BIO VET INNOVATOR MAGAZINE

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SPECIAL ISSUE 1

WORLD RABIES DAY 28 SEPTEMBER

RABIES DAY SPECIAL

"BRIDGING THE GAP BETWEEN SCIENCE AND SAFETY"

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BIO VET INNOVATOR MAGAZINE
EST. 2024
FUELING THE FUTURE

Preface

Dear Readers,

The Rabies Day Special Issue of Bio Vet Innovator Magazine marks an important contribution to the global efforts for rabies eradication, coinciding with ***World Rabies Day on September 28, 2024***. Rabies, a deadly zoonotic disease, continues to pose a significant threat to both human and animal health, particularly in regions where prevention and control measures are still developing. This issue, titled **"Rabies Day Special: Bridging the Gap Between Science and Safety"**, reflects our commitment to raising awareness, sharing knowledge, and encouraging collaboration in the fight against rabies.

In this special edition, we have brought together a collection of insightful articles, case studies, and creative contributions from professionals across various fields, including veterinary medicine, public health, microbiology, biotechnology, and more. From global eradication efforts to national success stories, this issue highlights the diverse approaches taken to address rabies, emphasizing the critical role of One Health strategies in combating this preventable disease.

Our expert contributors and guest editors have played a pivotal role in shaping this issue, offering their unique perspectives on rabies prevention, control, and treatment. Through their work, we aim to provide valuable insights that not only inform but inspire ongoing efforts to eliminate rabies once and for all.

We would also like to recognize the participants of our Best Article, and poster competitions, whose creativity and dedication have added an inspiring dimension to this issue. Every participant has made a significant contribution to raising awareness about rabies, and we are honored to showcase their efforts.

As you explore this issue, we hope it will serve as both a resource and a call to action—one that bridges the gap between science and safety and brings us closer to a rabies-free future.

Dr. Sudesh Kumar Dedar
Co-Founder & Editor in Chief
Bio Vet Innovator
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Preface

Dear,

It is with great pride that we present this special issue of Bio Vet Innovator Magazine, dedicated to ***World Rabies Day 2024***. Rabies continues to be one of the most preventable yet deadly zoonotic diseases, affecting both human and animal populations worldwide. This issue is our contribution to the global fight against rabies, focusing on scientific advancements, success stories, and ongoing challenges in the quest for a rabies-free world.

The theme of this issue, "Bridging the Gap between Science and Safety," highlights the critical importance of collaboration between the scientific community, veterinarians, public health experts, and local stakeholders. As we bring together articles, case studies, and creative contributions from professionals across the globe, we aim to showcase how collective efforts can bring about real change in rabies prevention and control.

This issue also marks an important milestone for Bio Vet Innovator, as we engage experts in the fields of veterinary science, One Health, and public health to contribute to the conversation. Our goal is not just to educate, but to inspire action and innovation in rabies eradication.

I would like to take this opportunity to express my heartfelt gratitude to all the contributors, authors, artists, and editorial team members who have worked tirelessly to make this issue a reality. Your commitment to the cause of rabies eradication and your belief in the power of education are what make this magazine possible.

Together, let us continue to push forward, knowing that a world free of rabies is within our reach.

For more information or to join our community, please visit www.biovetinnovator.in or contact us directly at biovetinnovator@gmail.com.

Thank you for your time and consideration. I look forward to welcoming you to the BIO VET INNOVATOR community.

Warm regards,

Dr. Anil Choudhary
Co-Founder & Managing Editor
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Acknowledgment

The creation of BioVet Innovator has been a journey of collaboration, dedication, and unwavering support from a community deeply committed to advancing veterinary, agriculture, and allied sciences.

First and foremost, we extend our heartfelt gratitude to the contributing authors, whose insightful articles and cutting-edge research form the backbone of this publication. Your expertise and passion are the driving forces behind this magazine.

