

Approach to the diagnosis and management of snakebite envenomation in South Africa in humans: Special patient groups and surgical aspects

T C Hardcastle,^{1,2,3} MMed (Chir), PhD; A Engelbrecht,^{3,4} MMed (Fam Med), FCEM (SA); V Lalloo,^{3,4} MMed (EM), FCEM (SA); C Bell,^{3,5} MB ChB; M Toubkin,^{3,6} RN (Trauma/Crit care), MSc (EM); F Motara,⁷ MFamMed, ACEM; M Kajee,⁸ RN (Trauma/Crit care)

¹ Trauma and Burns Service, Inkosi Albert Luthuli Central Hospital, and KwaZulu-Natal Department of Health, Durban, South Africa

² Department of Surgical Sciences, Nelson R Mandela School of Medicine, University of KwaZulu-Natal, Durban, South Africa

³ National Snakebite Advisory Group, Durban, South Africa

⁴ Department of Emergency Medicine, Faculty of Health Sciences, University of Pretoria, South Africa

⁵ Mosvold Hospital, KwaZulu-Natal Department of Health, and Department of Family Medicine, University of KwaZulu-Natal, Durban, South Africa

⁶ Netcare Emergency, Trauma and Transplant, Netcare Head Office, Johannesburg, South Africa

⁷ Department of Emergency Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

⁸ South African Snakebite Symposium Organizing Committee, Gauteng, South Africa

Corresponding author: T C Hardcastle (hardcastle@ukzn.ac.za)

This article explores the management of snakebite in vulnerable patient groups, namely children and pregnant women, as well as providing detail on the current best practice when caring for venom ophthalmia and surgical wounds resulting from snakebite. Finally, the optimal free-to-use medical record for accurate documentation of snakebite incidents is provided for use by South African practitioners.

S Afr Med J 2023;113(7):e1038. <https://doi.org/10.7196/SAMJ.2023.v113i7.1038>

Snakebite is not only confined to the adult population, but children and even pregnant women are at risk, although the latter are uncommonly bitten. Venom ophthalmopathy is painful, and found after venom 'spitting' by the spitting cobra groups. Cytotoxic bites may lead to extensive swelling or areas of tissue necrosis, and as such, the emergency unit may refer the patient to a surgeon for assessment. This article addresses these patient groups and the current best practice of eye care, wound care and surgical management. It also provides a useful set of clinical records to use during the management of snakebite presentations approved by the South African Snakebite Symposium (SASS), held in Nelspruit on 29 and 30 July 2022.

Special aspects regarding snakebite in children

Owing to their smaller size, children may present with more severe effects after snakebite, due to their lower volume of distribution relative to the injected venom mass. This higher venom-to-body-mass ratio can produce rapid and severe neurotoxicity, coagulopathy and extensive local tissue damage.^[1]

While children are not small adults, it is important to treat the child with a higher index of suspicion, and importantly, the *same dose of antivenom as in adults* must be administered when indicated.^[1-3] Adrenalin pre-dosing prophylaxis is given at 0.01 mg/kg, to a maximum of 0.25 mg.^[2] General treatment is as for adults, with early airway and ventilatory support, renal support and close observation. Antibiotics are controversial, and should only be given for infected cytotoxic bites, as a rule.^[1,4] Antivenom reactions are common and should be treated using an anaphylaxis protocol, which includes the use of intramuscular adrenaline, antihistamines and steroids.^[1,5,6] Mortality from antivenom reactions is low.^[1,5,6] As for adults, there is a risk for delayed serum sickness 5 - 25 days post antivenom, and this responds well to oral steroids.^[1]

Snakebite in pregnancy

Snakebites in pregnancy are fortunately rare, with very few case reports in the world literature, and only two from SA.^[7,8] While there appears to be a higher risk for fetal loss in the first and early second trimester (up to 40%), the approach and treatment should follow the usual methods as detailed for adults.^[7,8] Spontaneous abortion is common in early pregnancy; however, excessive bleeding is not, possibly owing to muscle contractions from the venom. Slowing of fetal movements and heart rate has been described, and cardiotocography is advised. Vasopressors and inotropes should be avoided in pregnancy.^[7] The risk for teratogenicity is low.^[7] In advanced pregnancy, left lateral positioning is preferred to ensure uterine perfusion.^[8]

Venom ophthalmia

The 'spitting cobras' and rinkhals can direct venom streams toward the eyes of the person or animal threatening them, and this leads to a painful rapid-onset ophthalmia. Treatment is directed at prevention of complications. The practice of applying antivenom into the eye has not been proven to be effective.^[9]

- Flush the affected eye/eyes with water or a balanced salt solution.
- If a local anaesthetic agent is available, add 2% lignocaine 1 mL/1 000 mL saline.
 - Add a mydriatic eye drop in cases where corneal damage is noted.
 - Do a slit lamp fluorescein check for corneal damage and cover with antibiotic drops for 5 days.

