

ONE HEALTH APPROACH TO RABIES IN INDIA: BRIDGING VETERINARY AND MEDICAL SYSTEMS TO ACHIEVE ZERO BY 2030

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Abstract

India carries close to a third of the global dog-mediated rabies burden [4,5] and has committed, through the National Action Plan for Dog-Mediated Rabies Elimination (NAPRE, 2021), to zero human deaths by 2030 [2,6]. This review asks why a country with a national plan, notifiable-disease status, domestic vaccine manufacturing and two documented state-level elimination successes still loses thousands of lives each year, and identifies the specific veterinary-medical interfaces that must be engineered before 2030. We synthesise the 2022-23 ICMR-NIE nationwide community survey [4,9], National Rabies Control Programme returns [6,8], WHO/WOAH/FAO guidance [1,2], national genomic surveillance [27,28], and elimination programmes from Goa [15], Sikkim [16], Bohol [17] and Latin America [18,19]. Modelled Indian mortality of 5,726 deaths annually exceeds the 54 suspected deaths notified in 2024 by roughly a hundredfold [4,8]. The binding constraint is architectural, not therapeutic. Four joints are broken: bite reports that never reach the veterinary sector, mass dog vaccination without a credible population denominator, post-mortem animal diagnosis concentrated in too few laboratories, and Integrated Bite Case Management (IBCM), which remains absent from NAPRE [6,20]. Whole-genome data showing predominant Arctic-like 1a circulation with state-level clustering indicate that transmission is largely local, that antigenic sites are conserved, and that district-scale elimination with traceable reintroduction is realistic [27,28]. Rabies elimination in India has become an integration problem rather than a scientific one. Seven measurable actions, each with a named owner and a 2030 indicator, would convert an adequate plan into a verifiable outcome [2,6].

Keywords: Rabies; One Health; NAPRE; Integrated Bite Case Management; mass dog vaccination; post-exposure prophylaxis; oral rabies vaccination; genomic surveillance; Zero by 30.

A bite that nobody investigated

A child is bitten on the face by a street dog. Vaccine is started within hours at a primary health centre, but no immunoglobulin, because the centre holds none. Nobody telephones the veterinary officer; the dog is never traced. Three weeks later the child dies of rabies, and the death enters a register no animal husbandry department will read.

A central investigation of the twenty-one Kerala deaths of 2022 found no vaccine failure and no escape variant, but delay: late presentation, poor bite management, low awareness, most of it preventable [10,34]. Kerala then logged over 100,000 bites and sixteen deaths in four months of 2025, several in people already vaccinated [8,34].

India is not short of tools: a National Action Plan for Dog-Mediated Rabies Elimination (NAPRE) across six ministries [6,7], a WOA Reference Laboratory [26], domestic biologicals [25], two states at zero [15,16]. What it lacks are the joints between them, the mechanism by which a bite becomes at once a clinical emergency and an epidemiological signal. Building them is what One Health means operationally [2,14].

The burden and the gap it reveals

The 2022-23 ICMR-NIE community survey, the first nationally representative estimate in twenty years [4,11], modelled a

death toll roughly a hundred times the number notified, and a fall of about three quarters over that period on wider vaccine access, intradermal regimens and awareness (Table 1) [4,11]. Exposure climbs the reporting chain; mortality does not (Figure 1) [4,8].

Zero by 30 is a verification standard, not a sentiment [2]: no country can certify elimination or target districts while it detects one death in a hundred [4,8]. One pairing in that table explains the treatment gap: of 467 facilities surveyed, about 80% stocked vaccine and 20% immunoglobulin [9], a cold chain that ends before the drug does.

