

ICMR research initiatives for prevention and control of snakebite envenomation in India

Rahul K Gajbhiye^{1,2*}, Joy Kumar Chakma²

¹ ICMR-National Institute for Research in Reproductive and Child Health, Mumbai, Maharashtra

² Model Rural Health Research Unit (MRHRU), Vani, District Nashik, Maharashtra, India 422215

*Corresponding author

Dr. Rahul K Gajbhiye

Scientist E & Head

DBT Wellcome Trust India Alliance Clinical and Public Health Intermediate Fellow

Department of Clinical Research Laboratory

ICMR-National Institute for Research in Reproductive and Child Health, Mumbai, India

Nodal Officer, MRHRU, Vani, District Nashik, Maharashtra

Email: gajbhiyer@nirrch.res.in



Abstract

Snakebite envenoming (SBE) is one of the major public health issues in India. SBE is an acute life-threatening emergency affecting mainly rural and tribal population. There is a paucity of data on incidence, mortality and morbidity of SBE in different geographical regions in India. The studies funded by Tribal Health Research Forum and National Task Force of Indian Council of Medical Research, demonstrated reduction in case fatality rate due to SBE. The efforts of ICMR also focused on community empowerment and capacity building of healthcare system in alignment with WHO strategy. With the strong commitment and coordination of various stakeholders, the WHO goals of 2030 are achievable.

Keywords: Snakebite, Envenomation, Prevention

Introduction

Snakebite burden in India

Snakebite envenoming (SBE) is an important health issue causing 81000 to 137000 deaths from 1.8 - 2.7 million cases globally.^[1] Apart from mortality, SBE causes permanent physical or psychological disabilities in nearly 400,000 people every year.^[2] Mainly, the farmers, agricultural labours, migratory population, tribes, hunters, and often earning members of their families are affected. This is compounded by non-scientific first aid, delayed health access, and suboptimal treatment contributing to poor outcomes.^[3] India alone contributes to half of the global burden of snakebites with ~ 58,000 deaths per year.^[4] Since snakebite is not a notifiable disease in India, the burden of snakebite is likely to be underestimated. A study from West Bengal reporting that only 7.2% of snakebite deaths were officially reported suggesting the discrepancy between SBE deaths reported by population based survey and hospital data.^[5]

The National mortality survey (2001-2003), reported mortality between 45,000 to 50,000 every year in India.^[4] This study also reported higher annual age-standardized mortality rates per 100,000 populations due to snakebite in 13 states: Andhra Pradesh (6.2), Madhya Pradesh (5.9), Odisha (5.6), Jharkhand (4.9), Bihar (4.9), Tamil Nadu (4.7), Uttar Pradesh (4.6), Chhattisgarh (4.4), Karnataka (4.2), West Bengal (3.5),

Gujarat (3.5), Rajasthan (3.3), and Maharashtra (3.0).^[4] Jharkhand and Odisha had higher deaths reported in the age group of 5–14 years. However, states like Andhra Pradesh, Bihar, Madhya Pradesh, and Uttar Pradesh reported SBE deaths higher in older age groups. It was observed that deaths due to SBE were higher in females in states like Bihar, Madhya Pradesh, Maharashtra, and Uttar Pradesh.^[4] Another study reported the highest absolute number of SBE deaths in 2019 at 51,100 deaths (95% UI 29,600–64,100).^[6] The study reported a decline in the age-standardized rate of death due to SBE from 7.3 per 100,000 (4.1–8.8) in 1990 to 4.0 per 100,000 (2.3–5.0) in 2019. The age-standardized death rates in Chhattisgarh, Uttar Pradesh, and Rajasthan were 6.5 deaths (3.5–8.4), 6.0 deaths (2.6–8.0), and 5.8 deaths (3.5–7.4) per 100,000, respectively. Among all the Indian states, the highest number of deaths were reported in Uttar Pradesh in 2019 [12,000 deaths (5230–16,100)]^[6]. During 2001–2014, the mean age-standardized SBE death rate in the Indian population was 4.8 per 100,000 population.^[7]

Out of the total 300 species of snakes that are found in India; nearly 60 species are categorised as venomous. *Daboia russelii* (Russell's viper), *Naja naja* (common Indian Cobra), *Bungarus caeruleus* (common krait) and *Echis carinatus* (saw-scaled viper) are distributed throughout the country and are responsible for most cases of envenoming, morbidity and mortality.^[8] The

only scientifically proven treatment for venomous snakebite is Anti-snake venom (ASV) which is produced by raising antibodies against snake venom in horses.

