

NATIONAL GUIDELINES FOR

SNAKEBITE MANAGEMENT IN NEPAL



2019



Government of Nepal
Ministry of Health and Population
Department of Health Services
Epidemiology and Disease Control Division
Teku, Kathmandu

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FOREWORD

I am very pleased to know that the Epidemiology and Disease Control Division (EDCD) has developed the **National Guidelines for Snakebite Management in Nepal** with the technical support from the WHO Country office, Nepal.

Snakebite envenoming is a potentially life-threatening medical emergency and mainly affects women, children and farmers with lower socio-economic status in rural Nepal. These bites result in mortality or chronic disability in the communities, especially among agriculture workers. Health seeking behavior and transportation barrier have always been a challenge in Nepal. Moreover, lack of adequate infrastructures, trained health workers, logistics challenges of anti-venom as well as traditional practices in the rural communities leads to delayed treatment of snakebite cases.

This guideline is intended to provide the available information on venomous snake found in Nepal, diagnosis of snakebite envenomation, its management and most importantly the correct methods to administer anti-snake venom (ASV). I sincerely hope that this guideline will support the national, provincial and local government authorities to guide the health workers on prevention and management of snakebites and ultimately be useful in saving human lives. Therefore, I highly recommend our health workers to adhere to the recommended steps provided by the guideline.

Lastly, I would like to express my sincere gratitude to EDCCD, WHO Country Office, Nepal and all others who have contributed in developing this guideline.


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FOREWORD

In Nepal, according to the WHO estimates, around 20,000 people are bitten by snakebite annually resulting in over 1000 deaths. Most of the fatalities are due to communities being unaware of simple measures to prevent snakebites, people practicing harmful traditional measures like using tight tourniquets and suction, victim not reaching hospitals on time and inadequate training of the health care providers.

Government of Nepal is committed to achieve the national target which is aligned with the WHO's target of 50% reduction in deaths and disabilities due to snakebite envenomation by 2030. For this, the government has been implementing various activities and accelerating its efforts. Epidemiology and Disease Control Division (EDCD) has been supplying anti-snake venom to the snakebite management centers, providing orientation to health workers on proper management of snake-bite.

It is my immense pleasure to express that the **“NATIONAL GUIDELINES FOR SNAKEBITE MANAGEMENT IN NEPAL”** has now been developed. The guideline is intended to ensure standardized, timely and effective management of snake bites in the country. I sincerely hope that this guideline will help health workers to ensure early intervention and efficient use of antivenom to save the human lives.

My sincere appreciation to WHO country office, Nepal for the overall support in developing the guideline. Finally, I would like to thank all the experts and my colleagues who have actively contributed and finalized this guideline.

Dr. Bibek Kumar Lal

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ACRONYMS

20 WBCT	20-minute whole blood clotting test
AKI	acute kidney injury
AAM	advanced airway management
BAM	basic airway management
BP	blood pressure
BT	bleeding time
BVM	bag-valve-mask
CT	clotting time
EAR	early anaphylaxis reaction
ET	endotracheal intubation
FFP	fresh frozen plasma
HCP	health care provider
IM	intramuscular
INR	international normalization ratio
IV	intravenous
KDOQI	kidney disease outcomes quality initiative
LMA	laryngeal mask airway
ml	milliliter
OPA	oropharyngeal airway
PIB	pressure immobilization
PR	pyrogenic reactions
RDT	rapid diagnostic test
VICC	venom-induced consumption coagulopathy
WHO	World Health Organization

INTRODUCTION

Snakebite is an important occupational hazard affecting farmers, plantation workers, herders and fishermen. Open-style habitation and the practice of sleeping on the floor also expose people to bites from nocturnal snakes, with children being at a particularly high risk. In rural Nepal, snakebite is an important public health problem. The agriculturally prosperous terai region with hot climate, high seasonal rainfall, lush natural vegetation, high density of rodents, rich reptiles and amphibian flora make an ideal habitat for snake to live and increase availability of marshy land to undergo hibernation. The abundance of snake and human activities, mainly agriculture, increases the man– snake encounter leading to snakebite. Nocturnal snakebite is also common in Nepal due to the sleeping habit.

Snakebite is a life threatening medical emergency and survival of the victims depends much on the appropriate first aid measures and immediate transportation to the nearest health center where the facility to administer anti-snake venom and supportive care is available. In developing countries where snakebite is mostly prevalent, traditional faith healers, snake charmers and religious man (Dhami) treat many snakebite victims. In rural population of Nepal, the doctor population ratio is far from accepted norms and most of the trained health workforce are based in urban areas. Therefore, the people of rural areas often seek health care from practitioners of indigenous medicine. Most of the death related to snakebite occurs before reaching the treatment center, either during transportation or at the village. Doctors or health workers at primary care level as well as some of the district and provincial level hospital do not treat snakebite, likely due to inadequate training on snakebite management during medical schools resulting in lack of confidence on management of snake envenoming. This national guidelines is intended to ensure standardized, timely and effective management of snakebite in the country.

Magnitude of the problem

Globally, the actual incidence and mortality associated with snakebite envenoming is poorly known, in part due to the lack of reliable information. In Nepal, WHO estimates that 20'000 people are bitten by snakes each year,

resulting in over 1000 deaths¹. Nevertheless, existing epidemiological data remain fragmented, and several studies suggest that the true burden of snakebite is much higher. A hospital-based retrospective survey conducted in 10 hospitals of eastern Nepal reported 4078 cases of snakebite (407/hospital/year) including 379 with signs of envenoming. The mortality in envenomed patients varied considerably among the centers from 3% to 58% (mean=21.37%)². Similarly, high numbers of snakebite cases were reported from the districts of western development region³, eastern⁴ and central Nepal⁵. The highest figures reported so far come from a community-based survey conducted in southeast Nepal in 2002 which revealed annual incidence and mortality rates of 1,162/100,000 and 162/100,000, respectively⁶.

An ongoing study “Snake-bYte: a nationwide cross-sectional community incidence study to assess and predict the impact of snakebite on human and animal health in Nepal” is likely to provide better statistics of snakebite in the community and outcome of snakebite including its economic impact. The mortality related to snakebite envenoming varies⁷. It may be related to quality of care of the patients, access to mechanical ventilatory support, health care knowledge and skill to timely and appropriately administer antivenom and intubate patients when indicated, inability to identify serious adverse effects, lack of standard protocol for management of snakebite, etc.

Need of the new guidelines on management of snakebite in Nepal

Medicine is an ever- changing science. As the new evidence becomes available, it is mandatory for caregiver to update their knowledge and practice. In light of this, there is a need to update previous snakebite management protocol published by Ministry of Health in 2003⁸. The updated guideline will emphasize on management of snakebite in the current view of knowledge and evidence. Snakebite remains a neglected tropical disease where there is few scientific research related to snakes and snakebite in Nepal. Nevertheless, this updated guideline will provide all the recent recommendations based on the global WHO guidance which is contextualized to the country setting. The guideline will be informative and is expected to provide a standardized national protocol for the management of snakebite to the health workers. The national guideline is also expected to avoid misuse of antivenom, help early recognition of clinical features of snakebite, reactions to antivenom, and provide appropriate management including artificial ventilation as required by the victim.

SNAKES OF MEDICAL IMPORTANCE IN NEPAL

So far, 89 snake species have been recorded in Nepal⁹. Among this great diversity of snakes, we know with certainty of 17 species of snake that are found in Nepal and have the front-fanged type of venom apparatus and thus are considered to be highly venomous and dangerous⁹. These snakes can be subdivided further into two groups: family elapidae and family viperidae and further species as depicted in (table 1) below.

Table 1: Snakes of medical importance in Nepal

FAMILY		SPECIES COMMON NAME	SCIENTIFIC NAME	LOCAL NAME
ELAPIDAE	COBRA	Common Cobra or Spectacled Cobra	<i>Naja Naja</i>	Goman, Nag
		Monocellate Cobra or Monocled Cobra	<i>Naja kaouthia</i>	Goman, Paniyadarad
	KRAIT	Common Krait	<i>Bungarus caeruleus</i>	Seto-kalo chure sarpa, Gadaich, Chure sarpa
		Banded Krait	<i>Bungarus fasciatus</i>	Gangawari, Panhelo-kalo chure sarpa, Kanthamala, Laxmi sanp, Raja sanp, Maher, Gwala sarpa, Ahiriniya sanp
		Himalayan Krait	<i>Bungarus bungaroides</i>	Pahadi karet, Himali karet
		Lesser Black Krait	<i>Bungarus lividus</i>	Sano kalo karet
		Greater Black Krait	<i>Bungarus niger</i>	Thulo kalo karet
		Wall's Krait	<i>Bungarus walli</i>	Bairi karet, Gadaich
		OTHERS	King Cobra	<i>Ophiophagus hannah</i>
	MacClelland's Coral Snake		<i>Hemibungarus Sinomicrurus macclellandii</i>	Mugasarp, Karkat nag

VIPERIDAE	TRUE VIPER	Russell's viper	<i>Daboia russelii</i>	Baghe sarpa, Suskar
	PIT VIPERS	Himalayan Pit Viper	<i>Gloydius himalayanus</i>	Bhyagute sarpa
		Tibetan Pit Viper	<i>Himalayophis tibetanus</i>	Haryou sarpa, Pattar, Karanko haryou sap
		Mountain Pit Viper	<i>Ovophis monticola</i>	Andho sarpa, gurube, Chhirbire sarpa
		Himalayan Habu Pit Viper	<i>Protobothrops spp.</i>	-
		White-lipped Pit Viper	<i>Trimeresurus albolabris</i>	Haryou sarpa, Pattar
		Kramer's Pit Viper	<i>Trimeresurus septentrional</i>	Haryou sarpa, Pattar

2.1 ELAPIDAE FAMILY

2.1.1 Cobra Species

Common Cobra or Spectacled Cobra

Its distribution is recorded throughout the lowlands and lower mountains of Nepal up to 1600 meter altitude. It is found in forests, grasslands, agricultural lands, and residential areas.



Figure 1: Spectacled Cobra (*Naja naja*) from Jhapa District, Nepal.
PC: S.K. Sharma

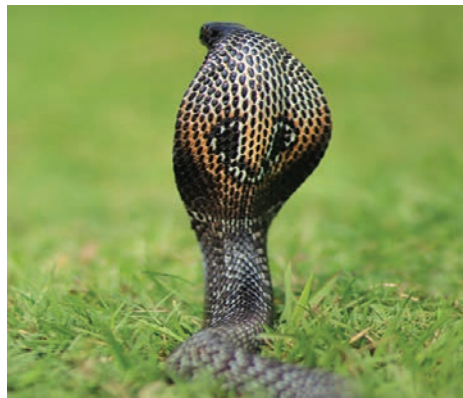


Figure 2: Spectacled Cobra (*Naja naja*). PC: R. Giri

Monocellate Cobra or Monocled Cobra

It is found throughout the lowlands and lower mountains of Nepal up to at least 3200 meter altitude. Prefers forests, grasslands, agricultural lands and residential areas close to water.



Figure 3: Monocellate Cobra (*Naja kaouthia*). PC: F.Tillack



Figure 4: Monocellate Cobra (*Naja kaouthia*). PC: M.P. Katila

2.1.2 Krait species

Common Krait

Found in lower low lands and lower mountains of Nepal (<1525 meter). It prefers agriculture and grass lands, forest and residential areas. It is often found hiding in houses, rodent burrows, piles of bricks, rocks, rubbles, or woods, crevices etc.



