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One Health Approach to Rabies

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Abstract:

More than 75% of emerging infectious diseases and approximately 60% of known human infectious diseases are transmitted from animals (Acharya et al., 2020). Among these zoonotic diseases, rabies is of major public health significance due to its almost invariably fatal outcome once clinical signs appear, despite being preventable through appropriate measures (Acharya et al., 2020; Akinsulie et al., 2024). The multifaceted nature of rabies transmission and control presents significant challenges, highlighting the need for an integrated and multisectoral One Health approach that recognizes the interconnection between human, animal, and environmental health (Acharya et al., 2020; Akinsulie et al., 2024). Current rabies prevention and control programs primarily focus on mass vaccination of domestic and community dogs and cats, public awareness, and post-exposure prophylaxis (Acharya et al., 2020). However, persistent transmission in endemic regions indicates the need for stronger coordination among all relevant stakeholders. Effective rabies control requires collaboration between medical and veterinary professionals, public health authorities, animal welfare organizations, environmental sectors, and local communities (Akinsulie et al., 2024). This review highlights the importance of the One Health approach in rabies prevention and control and discusses how integrated surveillance, animal vaccination, responsible animal population management, public education, timely post-exposure prophylaxis, and intersectoral collaboration can contribute to reducing the burden of rabies and achieving the global goal of eliminating dog-mediated human rabies deaths (Acharya et al., 2020; Akinsulie et al., 2024).

Introduction:

Rabies is a vaccine-preventable and the deadliest viral zoonotic disease, with nearly 100% fatality once clinical signs appear (Akinsulie et al., 2024). Over 99% of human rabies cases are dog-mediated, although the virus also occurs in domestic and wild animals, including bats (Akinsulie et al., 2024).

Transmission occurs mainly through the saliva of infected dogs via bites, scratches, or contact with mucous membranes or open wounds (Akinsulie et al., 2024). Effective control requires strong political commitment, mass dog vaccination, accessible pre- and post-exposure prophylaxis (PrEP and PEP), responsible dog ownership, prevention of dog bites and stray-dog populations, and robust surveillance for early detection and response (Akinsulie et al., 2024).

Transmission:

Rabies is caused by rabies virus (RABV), a member of the genus *Lyssavirus* in the family *Rhabdoviridae* (Akinsulie et al., 2024). The virus is maintained in various mammalian reservoirs, including dogs, foxes, wolves, jackals, raccoons, skunks, mongooses, and bats (Akinsulie et al., 2024). It can infect most mammals and is almost invariably fatal once clinical signs appear. Approximately 60,000 human deaths occur annually worldwide, with most cases in Africa and Asia resulting from bites of rabid dogs (Akinsulie et al., 2024). The major routes of transmission to humans are animal bites, exposure of mucous membranes or broken skin to infectious saliva, and rarely, aerosol inhalation (Akinsulie et al., 2024). Bites are the most common route, as virus-laden saliva is inoculated into muscle and subcutaneous tissues. Scratches contaminated with saliva can also transmit the virus, although less commonly. Intact skin is generally resistant to RABV (Akinsulie et al., 2024). After inoculation, the virus binds to nicotinic acetylcholine receptors at the neuromuscular junction and enters peripheral nerves, reaching the CNS through retrograde axonal transport (Akinsulie et al., 2024). It then spreads within the CNS and subsequently travels centrifugally through nerves to organs, particularly the salivary glands, facilitating transmission to another host. Human-to-human transmission is extremely rare and has been associated mainly with transplantation of organs from undiagnosed infected donors (Akinsulie et al., 2024).

Rabies At the Animal-Human Interface:

Rabies is primarily transmitted through the saliva of an infected animal, usually following a bite. Although many mammalian species can contract the disease, dogs remain the major source of human rabies in endemic regions (Akinsulie et al., 2024). This close relationship between animal infection and human disease places veterinarians at the centre of rabies prevention. Instead of responding only after a person has been exposed, veterinary interventions can reduce the risk of exposure by preventing rabies transmission within animal populations. Thus, the veterinary approach involves animal vaccination, surveillance, diagnosis, responsible ownership, appropriate dog population management and community education (Acharya et al., 2020; Akinsulie et al., 2024). These measures directly contribute to protecting human health.

