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REVIEW ARTICLE

Emergence of Rabies Cases in Kerala: A Public Health Concern

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ABSTRACT

Rabies remains a critical public health concern, particularly in India where it accounts for a significant proportion of global deaths. This review explores the emergence of rabies in Kerala, India, examining its epidemiology, transmission dynamics, preventive measures, and recent public health responses. Kerala has experienced a disturbing rise in rabies cases over the past five years, despite the availability of effective vaccines and immunoglobulins. The article highlights epidemiological trends, diagnostic methods, post-and pre-exposure prophylaxis, and the challenges identified in the global WOAH 2024 report. Emphasis is placed on Kerala's Integrated Bite Case Management (IBCM) strategy, intersectoral collaboration, and One Health approaches. It concludes by reiterating the importance of achieving the "Zero by 30" strategy to eliminate dog-mediated rabies by 2030.

KEYWORDS

• Rabies • Kerala • Public Health • Post-Exposure Prophylaxis • Dog Bites • Zero by 30 Strategy

Key Messages:

Rabies remains entirely preventable through timely vaccination, awareness, and intersectoral cooperation. Achieving the "Zero by 30" global target requires strengthening surveillance, ensuring vaccine accessibility, and implementing One Health strategies effectively.

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INTRODUCTION

Rabies is an important global public health problem, causing around 59,000 human deaths annually, with Asia and African regions accounting for 95% of the global burden[1]. Despite being underreported by up to 20 times in Asia and 160 times in Africa, the economic cost of dog-mediated rabies is estimated at 8.6 billion USD.[2,3] In India, rabies is endemic in all states and union territories except Andaman and Nicobar Islands Lakshadweep, with 6,644 deaths reported from 2012 to 2022 (0.55/million annually).[4] The annual estimates for rabies deaths in India vary from 12,700 to 20,000 (9.7–15.4 deaths/million).[5] In Kerala, reported animal bite from 2018 to2019 to 2021-22 (IDSP data) is 1.6%with deaths due to rabies ranging from 5 to 22 (1.2 to 3.8/lakh reported animal bites). Rabies is targeted for elimination globally by 2030.[6] Rabies is also known as hydrophobia and acute highly fatal viral diseases of the central nervous system caused by Lyssavirus virus type 1. Rabies virus (RABV) is present in the saliva of rabid animals. Upon biting, scratching, or licking on broken skin (cuts/abrasions) and intact mucus membrane, the virus enters the body. However, this zoonosis is unique in that a vaccine exists for almost all of the reservoir species, particularly dogs, making its elimination feasible.[7]

Burden of Rabies cases in India

According to WHO, India accounts for 36% of the global deaths due to rabies. India also accounts for 65% of the deaths due to rabies in the South-East Asia region. The National Rabies Control Program reported 6644 clinically suspected cases and deaths of human rabies between 2012 and 2022. In India, the sudden spike in the number of cases of rabies is a major public health concern.[8] Deaths due to rabies among vaccinated and unvaccinated individuals, especially in the State of Kerala, have caused great public concern. More over the burden of cases declined during the period of 1998 to 2012 (30,000 to 12,700) with rising up of cases to 20,847 in 2015.[9] Whereas in Kerala, the number of infected dogs has doubled since 2017, among 300 samples taken from dogs, 168 samples (56%) were found to be positive for rabies, compared to 32% in 2016.[10] As per the Integrated Disease Surveillance Program (IDSP) under the Ministry of Health and Family Welfare, India reported approximately 30.43 lakh dog bite cases, with 286 fatalities in 2023.[11] A nationwide community-based survey (2022–2023) estimated about 9.1 million animal bite cases occur annually among this 5.6 bites are attributable to dogs and approximately 5,726 human rabies deaths occur annually. Moreover, World Health Organization (WHO) indicates India contributes to 36% of global rabies deaths, with an estimated 18,000–20,000 deaths annually, disproportionately affecting children under 15 years.[12]