Figure 5: Common Krait (*Bungarus caeruleus*) PC: S.K. Sharma



Figure 6: Common Krait (*Bungarus caeruleus*). PC: R. Giri

Himalayan Krait

Found throughout the low-land and lower mountains of eastern Nepal. Recorded between 200 to 1500 meter altitude.



Figure 7: Himalayan Krait (*Bungarus bungaroides*) from Eagle Nest, Arunachal Pradesh, India. PC: S. Dalvi

Branded Krait

Found in lower low lands and lower mountains of Nepal. Prefers wet habitats and vicinity of water (e.g., ponds, streams, rice fields, near villages).



Figure 8: Banded Krait (*Bungarus fasciatus*). PC: R. Giri

Lesser Black Krait

Found throughout the low-land and lower mountains of Nepal. Envenoming by this snake has been recorded from eastern and central Nepal. Known from forests, grasslands, agricultural lands and residential areas below 250 meter altitude.



Figure 9: Adult male Lesser Black Krait (*Bungarus lividus*). PC: U. Kuch



Figure 10: Lesser Black Krait (*Bungarus lividus*). Ventral side of the same snake showing the light anterior part of the belly that is gradually obscured with dark pigment on the posterior body. PC: U. Kuch

Greater Black Krait

It is likely to be present throughout Nepal in lowlands and lower mountains, but so far recorded only from Kaski district at an altitude of 1450 meter.



Figure 11: Greater Black Krait (*Bungarus niger*). PC: S.K. Sharma



Figure 10: Greater Black Krait (*Bungarus niger*). PC: M.P. Katila

Wall's Krait

It is likely to be present throughout Nepal. However, so far found in southeast Nepal only.



Figure 13: Wall's Krait (*Bungarus walli*), specimen from Lakshmipur District, Bangladesh. PC: M.A.W. Chowdhury

2.1.3 Other species

King Cobra

It's habitation is likely throughout the lowlands and lower mountains of Nepal up to 3500 m altitude. Prefers forests and plantations in the vicinity of water and bamboo stands; rarely seen in disturbed agricultural lands.



Figure 14: King Cobra (*Ophiophagus hannah*). PC: R. Giri



Figure 15: Nesting King Cobra (*Ophiophagus hannah*). PC: M.P. Katila

MacClelland's Coral Snake

It is found in forests, scrublands and agricultural lands of lowlands and lower mountains from up to 220 meter.



Figure 16: MacClelland's Coral Snake (*Sinomicrurus macclellandi univirgatus*). PC: K.B. Shah

2.2 VIPERIDAE FAMILY

2.2.1 True viper species

Russell's Viper

The most dangerous snake of this family. However, it appears to be rare and known from very few localities in the lowlands only (<100-250 m altitude).



Figure 17: Adult Russell's Viper (*Daboia russelii*) from India, photographed at Madras Snake Park. PC: D.A. Warrell

2.2.2 Pit viper species

Himalayan Pit Viper

Distributed in the hills and mountains of Nepal from 1640 to 3060 meter altitude. Its preferred habitation is dry coniferous forests, subalpine scrublands, alpine meadows and agricultural lands.



Figure 18: Himalayan Pit Viper (*Gloydius himalayanus*), adult male from Kalopani, Mustang District, Nepal, 2500 m. PC: F. Tillack

Tibetan Pit Viper

This species is found at Phulchoki mountain and Helambu area of Sindhupalchowk district ranging from 2500 -2700 meter altitude. It's preferred habitat is oak and rhododendron forests and bush thickets and large rocky grass slopes.



Figure 19: Tibetan Pit Viper (*Himalayophis tibetanus*), adult male from Phulchoki, Godavari, Lalitpur District, Nepal, 2525 m altitude. PC: F. Tillack

Mountain Pit Viper

It is found in oak, rhododendron and coniferous forests, grasslands, often in agricultural lands, and in and around houses in the hills and mountains of 900-2680 meter altitude.



Figure 20: Mountain Pit Viper (*Ovophis monticola*), subadult specimen from Naudanda, Kaski District, Nepal, 1400 m altitude. PC: F. Tillack

Himalayan Habu Pit Viper

So far only been found in Simigaon of Dolakha District at an altitude of 2600 meter.



Figure 21: Himalayan Habu Pit Viper (*Protobothrops* sp.) from Dolakha District, Nepal, 2600 m altitude. Courtesy of California Academy of Sciences (CAS 90668). PC: F. Tillack

White Lipped Pit Viper

Found throughout the southern lowlands, hills and low mountains. Inhabits open forests, grasslands, agricultural lands and residential areas surrounded by vegetation; mostly lives in trees, shrubs and small bushes.



Figure 22: White-lipped Pit Viper (*Trimeresurus cf. albolabris*). Adult snake from southern Nepal. PC: A. Gumprecht, specimen courtesy of Fuhlrott Museum.

Kramer's Pit Viper

Common in the mid-hill regions of Nepal, where it inhabits scrublands, bamboo thickets, agricultural lands and forests at 900- 3050 meters altitude.



Figure 23: Kramer's Pit Viper (*Trimeresurus septentrionalis*), adult female from Dhikurpokhari, Kaski District, Nepal, 1500 m altitude. PC: F. Tillack



Figure 24: Kramer's Pit Viper (*Trimeresurus septentrionalis*). Photo by M.P. Katila

The majority of cases of envenoming occurring in our country are caused by elapid snakes, and in particular by the Indian spectacled cobra (*Naja naja*) and the common Indian krait (*Bungarus caeruleus*). However, as recently other snake envenoming due to other species of krait has been reported from Nepal, it is likely that other species may also contribute significantly but remains unnoticed.

In addition to the members of these two groups, one species of snake among the many that have enlarged teeth in the rear of the mouth, the **Red-necked Keelback** (*Rhabdophis subminiatus*), along with numerous species of snake with such a "rear-fanged" type of dentition occur in Nepal, and they are generally regarded as harmless or only mildly venomous.

However, this particular one is known to have caused serious envenoming in humans. All of the few known bites by this species happened in other countries, and in people who handled the snakes on purpose.

Red Necked Keelback



Figure 25: Red Necked Keelback (*Rhabdophis subminiatus*). PC: F. Tillack

Non-venomous species are also very common and may be involved in snakebites. Some of these non-venomous species are easily mistaken for venomous ones. For example, rat snakes (*Ptyas* and *Coelognathus species*) may be confused with cobras, while wolf snakes, which are common inside and around houses, have a color pattern similar to that of kraits. Bites can therefore be inflicted by a variety of species, in all kinds of environments. Neither the geographical distribution of these species nor their relative contribution to snakebite mortality and morbidity have been systematically studied in Nepal.

Rat Snake



Figure 26: Rat Snake (*Ptyas Mucosa*). PC: M.P. Katila

Common Wolf Snake



Figure 27: Copper-headed Trinket Snake (*Coelognathus radiatus*). PC: R. Giri

Copper-headed Trinklet Snake



Figure 28: Common Wolf Snake (*Lycodon aulicus*). Photo by R. Giri

CLINICAL MANIFESTATION OF COMMON VENOMOUS SNAKES OF NEPAL

Snake venom is a complex mixture of toxins. Composition of venom varies from one species to another. Even in same species, the venom composition, may vary according to geographical location and age of the snake. Therefore the clinical features may differ in severity although bitten by same species.

After the bite of a snake, victims may have following consequences:

1. No clinical manifestation except bite mark. This may be due to bite by non-venomous snakes or bite by venomous snake without injection of venom (Dry bite)
2. Local manifestation in the part of body that has been bitten. (table 2)
3. Systemic manifestation due to systemic absorption of venom. This may be neurotoxicity or hematotoxicity depending on the envenoming species.
4. Signs and symptoms due to traditional treatment for example; local gangrene due to tight tourniquet, pain abdomen, vomiting etc. due to congestion of chilies, herbal medicine etc. Tight tourniquet/s may cause pain, swelling and congestion that may be confused with local envenoming.

Note

Not all bites by venomous snakes are accompanied by the injection of venom, and therefore not all patients bitten by a venomous snake will develop symptoms and signs of envenoming. However, when envenoming does occur, it can be life-threatening.

3.1 LOCAL MANIFESTATIONS

Table 2: : Local manifestations of snakebite envenoming

Bite Mark	
<ul style="list-style-type: none"> ■ Fang mark may be obvious as single puncture, dual puncture or marks of multiple tooth marks. There may only be scratch mark also. However, it is not much helpful to diagnose venomous versus non-venomous snakebite. Venomous snake can have single puncture if one tooth is broken or nonvenomous may have distinct two punctures if they have large teeth. ■ Krait bite may leave no mark at all. ■ Bite in the arm or lower limb occurs to victim who unintentionally steps on or otherwise disturbs a snake while working in the field or walking. ■ This mode and site of bite is common in farmers, forester, students etc. Nocturnal snakebite usually occurs to people sleeping on ground and the bite may occur in trunk or other parts also. 	
Local Effects	
Cobra	<ul style="list-style-type: none"> ■ Envenoming usually produces local effects in the form of swelling and local pain with or without erythema or discoloration at the bite site. Blistering, bullae formation and local necrosis are also common. If it is infected, there may be abscess formation.
Krait	<ul style="list-style-type: none"> ■ Usually do not cause signs of local envenoming and can be virtually painless.
Viper	<ul style="list-style-type: none"> ■ Envenoming results in local pain and tissue damage, characterized by swelling, blistering, bleeding, and necrosis at the bite site, sometimes extending to the whole limb. Consequences of the local envenoming may last for weeks together and can produce significant morbidity. ■ Russell’s viper envenoming may lead to persistent bleeding from fang marks, wounds or any injured parts of the body due to venom induced coagulopathy. ■ Bleeding disorder is usually not seen in pit viper bite in Nepal. However, recently it is reported (case report) from southern and eastern Nepal. ■ Swelling or tenderness of regional lymph node denotes venom spread.



Figure 29: Local manifestation of Cobra bite. PC: S.K. Sharma



Figure 30: Healing wound of Cobra bite. PC: S.K. Sharma

3.2 SYSTEMIC MANIFESTATIONS

3.2.1 Elapidae group of snakes

- Cobra
- Krait
- King cobra
- Coral snakes

Their venom contains toxins which can either inhibit the release of acetylcholine (pre-synaptic toxins) or bind and block its receptor (post-synaptic toxins). Cobra venom is composed mainly of postsynaptic toxins that block muscle-type nicotinic acetylcholine receptors and are responsible for a curare-like paralysis, while krait venoms also contain large quantities of pre-synaptic toxins that inhibit the release of acetylcholine by destroying nerve endings.

The common clinical manifestation of envenoming by these snakes is neurotoxicity.

General manifestation of snake envenoming are:

- nausea, and vomiting
- pain abdomen
- malaise
- weakness
- drowsiness
- prostration
- excessive salivation, etc.

Note

Abdominal pain is particularly common in krait bite. Acute pain abdomen in suspected nocturnal snakebite may be the only initial clue to krait envenoming.

