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Rabies: From an Ancient Killer to a Disease, We Can Defeat

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Rabies: An Ongoing Global Public Health Concern

Rabies is a fatal zoonotic viral disease that affects all warm-blooded animals, including humans, dogs, cats, bats, foxes, and cattle. It is caused by the rabies virus, a neurotropic virus belonging to the *family Rhabdoviridae* and *genus Lyssavirus* (Khairullah et al., 2023). It is considered one of the oldest known viral diseases affecting the central nervous system of both humans and animals. Despite being entirely preventable through timely vaccination and post-exposure management, rabies continues to cause thousands of human deaths worldwide each year. The development of the first rabies vaccine by Louis Pasteur marked a major milestone in disease prevention and raised hopes for the eventual elimination of rabies. This objective has not been met, though, as rabies persists in a variety of animal reservoirs, both domestic and wild (Natesan et al., 2023).

In the 21st century, over 3 billion people remain at danger of contracting the rabies virus in more than 100 nations, and 50,000 to 55,000 people die from rabies every year worldwide. In India alone, 25,000 to 30,000 people die from the disease (Khairullah et al., 2023). These figures are particularly alarming because a substantial proportion of rabies victims are children living in resource-limited settings and also according to the World Health Organization (WHO), rabies is estimated to cause approximately 59,000 human deaths annually across more than 150 countries.

Rabies Virus: Structure, Transmission and Disease Progression

Morphology and Structural Characteristics: The rabies virus is 75 x 180 nm and has a rod or bullet-like shape with one conical end and one planar (concave) end. There is an envelope with glycosylated protein-G spikes within a host cell-derived lipid membrane (Fig 1) Liu et al., 2022).

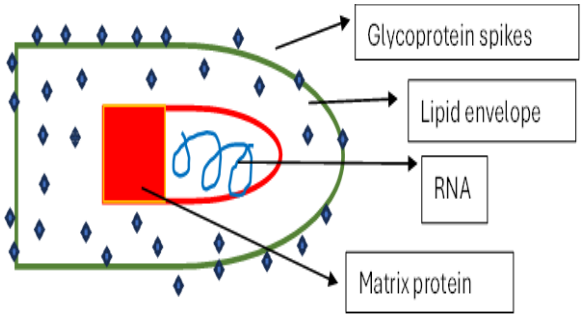

Figure 1: Structure of Rabies Virus

Transmission and Pathogenesis

It spreads by contact with saliva of rabid dog or via the bite of rabid dog. Human-to-human transfer is extremely uncommon (Fatima et al., 2023). After entry, it reaches the central nervous system and rapidly spreads, causing inflammation and severe neurological damage (Fig 2).

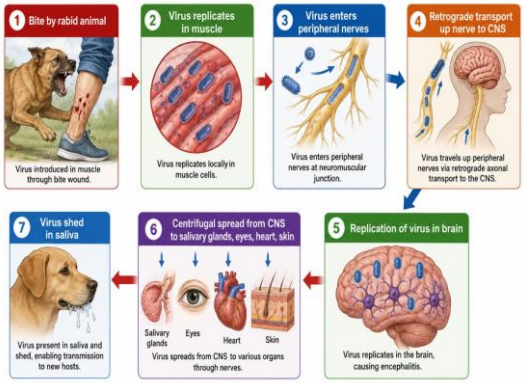

Figure 2: Pathogenesis of Rabies

Biological Variants of Rabies Virus

First form is **street virus** which is a naturally occurring rabies virus that is spread by saliva and has a lengthy and erratic incubation period. Second form is **fixed virus** which is a strain that has been modified for use in research and vaccinations and has a brief, predictable incubation period (Khan et al., 2025).

Clinical Presentation in Animals and Humans

- **Dogs & Cats:** Furious form (aggression, restlessness, biting) or paralytic/dumb form (pharyngeal paralysis, inability to swallow, drooling) (Ali, 2022)
- **Cattle & Horses:** Bellowing, ataxia, excessive salivation, progressive paralysis.
- **Wild Animals:** Loss of fear of humans, daytime activity in nocturnal species.
- **Human -**Fever, malaise, tingling at bite site, Hydrophobia, aerophobia, agitation, hallucinations, ascending flaccid paralysis (can mimic Guillain-Barré) and death (Khan et al., 2025)

