Snakebite Management in India, the First Few Hours : A Guide for Primary Care Physicians

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Snakebite in India continues to be a matter of medical concern and India remains amongst the group of countries with the highest mortality. India is also one of the world's leading producers of snake venom antiserum and therefore the understanding of the causals of snakebite mortality does not rest in snake venom antiserum shortages. The availability of treatment, particularly close to the scene of the bite, is a crucial factor in ensuring a positive outcome. In the majority of the States in India, 90+% of medical facilities are primary healthcare centres run by one doctor and with only basic equipment. If snakebite treatment is to be successful, these centres are a vital element, but virtually all existing treatment guides assume treatment at tertiary care hospitals with better equipment. A great many of these primary care hospitals do not treat snakebite, even when snake venom antiserum is available, simply because the doctor lacks confidence in being able to treat the patient. The result is that patients are referred to distant, better equipped hospitals and thus make journeys without the cover of snake venom antiserum. This paper provides guidance for the primary healthcare doctor in identification of medically significant snakes, treatment, referral criteria and equipment necessary to successfully manage snakebite in a primary care environment. [J Indian Med Assoc 2007; 105: 324-35]

Key words : Snakebite, treatment protocol, envenoming, snake venom antiserum.

It is possible to surmise, by looking at the textbooks, that snakebite only happens in a tertiary hospital setting. Chapters include diagnostic tests such as activated partial thromboplastin time (APTT) and fibrin degradation products (FDP), instructions are given in the use of mechanical ventilation and criteria for dialysis are specified1,2. Whilst all this is good information, it is usually only of use at the end of a long chain of activities commencing with a snakebite, in a rural setting. The victim's first point of contact with the medical system is usually the government run primary healthcare centre (PHC) or its equivalent. The PHC has basic equipment, no ventilator, no laboratory and no dialysis equipment and yet it is actually the most important step in the management of snakebite.

If the victim can receive effective initial treatment at this stage, precious time can be saved during a crucial period that otherwise is lost during the referral to better equipped hospitals3. Two factors that can often determine whether a victim is treated in the PHC are the confidence of the doctor as to how to manage snakebite effectively and an understanding of the basic drug, equipment and process profile that can easily be adopted in the PHC and which can lead to a successful management of snakebite. This article seeks to address those concerns and provide a practical approach to managing snakebite in the primary care centre.

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Identification of Medically Significant Snakes

Much of what has been written about identifying snakes of medical significance is misleading. For example, the notion of the 'big 4' has been shown to be inapplicable in modern India, as there are medically significant species emerging even today4. How to identify a species is frequently covered in forensic medicine textbooks and usually consists of scalation, pupil shape, width of belly scales, etc. Virtually all of this is impractical for a busy clinician as well as incorrect or unnecessary detail1. Identifying snake species is a complex business. The correct approach is to know which species are likely to be present in an area and what are the key identification features that give the doctor the best

clue as to the species being dealt with.
The cobra family are perhaps the most readily recognised species in the world. The spectacled cobra *(Naja naja)* is found throughout India whilst the monocled cobra *(N kaouthia)* is found in West Bengal, Madhya Pradesh, Orissa, Sikkim and Uttar Pradesh. A third variety of cobra, the central Asian or black cobra *(N oxiana)* is believed to be found in some of the northern states such as Jammu and Kashmir, Punjab and Rajasthan. This species has no distinct hood marking and resembles the patternless form. However, no definitive records exist and examples seen by the author in Rajasthan, Madhya Pradesh and Punjab were identified as patternless spectacled cobras.
The krait family is interesting as a number of newer species are emerging as snakes of medical importance. The common krait *(Bungarus caeruleus)* is the most frequently encountered and is seen throughout India except in northern Jammu and Kashmir, Himachal Pradesh and Arunachal Pradesh. The paired white bands and the large hexagonal scales along the top of the snakes back are key identification features.
The banded krait *(B fasciatus)* with its distinctive black and yellow bands and hexagonal scale is found in West Bengal, Madhya Pradesh, Orissa, Andhra Pradesh, Assam, Arunachal Pradesh, a small part of Maharashtra near Andhra and Bihar. The newer kraits are the Sind krait (B sindanus sindanus) found in Rajasthan; Wall's Sind Krait *(B sindanus walli)* found in Maharashtra, West Bengal, Uttar Pradesh and Bihar and the black krait *(B niger)* found in the north-east states including West Bengal, Sikkim and Assam. These kraits either have no markings, in the case of the black krait or have less obviously paired, equally spaced white bands, often with a large spot on the hexagonal scale. The hexagonal scale remains a constant key identifier throughout the krait species.
The Russell's viper *(Daboia russelii)* is endemic throughout India although absent in the north of Jammu and Kashmir and the desert districts of Rajasthan. Its key identification feature is the black edged, chainlike marking on the body and a white triangular marking on the head. It is worth remembering that juvenile Russell's viper, active at the start of the rainy season, is frequently confused with a saw scaled viper *(Echis carinatus)*.
The saw scaled viper *(Echis carinatus)* is found in most parts of India although it is rare or absent in the wetter areas such as coastal Kerala and the north-east of India. Its distinctive identification features are the hoop-like markings along the flanks and an arrow shaped mark on the head. In Rajasthan, Jammu and Kashmir and possibly Gujarat, the northern saw scaled viper *(Echis sochureki)* is found.
In the Western ghats the hump-nosed pit viper *(Hypnale hypnale)* has also been identified as a snake causing life threatening symptoms.