A special thank you to our editorial team, whose meticulous attention to detail and tireless efforts have shaped each issue into what it is today. Your commitment to excellence ensures that our readers receive the highest quality content. We also extend our sincere appreciation to our reviewers for their valuable input and support.

To our colleagues and mentors, your guidance and encouragement have been invaluable throughout this process. Your belief in the potential of this magazine inspires us to strive for excellence continuously.

Finally, we wish to thank our family and friends for their constant support and understanding as we dedicated countless hours to this project. Your love and patience have been our strength.

This magazine is not just a publication; it is a testament to the collective effort of a community passionate about innovation and the future of science. We look forward to continuing this journey together as we explore and shape the future of our field.

Dr. Anil Choudhary
Co-Founder & Managing Editor
Bio Vet Innovator Magazine

Dr. Sudesh Kumar Dedar
Co-Founder & Editor-in-Chief
Bio Vet Innovator Magazine

BIO VET INNOVATOR
EST. 2024
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About Us

Bio Vet Innovator Magazine, an open-access, peer-reviewed publication, launched on July 4th, 2024. It serves as a platform for researchers, students, scholars, and scientists to exchange ideas on cutting-edge topics in veterinary, agricultural, and allied sciences (Biotechnology, Microbiology, and Environmental).

The magazine's goal is to disseminate information on the latest innovations and emerging experimental technologies globally. By doing so, it facilitates the sharing of scientific discoveries and advancements within the global scientific community focused on veterinary, agriculture, and allied sciences.

Bio Vet Innovator Magazine will be published monthly as an online open-access magazine on our official website www.biovetinnovator.in

We welcome submissions of new information, novel technologies, and original articles from the fields of veterinary, agriculture, and allied sciences (Biotechnology, Microbiology, Environmental). To ensure credibility, all articles will undergo review by subject matter specialist editors, principal scientists, research scholars from various institutions, and senior professors from different universities in India. Accepted articles may cover a range of disciplines including Veterinary Science, Animal Science, Agriculture, Horticulture, Dairy Science, Fisheries, Forestry, Biotechnology, Life Sciences, and Environmental Sciences. Authors are requested to adhere to the author guidelines policy when submitting short communications and technical/popular articles.

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AIM

The goal of Bio Vet Innovator Magazine is to feature the most recent innovations and emerging experimental technologies poised for global adoption in veterinary, agriculture, and allied sciences.

This initiative aims to distribute scientific insights and the latest research findings throughout the global scientific community engaged in allied sciences worldwide.

MISSION

- Our mission is to strengthen the Animal husbandry practices and transfer the technologies from Lab to Farm.
- To transform innovations in Animal Science Sector into successful businesses for economic growth and employment.
- To act as a catalyst for nurturing entrepreneurial and start-up ecosystem for sustainable growth of livestock & allied sector.
- To love and care for each and every animal just like we would want someone to take care of.
- To connect the farmers with experts in research, technological advancement in Livestock and allied sector.
- To act as a platform for the dissemination of knowledge for the betterment of Livestock and allied sectors.
- To contribute for the development of Livestock and allied sector by introducing them to various schemes and polices through Bio Vet Innovator Magazine network.

VISION

The mission of Bio Vet Innovator Magazine is to provide an independent, authentic, high quality and peer reviewed platform to publish articles related to Veterinary Sciences, Animal Husbandry Practices, Livestock Sector and concerned allied sciences about latest innovations globally.

The word “Bio Vet Innovator” signifies the prominence given to the Animal Husbandry field and other allied sciences in today’s era.

Our magazine offers platform and broad coverage for Veterinary Science, Animal Husbandry, Agricultural Science and Allied sciences researchers and scientists for deliberating connecting throughout India and globally.

For all of these endowed with inquisitive mind and driven by professional goals, this magazine will be a voyage of discovery.

