Guidelines for Prevention Diagnosis and Management of Snakebite Envenoming in Kenya

Neglected Tropical Diseases Program
Ministry of Health
Government of Kenya

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FOREWORD

On the 24th of May 2018, the 71st World Health Assembly adopted a resolution which formally mandated the World Health Organization (WHO) to step up efforts towards addressing the global burden of snakebites. Kenya was one of the several member states which proposed this resolution, and the more than 30 countries which strongly supported it. The adoption came shortly after recognition of snakebite envenoming as a neglected tropical disease (NTD) in 2017.

A working group has been set up by WHO to prepare a strategic plan which will guide efforts to assess and address the global burden of snakebite envenoming (SBE). The ultimate goal is to attain a 50% reduction in the number of deaths and disabilities by the year 2030. This, it is believed, will help reduce the magnitude of the problem significantly, especially among the poor populations who are worst hit by the effects of SBE. The plan builds on WHO's concept of Universal Health coverage, which is also one of Kenya's Big Four Agenda, and seeks to ensure that snakebite victims are included in the drive to achieve the 2030 Sustainable Development Goals.

In line with the constitution of Kenya 2010, our mission is to build a progressive, responsive and sustainable health care system for accelerated attainment of the highest standard of health to all Kenyans. Through the NTD Program, the Ministry of Health has undertaken to develop these national guidelines for prevention, diagnosis and management of snakebite envenoming to serve as the standard and official guide to providing quality health care to all victims of the disease.

It is our expectation that all stakeholders and implementers will support the dissemination and utilization of these national guidelines, which will significantly contribute towards our vision of a healthy, productive and globally competitive nation.

Signed.

Ms. Susan N. Mochache, CBS
Principal Secretary

PREFACE

About 5.4 million snakebites occur each year, resulting in 1.8 to 2.7 million cases of envenomings. Although it is estimated that approximately 15,000 of these bites occur in Kenya, it is expected that this is an under-estimate. It is estimated that these global bites result in 81,000–138,000 deaths and leave approximately 400,000 people with permanent disabilities annually. Many bite victims prefer to seek treatment from alternative health care providers, leading to non-reporting and reduced estimates.

Most victims are poor rural dwellers and many are women and children. Children are prone to suffer more pronounced effects due to their smaller body mass, while women are more exposed to bites due to the nature of their day to day activities. Bites by venomous snakes can cause acute medical emergencies. These include severe paralysis that may prevent breathing, bleeding disorders that can lead to fatal haemorrhage, irreversible kidney failure, and severe local tissue destruction that can cause permanent disability and amputation.

Effective treatment of snakebite envenoming is currently unavailable in many countries. Where treatment is available, the cost can be prohibitive. The long-term effects of poor-quality treatment can drive vulnerable people further into debt and poverty. Over the past years, snakebites have continued to be a growing public health problem globally and locally. However, strong evidence has emerged which demonstrates significant benefit in early treatment of snakebite victims with antivenom compared to delayed treatment. Further, prevention has been touted as the best means with which the burden of snakebite envenoming can be reduced.

The importance of health education and behavior change communication (BCC) in reducing the number of snakebites cannot be over-emphasized. Currently, there are tools and technologies to help increase opportunities to expand the reach for those who most need treatment for envenomation. These guidelines have borrowed significantly from the World Health Organization's Consolidated Guidelines for Treating and Preventing Snakebites: recommendations for a public health approach; in addition to global and local evidence, and available operational implementation considerations.

Key areas covered in these guidelines include testing and linkage recommendations; standard care for snakebite victims; use of antivenom; patient management; monitoring; and support. These guidelines are an important tool meant to be used by teams of multi-disciplinary health care professionals and are presented in a simplified manner using a public health approach to prevention and treatment of snakebites.

Signed.

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Director of Medical Services

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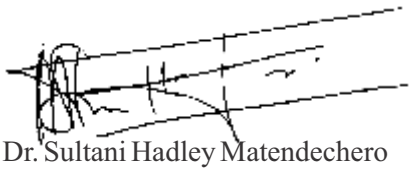
Signed



Dr. Sultani Hadley Matendechero
National Neglected Tropical Diseases Program Manager

INTRODUCTION

Snakes are legless carnivorous reptiles of the suborder *Serpentes*. Most species are nonvenomous, and those that have venom use it primarily to subdue or kill prey rather than for self-defense. Snakes are important in ecosystems, and act as natural pest controllers. Snakes prey on rodents, keeping their population numbers low. It has been reported that when snakes reduce the number of mice and other small rodents, the number of ticks that are carried by these rodents reduce, and as a result the prevalence of diseases that are spread by ticks such as lyme disease is reduced. Snakes are found all over Kenya, from savanna grassland, woodland, forests, with some species found in the ocean. Snakes shelter in termite hills, holes in the ground, holes in trees, rock fissures beehive. In Kenya, out of the 140 known snake species, 29 are venomous. Of the 29 venomous species only 13 are of medical importance as their venoms cause injury or death in extreme cases, and only 9 of these account for bites that require medical attention. Most snakes will avoid confrontation with humans, but are likely to bite when startled in their natural environment, or when they move into human habitat in search of food or water. It is important to teach communities how to live with snakes in order to avoid snake bites. In the unfortunate incident of a snake bite, it is important to seek medical attention as soon as possible. In many cases snakebites will not require treatment or the use of antivenom.

However, in cases where one is bitten by fast acting venom, delayed treatment can lead to serious injury or death.

Figure 1. *The puff adder is found across Kenya and is responsible for most of the venomous snake bite incidents recorded in the country.*

1.0 MORPHOLOGY AND DISTRIBUTION OF THE VENOMOUS SNAKES OF KENYA

This section provides a basic understanding of the different venomous snakes found in Kenya. With around 140 species of snakes found in the country it is not always easy to differentiate a venomous snake from a non-venomous one. Snakes vary in colour and size, from region to region. Sizes described below are for adult snakes and allowances must be made for juveniles accordingly. If further positive identification is required, it is advised to request help from experts in the field of Herpetology. In Kenya, these experts can be found at the National Museums of Kenya in Nairobi, other government agencies, and private sector.

Snakes in Kenya can be categorized according to the toxicity profile of their venoms. Some venom destroys the nerves (neurotoxic), others cause abnormal blood changes (hemotoxic), and others affect flesh or muscle tissues (cytotoxic).

1.1 CATEGORY 1: THE PREDOMINANTLY NEUROTOXIC SNAKES

Bites form snakes in this category are characterized by moderate or absent local swelling, progressive descending paralysis starting with drooping eyelids (ptosis) and paralysis of eye movements causing double vision. There may be painful and tender enlargement of lymph glands draining the bite site. The patient may vomit, the saliva may become profuse and stringy, and eventually there may be difficulties with swallowing and breathing. Species involved are the Mambas and Non-Spitting Cobras.

1.1.1 The Mambas (Dendroaspis)

Mambas are very long, thin, alert, nervous, fast moving and agile, arboreal or terrestrial, highly dangerous venomous snakes. They move around during the day and have a very potent, fast acting neurotoxic venom. There are four species known, all are restricted to the African continent, with three found in Kenya.

i. Black Mamba

***Dendroaspis polylepis*:** This is the longest venomous snake in Africa. Very large, the average length is 2.2–4.2m. It is more heavily built than other mambas and coloured greyish brown or olive brown with a black buccal lining. In defense, it rears up, distending a small hood, opening its mouth and hissing. Bites from this snake are serious medical emergencies as the venom moves through the body very quickly.

ii. Eastern Green Mamba

(*Dendroaspis angusticeps*): The total length rarely exceeds 2.5m. This species is uniformly bright green in colour and is strictly arboreal. In Kenya they are found along the coast and in two other isolated locations, one in Kibwezi/Chyulu area and the other in the Nyambene/Meru area.

iii. Jameson's Mamba

***Dendroaspis jamesoni*:** The average length is 1.2-2.8m. In Kenya, the snake appears bright green to yellowish green on the head and neck tapering to a black tail. The scales are edged with black. This species is mainly arboreal, and in defense it spreads a fine hood. (Only found in Western Kenya)

1.1.2 The True Cobras (Naja) and Tree Cobras (Pseudohaje)

The Non-Spitting Cobras

The non-spitting or neurotoxic cobras look like the spitting cobras, although they can also

spread wide hoods they cannot spit their venom. They have predominantly neurotoxic venom, and in Kenya they include the following three snakes:

i. Egyptian cobra

***Naja haje*:** Average length 1.5–2.2m. The colour is extremely variable: black, brown, grey, reddish or yellow on the dorsal surface, with a paler grey, brownish or yellowish ventral surface, with bands or blotches of darker colour and commonly a dark band below the neck. Unlike in spitting cobras, the supralabial (upper lip) scales of *N. haje* are separated from the orbit by small sub-ocular scales.

Figure 2. *The Egyptian cobra ready to strike*

ii. Eastern Forest Cobra

***Naja subfulva*:** This cobra was recently described and separated from the typical **Forest Cobra** *Naja melanoleuca* found in West Africa. Average total length is 1.5–2.7m. There are three distinct populations in Kenya, each differing in colour. Those from the forests of Western Kenya are glossy black, having a cream or white throat, and the anterior part of the belly has broad crossbar markings. The sides of the head are strikingly marked with black and white bars hence its old name the black and white-lipped cobra. Those from around Mt. Kenya have an olive fore-body tapering into a black tail with very faint lip bars. In specimens from the Kenya coast, the head, neck and forepart of the body are usually yellowish brown, heavily flecked with black speckles and may lack black and white barring on the sides of the head.

iii. Gold's Tree Cobra

***Pseudohaje goldi*):** Average total length is 1.5–2.7m. This fully arboreal cobra of the forest canopy is identified by its very large eyes. It is a long, thin, fast moving, very agile, predominantly black, rainforest snake with a bright yellow belly. In the laboratory, the venom has high lethal potency, but no cases of bites or envenoming are recorded. This snake is only found in Western Kenya.

