

THE LAST MILE TO ZERO: A ONE HEALTH PARADIGM FOR ENDING RABIES TRANSMISSION

Nikita Bhatt

B.V.Sc., CVASc., GBPUAT, Pantnagar, Uttarakhand, India

DOI: <https://doi.org/10.5281/zenodo.23412962>

Abstract

A bite can mark the beginning of a fatal disease—or the point where prevention and One Health converge. Rabies is an almost invariably fatal yet preventable zoonosis, with most human infections arising from dog-mediated transmission. Despite the availability of highly effective vaccines, post-exposure prophylaxis and proven control tools, rabies continues to persist where prevention systems remain fragmented or unevenly implemented. Gaps in canine vaccination, surveillance, community engagement, healthcare access and intersectoral coordination leave critical breaks in the prevention chain. Sustainable elimination therefore demands a dual-front strategy: suppress transmission at its animal source while ensuring that every exposed person can access timely and effective protection.

The One Health paradigm integrates human, animal and environmental health through coordinated action across veterinary, medical, public health, environmental and community sectors. Mass dog vaccination, responsible dog population management, timely case recognition, laboratory-supported surveillance, prompt wound management and equitable access to post-exposure prophylaxis form the core of rabies prevention. Community engagement and risk communication further strengthen responsible animal ownership, timely exposure reporting and vaccination uptake.

The global Zero by 30 initiative provides a shared vision to end human deaths from dog-mediated rabies by 2030. Achieving this goal demands sustained investment, resilient surveillance, strengthened veterinary and healthcare systems, equitable access to prevention and care, and coordinated multisectoral action. Rabies is therefore not merely a zoonotic disease but a defining test of One Health—where collective action can transform a preventable threat into an eliminable one and turn the vision of zero preventable rabies deaths into reality.

Keywords: One Health, Zoonosis, Zero by 30, post exposure prophylaxis, integrated surveillance.

Introduction

Rabies is a devastatingly fatal yet eminently preventable zoonosis, claiming an estimated 59,000 human lives each year, predominantly across Asia and Africa. With approximately 99% of human cases linked to infected dogs, controlling rabies at its animal source is central to breaking transmission. Despite effective vaccines and post-exposure prophylaxis, gaps in canine vaccination, surveillance, healthcare access, community awareness and intersectoral coordination continue to sustain transmission. The One Health paradigm reframes rabies control as a connected prevention continuum, converging human, animal and environmental health through

coordinated, cross-sectoral action. At its core, sustained dog vaccination, responsible dog population management, integrated surveillance, rapid post-exposure care and empowered communities work together to interrupt transmission at its source and drive the disease towards elimination. The global Zero by 30 initiative embodies this shared ambition, uniting nations and sectors around a singular goal: ending human deaths from dog-mediated rabies by 2030. Rabies is therefore more than a preventable zoonosis—it is a powerful test of One Health in action, where collective commitment can turn prevention into protection,

coordination into impact, and the vision of zero deaths into a reality.

The global rabies challenge: a prespective from India

Rabies embodies a striking paradox in global health: almost invariably fatal once clinical signs appear, yet preventable through proven interventions. Globally, rabies claims an estimated 59,000 human lives each year, with approximately 95% of deaths concentrated in Africa and Asia, while infected dogs remain responsible for up to 99% of human transmission.

India remains at the heart of the global rabies challenge, reporting approximately 9.1 million animal-bite exposures annually and an estimated 5,726 human rabies deaths each year. Despite the availability of effective vaccines and post-exposure prophylaxis, persistent gaps in canine vaccination, surveillance, timely access to care and community engagement continue to fuel transmission. These figures underscore a critical reality: India's path to rabies elimination depends not on discovering new solutions, but on delivering proven One Health interventions consistently, equitably and at scale.