Refer to an ophthalmologist for daily slit lamp examinations.

Surgical and wound management

Local wound care is usually all that is required in the first 24 - 48 hours post bite.^[1,3,10-12]

Place Patient Sticker Here
 Hospital / Clinic:
 Admission No.:
 Title: Prof. Dr. Rev. Mr. Mrs. Ms.
 Surname:
 Names:
 Attending Doctor:

**Snakebite Management:
 South African Consensus
 Guideline – Adapted
 For SASS 2022**



**EMERGENCY DEPARTMENT
 SNAKEBITE MANAGEMENT PATHWAY**

SUPPORTIVE PATHWAY TO BE COMPLETED WITH P1 DOCUMENT -
 ADD PATHWAY TO P1 DOCUMENT

SNAKEBITE TARGETED HISTORY			
Body Part Bitten	FRONT	BACK	
Time Bitten			
Current location of snake			
Description of the snake	<input type="checkbox"/> Dark brown	<input type="checkbox"/> Blowing sound (Adder)	<input type="checkbox"/> Characteristic hood & hiss (Cobra)
	<input type="checkbox"/> Green in colour	<input type="checkbox"/> Light brown	<input type="checkbox"/> Spotted
	<input type="checkbox"/> Black	<input type="checkbox"/> Small head	<input type="checkbox"/> Large head
	Other: _____		
Type of snake (if known)			
Signs & Symptoms	Cytotoxic Bites:		
	<input type="checkbox"/> Pain	<input type="checkbox"/> Swelling	<input type="checkbox"/> Discolouration
	Neurotoxic Bites:		
	<input type="checkbox"/> Metallic Taste	<input type="checkbox"/> Slurry Speech	<input type="checkbox"/> Ptosis (Difficulty Opening Eyes)
<input type="checkbox"/> Drowsiness	<input type="checkbox"/> Weakness	<input type="checkbox"/> Respiratory Difficulty	
Haemotoxic Bites:			
<input type="checkbox"/> Bleeding (Bite Site / Anywhere Else)	<input type="checkbox"/> Other: Specify _____		
Previous snakebites	<input type="checkbox"/> Yes <input type="checkbox"/> No	Date(s): _____	
Received Antivenom	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Abnormal Reaction/ Anaphylaxis after receiving antivenom	<input type="checkbox"/> Yes <input type="checkbox"/> No		

DISCLAIMER
 THE AUTHORS AND EDITOR HAVE EXERTED EVERY EFFORT TO ENSURE THAT THE CLINICAL PROCEDURES AND RECOMMENDATIONS DESCRIBED HEREIN ARE BASED ON CURRENT KNOWLEDGE AND STATE OF THE ART INFORMATION OBTAINED FROM ACKNOWLEDGED AUTHORITIES, TEXTS AND JOURNALS. HOWEVER, THEY CANNOT BE CONSIDERED ABSOLUTE AND UNIVERSAL RECOMMENDATIONS. EACH PATIENT SITUATION MUST BE CONSIDERED INDIVIDUALLY. THE READER IS URGED TO CHECK THE PACKAGE INSERTS OF DRUGS AND EQUIPMENT AND THE MANUFACTURERS RECOMMENDATIONS FOR INDICATIONS, CONTRAINDICATIONS, PROPER USAGE, WARNINGS AND PRECAUTIONS BEFORE USE. THE AUTHORS AND EDITOR DISCLAIM RESPONSIBILITY FOR ANY ADVERSE EFFECTS RESULTING DIRECTLY OR INDIRECTLY FROM INFORMATION PRESENTED IN THIS BOOKLET, UNDETECTED ERRORS OR MISUNDERSTANDINGS BY THE READERS.

The Original Netcare Emergency Department Snakebite Management Pathway (ISO ED 00107V1 Nov 2019) has been adapted and updated for The South African Snakebite Symposium 2022 as : Snakebite Management: A South African Consensus Guideline 2022.

