022	2023	Total
1	Morbidity	206	221	203	223	184	1037
2	Mortality	1	1	0	2	0	4

Table 1: The annual burden of snakebite envenoming and associated deaths in the country (Source: (Data from DHIS II)

snakebites are typically driven by defensive behavior or accidental encounters. Snakes often bite when they feel threatened or cornered. Seasonal peaks of snakebite incidences are usually associated with an increase in agricultural activity or seasonal rains, coinciding with unusual movement and activity by snakes. It is usually in the warm season from April to September when the snakes are active. The use of proper first aid, the availability of specific treatment at health facilities, and the health-seeking behavior of the victims determine the outcome of snakebites.

With the evolving scientific evidence and knowledge, much is now known about the species of venomous snakes responsible for these bites, the nature of their venoms, and the clinical manifestations of envenoming in humans. Anti-snake venom is the only effective and specific treatment for snake envenomation.

CLASSIFICATION OF SNAKE

Elapidae	Viperidae	Colubridae
• Relatively long and thin • Short fixed front fang • Uniformly coloured • Large smooth symmetrical scales on the top of the head	• Relatively short • Thick body with many small rough scales • Characteristic patterns of color • Long fangs, normally folded flat against the upper jaw, erected when strikes • Heat-sensing pit organ located between the nostril and eyes.	• Largest snake family: two-thirds of living snake species • Many different sizes, shapes, and colors • Lack venomous fangs • Most have wide scales • Some have glands, or groups of cells, behind each eye • Enlarged back teeth, known as rear fangs
• Cobras • King cobra • Kraits • Coral snakes • Australasian snakes • Sea snakes	• **Crotalinae (Vipers)** • Russell's viper • Pit vipers	• Red-neck Keelback • Buff-striped Keelback • Python • Rat Snake • Wolf Snake • Green Rat Snake

Table 2: Classification of snake

COMMON SNAKES IN BHUTAN

Venomous Snakes	Non-Venomous Snakes
1. Common Indian Cobra	1. Buff-striped keelback
2. Monocled Cobra	2. Python
3. King Cobra	3. Walnut Kukri Snake
4. Common Kraits	4. Rat Snake
5. Banded Krait	5. Wolf Snake
6. Greater Black Krait	6. Green Rat Snake
7. Lesser black krait	
8. Russell's Viper	
9. Mountain Pit Viper	
10. Green Pit Viper	
11. Himalayan Cat Snake	
12. Red-neck Keelback	
13. Coral snake	

(Source: Department of Forest; College of Natural Resources; Lobesa; Punakha; Bhutan)

Table 3: List of Common Snakes in Bhutan

Figure 2: Images of Venomous Snakes in Bhutan
(Picture courtesy: Mr. Kado Rinchen, Forest Ranger)

Figure 3: Images of Non-venomous Snakes in Bhutan
(Picture courtesy: Dr Suresh, CMO, Trongsa)

Identification of venomous snakes: There is no simple rule for identifying a venomous snake. However, some venomous snakes can be recognized by the presence of fangs, the shape of the head, the shape of the pupil, the presence of the pit, and their size, shape, color, pattern of markings, behavior, and sound they make when they feel threatened.

Identification of snakes based on description by victims or recognition from pictures is often unreliable. Occasionally, patients or accompanying persons may bring the killed snake for identification or have a picture of it. However, killing or taking pictures of snakes is discouraged as it wastes golden hours to seek treatment and also poses a risk of being bitten. Knowledge of local snake species, comparison of clinical effects in the patient against established species-specific syndromes, and consideration of the circumstances and timing of the incident can help infer likely biting species. This approach is widely used to guide treatment with polyspecific antivenom in endemic areas of Africa and Asia.

Snake venoms are a mixture of enzymes and non-enzymatic proteins that immobilize and digest the prey.

CLINICAL ASPECTS OF SNAKEBITE

All patients should be admitted for assessment and observation for at least 24 hours and immediately start treatment if necessary.

History taking:

A precise history of the circumstances of the bite, and the progression of local and systemic symptoms are very important.

Four useful initial questions:

1) *"Where have you been bitten?"*
2) *"When were you bitten and what were you doing?"*
3) *"Have you seen the snake?"*
4) *"How are you feeling now?"*

These answers might give a clue to the identification of the snake and direct the doctor to the system involved *(e.g If the patient was bitten at night while asleep, a krait was probably implicated; if in a paddy field, a cobra or Russell's viper; if while tending fruit trees, a green pit viper; if while swimming or wading in the water, a cobra.)*

Past medical and medication history should be noted especially the use of anticoagulants

Signs and symptoms of snakebite

1) **General symptoms:**
   - Fear and anxiety (hyperventilation, sweating, tremors, nausea)

2) **Local envenoming-** confined to the part of the body that has been bitten. These effects may be debilitating, sometimes permanently.
   - Fang marks
   - Local pain and tenderness
   - Local bruising and bleeding
   - Local swelling spreading proximally
   - Lymph node enlargement and lymphangitis draining the bite site

- Inflammation (swelling, redness, heat)
- Blistering(blebs, bullae, vesicles)
- Local infection and abscess formation
- Necrosis and ulceration