Figure 3. *Gold's tree cobra is only found in Western Kenya and is common in the Kakamega Forest.*

1.2 CATEGORY 2: THE PREDOMINANTLY CYTOTOXIC SNAKES

The bites from these snakes are characterized by painful and progressive swelling with blood-stained tissue fluid leaking from the bite wound, hypovolemic shock, blistering and bruising. The victim will complain of severe pain at the bite site and throughout the affected limb and painful and tender enlargement of lymph glands draining the bite site. Irreversible death of tissue may occur (necrosis/gangrene). Species that cause this type of envenoming include saw-scaled/carpet vipers, puff adders, Gaboon and Rhinoceros vipers, and Spitting Cobras.

1.2.1 The Spitting Cobras

The spitting or cytotoxic cobras are the only species in East Africa that can spit their venom. Spitting is a defensive behavior, and is usually aimed at the eyes. In Kenya, they include the following three species:

i. Red Spitting Cobra
Spitting cobra victims should wash their eyes as soon as possible. *Naja pallida*: Average length 70–150 cm. This snake is mainly orange or red with a broad black throat band. Others may be pale red, pinkish, yellow or steel grey.

ii. Black-Necked Spitting Cobra
Naja nigricollis: Average length 1.0–2.2m. This snake is mainly dark grey, black or brown above and below with pinkish red, yellowish or pale brown throat bands. The black spitting cobras in Narok County are larger than in other parts of the country, and are usually uniformly black in colour.

iii. Ashe's Spitting Cobra
Naja ashei: This very large species, named after Kenya's famous snakebite herpetologist James Ashe, is largely sympatric with *N. pallida* in East Africa. Average total length 1.5-2.1m. They are olive brown with a pale belly and no red, orange or pink markings on the throat. Ventral and dorsal scale row counts are consistently higher than other East African Spitting Cobras.

1.3 LARGE AFRICAN ADDERS OR VIPERS (BITIS)

These snakes have relatively thick bodies with flattened heads and upward-pointing nostrils, keeled scales and very short tails. There are four species found in Kenya, three are large and one is small.

i. Puff Adder
Bitis arietans: This is a very large, heavy bodied snake, maximum total length exceeding 1.9m. Puff adders in Kenya grow larger than anywhere else in Africa. Its colour is almost black, brown, reddish or even orange above, with distinctive pale, black-edged U or V marks along the dorsum becoming annular rings around the tail. The belly is pale with blackish marks. It inflates its body and hisses loudly by expelling air through its nostrils when threatened, giving out a large puffing sound which gives the snake its name. This snake causes most of the venomous snakebites in Kenya due to its habit of lying very still and not running away as other snakes do. It is one of the widely distributed snakes in Kenya.

ii. Gaboon Viper
Bitis gabonica: A massive, heavily built snake with a maximum length over 2.0m, a girth of 47 cm, a weight exceeding 12 kg, and fangs 5.5 cm long. This snake is one of the heaviest venomous snakes in the world. It has small "nose horn" scales and two distinctive black triangles beneath each eye. The colouring is brilliant, like an oriental carpet. There is a dorsal series of pale brownish or yellowish

Spitting cobra victims should wash their eyes as soon as possible

elongated rectangles, having rounded or pointed ends, with dark triangles at their anterior and posterior ends. The flanks bear a complicated series of triangular-shaped yellow or pale brownish areas, edged with dark scales and separated by brown, purple and yellow areas. The belly is yellowish, blotched with brown or black. The dorsum of the head is pale, apart from a narrow dark median line. This snake is only found in Western Kenya.

Figure 4. *The gabon viper's skin coloring and patterns blend perfectly with foliage on the ground.*

iii. Rhinoceros Viper

***Bitis nasicornis*:** Average length 60–120 cm (maximum 120 cm). A heavily built, semi-arboreal snake, with long "nose-horn" scales. On the end of the nose is a cluster of two to three pairs of horn-like scales, the front pair may be quite long. Its overall geometric colour pattern is like that of *Bitis gabonica*. However, it has brighter and more vivid colours. The top of the head is blue or green, the belly is dirty white to dull green, with numerous black and grey blotches. The scales are very sharply keeled. Unlike *B. gabonica*, the dorsum of the head bears a large dark arrow-shaped marking. This snake is only found in Western Kenya.

iv. Kenya Horned Viper

***Bitis worthingtonii*:** The smallest of the four *Bitis spp.,* found in Kenya. Average length 20–50 cm. A small, stoutly-built snake with prominent supraorbital "horns". Its colour is usually darkish brown or olive, with two lighter undulating lines along each flank. There is a dorsal series of dark triangular blobs and a dark arrow shaped marking on the back of the head. The belly is off-white and heavily mottled with small black patches. It looks like a small puff adder with two short horns, one above each eye. The snake is endemic to Kenya and is found in the Rift Valley between Naivasha and Eldoret. Bites are not well documented and often confused with those of the puff adder found in the same area. Bites are treated symptomatically.

Note that although included here in the group of predominantly cytotoxic snakes, North East-African Carpet Viper also cause considerable hemotoxic symptoms.

1.4 SAW-SCALED OR CARPET VIPERS (ECHIS)

Echis are relatively small slender-bodied snakes with overlapping keeled scales. The scales on the flanks have serrated keels. When the snake rubs its coils together in fear or irritation, a rasping sound is produced.

i. North East-African Carpet Viper / Saw-Scaled

***Echis pyramidum*:** Average length 30-85 cm. This snake is coloured greyish, brownish or reddish brown, with white dorsal oval markings connected by a dark band and flanked by a semi-complete pale undulating line. The belly is pale. This tiny viper has a reputation of being very aggressive. This snake is found north of the equator. In areas that it is found the density can be very large indeed. Although small, bites from this snake can be very serious, and should be treated as a medical emergency.

1.5 Category 3: The Deadly Back Fanged Snakes

All the back fanged snakes are known to produce venom. In the majority of Sub-Saharan African species this venom is very weak and produced in very small quantities. Although deadly to their reptilian prey in many cases their venom has little or no effect on humans. There are two species where fatalities have been recorded, with both being found in Kenya. A third genus (Toxicodryas) has been added because although bites have not been recorded, it has proved to be highly venomous in the lab. A key envenoming symptom from bites of this group is incoagulable bleeding. The 20 Minutes Whole Blood Clotting Test (20MWBCT) is therefore extremely useful in diagnosing bites from this group.

i. Boomslang

Dyspholidus typus: A truly arboreal snake, it is widely distributed in sub-Saharan Africa and is the only species in this genus. Average length is 1.20–1.5m. It has a short chunky head with very large emerald green eyes. The colour may vary from green, brown, black to reddish, with a lighter ventrum. Females have whitish to brown bellies. Boomslangs are diurnal, arboreal, unobtrusive and non-aggressive.

Figure 5. *The boomslang is often confused with the green mamba or the green bush snake.*

If cornered or restrained, they inflate the anterior part of the body to an impressive extent and strike. However, most require great provocation before biting. Majority of bites recorded were from people holding or trying to catch the snake. The Boomslang is often confused with the green mamba and the harmless green bush snakes (genus *Philothamnus sp.*) Serious envenomation from bites of this snake must be treated with an effective Monovalent Boomslang Antivenom.

ii. Vine Snake

Thelotornis spp: These very slender tree snakes occur throughout the forest and savanna regions of sub-Saharan Africa. Average length is 80–120 cm. They are cryptically coloured and difficult to detect, favouring low bush, shrubs and dead tree-stumps. The green or brown head is lance-shaped and looks like a leaf. It has a distinctive keyhole-shaped pupil. If threatened, it will inflate the first half to two-thirds of its body like the boomslang. Bites are rare; snake keepers and catchers are most at risk but fatalities are not known. No antivenom is available at the present time and serious envenomation may need blood replacement.

iii. Blanding's Tree Snake

Toxicodryas blandingii was *Boiga blandingii*: A very large tree snake found in rain forest canopy reaching 3.0m in length.

Males are black and yellow while females are olive green. The head is very broad and quite distinct from the neck. It is only found in Western Kenya. No antivenom is available at present and serious envenomation may need blood replacement.

1.6 Category 4: The symptomatically treated venomous snakes

There are a number of venomous snakes found in Kenya that although may cause swelling, pain and other minor envenoming symptoms, have not or rarely caused human fatalities. In each species, no antivenom is currently produced and therefore bites from these snakes are treated symptomatically.