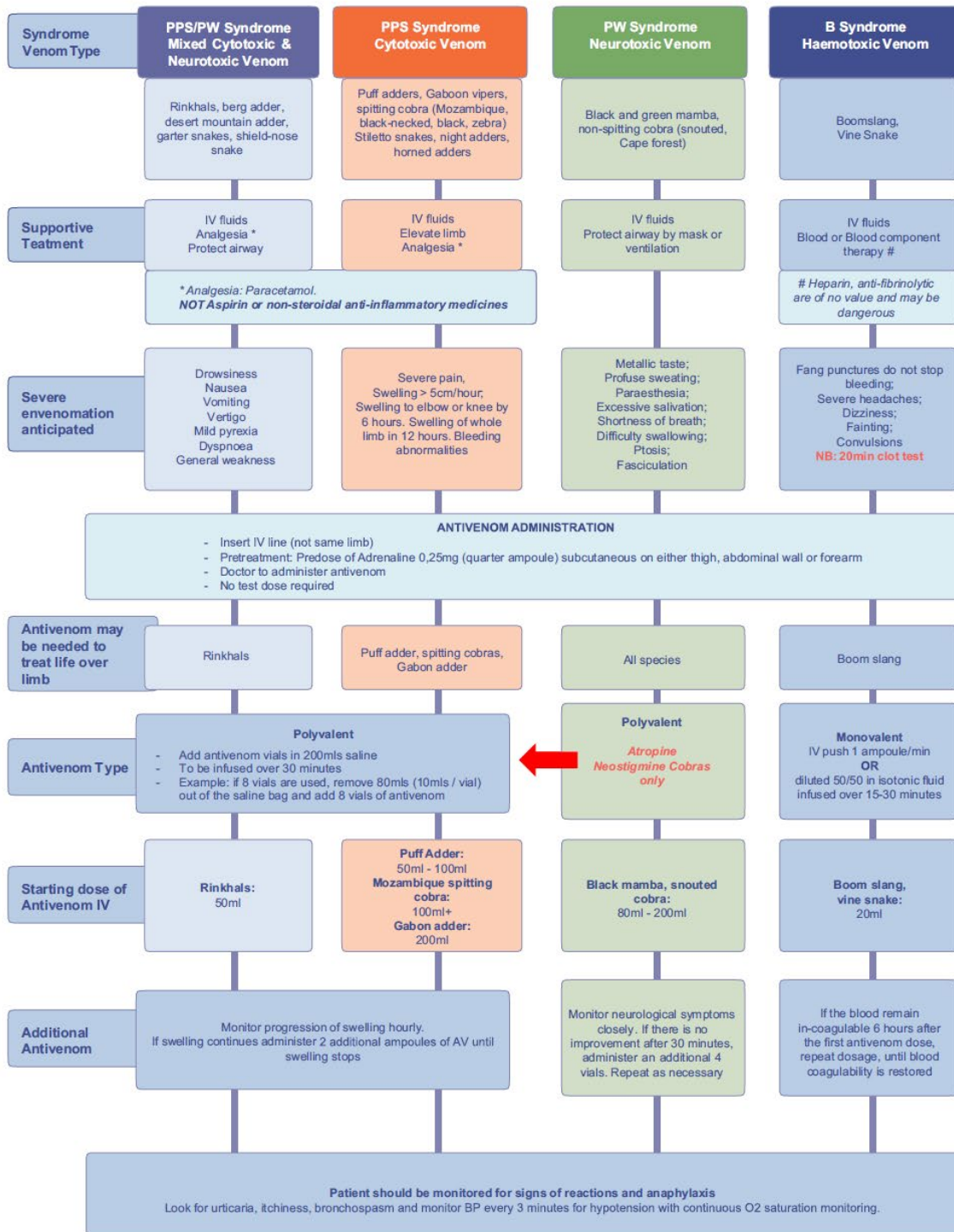
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Fig. 1A. Snakebite care pathway and medical records (4-page document).

