Snakebite and snake identification: empowering neglected communities and health-care providers with AI

With estimates of 81 410–137 880 deaths and 400 000 cases of disability globally every year,[1,2] snakebite envenoming needs urgent attention. WHO launched a road map in May, 2019, and by 2030 hopes to see three million effective treatments produced annually and to halve snakebite-associated deaths and disabilities.[1] Yet, before treating snakebite envenoming, there are fundamental questions: which species of snake has bitten the victim, what are the probable outcomes, and how can we intervene to improve the prognosis? These factors are central to understanding snakebite epidemiology.

Globally there are over 3700 snake species, 650 of which are venomous, and of these 250 are medically important.[1] Presumption of the identity of the biting species can result in inappropriate use of antivenoms, which are in scarce supply, costly, and can have side-effects.[3] Giving correct snake taxonomic attribution can improve epidemiological data and the specific coverage of antivenoms against species that occur in given regions and inform selection and use of appropriate antivenoms. In some settings, people who have suffered a snake bite or bystanders will either describe the biting snake, or even capture or kill it, creating additional risk to those involved[4] and potentially affecting the ecology of snake populations. But health-care providers, not being snake experts, often struggle to identify the snake and its misidentification can lead to inadequate management of the victim.[4] Given that snakebite envenoming is an acute emergency, the ability to rapidly select appropriate treatment (eg, antivenom, ventilatory support) and administer it is paramount.[4] Although immunoassays and molecular tools have been developed to identify some snakes, they have limitations (eg, cost, need for technicians, and poor specificity) and are currently only used in Australia and Papua New Guinea.[4,5] Rapid diagnostic tests are emerging, although none have yet been marketed, and their effective deployment in low-income and middle-income countries remains to be seen.[5] Currently, a syndromic approach is widely used to manage snakebite envenoming, which can also help to infer the identity of the biting snake, but this strategy has limitations.[4]

The rapid growth in smartphone use and Internet penetration in low-income and middle-income countries, as well as the availability of artificial intelligence (AI)-based animal identification techniques,[6] provide opportunity for snake identification from photos. For instance, the popular ornithology app Merlin Bird ID recognises more than 3000 American and European birds. If applied to snakes, this technology could improve our knowledge of their global diversity and abundance, particularly in countries where snake bites are a concern. For health workers and patients, this technology has potential to improve identification of biting species, facilitating access to, and appropriate stocking of effective antivenoms, and guiding better treatment by building profiles of endemic snake fauna and their clinical syndromes. The AI revolution in health care should embrace neglected communities who are affected by snakebite with a precision public health approach,[7] going beyond applications in high-income countries that target a few diseases. We have an opportunity to empower communities at risk of snakebite and health-care providers with AI, while building knowledge in snake biology and ecology and capacity to manage snakebite at all levels (eg, from the field, where snake bites occur, to the health facility level, where the victim is treated). Communities at risk are at the frontline and can participate in snake identification directly or indirectly by gathering and sharing data such as snake photos, location, and type of habitat. Additionally, snake experts, who provide the gold standard snake identification and are key to training the AI algorithm, could be integrated in health systems in countries with high frequencies of snakebite. This integration is already the case for other diseases with implications for entomologists or parasitologists. Such a collaborative approach involving communities at risk, health-care providers, and snake experts, all supported by AI, can strengthen health systems in line with WHO's road map (panel).[1]

For more on the **Merlin Bird ID app** see http://merlin.allaboutbirds.org/

A collaborative approach would continually generate eco-epidemiological (eg, snake and snakebite distribution) and clinical (eg, clinical signs, treatment, and patient outcome) data, which would develop the system itself for an improved understanding of

***Panel:* Uses of smartphone technology in snakebite**

- a computer vision algorithm and crowdsourcing (ie, involving the community of snake experts)[8] to identify the biting snake from a geo-localised photo taken by the victim, a bystander, or health worker
- first aid recommendations for the victim or bystander to avoid common unsafe practices
- guidance for urgent access to the nearest snakebite treatment centre by integrating information on road network, modes of transport, terrain specificities, availability of antivenom and other lifesaving health care,[9] and also letting the bitten person know of how urgent the care needed is
- a clinical decision support system for health-care providers to treat the victim

snakebite. This would also complement the syndromic approach to snakebite envenoming, by anticipating clinical signs on the basis of snake identity or, in the absence of a snake photo, by matching clinical signs with prevalent snakes in the geographical area where the bite occurred. This AI-based approach needs to be tested in the lab and in the field and depends on the taxonomic and geographical representativeness of the training dataset, availability of smartphones in poor settings, capacity and safety of taking a photo of the biting snake, and availability of information on antivenom stockpiles. In this context, initiatives such as the Snake Identification Service of Sri Lanka and the Big Four Mapping Project in India are highly relevant.

For the **Snake Identification Service of Sri Lanka** see https://snakesidentification.org/

For the **Big Four Mapping Project in India** see http://snakebiteinitiative.in/snake/

Although there are substantial challenges to the use of AI in snake identification and treatment of snakebite envenoming, we can overcome them. The roll out of WHO's road map between 2019 and 2030, together with the leadership of Ministries of Health, can promote AI research and uptake of digital solutions in snakebite-endemic countries. The WHO-International Telecommunication Union Focus Group on AI for Health, created in 2018 for benchmarking the development of AI algorithms, already supports a topic group on AI for snakebite and snake identification.[10] Our interdisciplinary team drives this group in collaboration with Médecins Sans Frontières, among others addressing snakebite envenoming in the field. Major stakeholders from the digital industry are committing to financially and technically support projects applying AI to global challenges, including snakebite (eg, the Computer Vision for Global Challenges workshop in June, 2019). Collaborations across sectors, including the engagement of communities and the role of non-governmental organisations, and sharing of resources are key to implementing WHO's road map and innovative digital approaches based on AI such as those proposed here.

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