



Viewpoint

National programme for prevention & control of snakebite in India: Key challenges & recommendations

Snakebite envenomation (SBE) is an acute, life-threatening, time-limiting, medical emergency affecting 1.8-2.7 million people with estimated 138,000 deaths annually across the globe¹. India contributes an average of 58,000 deaths annually². Similar to sub-Saharan Africa³, the magnitude of SBE is underestimated in South Asia⁴ and South-East Asia⁵. India is one of the world's most affected countries due to the large population engaged in agricultural activities, use of wattle and daub houses in snakebite-prone rural areas, several slum areas, presence of abundant venomous snakes and lack of community awareness regarding prevention and control of snakebites^{2,6,7}. In 2019, the World Health Organization (WHO) resolved to halve the global burden of snakebites by 2030⁸. India being a major contributor to the existing global burden of mortality⁵, efforts undertaken at the national and regional level would prove crucial in achieving the WHO targets 2030.

Although, standard treatment guidelines (STGs) for the management of snakebite were published in 2017⁹; the implementation of STG protocol remains very poor in public and private healthcare systems in India^{10,11}. Majority of the snakebites occur in rural/tribal areas with poor transportation facilities, especially during the night hours, thereby contributing to higher deaths¹². A national consultation meeting of all stakeholders was organized in New Delhi, India, in August 2022. The Ministry of Health and Family Welfare (MoHFW), Government of India (GoI), declared the launch of a national programme for prevention and control of SBE in the month of September 2022¹³. The launch of this dedicated national programme for snakebite by the Government of India is a welcome decision. In fact, India would be the first country in Asia to launch a national programme for prevention and control of snakebite. Based on our experience of snakebite

research in India, we summarize the challenges and recommend the strategies at three different levels, *i.e.* community, health system and policy level (Table).

Haffkine Institute in Mumbai, India, has been a pioneer in developing Indian polyspecific anti-venom since 1899¹⁴. The currently available anti-snake venom (ASV) in India is polyvalent. The polyvalent anti-venom is developed using venoms of big four venomous snakes *i.e.* common Indian cobra (*Naja naja*), common krait (*Bungarus caeruleus*), Russell's viper (*Daboia russelii*) and saw-scaled viper (*Echis carinatus*)¹⁵. The national programme should consider the diversity of venomous snake species and their toxins in different geographical regions in India. The available polyvalent anti-venoms do not neutralize the venom of certain species such as the hump-nosed pit viper (*Hypnale hypnale*). In addition, the effectiveness of polyvalent anti-venoms against the region-specific species such as Sochurek's saw-scaled viper (*Echis carinatus sochureki*) in Rajasthan and banded krait (*Bungarus fasciatus*) in West Bengal is questionable^{15,16}. Hence, the GoI should consider establishing region-specific venom banks and make provision for region-specific ASV during the process of implementation of the national snakebite programme. Another challenge is the non-compliance to the WHO standards and protocols for venom and anti-venom production. Hence, through the programme, it is essential to monitor whether ASV manufacturers adhere to the WHO's guidelines for the production, control and regulation of snake anti-venom immunoglobulins or not¹⁷. Reports suggest that a majority of the medical officers do not administer ASV due to the fear of adverse reactions including anaphylaxis^{6,9,10}. Also, significantly lower rates of adverse reactions are observed after the use of highly purified caprylic acid-stabilized IgG anti-venoms¹⁸.

Table. Key challenges at community, health system and policy level and recommended strategies for a national programme on prevention and control of snakebite in India