One Health Approach to Rabies Control:

It involves collaboration between human health, animal health and environmental sectors (Acharya et al., 2020; Akinsulie et al., 2024). Veterinarians play a key role in dog vaccination, surveillance and

investigation of suspected cases, while medical professionals provide risk assessment and post-exposure prophylaxis (PEP). Local authorities support mass vaccination, responsible dog population management and sanitation, while communities contribute through responsible pet ownership, awareness and early reporting of suspected cases (Akinsulie et al., 2024). In India, the National Action Plan for dog-mediated Rabies Elimination (NAPRE) promotes coordinated action through mass dog vaccination, human PEP, surveillance, public awareness and intersectoral collaboration (Ministry of Health and Family Welfare, Government of India, 2023). Rabies control demonstrates the practical value of One Health because effective vaccines and proven control measures can prevent human deaths while strengthening collaboration between veterinary, medical, public health and community systems (Acharya et al., 2020; Akinsulie et al., 2024).

Mass Dog Vaccination: The Veterinary Foundation

Mass vaccination of dogs is one of the most effective strategies for preventing dog-mediated rabies. WHO and WOAHA identify maintaining high vaccination coverage, commonly targeting at least 70% of dogs in at-risk areas, as essential for interrupting transmission (WHO, 2017; WOAHA, 2026). Veterinarians have a major role in planning and implementing these programmes. Their responsibilities include assessing dog populations, identifying areas with low vaccination coverage, ensuring appropriate vaccine administration, maintaining the cold chain, recording vaccinated animals and monitoring programme effectiveness (Acharya et al., 2020; Akinsulie et al., 2024).

Vaccination should include both owned and free-roaming dogs. Leaving unvaccinated populations outside vaccination programmes can create gaps in population immunity and allow continued circulation of the virus (WOAHA, 2026). Therefore, successful vaccination requires more than administering vaccines. It requires epidemiological planning, trained personnel, adequate logistics, reliable records and community participation (Acharya et al., 2020; Akinsulie et al., 2024).

Efficient And Effective Surveillance:

Effective rabies surveillance is essential for reliable disease data, early detection, risk assessment, and planning of vaccination and population-management programmes (Acharya et al., 2020). Surveillance should include domestic animals, stray/community dogs, wildlife, and wildlife-domestic animal interfaces, with standardized case definitions, clinical reporting, laboratory confirmation, and epidemiological surveys (Acharya et al., 2020). A One Health, multisectoral approach involving veterinary, medical, wildlife, and public-health sectors is important to identify transmission patterns and prevent spillover (Acharya et al., 2020; Akinsulie et al., 2024). In wildlife, oral rabies vaccination (ORV) can be used as an important control strategy where appropriate (Acharya et al., 2020). Strengthening surveillance and collaboration among stakeholders can improve the effectiveness of rabies control and support its long-term elimination.

The Veterinarian as The One Health Link:

Veterinarians occupy a unique position at the animal–human interface. Their role extends beyond treating individual animals and includes protecting communities from zoonotic diseases (Acharya et al., 2020). In rabies control, veterinarians can conduct vaccination of dogs and other susceptible animals, participate in mass dog vaccination programmes, investigate suspected rabies cases, support sample collection and laboratory diagnosis, strengthen animal rabies surveillance, advise owners about vaccination and responsible animal ownership, contribute to humane dog population management, educate communities about animal behaviour and bite prevention, and communicate relevant animal-health information to public-health authorities (Acharya et al., 2020; Akinsulie et al., 2024).

Every vaccinated dog represents not only an animal protected from rabies but also a potential reduction in the risk of transmission to humans (WOAH, 2026).

Integrated Management of Animal Bites:

Animal bites represent a direct point of interaction between veterinary and human healthcare systems. When a person is bitten by a potentially rabid animal, both the exposed person and the animal require appropriate management (Acharya et al., 2020; Akinsulie et al., 2024). The exposed person should immediately wash the wound thoroughly with soap and running water and seek medical attention. Depending on the exposure category and previous vaccination status, post-exposure prophylaxis may include rabies vaccination and rabies immunoglobulin when indicated (WHO, 2026).

At the same time, information about the biting animal—including its vaccination history, health status and circumstances of the exposure—can assist in assessing the situation. Effective communication between veterinarians and healthcare professionals can therefore improve the management of animal-bite cases (Acharya et al., 2020; Akinsulie et al., 2024). Animal surveillance and human PEP should function as connected components of the same rabies-control system.

Community Awareness and Participation in Rabies Prevention:

Public awareness programmes are essential for effective rabies prevention and control (Acharya et al., 2020; Akinsulie et al., 2024). In some communities, limited awareness may be associated with low literacy, socioeconomic challenges, and inadequate prioritisation of rabies. Increasing knowledge about dog vaccination, availability of post-exposure prophylaxis (PEP), responsible animal ownership, and prevention of dog bites can help reduce rabies transmission (Akinsulie et al., 2024).