Neurotoxic features

Elapidae bite is the predominant cause of morbidity and mortality related to snake envenoming in Nepal. The common neurotoxic features are:

- **Ptosis** - inability to retract upper eyelids on looking up.
- **Ophthalmoplegia**- double vision (perception of two images of a single object), blurred vision and inability to move eyes in the instructed direction.
- **Pupillary dilatation**- often non- responsive to light.
- **Inability (or limitation) to open mouth.**

- **Tongue extrusion-** inability to protrude the tongue beyond incisors teeth.
- **Inability to swallow**
- **Broken neck sign-** patients cannot hold his/her neck straight when sitting up (active or passive) from supine position. This is due to weakness of the flexor muscles of neck.
- **Skeletal muscle weakness-** limb weakness, flaccid paralysis and loss of deep tendon reflexes.
- **Loss of gag reflex-** inability to produces gag on touching palate or pharyngeal wall by cotton stick or throat swab. This leads to inability to clear secretion and drooling of saliva.
- **Paradoxical breathing-** outward protrusion of abdomen during deep inspiration.
- **Respiratory failure**

Other manifestation of neurotoxic envenoming can be

- Paralysis of jaw and tongue that may lead to upper airway obstruction and aspiration of pooled secretions because of the patient's inability to swallow.
- Numbness around the lips and mouth.
- Hypoxia due to inadequate ventilation (breathing) can cause cyanosis, altered sensorium and coma. This is a life threatening situation and needs urgent intervention.
- Krait bites often present in early morning with paralysis that can be mistaken for a stroke.
- Abdominal pain which may suggest sub-mucosal hemorrhages in the stomach is common manifestation of krait envenoming.

Although the neurotoxic clinical manifestations of envenoming are similar in bites caused by cobras and kraits, the pharmacodynamics of venom action is different. Certain features may help differentiate between cobra and krait envenoming as shown in the (table 3) below.

Differentiating features of cobra and krait bite with neurotoxic envenoming

Table 3: Differentiating features between cobra and krait bite with neurotoxic envenoming

Features	Cobra	Krait
Time of bite	Mostly on dusk and dawn or day time	Nocturnal bite (18:00 pm– 06:00 am)
Location of bite	Both indoor and outdoor	Mostly indoor (>90%)
Activity at the time of bite	Active (>80%)	Resting (>90%)
Symptoms (other than neurotoxicity) at admission <ul style="list-style-type: none"> ■ Pain abdomen ■ Pain at the bite site 	<ul style="list-style-type: none"> ■ Uncommon (<10%) ■ Common (>75%) 	<ul style="list-style-type: none"> ■ Common (40-70%) ■ No pain or minimum pain
Local sign at bite site <ul style="list-style-type: none"> ■ Swelling 	Seen in >80%	Not seen

Cobra venom usually has a more rapid effect and respiratory failure can occur as early as 30 minutes after the bite²³, while the evolution of symptoms after krait bites is comparatively delayed^{24,25,26}. Similarly, recovery after treatment is more rapid in the case of cobra bites, reflecting the reversibility of post-synaptic neurotoxicity. Conversely, the pre-synaptic neurotoxins found in krait venoms induce irreversible nerve damage, and clinical recovery, which chiefly depends on axonal repair, is usually delayed.



Figure 31: Bilateral ptosis in neurotoxic snakebite envenoming. PC: S.K. Sharma



Figure 32: Inability to protrude the tongue beyond incisors teeth in adult patient.
PC: S.Parajuli



Figure 33: Inability to protrude the tongue beyond the incisors teeth. PC: S. Parajuli

"Broken neck" sign observed in a girl bitten by a snake. Envenoming by cobras and kraits (in some areas also by Russell's Viper) frequently leads to progressive descending paralysis. Looking for the broken neck sign, which is caused by paralysis of the neck flexor muscles, should be part of the routine clinical assessment of patients.



Figure 34: Envenoming caused by Russell's Viper (*Daboia russelii*). PC: H.S. Bawaskar

3.2.2 Viperidae group of snakes

Major systemic manifestation of Russell's viper envenoming is systemic bleeding. It may also cause neurological manifestation as described above in section of neurotoxic envenoming. Of note, systemic manifestation of coagulopathy has not yet been reported in green pit viper envenoming in Nepal. However, recently it is reported (case report) from southern Nepal²⁷.

Spontaneous bleeding from various orifices and mucosal surface is the major manifestation of Russell's Viper envenoming. The bleeding may occur from

- venipuncture site
- gums
- nose (epistaxis)
- respiratory system (hemoptysis)
- gastrointestinal system (melaena, rectal bleeding)
- genitourinary system (hematuria, bleeding from vagina)
- bleeding into the mucosae (subconjunctival hemorrhage)
- skin (petechiae, purpura, ecchymosis)
- retina (bleeding into tears)
- bleeding from inflicted wound, if any
- bleeding into internal organs like brain and intra cranium, lungs or abdomen
- excessive bleeding and hypotension may lead to acute kidney injury (acute renal failure) and other organ dysfunctions
- prolonged bleeding time (BT) and clotting time (CT)
- increased prothrombin time and INR
- thrombotic strokes etc²⁸

Note

In the bed side, 20-minute whole blood clotting test (20WBCT) is performed to see the incoagulability of the blood to detect venom induced coagulopathy. The procedure to perform 20WBCT is given in (Annex 1)

Mild local swelling after the bite of a green pit viper near Damak, Jhapa, Nepal. In Nepal, painful swelling of the bitten body part is a characteristic feature of envenoming by pit vipers, vipers, and by cobras.



Figure 35: Mild local swelling after bite of a green pit viper PC: S.K. Sharma

Gum bleeding after snakebite. In Nepal, coagulation defects and spontaneous bleeding have been observed following bites by pit vipers like the Mountain Pit Viper (*Ovophis monticola*). However, this is also characteristic after bites by Russell's Viper (*Daboia russelii*), here in a case from India. Russell's viper envenoming is not common in Nepal.



Figure 36: Gum bleeding after snakebite envenoming PC: D.A. Warell

3.3 CLINICAL SYNDROME OF SNAKEBITE ENVENOMING IN NEPAL

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 sometime 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.

This clinical syndrome of snakebite in Nepal may be as follows. (table 4)

Table 4: Clinical syndrome of snakebite envenoming in Nepal

SYNDROME	FEATURES
SYNDROME 1	<ul style="list-style-type: none"> Local swelling or other features of local envenoming with paralysis with NO features of bleeding or clotting disturbances. <p>COBRA or KING COBRA</p>
SYNDROME 2	<ul style="list-style-type: none"> Nocturnal bite while sleeping on ground and paralysis with NO/or minimal local sign of envenoming. <p>KRAIT</p> <ul style="list-style-type: none"> Neuroparalysis associated with pain abdomen increases the likelihood of envenoming due to krait.
SYNDROME 3	<ul style="list-style-type: none"> Neurotoxicity with dark brown urine, severe muscle pain, without local swelling, bleeding or clotting disturbances and with or without renal failure. Bitten on land while sleeping indoors. <p>KRAIT (<i>B. niger</i>)</p>
SYNDROME 4	<ul style="list-style-type: none"> Marked swelling (sometime with blisters and necrosis) with incoagulable blood and /or spontaneous systemic bleeding. <p>RUSSELL'S VIPER (<i>Daboia russelii</i>)</p>
SYNDROME 5	<ul style="list-style-type: none"> Marked swelling on bitten limb/part often with blisters (sometime with severe pain) without bleeding or clotting disturbances. <p>PITVIPERS (<i>Ovophis monticola</i>, <i>Trimeresurus sp.</i>: <i>T. albolabris</i>, and <i>T. popeiorum</i>).</p>

3.4 LONG TERM COMPLICATIONS (SEQUELAE) OF SNAKEBITE ENVENOMING

Long term effects of snakebite may occur and can manifest in various forms

- Chronic ulceration, infection, osteomyelitis or arthritis
- Physical disability
- Chronic kidney disease due to bilateral renal cortical necrosis
- Chronic panhypopituitarism may occur in Russell’s viper envenoming
- Sequelae of intracranial bleeding in hematotoxic envenoming
- Delayed psychological morbidity like depression and anxiety, impaired functioning, post-traumatic stress disorder and unexplained residual physical disability as reported from Sri Lanka^{33,34}.



Figure 37: Sequelae of local envenoming of snakebite. PC: S.K. Sharma

DIAGNOSIS OF SNAKEBITE ENVENOMING

Neurotoxic envenoming

There is no laboratory investigation in Nepal that can help diagnose neurotoxic manifestation of snakebite.

Hematotoxic envenoming due to vipers

- Bleeding time (BT) and clotting time (CT): Prolonged.
- Prothrombin time and International normalization ratio (INR): Increased.
- 20-minute whole blood clotting test (20WBCT): Positive (Bedside test to see the incoagulability of the blood to detect venom induced coagulopathy. Please refer to annexe for procedure. (Annex 1)
- Kidney function test-serum urea and creatinine (to detect AKI): Raised urea and creatinine indicate kidney function impairment.
- Complete blood count, blood group etc.: Increased total WBC count indicate systemic envenoming. Hemoconcentration may occur due to systemic bleeding and platelet count may decrease in case of viper envenoming.

Point of care test for identification of envenoming species

All elapidae snakes envenoming causes neuroparalysis and produces overlapping clinical syndrome, therefore, it is often difficult to identify the biting species of snake accurately. A quick, reliable and applicable to field condition rapid diagnostic test for identifying the snake species is necessary. Development of such rapid diagnostic (RDT) strip test is in process to identify the biting species of snake in Nepal, albeit, hinder by cross reactivity for neurotoxic snakes. RDT to diagnose Russell's viper envenoming developed with collaboration with Miprolab, Germany is pending for field test.

MANAGEMENT OF SNAKEBITE ENVENOMING

Management of snakebite involves the following steps. (table 5)

Table 5: Steps for the snakebite management

STEPS	FEATURES
1	First aid treatment and transport to the hospital
2	Rapid clinical assessment and resuscitation
3	Antivenom treatment
4	Supportive/ancillary treatment
5	Treatment of the bitten part

5.1 FIRST AID TREATMENT AND TRANSPORT TO THE HOSPITAL

First aid is carried out by the victims themselves or bystanders using material that are readily available. No time should be wasted in search of materials for providing first aid. The most common cause of snakebite related death in Nepal is delay in reaching hospital. This is due to neuroparalysis, the commonest snakebite envenoming, leading to death in short time. So all means should be applied to transport the patients, as soon as possible, to the hospital or snakebite treatment center, where facilities to administer antivenom exist. Application of tourniquet might result in gangrene formation so strictly prohibited.

Recommended first aid treatment

REASSURANCE

- The victim may be very frightened and anxious. Reassure victim that most of the suspected snakebite are caused by nonvenomous snakes. Reassure victim on that snakebite is a treatable condition.

IMMOBILIZATION

- Immobilize the bitten limb with a splint or sling. Any cloth or bandage may be used for this, as done for fracture limb. Any form of movement causing muscle contraction like walking, undressing will increase absorption and spread of venom by squeezing veins and lymphatics.
 - Pressure immobilization (PIB) is believed to delay in spread of venom to systemic circulation and PIB method is commonly recommended by many experts in pre-hospital management. However, the pressure-immobilization technique demands special equipment and training and is not considered practicable for general use in Nepal. Searching for the material to apply pressure immobilization may cause delay in seeking much needed health care for treatment of envenoming^{35,36}. Moreover, envenoming by cobra and vipers snakes causes local tissue damage and localization of toxin by PIB may worsen tissue damage.
 - Pressure pad immobilization has been found to be useful in Myanmar. It's applicability in Nepal is not known.
-
- Remove rings, jewelries, tight fittings and clothing and avoid any interference with the bite wound to prevent infection, increase absorption of venom and increase local bleeding.

RAPID TRANSPORT

- The victim should be transported to the hospital where he can receive the medical care.
- The most common cause of death due to snakebite envenoming in Nepal is due to respiratory paralysis (and rarely shock due to bleeding from Russell's viper envenoming). In one of the community- based study, 80% of the patient with envenoming died even before reaching snakebite treatment center or hospital. Rapid transport using motorcycle has been found to decrease mortality in Nepal. The victim is seated and held between driver and pillion rider.