Key challenges	Recommended strategies
At the community level	
<ul style="list-style-type: none"> Lack of knowledge on venomous and non-venomous snakes, appropriate preventive measures⁶. Use of harmful methods (tourniquet, incision on bite area, etc.) as a first aid, superstitions, chanting of <i>mantras</i>, use of unproven herbal medicines⁶. Health-seeking behaviour-prefer to visit faith healers, <i>tantriks</i>, <i>Ozas</i>, <i>Sarpa Chikitsa</i>, etc.^{6,15}. 	<ul style="list-style-type: none"> Active engagement of forest department and herpetologists for identification and mapping of circulating venomous and non-venomous snakes in a specific geographical region. Community empowerment and active engagement of community leaders, religious leaders and school teachers to increase awareness on prevention, first aid and early transport of snakebite patients to the nearest health facility. Adequate training must be provided to the traditional healers to identify red flags in snakebite victims that require urgent referrals to healthcare facilities. Traditional healers along with the key community persons like the <i>Sarpanch</i> (head of the village), the school teachers, <i>gram sevak</i> (government representative in the village) and village elders form an important influencing group. Awareness programmes conducted by them would be better accepted.
At the health system level	
<ul style="list-style-type: none"> No attention paid to snakebite in the medical curriculum. No exposure to snakebite treatment during internship. MOs in State health services have no experience of snakebite management^{9,10}. No uniform protocol followed for snakebite treatment^{9,10}. MOs at PHC, CHC do not have confidence of ASV administration, fear of anaphylaxis^{6,9,10}. Lack of life support skills¹⁵. Irrational use of the intradermal ASV test leading to wastage of precious ASV³³. ASV intradermal skin test recommended by ASV manufacturers³⁴. 	<ul style="list-style-type: none"> To include snakebite management in the curriculum of training institutions of the State public health departments. Periodic training of MOs in PHCs, CHCs as per the latest national snakebite management protocol. Empowerment of frontline healthcare providers (ASHA, ANM, MPW) on prevention, first aid and timely referral for management of SBE. Mandatory short-term training of medical graduates during internship and as a part of the induction training on joining as MOs in the State health services. Training of nurses on treatment of snakebite with emphasis on ASV administration. ASV manufacturers in India (public and private sector) should immediately revise the ASV insert and remove the recommendation on ASV intradermal skin testing. To ensure safe, adequate supply of ASVs and other emergency medicines required for snakebite management.
At the policy level	
<ul style="list-style-type: none"> Huge gap between number of snakebite deaths reported from direct surveys and hospital-based data¹⁵. Snakebite is not a notifiable disease. The existing guidelines of MJPJAY+PMJAY provide Rs. 50,000 for snakebite patients requiring ventilator support. Patients who do not need ventilator support are excluded from getting the benefit of MJPJAY + PMJAY leading to extensive financial burden. SBE disproportionately affects the rural populations, migrant workers and people engaged in agriculture³². Long-term complications occur in around 15 per cent of survivors (musculoskeletal deformities, amputations, visual impairment, chronic kidney disease, paralysis and disability and psychological health consequences)^{9,32} 	<ul style="list-style-type: none"> Making the disease notifiable would further help to identify hotspots for SBE and directed attempts to reduce the incidence and mortality in these hotspots can be made. Online data entry of snakebite cases into a dedicated snakebite portal. Revision of policy to include all patients of SBE for free of cost treatment in all healthcare facilities (public and private hospitals). Financial assistance for deaths due to SBE. Directed efforts in states with high proportion of vulnerable population and high caseload will ensure effective administration and would help in cutting the cost of implementation in the whole country. States with high proportion of vulnerable population but low caseload should be empowered with robust surveillance systems to counter underreporting. Psychological counselling of family members of snakebite victims. Rehabilitation centre for management of snakebite related complications. Referral linkages to be established between PHCs, CHCs and tertiary care hospitals for transfer of critical patients who require higher-level management.

MOs, medical officers; MJPJAY, Mahatma Jyotiba Phule Jan Arogya Yojana; PMJAY, Prime Minister Jan Arogya Yojana; PHCs, primary health centres; CHCs, community health centres; ASHA, Accredited Social Health Activist; ANM, auxiliary nurse midwife; MPW, multipurpose worker; ASV, anti-snake venom; SBE, snakebite envenomation

Therefore, there is a need to conduct a detailed pre-clinical evaluation of the efficacy of the current as well as newer anti-venoms. These attempts may help to reduce the time of recovery, total dose of ASV required to neutralize the circulating venom and to improve the ASV's safety profile.

Non-availability or limited availability of ASV has been previously reported in India^{9,19,20}. Currently, there are eight Indian manufacturers for ASV with a total installed capacity of 6,752,000 vials per annum²¹ while, the installed capacity of government-owned ASV manufacturers is only 460,000 vials/annum (6.8%). However, only 1.5-2 million vials of ASV are produced every year in India²²⁻²⁴. Therefore, the union and State governments should ensure that sufficient doses of ASV are produced and made available in both public and private hospitals. There is a need for regular monitoring of ASV availability and utilization through the national programme.