India's National Action Plan for Dog-Mediated Rabies Elimination (NAPRE) translates the One Health vision into action by bringing together mass dog vaccination, accessible post-exposure prophylaxis, integrated surveillance, community participation and multisectoral collaboration. Yet the decisive shift lies beyond responding to bites—it lies in breaking the chain of transmission before it reaches the human host. Rabies elimination therefore demands a transition from reactive care to proactive prevention, transforming a disease that is preventable in principle into one that is eliminable in practice.

The one health imperative for rabies elimination

Rabies transcends the conventional boundaries of zoonotic disease—it reveals how seamlessly human, animal and public-health systems can converge around a shared threat. As dogs remain the principal source of human

infection, prevention must begin upstream, at the reservoir before exposure takes place. Yet once clinical disease manifests, rabies is almost invariably fatal, making each exposure a critical window for intervention. This continuum—from reservoir to human vulnerability—places rabies at the epicentre of One Health, where cross-sectoral convergence is pivotal to elimination. Breaking transmission demands action at every link. Mass canine vaccination suppresses the virus at its source, reinforced by responsible dog-population management, surveillance, accessible veterinary care and community stewardship. At the human interface, immediate wound cleansing and timely post-exposure prophylaxis convert exposure into protection, creating a continuous defensive barrier before transmission can take hold.

This shield gains strength when surveillance, diagnostics and communities operate as a single intelligence network. Integrated animal-human surveillance and laboratory confirmation sharpen early detection and enable precision-targeted response, while communities convert prevention from policy into practice through responsible ownership, vaccination, prompt reporting and timely care. When evidence informs action and communities power implementation, One Health evolves from a framework into a force for breaking transmission and accelerating elimination.

The One Health imperative therefore calls for a decisive shift—from responding to exposure to preventing it. Rabies represents a striking paradox in global health—a disease that is near-universally fatal once clinical disease emerges, yet eminently preventable with interventions already within reach. The challenge is no longer to discover what works, but to deliver what works—consistently, equitably and before the next exposure occurs. When surveillance informs action, communities drive prevention and every sector moves with a common purpose, the chain of transmission can be broken before it reaches the human host. Rabies elimination is not beyond reach; it is a matter of turning proven science into sustained, collective action—until prevention becomes universal and rabies becomes history.

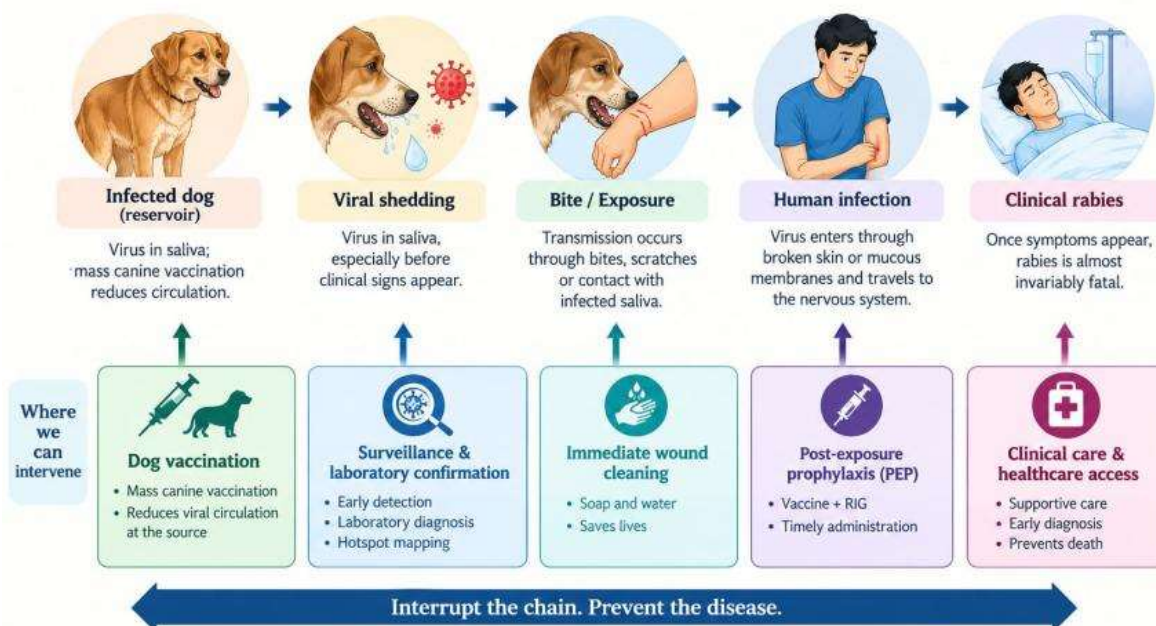
From source to shield: breaking the chain of rabies transmission