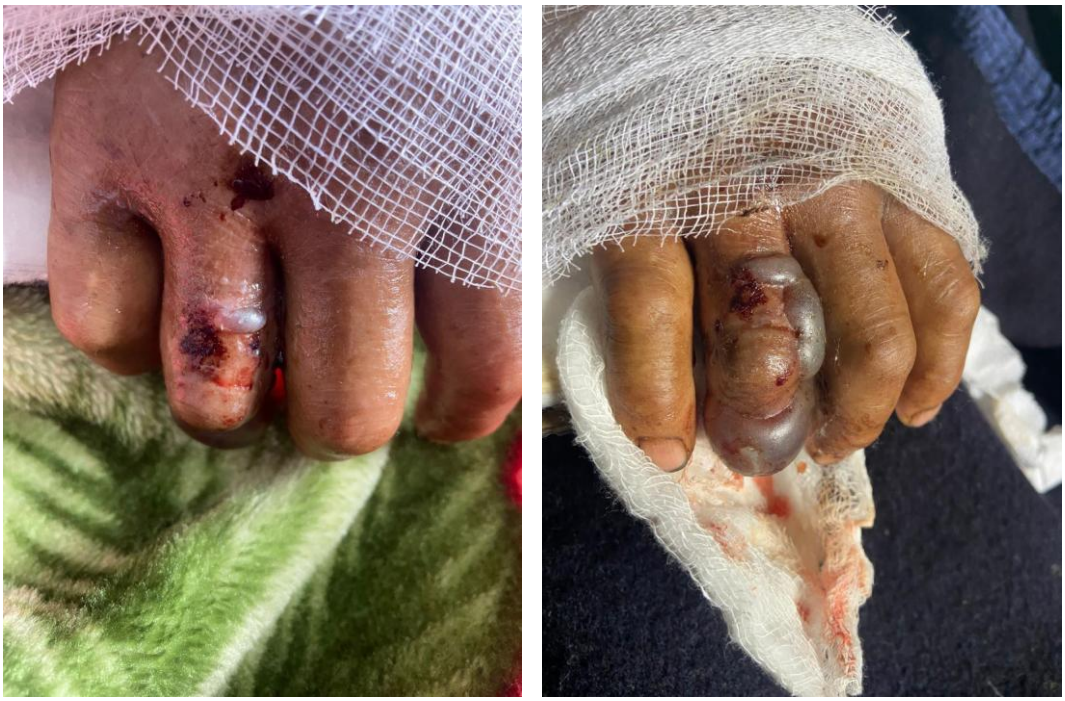


Figure 4: Images of local envenomation
(Picture courtesy: Dr Suresh, CMO, Trongsa)

3) Systemic envenoming- involving organs and tissues away from the part of the body that has been bitten. These effects may be life-threatening and debilitating, sometimes permanently.

General symptoms of systemic envenoming: Nausea, vomiting, malaise, abdominal pain, weakness, drowsiness, and prostration.

Neurotoxicity	Hemotoxic	Myotoxicity	Total
Ptosis Ophthalmoplegia Pupillary dilatation Drooling Speech difficulty Dysphagia Gait disturbance Diminished or absent deep tendon reflexes Intercostal and skeletal muscle weakness	Petechiae Purpura Bruising Epistaxis Gum bleeding Malena Hematuria Bleeding and oozing from old wounds and cannula site Intracranial hemorrhage	Muscle pain and tenderness Muscle weakness Trismus Compartment syndrome Dark urine -myoglobinuria and hemoglobinuria (Rhabdomyolysis) Reduced urine output Acute renal failure Cardiac arrest (hyperkalemia)	Visual disturbance, dizziness, faintness, collapse, shock, hypotension, Cardiac arrhythmia, and myocardial damage. Tachycardia Signs of poor perfusion (prolonged capillary refill, decreased urine output, altered mental status)

Clinical syndromes of snakebite:

It is important to know the biting species of snake to anticipate likely course of envenoming and potential complications that can either be anticipated, prevented or treated. It may be confusing sometimes as there may be considerable overlap of clinical features caused by venoms of different species of snake. However, description of the circumstances of bite and distinctive clinical manifestations based on epidemiological, clinical and laboratory data may help identify the biting species of snake.

Syndrome I
Local envenoming with bleeding/clotting disturbances - ***Viperidae*** *(all species)*

Syndrome II
Local envenoming with bleeding/clotting disturbances, shock or acute kidney injury, conjunctival oedema (chemosis) and acute pituitary insufficiency, with ptosis, external ophthalmoplegia, facial paralysis, bilateral parotid enlargement, pleural and pericardial effusions, pulmonary oedema, massive albuminuria, haemoconcentration. Multiple bleeding and clotting disorders.Russell's viper.

Syndrome III
Local envenoming with paralysis - ***Cobra or King cobra***

Syndrome IV
Paralysis with minimal or no local envenoming:
Bitten on land while sleeping on the ground - ***Krait***

Syndrome V
Paralysis with dark brown urine and acute kidney injury:
Bitten on land (with bleeding/clotting disturbance) - ***Russell's viper***
Bitten on land while sleeping indoors - ***Krait***

Investigations/laboratory tests

- 20-minute whole blood clotting test (20WBCT)

Procedure:

- Add 2 ml of freshly sampled venous blood in a small, new or dry, heat-cleaned glass tube
- Leave undisturbed for 20 minutes at ambient temperature.
- Tip the test tube once.

Interpretation:

- Positive - blood is unclotted or a weak friable clot that easily breaks when the tube is tipped.
- Negative - when blood clots

Sample collection **Negative:** Clotted **Positive:** Unclotted

Note:

- A positive test indicates that the patient has hypofibrinogenemia as a result of venom-induced consumption coagulopathy.
- A positive test is a probable diagnosis of a viper bite and rules out an elapid bite.
- If there is any inconsistent result, repeat the test with a "control" (blood from a healthy person such as a relative)
- 20WBCT can be repeated as needed

Caution:

- The test tube should be made of ordinary glass and do not use tubes,syringe or other vessel that is made of plastic, polystyrene, polypropylene
- Do not use a glass test tube cleaned with detergent as this may not stimulate clotting of the blood and may result in a false positive

Other ancillary tests (if facilities are available)

Test parameters	Interpretation
Hematological indices	
Hemoglobin concentration/ Haematocrit:	Transient increase indicating haemoconcentration as a result of generalized increase in capillary permeability. More often, there is a decrease reflecting blood loss or intravascular hemolysis

Test parameters	Interpretation
Prothrombin time (PT/INR)	PT/INR >1.2 indicates coagulopathy (in absence of use of anticoagulants)
Platelet count:	Decreased in victims of envenoming by vipers
White blood cell count	Early neutrophil leucocytosis due to systemic envenoming from any species.
Blood film	Fragmented red cells (schistocytes) due to microangiopathic haemolysis.
Plasma or serum	May be pinkish or brownish in gross haemoglobinaemia or myoglobinaemia.
Biochemical abnormalities	
Liver enzymes	Aminotransferases (especially AST) will be elevated in severe local or generalized muscle damage.
Muscle enzymes(creatine kinase)	Increased in severe local or generalized muscle damage. For early detection of rhabdomyolysis.
Electrolytes	Hyperkalemia, hyperphosphatemia, hypomagnesemia, and hypocalcemia seen in rhabdomyolysis.
	Low bicarbonate in metabolic acidosis as a result of acute renal failure. Hyponatraemia is reported in victims of krait bites.
Renal function test	AKI is common after bites from myotoxic or hemotoxic snakes. Renal pathologic changes include tubular necrosis, cortical necrosis, interstitial nephritis, glomerulonephritis, and vasculitis. Hemodynamic alterations caused by vasoactive mediators and cytokines and direct nephrotoxicity account significantly for the development of nephropathy.
Arterial blood gas	May show evidence of respiratory failure (neurotoxic envenoming) and acidaemia (respiratory or metabolic acidosis). Arterial puncture is contraindicated in suspected coagulopathy.

