

ONE HEALTH, ONE GOAL: BREAKING THE CHAIN OF DOG-MEDIATED RABIES IN INDIA

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Abstract

Rabies remains one of the oldest, most lethal, yet entirely preventable viral zoonoses known to human history. Driven predominantly by dog-mediated transmission, the disease takes tens of thousands of lives annually, with India disproportionately bearing a significant percentage of the global mortality burden. Despite the absolute efficacy of pre- and post-exposure biologicals, systemic fragmentation between public health, veterinary infrastructure, municipal governance, and environmental management has historically hindered sustained control. The One Health approach offers an integrative, cross-sectoral operational model that unifies human, animal, and environmental domain strategies to disrupt the Lyssavirus transmission cycle. This article examines the biological, epidemiological, and socioeconomic dynamics of rabies in India; evaluates the policy architecture under the National Action Plan for Dog Mediated Rabies Elimination by 2030 (NAPRE); highlights real-world models such as the Goa Rabies Elimination Project and outlines actionable, interdisciplinary pathways required to secure a rabies-free future.

Keywords: One Health, Rabies Elimination, NAPRE, Zoonoses, Mass Dog Vaccination, Post-Exposure Prophylaxis

Introduction

Rabies, caused by neurotropic viruses within the genus *Lyssavirus* (family *Rhabdoviridae*), presents a stark paradoxical reality in 21st-century medicine: it carries a case fatality rate approaching 100% once clinical symptoms manifest, yet it is 100% preventable when prompt Post-Exposure Prophylaxis (PEP) is administered (WHO, 2018a).

Globally, rabies is responsible for an estimated 59,000 human deaths each year, predominantly affecting rural and economically disadvantaged populations in Asia and Africa (WHO, 2018b). India accounts for a major share of this burden, with dog bites responsible for over 96% of all human rabies transmissions in the country (NCDC, 2021). The persistence of rabies is not merely a failure of therapeutic medicine; it represents a structural breakdown at the intersection of public health policy, veterinary services, urban planning, and ecological management (Taylor & Nel, 2015). Historical efforts to combat rabies in India suffered from siloed interventions:

- Medical sectors focused exclusively on clinical bite management and post-bite vaccination.
- Veterinary sectors operated with limited resources for stray dog immunization.

- Municipal authorities struggled with unmanaged solid waste that sustained urban stray populations.

Recognizing these systemic limitations, the global community-led by the Quadripartite alliance: World Health Organization (WHO), World Organisation for Animal Health (WOAH), Food and Agriculture Organization (FAO), and United Nations Environment Programme (UNEP)—framed the global goal of "Zero human deaths from dog-mediated rabies by 2030" (Zero by 30) (WHO, 2018b). Central to achieving this milestone is the operationalization of a One Health approach—a collaborative, multisectoral, and transdisciplinary framework working at local, national, and global levels to attain optimal health outcomes by recognizing the interconnection between people, animals, plants, and their shared environment.

Pathophysiology and epidemiology of rabies *The neurotropic journey of rabies virus*

The rabies virus is a bullet-shaped, single-stranded, negative-sense RNA virus. Following a bite or scratch from an infected mammal (predominantly *Canis lupus familiaris*), the virus

enters local muscle tissues via infected saliva (WHO, 2018a).

1. **Local Replication:** Initial viral replication occurs within muscle cells surrounding the wound.
2. **Peripheral Entry:** The virus binds to nicotinic acetylcholine receptors at the neuromuscular junction.
3. **Retrograde Axonal Transport:** It ascends the peripheral nerves to the dorsal root ganglia and spinal cord at a speed of approximately 8 to 20 mm/day (WHO, 2018a).
4. **Encephalitis:** Upon entering the central nervous system (CNS), rapid viral replication triggers acute, progressive encephalomyelitis.
5. **Centrifugal Spread:** The virus travels along autonomic nerves to peripheral tissues, including the salivary glands, completing its transmission pathway.