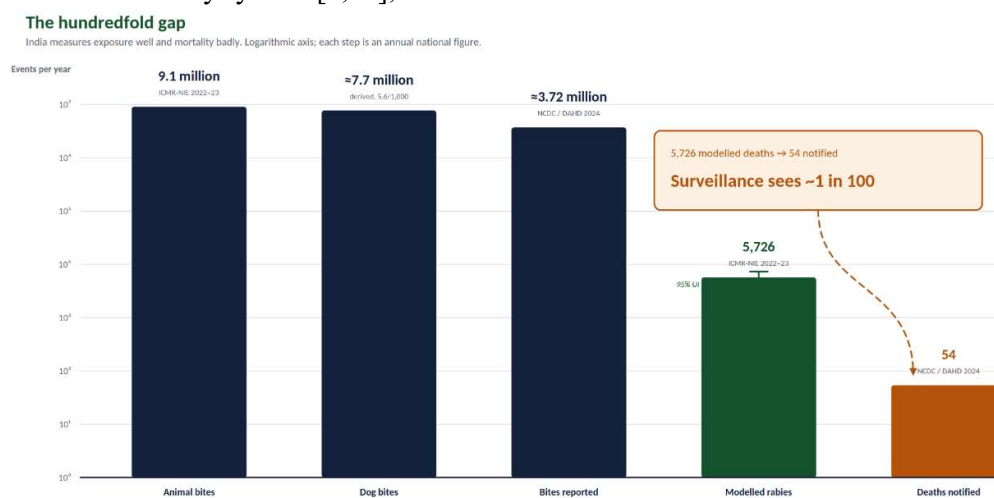


Fig. 1. The rabies surveillance funnel in India (logarithmic axis). Author-generated figure based on data from [4,8].

Table 1. India's rabies dashboard: what the numbers say, and what they conceal

INDICATOR	VALUE	SOURCE	WHY IT MATTERS
Animal bites	9.1 million	ICMR-NIE (2022-23) [4]	Scale of PEP liability
Dog-bite incidence	5.6 per 1,000 (4.8-6.6)	ICMR-NIE (2022-23) [4]	Dogs dominate exposure
Modelled rabies deaths	5,726 (95% UI 3,967-7,350)	ICMR-NIE (2022-23) [4]	The 2030 target
Deaths notified	54	NCDC-DAHD (2024) [8]	Detection ≈1% of burden
Bites reported	~3.7 million (≈10,000/day)	NCDC-DAHD (2024) [8]	Exposure reported; mortality not
No ARV received	20.5%	ICMR-NIE (2022-23) [4]	Access and awareness gap
Full schedule completed	40%	ICMR-NIE (2022-23) [4]	Adherence, not availability

RIG when eligible	about one tenth	ICMR-NIE (2022-23) [4]	Decisive in Category III
Facilities with ARV / RIG	~80% / ~20%	ICMR-NIE facilities (2025) [9]	Supply, not judgement
Household dogs vaccinated	about half	ICMR-NIE (2022-23) [4]	Owened dogs cannot reach 70%
20-year decline	~75%	ICMR-NIE (2022-23) [4,11]	Real progress, unfinished

NCDC = National Centre for Disease Control; DAHD = Department of Animal Husbandry and Dairying; UI = uncertainty interval; ARV = anti-rabies vaccine; RIG = rabies immunoglobulin; PEP = post-exposure prophylaxis. Sources: [4,8,9,11].

Anatomy of a coordination failure

Responsibility is distributed with admirable breadth and almost no connective tissue: notification split between health and animal-disease law [12,36], dog sterilisation and vaccination with urban local bodies under the Animal Birth Control Rules, 2023 [13], coordination with the National One Health Mission [14].

The consequence is structural: the victim enters the medical system, the dog stays in the municipal one, and the virus is recorded in neither [6,12,13]. Municipal bodies are measured on dogs sterilised, hospitals on doses issued; nobody owns the number that decides elimination [1,2]. India has 279 model anti-rabies clinics and fourteen strengthened laboratories [6,26]; several states still lack a State Action Plan [10].

In suo motu proceedings the Supreme Court has since forced movement where guidance could not, requiring in August and November 2025 sterilise-vaccinate-release except for rabid or dangerously aggressive dogs, clearance of institutional premises, and designated feeding zones; in May 2026 it declined to dilute those orders, directing that every district hold a functioning Animal Birth Control centre and anti-rabies vaccine at all times [35]. removal without coverage disturbs

population structure while leaving transmission intact [1,15], and shelter capacity falls an order of magnitude short [13,35]. Courts can compel logistics; only veterinary services can compel epidemiology.

