



Agile and reactive rabies vaccination techniques in countries with low and middle incomes

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Rabies are still a major public health risk in low- and middle-income nations, endangering both human and animal health. Rabies is caused by rabies virus (RABV) from the *Rhabdoviridae* family of the genus *Lyssavirus*. The infection affects the central nervous system, mainly the brain and spinal cord, causing acute encephalitis, which has the highest case fatality rate ever recorded—nearly 100%. Although all mammals can be infected by RABV, dogs are thought to be the main source of infection. Dog bites cause 95% of human cases of rabies, but in endemic areas, this number increases to 99% (Harischandra, Gunesequera et al. 2016). To effectively battle rabies in situations with limited resources, this editorial addresses the use of agile and reactive vaccination tactics. Agile vaccination highlights the flexibility and adaptability of vaccination efforts, enabling prompt modifications in response to evolving epidemics and epidemiological trends. Conversely, reactive vaccination concentrates on high-risk or locations with confirmed cases of rabies in an effort to establish a barrier that will prevent the virus from spreading.

Rabies is thought to cause approximately 59,000 deaths worldwide each year; 45% of these deaths occur in the nations that make up the South Asian Association for Regional Cooperation (SAARC), with deaths

mostly occurring in Africa, the Middle East, and Central Asia (Tiwari, Gogoi-Tiwari et al. 2021). Eight of the 11 countries in the World Health Organization (WHO) South East Asia (SEA) region—Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka, Thailand and Timor-Leste—are endemic for rabies, putting over a billion people at risk of contracting the disease. With an estimated 35,000 fatalities annually in Asia, over 60% of deaths are reported in poor and rural areas.

Unlike many other illnesses, rabies can be prevented from being clinically manifested by prompt vaccination, even after an individual has been exposed to the virus. Neural tissue and cell culture vaccines are the two kinds of rabies vaccines available for human use. The WHO recommends switching from nerve tissue vaccines to safer, more effective vaccines created using cell culture as soon as possible. In recent years, cell culture vaccines, which are less expensive and require less vaccination, have been developed (Acharya et al. 2020). Standard intramuscular delivery of rabies vaccinations is not a necessary substitute for intradermal immunization using cell culture-based vaccines. Since intradermal vaccination uses fewer vaccines for both pre- and postexposure prophylaxis, it is safer and more immunogenic than intramuscular immunization, which reduces direct expenses. As a result, this option should be taken into account in situations when resources are limited.

Although most countries are expanding their dog bite-focused rabies case reduction programs, an increase in dog bites is impeding efforts to achieve the global aim of zero cases by 2030. Given that dogs are the main hosts

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of RABV, massive vaccination of dogs is essential. To guarantee coverage in rural regions, where the majority of rabies cases occur, coordinated efforts by government agencies, nongovernmental organizations, and local people are needed. Outreach initiatives and mobile immunization clinics can reach outlying areas and provide immunizations together with rabies prevention information. Improving coverage and compliance can be achieved by leveraging technology, such as SMS notifications for immunization schedules and reminders. The building capacity is also essential. Vaccine clinics and PEP administration training for local healthcare personnel can improve readiness and speed up reaction times (Rupprecht, Mshelbwala et al. 2023).

With the help of numerous governmental and nongovernmental organizations, the Nepalese government, local authorities, and concerned parties are working to reduce the number of rabies cases by immunizing dogs on a large scale, implementing animal birth control programs in the nation's densely populated areas, and running awareness campaigns. Sensitive tactics emphasize quick action in response to suspected cases to successfully counter this danger. It is essential to discover the virus early using monitoring systems so that infected people may be treated and isolated immediately. Rapid identification via rapid testing kits can help health authorities treat at-risk individuals with postexposure prophylaxis (PEP) as soon as possible. Mass vaccination campaigns aimed at at-risk human populations as well as domestic animals such as dogs are common components of agile vaccination programs in low- and middle-income countries.

The WHO has set a 2030 deadline for developing nations such as Nepal to eradicate dog-transmitted human rabies; nevertheless, official statistics indicate that the number of dog bite cases has been increasing annually. Consequently, there is now a greater need for rabies vaccination. During the 2019–20 fiscal year, 35,250 persons nationwide requested rabies vaccination at state-run medical institutions. In 2020–21, the number of victims increased to 56,619, most of whom were from dog attacks. A significant barrier to reducing rabies deaths and achieving the target of completely eradicating dog-transmitted human rabies by 2030 is the fact that not all dog bite events are reported to the authorities or that all victims pursue treatment. The lack of information and treatment available only in large cities is another obstacle to reducing rabies deaths and reaching this aim. Programs for preventing and controlling rabies are mostly focused on the Kathmandu Valley and other metropolitan regions; however, they have hardly made an inroad into Nepal's rural, remote areas, which account for 94% of all recorded