Figure 38: Use of sling to immobilize the bitten limb. PC: M Rai



Figure 39: The snakebite victim is held firmly between the motorcycle driver and an assistant pillion rider to prevent the patient falling from the vehicle during transport. PC: S.K. Sharma

CAUTION- methods that are either not useful or harmful, hence MUST BE DISCOURAGED

<p>Tight arterial tourniquet must never be recommended</p>	<p>Tight tourniquets made of rope, rubber tubes, saline tube, string and cloth etc., have been used extensively in rural Nepal with the belief that it prevents spread of venom. This dangerous practice may lead to gangrene, necrosis and loss of the limb. It may also provide patient a false sense of security leading to delay in seeking hospital care.</p>
<p>Delay the release of tight tourniquets if patient has already applied this popular method of first-aid</p>	<p>Ideally, the tight tourniquet should only be released when patient is in hospital under medical care and the facilities for resuscitation is ready. Treatment should be started before such release of tight tourniquet.</p>
<p>These practices must be discouraged</p>	<p>Cutting and sucking of bite site. Application of snake stone (Jharmauro). Application of electric current. Application of various chemicals, cow dung etc.</p>



Figure 40: Cycle tube being use as tourniquet in Snakebite. This should be discouraged. PC: S. Parajuli.



Figure 41: Consequences of arterial tourniquet. PC: S.K. Sharma.

Note

- Transfer the patients to nearest health facility (snakebite treatment center, health Center, hospital, medical college etc.) as quickly as possible.
- Do not waste time seeking advice of traditional healer. The only proven therapy for snakebite envenoming is antivenom and supportive treatment.
- If patient has difficulty in swallowing saliva or nasal voice or vomiting, do not feed. It may cause aspiration or choking.
- If biting snake is seen, do not attempt to kill the snake. However, if the snake has been already killed, it should be taken safely (do not handle snake bare handed) to treatment center. It may help identify biting species of snake.

Best practices from Nepal

Motorcycle volunteer program to minimize deaths related to snakebite

The motorcycle volunteer programme is a network of motorcycle owners in remote lowland villages of eastern Nepal. Volunteers serve round the clock transporting suspected or proven snakebite victims as quickly as possible to the nearest hospital or healthcare center where facilities for snakebite treatment exist. The snakebite victim is held firmly between the motorcycle driver and an assistant pillion rider to prevent the patient falling from the vehicle during transport. (figure 42) This program tested in clinical research precedes awareness programmes and emphasizes earlier transport of the victim to an appropriate snakebite treatment center by motorcycle. It also provides educational messages and simple slogans such as

"bitten by snake – catch motorcycle volunteers – reach treatment center – save life!"

It is proven to help in minimizing snakebite related deaths^{10,37}.



Figure 42: A snakebite victim being transported in a motorcycle. PC: S.K. Sharma

5.2 RAPID CLINICAL ASSESSMENT AND RESUSCITATION

Snakebite is a medical emergency. Therefore, a quick clinical assessment should be done to decide if patient needs immediate resuscitation or antivenom therapy. Snakebite victims may arrive hospital late. They may therefore show early or late sign of envenoming and/or its complications. Therefore, all snakebite patients must be assessed rapidly on arrival to treatment center. They may look moribund, but may be still salvageable by appropriate resuscitation. Rapid clinical assessment and resuscitation using ABCDE approach should be initiated.

- Airway
- Breathing
- Circulation
- Disability of the nervous system
- Exposure and environmental control

Emergency management of respiratory depression (and shock) and timely administration of antivenom and assisted ventilation, if needed, is the key initial intervention in patient with snakebite envenoming.

Airway obstruction or respiratory failure caused by neurotoxic envenoming requires immediate airway support. Immediate oxygen administration by any available means (nasal prongs, catheter, mask etc.) and bag-mask ventilation (if available) should be done. If facility is available, patient should be intubated and should be put on mechanical ventilator or manual breathing by Ambu bag (see indication for intubation below).

In case of Russell's viper bite, shock may occur because of hemorrhage due to incoagulable blood, fluid shift into bitten limb, myocardial depression and vasodilation due to direct effect of venom. This patient must be treated promptly with rapid infusion of normal saline and blood transfusion (if bleeding profusely) and antivenom started as soon as possible. They may also require vasopressor if shock persist. If patient presents with no symptom or sign of envenoming, patient should be kept under observation for at least 12 hours, preferably for 24 hours. It is due to uncertainty of

species responsible for the bite, dry bite versus envenoming, the amount of venom injected, and the variability of time for development of symptom or sign due to envenoming.

5.3 ANTIVENOM TREATMENT

5.3.1 Snake Venom

Snake venoms are complex chemical mixture of enzymes, polypeptides, non-enzymatic proteins, nucleotides, and other substances, many of which may have different properties. New characteristics of venom are being added constantly.

Neurotoxins- Snake venom toxin has two types of neuromuscular blocking toxins, pre-synaptic and postsynaptic. Although it is simplification of actual complex nature of venom, it helps easy understanding nature of common envenoming in Nepal. Presynaptic neurotoxins are phospholipase A2 (PLA2) toxins (mostly beta-neurotoxins) that damage the terminal axon at the neuromuscular junction (NMJ). The action of beta-neurotoxin is unlikely to be reversed by antivenom or anticholinesterase. The postsynaptic neurotoxins (alpha-neurotoxins) bind to the post-synaptic acetylcholine receptor in NMJ. It can usually be reversed by antivenom or anticholinesterases.

Hematotoxins- The common family of hematotoxin are metalloproteinases. The snake venom components that act on the coagulation system include factor V activators, factor X activators, prothrombin activators, and thrombin-like enzymes or fibrinogenase. They cause consumptive coagulopathy and hemorrhage. The zinc metalloproteinases also acts on blood vessel walls.

Cytotoxins- These locally acting venoms mostly consist of phospholipase A2, phosphodiesterases, hyaluronidases, peptidases, metalloproteinases etc. They causes local swelling, blister, necrosis in bitten site/limb. These venoms are found in Cobra and Russell vipers.

5.3.2 Antivenom

Antivenom is the only specific treatment for snakebite envenoming. Since the advent of antivenom, case fatalities due to snakebites have drastically diminished.

The currently available antivenom in Nepal is imported from India and is polyvalent. It is effective against the four common species of snakes found in India; Russell's Viper (*Daboia russelii*), Common Cobra (*naja naja*), Common Krait (*Bungarus caeruleus*) and Saw Scaled Viper (*Echis carinatus*). Saw scaled viper is not yet reported from Nepal.

- Antivenom should be used as early as possible when indicated i.e. when patient develops systemic feature of envenoming. The venom which is not attached to receptor and freely flowing in blood stream (and tissue) is neutralized by antivenom.
- Administration of antivenom carries risk of anaphylactic reactions and should not therefore be used unnecessarily. It is also costly and scarce.
- Currently available antivenom in Nepal should not be used in pit vipers envenoming. Polyvalent antivenom imported in Nepal is available in lyophilized powder form. Each vial is reconstituted with 10ml of sterile water for injection (supplied along with vial) for IV administration.

Note

Antivenom is the only specific antidote to snake venom. The most important decision in the management of a snakebite victim is whether or not to give antivenom.

Indication of antivenom

In Nepal, the most common cause of snakebite envenoming results in neuroparalysis caused by cobra and krait species. Russell's viper envenoming is seen in very few places in Nepal. The indication of antivenom is/are as follows: (table 6)

Table 6: Indications for administering antivenom

Evidence of Neurotoxicity	<ul style="list-style-type: none"> ■ Ptosis, external ophthalmoplegia, broken neck sign, respiratory difficulty, etc.
Evidence of Coagulopathy	<ul style="list-style-type: none"> ■ Evidence of coagulopathy primarily detected by 20 WBCT or visible spontaneous systemic bleeding, bleeding gums, etc., including myoglobinuria and hemoglobinuria. ■ Rapid extension of local swelling (more than half of limb) which is not due to pit vipers or tight tourniquet application.
Evidence of Cardiovascular Collapse	<ul style="list-style-type: none"> ■ Shock and hypotension (in case of Russell's viper bite).
Evidence Of Acute Kidney Injury	<ul style="list-style-type: none"> ■ Traditionally AKI is an indication for antivenom therapy. However, AKI in absence of hematotoxic manifestation is highly unlikely.

Route of administration and dosage of antivenom

Reconstituted antivenom is administered intravenously. Each vial is diluted with 10 ml. of sterile water as supplied with the antivenom. Reconstituted antivenom can be administered either in infusion or as intravenous (IV) bolus injection.

Prophylactic adrenaline (table 7) should be routinely used before initiation of antivenom treatment to prevent antivenom reaction except in older patients with evidence or suspicion of underlying ischemic heart disease or cerebrovascular disease.

Table 7: Dose of prophylactic Adrenaline- subcutaneous adrenaline (0.1 %)

Age	Dose (µg)	Volume (ml)
> 13 yrs.	250 µg	0.25
> 10 -12 yrs.	200 µg	0.20
> 5 - 10 yrs.	125 µg	0.12

Table 8: Route of administration and dose of antivenom

ANTIVENOM ROUTE	
IV Infusion	<p>Adult</p> <p>Reconstituted antivenom is diluted in 5-10ml/kg body weight (approximately 250 to 500ml) of isotonic saline or glucose and administered as infusion@2ml/minute.</p>
	<p>Children</p> <p>Reconstituted antivenom is diluted in 3-5ml/kg body weight of isotonic saline or dextrose water and administered as infusion @ 2ml/min.</p>
IV Injection	<p>Reconstituted antivenom is administered by slow IV @2ml/minute. However, this route is not practiced commonly.</p>
ANTIVENOM DOSE	
Neurotoxic envenoming	
Initial dose	<p>10 vials (100 ml) is further diluted or mixed with dextrose water or saline (100 ml to 400 ml). Then it is administered with intravenous infusion at the rate of 2ml/minute (40-60 min @60-70 drops/min).</p>
Repetition of the antivenom dose in neurotoxic envenoming	<p>If neurological sign/s deteriorates (or neurological score worsen, if score calculated at baseline and thereafter every hour) an IV push of 5 vials of antivenom (50 ml reconstituted antivenom) should be administer @ 2ml/min.</p> <p>Note: Do not repeat antivenom even if neurological sign persists. It should be repeated only if neurological sign/s deteriorates.</p>

Hematotoxic envenoming (Russell's viper envenoming)	
Initial dose	Same as dose for neurotoxic envenoming.
Repetition of dose	Persistence or recurrence of blood incoagulability after every 6 hours of antivenom dose. Repeat 20WBCT (or other test for coagulation) after 6 hours. If 20WBCT is abnormal (incoagulable blood) or other coagulation test are abnormal repeat 5 vials of antivenom (50 ml reconstituted antivenom) IV push @ 2ml/min.
Remember !! Snakes inject the same dose of venom into children and adults. Therefore, the dose of antivenom for children is same as adult dose.	

Reasons for failure to respond to antivenom

It must be remembered that all patients with features of envenoming may not respond to antivenom administered. Failure of response to antivenom may be due to the following reasons:

- Excessive delay in administration of antivenom after envenoming leading to poor response to antivenom. This is specially so in case of krait envenoming.
- Patient with established respiratory failure. Patients with respiratory failure need artificial ventilation and antivenom alone will not suffice.
- If antivenom administered does not contain neutralizing antibodies against the venom of biting species.
- Insufficient dose of antivenom. Clinical trial in Nepal has shown that the mean dose of antivenom required to treat neurotoxic envenoming is 12.5 ± 3.9 vial per patients. However, it may range from as low as five vials to 20 vials, rarely, as high as 30 vials.
- Inactive or poor quality antivenom.