Test parameters	Interpretation
Urine Routine Examination	Pink, red, brown, and black urine color due to haemoglobinuria or myoglobinuria Presence of erythrocytes in urine microscopy Presence of red cell casts indicating glomerular bleeding Presence of protein (albumin) is an early indicator of acute kidney injury by Russell's viper envenoming
Other additional investigations if indicated	
Electrocardiography	Tachyarrhythmias, sinus bradycardia, ST-T wave changes, varying degrees of atrioventricular block, tall T wave(hyperkalaemia), ischemic changes due to Myocardial infarction especially bites by Najah
Echocardiography	Decreased left ventricular ejection fraction seen in hypotensive and shocked patients.
Radiography	Chest radiography to detect pulmonary oedema (e.g. after bites by vipers), pulmonary hemorrhages and infarcts, pleural effusions, and secondary bronchopneumonia.
Ultrasound:	To detect DVT, pleural and pericardial effusions and bleeding in serous cavities.
CT and MRI brain	To detect intracranial hemorrhages and ischaemic changes

Note: There are many point-of-care testing methods (venom detection kits) in development elsewhere;including lateral flow assays, enzyme-linked immuno-sorbent assays that can specifically identify the types of snake species envenomation. These can help guide the physician to use mono-valent anti-venoms.

MANAGEMENT OF SNAKEBITES

First aid treatment and transport to the nearest hospital

First aid should be provided immediately after the bite if possible, before the patient reaches a primary health care center or hospital. It is an attempt to slow down the systemic absorption of venom. It can be performed by the snakebite victims themselves or by anyone else who knows how to provide first aid.

- Reassure the victim who may be very anxious
- Minimize movement and exertion of the victim
- Immobilize the bitten limb with a splint or sling. Any movement or muscular contraction increases the absorption of venom into the bloodstream and lymphatics
- Remove any ornaments and tight clothing before swelling starts
- If the necessary equipment and skills are available, consider pressure immobilization or a pressure pad unless an elapid bite can be excluded
- The patient should be transported to the nearest health care center as soon as possible (do not let the patient walk)

DON'TS of First Aid

Tight tourniquets are not recommended as the limb might get damaged by ischaemia.

Release of tight bands, bandages and ligatures: Ideally, these should not be released until the patient is under medical care in hospital, resuscitation facilities are available and antivenom treatment has been started.

Avoid any interference with the bite wound (incisions, rubbing, vigorous cleaning, massage, application of herbs or chemicals) as this may introduce infection, increase absorption of the venom and increase local bleeding.

Do not kill or handle the snake as even a severed head can bite and are poisonous!

Management at the Primary Health Care Center or Hospital

Management at the Primary Health Care Center or Hospital

Perform the Quick Check
Airway, Breathing, Circulation, Disability, and Exposure (ABCDE) and Evaluate for life-threatening conditions.
Resuscitate immediately if necessary (refer ANNEX 1)

Examine the site of the bite for signs of fang marks, local necrosis, blister formation, or bleeding, swelling, and tender regional lymph nodes.

Assess for non-specific symptoms of systemic envenomation: nausea, vomiting, abdominal pain, dizziness, and headache.

Assess for bleeding

- External: from gums, subconjunctival, skin ecchymosis or petechiae, wounds, or ulcers, needle puncture sites
- Internal: intracranial, gastro-intestinal and genitourinary
- Perform the 20-minute whole blood clotting test (20WBCT) and check platelet count

Other sensitive tests include: PT/INR and aPTT, D-dimer, fibrinogen if available

Assess for signs of neurotoxicity

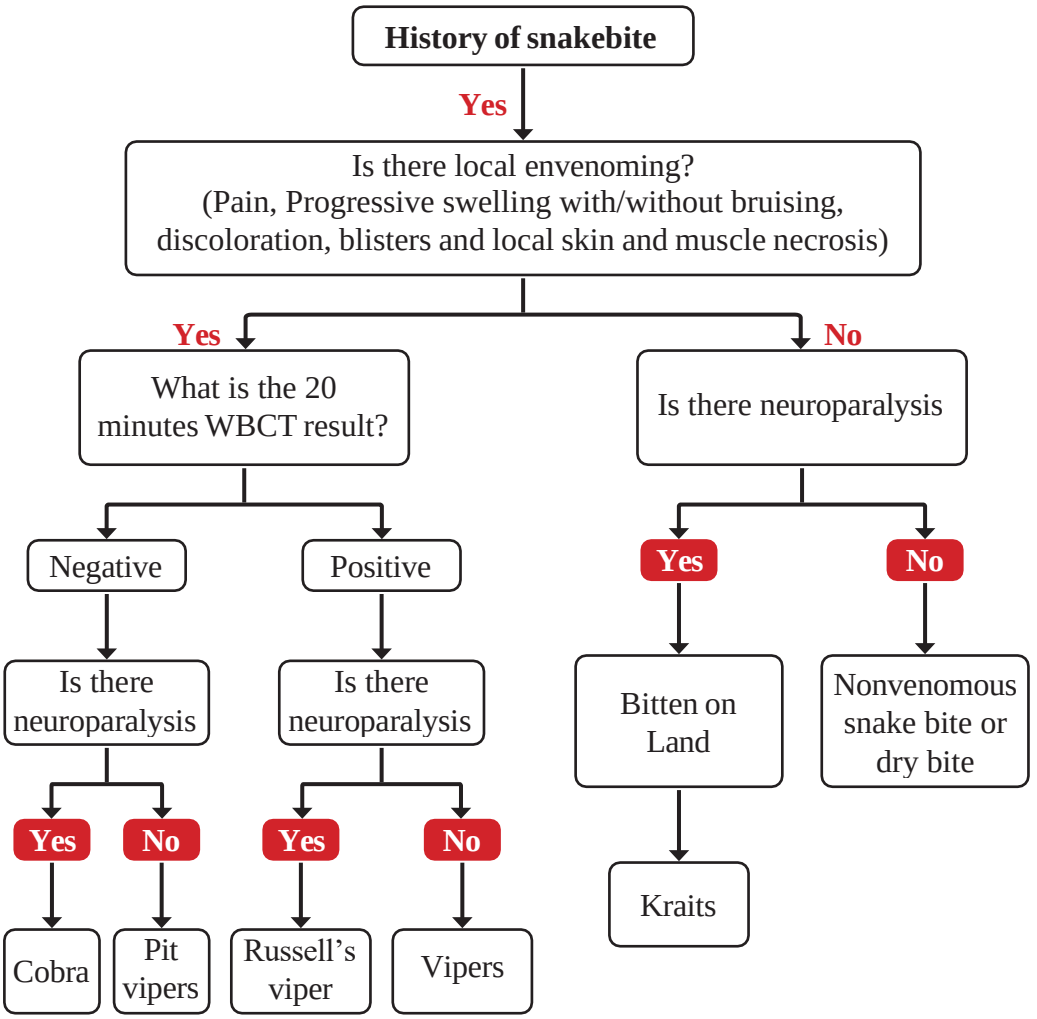
- Ptosis, double vision, difficulty swallowing and talking, neck muscle weakness (broken neck sign), difficulty breathing and paralysis with respiratory failure.