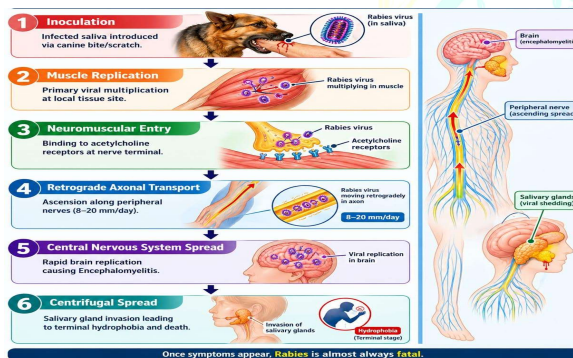


Fig. 1: Pathophysiology and Progression of Rabies Transmission

Epidemiology and socio-economic impact in INDIA

In India, the endemic nature of rabies is maintained by a vast, free-roaming dog population estimated at tens of millions (NCDC, 2021). The socioeconomic dynamics of rabies disproportionately impact lower-income demographics:

- Children aged 5–15 years constitute nearly 40% of all bite victims due to their proximity to free-roaming dogs and limited awareness of bite management (Sudarshan *et al.*, 2007).
- Out-of-pocket costs associated with travel, lost wages, and purchasing Rabies Immunoglobulin (RIG) or Post-Exposure Vaccines impose severe economic strains on vulnerable households (Sudarshan *et al.*, 2007).

The one health framework: bridging the divide

The One Health paradigm operates on the premise that human health cannot be safeguarded in isolation from animal welfare and environmental management (Taylor & Nel, 2015). Addressing rabies through this lens requires synchronizing three core pillars:



Fig. 2: Interdisciplinary One Health Transmission Interruption Framework

Human health sector: access, affordability, and education

- **Intradermal Regimens:** Transitioning from intramuscular (IM) to cost-effective intradermal (ID) rabies vaccination regimens (such as the updated 2-site Thai Red Cross schedule: Days 0, 3, 7, and 28) reduces the required vaccine volume by up to 80%, drastically lowering costs for public healthcare systems (WHO, 2018a).
- **Post-Exposure Prophylaxis (PEP):** Ensuring immediate access to thorough wound washing with soap and running water for at least 15 minutes, followed by prompt administration of cell-culture anti-rabies vaccines and wound infiltration with monoclonal antibodies or RIG for Category III exposures (WHO, 2018a).
- **Notifiable Disease Status:** Declaring human rabies a mandatory notifiable disease ensures real-time epidemiological tracking and rapid outbreak containment (NCDC, 2021).

Animal health sector: breaking the transmission chain

- **Mass Dog Vaccination (MDV):** Epidemiological models demonstrate that achieving and sustaining a minimum of 70% vaccination coverage among dog populations breaks the epizootic cycle and

establishes herd immunity, preventing rabies spillovers to humans (Coleman & Dye, 1996; WHO, 2018b).

- **Humane Population Control:** Coupling MDV with robust Animal Birth Control (ABC) programs—specifically surgical sterilization—stabilizes the stray dog demographic, reduces territorial aggression, and minimizes bite incidents (Ministry of Fisheries, Animal Husbandry and Dairying, 2021).
- **Active Veterinary Surveillance:** Implementing field diagnostic kits (e.g., Direct Rapid Immunohistochemical Tests - dRIT) to rapidly confirm rabies in suspected animal carcasses (Gibson *et al.*, 2022).

Environmental and municipal sector: carrying capacity reduction

- **Solid Waste Management:** Urban stray dog populations thrive due to accessible organic waste around open dumpsters, informal market stalls, and unregulated abattoirs. Municipal sanitation reforms—including sealed waste collection bins and strict slaughterhouse waste management—directly reduce the ecological carrying capacity for stray populations (Taylor & Nel, 2015).
- **Urban Infrastructure:** Safe public spaces, community feeding zones, and stray animal management policies prevent human-wildlife and human-canine conflicts.

Policy landscape in india: napre and national strategies

India's commitment to rabies elimination gained unprecedented structural momentum with the launch of the National Action Plan for Dog Mediated Rabies Elimination by 2030 (NAPRE), spearheaded by the National Centre for Disease Control (NCDC) and the Ministry of Health and Family Welfare, in collaboration with the Ministry of Fisheries, Animal Husbandry and Dairying (NCDC, 2021).