instances of rabies and dog bites. Several districts in Nepal, including Kanchanpur, Dailekh, Jajarkot, Chitwan, Dhading, Ramechhap, Siraha, Jhapa, Siraha, Sindhuli, Surkhet and Morang, have reported an increase in rabies epidemics in the past several years, with 159 outbreaks and 427 animal deaths (Devleesschauwer, Aryal et al. 2016). Given the heterogeneous eco-climatic conditions and paucity of studies, there is still much to learn about the epidemiology of rabies in Nepal. A small number of financed studies have been conducted on rabies; however, these studies are essentially passive epidemiological reports of rabies cases and do not contribute much to the knowledge base for Nepal's national rabies control program. Problems with the present rabies control initiatives demonstrate the necessity for new initiatives that effectively control the disease while taking into consideration the socioeconomic and ecological realities of the area.

A separate One Health Unit could be established within ministries with the responsibility of conducting research to determine the factors and routes by which the rabies virus spreads, as well as utilizing the results of that research to develop and execute creative plans aimed at disrupting the virus's chain of transmission in animal hosts and, as a result, lowering the occurrence of the disease in humans. A multipronged approach focused on tight cooperation between the veterinary and human sectors as well as a larger community of practice is required to accomplish our 2030 dog-mediated rabies eradication target in all affected nations. Using the OIE's international standards for rabies diagnosis, vaccination, and control in animals as well as the recently released WHO guidance on accelerated human vaccination schedules (including accelerated dose and cost-saving options for preexposure and postexposure) will make programmatic delivery more feasible and straightforward, enabling countries to proceed with the implementation of the Global Strategic Plan.

Furthermore, raising community awareness through informational campaigns about how to prevent rabies, how to properly care for wounds, and how important vaccinations are might encourage people to take preventative action. Programme continuation can be guaranteed via sustainable funding sources, including through collaborations with international health organizations or creative funding models. To save costs and increase accessibility, this includes funding for vaccine manufacture in LMICs. To prevent and manage rabies, a One Health approach brings together the fields of environmental health, animal health, human health, and other pertinent fields. The following are some essential elements of a One Health strategy for rabies prevention and control in LMICs:

Immunization schedules

Dog vaccination: Vaccinating more than 70% of dogs, as they are the main vector via which people obtain rabies. **Wildlife Vaccination:** Oral rabies vaccination programs have the potential to be successful in some areas, particularly those with substantial animal reservoirs. Wildlife animals include foxes, bats, and raccoons.

Surveillance and tracking

Monitoring human cases to detect epidemics and trends in transmission is known as “human surveillance.” The monitoring of rabies cases in animals to pinpoint high-risk regions and species is known as animal surveillance. Environmental variables that might aid in the spread of rabies, such as the location of natural regions where the disease is present, should be considered.

Education and awareness

Public awareness should be increased through campaigns to inform people about the dangers of rabies, its transmission routes, and the value of vaccination pets. Health-care personnel should be trained to identify and handle cases of rabies in an acceptable manner.

Management of stray animals

Putting in place plans for conscientious pet ownership and reducing the number of stray animals.

Investigation and originality

Allocating resources toward the creation of novel and enhanced vaccinations. Better and more easily available diagnostic methods should be developed to identify rabies more quickly.

Legislation and policy

Upholding regulations mandating vaccinations for pets and conscientious ownership. Cross-sector collaboration involves the creation of task forces or committees to facilitate coordination across the departments of environmental health, animal health, and human health.

Global cooperation

Collaborating on coordinated rabies control initiatives with international organizations such as the Food and Agriculture Organization (FAO), the World Health Organization (WHO), and the World Organization for Animal Health (OIE).

Emergency reaction and sustainability

Strategies for quickly combating epidemics, including widespread immunization drives and postexposure treatment, should be developed. Building local capacity can be

achieved by funding veterinary and medical staff training programs in impacted regions.

Long-term commitment

Therefore, long-term, consistent efforts are needed to eradicate rabies. Through the integration of these strategies, a One Health approach can successfully lower the incidence of rabies in both animal and human populations, ultimately contributing to the WHO 2030 worldwide objective of eradicating rabies-related fatalities in humans.

To summarize, effective and flexible rabies vaccination programs are critical for preventing the spread of this fatal illness and preserving human life in low- and middle-income countries. With the help of community involvement, large vaccination programs, early identification, sustainable finance, and other tactics, rabies may be effectively eradicated as a hazard to public health.

Authors' contributions

A.S. studied the epidemiology and incidence of rabies in SAARC countries, and R.K. and S.A. analyzed the way forward to accomplish the 2030 dog-mediated rabies eradication target in all affected nations through one health approach and prophylactic measures.

Competing interests

The author declares that he/she has no competing interests.

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