Assess for signs of muscle breakdown

- Muscle pains and black urine
- Urine dipstick test (if available) may be positive for hematuria
- Raised serum alanine transaminase (ALT), aspartate transaminase (AST) and creatine kinase.

Other investigations may include: Chest X-ray, ultrasonography

Diagnostic algorithm for snakebite



ANTIVENOM

Antivenom is immunoglobulin purified from the plasma of equine (horse, mule, donkey) or ovine (sheep) that has been immunized with the venoms of one or more species of snake.

There are two types of antivenom:

- **Monovalent**

Monospecific antivenom that neutralizes the venom of only one species of snake.

- **Polyvalent**

Polyvalent anti-snake venom serum raised in horses using the venoms of the four most important venomous snakes in India (Indian cobra, Common krait, Russell's viper, Saw-scaled viper). This antivenom is imported to Bhutan from India and it is available in lyophilized powder form.

Storage and shelf-life

To retain their full potency within the limits of stated expiry dates, lyophilised antivenoms (shelf life about 5 years) should be stored at below 25ºC and liquid antivenoms (shelf life 2-3 years) should be stored at 2-8 ºC and not frozen.

Indications for antivenom administration

Any of the following findings indicates the need to administer antivenom without delay:

Systemic envenoming	Local envenoming
• Evidence of neurotoxicity: ptosis, external ophthalmoplegia, paralysis etc. • Evidence of coagulopathy: INR >1.2, PT 4-5 seconds, platelet < 100,000/cu mm. • Evidence of cardiovascular abnormalities: hypotension, shock, cardiac arrhythmia, abnormal ECG. • Evidence of acute kidney injury: Oliguria/anuria, rising blood urea/ creatinine. • Evidence of hemoglobin-myoglobinuria: dark brown urine, urine dipstick, evidence of intravascular haemolysis/ rhabdomyolysis. • Supporting laboratory evidence of systemic envenoming.	• Progressive extension of swelling of the affected limb involving one major proximal joint within 24 hours (For example swelling beyond wrist or ankle in hand or feet). • Local swelling involving more than half of the bitten limb (in the absence of a tourniquet) within 48 hours of the bite. • Development of enlarged lymph nodes draining the bitten limb with other clinical signs of systemic envenomation.

Note:

- Antivenom is the only specific antidote to snake venom and the most important decision in the management of a snakebite victim is whether or not to give antivenom.
- Inappropriate use of antivenom should be strongly discouraged
- The risk of reactions should always be taken into consideration.

Antivenom administration and dosage

Premedication

Premedication with low-dose adrenaline is given before antivenom to prevent or reduce reactions.

Adrenaline (1:1000 solution)

- Adults (with no underlying ischemic heart disease or CVD)

  0.25 ml subcutaneously
- Children

0.005 ml/kg body weight subcutaneously

- WHO Guidelines 2016, p. 134

Premedication with antihistamine and hydrocortisone is NOT advocated
"Use of antihistamine, corticosteroid and the rate of intravenous infusion of antivenom (between 10 and 120 minutes), do not affect the incidence or severity of early antivenom reactions".

Note:

- Antivenom should be started as soon as it is indicated
- Skin sensitivity test and test dose is not recommended
- Anaphylactic dose of adrenaline should be drawn up and kept ready at the bed-side before antivenom is administered.
- Antivenom should be given by the intravenous (IV) infusion diluted in NS/5% Dextrose over 1 hour
- Patients must be closely observed for at least TWO hours after starting antivenom administration, so that early anaphylactic reactions can be detected and treated early.
- Local administration of antivenomatthesite of thebite is not recommended, as it is extremely painful, and may increase intracompartmental pressure.
- Intramuscular injection of antivenom is not recommended, as antivenoms are large molecules absorbed slowly via lymphatics and bioavailability is poor.
- Snakes inject the same dose of venom into children and adults. Children must therefore be given exactly the SAME dose as adults.

Route and dose of antivenom administration

System	Anti-Venom Dose
Neurotoxic Envenoming	Initial Dose • 10 vials (100 ml) diluted in 5%dextrose or saline (100 ml to 400 ml) over 60 minutes
	Repeat Dose • If neuroparalysis progresses over the next two hours, repeat same dose of antivenom Note: Do not repeat antivenom if there is no worsening of neurological signs and symptoms • **Do Not exceed 20 vials**
Hemotoxic Envenoming	Initial Dose • 10 vials diluted in 5% dextrose or saline (100 ml to 400 ml) over 60 minutes
	Repeat Dose • Repeat 20WBCT (or other test for coagulation) after 6 hours. • If 20WBCT is positive or other coagulation tests are abnormal, repeat 5 vials of antivenom over 60 minutes. • Continue the cycle till the blood clots. • The initial dose should be repeated after 1 hour if continued systemic bleeding. • **Do not exceed 30 vials.**
Local Envenoming	• Follow similar protocol of Hemotoxic Envenoming

Note:

- Pregnant women should be monitored for fetal distress, uterine contractions, vaginal bleeding and threatened abortion.
- Lactating women who have been bitten by snakes should be encouraged to continue breastfeeding.

Response to Treatment

- Systemic symptoms usually improve over minutes to hours.
- Hypotension may improve within the first 30-60 minutes.
- Coagulopathy usually resolves over a number of hours (depending on the snake species). Spontaneous bleeding ceases by about 20 minutes.
- Coagulation tests often normalize or whole blood clotting is restored by about 6-8 hours but depends on snake species. Repeat of 20-minute whole blood clotting test after 4−6 hours is recommended.
- Neuroparalysis stops progressing but does not recover immediately. Neurotoxic envenoming in cobra bites may begin to improve as early as 30 minutes whereas envenoming with presynaptic toxins (kraits and sea snakes) may respond gradually
- Local necrosis will not be reversed but should not progress.
- Active haemolysis and rhabdomyolysis may cease within a few hours and the urine returns to its normal color.
- Rarely signs of systemic envenoming may recur within 24–48 hours after treatment.

Antivenom reactions

Three types of antivenom reactions can occur after its administration

Early anaphylactic reactions	Pyrogenic (endotoxin) reactions	Late (serum sickness type) reactions
Starts within 0 - 180 minutes **Dermatological:** Itchy scalp; red, raised itchy rash; swollen eyes and face; generalized rash **Gastrointestinal:** diarrhea, nausea, vomiting, and abdominal pain **Respiratory:** Noisy breathing (wheeze or stridor), persistent cough, Cyanosis; swelling of tongue and lip; **Cardiovascular:** Tachycardia, hypotension; cerebral hypo-perfusion (decreased level/loss of consciousness).	Usually, these develop 1-2 hours after treatment. Symptoms include chills and rigor, fever, vasodilation, and hypotension. Febrile convulsions may be precipitated in children. These reactions are caused by pyrogen contamination during the manufacturing process. They are commonly reported.	Develop 1-12 (mean 7) days after treatment. Clinical features include fever, nausea, vomiting, diarrhea, itching, recurrent urticaria, arthralgia, myalgia, lymphadenopathy, periarticular swellings, mononeuritis multiplex, proteinuria with immune complex nephritis, and, rarely encephalopathy.