1.African Burrowing Asps or **Mole Vipers** (Atractaspis)

Burrowing asps are found in a wide variety of habitats, including desert, semi-desert and lowland forests. They are fossorial (burrowing), living mostly underground in deserted termite mounds, under stones or logs, or in soft soil or sand. They are coloured predominantly grey, black or brown. Most are relatively small (30–70 cm in length). They are glossy, with a head indistinct from the neck. A very short tail ends abruptly, giving the snake a "two-headed" appearance reflected in some local names. These snakes are easily confused with several species of non-venomous black snakes. The head is short with tiny dark looking eyes. These snakes are nocturnal and usually emerge on warm, wet evenings, especially after heavy rains. When the snake bites (strikes), one fang is protruded out of the side of the mouth and is then hooked or jabbed into the victim with a backward jerk of the head ("side swipe"). They are extremely irritable, striking in sideways swings and sweeps (multiple bites), and showing annoyance by flattening the body. Accidental bites usually occur at night when the victim treads on the snake in a gutter or water-logged path after heavy rain. The burrowing asps, for which bites have been reported in Kenya, include the following two species.

i. Bibron's Burrowing Asp (*Atractaspis bibronii*)
ii. Kenya Small-scaled Burrowing Asp (*Atractaspis fallax A. micro-lepidota*)

2. African Night Adders (Causus)

The night adders are small (less than 1.0m), and despite their name are active by day and by night. They are not adder-like, and are fairly stout with the head being only slightly distinct from the neck. The venom fangs are short compared to those of genus Bitis. They have round pupils (most adders have vertical slit eye pupils) and large symmetrical scales on top of the head (most vipers have small scales). When threatened, they hiss and puff ferociously, inflating the body. They may also raise the forepart of the body off the ground and slide forward with the neck flattened, looking quite cobra-like.

i. **Snouted Night Adder** (*C. defilippii*) only found in the Kenyan Coast.
ii. **Forest Night Adder** (*C. lichtensteini*) only found in Western Kenya.
iii. **Green Night Adder** (*C. resimus*) found in the Coast, Western, and South Rift (Mara).
iv. **Rhombic Night Adder** (*C. rhombeatus*) found in the Central Highlands including Nairobi.

Figure 6. *The Rhinocerous viper is only found in Western Kenya, mostly in the Kakamega Forest*

3. The Bush Vipers (Atheris) and Montane Viper (Montatheris)

Bush vipers are relatively small (78 cm), mainly arboreal snakes inhabiting forests of tropical Africa. One species, *Montatheris hindii* is terrestrial. They have a broad head, narrow neck and a slender tapering body. Most species have small, rough overlapping scales and prehensile tails. The eyes are relatively large with vertical pupils.

Figure 7. *The Mt. Kenya bush viper*

i. Prickly Bush Viper (*Atheris hispida*) is only found in Western Kenya.
ii. Green Bush Viper (*Atheris squamigera*) is only found in Western Kenya.
iii. Mount Kenya Bush Viper (*Atheris desaixi*) is only found in Mt. Kenya and Nyambene.
iv. Kenya Montane Viper (*Montatheris hindii*) is only found in Mt. Kenya and the Abadares.

4. African Garter Snakes (Elapsoidea): These snakes have an average total length of 25–50 cm. Related to the cobras, they are small, black, fossorial (burrowing), nocturnal elapid snakes, with very short tails, cylindrical bodies, no distinct neck and a bluntly rounded rostral scale as in other burrowing species. The young are brightly banded, but the bands fade as they mature. These banded or ringed markings are diagnostic of the genus. They are sluggish and not aggressive. The garter snakes in Kenya include:

i. East African Garter Snake (*Elapsoidea loveridgei*) is only found in the Central Highlands and Nairobi.
ii. Usambara Garter Snake (*Elapsoidea nigra*) is only found in Shimba Hills

1.7 Category 5: The sea snakes – Myotoxic Envenomation

Although there are several species of sea snakes in the world, there is only one species that has been recorded off the Kenya coast. That is the truly pelagic Yellow Bellied Sea Snake. Myotoxic envenomation is characterized by negligible local swelling, increasing generalized muscle pain and tenderness (myalgia) associated with features of neurotoxic envenoming and progressive descending paralysis culminating in paralysis of breathing. The species involved is the yellow-bellied sea snake.

Yellow-Bellied Sea Snake
Pelamis platuru: Average total of 60–70 cm. The head is narrow and flattened, with an elongated snout. The colour is usually black above and yellow to yellow-brown below, but the coloration may be extremely variable. The distinctive oar-shaped tail has distinct black and white reticulated markings. Docile in nature, the snake is quite rare on the East African Coast with specimens usually washed ashore after a storm or rough weather out at sea.

2.0 PREVENTION OF SNAKEBITES

Prevention aims at reducing, on the one hand, the number of snake bites, and, on the other, the severity of the envenomation and the resultant injury and death. Hence, prevention can be organized on two levels: we must learn how to avoid bites, and we must improve treatment of snake bites.

2.1 CIRCUMSTANCES OF SNAKEBITES

Most snakebites are usually reported to occur when someone accidentally steps on the snake either in the dark or in the undergrowth. Most of the victims of snakebites are normally barefoot or wearing only sandals. Majority of snakebites occur at the beginning of the rainy season. They may occur during harvesting or clearing of bushes. The snake may be picked up unintentionally in a handful of foliage/ firewood or intentionally by someone who is trying to show off and in the process bite the person. Some snakes get into the house in search of food and water. People sleeping on the floor may roll over onto the snake in their sleep. Sea snake bites in rare circumstances may occur when fishermen pick the animals out of their hand nets or when people are bathing or washing clothes in estuaries.

2.2 SNAKEBITE AS AN OCCUPATIONAL DISEASE

In Kenya, the risk of snakebite is strongly associated with different geographic areas and occupations. A high number of snakebites are reported from farming regions, dry arid and pastoralist areas. Plantations (sugarcane, sisal, cotton, tea, coffee), herding, fishing, displaying and performing with snakes (snake handlers) and in the preparation of traditional medicines.

2.3 WHAT TO DO WHEN BITTEN BY A SNAKE?

After a snakebite, the victim may notice some pain at the location of the bite followed by swelling. Symptoms and signs vary according to the species of snake responsible for the bite and the amount of venom injected. The victim should immediately notify the community, and arrangements should be made to transport the victim to a medical facility.

Delayed hospital treatment can result in death!

When handling a snakebite victim one should:

1. **Reassure the victim who may be terrified.**
2. **Move the patient to safety to avoid more bites.**
3. **Remove constricting clothing, rings, bracelets and bands from the bitten limb.**
4. **Immobilize the whole patient, especially the bitten limb, using a splint or sling.**
5. **The pressure- immobilization technique may be used in confirmed neurotoxic bites.**
6. **Lay the patient in recovery position to avoid aspiration of vomit.**
7. **Transport the victim to a medical facility**

2.4 REDUCING RISK OF SNAKEBITES

Most snakes are averse to humans and prefer to hide away on detecting any human movement. However, in rare cases, snakes may bite for various reasons. In this section, we shall share information to help reduce the risk of getting a snakebite. It is important to find out about the snakes in your locality and when you travel to a new place.

There are many chemicals and concoctions believed to be snake-repellent but they are not proven to be effective.

At home and at work we should:

1. **Teach children about the dangers of coming into contact with snakes and how they can avoid where snakes are likely to be found.**
2. **Keep grass short and cut away bushes near homesteads.**
3. **Storing water in open containers near our homes or offices. Snakes often come to our dwellings in search of drinking water.**
4. **Avoid storing heaps of materials next to our homes and offices. Snakes often hide in spaces under heaps of materials such as logs or rocks.**
5. **Always wear trousers, gloves and boots when handling materials stored outside in heaps or in a dark store.**
6. **Avoid handling snakes even if you think they may be dead.**
7. **Avoid keeping chickens in houses. They will attract snakes.**
8. **Always use a torch and a walking stick when walking outdoors at night.**
9. **Using mosquito net can help to avoid snake bites if it is well tucked under the mattress or sleeping mat.**
10. **Avoid running over snakes since they may not die immediately and harm others later or even worse, climb and harm those on the vehicle.**

Children in schools are particularly effective ambassadors of information

2.5 IMPLEMENTING PREVENTIVE STRATEGIES FOR COMMUNITY EDUCATION

Snakes have adapted to a wide range of habitats and prey species. All snakes are predatory carnivores; none are vegetarians although some eat eggs. Since snakes are preyed upon by other animals, they tend to be secretive and have evolved many survival strategies. By understanding something about snakes' habits, simple precautions can be adopted to reduce the chance of encounters and subsequent bites. Some truths apply to all snakes: they prefer not to confront large animals (such as humans); thus, it is best to give them the chance or time to slither away.

Some species are mainly nocturnal hunters and others are mainly diurnal hunters. Many snakes are non-venomous, while others are only mildly venomous and not particularly dangerous to humans. However, a few are highly venomous and their bites are potentially lethal. Snakes are necessary for maintaining a healthy balance in nature; they should not be needlessly killed. It is important that everyone learns which dangerous snakes occur in the local community or area. People also need to learn how to avoid being bitten by snakes as will be described in subsequent sections.

2.5.1 In Our Homes

Snakes and other animals often avoid noisy places as they are shy, and for this reason snakes often avoid human dwellings. However, snakes may enter our homes in search of food, water, or to find a temporary hiding place.

2.5.2 In Our Compounds, farmyards and gardens

Snakes are found in our compounds, farmyards, and in our gardens as this is their natural habitat. Quite often people step on snakes when walking in compounds with long grass, resulting in a snake bite. To increase visibility in our compounds we should always keep the grass short. Many snakebites occur when gardening, or during ploughing, planting and harvesting as during these activities people tend to reach under bushes, disturb rocks, and clear debris where snakes often hide. We should always wear protective clothing when performing garden or farm related activities.