Patient Arrival

When the patient arrives, the first priority is to deal with any serious symptoms. Does the patient show any signs or symptoms of envenomation and, if so, proceed to the snake venom antiserum administering phase. If the patient has brought the dead snake, look for the key identification features and try to determine if the snake is venomous or not. Determine if the snake has actually bitten the patient; is there a bite mark, did the patient see and/or feel the bite. It is important to remember that bite marks are of no use in determining whether the patient was bitten by a venomous or non-venomous species5. Many venomous species have more than one set of fangs and can leave multiple puncture marks. Many non-venomous species have two enlarged teeth that can leave two puncture marks.
Ask the patient how long ago they were bitten as this can give useful indications as to the progress of any envenomation. Determine if any first aid measures have been taken such as ingestion of ghee as this can cause confusing symptoms such as vomiting.
If a tourniquet has been employed, palpate the distal pulse before removal. The absence of a pulse is good evidence that blood flow has been impaired and on tourniquet removal, the victim should be

closely observed for any sudden onset of symptoms. If the pulse is present then there is less likelihood of a sudden deterioration.
Administer the 20WBCT to determine the coagulation status of the patient 6,7. A few ml of fresh venous blood are left undisturbed in a new, clean and dry test tube for 20 minutes. The tube is then gently tilted. If the blood remains liquid then this is good evidence of consumption coagulopathy and snake venom antiserum is required. If the blood has clotted, no further action should be taken until the next test or other symptoms manifest. The patient should be given a 20WBCT every 30 minutes for the first 4 hours and hourly after that.

Snake Venom Antiserum : Yes or No ?

In the PHC, the decision as to whether to administer snake venom antiserum, is uncomplicated by reliance on a great many tests. Snake venom antiserum is a costly solution to snakebite and is not without risk; therefore it should only be administered when the doctor is sure that there is unneutralised, unbound venom in the blood or tissue fluid. The symptoms or signs that confirm this and lead us to administer snake venom antiserum are few in number.
In the case of snakes causing haemostatic disturbances ie, members of the viper family, a 20WBCT indicating incoagulable blood or evidence of spontaneous bleeding such as from the gums will indicate that snake venom antiserum is required. In the case of species causing neurological impairment ie, all cobras, kraits and rarely Russell's viper8 the signs will be visual, initially involving muscles enervated by the cranial nerve (ptosis, ophthalmoplegia, difficulty in swallowing). These constitute evidence of systemic envenomation.
In the case of local swelling, considerable confusion results from the inappropriate use of protocols, developed for use against snakes in other countries, being applied in India. One of the key textbooks, used in Indian medical education, provides a chapter on snakebite management which outlines the use of snake venom antiserum in cases of purely local swelling9. In India, this should be ignored as the bites of a great many non-venomous snakes will result in purely local swelling which is not venom driven. However, certain levels of swelling are indications that the swelling has to be venom driven and thus evidence of envenomation. How do physicians recognise venom driven swelling?
The first principle is that if the swelling involves at least half of the bitten limb within a few hours of the bite and in the absence of a tourniquet7. Tourniquets can cause swelling of their own accord and thus can complicate the process of determining whether there is envenomation or not. Once the tourniquet has been removed for one hour, however, if the swelling rapidly continues this is good evidence that the swelling is venom driven and snake venom antiserum is applicable.
The second principle is whether the swelling has crossed a joint within the first hour or two of the swelling starting7. This should also be a current phenomenon. Victims who arrive after several hours and state that the swelling was rapid would not fall under this category, as either a 20WBCT indicating incoagulable blood or visible neurological signs would take precedence.
The general rule with swelling is that it should be severe, indicative of envenomation by either speed of swelling or severity and should be current. Swelling that is several hours old is not good evidence of current envenomation with free flowing unbound venom. The primary indicators will be the 20WBCT or visible neurological signs. Patients who show evidence of envenomation should receive snake venom antiserum. Those who do not show manifestation should be kept for 24 hours under observation, given a tetanus toxoid injection and discharged.

How Much Snake Venom Antiserum and Why ?