Management of Anaphylaxis

- Stop the antivenom immediately
- Put patient in recovery position, if required
- Check for airway, breathing and circulation
- Administer adrenaline injection as follows: (0.01mg/kg of the 1:1000)

Age	Dose
0 months - <12 months	0.05mg (0.05ml)
12 months - < 6 years	0.1mg (0.1ml)
6 years - <12 years	0.2mg (0.2ml)
12 years and above	0.5mg (0.5ml)

*****The route is IM at the anterolateral aspect of the thigh and can be given through the clothing**

- If no improvement after 5 minutes, repeat the dose two times if required.
- Give oxygen by face mask.
- Call for professional assistance but never leave the patient alone.
- Call an ambulance (or arrange other means of transportation) and a medical officer, if necessary, after the first injection of adrenaline, or sooner if there are sufficient people available to help you.
- Stabilize the patient and refer to the higher center for further management if necessary.

***Additional management for refractory anaphylaxis**

1) Patients in shock:
   - Lay the patient in supine position with their legs elevated
   - IV 0.9% saline (1-2 L rapidly in an adult)
   - IV adrenaline infusion (adult dose) 1 ml of (1 in 1000,1 mg/ml) in 250 ml 5% Dextrose or 0.9% NS.
   - Infuse at 1-4 mcg/minute (15–60 drops/min using a micro-dropper burette chamber), increasing to maximum 10 mcg/min).
   - In patients who remain hypotensive, a vasopressor agent such as dopamine (dose 400mg in 250ml of 5% dextrose or 0.9% saline infused at 2–5 mcg/kg/min)
2) Patients who are dyspnoeic, with bronchospasm or angioedema
   - Propped up at 45 degrees and oxygen inhalation
   - Nebulised/ inhaled and/or parenteral bronchodilator - salbutamol

Treatment of Pyogenic Reaction.

- Give paracetamol: Adult dose is 500 mg to 1 gm, 4 to 6 hourly. Maximum dose is 4 gm/day. Children 10-15 mg/kg . Maximum dose is 100mg/kg/day
- Do not interrupt antivenom unless hypotension is present.
- In presence of cardiovascular shock, in patient who received/receiving antivenom, should be treated as anaphylaxis

Note:

- After the patient has recovered from the early anaphylactic or pyrogenic reaction, the indications for antivenom therapy should be critically re-examined.
- If antivenom is still indicated, restart slowly for 10-15 minutes keeping the patient under close observation and then resume normal drip rate until the total dose has been given.

Treatment of Late serum sickness

- Antihistamine: Promethazine 25 mg twice a day * 3 days (Adults) and 0.25 mg/kg/day in divided doses* 3 days (children)
- Prednisolone: If no improvement with antihistamine
  Adults 5 mg six hourly and children 0.7 mg/kg/day in divided doses for 5-7 days.

Contraindications to antivenom

- There is no absolute contraindication.
- However, patients who have reacted to horse (equine) or sheep (ovine) serum in the past and those with a strong history of atopic diseases (especially severe asthma) are at high risk of severe reactions. Therefore, antivenom should only be given if they have signs of systemic envenoming

MANAGEMENT OF COMPLICATIONS

1. Treatment of neurotoxic envenoming

Antivenom treatment alone cannot be relied upon to save the life of a patient with bulbar and respiratory paralysis. Once there is loss of gag reflex and pooling of secretions in the pharynx, failure of the cough reflex, or respiratory distress, the patient will need airway protection and assisted ventilation.

- For airway protection and assisted ventilation, refer to Annexure 1.
- Trial of anticholinesterase: Anticholinesterase drugs have a variable, but potentially very useful effect in patients with neurotoxic envenoming, especially those bitten by cobras.

Neostigmine and Atropine combination Dosage schedule

Baseline observations or measurements are made against which to assess the effectiveness of the anticholinesterase. Atropine is given together with neostigmine to block its muscarinic side effects (bradycardia).

- Inj. Atropine 0.3mg-0.6mg IV followed by Inj. Neostigmine 0.01mg/kg up to 0.5mg IV or IM every 30 minutes ,until neurotoxic features improve((in adults)
- Inj. Atropine 0.02mg/kg up to 0.6mg followed by Inj. Neostigmine 0.025 to 0.04mg/kg up to 0.5mg IV or IM every 30 minutes (In children)

The patient is observed over the next 30-60 minutes for signs of improved neuromuscular transmission. Ptosis may disappear and ventilatory capacity (peak flow, FEV-1 or maximum expiratory pressure) may improve

Patients who respond convincingly can be maintained on :

- Inj. Neostigmine 0.5-2.5 mg (IM/IV/SC) with Atropine every 1-3 hours up to 10 mg/24 hours maximum for adults
- Inj. Neostigmine 0.01-0.04 mg/kg(IM/IV/SC) with atropine as above every 2-4 hours for children

Or

- Oral Neostigmine 15 mg four times a day
- Oral Atropine 0.6mg twice a day

Stop Atropine neostigmine dosage schedule if:

- Patient has complete recovery from neuroparalysis. Rarely can have recurrence, carefully watch patients for recurrence.
- Patient shows side effects in the form of fasciculations or bradycardia.
- If there is no improvement after 3 doses,this indicates probable krait bite

2. Management of haemostatic disturbances

- Venom-induced consumption coagulopathy (VICC) is due to the activation of the clotting pathway by procoagulant snake toxins and consumption of clotting factors.
- Bleeding and clotting disturbances usually respond satisfactorily to treatment with specific antivenom, but the dose may need to be repeated several times, at six hourly intervals, before blood coagulability (assessed by the 20WBCT or PT/INR, aPTT) is finally and permanently restored.
- In persistent severe bleeding or imminent urgent surgery, once antivenom has been given to neutralize venom procoagulants and other antihemostatic toxins, restoration of coagulability and platelet function can be accelerated by giving fresh frozen plasma, cryoprecipitate, fresh whole blood or platelet concentrates.
- FFP administration after ASV administration results in more rapid restoration of clotting function in most patients. Early FFP administration (< 6-8 h) post-bite is less likely to be effective.
- Administer 10-15 ml/kg of FFP over 30–60 min within 4 hours of ASV administration. The aim should be a return of coagulation function, as defined by an INR of < 2.0, at 6 h after ASV administration was commenced.
- Non–response to FFP can occur with use of FFP that has low activity of FV and FVIII, because of either poor storage or premature thawing (> 24 hours) prior to administration.
- Avoid any injection (subcutaneous, intramuscular). Repeated venipuncture can be avoided by using an indwelling cannula.