ICMR-NIRRH research on snakebite

The genesis of the snakebite research in ICMR-NIRRH was learnings from Model Rural Health Research Unit (MRHRU) Dahanu, Maharashtra. While establishing Maharashtra's first MRHRU in Dahanu, District Palghar, the burden of SBE and key knowledge gaps in snakebite research were identified in 2013. Snakebite envenomation was reported as a major public health problem in the tribal block of Dahanu with the case fatality rate as high as 4.5%.^[9]

The National Snakebite Management Protocol was released in 2009.^[10] However, there was no awareness of the national protocol, and medical officers did not receive any formal training for snakebite management as per Snakebite Management Protocol.^[9] Therefore, medical officers did not follow the national protocol for the management of snakebites. ASV intradermal skin test was practiced by the medical officers and ASV was given in cases of non-venomous snakebites leading wastage of precious ASV.^[11] To address these gaps, an implementation research project was conducted in Dahanu block of Palghar, Maharashtra. The study focused improving the community awareness and capacity building of healthcare system. The study was funded by the Tribal Health Research Forum of ICMR and received mentoring support from Dr. Vishwa Mohan Katoch, former Secretary, Department of Health Research and former Director General, ICMR. Dr. Himmatrao Bawaskar, a national expert and internationally recognized researcher on snakebite prevention, diagnosis, and management provided support for the capacity building of healthcare system in Dahanu block, Maharashtra. In early 2016, ICMR co-facilitated development of an Indian guideline on the management of snakebite. These guidelines covered critical issues in clinical diagnosis and management of snakebite including symptoms and signs of envenomation, first aid, transport and referral criteria, dose of ASV, anaphylactic reactions and complications. The guidelines also covered snakebite management in at PHC, CHC and also at tertiary health care facility. These guidelines were developed with an aim of covering management of SBE in all populations and age groups including pregnant women and children. These standard treatment guidelines were then released by Ministry of Health and Family Welfare in 2017.^[12]

In Dahanu, we conducted a facility assessment to understand ASVs distribution and utilization. Interviews of frontline healthworkers (ANMs, MPWs)

and doctors were conducted for documenting their knowledge of SBE.^[3] Focus group discussions were conducted for the communities and the traditional healers to understand their perspective in developing awareness materials.^[3] As a part of the study, we developed the educational materials, including the posters, training manuals in regional language (Marathi). IECs were distributed in all healthcare facilities [sub centre, PHCs, Rural Hospital (RH), Sub District Hospital (SDH)], Anganwadi, Community centres, schools including tribal residential schools, Gram Panchayats etc. Copies of Snakebite Treatment Guidelines (STG), 2017 and Training manuals were provided to all PHCs, RH and SDH in Dahanu block. Community awareness programmes on prevention, first aid and treatment of SBE were conducted with the help of local politicians, religious leaders and state health workers. Intense training of medical officers was conducted as per STG 2017 in Dahanu block by Dr. Himmatrao Bawaskar, one of the leading experts who developed national snakebite treatment protocol (STG, 2017). Training was provided to Sarpamitra (snake rescuers), ANMs, ASHA, MPWs and Tantrics in Dahanu block. These interventions led to drop in mortality rate from 4.5% to 0.4%.^[3]

WHO included SBE in the list of neglected tropical diseases in 2017.^[14] In 2019, WHO gave a roadmap for achieving the reduction of 50 % mortality and morbidity by the year 2030.^[15] The WHO strategy is focused on prevention; availability of safe and effective treatment; empowering the health systems; and improved linkages, coordination, and resources. One of the important components of WHO strategy is the empowerment of the community through awareness and education. The development of anti-venom, availability and affordability of anti-venoms are also incorporated in the WHO strategy.^[15,16]

Much before the World Health Assembly (WHA) resolution (2017) and WHO strategy (2019) to combat snakebite, Department of Health Research and ICMR-Tribal Health Research Forum funded an implementation research study on SBE in tribal block of Dahanu, Maharashtra. From 2013 onwards, ICMR initiated research programmes for a) generating evidence on the burden of snakebite and strengthening surveillance, prevention, treatment programme; b) training of healthcare workers on the prevention, diagnosis and treatment of SBE as per national snakebite protocol; c) supporting research on snakebite envenoming, particularly implementation research and d) promoting community awareness of snakebite envenoming, through culturally appropriate IECs and encouraging community participation in increasing awareness and prevention efforts in India.

ICMR National Task Force on snakebite research

ICMR had set up a Task Force on Venom Research in 2014 and which accomplished six projects under the Division of Basic Medical sciences (BMS). This Task Force was reconstituted as “ICMR-National Task Force for Research on Snake Bite in India” in August 2019 to look into the following focus areas for research:

1. Prevalence study including mapping of hotspots of Snake Bite in India, type of snake involved, outcomes, and risk factors.
2. Prevention of Snake Bite and its mortality and morbidity
3. Provision of Anti-venom, essential drugs and facilities at PHCs
4. Health system strengthening through training of doctors and paramedics of PHCs and CHCs on Standard Treatment Guidelines for the Management of Snake Bite, MoHFW (2016) and National Snakebite Management Protocol (India), 2009.
5. Basic and translational research on Snake Venom
6. Development of diagnostics and therapeutics of snakebite

The ICMR National Task Force (NTF) recommended two national projects on snakebite. These snakebite research projects were included in the priority research areas under Honorable Prime Ministers vision 2022 and thereafter.