FOCUSED PHYSICAL ASSESSMENT BY TRAUMA TEAM					
<p><i>Assessment should be focused on deciding if a significant envenomation has occurred and differentiating which envenomation syndrome is presenting:</i></p> <p>PPS (spitting cobras, puff adder, gaboon adder)- look for the rate of swelling, progression, discoloration and blistering at the site.</p> <p>Mild to moderate swelling - Stiletto snakes/night adders - cause less swelling with potential local damage but only needs conservative treatment.</p> <p>PW (mambas, non spitting cobras) - any neurological sign is a medical emergency as it may lead to respiratory arrest. Early signs are metallic taste, parasthesia, blurred vision with ptosis, difficult speech and swallowing. Patient may have a "drunk" appearance. Full preparation for intubation and ventilation should be made if any of these signs are present.</p> <p>Bleeding (boomslang, vine snake) - may take many hours to develop, thus cautious monitoring is essential. Bleeding from the bite site and oropharyngeal area (gums) are often the first signs. 20 minute Clotting test is positive in these patients.</p>					
Draw a ring around the bite area with a permanent marker pen and record the time inside the drawn ring					
Monitor every 30 minutes for progression of symptoms and swelling of the area.					
Examine the patient for tooth and fang marks or even tiny scratch (Boom slang or Black mamba)					
Local Signs	<input type="checkbox"/> Swelling <input type="checkbox"/> Persistent Bleeding <input type="checkbox"/> Discolouration / Blistering Other _____				
Systemic Signs	<input type="checkbox"/> Neurotoxic / Paralysis <input type="checkbox"/> Cardiovascular Instability				
ALLERGY PROFILE					
Any medication allergy? <input type="checkbox"/> Yes <input type="checkbox"/> No					
Have you had antivenom treatment before? <input type="checkbox"/> Yes <input type="checkbox"/> No					
Do you suffer from asthma or hay fever? <input type="checkbox"/> Yes <input type="checkbox"/> No					
Have you had infantile eczema? <input type="checkbox"/> Yes <input type="checkbox"/> No					
Any other allergies, e.g. food (peanuts) or bee stings? <input type="checkbox"/> Yes <input type="checkbox"/> No					
Have you ever been bitten by a snake before? <input type="checkbox"/> Yes <input type="checkbox"/> No					
If any of the answers above are Yes – Prepare for High Possibility of Anaphylaxis					
MEDICATION PRESCRIPTION AND ADMINISTRATION					
Drug Name	Dose	Route	Site	Time	Signature
Prescribing Dr				Signature	
PPS: Painful Progressive Swelling PW: Progressive Weakening B: Bleeding					
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Fig. 1B.



(Adapted for the South African Snakebite Symposium 2022)
 (Snakebite Management: South African Consensus Guideline – SASS 2022)
 (Swaziland Antivenom Foundation 2018)
 ISO ED 00107 V1 Nov 2019 NETCARE

(Blaylock, 2005) and see also Muller et al SAMJ 2012 – use of atropine and neostigmine

Fig. 1C.

20 MINUTE CLOTTING TEST FOR BOOMSLANG, VINE SNAKE BLEEDING SYNDROME - HAEMOTOXIC VENOM					
Rapid test of blood coagulability, done at bedside					
Take a few millilitres of blood by venepuncture and place in a new, clean, dry glass vessel					
Leave undisturbed at room temperature for 20 minutes	Start Time:	End Time:			
Tilt once to see whether or not the blood has clotted.					
Other more sensitive laboratory tests: prothrombin time (often reported as INR), thrombin and fibrinogen levels, activated partial thromboplastin times and measurement of fibrinogen degradation products and D-dimer concentrations.					
Laboratory investigations to include: urinalysis, full blood count, urea and electrolytes and serum creatinine.					
REACTION TO ANTIVENOM		POSITIVE ANTIVENOM RESPONSE			
Urticaria		Progression of Swelling Stopped			
Pruritis		Improvement of Neurotoxic Effects within 30 min			
Febrile Reaction		Blood Pressure normalises within 1 hour			
Restlessness / Confusion		Cardiac Arrhythmias improve rapidly			
Bronchospasm		Cardiovascular effects (hypotension, sinus bradycardia) may respond within 10-20 min			
Hypotension		Spontaneous Systemic Bleeding usually stops within 15-30 min			
		Blood Coagulopathy			
Other:					
SNAKE VENOM OPHTHALMIA - FIRST AID					
Immediate irrigation with water or bland solution					
MEDICAL PRACTITIONER					
Single application of local anaesthetic eye drops (overcome tightly closed eyelids during irrigation)					
Fluorescein Staining					
Slit lamp					
Corneal Erosion					
Antibiotic Eye Drops / Ointments					
Mydriatic					
Eye pad					
Daily Slit Lamp Examination until cured					
EMERGENCY CONTACT NUMBERS FOR ADVICE					
KZN Region (Incl. Eastern Cape)		Gauteng Region (Incl. Free State and Northern Cape)		Western Cape Region (Incl. National or International)	
Prof Tim Hardcastle	+27 82 468 1615	Prof D Engelbrecht	+27 84 789 7364	Cape Town Poison Centre	+27 86 155 5777
Dr Jenna Taylor	+27 73 124 02450	Dr Vidya Laloo	+27 82 700 2732		
Dr Sharadh Garach	+27 82 495 0135	Jason Seale	+27 82 781 8498		
Dr Christoff Bell	+27 73 174 0199	Arno Naude`	+27 83 739 9303	Mpumalanga Region	
Dr Roshen Maharaj	+27 83 378 0919	Mande Toubkin	+27 82 820 7914	Chris Hobkirk	+27 82 372 3350
		Prof K D Boffard	+27 82 551 4960		
		Mike Perry	+27 83 448 8854		
		Johan Marais	+27 82 494 2039		