Vaccinating dogs: the governing arithmetic

Elimination needs about 70% of dogs immune in a defined area, held for three years and renewed as turnover erodes it (Figure 2) [1,2]. The difficulty is the denominator: the 2019 livestock census counted 1.53 crore free-roaming dogs against independent estimates of roughly 6 crore [8,21], and a denominator wrong by fourfold cannot support a coverage figure, a stopping rule or an audit.

Where the denominator was solved, so was rabies: Goa's smartphone-directed teams took human deaths from 17 in 2014 to zero [15], and Sikkim held zero for a decade, its two deaths in 2016 an incursion at the West Bengal border rather than a programme failure.[16].

Catching teams cannot reach the least catchable quarter of dogs, the gap oral vaccination now fills (Table 2) [21–23]; and every sterilisation is a vaccination already bought, so recording it at individual-dog resolution is the cheapest surveillance upgrade available.

Table 2. Dog vaccination strategies: reach, evidence and role

STRATEGY	REACH	EVIDENCE IN INDIA	ROLE IN THE MIX
Owened-dog parenteral campaigns	Handleable, owned dogs	About half of household dogs [4]	Necessary but insufficient

Catch-vaccinate-release teams	Free-roaming, catchable dogs	Goa: >95,000 dogs, ~70% coverage, canine cases –92% [15]	Backbone of elimination
CNVR integration with ABC	Dogs already being handled	Mandated under ABC Rules 2023 [13]	Zero marginal cost; record as immunisation
Oral rabies vaccination (SPBN GASGAS)	Uncatchable tail	Non-meat bait field-tested in Goa; WOAH-compliant; safety reviewed [21–23]	Complement for low-catchability wards
Ring vaccination on detection	Radius around a case	Used in Goa and Sikkim [15,16]	Outbreak containment, not routine use
Culling or relocation	—	No evidence of transmission interruption [1,2]	Not a control measure

CNVR = catch–neuter–vaccinate–release; ABC = Animal Birth Control. Sources: [1,2,4,13,15,16,21–23].

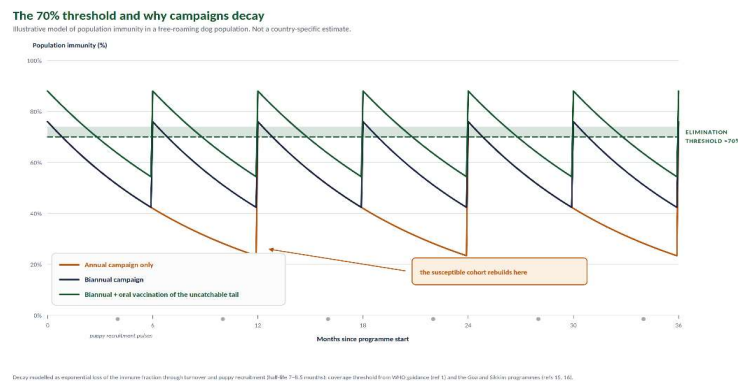


Fig. 2. Population immunity decay under three campaign schedules. Author-generated figure based on data from [1, 2, 15]

Diagnosis: the weak link sits in the district

Animal confirmation still depends on the direct fluorescent antibody test (DFA), which most district disease investigation units cannot run [26,30]. The bottleneck is not scientific but geographic: samples that must travel rarely arrive in testable condition (Figure 3) [24,30].

Validated alternatives sit lower in the system: a Puducherry study confirmed the direct rapid immunohistochemical test (dRIT), lateral-flow assay and one-step RT-PCR as reliable alternatives [24], and the WOAH Reference Laboratory at KVAFSU-CVA, Bengaluru, now supports satellites, one in Assam returning 88 positives from 193 samples [26].