Community participation is equally important. People should be encouraged to report suspected rabid animals and seek medical attention promptly after animal bites or scratches. Children are an important target group because they frequently interact with dogs and may not recognise risky animal behaviour (WHO, 2026). School and community programmes can teach children safe animal interaction and appropriate actions following exposure.

Veterinarians can contribute significantly to awareness programmes by providing information on animal vaccination, behaviour, responsible ownership, and disease prevention. Collaboration among veterinarians, healthcare professionals, schools, and communities can strengthen rabies prevention and control (Akinsulie et al., 2024).

Challenges In Rabies Control:

Despite the availability of effective vaccines and preventive measures, several challenges remain. These include inadequate vaccination coverage, difficulty reaching free-roaming dogs, inaccurate dog population estimates, limited diagnostic capacity, inadequate surveillance and gaps in communication between veterinary and medical sectors (Acharya et al., 2020; Akinsulie et al., 2024). Limited access to healthcare and lack of awareness can also result in delays in seeking post-exposure prophylaxis (Akinsulie et al., 2024). These challenges demonstrate why isolated interventions are insufficient. A successful One Health programme requires continuous coordination, adequate resources, reliable surveillance and active community participation (Acharya et al., 2020; Akinsulie et al., 2024).

Future Perspectives:

Future rabies-control programmes should focus on strengthening mass dog vaccination and improving veterinary surveillance. Digital vaccination records, geographic information systems and mobile-based disease reporting can help identify high-risk areas and monitor vaccination coverage (Akinsulie et al., 2024). Improving regional veterinary diagnostic capacity can facilitate rapid confirmation of suspected cases. Sharing animal and human rabies data can also allow authorities to identify clusters of animal cases and human exposures more efficiently (Akinsulie et al., 2024). Veterinary education should increasingly incorporate epidemiology, zoonotic disease surveillance, outbreak investigation and risk communication. Future veterinarians should be prepared not only to manage individual animals but also to contribute to population-level disease prevention (Akinsulie et al., 2024).

India And the Goal of Zero By 30:

India has adopted a national strategy for eliminating dog-mediated rabies through the National Action Plan for dog-mediated Rabies Elimination (NAPRE) (Ministry of Health and Family Welfare, Government of India, 2023). The programme promotes mass dog vaccination, human pre- and post-exposure prophylaxis, surveillance, public awareness and collaboration between veterinary and public-health sectors (Ministry of Health and Family Welfare, Government of India, 2023). The global Zero by 30 strategy aims to end human deaths from dog-mediated rabies by 2030 (WHO et al., 2018). Achieving this goal requires sustained vaccination of dogs, accessible human healthcare, effective surveillance and strong coordination between sectors (Acharya et al., 2020; Akinsulie et al., 2024).

For India, the veterinary profession will remain particularly important because of the country's large and diverse dog population and the complexity of managing free-roaming dogs across urban and

rural settings.

Discussion:

Utilizing the One Health approach: targeting the critical control points in the epidemiological triads. The One Health approach recognizes the interface and interdependence between the health of humans, animals, and their shared environment. The concept adopts collaborative efforts across multiple disciplines and sectors at the local, national, regional, and global levels to enhance integrated disease surveillance, interventions, and sustainably balance and optimize the health of people, animals, and ecosystems (Akinsulie et al., 2024). The below figure describes a conceptual framework using One Health to control and achieve the Zero Rabies agenda by 2030 (Akinsulie et al., 2024).