Manufacturing of anti-venoms in India is equine based²². Therefore, another aspect to consider during manufacturing and testing is to safeguard equine health. The GoI issued the amended protocol for the use of equines for production of hyperimmune sera (ASVS) in 2005 that sets out clear rules pertaining to their age and weight, bleeding schedule and amount of blood to be collected and their rehabilitation after use²⁵. The national programme should provide for mechanisms to ensure ethical treatment of the equine and to improve the process of harvesting equine sera in the most productive ways. A coordinating centre at the national level is hence required for framing guidelines and policies, managing snakebite mortality and morbidity database, ensuring quality controls, following ethical obligations and, monitoring and evaluation of the snakebite programme. The government should appoint experts on snakebite management as programme managers of such a centre at national and State levels. A physician with experience in snakebite management should be designated as Neglected Tropical Diseases Officer in each district of the high burden States such as Bihar, Jharkhand, Uttar Pradesh, Andhra Pradesh, Telangana, Odisha, Maharashtra, Madhya Pradesh, Rajasthan and Gujarat. Periodic policy inputs and research should also be an integral part of the programme. There is also a need to establish a dedicated snakebite clinical research cum training centre (SCRTC) in one of the high burden States such as Maharashtra where both clinical expertise in snakebite treatment and, clinical

and public health research expertise on snakebite are available^{6,10,11,26-29}. A periodic review of the challenges and shortcomings of STGs needs to be conducted for evidence-based update on management of SBE. An underestimation of the snakebite morbimortality due to reliance on hospital based data is another challenge. Making snakebites notifiable in the national programme can aid in gauging the actual burden. These activities can be coordinated through the SCRTC.

Another point is that, presently SBE is not included in the medical graduation (MBBS) curriculum and no attention is paid to the diagnosis and management of SBE during the internship of MBBS doctors. Through the proposed national programme on snakebite, teaching activities in medical and nursing colleges may be undertaken and regular training programmes for doctors and nurses, especially in regions of high incidence of snakebites may be organised. The evaluation of baseline knowledge and improvement after training may also be assessed for medical officers and frontline health workers. Training materials and culturally appropriate information, education and communication strategies may be adopted to disseminate to public health facilities all over India. The long-term goal of the programme should be to establish Model Snakebite Management Centre at a community health centre, District Hospital, in the high-burden States.

In India, nearly 70 per cent the population lives in rural areas and depends on agriculture, hunting, fishing, forestry and poultry for livelihood³⁰. Therefore, humans and livestock in rural areas are vulnerable to snakebites. Along with the burden on human population, snakebite also causes heavy economic losses by affecting the domestic animals and livestock population⁶. The case fatality rate due to snakebites in livestock is reportedly as high as 47 per cent³¹. Hence, a collaboration between human and veterinary health systems, as recommended by the WHO's 'One Health' model, should be sought to bring out a coherent change³². There is a need for integrating the national snakebite prevention and control programme with institutions such as National Institute of One Health and other institutions of human and veterinary medicine at State as well as central levels.

The communities affected by snakebites are often those with the least access to healthcare services and treatment. Hence, flexible policies should be designed to accommodate the geographical and cultural diversity of India. Herpetologists, forest department officials,

Panchayat officials, village elders and other influential people along with tribal residential school teachers should be an integral part of the process to implement best practices and policies at the local level. Community engagement at every level of decision-making and implementation warrants decentralization of power and finances.

The plan of action for the prevention and control of snakebites in India should be considered as per the objectives of the WHO strategy for the prevention and control of snakebite envenoming³². To develop a national programme that engages communities, ensures safe and effective treatment, builds health system capacity and promotes intersystem collaborations for reducing the impact of snakebite envenoming in the Indian population is, therefore, most crucial. Such a programme will play a major role in reducing the mortality and morbidity in India, thereby achieving the targets of WHO 2030.

Financial support & sponsorship: None.

Conflict of Interest: None.