NOTE

Do not use more than 20 vials of antivenom. Administration of higher dose antivenom is unlikely to be useful, if the patient has not responded to initial bolus or around 20 vials of antivenom.

Observation and monitoring

Patient receiving antivenom requires continuous observation and frequent monitoring of vital signs. Careful clinical assessment for appearance of signs and symptoms of antivenom reaction should be performed. The anaphylaxis reaction may be life threatening and no time may be available to draw adrenaline from ampule. Therefore, adrenaline (epinephrine) must be ready, drawn up in a syringe, prior to commencing administration of antivenom.

5.3.3 Antivenom reactions

Three types of antivenom reaction can occur. Significant number of patients develops reaction to antivenom. Around 80% of patients developed some reactions to antivenom in the clinical trial conducted in Nepal²². Although, rarely IgE-mediated Type I reaction can occur in person previously exposed to animal serum (e.g. Tetanus toxoid injection), it is usually dose related. Three types of reaction to antivenom administration are:

- **Early anaphylactic reactions (EAR):** Anaphylaxis is a serious allergic reaction that is rapid in onset and may cause death. It usually develops within 3 hours of antivenom initiation. Common features are itching, which may be intense, urticaria, fever, angio-edema, dyspnea due to bronchospasm, laryngeal edema, hypotension etc. Other features are abdominal pain, vomiting, diarrhea, etc.
- **Pyrogenic reaction:** Usually develops 1-2 hrs. after treatment initiation. Features include, chills, rigors, fever, fall of blood pressure, febrile convulsion may develop in children.
- **Late reaction (serum sickness type):** May develop 1- 12 (mean 7) days after treatment. Features include fever, itching, recurrent urticaria, arthralgia, myalgia, lymphadenopathy, proteinuria etc.

For treatment of EAR/anaphylaxis, pyrogenic reaction and late reaction (serum sickness), please refer to (Annexe 2)

Detection of early anaphylaxis (EAR) and pyrogenic reactions (PR)

EAR and PAR usually occurs within 3 hours after initiation of antivenom administration. Symptoms and signs that are consistent with EAR or PAR should be identified; some are common to both the conditions (fever, hypotension) but others help in distinguishing EAR from PAR.

Following associated features help to identify EAR.

- itching, urticaria, swollen lips or tongue
- respiratory symptoms - dry cough, wheezing, stridor, hoarse voice, 'lump in throat'
- digestive symptoms - nausea, vomiting, abdominal colic, diarrhea
- identify symptoms and signs of life-threatening anaphylaxis/EAR
 - airway- obstruction/compromise
 - breathing- tachypnoea, wheezing
 - circulation- hypotension or shock +/- poor peripheral circulation

Urticaria should be regarded as an early sign of anaphylaxis and treated as 'full blown' anaphylaxis. Itching alone is not life threatening but requires close monitoring.

NOTE

Adrenaline (epinephrine) must be ready, drawn up in a syringe, prior to commencing administration of antivenom. This is in addition to administration of prophylaxis subcutaneous adrenaline dose.

5.4 SUPPORTIVE/ANCILLARY TREATMENT

Treatment of neurotoxic envenoming: Antivenom treatment alone cannot always prevent respiratory paralysis, and patients showing signs of respiratory distress should be artificially ventilated to avoid asphyxiation (discussed further in respiratory support chapter). Complete recovery has even been observed in the absence of treatment with antivenom after 36 to 72 hours of artificial ventilation. Similarly patient presenting in shock needs resuscitation. Russell's viper envenomation may lead to renal failure which may require dialysis support.

For airway protection and management please refer (Annexe 3)

For treatment of hypotension and shock please refer (Annexe 4)

For management of acute kidney injury resulting from Russell's viper envenomation please refer (Annexe 5)

5.5 TREATMENT 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.
- In case of local necrosis and gangrene: Surgical debridement should be done. It may take long time to heal the wound. Broad spectrum antibiotic is indicated if there is 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.

REFERRAL OF SNAKEBITE PATIENTS

Indication for referral

Patient requiring

- Respiratory support
- Deteriorating neurologic manifestations
- Surgical intervention-necrosis / fasciotomy
- Spontaneous persistent bleeding in spite of antivenom administration in adequate dose
- Co-morbid diseases like heart failure or chronic kidney disease
- Acute kidney injury

Where to refer

- Center with facilities to provide mechanical ventilation in case of neuromuscular paralysis
- In case of AKI - center having dialysis facilities
- In case of necrosis (or likely need for fasciotomy) – center with experience in management of snakebite wound

What to do before transfer

- Open IV line
- Give antivenom if features of systemic envenoming exist. Adrenaline prophylaxis must be given before starting antivenom
- If antivenom not available – give neostigmine and atropine in case of neurotoxic envenoming

Instructions while referring/transferring the patient

- Explain the reason for referral to the patient party.
- If possible provide prior intimation to the receiving center, specially to know the availability for assisted ventilation.
- Arrange for an ambulance and transfer the patient in center where mechanical ventilator and dialysis facilities are available.
- It is critical to provide airway support while transferring patient. This should be done with the help of an accompanying staff.
- A referral note should mention about the treatment given (specially antivenom) and the condition of the patient at the time of transfer.
- Instruct one staff to accompany the patient during transportation if required.

ROLE OF DIFFERENT LEVEL OF HEALTH SERVICES FOR SNAKEBITE MANAGEMENT

Snakebite mostly affects the poorest people living in rural Nepal. The medical facilities to treat snakebite victims may/may not be available in the rural areas of Nepal where snakebite mostly takes place. Therefore, it is necessary to promote rapid transfer of patient to treatment center where facilities to administer antivenom exist. In the health care delivery service of Nepal, health post and/or primary health center is expected to be at the closest to snakebite incidents. If the health care provider at health post and PHC can be properly trained on management of snakebite, many lives can be saved. The referral needed will be those who needs respiratory or other supportive measures. For this, strengthening of the centers in terms of logistic and human resource is necessary. Until then, different level of health care services will have different role in the management of snakebite victims.

It is also to be noted that, in Nepal, besides the government health sector, snakebite victims are also managed by not for profit organization (for example snakebite management center, Damak Red Cross subcenter), Nepalese army, private sectors, etc.

Districts hospitals and higher centers

(facility to treat snakebite envenoming is available)

Follow management of snakebite as given in chapter 5.

Health post/primary health care centers

(If facility to treat snakebite does not exist/ antivenom and trained manpower not available)

Table 9: Role of health post/primary health care centers for snakebite management

<ul style="list-style-type: none"> ■ Reassure the victim.
<ul style="list-style-type: none"> ■ Provide recommended first aid.
<ul style="list-style-type: none"> ■ Start an IV line.
<ul style="list-style-type: none"> ■ Quick assessment of the snakebite victim to identify if there are features of envenoming or not (described in the clinical feature above).
<p>If features of envenoming is present</p> <ul style="list-style-type: none"> ■ Give neostigmine and atropine. ■ Dose in Adult: Inj. Atropine 0.3 - 0.6mg I/V followed by Inj. Neostigmine 0.01 mg/kg up to 0.5mg IV or IM every 30 minutes until neurotoxic features improve. Atropine should also be re-dosed periodically as indicated by significant bradycardia especially with hypotension. ■ Children: Inj. Atropine 0.02mg/kg up to 0.6mg followed by inj. Neostigmine 0.025 to 0.04mg/kg up to 0.6mg in children IV or IM every 30 minutes. ■ Arrange the transfer of the patient. ■ Place the patient in recovery position (transfer in such position if ambulance or other 4 wheeler can be arranged). Transfer in motor bike can be faster (IV canula should be in place and IV fluid should not be attached if transferring in motorbike). <p>If feature of respiratory distress is present</p> <ul style="list-style-type: none"> ■ Start oxygen, if available. ■ Place T tube, if available. ■ Bag Valve Mask (Ambu bag) ventilation (if available).. ■ LMA placement, if available
<p>If features of envenoming is not present</p> <ul style="list-style-type: none"> ■ Reassure victim and provide recommended first aid. ■ Start IV Line and arrange transfer.

MANAGEMENT OF SNAKEBITE ENVENOMING WHEN NO ANTIVENOM IS AVAILABLE

Neuroparalysis

Two most important species of snakes that causes neuroparalysis in Nepal are Cobra and Krait. The most important neuromuscular blocking venom component of cobra is post synaptic (α) neurotoxins, such as α -bungarotoxin, which produces a curare-like non-depolarizing, competitive post synaptic block by binding to acetylcholine receptors at the motor endplate. This blockade can be antagonized by neostigmine. Therefore, in cobra envenoming it is useful to administer neostigmine (along with atropine). The dose of neostigmine is neostigmine methylsulphate, 0.5-2.5 mg every 1-3 hours. Maximum dose that can be given for adult is 10 mg/24 hours. For children, 0.01-0.04mg/kg every 2-4 hours. It can be given by intramuscular, intravenous or subcutaneous injection. Neostigmine must be given together with atropine to block muscarinic side effects. However, assisted ventilation may still be required.

Krait venom produces neuromuscular paralysis by presynaptic neurotoxins, such as β -bungarotoxin. β -bungarotoxin damages the nerve endings. It produces pre-synaptic toxicity characterized by depletion of synaptic vesicles, destruction of motor nerve terminals, and axonal degeneration followed by reinnervation preventing further release of transmitter⁴⁵. Therefore, the neuromuscular paralysis is prolonged in krait envenoming and it does not respond to treatment by neostigmine. Therefore, in case of neurotoxic paralysis by krait bite, assisted ventilation is required. In a rare case series of 60 patients with envenoming by the many-banded krait (*Bungarus multicinctus*) in Vietnam for whom antivenom was not available, 87% needed mechanical ventilation for a mean of 8 days, the mean duration of the ICU stay was 12 days, and hospital mortality was 7%⁴⁶.

Coagulopathy

Venom-induced consumption coagulopathy (VICC) is due to the activation of the clotting pathway by procoagulant snake toxins and consumption of clotting factors. Antivenom, containing antibodies against envenoming species, is the recommended standard treatment for snake envenoming.

Antivenom available in Nepal, imported from India, contains neutralizing antibodies against Russell's viper, therefore, is useful to treat Russell's viper induced coagulopathy. Indian antivenom does not contain neutralizing antibody against pit vipers (even if they cause VICC). Antivenom will neutralize the circulating venom and stop the consumption coagulopathy process. However, it will take another 24 to 48 hours for liver to produce clotting factors for full recovery of the clotting factor⁴⁷. Therefore it is logical to supplement FFP after administration of antivenom in these groups of patients.

A recent randomized controlled trial in Russell's viper envenoming, neither fresh frozen plasma hastened recovery of coagulopathy nor low-dose antivenom worsened coagulopathy⁴⁸. While treating patients with VICC and in absence of specific antivenom, strict bed rest, avoiding injuries including intramuscular injection, avoiding straining and constipation, as practiced for other platelet and coagulation disorders is likely to be useful to prevent bleeding in vital organs. Transfusion of fresh frozen plasma (FFP) or cryoprecipitate with platelet concentrates is only indicated in cases of life-threatening hemorrhage in conjunction with antivenom administration or, when antivenom is not available and the patient has major bleeding. If FFP is not available whole blood transfusion may be considered, in this scenario. However, in absence of neutralizing antivenom and in presence of circulating venom procoagulant toxins, the clotting factors administered are rapidly consumed and it may lead to formation of microthrombi in the circulation.