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Chief Editor of Rabies Day Special Issue: Dr. G. Kavitha

Dr. G. Kavitha
Chief Editor, Rabies Day Special Issue
Assistant Professor at Veterinary College, KVAFSU, Gadag

About Chief Editor

We are honored to have **Dr. G. Kavitha** as the Chief Editor for the Rabies Day Special Issue of ***Bio Vet Innovator Magazine***. Dr. Kavitha is an accomplished Assistant Professor at the Veterinary College, KVAFSU, Gadag, with an impressive 12 years of experience in the field of Veterinary Microbiology.

Dr. Kavitha completed her **Ph.D. on rabies at the KVAFSU-CVA Rabies Diagnostic Laboratory**, a **WOAH Reference Laboratory for Rabies**, under the esteemed guidance of **Dr. Shrikrishna Isloor**, the Laboratory Director and Professor. In 2023, her exceptional contributions in rabies research were recognized with the prestigious **Young Scientist Award** by the Association for Prevention and Control of Rabies in India (APCRI) and the **University Gold Medal** for her Ph.D. research.

A key highlight of her Ph.D. research was the development of innovative **in-house immunodiagnostic assays for rabies in animals**, a significant step forward in rabies diagnostics. Her work extends beyond research; she has been actively involved in organizing numerous national and international training programs, serving as a resource person for vets on rabies diagnosis and brain sample collection.

Dr. Kavitha's commitment to the global and national goal of **rabies elimination by 2030** is truly inspiring, and her expertise and leadership as the Chief Editor for this special issue will undoubtedly elevate its quality and impact.

We are thrilled to have her lead this edition, dedicated to furthering the cause of rabies eradication and contributing to a safer, rabies-free world.

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July | 2024

Volume 1; Issue 1

'Fueling the Future of Sciences'

Dr. Sudesh Kumar Dedar
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Co- founder

"The health of humans, animals, and ecosystems are interconnected – protecting one protects them all."
– One Health Initiative

Bio Vet Innovator Magazine

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'Fueling the Future of Sciences'

Volume 1; Issue 2

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Upcoming Book: Call for Book Chapters

"Innovative Poultry Science: Trends, Disease Management, and Future Perspectives"

Brief Info:

We are pleased to invite contributions for an upcoming book titled "Innovative Poultry Science: Trends, Disease Management, and Future Perspectives." This book aims to provide a comprehensive overview of the latest advancements, trends, and future directions in poultry science, with a particular focus on disease management, nutrition, and sustainability. The book is intended for researchers, academics, industry professionals, and students, offering in-depth insights into the evolving landscape of poultry science.