The onset of the rainy season also coincides with a period where many snakebite incidents are recorded. Heavy rains often wash debris to the edge of roads and rivers, heaping it and creating areas where snakes hide. In some areas species such as burrowing asps (Atractaspis) are flushed out of their burrows by rain water. We should always be careful when moving around in our compounds, farmyards and gardens especially after heavy rains

At home and at work we should:

1. **Do not keep livestock, especially chickens, in the house, as some snakes will come to hunt them.**
2. **Store food in rat-proof containers.**
3. **Raise beds above floor level and use mosquito nets completely tucked in under the sleeping mat. This will guard against snakes as well as centipedes, scorpions.**

In the compound, farmyard, or garden:

1. **Use a torch, walking stick and wear proper shoes when walking outside at night.**
2. **Clear heaps of rubbish, building materials and other refuse from near the house.**
3. **Do not have tree branches touching the house.**
4. **Keep grass short and clear the ground around your house.**
5. **Clear the undergrowth so that snakes cannot hide close to the house.**
6. **Keep your granary away from the house (it may attract animals that snakes will prey on).**
7. **Water sources, reservoirs and ponds may also attract animals of prey.**
8. **Avoid collecting firewood and foliage at night.**
9. **Watch where you step.**
10. **Do NOT put your hands in holes, nests, or any other cracks and crevices where snakes may be resting.**
11. **Always listen to domestic and wild animals. They have sharp eyes and ears, and will raise alarms when predators such as snakes are approaching.**

WARNING!
Be careful when handling dead or apparently dead snakes: even an accidental scratch from the fang of a snake's severed head may inject venom

2.6 WORKING WITH THE COMMUNITY TO REDUCE SNAKEBITES BURDEN

Preparing information in a variety of local languages is an important step in public education. Materials may be in video or short statements with diagrams for easy transmission via social media or internet. In more formal places, posters with simple but vital information can be displayed to create public awareness. It is useful to perform public awareness campaigns using multiple channels such as TV, radio and organized communities for instance professional meetings and religious gatherings. Posters can be effective in places with large human traffic like markets and in public transport vehicles.

2.7 WHAT IF A SNAKE BITES YOU?

In case of a snakebite, it is important for the victim to remain calm and to notify anybody nearby of the snakebite incident. Making the correct decisions in a timely manner may save a life.

When a snake bites:

1. **Remain calm**
2. **Do NOT chase or kill the snake.**
3. **Remove any materials that are tight around the hand or leg or waist (jewellery, tight clothing, etc.).**
4. **Contact the nearest health worker and make your way to the nearest health facility.**
5. **Do NOT try to cut and suck from the bite area.**
6. **Do NOT apply ice to the bite area either.**

2.8 DEATH FROM SNAKEBITE

Few attempts have been made to examine the factors responsible for death in cases of bites by identified species of snakes. The experience in Kenya reveals that the species causing most deaths were Puff Adders, Cobras, vipers and Mambas (Black and Green).

2.8.1 VISIT TO TRADITIONAL HEALTH PRACTITIONERS AS AN IMPORTANT CAUSE OF DEATH

Hospital treatment may be delayed by visits to traditional health practitioners and problems with transportation. Death on the way to hospital as a result of inadequate artificial ventilation or failure to attempt such treatment, failure to treat hypovolaemia in shocked patients, airway obstruction, complicating infections, and failure to observe patients closely after they had been admitted to hospital.

2.8.2 TIME BETWEEN SNAKEBITE AND DEATH

Although very rapid death after snakebite has been reported (e.g. reputedly "a few minutes" after a bite by the Black Mamba *Dendroaspis polylepis*), it is clear from studies of large series of snakebite deaths that many hours usually elapse between bite and death in the case of elapid envenoming, and several days, or even longer, in the case of viper envenoming.

2.9 EMERCENCY SIGNS

The local symptoms and signs in the bitten part include fang marks, local pain, local bleeding, bruising, lymphangitis (raised red lines tracking up the bitten limb), lymph node enlargement, inflammation (swelling, redness, heat), blistering, local infection, abscess formation and necrosis.

Emergency signs and symptoms:	
1. Tingling sensation around the mouth	4. Faintness or shock
2. Inability to swallow saliva	5. Drooping eyelids
3. Limb weakness	6. Bleeding

3. THE STAGES OF MANAGEMENT OF SNAKEBITES IN KENYA

3.1 FIRST AID AND TRANSPORT TO MEDICAL CARE

AIMS OF FIRST AID

1. **Attempt to retard systemic absorption of venom.**
2. **Preserve life and prevent complications before the patient can receive medical care**
3. **Control distressing or dangerous early symptoms of envenoming.**
4. **Arrange the transport of the patient to a place where they can receive medical care.**

ABOVE ALL AIM TO DO NO HARM!
REMEMBER THAT LESS IS OFTEN BEST

3.2 ESSENTIAL FIRST AID PROCEDURES

Using material available the victims can initiate first aid themselves. As first aid is being administered, arrangements should be made to transport the patient to a medical facility. Reassure the victim who may be terrified. Move the patient to safety to avoid more bites. Remove constricting clothing, rings, bracelets and bands from the bitten limb. Immobilize the whole patient, especially the bitten limb, using a splint or sling.

Note: *Muscular contractions will promote the absorption and spread of venom from the bite site via veins and lymphatics. The pressure-immobilization technique may be used in confirmed neurotoxic bites.*

Lay the patient in recovery position so that if they vomit they are less likely to aspirate it into their lungs. Mechanical extraction of venom (multiple superficial incisions, suction, ligatures and black stone) have no role in first aid management of snakebite.

3.2.1 Detailed clinical assessment

In the detailed clinical assessment FOUR (4) fundamental questions should be asked:

1. *Where were you bitten?*
   Look for fang marks, swellings, bruises or bleeding, evidence of pre-hospital treatment, descending paralysis.

2. *When were you bitten?*
   Some patients come early before the development of symptoms and signs of envenoming while others arrive late with complications (gangrene, pneumonia, acute kidney injury, or renal failure).

3. *Where is the snake that bit you?*
   Can you describe it?
   Cobras' rear up and hood. Tree snakes include mambas, forest cobras and boomslang. Any green snake longer than 1 meter is likely to be a green mamba or boomslang.

4. *How do you feel now?*
   Faintness, dizziness, indicating hypotension, shock, local pain, painful enlarged nodes. Check for details of prehospital treatment (tourniquet, herbal remedies).

3.3 MANAGEMENT AT COMMUNITY LEVEL

- Reassure the patient.
- Look for obvious evidence of a bite (fang marks, swelling).
- Immobilize the patient.
- Transport the patient to medical care as quickly, safely and passively as possible (in recovery position) by motor vehicle, boat, bicycle, stretcher etc.
- Discourage use of tight ligatures, incisions, suction, application of herbs, ice.
- In the case of venom in the eyes, wash with large amounts of water.

3.4 TRANSPORT TO HOSPITAL

Transport the patient as quickly and as passively as possible to the nearest facility available for medical care (health clinic, dispensary or hospital). Use a cell phone and other forms of communication to call for help. Alert the medical facility ahead of arrival. Ideally, patients should be transported in recovery position on a stretcher, in a motor vehicle, on a bicycle (as a passenger), or by boat, or the patient can be carried using the "fireman's lift". **Avoid the many harmful and time-wasting traditional first-aid treatments.**

WHEN ADMINISTERING FIRST AID DO NOT:

1. **Attempt to catch the snake.**
2. **Burn the snake bite or burn wound caused by the snake bite.**
3. **Make incision or excision on or around the wound.**
4. **Make tattoos near or around the wound.**
5. **Immediate prophylactic amputation of the bitten digit,**
6. **Perform suction by mouth,**
7. **Use any vacuum pumps or "venom-ex" apparatus on the wound.**
8. **Instillation of chemical compounds such as potassium permanganate on the wound.**
9. **Apply ice, tourniquet, "snake stones", or electric shocks.**
10. **Give the bite victim caffeinated drinks or alcohol.**

4. MANAGEMENT OF SNAKEBITE AT DIFFERENT LEVELS OF CARE

4.1 AT THE RURAL DISPENSARY OR HEALTH CENTRE (LEVEL II AND III HEALTH FACILITIES)

History and physical examination- local swelling, painful, tender glands, persistent bleeding from the bite wound, Blood Pressure, pulse rate, bleeding gums, nose, vomiting, level of consciousness, drooping eyelids and other signs of paralysis. 20 minutes WBCT, urine exam, identity of the snake if its bought in. Assess need for referral. Analgesia by mouth (paracetamol or tramadol).

Give antivenom at the health centre if indicated and available and watch for early signs of anaphylactic reaction. In case of descending paralysis ensure an unobstructed passage way, give oxygen by mask, and transfer the patient to a better equipped hospital.

Discourage the use of corticosteroids, antihistamines and heparin.

DO NOT GIVE NON-STEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDS) LIKE ASPIRIN, DICLOFENAC, IBUPROFEN.

4.2 AT THE SUB-COUNTY (DISTRICT HOSPITAL)

- More detailed clinical and laboratory assessment including biochemical and hematological measurements, ECG or radiography as indicated.
- Give antivenom if indicated. If no antivenom is available, transfer to a hospital that has antivenom or treat conservatively (transfusion of blood or fresh frozen plasma).
- If the patient is still in a lot of pain, consider giving stronger parenteral opioid medicines.
- In cases of local necrosis or gangrene, give tetanus toxoid booster, antibiotics and consider surgical debridement of dead tissue.
- In case of paralysis, insert an endotracheal tube, i-Gel supragottic airway, or a laryngeal mask airway. In respiratory failure assist manually by an aesthetic (ambu-bag) or a mechanical ventilator.
- In case of acute kidney injury, treat with peritoneal dialysis. If this is not available, transfer to a specialized hospital. If the patient is bleeding or is severely anaemic, consider blood transfusion.
- Simple rehabilitation by physiotherapist and occupational therapist.