Rabies cases in Kerala

Identification of Rabies Hotspots and Risk Zones in South and Central Kerala focused on spatial analysis of geocoded laboratory-confirmed rabies cases across nine districts in south and central Kerala. It identified Thiruvananthapuram, Thrissur, and Kollam as the highest-risk areas, while Idukki had the lowest. Notably, all municipal corporations were categorized as hotspots, demonstrating widespread risk.[31] In Kerala, there is an upward curve in rabies deaths in recent years and at an alarming rate over the past four to five years. According to the Health Department, two rabies deaths were reported in 2016; it rose to three deaths in 2017, then nine deaths in 2018, eight in 2019. In the pandemic year of 2020, the figure came down to five. In 2021, the number more than doubled to 11. There were 15 deaths in 2022, 17 in 2023, and 22 in 2024.[13]

Epidemiology

Agent: Lyssaviruses have a non-segmented RNA genome that encodes five viral proteins. The lyssavirus particle is shaped like a bullet, 100–300 nm long and 75 nm in diameter. Rabies virus (RABV) is present in the saliva of rabid animals. Upon biting, scratching, or licking on broken skin (cuts/abrasions) and intact mucus membrane, the virus enters the body.[14]

Age: Although all ages are susceptible, rabies is most common in children aged less than 15 years. On an average, 40 percent of post exposure immunization are given to children aged 5- 14 years.[15] In India, rabies is transmitted commonly by dogs and cats (~97%), followed by wild animals (2%) such as mongoose, foxes, jackals, and wild dogs, and occasionally by horses, donkeys, monkeys, cows, goats, sheep, and pigs. The presence of unvaccinated free-roaming dogs (FRD) or street dogs is a major contributor to the high incidence of Rabies in India, which is endemic. Apart from humans, Rabies also causes significant mortality among

livestock animals such as bovine, cattle and small animals. Contraction of Rabies through inhalation of virus-containing aerosols or transplantation of infected organs is described, but extremely rare.[14] Further, about 96% of the mortality and morbidity due to rabies is associated with dog bites. Although Rabies affects people of all age groups, children are the most vulnerable which constitutes 40% of people exposed to dog bites in rabies-endemic areas. As per WHO estimates, India accounts. for 36% of the global and 65% of the human rabies deaths in the South East Asia Region.[16]

Animal/Dog Bites Cases in India: The number of Animal Bites reported under the Integrated Disease Surveillance Project, has increased from 42 lakhs in 2012 to 72 lakhs in 2020. These bites include bites from animals such as due to dog, cat, monkeys. which requires Rabies Post Exposure Prophylaxis.

Mode of Transmission

People are usually infected following a bite or scratch from an animal with rabies, and transmission to humans by rabid dogs accounts for up to 99% of cases. It is also possible but rare, for people to get rabies from non-bite exposure includes scratches, abrasions, or open wounds that are exposed to saliva or other potentially infectious material from a rabid animal. RABV enters the body through open skin (scratches, bites or other open wounds) or by direct contact with mucosal surfaces, it cannot cross intact skin. RABV may replicate in muscle or other local tissues after exposure and gain access to motor endplates and motor axons to reach the central nervous system. Viruses can also enter motor axons in peripheral nerves directly during a penetrating injury.[17] All warm-blooded animals are vulnerable to infection by the rabies virus. However, the degree of species susceptibility varies considerably. In India, the domestic dog is the major reservoir of rabies.[18]

Pathogenesis

On entering into the human body through wounds or direct contact with mucosal surfaces, the rabies virus either multiplies at the local site of inoculation in non-nervous tissues or directly enters peripheral nerves and travels by retrograde axoplasmic flow to the central nervous system before its spread towards the brain via the nerves. It does not follow the hematogenous route of spread. The movement of the virus is extremely slow (5–100 mm per day) which results in a long incubation period. The incubation period of the majority of cases is 2–3 months, while 2– 3% of cases have had an incubation period > 1 year, with an exceptional case of 8 years. Because of the wide range of incubation periods, post-exposure prophylaxis should be given as soon as possible, however, it should not be denied to persons reporting late as well.[19]