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Fig. 1D.

Most cases of cytotoxic bites will result in some degree of tissue inflammation, and often eventual necrosis. In the early phase of care, blisters and tense bullae can be left alone if the skin is intact and imminent rupture unlikely. However, blisters that have already ruptured should be debrided and cleaned with a chlorhexidine-based antiseptic solution, then covered with a silver or honey-based dressing.

Other blisters are best allowed to mature for ~48 hours, and then may be debrided to clean edges, similar to deep partial burn wounds. These are then covered with a dressing containing silver-based products (or honey-based products), as infection prophylaxis. Suitable absorbent material is used to provide top cover to ensure a moist non-sloughy wound bed.

The wounds are re-assessed after 48 hours, and if infected, debrided, and abscesses drained. Antibiotics are not used prophylactically and are given on indication after wound cultures if the patient has systemic signs.^[1,4] Non-septic, necrotic wounds should be left for 5 - 7 days to demarcate before conservative debridement to healthy bleeding tissue is performed.^[1,3,4] The use of negative-pressure wound care devices may be beneficial, if available.^[1] Finally, skin grafts may be necessary after some time, but should not be performed before ~10 days post bite.^[1,3,12]

Before discharge, patients should be referred to physiotherapy and occupational therapy for rehabilitation of the affected limb if swollen, or where skin grafts have been performed. This will entail motor functional retraining and possibly the use of compression garments for scar maturation.

Pseudo-compartment syndrome

True compartment syndrome is extremely rare in snakebites. The swelling seen in cytotoxic bites is localised to the subcutaneous tissues, as seen on ultrasound studies of patients bitten in KwaZulu-Natal Province.^[13] The misleading clinical appearance of pseudo-compartment syndrome is unfortunately the reason that many unnecessary fasciotomies are performed. Pain, pallor, tense swelling, pain on passive stretch and absent pulses may be found in pseudo-compartment syndrome. A key distinguishing feature of pseudo-compartment syndrome is that pressures when measured with a Stryker or similar self-made pressure monitoring device are <30 - 40 mmHg. While not yet standard of care, ultrasound studies have been shown to be useful in avoiding unnecessary fasciotomy, and are far less painful than traditional intra-compartmental pressure devices.^[13]

Animal studies have demonstrated that fasciotomy is ineffective in saving envenomed muscles.^[12] The venom affects the muscle primarily, and this leads to delayed recovery, with or without fasciotomy.^[2,14,15] Medical treatment with aggressive elevation of the affected limb above the level of the heart, antivenom administration at the high end of the dose range for painful progressive swelling including 2-hourly follow up doses and the administration of osmotic diuretics can prevent the vast majority of fasciotomies and *must be completed prior to fasciotomy* with re-assessment of the limb.^[1,3] The rare occasion of a true compartment syndrome is usually associated with prolonged tourniquet use, delayed presentation to hospital and lack of antivenom use.

Medical records

Documentation of snakebite care is an important medicolegal aspect. The emergency unit flowchart that was adapted (with permission from the Netcare group) to include the recent developments in snakebite treatment will ensure that no important decisions are missed or incorrect therapy is offered, with timely investigations and treatment (see Fig. 1 – a 4-page document for recording the management of snakebite victims)

Conclusion

Most morbidity related to snakebites and the associated serious sequelae are largely preventable, provided there is suitable care for venom ophthalmopathy and conservative surgical wound care, and if the specific needs of children, the most neglected snakebite group, and on rare occasions pregnant women, are taken into consideration.^[16]

Declaration. None.