4.3 REFERRAL HOSPITAL

- Advanced surgical management of local necrosis.
- Give antivenom if indicated
- Continue with transfusion if bleeding
- More advanced investigations including bacterial cultures and imaging (CT scans) as indicated.
- If the patient has evidence of acute kidney injury – peritoneal or haemodialysis or haemofiltration.
- In case of paralysis, insert an endotracheal tube or a laryngeal mask airway. In respiratory failure assist manually by an aesthetic (ambu-bag) or a mechanical ventilator.
- Rehabilitation by physiotherapists.

5 CLINICAL ASSESSMENT

5.1 CLINICAL PRESENTATION OF SNAKE-BITES

5.2.1 Early symptoms and signs

Following the immediate pain of mechanical penetration of the skin by the snake's fangs, there may be increasing local pain (burning, bursting, throbbing) at the site of the bite followed by local swelling that gradually extends proximally up the bitten limb. There may be tenderness with painful enlargement of the regional lymph nodes draining the site of the bite.

Symptoms and signs vary according to the species of snake responsible for the bite and the amount of venom injected. The proportion of dry bites ranges from more than 50% in the case of night adders (genus Causus) to less than 10% following saw scaled viper bites (WHO 2010 Guidelines). Sometimes the identity of the biting snake can be confirmed by examining the dead snake. It may be strongly suspected from the patient's description or the circumstances of the bite or from knowledge of the clinical effects of the venom of that species. This information will enable the doctor to choose an appropriate antivenom, anticipate the likely complications and, therefore, take appropriate action.

If the biting species is unknown, the patient should be observed closely to allow for the recognition of the emerging pattern of symptoms, signs and results of laboratory tests ("the clinical syndrome"), together with other evidence that may suggest which species was responsible.

Table listing most common local and systemic signs and symptoms.

Local symptoms and signs	Generalized (systemic) symptoms and signs
Fang marks	Nausea, Vomiting
Incisions Local pain	Malaise
Local bleeding	Abdominal pain
Bruising	Weakness Drowsiness
Lymphangitis (red lines tracking up the bitten limb)	Prostration.
Lymph node enlargement	
Inflammation (swelling, redness, heat)	
Blistering	
Local infection, abscess formation	
Necrosis	

5.1.2 Cardiovascular

Visual disturbances, dizziness, faintness, collapse, shock, hypotension, cardiac arrhythmias, pulmonary oedema, and conjunctival oedema (chemosis).

5.1.3 Bleeding and clotting disorders

Traumatic bleeding from recent wounds (including prolonged bleeding from the fang marks) and from old partly-healed wounds.

Spontaneous systemic bleeding - from gums, epistaxis, bleeding in the tears, intracranial haemorrhage, meningism resulting from subarachnoid haemorrhage. Lateralizing signs and/or coma from cerebral haemorrhage, haemoptysis, haematemesis, rectal bleeding or melaena, haematuria, vaginal bleeding, ante-partum haemorrhage in pregnant women, bleeding into the mucosae (e.g. conjunctivae), skin (petechiae, purpura, discoid haemorrhages and

ecchymoses) and retinal bleeding. Cerebral arterial thrombosis may lead to thrombotic stroke.

5.1.4 Neurological *(Elapidae)*

Drowsiness, paraesthesiae, abnormalities of taste and smell, "heavy" eyelids, bilateral ptosis, external ophthalmoplegia, paralysis of facial muscles and other muscles innervated by the cranial nerves, nasal voice or aphonia, regurgitation through the nose, difficulty in swallowing secretions, respiratory and generalized flaccid paralysis and paradoxical breathing.

5.1.5 Skeletal muscle breakdown

Commonly from sea snakes, may lead to generalized pain, stiffness and tenderness of muscles, trismus, myoglobinuria, hyperkalaemia, cardiac arrest, acute kidney injury.

5.1.6 Renal symptoms

These may be characterized by loin (lower back) pain, haematuria, haemoglobinuria, myoglobinuria, oliguria/anuria, symptoms and signs of uraemia (acidotic breathing, hiccups, nausea, pleuritic chest pain etc) (Vipers, sea snakes and colubrids such as boomslang and twig snake).

5.2 DRY BITES AND BITES FROM NON-VENOMOUS AND OTHER 'BITES'

Some people who are bitten by snakes or suspect or imagine that they have been bitten, may develop quite striking symptoms and signs even when no venom has been injected. This results from an understandable fear of the consequences of a real venomous bite. Anxious people may hyperventilate and may develop pins and needles of the extremities, stiffness or tetany of their hands and feet and dizziness. Others may develop vasovagal shock after the bite or suspected bite. In other cases, patients may become highly agitated and irrational and may develop a wide range of misleading symptoms. Blood pressure and pulse rate may increase, with sweating and trembling.

5.2.1 Rapid clinical assessment and resuscitation

Rapid clinical assessment and resuscitation are essential. Patients may arrive in hospital between hours and many days, after being bitten. They may therefore, show early or late signs of envenoming or its complications. It is essential that all patients with a history of snakebite be assessed rapidly.

Airway, respiratory movements **(Breathing)** and arterial pulse **(Circulation)** must be checked immediately.

5.2.2 Urgent intervention

Patients bitten by venomous snakes may present with any of the following problems requiring urgent intervention:

- Profound hypotension and shock, resulting from hypovolaemia secondary to extravasation of plasma volume into the bitten limb, external or concealed blood loss, persistent vomiting and failure of adequate oral fluid intake.
- Direct cardiovascular effects of the venom (for example, after viper/adder and Atractaspis bites.
- Auto pharmacological effects of the venom (activation/inhibition of physiological vasomotor systems, such as the angiotensin-renin-bradykinin system, by venom toxins.
- Anaphylaxis provoked by antivenom given outside hospital or, rarely, provoked by venom in those who have been sensitized by previous exposure.
- Sudden deterioration after release of a tourniquet or compression bandage, resulting in shock, bleeding or respiratory paralysis. These bands, bandages or ligatures should not be removed hastily by hospital staff before antivenom treatment has been initiated.
- Airway obstruction resulting from aspirated vomit or the tongue blocking the

upper airway, especially in patients with evolving bulbar paralysis who have not been transported to hospital in the left lateral (recovery) position.
- Vomiting can be the result of systemic envenoming or ingestion of emetic traditional herbal remedies.
- Terminal respiratory failure from progressive neurotoxic envenoming that has led to paralysis of the respiratory muscles.
- Intracranial haemorrhage after envenoming by saw-scaled vipers (Echis), some other vipers and boomslang.
- Cardiac arrest resulting from hyperkalaemia in patients with massive generalized skeletal muscle breakdown (rhabdomyolysis).
- Acute kidney injury due to shock and rhabdomyolysis.
- Septicaemia from secondary infection of necrotic bite wounds or of incisions made at the site of the bite or from complicating aspiration pneumonia (see above

6. SYNDROMIC MANAGEMENT OF SNAKE BITES

6.1 SYNDROMES OF ENVENOMATION

SYNDROME	DESCRIPTION
SYNDROME 1	Marked local swelling with coagulable blood
SYNDROME 2	Marked local swelling with incoagulable blood and/or spontaneous systemic bleeding
SYNDROME 3	Progressive paralysis (neurotoxicity)
SYNDROME 4	Mild or negligible local swelling with incoagulable blood
SYNDROME 5	Mild swelling alone

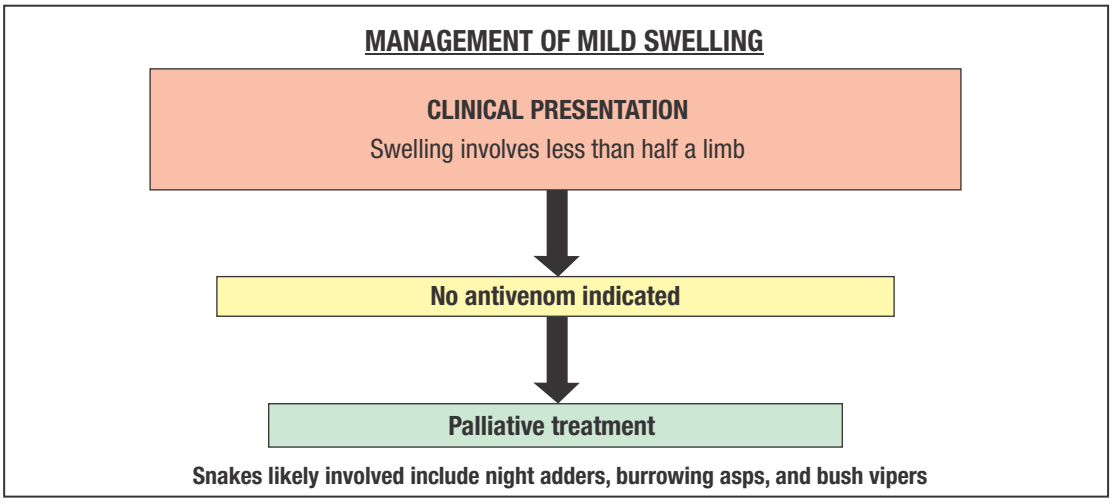
6.2 LABORATORY INVESTIGATIONS

20 MINUTE WHOLE BLOOD CLOTTING TEST (20WBCT)

- Take 2 ml of blood from the patient and pour it into a new, clean, dry glass test tube.
- The test tube must be made of glass and NOT plastic. The tube MUST be new. Avoid old tubes that have been washed in detergent/soap.
- Leave the test tube undisturbed at ambient temperatures for 20 min.
- After waiting for 20 min gently tilt the test tube.
- If the blood is all liquid (no clots) then the patient has incoagulable blood.
- If there is a clot in the tube the blood is still coagulable.