Clinical Manifestations:

Initial symptoms of rabies include fever, pain and unusual or unexplained tingling, pricking, or burning sensations at the wound site. As the virus moves to the central nervous system, progressive and fatal inflammation of the brain and spinal cord develops. Clinical rabies in people can be managed but very rarely cured, and not without severe neurological deficits. There are two forms of rabies: Furious rabies results in hyperactivity, excitable behaviour, hallucinations, lack of coordination, hydrophobia (fear of water) and aerophobia (fear of drafts or of fresh air). Death occurs after a few days due to cardio-respiratory arrest. Paralytic rabies accounts for about 20% of the total number of human cases. This form of rabies runs a less dramatic and usually longer course than the furious form. Muscles gradually become paralyzed, starting from the wound site. A coma slowly develops and eventually death occurs. The paralytic form of rabies is often misdiagnosed, contributing to the under-reporting of the disease.

DIAGNOSIS

Currently there are no WHO-approved diagnostic tools for detecting rabies infection before the onset of clinical disease. Clinical diagnosis of rabies is difficult without a reliable history of contact with a rabid animal or specific symptoms of hydrophobia or aerophobia. Postmortem confirmation of rabies infection is done by various diagnostic techniques that detect whole viruses, viral antigens, or nucleic acids in infected tissues (brain, skin or saliva).[20] Rabies can be confirmed in patients early in the illness by antigen detection using immunofluorescence of skin biopsy and by virus isolation from saliva and other secretions.

PREVENTION AND CONTROL

The essential measures required for the control of Rabies are eliminating the diseases in domestic animals such as dogs and immune prophylaxis for humans.

Rabies vaccine

The rabies vaccine prevents the fatal rabies virus infection by causing the body to produce antibodies, administered either before potential exposure (pre-exposure prophylaxis) to high-risk individuals like animal handlers or travelers, or after an exposure (post-exposure prophylaxis) from a bite, scratch, or lick, in conjunction with Rabies immune globulin (RIG). It's crucial to complete the prescribed vaccination schedule, which involves multiple doses over a period of days or weeks, to ensure the immune system develops protection against the virus.[21] There are two types of vaccines. 1. Culture Vaccines (CCVs): These are the modern standard for human immunization. 2. Nerve Tissue Vaccines: An older type of vaccine.

Post-Exposure Prophylaxis (PEP)

It is usually given after a potential exposure, such as a bite, scratch, or lick from a rabid animal. This is a medical emergency and requires immediate attention. PEP should be administered using a 5-dose vaccine regimen, which includes one dose of vaccine on days 0, 3, 7, 14, and 28.[22] PEP is the emergency response to a rabies exposure. This prevents the virus from entering the central nervous system. A well performed wound risk assessment and PEP protocol consists of: extensive wound washing with water and soap for at least 15 minutes soon after an exposure, a course of rabies vaccine and administration of rabies immunoglobulin or monoclonal antibodies into the wound, if indicated.

Exposure risk and indications for PEP

Depending on the severity of exposure, administration of a full PEP course is recommended as follows:

Categories of contact with suspect rabid animal	Post-exposure prophylaxis measures
Category I - touching or feeding animals and animal licks on intact skin (no exposure)	Washing of exposed skin surfaces and there is no PEP
Category II - nibbling of uncovered skin and minor scratches or abrasions without bleeding (exposure)	Wound washing and immediate vaccination
Category III - single or multiple transdermal bites or scratches, contamination of mucous membrane or broken skin with saliva from animal licks and exposures due to direct contact with bats (severe exposure)	Wound washing, immediate vaccination and administration of rabies immunoglobulin/monoclonal antibodies

NB: Category II and III exposures require human rabies vaccination[20]

Animal Prophylaxis

Vaccinating domestic animals, particularly dogs, is a cornerstone of rabies control, effectively eliminating the disease at its animal source and owners should keep pets up-to-date on their vaccinations and minimize contact with wild animals to lower the overall risk of exposure.