Rahul K. Gajbhiye¹, Hrishikesh Munshi¹ & Himmatrao S. Bawaskar^{2,*}

¹Department of Clinical Research Laboratory, ICMR-National Institute for Research in Reproductive & Child Health, Mumbai 400 012 & ²Bawaskar Hospital & Clinical Research Centre, Mahad 402 301, Maharashtra, India

*For correspondence:
himmatraobawaskar@gmail.com

Received November 23, 2022

References

- Gutiérrez JM, Calvete JJ, Habib AG, Harrison RA, Williams DJ, Warrell DA. Snakebite envenoming. *Nat Rev Dis Primers* 2017; 3 : 17063.
- Suraweera W, Warrell D, Whitaker R, Menon G, Rodrigues R, Fu SH, *et al.* Trends in snakebite deaths in India from 2000 to 2019 in a nationally representative mortality study. *Elife* 2020; 9 : e54076.
- Farooq H, Bero C, Guilengue Y, Elias C, Massingue Y, Mucopote I, *et al.* Snakebite incidence in rural sub-Saharan Africa might be severely underestimated. *Toxicon* 2022; 219 : 106932.
- Alirol E, Sharma SK, Bawaskar HS, Kuch U, Chappuis F. Snake bite in South Asia: A review. *PLoS Negl Trop Dis* 2010; 4 : e603.
- Roberts NLS, Johnson EK, Zeng SM, Hamilton EB, Abdoli A, Alahdab F, *et al.* Global mortality of snakebite envenoming between 1990 and 2019. *Nat Commun* 2022; 13 : 6160.
- Chaaithanya IK, Abnave D, Bawaskar H, Pachalkar U, Tarukar S, Salvi N, *et al.* Perceptions, awareness on snakebite envenoming among the tribal community and health care providers of Dahanu block, Palghar District in Maharashtra, India. *PLoS One* 2021; 16 : e0255657.
- Longbottom J, Shearer FM, Devine M, Alcoba G, Chappuis F, Weiss DJ, *et al.* Vulnerability to snakebite envenoming: A global mapping of hotspots. *Lancet* 2018; 392 : 673-84.
- Minghui R, Malecela MN, Cooke E, Abela-Ridder B. WHO's Snakebite Envenoming Strategy for prevention and control. *Lancet Glob Health* 2019; 7 : e837-8.
- Standard Treatment Guidelines on the Management of Snake Bites. Ministry of Health & Family Welfare, Government of India; 2017. Available from: https://nhm.gov.in/images/pdf/guidelines/nrhg-guidelines/stg/Snakebite_Full.pdf, accessed on December 28, 2022.
- Gajbhiye R, Khan S, Kokate P, Mashal I, Kharat S, Bodade S, *et al.* Incidence & management practices of snakebite: A retrospective study at Sub-District Hospital, Dahanu, Maharashtra, India. *Indian J Med Res* 2019; 150 : 412-6.
- Gajbhiye RK, Chaaithanya IK, Munshi H, Prusty RK, Mahapatra A, Palo SK, *et al.* National snakebite project on capacity building of health system on prevention and management of snakebite envenoming including its complications in selected districts of Maharashtra and Odisha in India: A study protocol. *PLoS One* 2023; 18 : e0281809.
- Bawaskar HS, Bawaskar PH, Punde DP, Inamdar MK, Dongare RB, Bhoite RR. Profile of snakebite envenoming in rural Maharashtra, India. *J Assoc Physicians India* 2008; 56 : 88-95.
- Dr. Mansukh Mandaviya Chairs 7th Meeting of Mission Steering Group for NHM. Press Information Bureau. New Delhi; 2022. Available from: <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1857490>, accessed on June 10, 2022.
- Gutiérrez JM, Maduwage K, Iliyasu G, Habib A. Snakebite envenoming in different national contexts: Costa Rica, Sri Lanka, and Nigeria. *Toxicon: X* 2021; 9-10 : 100066
- Chakma JK, Menon JC, Dhaliwal RS, Indian Council of Medical Research. White paper on venomous snakebite in India. *Indian J Med Res* 2020; 152 : 568-74.
- Ghosh S, Mukhopadhyay P, Chatterjee T. Management of snake bite in India. *J Assoc Physicians India* 2016; 64 : 11-4.
- World Health Organization. Expert Committee on Biological Standardization. *WHO Guidelines for the Production, Control and Regulation of Snake Antivenom Immunoglobulins*. Available from: <https://www.who.int/publications/m/item/snake-antivenom-immunoglobulins-annex-5-trs-no-1004>, accessed on December 28, 2022.
- Rojnuckarin P. Clinical uses of snake antivenoms. In: Gopalakrishnakone P, Faiz A, Fernando R, Gnanathanan