Rabies elimination begins upstream—at the human–animal–environment interface—where the chain of transmission can be disrupted before it reaches the human host. As dogs constitute the principal source of human rabies, sustained mass canine vaccination is the cornerstone of elimination, with population-level coverage of at least 70% essential to markedly reduce viral circulation and community risk. Yet vaccination alone cannot deliver lasting protection. It must be reinforced by evidence-based dog population management, responsible ownership, accessible veterinary services and sustained community stewardship, including appropriate identification and registration, prevention of uncontrolled breeding and timely veterinary care. Together, these measures shift rabies control from a reactive response to a proactive source-control strategy—reducing infection where it begins and protecting human lives before exposure occurs.

Yet source control must be matched by an equally decisive shield for those exposed. The moment an exposure occurs, prevention becomes a race against time: immediate,

thorough wound cleansing with soap and running water is the first lifesaving step, followed by appropriately indicated post-exposure prophylaxis (PEP) without delay. For severe exposures requiring passive immunisation, rabies immunoglobulin (RIG) provides critical early protection when administered according to established recommendations, with appropriate infiltration into and around the wound. For individuals whose occupation, environment or activities place them at sustained risk, pre-exposure prophylaxis (PrEP) adds a proactive layer of protection before exposure occurs.

Together, these measures create a continuum of human protection—intervening immediately after exposure, strengthening protection before exposure, and preventing the virus from crossing the final barrier to fatal disease. Together, these interventions create a continuum of protection—from reducing infection in the animal reservoir to preventing disease in exposed people. The true strength of a One Health strategy lies not in any single measure, but in ensuring that these interventions function as an integrated chain, because every link strengthened is another opportunity to stop rabies before it becomes fatal.



Strengthening the one health continuum for rabies elimination

Once transmission is disrupted at its source and the exposed individual is protected, lasting elimination depends on strengthening the

systems that sustain this break in the chain. The veterinary sector must therefore evolve from managing individual cases to driving population-level prevention, with veterinarians at the forefront of mass canine vaccination, responsible dog population management, case investigation, outbreak response, diagnostic sample collection and community engagement.

Veterinary action must shift from treating cases to intercepting transmission, with integrated surveillance and diagnostics transforming individual cases into actionable epidemiological intelligence. At the community interface, communication must advance from awareness to stewardship, strengthening responsible ownership, vaccination uptake, prompt bite reporting and timely post-exposure care. Rabies is shaped by the spaces where humans and animals intersect. Free-roaming dogs, urbanisation, waste and animal movement can sustain transmission, while digital tools can turn fragmented data into a dynamic map of risk. When ecological insight meets digital precision, surveillance moves beyond tracing yesterday's transmission to anticipating tomorrow's risk—turning reaction into foresight and data into prevention.

For India, these interconnected efforts converge through the National Action Plan for Dog-Mediated Rabies Elimination (NAPRE), translating the One Health vision into coordinated action through sustained mass dog vaccination, accessible pre- and post-exposure prophylaxis, public education, community participation, intersectoral collaboration and operational research, with the overarching goal of zero human deaths from dog-mediated rabies by 2030. Yet achieving this ambition demands more than individual interventions—it demands integration at every level. The journey from source to shield must therefore evolve into a unified continuum of action, where the veterinarian, clinician, laboratory, community, environment and digital intelligence operate as interconnected forces—preventing exposure, detecting transmission, directing intervention and ultimately turning rabies elimination from a global aspiration into a measurable reality.