Pre-Exposure Prophylaxis (PrEP):

In Kerala, there is an upward curve in rabies deaths in recent years and at an alarming rate over the past four to five years. In this context, the demand for pre-exposure prophylaxis vaccination to be implemented among larger population ahead of possible animal exposure or bite, has been raised by health experts as a public health concern. Presently it is recommended for those with high-risk of future exposure to the virus, such as veterinarians, animal handlers, or travelers to countries where rabies is common. It is administered intramuscularly on day 0 and day 7 as two shots followed by two booster doses which is enough to generate an immune response and the immunoglobulin is not required in case of animal bite in future.[13]

CONTROL OF URBAN RABIES

Since dog is the major source of infection, the most logical and cost-effective approach is elimination of stray and ownerless dogs combined with a program of swift mass

immunization, in the shortest possible time, of at least of the entire dog population of the area. Other methods include registration and licensing of all domestic dogs, restraint of dogs in public places, immediate destruction of dogs and cats bitten by rabid animals, quarantine for about 6 months of imported dogs and health education of people regarding the care of dogs and prevention of rabies.

Immunization of Dogs

Prophylactic vaccination of dogs against rabies is one of the most important weapons in rabies control. Studies have shown that, in general, 80—90% of the dog population is accessible for vaccination, all dogs should receive primary immunization at the age of 3-4 months and booster doses should be given at regular intervals, according to the type of vaccine used.[23]

KERALA'S CONTEX

In Kerala, there is an upward curve in rabies deaths in recent years and at an alarming rate over the past four to five years.[13] further reported animal bite from 2018 to 19 to 2021-22 (IDSP data) is 1.6% with deaths due to rabies ranging from 5 to 22 (1.2 to 3.8/lakh reported animal bites). Rabies is targeted for elimination globally by 2030[24] Moreover the number of dog bite cases among children are more and bites to the head, face, and fingertips involve more risk because of the rich nerve supply further they are more prone to be severely bitten on the neck, head and face. This facilitates the movement of the virus for a short distance ie, from face to brain. In addition, to prevent the entry of the virus in to nerves, wounds should be washed immediately with soap to reduce the total viral load. Further delayed first aid measure and failure to administer serum immunoglobulin into deep wounds are the other risk factors for most of the death cases. Most of the cases reported in Kerala were children in the school age group ranging from 5 to 12years from various districts such as Alappuzha, Pathanamthitta, Malappuram and Thiruvananthapuram. About 9 lakh animal bites were reported in the State in recent years. But only 2% to 3% of these exposures were rabid, and PEP were given and 30% of the bites require IG serum.[25] In this context, Pre-exposure prophylaxis (PrEP) plays a vital role and health experts recommends that it has to be implemented among larger population ahead of possible animal exposure or bite, as a public health concern. Presently veterinarians and animal handlers who are at risk of animal bites almost are getting it. In this, only two shots of the vaccine are enough to generate an immune response and need to take only two booster shots and the Immunoglobulin Serum is not required in case of animal bite in future. Even though effective vaccines and life-saving immunoglobulin exist, rabies prevention in India faces a grim paradox with 18,000–20,000 death cases in each year. India carries the world's heaviest burden of rabies deaths, accounting for over one-third of global fatalities. Children under 15 are disproportionately affected, often because their bites go unnoticed or untreated.[26] If vaccination starts too late, or wounds are not cleaned properly, the vaccine may not have sufficient time to provide protection. Furthermore, severe cases, such as deep bites or those on the face, often necessitate rabies immunoglobulin (RIG) alongside the vaccine to offer immediate, passive immunity. Moreover, several factors undermine vaccine effectiveness. Improper storage conditions, especially heat exposure, can compromise vaccine potency. Errors in administration, such as injecting at the wrong site, also reduce protection. Host factors, too, play a crucial role.[27] Integrated Bite Case Management (IBCM) strategy involves integrated human and animal surveillance to pick up all animal bite cases in the community and systematic follow-up investigations on the human and animal side. Moreover, accuracy in rabies reporting and proper data gathering helps us estimate the disease burden and identify geographic locations where rabies transmission is more so that appropriate measures such as ring vaccination of all domestic and free-roaming dogs within a two km radius can be adopted to protect the community," About 9 lakh animal bites are reported in the State in recent years. But only 2% to 3% of these exposures would be actually rabid, every reported case has to be given PEP. About 30% of the bites require IG serum. Building intersectoral partnerships and team work of all stakeholders, community counselling all are key to the success of IBCM strategy.[26]