Diagnostic Approaches for Rabies Confirmation

Early symptoms of rabies might mimic those of other common viral illnesses, making diagnosis difficult. It is challenging to make a firm diagnosis until neurological symptoms manifest in both humans and live animals. When diagnosing rabies, histopathology is crucial, particularly in cases that are post-mortem. Negri bodies are eosinophilic, round-to-oval inclusion bodies that are frequently seen in the cytoplasm of neurons, especially in the hippocampus and cerebellar Purkinje cells, when brain tissue is examined under a microscope (Fig 3a). Inflammation, neuronal degeneration, and perivascular lymphocytic infiltration are possible extra findings (Andadari et al., 2024). The confirmation of rabies is typically accompanied by laboratory tests such fluorescent antibody testing or PCR to identify the viral antigen or genetic material, even when histology offers supporting evidence.

The presence of the rabies virus in saliva or brain tissue is verified by laboratory tests such as reverse transcriptase polymerase chain reaction (RT-PCR), the direct fluorescent antibody (DFA) test (Fig. 3b), which is the gold standard test for rabies and immunohistochemistry (Fig. 3c) (Candia-Puma et al., 2024). Isothermal amplification mediated by the reverse transcription loop, or RT-LAMP is employed in the diagnosis of rabies (Sandala et al., 2023). It works at a constant temperature without the use of specialist thermal cyclers, is especially useful in low-resource or field settings, and rapidly detects viral RNA. Post-mortem brain examination, particularly the identification of Negri bodies in neurons, is still a traditional diagnostic method for animals. For disease surveillance, prevention, and control, a prompt and precise diagnosis is crucial.

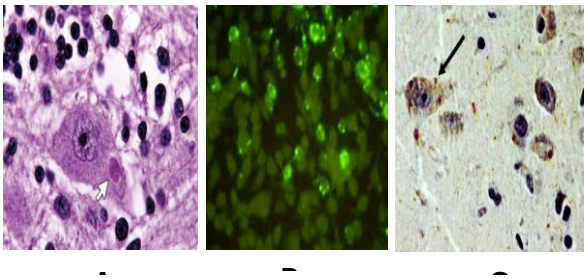

Figure 3: Diagnosis of rabies. (A) Negri bodies (arrow) in the cytoplasm of an undamaged neuron (dense, eosinophilic, and sharply defined). (B) Gold standard rabies test, the positive direct fluorescent antibody test, displays rabies antigens as fluorescent, apple-green patches. (C) Immunohistochemical analysis of Negri bodies in rabies.

Strategies for Interrupting Rabies Transmission

- **Mass Dog Vaccination** – Mass vaccination of the dog population is necessary. Vaccination of at least 70% of the dog population is considered the most effective strategy for interrupting rabies transmission (Undurraga et al., 2020).
- **Post-Exposure Prophylaxis (PEP)** – Thorough wound washing followed by timely administration of anti-rabies vaccines and immunoglobulins can effectively prevent disease development (Table 1).

✓ Wash the wound immediately with soap and running water for at least 15 minutes to reduce the risk of rabies virus infection.

✓ Clean and disinfect the wound using an antiseptic such as iodine solution or alcohol-based disinfectants. Seek medical attention without delay, even if the bite or scratch appears minor or several hours/days have passed since exposure.

✓ Rabies Immunoglobulin (RIG) should be administered for Category III exposures (deep bites, multiple wounds, or contamination of mucous membranes) along with anti-rabies vaccination.

✓ Anti-rabies vaccination should be started promptly according to the recommended post-exposure prophylaxis schedule.

✓ Tetanus prophylaxis and antibiotics may be required depending on the severity and contamination of the wound.

- **Community awareness and Education** – School-based education programmes, awareness campaigns, and community outreach activities promote responsible behaviour and timely healthcare seeking.
- **One Health Collaboration** – Coordinated efforts among veterinarians, physicians, public health authorities, and non-governmental organisations strengthen surveillance and prevention programmes (Machalaba et al., 2021).
- **Successful Global Models** – Countries such as Sri Lanka and the Philippines have achieved substantial reductions in rabies incidence through sustained vaccination campaigns and public education initiatives (Kanda et al., 2021).
- **India's Progress Toward Elimination** – Integrated dog vaccination programmes and community participation, as demonstrated in states such as Goa, highlight the feasibility of achieving the national and global rabies elimination targets.