1. Nationwide Study to estimate incidence, mortality, morbidity and economic burden due to snakebite in India.

This project is being conducted covering 14 states, 39 districts, and 372 blocks covering nearly 7% of Indian population. This study is expected to generate comprehensive epidemiological data and evidence on the actual burden on health and socio-economic fallout due to snakebites and also gaps in the health system in the timely referral and management of venomous snakebites. It is also expected to generate information on hotspot of venomous snakebites and bites by different species.^[17]

2. ICMR National Snakebite Project (INSP) on capacity building of health system on prevention and management of snakebite envenomation including its complications

The ICMR National Snakebite Project (INSP) was carried out in Shahapur block of Thane district in Maharashtra, Aheri block of Gadchiroli district in

Maharashtra, Khordha block of the Khordha district in Odisha and Kasipur block of the Rayagada district in Odisha. The study will be useful for providing inputs for National Snakebite Management Protocol relevant to public health system taking into consideration regional differences in India. The two-year implementation research involves collection of retrospective data collection, community focus group discussions, facility check survey, training of doctors, interviews of frontline healthcare workers, development of comprehensive culturally appropriate IEC material in local languages, capacity building of public health care system.^[1] The outcome of the study will be reduction in case fatality rate due to SBE in study areas. The study will empower the community and health system for prevention and improved management of snakebites in selected regions in India. The results of the study will be crucial for establishing centres of excellence for snakebite management.

IEC materials & technical support to state governments

SBE often affects people living in rural and tribal areas mainly engaged in hunting, farming and other agricultural activities.^[15] Majority of the snakebite victims visit the traditional faith healers, tantrics. Therefore, providing education to the community is very important so that there is a change in health seeking behaviour of the community. Most of these deaths are preventable and therefore conducting community awareness programmes on prevention and first aid and treatment of snakebite is extremely important. Simple, cost effective preventive measures can prevent a snakebite. We developed the culturally appropriate educational and awareness materials in regional languages through the INSP project, and these educational and awareness materials will be useful for the states having high burden of snakebites in India. Flow chart on the management of snakebite at PHC and CHC was developed by the expert group of ICMR NTF study. Snakebite information brochures for community are developed. IEC posters on knowledge, prevention, and first aid of snakebite are developed. Training manuals covering information on venomous and non-venomous snakes, prevention, first aid, treatment of SBE etc. are developed for ASHAs, ANMs, MPWs and other healthcare workers. The training booklet of health care workers, MO flow chart, snake identification chart, snakebite awareness posters and snakebite brochures are available online.

ICMR-NIRRH is providing technical support on snakebite management training for Maharashtra and Odisha states through the ICMR National task force study. Training of ASHAs on prevention and, first aid of SBE was conducted nationwide through the ICMR NTF

study. Majority of the medical officers in PHCs and CHCs do not have confidence and experience of ASVs administration as a result, the snakebite patients are not managed at PHC and CHCs and are referred to higher centres leading to delay in ASV administration and death of snakebite patients during transportation. The community empowerment through culturally appropriate IECs, capacity building of health system and implementation of Standard Treatment Guidelines (STG, 2017) for snakebite treatment will help in improving the outcomes with reduction in deaths due to snakebite in India.

Snakebite research to Policy and National programme

The results of the MRHRU Dahanu study were published in national and international journals. Based on the publications, a policy brief was prepared to highlight the policy issues that need urgent attention by the state, central government and ASV manufacturers. This policy brief was released by Dr Harsh Vardhan, the then Honourable Union Health Minister, Government of India on 20th February 2020 at Mumbai. An Earlier study conducted through MRHRU Dahanu revealed the unnecessary practice of ASV intradermal test being carried out by Medical Officers^[9,11] and also that the ASV manufacturers recommended this practice in their ASV vial inserts.^[13] This issue was brought to light of the Public Health Department, Government of Maharashtra and Managing Director Haffkine Biopharma, Mumbai. The copy of the policy brief was sent to the ASV manufacturers and other relevant stakeholders. An article was published to discuss issues responsible for high mortality and morbidity due to SBE and the article also provided policy recommendations for improving quality of venom and anti-snake venom, prevention of SBE etc.^[8]

To further develop strategies to counter the rising burden of snakebites in India, authors (RG and JC) along with other experts were invited for a policy talk by the NITI Aayog on 19th May 2022. We outlined the need to develop a national programme for snakebite management in India that should not only encompass all the proved components of snakebite prevention and management but also take in to account all the regional variations across the high burden states and most affected populations in India. To deal with the underreporting of cases at health facilities, we advocated for notification of snakebite cases and deaths in India and strengthening of the Standard Treatment Guidelines (STG, 2017) for snakebite management issued by the Government of India.