PREVENTION OF SNAKEBITE

Snakebites are seasonal events. It occurs when snake comes out of hibernation and after rain. Kraits are mainly nocturnal, but other species, like cobras are mainly diurnal and active during dusk and dawn. Be careful about snake and their bites after rains, during flooding, at harvest time and at night and at places where snakes can be hiding. Snakes prefer not to confront large animals such as humans so give them the chance to slither away.

Attention to the following recommendations for community education might reduce the risk of bites. Following recommendations can be made in general to prevent snakebite. (Table 10)

Table 10: Measures to be taken to avoid snakebite

HOW TO AVOID SNAKEBITE
<ul style="list-style-type: none"> ■ Community based education to prevent snakebite.
<ul style="list-style-type: none"> ■ As snakes prefer dry places during rainy season (as water enter their habitation) and species like kraits enter human dwelling in search for food (rat, chicken etc.), their entry to house should be prevented as far as practical.
<ul style="list-style-type: none"> ■ Keep household clean by cutting grasses, bushes, and plants, remove heaps of rubbish, building materials etc. from near and around house.
<ul style="list-style-type: none"> ■ Bamboo, wood piles should be removed from household so that snake cannot hide.
<ul style="list-style-type: none"> ■ Close door, windows properly, so that snake cannot enter house.
<ul style="list-style-type: none"> ■ If possible, store food in rat-proof containers.
<ul style="list-style-type: none"> ■ Try to avoid sleeping on floor. If it is unavoidable, then mosquito net should be used and tucked well under the mattress or sleeping mat. It not only prevents from krait bite but also from mosquito bite.
<ul style="list-style-type: none"> ■ Keep your granary away from the house, it may attract rodents that snakes will hunt.

- Use a light when you walk outside the house or visit the latrine at night.
- Take extra care walking/working in places where snakes are likely to inhabit or hide.
- Use high shoes or boots while walking in paddy field, bushes, long grasses.
- In dark, use light or strike the path using stick. Snake will move away, if it is present there.
- Never play with snakes, or irritate them even if they are dead. Never provoke them, they usually do not bite if not irritated or provoked.
- Never insert hands into long grasses, tree holes or mud holes. Take care while pulling straw.
- Shoes and cloths should be check before wearing, in an area where snakes are abundant.

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ANNEXES

20 MINUTES WHOLE BLOOD CLOTTING TEST (20WBCT)

Procedure and interpretation

- Use the necessary precautions for taking blood.
- Place 3 ml of freshly sampled venous blood in a small, new, dry, glass tube.
- Leave the tube standing undisturbed for 20 minutes at ambient temperature.
- Gently tip the tube once.
- If the blood is still liquid (unclotted) and runs out, the patient has uncoagulable blood.

Timing of test

- The test should be performed on patient on admission, who is suspected to be bitten by Russell's Viper.
- If on admission the test shows uncoagulable blood or if the patient has spontaneous bleeding, the test should be repeated every six hours after initiation of antivenom .
- If on admission the test is normal (coagulable blood), the test should be repeated when spontaneous bleeding occurs.

Important notes

- If the tube used is not made of ordinary glass or if it has been cleaned with detergent, the tube's wall may not stimulate clotting and the test will be invalid.
- If the result of the test is doubtful, repeat the test in duplicate, and include a blood sample from a control (non-venomated person such as a relative).
- Do not confuse whole blood with serum; it is normal to have the clear serum running out when the tube is tipped after 20 minutes.
- It is not indicated in identified Cobra or Krait bite.



Figure 43: Whole Blood Clotting Test. The blood is in coagulable signifying venom induced consumption coagulopathy. PC: D.A. Warrell

TREATMENT OF ANTIVENOM REACTIONS

Treatment of Early Anaphylaxis Reaction/Anaphylaxis

Table 11: Recommended treatment for early anaphylaxis reaction/anaphylaxis

ACUTE PATIENT MANAGEMENT

- INTERRUPT antivenom (and neostigmine and atropine if patient is receiving).
- Give IM aqueous Adrenaline. **(Box1)**
- Place the patient in recumbent position and elevate lower extremities.
- Oxygen: Give 6 - 8 liters per minute via facemask (or nasal prong if facemask is not available).
- Normal saline rapid bolus- Treat hypotension with a rapid infusion of normal saline.
 - o start with 1L for adults
 - o start with 20 mL/kg for children
 - o Open the drip to run in as fast as possible (use 16 G IV cannula).
- Repeat the same volume if hypotension/signs of cardiovascular shock remains. See **(Box 2)** for targeted systolic BPs.
- Patients with underlying heart disease require less volumes of fluid, so look for signs of fluid overload (edema legs, raised JVP, bilateral basal crepitation in chest) before another fluid bolus is started.
- Give IV Chlorpheniramine **(Box1)** slowly over several minutes or IM for the relief of urticaria and itching only. Repeat the same dose if persistent itching or urticaria. Note: Chlorpheniramine frequently induce drowsiness and may also cause hypotension (that is why it must be given slowly). Arouse the patient before assessing signs of neurotoxicity.
- Give IV Hydrocortisone (adults 100 mg, children 2 mg/kg body weight).
- Nebulized Salbutamol: for bronchospasm resistant to IM epinephrine, give 2.5 to 5mg in 3mL saline via nebulizer; if bronchospasm persists, repeat every 15 minutes four times, then every two hours till disappearance of wheeze.
- General measures
 - o Closely monitor vital signs: BP, pulse rate, oximetry (if available).
 - o You may seek help of snakebite expert, if needed via cellphone.
 - o DO NOT restart antivenom following a life-threatening EAR (bronchospasm, angio-edema, cardiovascular shock) without appropriate set up for resuscitation available.

PATIENT MANAGEMENT WHEN STABLE

- Patients can develop a second anaphylactic reaction, so it is reasonable to prevent this.
- Continue IV hydrocortisone 100 mg or 50 mg (6-12 years) or 25 mg (< 6 years) every 6 hour for 24 hrs.
- Oral prednisolone 1 mg/kg (max dose 60 mg in adults) once daily in the morning with food for 2 days.
- Oral chlorpheniramine 4 mg, 2 mg (6-12y), 1 mg (< 6y) mg every 6 hour x 3 days for the relief of itching or urticaria only.

PATIENT MANAGEMENT IF ANTIVENOM HAS TO BE RESTARTED

- Managing such patients is difficult, so consider transfer to ICU.
- If already on steroids (as above), continue IV hydrocortisone.
- If has to be restarted in the clinic, an IV adrenaline infusion will be required and should be started before giving antivenom.
- The dose of IV adrenaline infusion is:
 - Add 1 mg of adrenaline to 100 ml normal saline (this contains 1 mg in 100 mL = 1000 mcg in 100 mL = 10 mcg in 1 mL = 10 mcg/mL).
 - Use an infusion pump or pediatric drip set with micro drops (see chart for drop rate)..
 - If the patient is still hypotensive/has signs of anaphylaxis, start at 0.5-1 mL/kg/h depending on how severe the reaction is.
 - If the patient is normotensive and stable, start at 0.25 mL/kg/h.
 - Titrate up or down according to response (see above) and side effects.
 - Stop infusion 30 minutes after resolution of all symptoms and signs.

Box 1: Dose and route of adrenaline and chlorpheniramine for different age group.

Age Group	Dose	Route
Adrenaline		
Adults & children ≥ 13 yrs	0.5 mg	IM
Children aged 6-12 yrs	0.3 mg	IM
Children ≤ 5yrs	0.15 mg	IM
Chlorpheniramine		
Adults & children ≥ 13 yrs	10 mg	IV slowly over several minutes or IM
Children aged 7 to 12 yrs	5 mg	IV slowly over several minutes or IM
Children aged 6m to 6 yrs	2.5 mg	IV slowly over several minutes or IM
<p>Note: Adrenaline is available as 0.1% solution, 1 in 1,000 dilution containing 1mg/ml in 1ml vial, 0.5 mg = 500 mcg = 0.5 mL, give adrenaline IM into anterolateral thigh. There are NO absolute contraindications to adrenaline in the setting of anaphylaxis. Repeat the dose every 3-5 minutes until blood pressure is stabilized and signs of poor peripheral perfusion are better.</p>		

Box 2: Targeted systolic blood pressures during treatment of anaphylaxis

Age Group	Systolic blood pressure
Adults	100 mmHg
Children aged > 10 yrs.	90 mmHg
Children aged 5 to 9 yrs.	80 mmHg

Box 3: Dosing table for adrenaline infusion, expressed as ml/h for 3 different doses of adrenaline

Weight (kg)	0.25 ml/kg/h	0.5 ml/kg/h	1 ml/kg/h
15	3.75	7.5	15
20	5	10	20
25	6.25	12.5	25
30	7.5	15	30
35	8.75	17.5	35
40	10	20	40
45	11.25	22.5	45
50	12.5	25	50
60	15	30	60
65	16.25	32.5	65
70	17.5	35	70
80	20	40	80
90	22.5	45	90

Note

Adrenaline (epinephrine) must be ready, drawn up in a syringe, prior to commencing administration of antivenom. This is in addition to administration of prophylaxis subcutaneous adrenaline dose.

Table 12: Treatment of pyrogenic reaction

<ul style="list-style-type: none"> Do not interrupt antivenom unless hypotension is present.
<ul style="list-style-type: none"> Give injection 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.
<ul style="list-style-type: none"> Treat hypotension with rapid infusion of normal saline: 1 to 2 liters IV to be repeated if signs of hypotension remain.
<ul style="list-style-type: none"> In presence of cardiovascular shock, in patient who received/receiving antivenom, should be treated as anaphylaxis.

Table 13: Treatment of serum sickness

Anti-histaminic Pheniramine maleate	Adults: 25 mg twice a day * 3 days Children: 0.25 mg/kg/day in divided doses* 3 days
If no response to antihistaminic Prednisolone	Adults: 5 mg, 6 hourly * 7 days Children: 0.7 mg/kg/day in divided doses* 7 days

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 respiratory muscle paralysis

Three basic pillars of airway managements are

1. Maintaining patency of airways
2. Protection against the aspiration
3. Making sure of oxygenation and ventilation

Guide to airway management and respiratory support

1. Basic airway management

Before basic airways management it is important to assess if patient is breathing or not.

How to assess breathing?

- Place your ear near the victim's mouth and nose, keeping your gaze towards the victim's chest. This will allow to look for movement of chest (rise and fall).
- Listen for breathing air during exhalation, feel for the flow of air against your cheek.
- This assessment should be completed within 10 seconds, but preferably in 5 seconds.
- If oxygen is available, administer by any available means (nasal prongs/catheters, mask, bag-valve-mask etc.).
- If suction is required, it should be done as quickly as possible to prevent prolonged interruption of oxygen administration.
- Bag-mask ventilation is the cornerstone of basic airway management. This technique is not easy and needs practice to become skilled.

Opening and maintaining the airway

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

A. Head-tilt-chin-lift**B. Jaw thrust with or without head tilt****A. Head-tilt-chin-lift**

It brings the patient's head into the "sniffing" position.