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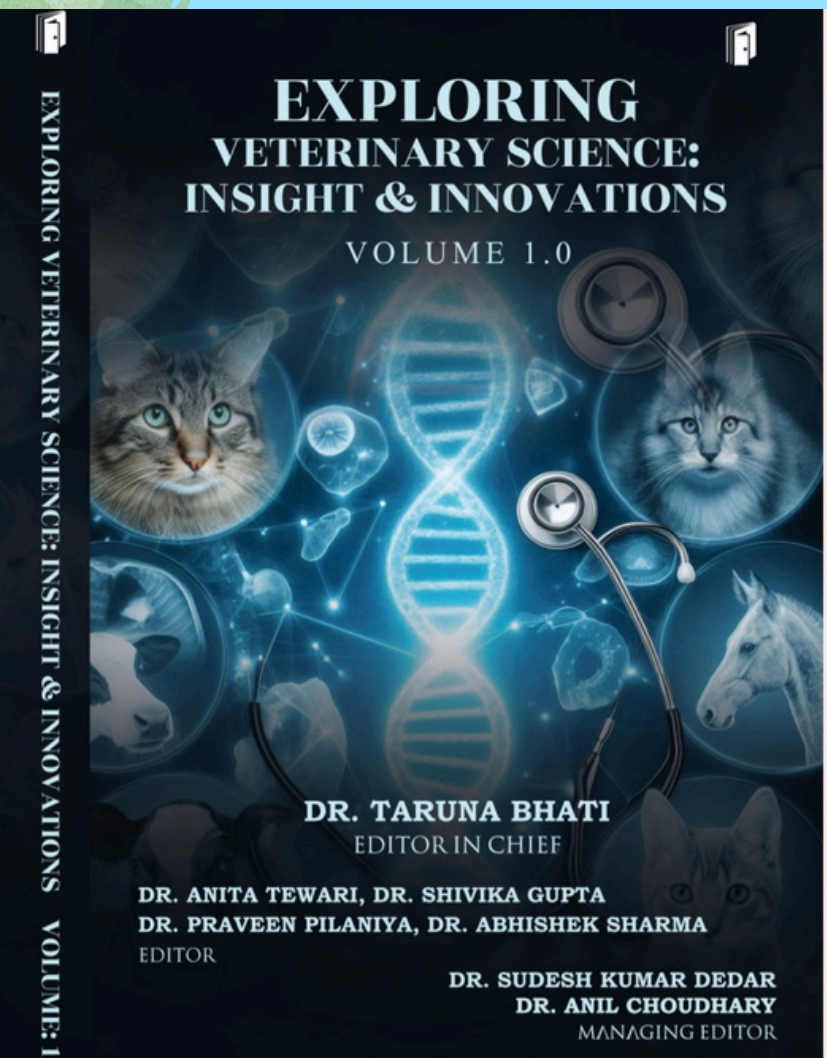
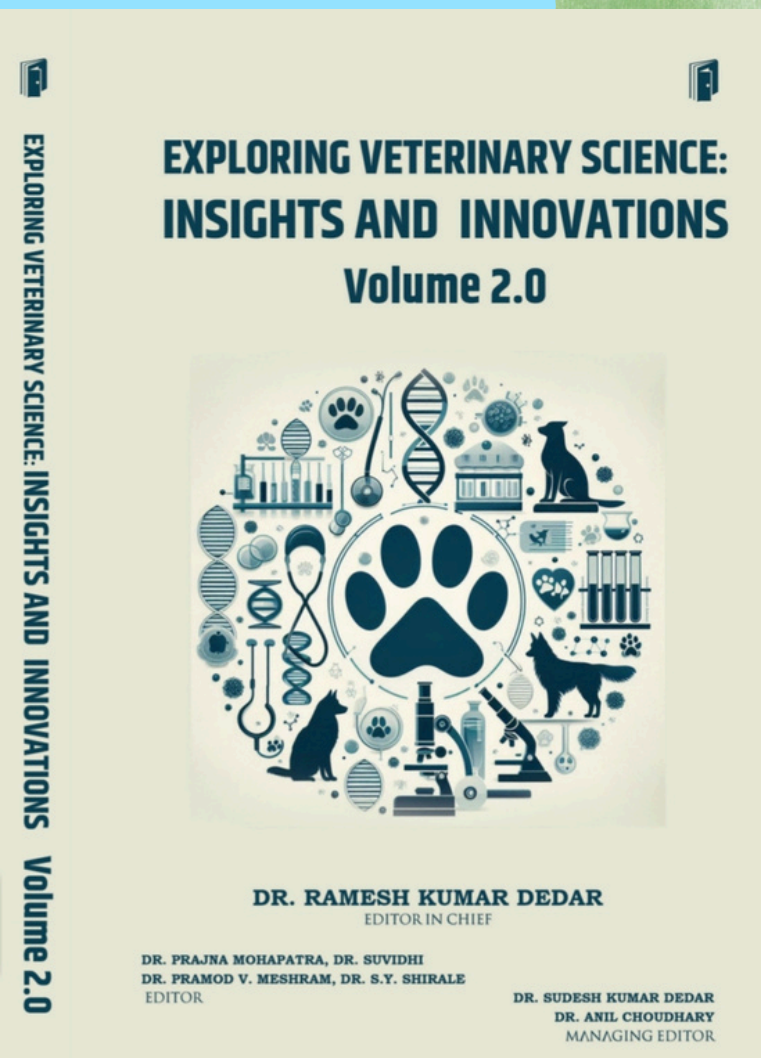
30th September, 2024