The national consultation meeting of all stakeholders was organized at New Delhi, India in August 2022.

During the meeting, it was decided to launch a national programme for prevention and control of snakebite envenomation.^[18] Based on our experience, we provided a detailed guidance on components of national programme for prevention and control of snakebite envenomation in India.^[19] The National Consultation meeting was organised by National centre for Disease Control (NCDC) in July 2022 for drafting a National Action plan for Prevention and Control of Snakebite Envenoming (NAP-SE). Subsequently, a National conclave was organised in October 2023 for endorsement of NAP-SE by various stakeholders. For effective implementation of the NAP-SE, a strong commitment and coordination is required at different levels specifically NCDC, Ministry of Health and Family Welfare, Government of India, Department of Health Research, Indian Council of Medical Research, NITI Aayog, and State Health Authorities all over India. Through the combined efforts of various stakeholders including ICMR, NCDC, MOHFW, WHO, the mortality and morbidity due to SBE can be reduced as per the WHO goal of 2030.

Acknowledgment

Dr V M Katoch, Dr Balram Bhargava, Dr Soumya Swaminathan, Dr Rajiv Bahl, Dr R S Dhaliwal, Dr Smita Mahale, Dr Geetanjali Sachdeva, Dr Himmatrao Bawaskar, Dr Hrishikesh Munshi and members of ICMR National Task Force on snakebite are sincerely acknowledged.

Conflicts of Interest

No conflicts to declare.

References

1. 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.
2. Gutiérrez JM, Calvete JJ, Habib AG, Harrison RA, Williams DJ, Warrell DA. Snakebite envenoming. *Nat Rev Dis Primers* 2017; 3: 17063.
3. 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.
4. Mohapatra B, Warrell DA, Suraweera W, Bhatia P, Dhingra N, Jotkar RM, et al. Snakebite Mortality in India: A Nationally Representative Mortality Survey. *PLOS Neglected Tropical Diseases* 2011; 5: e1018.

5. Majumder D, Sinha A, Bhattacharya SK, Ram R, Dasgupta U, Ram A. Epidemiological profile of snake bite in south 24 Parganas district of West Bengal with focus on underreporting of snake bite deaths. *Indian J Public Health* 2014; 58: 17–21.
6. Roberts NLS, Johnson EK, Zeng SM, Hamilton EB, Abdoli A, Alahdab F, et al. Global mortality of snakebite envenoming between 1990 and 2019. *Nature Communications* 2022; 13: 6160. [Available from: <https://doi.org/10.1038/s41467-022-33627-9>].
7. 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.
8. 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.
9. 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.
10. National snakebite management protocol. India: Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India. 2009. [Available from <http://statehealthsocietybihar.org/nationalsnakebitemanagementprotocol.pdf>, accessed on July 16, 2023].
11. 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–
12. Standard Treatment Guidelines. Management of Snakebite. National Health Systems Resource centre; 2017. [Available from: <https://nhsrcindia.org/sites/default/files/2021-05/Management%20of%20Snake%20Bite.pdf>, accessed on July 16, 2023].
13. Gajbhiye R, HimmatraoBawaskar, Yadav A, Mahale S. A Model for addressing burden of Snakebites in rural areas through Health System Capacity building. Policy brief, 2020. [Availablefrom:<https://nirrh.res.in/wp-content/uploads/2021/08/Snakebite-Dr-R-Gajbhiye.pdf>, accessed on July 16, 2023].
14. Burki T. Resolution on snakebite envenoming adopted at the WHA. *Lancet* 2018; 391: 2311.
15. Lancet T. Snakebite—emerging from the shadows of neglect. *The Lancet* 2019; 393: 2175.
16. Minghui R, Malecela MN, Cooke E, Abela-Ridder B. WHO’s Snakebite Envenoming Strategy for prevention and control. *The Lancet Global Health* 2019; 7: e837–8.
17. Menon JC, Bharti OK, Dhaliwal RS, John D, Menon GR, Grover A, et al. ICMR task force project-survey of the incidence, mortality, morbidity and socio-economic burden of snakebite in India: A study protocol. Soto-Blanco B, editor. *PLoS ONE* 2022; 17: e0270735.
18. 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 July 16, 2023].
19. Gajbhiye R, Munshi H, Bawaskar H. National programme for prevention & control of snakebite in India: Key challenges & recommendations. *Indian J Med Res* 2023; 0: 0.