Acknowledgements. We recognise the inputs of the SASS conference participants and the congress support from Gift of the Givers.

Author contributions. All authors contributed equally to the contents of the article and TCH managed the submission and corrections as needed

Funding. None.

Conflicts of interest. None.

1. Le Geyt J, Pach S, Gutiérrez JM, et al. Paediatric snakebite envenoming: Recognition and management of cases. *Arch Dis Child* 2021;106(1):14-19. <https://doi.org/10.1136/archdischild-2020-319428>
2. Müller GJ, Modler H, Wium CA, Veale DJH, Marks CJ. Snake bite in southern Africa: Diagnosis and management. *CME* 2012;30(10):362-382.
3. Pattinson JP, Oosthuizen G, Tilbury CR, Wood D. Chapter 40. Approaches to snake envenomation in Southern Africa. In: Mackessy SP (ed). *Handbook of Venoms and Toxins of Reptiles*. 2nd ed. London: CRC press, 2021.
4. Wagener M, Naidoo M, Aldous C. Wound infection secondary to snakebite. *S Afr Med J* 2017;107(4):315-319. <https://doi.org/10.7196/SAMJ.2017.v107i4.12084>
5. Variawa S, Buitendag J, Marais R, Wood D, Oosthuizen G. Prospective review of cytotoxic snakebite envenomation in a paediatric population. *Toxicon* 2021;190:73-78. <https://doi.org/10.1016/j.toxicon.2020.12.009>
6. Buitendag JJP, Variawa S, Wood D, Oosthuizen G. An analysis of paediatric snakebites in north-eastern South Africa. *S Afr J Surg* 2021;59(3): 97-101.
7. Patanowitz L, Guidozi F. Management of snake and spider bite in pregnancy. *Obstet Gyn Survey* 1996;51:615-620.
8. Wium L. Neurotoxic snake bite in pregnancy. *Obstet Med* 2021;14(3):187-189. <https://doi.org/10.1177/1753495X211019236>
9. Chu ER, Weinstein SA, White J, Warrell DA. Venom ophthalmia caused by venoms of spitting elapid and other snakes: Report of ten cases with review of epidemiology, clinical features, pathophysiology and management. *Toxicon* 2010;56(3):259-272. <https://doi.org/10.1016/j.toxicon.2010.02.023>
10. Pattinson JP, Kong VY, Bruce JL, et al. Defining the need for surgical intervention following a snakebite still relies heavily on clinical assessment: The experience in Pietermaritzburg, South Africa. *S Afr Med J* 2017;107(12):1082-1085. <https://doi.org/10.7196/SAMJ.2017.v107i12.12628>
11. Kingdom of eSwatini. National Snakebite Management Guidelines. eSwatini Antivenom Foundation, 2021.
12. Garfin SR, Castiliona RR, Mubarak SJ, Hargens AR, Russell FE, Akeson WH. Rattlesnake bites and surgical decompression: Results using a laboratory model. *Toxicon* 1984;22(2):177-182. [https://doi.org/10.1016/0041-0101\(84\)90018-7](https://doi.org/10.1016/0041-0101(84)90018-7)
13. Wood D, Sartorius B, Hiff R. Ultrasound findings in 42 patients with cytotoxic tissue damage following bites by South African snakes. *Emerg Med J* 2016;33(7):477-481. <https://doi.org/10.1136/emered-2015-205279>
14. Russell JJ, Schoenbrunner A, Janis JE. Snake bite management: A scoping review of the literature. *Plast Reconstr Surg Glob Open* 2021;9(4):e3506. <https://doi.org/10.1097/GOX.0000000000003506>
15. Gutiérrez JM, Escalante T, Hernández R, Gastaldello S, Saravia-Otten P, Rucavado A. Why is skeletal muscle regeneration impaired after myonecrosis induced by viperid snake venoms? *Toxins* 2018;10(5):182. <https://doi.org/10.3390/toxins10050182>
16. Pach S, Le Geyt J, Gutiérrez JM, et al. Paediatric snakebite envenoming: The world's most neglected 'neglected tropical disease'? *Arch Dis Child* 2020;105(12):1135-1139. <https://doi.org/10.1136/archdischild-2020-319417>

Accepted 2 May 2023.