Note:

- Heparin is ineffective against venom-induced thrombin and may cause bleeding on its own account. It should never be used in cases of snakebite.
- Antifibrinolytic agents are not effective and should not be used in victims of snakebite.

3. Management of oliguria and acute kidney injury

AKI can be diagnosed on the basis of KDIGO criteria .

- Urine volume <0.5 ml/kg/hour for six hours, or an increase in serum creatinine by ≥0.3 mg/dl within 48 hours,

- or/and Increase in serum creatinine to ≥1.5 times baseline, which is known or presumed to have occurred within the prior seven days

Monitoring :

- Serum/plasma urea, creatinine and electrolytes be monitored daily if possible, until renal failure is resolved. If possible, pH, bicarbonate, calcium, and phosphate should be measured.
- Closely measure urine output hourly

Treatment of AKI

- Look for the volume status of the patient. Hypovolemia can be detected in the bedside by looking for postural hypotension and/or passive leg-raising test.
- Give 250-500 ml of intravenous normal saline over one hour as a fluid challenge. Adults can be given two liters of isotonic saline over one hour while closely monitoring for signs of fluid overload and urine output.
- Diuretic use: After adequate fluid replacement a single dose of furosemide should be given. The dose depends on body weight (1- 1.5mg/kg). Observe urine output for 2 hours. If urine output is <200ml, do not use further furosemide and refer the patient to a center that has facilities for dialysis.

Forced Alkaline Diuresis (FAD)

If urine output does not improve or dipstick positive for blood, give a trial of FAD within the first 24 hours of the bite to avoid pigment nephropathy leading to acute tubular necrosis(ATN). Delayed FAD has no role. Sequence of FAD in adults is as follows:

Inj. Frusemide 40 mg IV stat

Inj. Normal saline 500 ml + 20 ml of $NaHCO_3$ over 20 minutes

Inj. Ringer's lactate 500 ml + 20 ml of $NaHCO_3$ over 20 minutes

Inj. 5% dextrose 500 ml + 10 ml of Potassium Chloride over 90 minutes

Inj. Mannitol 150 ml over 20 min

- Whole cycle completes in 2 h 30 min and urine output of 3 ml/min is expected.
- If the patient responds to the first cycle continue for 3 cycles. FAD converts oliguria into polyuria and avoid ATN and acute kidney injury needing dialysis in more than 75% patients.

- If there is no response to furosemide discontinue FAD immediately and refer to a higher Center for Dialysis.

Caution: Intravenous bicarbonate may precipitate profound hypocalcaemia and seizure, especially in patients with rhabdomyolysis

Detection and management of Hyperkalemia

Hyperkalaemia (>7 mmol/l or hyperkalaemic ECG changes-tall peaked T waves, prolonged P-R interval, absent P wave, wide QRS complexes):

1. Give 10 ml of 10% calcium gluconate intravenously over 2 minutes (with ECG monitoring if possible) repeated up to 3 times.
2. Give 50 ml of 50% dextrose with 10 units of soluble insulin intravenously.
3. Sodium bicarbonate 40 ml of 8.4% by slow intravenous infusion.
4. Salbutamol aerosol by inhaler may also be used (10 - 15 mg).

Indications for hemodialysis:

1. Clinical uraemia (encephalopathy, pericarditis etc.)
2. Fluid overload not responding to diuretics
3. Plasma potassium concentration > 7 mmol/l or hyperkalaemic ECG changes
4. Symptomatic acidosis
5. blood biochemistry - one or more of the following (Relative indication)
    - Blood urea >130 mg/dl
    - Sr. Creatinine > 4 mg/dl
    - Evidence of hypermetabolism in the form of daily rise in blood urea 30 mg/dL (BUN > 15), Sr. Creatinine > 1 mg/dL, Sr. Potassium > 1 mEq/L and fall in bicarbonate >2 mmol/L

Note : Biochemical criteria alone is not the indication of hemodialysis

4. Management of the bitten part

- The bitten limb may be swollen and painful, therefore, should be nursed in the most comfortable position.
- Elevation of limb with rest.
- Simple washing with antiseptic solution like chlorhexidine, povidone iodine etc.

- Broad-spectrum antibiotic if features of infection (amoxicillin/clavulanic acid, piperacillin/tazobactam, ciprofloxacin and third-generation cephalosporin).
- In case of local necrosis and gangrene: Surgical debridement should be done. It may take a long time to heal the wound. Broad spectrum antibiotics are indicated if there is a feature of infection. It may require skin grafting.
- Snakebites are considered tetanus-prone wounds. So, tetanus toxoid IM injection should be given. If patient presents with coagulopathy, it should be postponed until after resolution of coagulopathy.

5. Management of Compartment Syndrome

Swelling of muscles due to venom effect, especially in tight tissue compartments like finger pulps or anterior tibial compartment may result in increased tissue pressure above venous pressure and may cause ischemia. The most reliable test to objectively measure intra-compartmental pressure is directly through a cannula introduced into the compartment and connected to a pressure transducer or manometer. This can be done by using saline manometers or newer specialized equipment such as the Stryker Intra-compartmental Pressure Monitoring Equipment.

The signs and symptoms of compartment syndrome can be the following:

- Pain on passive stretching
- Pain out of proportion
- Pulselessness
- Pallor
- Paresthesia
- Paralysis

Established compartment syndrome may need fasciotomy. However, fasciotomy must not be done, even if required, until coagulation abnormalities are corrected, otherwise the patient may die due to bleeding. It is also suggested that treatment with anti-venom itself may reduce swelling and intra-compartmental pressure.

Other therapies

Tetanus prophylaxis

Snakebites are considered tetanus-prone wounds and prophylaxis should be provided as needed. In patients with coagulopathy, tetanus prophylaxis should be postponed until after resolution with antivenom therapy.

Antibiotics

Evidence does not support the use of empiric antibiotics to prevent secondary infection after snake bite unless a secondary infection occurs.

Management of snakebites at different levels of healthcare facilities

All levels of the health service can contribute to the management of patients with snakebites. Since the treatment of severe envenoming is a medical emergency that may require a range of medical skills, equipment, antivenom, and other medicines, referral should be to the higher level of care that is readily available. However, in the rural areas where snakebites are most frequent, transfer to a hospital may not be feasible within the reasonable time frame of a few hours. In that case, a lower level of health facility services must cope with the emergency as suggested below.