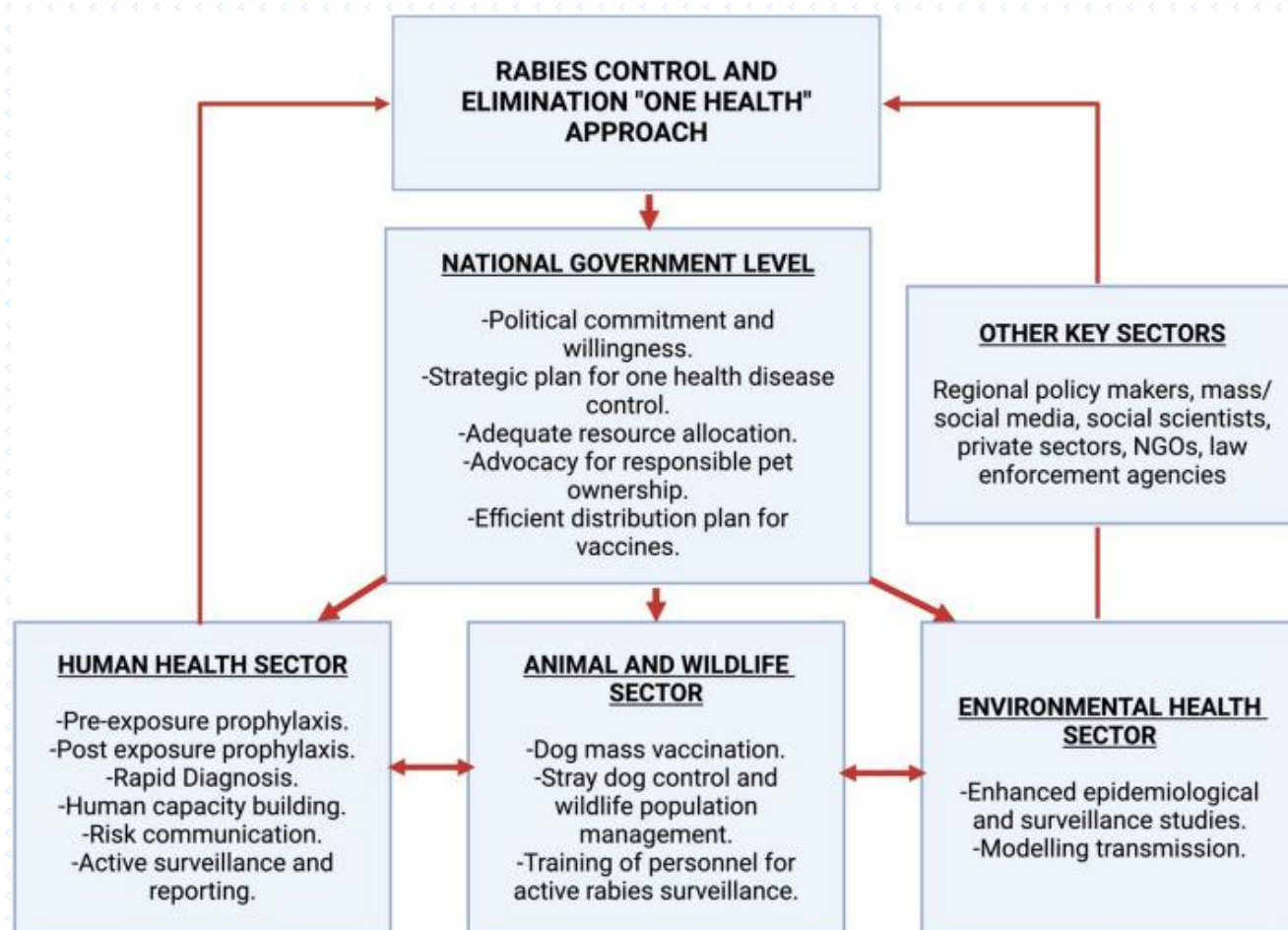


Figure 3. Conceptual framework for the One Health approach to rabies prevention and control towards achieving the Zero by 30 goal. Adapted from Akinsulie et al. (2024).

Due to the multifaceted complexity of rabies control and prevention, the One Health concept is now being incorporated into national One Health strategic plans in various countries across the world to mitigate prioritized One Health zoonoses such as rabies and enhance swift outbreak management of the disease in both humans and animals (Akinsulie et al., 2024). Furthermore, the adoption of the One Health approach is critical to the economies of low- and middle-income countries (LMICs), as this can reduce public health budgets associated with control of dog bites and PEP (Akinsulie et al., 2024).

Conclusion:

Rabies clearly demonstrates the need to integrate animal health, human health and environmental health within a unified One Health framework. Since dogs remain the principal source of human rabies in most endemic regions, effective rabies prevention must begin with control of infection in dog populations (Acharya et al., 2020; Akinsulie et al., 2024). Mass dog vaccination, veterinary surveillance, laboratory diagnosis, responsible dog ownership, humane population management, community education and timely human post-exposure prophylaxis are interconnected components of successful rabies control (Acharya et al., 2020; Akinsulie et al., 2024).

Veterinarians play a crucial role in this system through animal vaccination, surveillance, diagnosis, bite investigation and community education, thereby reducing the risk of transmission to humans (Acharya et al., 2020). However, sustainable rabies elimination requires coordinated efforts among veterinarians, medical and public-health professionals, laboratories, local authorities and communities (Akinsulie et al., 2024). Experiences from different regions also demonstrate that rabies elimination is an achievable goal when these sectors work together under a coordinated One Health strategy (Akinsulie et al., 2024). Ultimately, rabies elimination begins at the animal-human interface, and protecting animal health is an essential step towards protecting human health and achieving a rabies-free future.

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