Once the patient has demonstrated envenomation under the above criteria, the question is how much snake venom antiserum should be given? snake venom antiserum package inserts recommend a minimum of two vials and a great many doctors use this as the starting dose10. However, the initial dose is given to neutralise the likely average dose of venom injected by the snake. Research has given some indications as to what that level of venom will be: 63mg ± 7mg in the case of Russell's viper11. Indian polyvalent snake venom antiserum neutralises 6mg14 of Russell's viper venom per vial and therefore the starting dose should be 8-10 vials! This snake venom antiserum should be administered over 1 hour12. It is counter intuitive to administer snake venom antiserum over longer periods; if the patient is envenomated they require the snake venom antiserum now. The half-life of Indian snake venom antiserum is around 90 hours, so it will not disappear and there is no requirement to extend the administration period. It is also evident that 10 vials will not cure all patients. The snake is capable of injecting more than the average level of venom. However, from the PHC doctor's perspective 10 vials is the best starting dose before referral to a higher centre as there are other complications which will determine that any second dose should be given elsewhere.

Confident Management of Adverse Snake Venom Antiserum Reactions

It is certainly true that the level of adverse reactions to Indian snake venom antiserum is higher than experienced with more expensive snake venom antiserum produced in the developed world. However, the unintended consequence of constantly stating the level of adverse reactions has been that a great many doctors in PHC have been reluctant to administer snake venom antiserum, and prefer to refer a victim to a higher centre, rather than face the risk locally. Test doses of snake venom antiserum should not be administered as they are poor predictors of early anaphylactoid reactions and may presensitise the patient to the snake venom antiserum13. Prophylactic use of adrenaline14 or hydrocortisone and antihistamine15 has been recommended and can be considered, however the techniques have no statistically powerful research evidence.

The most significant point is that adverse reactions, whether they be immune system generated in the case of anaphylactoid reactions or pyrogen related in the case of pyrogenic reactions, are straightforward to manage if approached early and with the correct drug of choice16.

Research evidence has clearly demonstrated that early recognition of a reaction and immediate intervention gives the best outcomes. At the first sign of any of the following eg, urticaria, itching, shivering, chills, nausea or vomiting, hypotension, bronchospasm, angio-oedema then: (1) Switch off the snake venom antiserum. (2) Administer 0.5mg 1:1000 adrenaline IM for adults, 0.01mg/kg for children. (3) Administer hydrocortisone and antihistamine to provide longer term protection (it should be remembered that hydrocortisone is not biologically active for several hours and therefore is not the drug of choice in the acute phase of anaphylaxis). (4) Wait for 10-15 minutes and if the condition has not improved administer a second dose of adrenaline in the same way. (5) Once condition has improved resume snake venom antiserum administration.

A great many reactions will be resolved by a single administration of adrenaline; however some may require a second dose. In extremely rare cases a third dose may be required.

The IM route is selected due to the speed of action of adrenaline; it takes 8 minutes to reach average blood plasma levels by the IM route whereas it takes 34 minutes via the subcutaneous route17. The length of time required to manage the reaction must be minimised as the victim is without snake venom antiserum for this critical period.

Neurological Additional Steps

In the case of neurotoxic envenoming, once the snake venom antiserum has been administered, the next step is to administer a neostigmine test to establish if the victim reacts to anticholinesterase. There is good research evidence indicating that postsynaptic impairment, such as that caused by cobra venom, responds well to neostigmine as it prolongs the life of acetylcholine giving it increased probability of binding to a nicotinic receptor18. In cases of presynaptic envenoming such as kraits or Russell's viper, a positive response is unlikely but the test should be tried in any case. It should be remembered that this is a 'test'; if the victim shows an improvement in symptoms then neostigmine should be continued. If there is no improvement during the test then neostigmine should be discontinued.
The test is administered as follows:
(1) An objective measure of impairment is selected such as single breath count, length of time upward gaze can be maintained, etc, and the value established.
(2) For adults 1.5mg of neostigmine (paediatric dose 0.04mg/kg) is administered IM along with 0.6mg atropine IV (paediatric dose 0.05mg/kg) to counteract the muscarinic effects of the neostigmine.
(3) Every 10 minutes the objective measure is reassessed to determine if any improvement is present. Neostigmine takes approximately 20 minutes to reach effective blood plasma levels, so the first 2 readings should not improve by much, if at all. By the third reading any improvement should start to become evident.
(4) If the victim shows improvement administer 0.5mg neostigmine IM half hourly with atropine via slow infusion. If no improvement is shown discontinue neostigmine.