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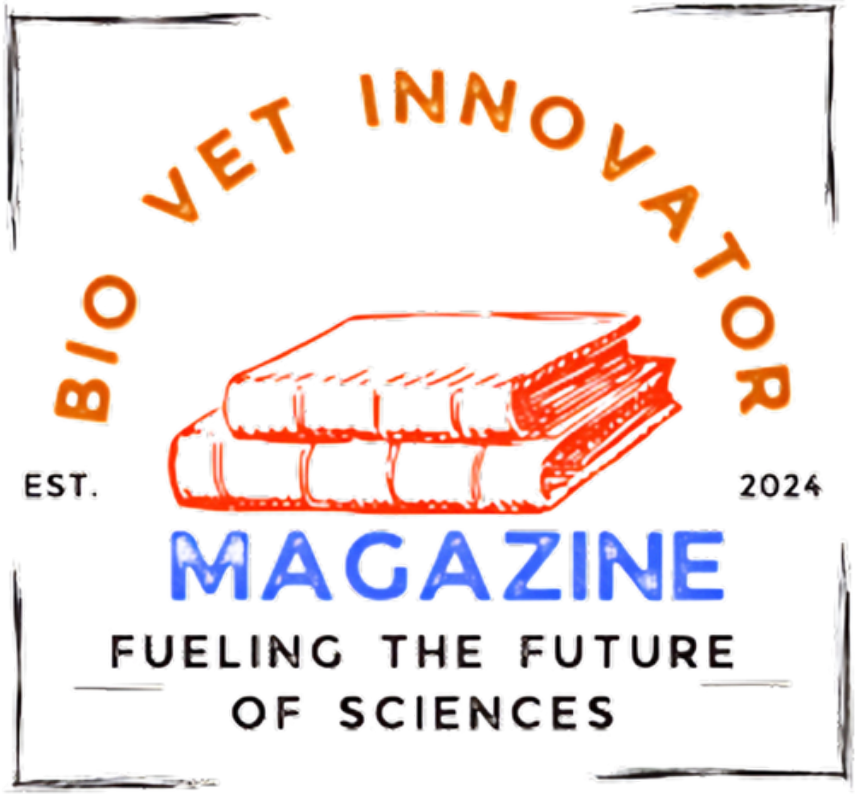

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CONTENT

Bio Vet Innovator Magazine

Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies: Understanding and Control Strategies

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Introduction:

Rabies is an acute, progressive viral encephalomyelitis that primarily affects carnivores and bats, but any mammal can be infected. It is a preventable yet deadly viral infection, usually transmitted through bites, scratches, or saliva of infected animals, particularly domestic dogs, which are the main source of human exposure (WHO, 2013).

Rabies virus belongs to Rhabdoviridae family and characterized by its bullet shape and single-stranded, negative-sense RNA structure. Its envelope and ribonucleocapsid core increase its virulence, leading to severe symptoms like hydrophobia and aerophobia. These symptoms arise from nervous system infection, typically seen in the furious form of rabies, which accounts for 80% of human cases. The other 20% are paralytic cases. Initial symptoms such as fever, headache, and fatigue quickly progress to encephalomyelitis and delirium. Rabies disproportionately affects poor and rural populations, with most deaths occurring in children under 15 years in Asia and Africa. However, the incidence of rabies has significantly decreased, especially in developed countries, thanks to the development of rabies vaccine by Louis Pasteur in 1885 and subsequent public health measures such as widespread animal vaccination and post-exposure prophylaxis (Koury and Warrington, 2023).