Precautions

- Do not perform if neck injury is suspected. Use Jaw thrust instead
- Avoid closing mouth or compressing chin soft-tissue

Technique

- One hand on forehead to tilt head back
- Infant
 - Head in neutral position
 - Do not overextend head and neck
- Child and adult
 - Head and neck slightly extended
 - Line from chin to jaw angle perpendicular to floor
 - Use other hand's fingers under bony part of chin
 - Do not use thumb to lift chin
 - Lift mandible upward and outward

B. Jaw thrust

This is very effective maneuver and can also be performed in the presence of cervical injury. It will help the tongue to move anteriorly and minimize the tongue's ability to obstruct the airway.

Technique

- Place 2-3 fingers under each side of lower jaw angle
- Lift jaw upward and outward



Figure 44: Head-tilt Chin-lift technique.
PC: S.K. Sharma



Figure 45: Jaw thrust technique.
PC: S.K. Sharma

Bag-mask/bag-mask-valve Ventilation

In a health care center, a commonly used method for providing initial respiratory assistance is with a bag-mask/bag-valve-mask (BVM). Bag-mask ventilation is a crucial airway management skill; however, it is not easy to perform it correctly. It needs practice to master it. Properly performed bag-mask ventilation enables health care provider (HCP) to provide adequate ventilation and oxygenation to a patient requiring airway support. This in turn gives the HCP sufficient time to pursue a controlled, well-planned approach to definitive airway management, such as endotracheal (ET) intubation.

Technique

- Successful bag-mask ventilation depends on three things: a patent airway, an adequate mask seal, and proper ventilation.
- One hand is used to maintain face seal, position head (“sniffing” position, in absence of cervical spine injury) that maintain the airway patency.
- Thumb and index finger is used to maintain face seal.
- Middle finger is placed under mandibular symphysis.
- Ring/little finger is under angle of mandible.
- Maintain jaw thrust/mouth open.
- Other hand is used to ventilate and gives breaths at approximately the normal respiratory rate for the patient by squeezing/pressing the bag, looking for visible chest rise. Any chest movement is usually adequate, especially in children.



Figure 46: Bag-mask-valve ventilation PC: S.K. Sharma

Note

- Mask or wrist/hand of health care providers must not rest on the patient's eyes during BVM as this can cause a vagal response or damage to the eyes.
- 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 mouth. Look inside the victim's mouth. There may be blood, vomit or excessive oral secretions contributing to airway obstruction and putting the patient at risk of aspirating (inhaling) this material into their lungs.
- Other foreign body, if present should be removed by using forceps. Do not use hand. Hand may push material further inside mouth and there is risk of being bitten.
- Keeping patient in recovery position may 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 (OPA), 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.
- An endotracheal tube should be inserted as soon as possible in any patient unable to protect his or her airway. This is especially true for patient with neurotoxic envenoming.
- Inability to insert OPA device in snakebite usually indicates severe hypoxia, hypoglycemia, seizure etc. leading to trismus. Sometime, if patient may be awake and simply resist the insertion of OPA.

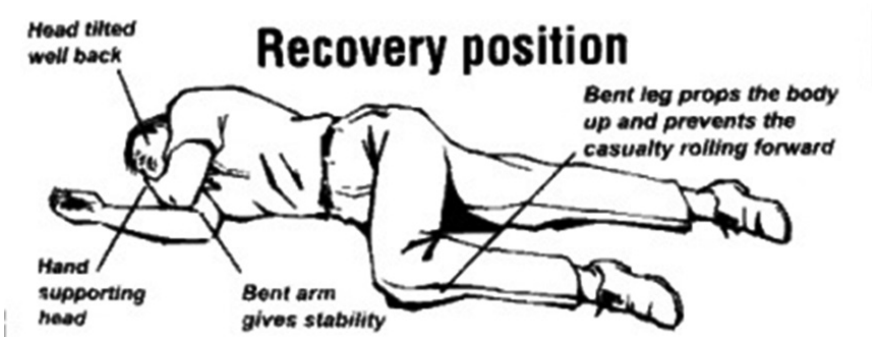
2. Advanced airway management (AAM)

Endotracheal intubation is the commonest method for AAM. Another method is placement of supraglottic devices like Laryngeal mask airway. In a patient with envenoming who needs sustained supported ventilation or to prevent possibility of asphyxiation or airway obstruction, advance airways management is required.

Indications

- Imminent respiratory arrest (breathing is absent or inadequate).
- No breathing is discernable within 10 seconds (or 5 seconds in a child, 2 seconds in a baby).
- The respiratory rate is very slow (be aware of normal breathing pattern).

- The depth of respiration is shallow.
- The patient is taking agonal gasping breaths.
- The patient is cyanosed centrally (blue lips, ears, or tongue).
- Oxygen saturation <90% (equivalent to PaO₂ <60mmHg) despite high flow oxygen.
- Neck muscle weakness with shallow respiration or paradoxical breathing.
- Upper airway obstruction with stridor (secretion pooling in upper airways or secondary to anaphylaxis).
- Oxygen saturation <90% (equivalent to PaO₂ <60mmHg) despite high flow oxygen.
- Accumulation of secretion/vomitus/blood due to loss of gag reflex and paralysis of pharyngeal muscle leading to airway obstruction or possibility of pulmonary aspiration.
- Blood gas measurement showing respiratory acidosis (hypoxia PaO₂ < 60 mm Hg with PaCO₂ > 45 mm Hg).



Endotracheal Intubation

Positioning of the patient

The classic “sniffing” position is usually adequate, but further elevation is almost always better for glottic exposure. If glottis is not adequately visualized, increase head elevation by flexing the lower neck. If available, an assistant should perform these maneuvers. Avoid the common tendency to extend the neck, which generally does not improve the view. Tongue should be always be positioned in the left side of the mouth. Pre-oxygenate the patients until intubation is initiated.

Essential instruments and medicines for endotracheal intubation: The acronym STOP MAID may be useful to remember the list.

S	Suction
T	Tools for intubation (laryngoscope blades, handle)
O	Oxygen
P	Positioning
M	Monitors, including electrocardiography, pulse oximetry, blood pressure, EtCO ₂ , and esophageal detectors
A	Assistant; Ambu bag with face mask; airway devices (different sized ETTs, 10 mL syringe, stylets); assessment of airway difficulty
I	IV access
D	Drugs for pretreatment, induction, neuromuscular blockade (and any adjuncts)

These do provide protection of the lower airway (the lungs) against contamination by fluids and also permit higher ventilation pressures and the highest inspired oxygen concentrations. Typically, a cuffed tube for adults and an uncuffed tube for children is use. Although the use of cuffed (low pressure, high volume) tubes for children is becoming more acceptable. However, they require a laryngoscope to permit visualization of the laryngeal structures. To insert these devices safely and quickly (to reduce the period of no ventilation, and hence the risk of hypoxia) experience is required. Essentially an endotracheal tube is inserted under laryngoscopic vision between the vocal cords so that its tip lies in the mid trachea.

Laryngeal Mask Airway

The laryngeal mask airway (LMA), is an extremely useful device for ventilating patients. LMA airway is an airway device that can be inserted into the pharynx to allow ventilation and oxygenation in patient with envenoming and in need of airway support. LMA does not require special equipment to insert it, and can even be inserted by medically untrained person, after some training. However, LMA does not protect against aspiration.



Figure 47: Insertion of an endotracheal tube. PC: S.K. Sharma



Figure 48: Envenoming by kraits and cobras frequently results in respiratory paralysis. In these cases, early assisted ventilation is life-saving. Here it is performed manually using an Ambu bag on a paralyzed patient bitten by a common krait (*Bungarus caeruleus*). PC: D.P. Pandey

Size selection of LMA

In general, the size 4 LMA will be suitable for most adult females and the size 5 for adult males up to 100 kg. In Nepali people size 4 should fit for most of the adult.

Box 4: Size selection of LMA

Size 1	under 5 kg
Size 1.5	5 to 10 kg
Size 2	10 to 20 kg
Size 2.5	20 to 30 kg
Size 3	30 kg to small adult
Size 4	adult
Size 5	large adult

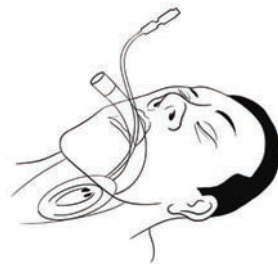
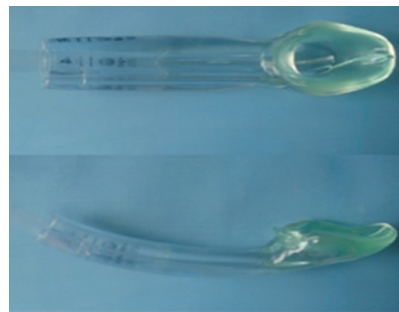


Figure 49: Laryngeal mask airways

Technique to insert LMA

- Before insertion, inflate the cushion on the mask and check for the leak or abnormal bulging.
- Deflate the cushion.
- Lubricate the posterior surface of the LMA for easy sliding. Do not put lubricant on laryngeal opening.
- Place the patients head in “sniffing” position.
- Insert with the LMA cuff outlet facing towards the patient’s chin. When inserting the LMA hold it like a pen, with the index finger positioned along the LMA tube so that the fingertip is positioned where the base of the tube meets the junction with the cuff.
- Glide the device downwards and backwards along the hard palate with a continuous but gentle push until a definitive resistance is felt.
- If the LMA is properly seated, the tube rises slightly out of the mouth as cuff is inflated and the area over the larynx gets lifted. The incisors should be resting on the integral bite-block.
- Check ventilation Immediately.