Other useful tests depending on availability:

1. Haemoglobin/PCV/Platelet count/PT/APTT/FDP/D-Dimer
2. Peripheral smear
3. Urine Tests for Proteinuria/RBC/Haemoglobinuria/ Myoglobinuria
4. Biochemistry for Serum Creatinine/Urea/Potassium
5. Oxygen Saturation/PR/BP/RR/Postural Blood Pressure
6. ECG/X-Ray/Ultrasound



MANAGEMENT OF MARKED SWELLING WITH INCOAGUABLE BLOOD AND/OR

CLINICAL PRESENTATION

Painful rapid progressive swelling

Spontaneous systemic bleeding

Blistering

Necrosis

↓

Perform 20 Minutes Blood Clotting Test (20WBCT)
If Blood is incoaguable asses for spontaneous systemic bleeding

↓

Give polyvalent antivenom (in Echis bites give monovalent antivenom is recommended)
Perform blood transfusion

Snakes likely involved include puff adders, carpet vipers, gabon vipers, and bush vipers

MANAGEMENT OF PROGRESSIVE PARALYSIS SYNDROME

CLINICAL PRESENTATION

Pins and needles around the mouth

Ptosis

Dyspnea

Painful progressive swelling

Inability to swallow saliva

Widespread myalgia

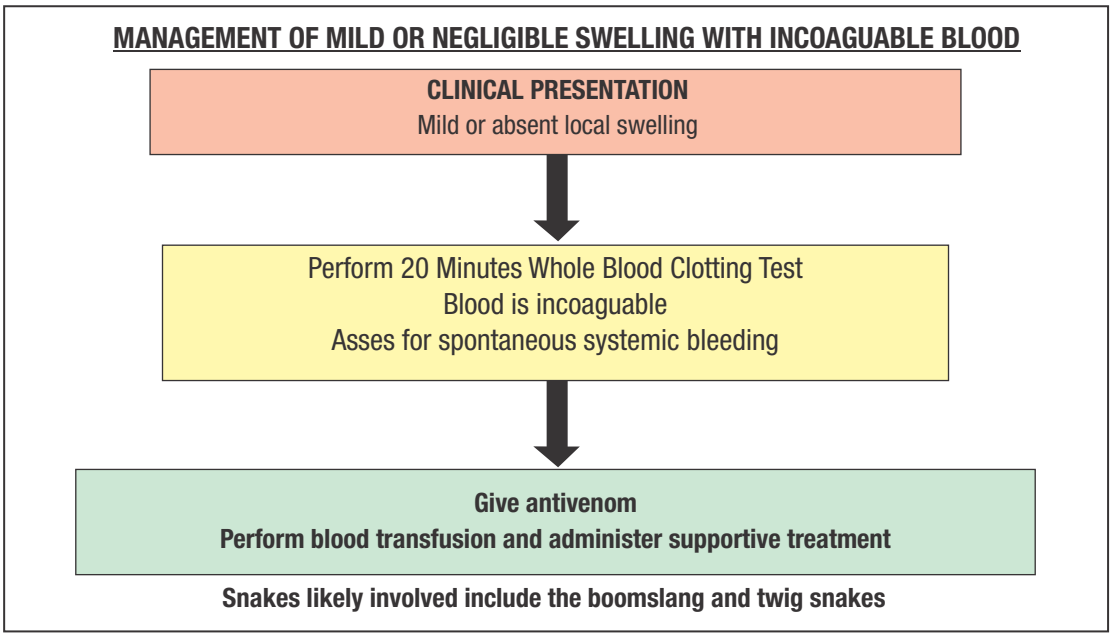
↓

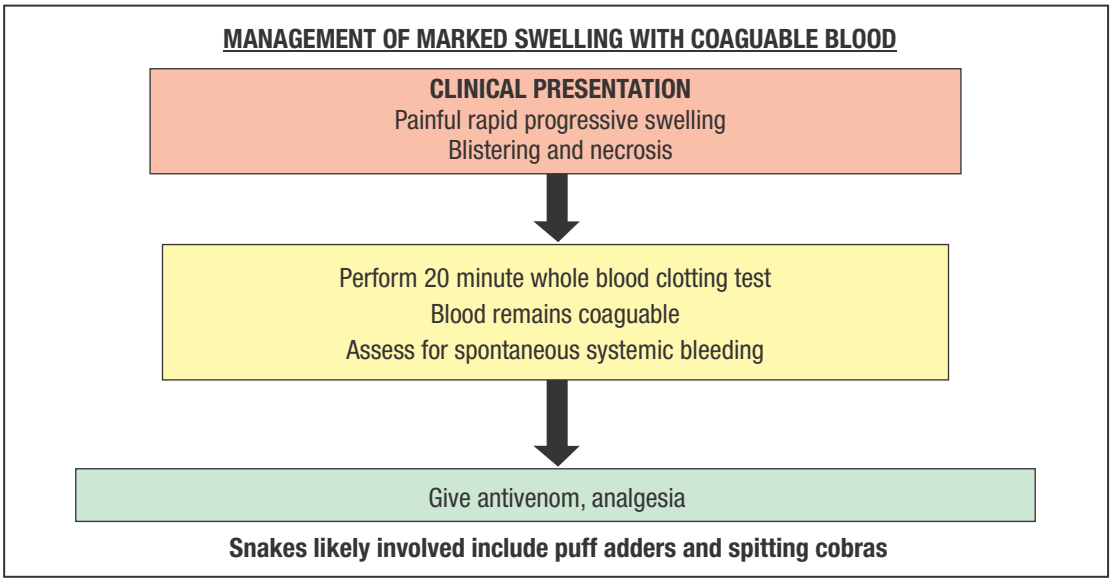
Maintain airways, suction,
Place patient in coma position,
Ventilate, give oxygen

↓

Give polyvalent antivenom

Snakes likely involved include forest cobra, Egyptian cobra, black mamba, green mamba, and Jameson's mamba





6.3 EMERGENCY MANAGEMENT OF SNAKE BITE

Snakebite is a medical emergency. Ideally, all patients bitten by snakes should be assessed by medically-trained staff and patients must be kept under observation for at least 24 hours.

6.3.1 ANTIVENOM TREATMENT

These are the only specific antidotes for snakebite. They are produced in large domestic animals (horses, donkeys or sheep) by hyper immunizing them against a single snake venom (monovalent/monospecific) or multiple snake venoms (polyvalent/poly-specific) from snakes in the geographical area where the antivenom is intended to be used.

Antivenoms are either refined whole IgG

antibodies or IgG body fragments such as $F(ab)_2$ or Fab which are free from other plasma proteins such as albumin, fragments such as Fc, aggregates (a major cause of antivenom reactions), pyrogens and microbes. They are either lyophilized or stored as a liquid (2-8°C). Poly-specific antivenoms can be used in syndromic management of snakebites where the snake identity is uncertain; whereas monospecific antivenoms require precise knowledge of the snake species responsible for the bite.

Antivenoms neutralize a fixed amount of venom; therefore, the same dose/volume of antivenom must be administered to children and adults. Antivenom administration is still indicated as long as the injected venom is still active in the patient's body. Notably, systemic envenomation may persist for several days after a bite (e.g. incoagulable blood after saw scaled viper bite in Kenya).

Since antivenom is scarce, expensive and may have serious adverse effects, it should be administered only when indicated.

6.3.2 Indications for antivenom

- Incoagulable blood or spontaneous systemic bleeding
- Neurotoxic signs.
- Hypotension, shock, cardiac arrhythmia.
- Local swelling involving more than half of the bitten limb
- Rapid extension of swelling (beyond the wrist or ankle) within a few hours of bites of hands or feet.
- If the victim is a child with any but most minor bites

Since antivenoms are not indicated in the majority of bites, they should not be used indiscriminately.

6.3.3 Contraindications to antivenom

There is no absolute contraindication to antivenom when a patient has life-threatening systemic envenoming. However, patients with an atopic history (severe asthma, hay fever etc.) have an increased risk of severe reactions.

6.3.4 Timing of antivenom treatment

Antivenom should be given as soon as possible. Once signs of systemic or severe local envenoming are evident It is almost never too late to try antivenom treatment for persistent systemic envenoming; it has proved effective in reversing coagulopathy 10 days or more after Echis bites.

Children should be given the same dose of antivenom as adults.

Pretreatment with subcutaneous adrenaline is IMPORTANT to prevent or diminish the reaction

6.4 ANTIVENOM ADMINISTRATION

6.4.1 Antivenom specificity

If the species responsible for the bite is known for certain, monospecific antivenom is the optimal treatment. However, in areas where the venoms of a number of different species produce similar clinical effects, polyspecific antivenoms must be used in the majority of patients who do not bring the dead snake for identification.