Current Strategies for Rabies Control in India:

Effective control of rabies in dogs is crucial for reducing human rabies cases in the long term, achievable through mass dog vaccination and population control measures. Aligning with the global goal to eliminate human deaths from dog-mediated rabies by 2030 (Zero by 30), India introduced its National Action Plan for the Elimination of Dog-mediated Rabies (NAPRE) in 2021. This plan mandates human rabies to be a notifiable disease across all states, establishing effective reporting and surveillance systems. Enhanced diagnostic services and vaccine availability will follow, addressing gaps in rabies control policies.

Vaccination remains the cornerstone for preventing rabies in exposed individuals. Post-exposure prophylaxis (PEP) includes thorough wound cleaning and administration of rabies immunoglobulin and vaccines.

There are various types of rabies vaccines with differing safety profiles and immunogenicity, driving ongoing research for improvement. Live-attenuated vaccines pose risks like inducing rabies due to mutations, while inactivated vaccines have lower immunogenicity and require multiple doses, making them costlier. This has led to the development of adjuvanted vaccines (Astray et al., 2017). Current research focuses on next-generation vaccines, such as genetically modified and viral vector-based vaccines, though challenges related to safety and effective distribution persist. Preventative measures also include animal vaccination and public awareness campaigns. In 2018, the Global Strategic Plan aimed to eradicate human deaths due to rabid dogs by 2030, emphasizing animal vaccination (Natesan et al., 2023).

Primary objective of PEP is to neutralize the rabies virus at the bite site, preventing its entry into the nervous system. PEP should begin as soon as possible after exposure, accompanied by proper wound care and rabies immunoglobulin (RIg) infiltration when necessary. Pre-exposure prophylaxis (PrEP) aims to stimulate the immune system to produce rabies virus-neutralizing antibodies (RVNA) before potential exposure, requiring only a few vaccine boosters in case of subsequent exposures to trigger a rapid immune response and prevent infection.

Human Rabies Vaccination: PrEP and PEP

Pre-exposure prophylaxis (PrEP) is administered to individuals at high risk of exposure to rabid animals such as veterinarians, laboratory staff, animal handlers and people living or traveling to high-risk areas. The PrEP schedule consists of three intramuscular (1 ml) or intradermal (0.1 ml) injections of cell culture or embryonated egg-adapted vaccine on days 0, 7, and 21 or 28. Post- exposure prophylaxis (PEP) given after a suspected rabid animal bite to prevent disease development, involving human rabies immune globulin and a rabies vaccine on the day of exposure, followed by a series of injections on days 0, 3, 7, 14, and 28 (Singh *et al*., 2017).

In rabies endemic areas, any animal bite or contact from a suspected rabid animal necessitates prompt PEP, including wound treatment and immunization based on injury location. Goa, India, successfully eliminated human rabies through PEP access, awareness campaigns, and enhanced surveillance (Gibson *et al*., 2022).

Conclusion:

Rabies control in India poses a significant public health challenge. Effective prevention and control hinge on developing cost-effective vaccination technology for humans and animals, implementing state-level rabies control programs in collaboration with national and international health agencies, and raising public awareness. The One Health concept plays a crucial role in preventing and controlling rabies in India.

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Bio Vet Innovator Magazine

Volume 1 : Special Issue 1 : World Rabies Day - 2024

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परिचय:

रेबीज़ एक अत्यधिक घातक वायरल बीमारी है जो जानवरों से इंसानों में फैल सकती है। यह ज़ूनोटिक बीमारी है, यानी इसे संक्रमित जानवरों के काटने या खरोंचने से मानव में भी संक्रमण हो सकता है। यह बीमारी आमतौर पर संक्रमित जानवरों, खासकर आवारा कुत्तों, चमगादड़ों, रैकून, स्कंक और लोमड़ियों के काटने या खरोंच से फैलती है। रेबीज़ वायरस केंद्रीय तंत्रिका तंत्र को प्रभावित करता है, जिससे मस्तिष्क में सूजन (एन्सेफलाइटिस) हो जाती है और गंभीर स्थिति में मृत्यु हो सकती है।