Challenges and opportunities for the next miles in global rabies control" — A WOAH *(World Organisation for Animal Health)* preprint from October 2024. It examines barriers in dog vaccination, vaccine quality, surveillance, and

the potential of oral rabies vaccines (ORV) to improve coverage particularly for hard-to-reach dog populations.

Key Challenges in the WOAH Report includes

1. **Under-Vaccination of Dogs:** More than 130 million dogs are vaccinated each year in endemic regions yet coverage falls three times below the level needed to achieve herd immunity.
2. **Limited Reach with Parenteral Vaccines:** The traditional injection-based (parenteral) vaccination method struggles to reach stray, feral, or unhandled dogs. ORV, delivered in vaccine-laden baits, offers a promising alternative but scaling it sustainably remains a challenge.
3. **Vaccine Quality & Surveillance Shortfalls:** Some programs have used low-quality or ineffective vaccines, resulting in outbreaks and setbacks. Weak surveillance means the true burden of rabies may be underreported, undermining elimination efforts.
4. **Fact-based Infographic on Rabies Prevention:** A WHO-style infographic highlighting prevention strategies like mass dog vaccination, bite avoidance, wound care, and post-exposure prophylaxis reminding us that every rabies death is preventable when proper measures are in place.
5. **Human Rabies Treatment Challenges:** A snapshot of key obstacles in treatment implementation, such as vaccine availability, infrastructure, and clinical complexity.
6. **Healthcare System Structure:** It explains healthcare delivery, stressing how accessibility and resources vary across regions underlining how prevention and treatment gaps emerge when care is structurally fragmented.
7. **Integrated Bite Case Management (IBCM) Workflow:** surveillance and coordination hurdles in rabies case management includes delays and gaps in bite reporting, animal monitoring, and feedback loops, infrastructure non availability, lack of awareness about preventive behaviour, treatment & Supply issues like vaccine availability, administration barriers, and clinical protocol complexity.[28]

Elimination of Rabies - The 'zero by 30' strategy

The global health community is committed to eliminating dog-mediated human rabies deaths by 2030. In 2015, the Tripartite alliance comprising of Food and Agriculture Organisation, World Organization for Animal Health, and World Health Organization issued a call for action to eliminate dog-mediated human rabies by 2030 at the Global Rabies Conference. United Against Rabies initiative is advancing this goal through the One Health approach.[29] This multi-sectoral collaboration aims to jointly develop evaluation frameworks for epidemiology and surveillance, support a shared vision of global health security, and informed decision-making. Adopting these One Health capacity-strengthening exercises could significantly enhance India's rabies control efforts and could pave the way towards the elimination of human rabies by 2030 and are determined to reach the global target of "Zero human deaths due to dog-mediated Rabies by 2030".[30]

CONCLUSION

Rabies continues to be a neglected but preventable disease. Strengthening prevention strategies, public awareness, and coordination between veterinary and human health sectors is crucial for its elimination. Achieving zero human rabies deaths by 2030 demands sustained governmental commitment, community engagement, and improved surveillance mechanisms.

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Abbreviations

PrEP- Pre exposure prophylaxis
PEP**-** Postexposure prophylaxis
WOAH- World organisation for animal health
IBCM- Integrated bite case management
RIG- Rabies immunoglobulin
FRD- Free roaming dogs
IDSP- Integrated disease surveillance programme
RABV- Rabies virus
USD- United states dollar