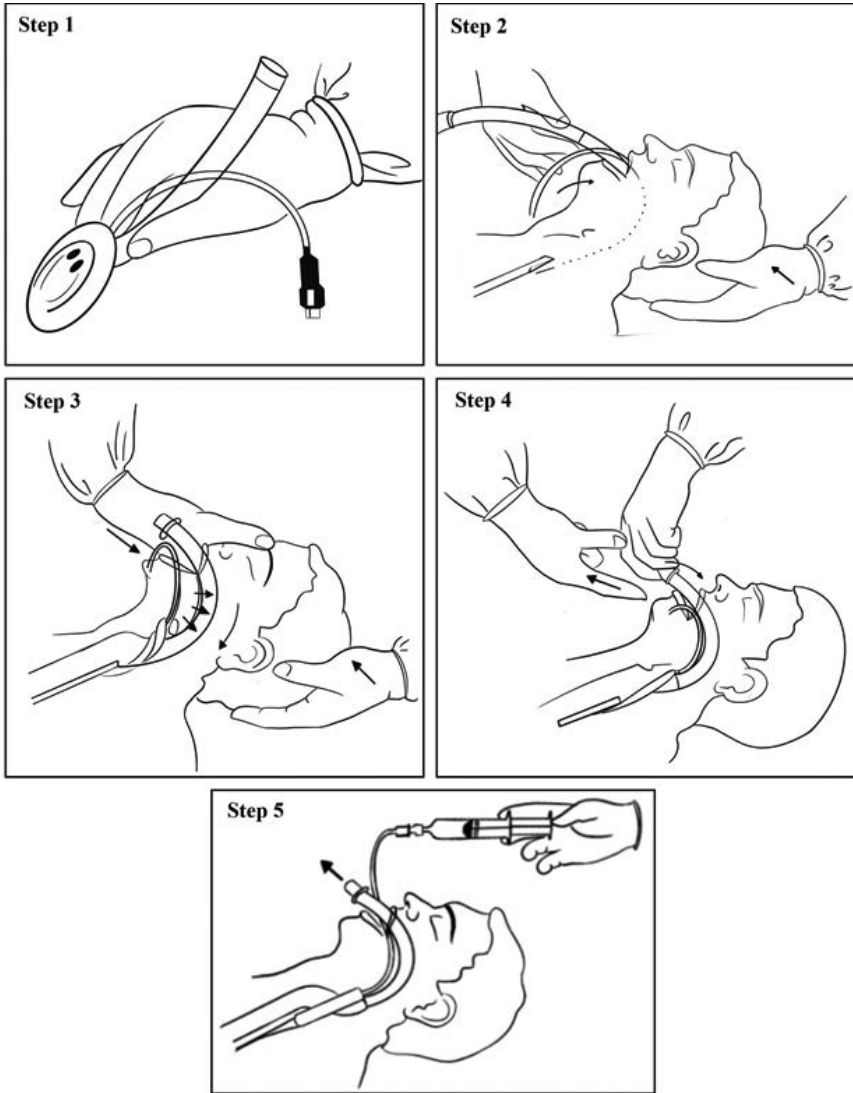


Figure 50: Steps to insert LMA

TREATMENT OF HYPOTENSION AND SHOCK

In Nepal, this is seen in patient with Russell's viper envenoming. Hypotension and shock results from bleeding, leakage of large amount of fluid into the bitten limb and sometimes due to direct myocardial depression and vasodilatation due to venom effect⁴¹. Before the setup for the antivenom and/or intravenous line is made, the foot end of the bed should be elevated to improve the cardiac filling. Usually antivenom can reverse the bleeding manifestation of envenoming, though antivenom might have to be repeated. The need of repeat antivenom can be assessed by the 20-WBCT till the blood coagulability is achieved. The patient may also need infusion of large amount of fluid (normal saline or blood). If shock is not reversed, vasoactive medications (dopamine or noradrenaline), should be started as done for patient with septic shock. The dose of dopamine is 2.5-5 micro g/kg/minute and dose of noradrenaline is 0.05 to 0.3 microgram/kg/min¹⁰.

MANAGEMENT OF ACUTE KIDNEY INJURY RESULTING FROM RUSSELL'S VIPER ENVENOMING

Russell's viper can cause generalized rhabdomyolysis induced by PhospholipaseA2, which may cause myoglobinemia, hyperkalemia, and acute kidney injury (AKI)^{10,42}. AKI may also result from the direct action of some venoms and associated hypotension due to bleeding⁴³.

AKI can be diagnosed on the basis of KDOQI criteria⁴⁴. Therefore careful monitoring of urine output is helpful in patients envenomed by Russell's viper envenoming.

- Urine volume <0.5 ml/kg/hour for six hours, or
- Increase in serum creatinine by ≥ 0.3 mg/dl within 48 hours, or
- Increase in serum creatinine to ≥ 1.5 times baseline, which is known or presumed to have occurred within the prior seven days

Patient may become symptomatic at advance stage of acute kidney injury. These manifestations may be but not limited to, fluid overload in the form of leg edema, or pulmonary edema, uremic features like nausea, vomiting, acidotic breathing, hiccough, altered mentation, pericarditis, convulsion etc.

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 200-250 ml of intravenous normal saline over one hour as fluid challenge. If patient's chest is clear and neck veins are not distended, fluid should be continued further.
- Diuretic use: After adequate fluid replacement a single dose of furosemide should be given. The dose depend on body weight (1- 1.5mg/kg). Observe urine output for 2 hours. If urine output is <200 ml, do not use further furosemide and refer the patient to center that have facilities for dialysis.
- Patient with features of volume overload not responding to diuretics, clinical features of uremia, hyperkalemia not responding to medical treatment or with ECG changes of hyperkalemia, severe metabolic acidosis, anuria etc. are indication for dialysis.

COMPARTMENT SYNDROME

Compartment syndrome is very uncommon clinical entity in snakebite in Nepal. Many at times it is over-diagnosed. Presence of 6ps (Pain on passive stretching, Pain out of proportion, Pulselessness, Pallor, Paresthesia, and Paralysis) considered to be markers of compartment syndrome was not found to be reliable in small study from India. Swelling of muscles due to venom effect, especially in tight tissue compartment 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. This can be done by using saline manometers or newer specialized equipment such as the Stryker Intra-compartmental Pressure Monitoring Equipment and connected to a pressure transducer or manometer⁵². However, it is to be noted that muscle sufficiently envenomed and swollen to cause intra compartmental syndromes, may already be irreversibly damaged by the direct effects of the venom⁵³. Established compartment syndrome may need fasciotomy. However, fasciotomy must not be done, even required, until coagulation abnormalities is corrected, otherwise the patient may die due to bleeding. It is also suggested that treatment with anti-venom itself may reduce the intra compartmental pressure.

DOS AND DON'T'S AFTER A SNAKEBITE

If you are Bitten by a Snake

- Don't panic. Most snakes are not dangerous, and even those that are dangerously venomous often do not inject venom when it bites a person.
- Don't risk further bites or delay appropriate treatment by attempting to search, capture or kill the snake. However, if the snake is already killed, it should be carried safely along with the patient to the treatment center for identification.
- Immobilize the bitten limb with a splint or sling and keep it still as much as practical.
- Don't run. If possible, let others carry you immediately (preferably by motor vehicle) to the nearest health center where antivenom serum is available. Using a motorcycle will help to save time.
- Don't cut, burn or suck the bite site or the bitten body part.
- Don't use herbs, chemicals, ice/cool packs or electric shocks.

ANNEXE 8

RECORDING AND REPORTING TOOLS

1. Monthly reporting form

		No of snakebite cases	No of venomous snakebite cases	No of deaths due to snakebite envenomation	No of cases who received antivenom	No of antivenom vials used	No of anti venom vials received in last month	Current stock of antivenom (vials)
Age	≤14 years	M						
		F						
	≥ 15 years	M						
		F						
TOTAL								

2. Case investigation form-snakebite envenoming

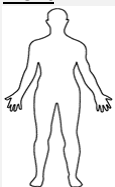
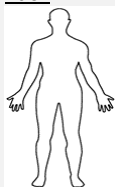
Name of Health Facility: _____

Address: _____

PATIENT'S DETAILS

Name:	
Age/Sex:	
Address:	
Occupation:	

DETAILS OF SNAKEBITE

Date of bite:		
Time of bite:		
Location at the time of bite:	Field ____ Road ____ Others ____	Garden ____ Forest ____
Site of bite: (Mark [x] at the site of bite in the diagram)	Front 	Back 
Did the patient see the snake?	Yes ____ No ____	If yes, Krait ____ Cobra ____ Viper ____ Unknown ____ Any local name ____
Tourniquet:	Yes ____ No ____	If Yes, No of tourniquet _____
Local treatment/practice:	Soap and water ____ Incision/Draining ____	Sucking ____ Others ____
Whether patient had visited any other place before arriving to hospital:	Yes ____ No ____	If Yes, Where Faith healer ____ Private Hosp ____ Govt hospital ____
Past history of snake bite:	Yes ____	No ____
Mode of transportation:	Ambulance ____ Jeep/Van/Car ____	Motorcycle ____ Bicycle ____ Others ____
Time between snakebite and symptoms development:		

CLINICAL FEATURE

A. At the time of arrival	
BP: _____ mm Hg	Temp: _____
Pulse: _____ /min	Fang mark: Definite mark _____ Scratch mark _____ No mark _____
RR: _____ / min	
B. During the hospital stay	
Local symptoms:	Pain ___ Bleeding ___ Swelling ___ (>half of limb/<half of limb) Blister ___ Cellulitis _____ Necrosis _____ Scalding _____ Compartment syndrome _____ Burning _____ Neuritis _____
Neurotoxicity:	Inability to frown _____ Ptosis _____ Diplopia _____ Blurred vision _____ Hypersalivation _____ Dysphonia _____ Difficult in swallowing _____ Neck muscle weakness _____ Respiratory muscle weakness _____ Altered sensorium _____
Bleeding symptoms:	Continuous bleeding from the bite site _____ Gingival bleeding _____ Petechiae _____ Hematuria _____
Other symptoms:	

INVESTIGATION

20 minute Whole Blood Clotting Test (WBCT) normal: Yes ___ No ___ Not done _____

TREATMENT AND MANAGEMENT

Describe:	
Anti-snake venom:	Number of vials given: Date and time of initiation of ASV: Name of the manufacturer:
List any other drugs given	

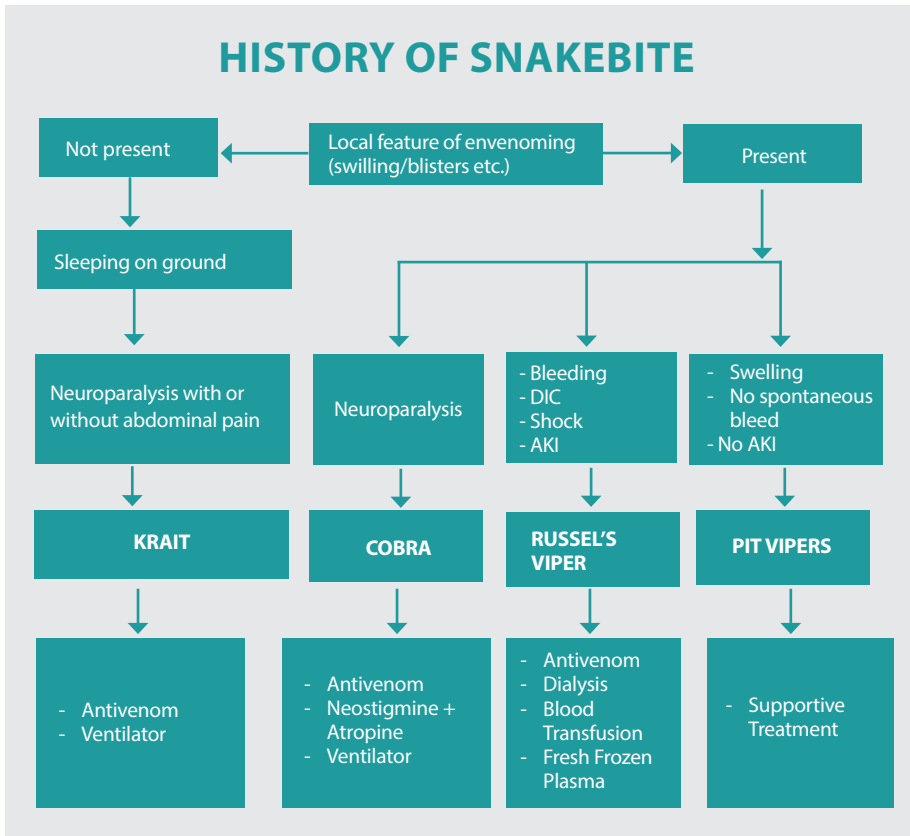
Discharge date & time: ___/___/___ (dd/mm/yyyy) at ___:___ am /pm

Outcome: Improved ___ Referred ___ Died during treatment ___ Brought dead ___ LAMA _____

If referred, which Hospital: _____

Health Care Provider's Name/Position: _____ **Signature:** _____

FLOWCHART FOR APPROACH TO SNAKEBITE IN NEPAL



MAJOR INDIAN ANTIVENOM MANUFACTURERS

MANUFACTURER

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Haffkine Bio-Pharmaceutical

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Website: www.premiumserums.com

Polyvalent Snake Venom Antiserum both in lyophilized or liquid form

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Website: www.mediclonebiotech.com

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Email: info@biologicale.com
Website: www.biologicale.com

Note

Antivenom produced in India are polyvalent containing antivenom against common cobra, common krait, Russell’s viper and saw scaled viper

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