Sequencing of 630 Indian isolates shows a predominant, antigenically conserved Arctic-like 1a lineage in tight state-level clusters (Figure 4) [27,28], settling two field questions:

vaccine escape does not explain prophylaxis failure [25,34], and transmission is local enough for district-scale elimination, with reintroduction traceable [27]. Two blind spots remain. Rural India reports fewer bites and suffers more deaths, because distance and traditional remedies both delay prophylaxis [4,11].

The wildlife and livestock interface is unmonitored: rabies is confirmed in the endangered Asiatic wild dog [29], and livestock rabies is rarely sequenced [27]. Neither changes the strategy, which remains dog vaccination [1,2]; both decide whether India can demonstrate elimination in 2030.

Integrated Bite Case Management: the missing bridge

Integrated Bite Case Management (IBCM) is the procedural bridge: a bite triggers

not only clinical management but also veterinary assessment of the biting animal, with the findings feeding back into patient care and surveillance (Figure 5) [2,20]. It improves prophylaxis decisions while converting bite reports into actionable epidemiological data [15,20].

The model has already worked in practice. Goa eliminated human rabies by combining mass dog vaccination, IBCM, hotline-based investigations and school education [15]. Sikkim's SARAH programme sustained elimination for a decade, with the 2016 deaths reflecting border incursion rather

than programme failure [16]. Bohol, Philippines reached zero through intersectoral governance, ordinances and school-based education [17], while coordinated programmes across Latin America and the Caribbean have reduced human and canine rabies by about 95% since 1983 [18,19]. Kerala is now generating India's own effectiveness and cost-effectiveness evidence through a stepped-wedge IBCM trial in primary care [20].

Despite this evidence, IBCM remains absent from NAPRE, making it one of the most consequential gaps in India's rabies elimination strategy [6,20].

What the genomes tell the programme

Whole-genome sequencing of 630 Indian rabies virus isolates. Both panels are schematic.

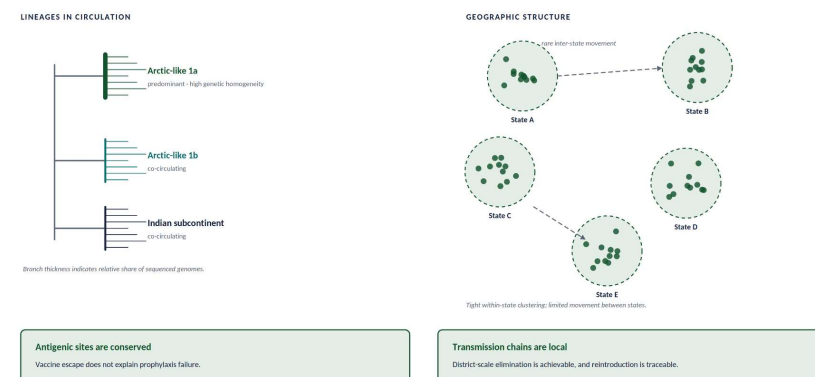


Fig. 4. Lineage composition and geographic structure of Indian rabies virus. Both panels are schematic. Author-generated figure based on data from [27,28].

Bite to decision: two pathways, one bridge

Integrated Bite Case Management adds one step and produces two outputs.