6.4.2 Antivenom dosage

Polyspecific antivenoms can be just as effective as monospecific antivenoms for the prescribed range of venoms which they cover and may be less expensive. Depending on their method of production, a larger dose may be required to provide the same specific neutralizing power as monospecific antivenom (see above).

For dosing information, please refer to product information leaflets of registered antivenoms in Kenya.

6.4.3 Adminstration

Antivenom is most effective when given by intravenous infusion over 30-60 minutes. Intravenous "push" injection is indicated in the initial management of neurotoxic bites and ensures that someone remains at the patient's side during the crucial first 10-15 minutes after the start of treatment, when early reactions are most likely to occur.

Intramuscular injection is not ideal and not generally recommended as absorption is very slow and there is a risk of haematoma formation in patients with incoagulable blood.

6.4.4 Response to antivenom

Neurotoxic signs are reversed slowly. The polyvalent antivenom in the acute phase of neurotoxicity will usually not prevent progression of neurotoxic effects, most notably respiratory paralysis, and consequently the patient will not survive without life support. However, intravenous administration of adequate dose of antivenom will decrease the time course of muscle paralysis and recovery. Spontaneous systemic bleeding usually stops within 15-30min, and blood coagulability is restored within about 6 hours if an adequate dose of antivenom has been given. A 20min WBCT is used to monitor the dose of antivenom in patients with coagulopathy. If the blood remains incoagulable 6 hours after the first dose, the dose should be repeated and so on, every 6 hours, until blood coagulability is restored.

In cytotoxic envenoming, administration of polyvalent antivenom will not reverse but may limit further tissue damage. The hemostatic effects of boomslang and saw scaled viper envenomings are rapidly reversed by their specific antivenoms at any time after the bite. The life-threatening adverse reactions (anaphylaxis), pyrogenic (feverish) reactions may be treated by adrenaline (0.5 ml- 1:1000 for adults).

Corticosteroids are used in serum sickness, an immune complex disease which manifests about 1 week after administration of antivenom. These adverse reactions are minimized by prophylactic administration of adrenaline prior to antivenom administration. Most antivenoms have a shelf life of 3 years.

6.5 ANTIVENOM ADVERSE REACTIONS

6.5.1 Early (anaphylactlc) reactions

Early reactions begin 3-60 minutes after starting intravenous administration of antivenom.

Cough, tachycardia, itching (especially of the scalp), urticaria fever, nausea, vomiting and headache are common symptoms. More than 5% of patients with early reactions develop systemic anaphylaxis: hypotension, bronchospasm and angio-oedema. However, there are few reports of deaths reliably attributed to these reactions. The vast majority of early anaphylactic antivenom reactions are not immediate type I hypersensitivity reactions but result from complement activation by aggregates of IgG or its fragments present in the antivenom. Adrenaline (epinephrine) 0.1% (1 in 1000) should be given intramuscularly in a dose of 0.5-1.0 ml for adults, 0.01 mg/kg for children. This should be followed by an intravenous injection of an H1 antagonist (antihistamine) such as chlorphenamine maleate (10 mg for adults, 0.2 mg/kg for children) or promethazine (25 mg intramuscularly in adults; contraindicated in children <2 years of age; in children 5-10 years old 6.25–12.5 mg and in children 10-16 years old 12.5–25 mg intramuscularly).

6.5.2 Pyrogenic reactions

These result from pyrogen contamination of the antivenom during manufacture. They begin within 1-2 hours after treatment. There is an initial chill with cutaneous

vasoconstriction, gooseflesh and shivering. Temperature rises sharply during the rigors and there is intense vasodilatation, widening of the pulse pressure and eventual fall in mean arterial pressure. In children, febrile convulsions may occur at the peak of the fever. Patients should be laid flat to prevent postural hypotension. Their temperature should be reduced by fanning, tepid sponging and antipyretic medicines such as paracetamol (15 mg/kg) given by mouth, suppository or via nasogastric tube.

6.5.3 Late reactions

Late (serum sickness type) reactions occur 5-24 (average 7) days after treatment. There is itching, urticaria, fever, arthralgia, peri-articular swellings, proteinuria and sometimes neurological symptoms. Antihistamines are used for milder attacks, but in severe cases, including those with neurological symptoms, a short course of prednisolone should be given.

7. ANCILLARY TREATMENT

7.1.1 Tetanus toxoid:
It is recommended to give a prophylactic booster dose of tetanus toxoid to all snakebite victims.

7.1.2 Wound infection
The bite of a snake may introduce bacteria into the tissues, and the risk of local infections greatly increases if the wound has been incised or if it contains necrotic tissue. Antibiotic treatment should be delayed until there are definite signs of infection or if the wound is necrotic. Appropriate blind antibiotic treatment is with chloramphenicol or amoxicillin with clavulanic acid. Prophylactic antibiotics are not appropriate unless the wound has been grossly interfered with or is frankly necrotic.

7.1.3 Care of the bitten limb
The wound should be cleaned with an antiseptic. Blisters and bullae should be left intact. Snake-bitten limbs should be nursed in the most comfortable position but should not be elevated excessively if there is tense swelling or suspicion of incipient intracompartmental syndrome as this increases the risk of ischaemia. The wound should be examined frequently for evidence of necrosis: blistering, blackening or depigmentation of the skin, loss of sensation and a characteristic smell of putrefaction.

7.1.4 Debridement of necrotic tissue
Necrotic tissue should be debrided by a surgeon under general or local anaesthesia as soon as possible to reduce the risk of secondary infection and to promote eventual healing. Skin appearances may be deceptive, for necrosis can undermine apparently normal skin. Large areas may be denuded of skin; recovery can be accelerated by applying split skin grafts immediately after debridement provided that the wound is not infected. Fluctuant areas, suggestive of an underlying abscess, should be aspirated and opened for drainage. In some cases, muscle fibers damaged by snake venom myotoxins (phospholipases A2) may regenerate if the muscle sheath is left intact and so debridement should be restrained.

7.1.5 Compartment syndrome
These are uncommon and over-diagnosed but require urgent attention. The clinical appearance of snake-bitten limbs often suggests that there is a compartment syndrome. There may be severe pain, tense tender swelling, cold cyanosed anaesthetic skin, pain on passive stretching of the muscles and apparently absent pulses. Compartment syndromes of hands and feet tend to self-decompress via the bite site. If a compartment syndrome in a limb is suspected, the patient may be treated conservatively for one hour with the appropriate antivenom and intravenous mannitol 100 g (500 ml of 20% solution in adults, less for children). Should conservative treatment fail, open full length fasciotomy should be performed providing there is no coagulopathy or gross thrombocytopenia. However, bites involving the finger pulps are frequently complicated by necrosis. Expert surgical advice should be sought, especially if the thumb or index finger is involved.

7.1.6 Vessel entrapment syndrome
This is uncommon and is usually due to massive swelling compressing the femoral vessels beneath the inguinal ligament. It presents as a cool, blister covered leg with absent distal pulses. Provided there is no coagulopathy and the leg is still viable, division of the inguinal ligament and multiple fasciotomies are required.

7.1.7 Nerve entrapments
Examples include; median carpal tunnel syndrome, femoral nerve i.e. meralgia paraesthetica. They are treated conservatively.

7.1.8 Muscle haematomas

Examples include; iliacus haemorrhage causing unilateral weakness of hip flexion as in patients with haemophilia) are treated conservatively after correction of the haemostatic disorder with antivenom and, in some cases, clotting factors.

7.1.9 Vascular thromboses

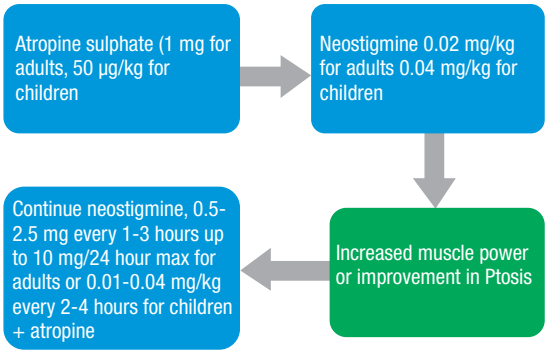
Deep vein thrombosis may be suspected when the swelling of a leg fails to subside after 2-3 weeks. Arterial and venous thromboses are rare complications reported after bites by vipers. Arterial thrombosis is suspected when agonizing pain develops rapidly in a limb, there is a sharply demarcated cold distal area and arterial pulses prove undetectable. Amputation of doomed digits and limbs is the last resort but the decision must be made and agreed upon by the patient and family before life-threatening septicaemia, gas gangrene or tetanus supervenes. Haemostatic abnormalities. Once adequate doses of antivenom have been given to neutralize venom antihaemostatic factors, recovery of normal hemostatic function may be accelerated by giving fresh whole blood. Heparin and antifibrinolytic agents should never be used in snake bitten patients.

7.2 Neurotoxic envenoming

The airway must be protected in patients developing bulbar and respiratory paralysis. Once secretions begin to pool in the pharynx, a cuffed endotracheal tube or laryngeal mask airway must be inserted. Antivenoms cannot be relied upon to reverse neurotoxicity or prevent its progression to respiratory paralysis.

7.2.1 Anticholinesterases

Neuromuscular blockade by post-synaptic neurotoxins may be partly overcome using anticholinesterase medicines. All patients with neurotoxic symptoms except those thought to have been bitten by mambas should be given an anticholinesterase test (Tensilon test). Neostigmine and glycopyrronium are used.