Table 1: Vaccination Schedule for Rabies in Humans and Animals

Target Group	Prophylaxis Type	Schedule	Route	Special Notes
Humans (High-risk groups: veterinarians, laboratory personnel, animal handlers, wildlife workers)	Pre-exposure prophylaxis (PrEP)	Day 0 and 7	IM or ID	Booster doses based on risk assessment and antibody monitoring where indicated
Humans – Unvaccinated, Immunocompetent (Category II Exposure)	Post-exposure prophylaxis (PEP)	IM: Days 0, 3, 7, 14; ID: 0.1 mL at 2 sites on Days 0, 3, 7	IM or ID	No RIG required
Humans – Unvaccinated, Immunocompetent (Category III Exposure)	Post-exposure prophylaxis (PEP)	IM: Days 0, 3, 7, 14; ID: 0.1 mL at 2 sites on Days 0, 3, 7	IM or ID	Rabies Immunoglobulin (RIG) required once, preferably on Day 0 (up to Day 7 after first vaccine dose)
Humans – Unvaccinated, Immunocompromised	Post-exposure prophylaxis (PEP)	Days 0, 3, 7, 14, 28	IM	RIG required for Category III exposures; antibody titre confirmation recommended
Humans – Previously Vaccinated	Post-exposure prophylaxis (PEP)	IM: Days 0, 3; ID: 0.1 mL at 2 sites on Days 0, 3	IM or ID	RIG not required
Dogs and Cats (Primary Vaccination)	Prophylaxis	First dose at 12–16 weeks (3–4 months) of age	SC or IM	Use approved inactivated/killed rabies vaccine
Dogs and Cats (Booster Vaccination)	Prophylaxis	Booster 1 year after primary vaccination, then every 1–3 years according to vaccine label	SC or IM	Core vaccine; mandatory in many regions
Livestock (Cattle, Horses, Sheep, Goats)	Prophylaxis	Primary vaccination at 3 months, booster after 1 year, then annually	IM or SC	Recommended in endemic or high-risk areas, especially for valuable animals
Wildlife (Foxes, Raccoons and Other Reservoir Species)	Mass Rabies Control	Distribution of oral vaccine baits in the environment	Oral	Used in wildlife rabies control and elimination programs

Recommended intramuscular (IM) injection sites are the deltoid muscle of the upper arm in adults and the anterolateral aspect of the thigh in children younger than 2 years of age

Why Immediate Action is Essential

Rabies remains one of the deadliest infectious diseases, yet it is entirely preventable. Immediate action is required for several important reasons:

Unacceptably High Mortality

- Rabies claims one human life approximately every nine minutes worldwide despite the availability of effective vaccines.
- According to new in Hindustan times, recently, a 22-year-old state-level Kabaddi player, Brajesh Solanki, from Bulandshahr, died of rabies after being bitten by a stray puppy. He did *not* get anti-rabies treatment immediately.

Global Commitment to Zero Deaths

- International organizations including WHO, OIE, FAO, and GARC have endorsed the global target of "Zero Human Deaths from Dog-Mediated Rabies by 2030."
- Continued delays in implementing control measures may jeopardize this goal.

Substantial Economic Impact

- Rabies imposes an estimated annual global economic burden exceeding $8.6 billion through healthcare expenditures, productivity losses, and livestock mortality.
- Investing in prevention remains far more cost-effective than managing outbreaks and human exposures.

You, Me, and the Community: Partners in Rabies Elimination

Rabies elimination is not the task of veterinarians or doctors alone—it is a community mission (Sander, 2025).

- You – As individuals, people must seek immediate treatment after an animal bite, avoid traditional remedies, and spread awareness.
- Me – As veterinarians and health professionals, we hold the responsibility to educate communities, promote vaccination drives, and coordinate rapid responses.
- Community – Collective efforts, from local panchayats to urban municipalities, can ensure dog vaccination, population management, and public education campaigns.

This triad of responsibility is the cornerstone of rabies prevention.

Conclusion and Future Perspectives

Rabies may be ancient, but it is far from inevitable. The tools needed to prevent and control this disease already exist—vaccination, awareness, and timely treatment. The challenge lies in ensuring that these measures reach every community and every individual at risk. Through responsible animal care, regular vaccination programmes, and increased public awareness, countless lives can be saved. Every preventive step taken today brings us closer to a future where rabies is no longer a threat to humans or animals.

Rabies is 100% preventable, but only if awareness is transformed into action. Together---You, Me, and the Community—we can make rabies history."

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