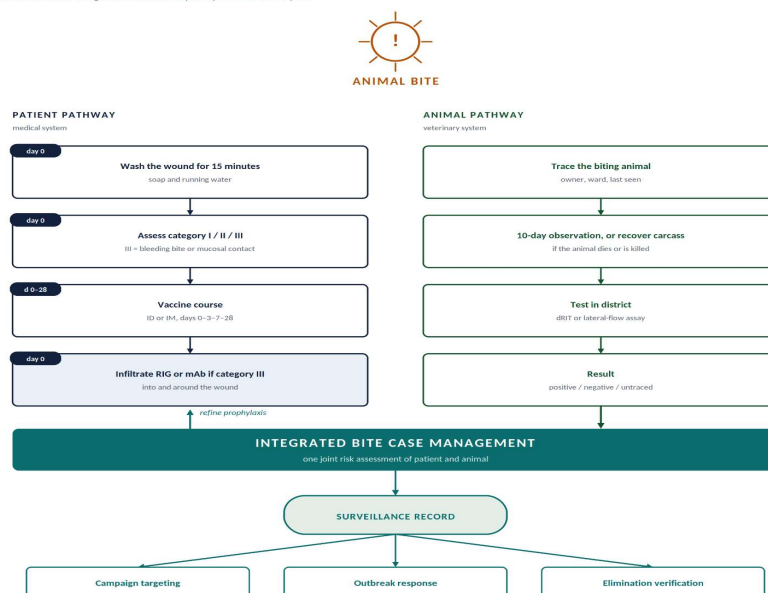


Fig. 5. The Integrated Bite Case Management pathway, patient and animal in one record. Author-generated figure based on [2,15,20].

The economics of doing it in the wrong order

Post-exposure prophylaxis (PEP) saves the individual in front of you and changes nothing about next year: at 9.1 million bites it is a permanent recurring liability [4], with Karnataka alone logging 40,000 bites a month [8]. Dog vaccination is the opposite kind of spending, a bounded investment that retires the hazard [2,31]; Indian modelling finds canine vaccination with improved PEP access the cost-effective frontier [31].

Three efficiency gains remain unbanked. Intradermal regimens, approved in India since 2006, use 60-80% less vaccine but are still not universal [1,10]. Immunoglobulin reaches about a tenth of eligible patients [4,9], an equity failure domestic monoclonal antibodies can now close

[32,33]. And pre-exposure prophylaxis for children in districts with poor PEP access converts an emergency that depends on immunoglobulin into two booster doses that do not [1].

Seven things that must change before 2030

Table 3 sets out seven actions, each with an owner and an indicator verifiable in 2030 [6]. They close the four broken joints: routing bite records and writing IBCM into NAPRE restore reporting [6,20]; a denominator, one sterilisation-vaccination record and an oral vaccination pilot restore coverage [13,21]; district testing restores confirmation [24,26]; and pre-exposure prophylaxis protects children where immunoglobulin is scarcest [1,9].

Table 3. Seven priority actions, with owners and indicators for 2030

PRIORITY ACTION	ACCOUNTABLE OWNER	VERIFIABLE INDICATOR BY 2030
Route every bite record, with an animal identifier, to the district veterinary officer [2,6,20]	NCDC with state health departments and AHD	% of IHIP bite entries with animal follow-up
Publish a dog denominator per local body [13,15]	Urban local bodies with AHD	Denominator published, revised every three years
Write IBCM into NAPRE as a costed component when Kerala reports [6,20]	MoHFW and DAHD	IBCM in NAPRE with a budget line
dRIT or lateral-flow capability in every district [24,26]	State AHD with the WOAH Reference Laboratory	% of districts confirming in-district under EQA
One record for ABC sterilisation and vaccination [13,15]	Urban local bodies	Individual-dog records auditable by the state
Pilot oral vaccination in two or three low-catchability wards [21–23]	NCDC with DAHD	Coverage gain in pilot wards versus controls
PrEP for children in low-RIG-access districts [1,9]	State health departments	Districts with PrEP, by RIG availability quartile

IHIP = Integrated Health Information Platform; AHD = Animal Husbandry Department; MoHFW = Ministry of Health and Family Welfare; PrEP = pre-exposure prophylaxis; EQA = external quality assurance. Sources: [1,2,6,9,13,15,20–24,26].

Conclusion

What remains is plumbing: a bite visible to a veterinary officer within hours, a dog's vaccination status the state can defend, a suspect carcass testable in the district where it died. Stronger Together, the theme for World Rabies Day 2026, has a precise operational meaning

here. The child in the opening paragraph did not die because science failed her; she died in the gap between two systems both, separately, doing their jobs. Closing that gap is the whole of the remaining task, and it is within reach.

Declarations

Author contributions. All authors contributed to conceptualisation, literature synthesis, figure

design, drafting and critical revision, and approved the final manuscript.

Conflicts of interest. The authors declare no competing interests.

Data availability. This review analyses published literature and publicly reported programme data; all sources are cited. All figures are original and were generated by the authors.

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