Key Strategic Pillars of NAPRE:

1. **Operationalization of State Action Plans (SAPRE):** Translating national frameworks into state and district-level operational roadmaps (NCDC, 2021).
2. **Integrated Inter-Ministerial Governance:** Establishing joint One Health committees from national down to Panchayat levels (Ministry of Fisheries, Animal Husbandry and Dairying, 2021).
3. **Digital Health Infrastructure & Surveillance:** Deploying unified digital portals and GIS-enabled surveillance systems to track animal bite hot spots and vaccine stocks (Gibson *et al.*, 2022).
4. **Community Capacity Building:** Integrating rabies first-aid modules into rural healthcare networks (via ASHA and ANM workers) and eradicating harmful traditional remedies (NCDC, 2021).

Sector Domain	Primary Responsibilities under NAPRE	Key Performance Indicators
Human Health	Universal PEP access, implementation, mandatory rabies reporting	100% PEP availability at PHCs; 0 human rabies deaths target
Animal Health	Mass dog vaccination campaigns, ABC programs, animal surveillance	≥ 70% canine vaccination coverage; sustained birth control targets
Municipal/Local Bodies	Waste management reform, stray dog census, abattoir sanitation controls	Reduction in unmanaged urban food waste; systematic stray mapping
Education & Civil Society	Public awareness campaigns, responsible pet ownership, school education	Elimination of dangerous wound treatments; early bite reporting

Lessons from the field: the goa one health model

The efficacy of the One Health strategy in India is validated by the success of Mission Rabies in the state of Goa. Goa became the first Indian state to be declared a Human Rabies-Free Zone after registering zero human rabies cases for several consecutive years.

Key Elements of the Goa Success Story

- **Data-Driven Mass Vaccination:** Utilizing smartphone applications equipped with spatial GIS tracking to map stray dog populations in real time, ensuring digital verification of >70% canine vaccination coverage across urban and rural sectors (Gibson *et al.*, 2022; Yale *et al.*, 2021).

- **Centralized Rabies Surveillance:** Deploying a dedicated 24/7 rabies hotline and rapid response teams to capture, isolate, and diagnose suspected rabid animals, while immediately tracing human contacts for emergency PEP.
- **Extensive Educational Outreach:** Educating over one million school children and community members on dog body language, bite prevention, and immediate post-bite first aid.

The Goa model demonstrates that eliminating dog-mediated human rabies does not require complex technological breakthroughs; it requires the methodical, technology-enabled execution of established interventions through cross-sectoral coordination.

Challenges, strategic recommendations and road ahead

While national policies like NAPRE provide a solid blueprint, several operational challenges must be resolved to scale success across the sub-continent:

1. **Intra-regional Cold Chain and Vaccine Supply Continuity:** In rural PHCs, supply disruptions of Anti-Rabies Vaccines (ARV) and Rabies Immunoglobulin (RIG) remain a challenge. Adopting intra-dermal regimens across all state healthcare facilities will maximize dose utilization and stretch supply chains (WHO, 2018a).
2. **Standardization of Animal Birth Control Infrastructure:** ABC facilities must strictly

adhere to humane surgical standards, infection control, and post-operative care to prevent animal morbidity and maintain public trust.

3. **Cross-Border Surveillance:** Rabies does not respect municipal or state boundaries. Regional One Health task forces are required to manage stray dog movements across state lines.
4. **Integration of Environmental Management:** Municipal corporations must formalize urban waste management plans specifically designed to reduce food sources for free-roaming dogs, treating waste control as a primary health intervention.

Conclusion

Rabies stands as a diagnostic test for modern public health architecture. The tools to defeat this fatal virus—effective human vaccines, biologicals, canine immunizations, and animal management strategies—have existed for decades. What was missing was the structural bridge connecting these tools into a unified, operational framework. By embracing the One Health paradigm, India is bridging this divide. Through sustained political commitment, inter-ministerial coordination under NAPRE, robust municipal waste management, digital surveillance networks, and active community participation, achieving Zero Human Rabies Deaths by 2030 is an attainable reality. Defeating rabies will save thousands of human and animal lives while establishing a successful blueprint for managing other emerging zoonotic threats in the 21st century.

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