At the community or village level

- Ask the history of snakebite and look for obvious evidence of a bite (fang puncture marks, swelling of the bitten part, etc.).
- Wash the bitten area with soap and water.
- Limit the movement and exertion of the patient.
- Immobilize the bitten limb, give reassurance, and cover with clean clothing.
- Don’t elevate the bite area above the heart level.
- Avoid feeding or drinking to prevent the risk of aspiration.
- Arrange transport of the patient to medical care as quickly, and safely (Call 112 for assistance).
- Discourage time-wasting and potentially dangerous traditional treatments such as tight ligatures (tourniquets), incisions, ice, suction, application of herbs and chemicals, etc.
- If the snake responsible has already been caught or killed, take it with the patient but ensure safety by avoiding direct contact with the snake (usually killing or bringing the snake to the hospital is not encouraged).

At the Primary Health Care Centers

- Carry out a medical assessment by triaging (ABCDE) including history taking and simple physical examination –look for signs of local or systemic envenomation.
- Identify the snake (if brought).

- Give analgesia by mouth if required: Paracetamol orally as required (not aspirin or non-steroidal anti-inflammatory drugs which can cause bleeding).
- Vomiting may occur, so place the person on their left side in the recovery position.
- Treatment for bite wound :
  - » Wash with antiseptic solution
  - » Broad-spectrum antibiotic if features of infection present
  - » Perform 20WBCT if possible
  - » Tetanus toxoid IM injection should be given if indicated and in suspected coagulopathy, it should be postponed until resolution of coagulopathy
- Give intravenous fluid to correct hypovolemic shock. If the patient fulfills criteria for antivenom treatment- refer to a higher center.
- Mark with a pen, the progress of swelling on the limb and note the time.
- If a tourniquet is in place, do not remove it, till the definitive treatment is available.

At the hospital without specialized care

- Carry out a more detailed clinical and laboratory assessment and triaging (ABCDE) including biochemical and hematological measurements, ECG or radiography as indicated.
- Reassess analgesia, if required, consider opioids as required with great caution (e.g. pethidine or morphine).
- Perform 20WBCT and other blood parameters that are available.
- Closely monitor the progression of envenomation with time.
- Administer anti-snake venom if indicated.
- If the patient has evidence of bulbar or respiratory paralysis/failure, insert endotracheal tube or laryngeal mask airway and assist ventilation manually or with mechanical ventilators.
- Consider blood transfusion if the patient is profusely bleeding and/or severely anemic.
- Dialysis to be provided if indicated and available.
- Implement simple rehabilitation (physiotherapy/exercising of bitten limb).

Indications for referral to higher centers

- Patient requiring respiratory support
- Deteriorating neurologic manifestations
- Surgical intervention-necrosis/fasciotomy
- Spontaneous persistent bleeding in spite of antivenom administration in adequate dose
- Comorbid diseases like heart failure or chronic kidney disease
- Worsening acute kidney injury

At the hospital with specialized care/Referral Centers

- Triage the snakebite patient (ABCDE).
- Advanced ICU care and management.
- More advanced surgical management of local necrosis (e.g. split skin grafting) and fasciotomy if necessary.
- Investigations including bacterial cultures and imaging (CT scans) as indicated.
- Urgent dialysis if indicated.
- Management of hemostatic disturbances - transfusion of fresh frozen plasma, cryoprecipitate (fibrinogen, factor VIII), fresh whole blood or platelet concentrates.
- Implement rehabilitation by physiotherapists.

Long-term complications (sequelae) of snakebite

- Amputation of limb
- Chronic ulceration
- Osteomyelitis
- Contractures, arthrodesis or arthritis
- Malignant transformation of skin ulcers
- Chronic kidney disease
- Chronic panhypopituitarism or diabetes insipidus (Russell's viper bites)
- Chronic neurological deficit (post intracranial hemorrhage and thrombosis)
- Loss of secondary sexual hair, libido, amenorrhoea and testicular atrophy

- Hypothyroidism
- Pituitary Infarction (Russell's viper in Myanmar and South India) (Tun-Pe et al., 1987)

Rehabilitation

- In patients with severe local envenoming, the limb should be maintained in a functional position to avoid functional effects like persistent stiffness and induration due to sclerosis of veins, lymphatics and tissue planes leading to severe deformity, tissue loss which eventually requires skin grafting, debridement and amputation.
- Restoration of normal function in the bitten part should be started by simple exercises while the patient is still in hospital.
- After the patient has been discharged from the hospital, a timetable of rehabilitation activities and instructions should be given to the patient and the relatives or patient attendant.

Review and follow up

- On discharge, patients should be followed up ideally after 7 days.
- If there is worsening of symptoms or signs such as evidence of bleeding, worsening of pain and swelling at the site of bite, difficulty in breathing, altered sensorium etc, need to review at emergency immediately.

Preventive measures on snake bites

- All snakes are predatory carnivores.
- Many species are mainly nocturnal but other species are mainly diurnal.
- Be especially vigilant about snake bites after rains, during flooding, at harvest time and at night. Snakes prefer not to confront large animals such as humans so give them the chance to slither away.
- Avoid snakes as much as possible, and be cautious when handling dead or seemingly dead snakes. Even an accidental scratch from the fang of a severed snake's head may inject venom.
- Keep young children away from areas known to be snake-infested, and use protective equipment, clothing and boots in the fields and forest.
- Ensure clean and clear surroundings.
- Do not try to kill or play with the snakes if you encounter them.

Preventive Strategy:
Prevent snakebites and provide effective first-aid
Ensure access to life-saving treatment and care
Improve availability of quality, effective, safe and affordable antivenoms
Health advocacy and awareness campaign

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ANNEXES

Annexure 1: Quick Check of ABCDE

	ASSESSMENT
Airway	• Throat and tongue Swelling • Hoarse voice • Stridor (Patients may feel their throat is closing)
Breathing	• Respiratory rate • Hypoxemia (SpO2< 94% RA) • Difficulty in breathing/fatigue
Circulation	• Pale, clammy skin • Tachycardia • Dizziness • Hypotension • Arrhythmia • Cardiac arrest
Disability	• Decreased conscious level • Neurological deficits
Exposure	• Exposure and examination of the bite site

AIRWAY PROTECTION AND MANAGEMENT

Airway obstruction/inadequacy in the neurotoxic snake envenoming can occur in several ways

- Prolapse of the tongue into posterior pharynx
- Loss of muscular tone in soft palate
- Obstruction due to pooling of oropharyngeal secretion due to inability to swallow
- Mechanical failure due to respiratory muscle paralysis

Three basic pillars of airway managements are :

1. Maintaining patency of airways (Basic and advanced Airway management)
2. Protection against the aspiration
3. Making sure of oxygenation and ventilation

1. Basic airway management.

Two positioning maneuvers are performed to improve airflow in the patient receiving basic airway management.