It is important to note that atropine must always be given concurrently with cholinesterase inhibitors (e.g. neostigmine). Since mamba venoms contain an anticholinesterase (fasciculin), it is theoretically inappropriate to use the Tensilon test in suspected or proven victims of mamba bites.

7.2.2 Acute Kidney Injury

Acute kidney injury may be caused by haemorrhage, ischaemia DIC and renal vasoconstriction, haemoglobinuria or myoglobinuria, direct nephrotoxicity and immune complex glomerulonephritis. This complication can occur in any case of severe envenoming especially if there has been prolonged profound hypotension. Patients should be managed conservatively until dialysis is indicated.

7.3 MANAGEMENT OF ENVENOMATION IN PREGNANCY

During the last trimester of pregnancy avoid the supine hypotensive syndrome by resuscitating the mother while she sits up or place her in the left lateral decubitus position or raise the left hemipelvis.

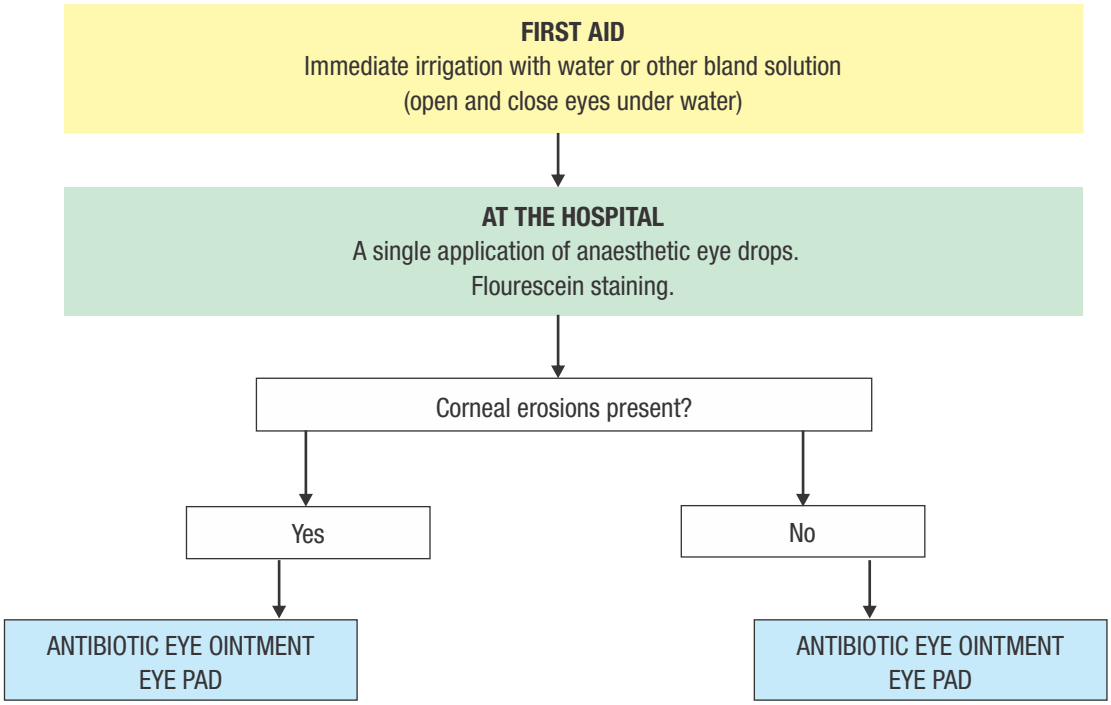
Envenoming by saw-scaled or other vipers that cause a bleeding diathesis may cause ante-partum hemorrhage.

Pregnant women should be questioned about and examined for evidence of vaginal bleeding and, in the third trimester, fetal heart rate and uterine contractions should be monitored. Fetal bradycardia may indicate fetal envenoming. Late deceleration of fetal heart rate in relation to uterine contractions indicates fetal distress.

Envenomed pregnant women are at risk of ante- and post-partum hemorrhage, premature labour, fetal distress and stillbirth.

Early adequate antivenom treatment is indicated, its benefits outweighing the risks to the mother and fetus e.g. of anaphylactic antivenom reactions. Ephedrine is recommended as prophylaxis prior to antivenom administration as adrenalin may induce vasoconstriction.

7.4 Management of venom in the eyes



7.5 TRADITIONAL PRACTICES AND BELIEFS ON SNAKEBITE

Traditional practices and healers are held in high esteem in most African communities and play a large role in the village-based treatment of many illnesses, including snakebite. There is need to educate traditional practitioners in evidence-based snakebite management and to make use of the trust and belief members of the community have in them. It should be emphasized that in many cases of snakebite, traditional healing procedures have resulted in delayed transfer of victims to health-care facilities, thus increasing the risk of permanent harm or death. Traditional healers should, therefore, be encouraged not to delay the victim's transfer to a health-care facility. They should also be discouraged from engaging in practices that may endanger lives, especially where efficacy has not been

established. These include incisions applying the black (snake) stone and tight tourniquets, and administering unproven herbal remedies. To date, no herbal or traditional remedy for snakebite has proved effective in a clinical trial. To validate efficacy of African traditional treatments, properly designed scientific research should be instigated.

These methods are absolutely contraindicated as they are all potentially harmful and none has any proven benefit. Incisions provoke uncontrolled bleeding if the blood is incoagulable; may damage nerves, blood vessels or tendons; and introduce infection. Suction, chemicals and cryotherapy increase the risk of tissue necrosis. The victim should not consume caffeinated drinks or alcohol.

No herbal or traditional remedy have been tested for effectiveness in clinical trials to date.
Until tested, most traditional first aid methods should be discouraged: They may do more harm than good!

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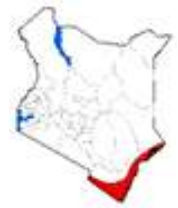
APPENDIX ONE: QUICK REFERENCE GUIDE

	Species		Length (m)	Colour	Distribution	Habitat	Venom	Main Symptoms
1.	**Black Mamba** *D. polylepis*		1.5-3.2	Grey, white, olive brown, or yellow brown		Woodlands and coastal savannah	Neurotoxin and Cardio-toxin	Breathing difficulty leading to immediate death
2.	**Eastern Green Mamba** *D. endroaspis angusticeps*		1.2-2.3	Green		Woodlands and Forests	Neurotoxin	Breathing difficulty leading to immediate death
3.	**Jameson's Mamba** *D. jamesoni*		1.5-2.2	Dull green		Forests	Neurotoxin	Breathing difficulty leading to immediate death
4.	**Egyptian Cobra** *N. haje*		1.2-2.7	Usually brown, grey-brown or reddish brown above, cream or		Savannah, Woodlands and Forests	Neurotoxin	Breathing difficulty leading to immediate death

	Species		Length (m)	Colour	Distribution	Habitat	Venom	Main Symptoms
5.	**Eastern Forests Cobra** *N. subfulva*		1.2-2.7	Black and white		Woodlands and Forests	Neurotoxin	Breathing difficulty leading to immediate death
6.	**Gold's Tree Cobra** *P. goldii*		1.2 – 2.7	Yellow and black		Forests	Neurotoxin	Breathing difficulty leading to immediate death
7.	**Red Spitting Cobra** *N. pallida*		0.7-1.2	Red		Savannah, Woodlands, semi-desert and Grasslands	Cytotoxic (bite or spit)	Swelling, necrosis
8.	**Black-necked Spitting Cobra** *N. nigricollis*		1.0-1.8	Black, grey, or coppery red		Grasslands and Woodlands	Cytotoxic (bite or spit)	Swelling, necrosis

	Species		Length (m)	Colour	Distribution	Habitat	Venom	Main Symptoms
9.	James Ashe's Spitting Cobra (Large Brown		1.2 – 2.7	Brown, grey or yellow-brown		Savannah, Woodlands and Grasslands	Cytotoxic (bite or spit)	Swelling, necrosis
10.	Puff Adder *B. arietans*		0.7-1.7	Grey, brown, yellowish		Savannah, Woodlands and Forests	Cytotoxic, causes hypovolemic shock and mild coagulopathy.	Destroyed tissues, severe pain, swelling
11	Gaboon Viper *B. gabonica*		1.7- 2.1	Black and yellow		Forests, Woodlands	Cytotoxic, causes hypovolemic shock, coagulopathy	Pain, blood blisters and destroying tissues
12	Rhinoceros Viper *Bitis nasicornis*		0.6-1.3	Red, yellow, blue, green and black		Forests	Haematotoxic and cytotoxic.	Bleeding from all openings, swelling, pain

	Species		Length (m)	Colour	Distribution	Habitat	Venom	Main Symptoms
13	**North-east African Carpet Viper (Saw-scaled Viper)** *E. pyramidum*		0.7-1.7	Green, brown and yellow		Savannah, Woodlands and Forests	Haemotoxic and cytotoxic.	Swelling, necrosis
14	**Boomslang** *D. typus*		0.9-1.7	Green		Woodlands and Grasslands	Hemotoxic and nephrotoxic	Bleeding from all openings, mild swelling
15	**Twig Snake** *T usambaricus*		0.7-1.5	Grey, green and brown		Forests	Hemotoxic and nephrotoxic.	Bleeding from all openings, swelling
16	**Yellow-bellied Sea Snake** *H. platurus*		0.7-0.9	Black above, yellow below		Ocean	Myotoxic, neurotoxic and nephrotoxic.	Paralysis of leg, muscle pain, joint pain, droopy eye lids, blurry vision