From persistent gaps to accelerated elimination

Despite the availability of proven vaccines, effective diagnostics and reliable preventive tools, the greatest barriers to rabies elimination lie not in what can be done, but in how consistently and equitably it is delivered. Gaps in canine vaccination coverage, dog-population assessment, surveillance, timely reporting, diagnostic capacity and access to post-exposure prophylaxis, compounded by fragmented coordination and persistent community-level barriers, continue to leave vulnerabilities in the prevention chain. Closing these gaps demands a decisive transition from fragmented interventions to an integrated, adaptive and data-driven One Health system—one that anticipates transmission, reaches underserved populations and converts proven solutions into sustained population-level impact. Accelerating elimination requires precision, integration and foresight. Evidence-driven vaccination planning, digital dog and vaccination registries, geospatial intelligence, decentralised diagnostic capacity and strengthened animal–human reporting networks can make interventions more targeted and responsive. Innovative approaches to free-roaming dog management, public–private partnerships and sustained community participation can further extend their reach and durability. The critical shift is from reacting to detected cases to anticipating where transmission may persist—and intervening before the next exposure occurs. In this transition, data becomes intelligence, innovation becomes implementation, and prevention becomes the driving force of elimination. By transforming data into intelligence, innovation into implementation and communities into active partners, the pathway to rabies elimination can become faster, more equitable and more sustainable.

Conclusion

Rabies embodies one of global health's most compelling paradoxes—almost invariably fatal once clinical disease emerges, yet remarkably preventable before it does. Its elimination does not await another scientific

breakthrough; it demands the seamless convergence of solutions already within our reach. Sustained canine vaccination, responsible dog population management, timely post-exposure prophylaxis, integrated surveillance, laboratory capacity, empowered communities and digital innovation must operate not as isolated interventions, but as interconnected links in a single One Health continuum—moving rabies control from prevention of individual deaths towards interruption of transmission itself.

Achieving Zero by 30 will require more than isolated successes—it will require sustained, equitable and coordinated action

across every link of the One Health continuum. The true measure of progress will not be the number of interventions delivered, but the exposures prevented, lives protected and transmission chains permanently broken. On World Rabies Day, the opportunity is clear: the science is ready, the tools are available, and the pathway is known. What remains is to turn collective knowledge into collective action. When One Health becomes not merely a framework but a shared commitment, every vaccinated dog, every protected person and every interrupted transmission chain moves us one step closer to a world where rabies is preventable everywhere—and fatal nowhere.

References

1. Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M, et al. Estimating the global burden of endemic canine rabies. *PLoS Negl Trop Dis*. 2015;9(5):e0003709. doi:10.1371/journal.pntd.0003709.
2. World Health Organization, Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, Global Alliance for Rabies Control. Zero by 30: The global strategic plan to end human deaths from dog-mediated rabies by 2030. Geneva: World Health Organization; 2018.
3. Phukan P. One Health implementation for rabies elimination in India by 2030: Progress, governance, challenges, and policy alignment. *One Health*. 2026;23:101520. doi:10.1016/j.onehlt.2026.101520.
4. World Health Organization. Rabies vaccines: WHO position paper—April 2018. *Wkly Epidemiol Rec*. 2018;93(16):201-220.
5. World Health Organization. Rabies—India. New Delhi: World Health Organization; 2024.
6. World Health Organization. United against rabies forum: Zero by 30—One Health in action. Geneva: World Health Organization; 2021.

Cite this article:

Nikita Bhatt. (2026). The last mile to zero: a one health paradigm for ending rabies transmission. *Vet Farm Frontier*, 03(09), 56–60. <https://doi.org/10.5281/zenodo.23412962>