A. Head-tilt Chin-lift: It brings the patient's head into the "sniffing" position (precaution: Do not perform if neck injury is suspected. Use Jaw thrust instead). Lifting the chin ensures the patency of upper airway occluded by falling backward of the tongue. At the same time it prevents the movement of cervical spine in trauma cases.

B. Jaw thrust

C. Infant: Head in neutral position. Do not over extend head and neck.

- Inspect the mouth of the patient. There may be pooling of secretion, blood or vomitus. These may obstruct airways. Do suction to remove the collection inside the mouth.
- Foreign bodies, if present, should be removed by using forceps. Do not use your hand. Hand may push material further inside the mouth and there is risk of being bitten.
- Keep the patient in a recovery position to help drain secretion, prevent tongue from falling back. This position may be useful in snakebite victims with adequate respiratory efforts and excessive secretion in mouth.
- To maintain open airway, insert an oropharyngeal airway, measured to suit the patient (from the corner of the mouth to the angle of the jaw), being sure to avoid causing trauma to the lips and mouth. This will prevent the tongue from occluding the airway and provide an open conduit for air to pass until endotracheal intubation is available.

2. Advanced airway management

Endotracheal intubation should be done as soon as possible in any patient unable to protect his or her airway and needing sustained supported ventilation. Another method is placement of supraglottic devices like the Laryngeal mask airway and tracheostomy.

B – BREATHING

Assessing breathing: LOOK, LISTEN AND FEEL

- Place your ear near the victim's mouth and nose, keeping your gaze towards the victim's chest. Look for the chest to rise and fall, listen for air escaping during exhalation, feel for the flow of air against your cheek. Take at least 5 seconds but no more than 10 seconds to make this assessment.
- If oxygen is available, it should be administered by any available means (nasal prongs/catheters, mask, bag-valve-mask etc.) between each suctioning attempt (which should not be prolonged). Arterial peripheral oxygen saturation (SpO2) should be monitored by a digital oximeter.
- If breathing is present and adequate (with or without airway opening maneuvers),put the victim in the recovery position to protect airway patency(Dangers of vomiting and aspiration) and keep checking for breathing every 2 minutes.
- If breathing is absent or inadequate, such as if:
  - » No breathing is discernible within 10 seconds (or 5 seconds in a child, 2 seconds in a baby);
  - » The respiratory rate is low;
  - » The depth of respiration is inadequate(shallow) (the tidal volume is low);
  - » The patient is taking agonal (gasping)breaths;
  - » The patient is cyanosed centrally (blue lips, ears, or tongue)
  - » The measured blood peripheral oxygen saturation is low ;
  - » The end-tidal CO2, by whichever method is being used, is high, or climbing;

ASSISTED VENTILATION IS REQUIRED!

- Non-invasive ventilation: Expired Air Resuscitation (Rescue breaths) when no health facilities immediately available) and Bag-mask ventilation
- Invasive Ventilation: Intubation and mechanical ventilation

C-CIRCULATION

Check pulse rate, blood pressure and capillary refill time (< 2 seconds). Inspection of the skin gives clues to circulatory problems. Color changes, sweating, and a decreased level of consciousness are signs of decreased perfusion.

- If in shock, insert two large bore cannula – at least 16 or 18 gauge.
- Attach Ringers lactate or Normal Saline. Give one liter rapidly with infusion wide open.
- Assess response of pulse, Systolic Blood pressure and signs of perfusion (urine output, mental status).
- If still in shock and no evidence of fluid overload, give another bolus. Treatment with crystalloids should be controlled by observation of the fluid status (jugular venous pressure, respiratory rates and crepitations.
- If still in shock after 2 liters and suspect ongoing blood loss, start blood transfusion and search again for a source of bleeding.
- In patients with evidence of a generalized increase in capillary permeability, a selective vasoconstrictor such as dopamine should be given (Refer Annex 3)
- Insert urinary catheter and monitor hourly urine output. A urine output of at least 0.5ml/kg/hr suggests adequate hydration.

D-Disability

What is the level of consciousness? The level of consciousness can be rapidly assessed using the AVPU method, where the patient is graded as alert (A), voice responsive (V), pain responsive (P), or unresponsive (U). Common causes of unconsciousness include profound hypoxia, hypercapnia, cerebral hypoperfusion, intracranial hemorrhages or the recent administration of sedatives or analgesic drugs. The best immediate treatment for patients with a primary cerebral condition is stabilization of the airway, breathing, circulation, correcting dyselectrolytemia and hypoglycemia if present.

E-Exposure

Examine bitten parts of the body thoroughly and full exposure of the body may be necessary in case of suspected snakebite. Respect the patient's dignity and minimize heat loss.

Annexure 2: Adrenaline infusion dosing

Adrenaline 1mg (1:1000) in 250 ml 5% Dextrose or NS	
mcg/min	**Drops/minute**
1	15 drops
2	30 drops
3	45 drops
4	60 drops

Annexure 3: Dopamine Drip Chart

(Dopamine in 400 mg in 250 ml 5% Dextrose which yields a concentration of 1600 mcg/ml)

A= ml/hr via Infusion pump

B= drops per minute via adult Burette (drop factor 1 ml= 20 drops)

C= drops per minute via micro-drip set for children (drop factor 1 ml= 60 drops)

Dosage mcg/kg/min	**1mcg/kg/min**			**2mcg/kg/min**			**3mcg/kg/min**			**4mcg/kg/min**		
Body weight	**A**	**B**	**C**	**A**	**B**	**O**	**A**	**B**	**C**	**A**	**B**	**C**
10kg	1	20	60	1	20	60	1	20	60	2	40	120
15kg	1	20	60	1	20	60	2	40	120	2	40	120
20 kg	1	20	60	2	40	120	2	40	120	3	60	180
25 kg	1	20	60	2	40	120	3	60	180	4	80	240
30 kg	1	20	60	2	40	120	3	60	180	5	100	300
35 kg	1	20	60	3	60	180	4	80	240	5	100	300

40 kg	2	40	120	3	60	180	5	100	300	6	120	360
45 kg	2	40	120	3	60	180	5	100	300	7	140	420
50kg	2	40	120	4	80	240	6	120	360	8	160	480
55 kg	2	40	120	4	80	240	6	120	360	8	160	480
60 kg	2	40	120	5	100	300	7	140	420	9	180	540
65 kg	2	40	120	5	100	300	7	140	420	10	200	600
70 kg	3	60	180	5	100	300	8	160	480	11	220	660
75 Kg	3	60	180	6	120	360	8	160	480	11	220	660