- CA, Habib AG, Yang CC, editors. *Clinical toxinology in Asia Pacific and Africa*. Dordrecht: Springer Netherlands; 2015. p. 437-52.
19. Bawaskar HS. Snake venoms and antivenoms: Critical supply issues. *J Assoc Physicians India* 2004; 52 : 11-3.
 20. Ralph R, Sharma SK, Faiz MA, Ribeiro I, Rijal S, Chappuis F, *et al*. The timing is right to end snakebite deaths in South Asia. *BMJ* 2019; 364 : k5317.
 21. Ministry of Health & Family Welfare, Government of India. *Steps taken to reduce deaths due to snake bites*. Available from: <https://pqars.nic.in/annex/258/AS70.pdf>, accessed on December 28, 2022.
 22. Whitaker R, Whitaker S. Venom, antivenom production and the medically important snakes of India. *Curr Sci* 2012; 103 : 635-43.
 23. Ministry of Health & Family Welfare, Government of India. *National Health Profile (NHP) of India-2021*. Available from: <https://www.cbhidghs.nic.in/showfile.php?lid=1160>, accessed on December 28, 2022.
 24. Pashudhan Praharee. *Snake venom production for antivenom in India*.; Available from: <https://www.pashudhanpraharee.com/snake-venom-production-for-antivenom-in-india/>, accessed on December 28, 2022.
 25. Ministry of Environment & Forests (Animal Welfare Division), Government of India. *Amendments in the protocol for use of equines for production of hyper immune sera (ASVS)*. Available from: <https://cpcsea.nic.in/WriteReadData/userfiles/file/Amenment%20in%20Equine%20guidelines.pdf>, accessed on December 28, 2022.
 26. Bawaskar HS, Bawaskar PH, Bawaskar PH. The global burden of snake bite envenoming. *J R Coll Physicians Edinb* 2021; 51 : 7-8.
 27. Bawaskar HS. Snake bite poisoning: A neglected life-threatening occupational hazard. *Indian J Crit Care Med* 2014; 18 : 123-4.
 28. Kalantri S, Singh A, Joshi R, Malamba S, Ho C, Ezoua J, *et al*. Clinical predictors of in-hospital mortality in patients with snake bite: A retrospective study from a rural hospital in central India. *Trop Med Int Health* 2006; 11 : 22-30.
 29. Punde DP. Management of snake-bite in rural Maharashtra: A 10-year experience. *Natl Med J India* 2005; 18 : 71-5.
 30. Office of the Registrar General and Census Commissioner, India (ORGI). *Census of India 2011-rural urban distribution of population*. Available from: <http://file:///C:/Users/drhsm/Downloads/Census%20of%20India%202011-Rural%20Urban%20Distribution%20of%20Population.pdf>, accessed on December 28, 2022.
 31. Bolon I, Finat M, Herrera M, Nickerson A, Grace D, Schütte S, *et al*. Snakebite in domestic animals: First global scoping review. *Prev Vet Med* 2019; 170 : 104729.
 32. World Health Organization. *Snakebite envenoming: A strategy for prevention and control*. Geneva: WHO; 2019. p. 70.
 33. Chaaithanya IK, Salvi N, Bhoje P, Bhorekar S, Yadav A, Mahale S, *et al*. Anti-snake venom (ASV) intradermal skin test, a common clinical practice in the primary health care setting in tribal block of Dahanu, Maharashtra, India. *J Assoc Physicians India* 2020; 68 : 87-8.
 34. Gajbhiye RK, Bawaskar H, Yadav A, Mahale S. *A model for addressing Burden of snakebites in rural India through health system capacity building, policy brief; February, 2020*. Available from: https://www.researchgate.net/publication/342708249_A_Model_for_addressing_burden_of_Snakebites_in_rural_areas_through_Health_System_Capacity_building, accessed on January 18, 2023.