Optimised and Stable Referral

Once the patient has been correctly identified as being envenomated, administered the initial dose of 10 vials of snake venom antiserum, monitored and treated for any anaphylactoid reaction and administered the neostigmine test, in a neurotoxic envenomed patient, the next decision is whether and when to refer the patient to a better equipped hospital.
In the case of haemotoxic envenomations there are known complications that can arise that will need access to laboratory testing to identify and in addition, potential surgical intervention to resolve. In the case of all the main viper species, systemic bleeding caused by the action of haemorrhagic toxins in the venom is a major concern19. This will require diagnosis by the use of haemoglobin levels and packed cell volume amongst others. In the case of Russell's viper and hump-nosed viper, renal failure is a frequent complication20. Again access to a laboratory for serum creatinine and urea readings will be vital.
After the patient has received the initial dose of snake venom antiserum and has been stabilised for anaphylaxis the patient should be referred to a secondary hospital, if equipped with laboratory facilities that can carry out the required blood tests, or to a tertiary centre. In the case of haemotoxic patients the initial dose of snake venom antiserum will be neutralising unbound, free flowing venom during the journey. As the liver requires 6 hours to restore clotting factors, the victim will not require further snake venom antiserum for 6 hours after the initial dose is administered7. Therefore a 6-hour treatment window exists during which the patient can be moved to another hospital.
In the case of neurotoxic bites, the major concern is respiratory failure which affects both cobras and kraits. Once the initial dose of snake venom antiserum has been given, the victim stabilised for any anaphylactoid reaction and the results of the neostigmine test has been established the victim should be assessed.
If the victim's condition has worsened or has not improved, a second dose of 10 vials should be given after 1 hour, if there is no danger of imminent respiratory failure. Two doses of 10 vials mark the total

amount of snake venom antiserum required for a neurotoxically envenomed patient in India. At this stage the victim will either recover or progress to respiratory failure. A basic means of assessing imminent respiratory failure, in a PHC setting, is the ability of the patient to neck raise. If a supine patient cannot raise their head this is useful evidence of likely respiratory failure.
If the patient recovers, without developing respiratory failure they can be discharged locally unless there is a requirement for surgical intervention to handle necrosis, which would necessitate referral to a higher centre.
If at any stage the victim exhibits signs of imminent respiratory failure they should be moved to a hospital which can provide mechanical ventilatory support. The victim should be transported by vehicle with an additional person, other than the driver, who can provide basic airway support with the ambubag and airway management instrument. The critical risk here is that full respiratory arrest will occur during the journey21. If basic respiratory support is provided during the journey the victim will likely have a positive outcome.
If imminent respiratory failure is indicated, while administering the initial or second dose of snake venom antiserum, continue the infusion during transport, if possible. The need to neutralise any unbound venom will remain.

Preparing for the Snakebite Season

For the PHC that deals with snakebite or is intending to start dealing with snakebite it is important that guidance is available on the drug and equipment profile and what processes can be adopted to ensure the best patient outcome. As a basic set-up the following drugs should be available in the PHC:
• Thirty vials of polyvalent snake venom antiserum. This number is based on 20 vials being the maximum required to handle a neurotoxic bite that does not require referral to a secondary or tertiary centre. Thirty vials would enable the doctor to manage this bite and still be able to treat a further haemotoxic bite that arrived during treatment. These numbers are basic guidelines and should be adjusted for local conditions and snakebite profile.
It is important to stress to the procurement agency in the State that this snake venom antiserum is not incremental to normal usage, but rather it is substitutional for snake venom antiserum that would normally be administered at a referral hospital.
• Adrenaline 6 doses of 0.5mg, in addition, antihistamine and hydrocortisone.
• Neostigmine 3 doses of 1.5mg plus 8-9mg for continued administration if the initial test dose shows improvement. Atropine should also be available for several doses of 0.6mg.
In terms of equipment one piece is essential, two pieces are ideal :
• An ambubag for providing basic respiratory support.
• An airway protection device such as a laryngeal mask airway or a laryngeal tube. It is often very difficult to maintain respiration in a snakebite victim with an ambubag alone. The flaccid paralysis in neurotoxic envenoming makes it difficult to effectively inflate the lungs. The LMA or laryngeal tubes are simple, inexpensive devices which can be speedily applied.

First Aid Advice

The PHC is the medical institution that has the most frequent contact with victims. In that event it is essential that physicians give victims and bystanders the correct advice as to what first aid to carry out in the event of a bite.
It consists of the following:
(1) Reassure the patient. Seventy per cent of all snakebites are from non-venomous species. Only 50% of bites by venomous species actually envenomate the patient.
(2) Immobilise in the same way as a fractured limb. Use bandages or cloth to hold the splints, not to block the blood supply or apply pressure. Do not apply any compression in the form of tight ligatures22

or pressure bandages, they don't work23 and can be dangerous!
(3) Get to hospital immediately. Traditional remedies have no proven benefit in treating snakebite.
(4) Tell the doctor of any systemic symptoms such as ptosis that manifest on the way to hospital.
This method will get the victim to the hospital quickly, without recourse to traditional medical approaches.

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