यदि किसी संक्रमित जानवर के संपर्क में आने के बाद तत्काल उपचार नहीं किया जाए, तो यह बीमारी जल्दी ही घातक साबित हो सकती है। रेबीज़ का कोई प्रभावी इलाज नहीं है, लेकिन अगर घाव की त्वरित सफाई और टीकाकरण किया जाए, तो रेबीज़ से बचा जा सकता है। रेबीज़ से होने वाली मानव मौतों में से 99% मामलों में कुत्ते इसका मुख्य कारण होते हैं। भारत में रेबीज़ व्यापक है और दुनिया भर में रेबीज़ से होने वाली मौतों का 36% हिस्सा भारत से आता है। हर साल 28 सितंबर को विश्व रेबीज़ दिवस मनाया जाता है, जो इस बीमारी के प्रति जागरूकता फैलाने के लिए समर्पित है।

इटियोलॉजी:

रेबीज का कारण रबडोविरिडी परिवार का लिसा वायरस होता है और इसमें एकल-स्ट्रैंडेड RNA जीनोम होता है। यह वायरस गोली के आकार का होता है और विशेष रूप से तंत्रिका तंत्र को प्रभावित करता है। रेबीज वायरस बहुत नाजुक होते हैं और आसानी से नष्ट हो सकते हैं।

संचरण:

संक्रमित कुत्ते की लार रेबीज फैलने का सबसे सामान्य स्रोत होती है, क्योंकि बीमारी के लक्षण दिखने से पहले ही कुत्ते की लार ग्रंथि में रेबीज वायरस की बड़ी मात्रा मौजूद होती है।

चिकत्सीय संकेत: रेबीज के लक्षण दो मुख्य रूपों में विभाजित होते हैं: उग्र रूप (फ्यूरियस फॉर्म) और पैरालिटिक रूप (डंप फॉर्म)

कुत्ते और बिल्ली में:

1. उग्र रूप (व्यवहार और उत्तेजना में बदलाव):

उग्र रूप में कुत्ते अत्यधिक हिंसक हो जाते हैं, लंबी दूरी तक भाग सकते हैं, और काल्पनिक चीजों को पकड़ने की कोशिश करते हैं। पानी पीने में असमर्थ होते हैं, अत्यधिक लार गिरती है, और उन्हें प्रकाश से डर (फोटोफोबिया) हो जाता है। उनकी आवाज में बदलाव आता है और जबड़ा ढीला हो जाता है, जिससे जीभ बाहर लटक जाती है।

2. पैरालिटिक रूप (डंप फॉर्म):

पैरालिटिक रूप (डंप फॉर्म) में जानवर खुद को अंधेरी जगहों में छिपा लेते हैं। इस दौरान जबड़े, जीभ और पिछले हिस्से का पक्षाघात हो जाता है, जिससे वे काटने में असमर्थ होते हैं। अंततः श्वसन पक्षाघात के कारण उनकी मृत्यु हो जाती है।

मवेशियों में:

1. उग्र रूप:

उग्र रूप में, जानवर अन्य जानवरों या वस्तुओं पर आक्रामक रूप से हमला करते हैं। वे जोर से चिल्लाते हैं और उनकी चाल असंयमित हो जाती है। अत्यधिक लार बहने लगती है और थूथन में कंपन होता है। इस अवस्था में जानवर यौन उत्तेजना और आक्रामक व्यवहार प्रदर्शित करते हैं, साथ ही गले का पक्षाघात भी हो जाता है।

2. पैरालिटिक रूप:

पैरालिटिक रूप में, जानवरों के पिछले हिस्से में ढीलापन आ जाता है और चलते समय वह हिलने लगता है। इस दौरान लार का अत्यधिक गिरना होता है और जम्हाई जैसी गतिविधियां देखी जाती हैं, जिससे उनकी सामान्य गतिविधियां प्रभावित हो जाती हैं।

घोड़े में:

घोड़ों में रेबीज के लक्षणों में मांसपेशियों में कंपन, गले का पक्षाघात और सुस्ती शामिल होती है। इसके साथ ही अचानक लंगड़ापन आ सकता है और घोड़ा बार-बार सिर पटकने जैसी हिंसक गतिविधि कर सकता है।

मनुष्यों में:

मनुष्यों में रेबीज के लक्षण काटने की जगह पर दर्द और जलन से शुरू होते हैं। वायरस धीरे-धीरे मस्तिष्क तक पहुंचता है, जिससे लक्षण दिखने लगते हैं और बीमारी घातक हो जाती है। पानी पीने की कोशिश में गले में दर्दनाक ऐंठन (हाइड्रोफोबिया) हो सकती है। रोगी को बेचैनी, अजीब व्यवहार, ऐंठन, और अत्यधिक लार भी हो सकती है। आमतौर पर कुछ दिनों में मौत हो जाती है।

निदान:

अगर कोई जानवर केंद्रीय तंत्रिका तंत्र के लक्षण दिखाता है और उसका टीकाकरण इतिहास अज्ञात है, तो रेबीज को संभावित कारण माना जाना चाहिए। रेबीज की पुष्टि के लिए कॉर्नियल इंप्रेशन स्मीयर और मस्तिष्क के फ्लोरोसेंट एंटीबॉडी परीक्षण (एफएटी) का उपयोग किया जाता है। एफएटी एक तेज और विश्वसनीय परीक्षण है जिसकी सटीकता 99.9% है। इसके अलावा, विक्रेताओं की स्टेनिंग तकनीक के माध्यम से मस्तिष्क में नेग्री बॉडीज (इंट्रासाइटोप्लाज्मिक इंक्लूजन बॉडीज) की पहचान की जाती है।

संपर्क के बाद उपचार:

किसी संक्रमित जानवर के संपर्क के बाद रेबीज से बचाव के लिए तुरंत घाव की सफाई और टीकाकरण किया जाना चाहिए, जिससे लगभग 100% मामलों में रेबीज से बचाव हो सकता है। इसके लिए घाव को फेनोलिक साबुन या बहते पानी से अच्छी तरह धोकर साफ किया जाता है। इसके बाद एंटीसेप्टिक्स लगाई जाती हैं। घाव पर पट्टी या टांके लगाने से बचना चाहिए। सबसे महत्वपूर्ण बात, जल्द से जल्द एंटी-रेबीज वैक्सीन दी जानी चाहिए।

Citation: आशा, पजा, रवि डबास, प्रत्यांशु श्रीवास्तव, रूपम सचान, अंकित सरन. (2024). रेबीज़: एक घातक ज़ूनोटिक बीमारी. In Bio Vet Innovator Magazine (Vol. 1, Issue Sp 1, pp. 4–6). Bio Vet Innovator Magazine. https://doi.org/10.5281/zenodo.13870188

संपर्क के बाद टीकाकरण शेड्यूल:

अगर जानवर पहले से टीकाकरण नहीं हुआ है, तो काटने के 24 घंटे के भीतर टीका शुरू किया जाता है और फिर 3वें, 7वें, 14वें, 28वें, और अगर जरूरत हो तो 90वें दिन (एसेन का शेड्यूल) पर टीका दिया जाता है।

Citation: आशा, पजा, रवि डबास, प्रत्यांशु श्रीवास्तव, रूपम सचान, अंकित सरन. (2024). रेबीज़: एक घातक ज़नोटिक बीमारी. In Bio Vet Innovator Magazine (Vol. 1, Issue Sp 1, pp. 4–6). Bio Vet Innovator Magazine. https://doi.org/10.5281/zenodo.13870188

Bio Vet Innovator Magazine

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Insights on Feline Rabies

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Introduction:

Rabies, one of the deadliest zoonotic virus world has ever seen. Though world is progressing in many sectors even in medical science, still there is no specific treatment ever successful for rabies till date. The options we have for decreasing the prevalence of rabies is by understanding and abruption of lifecycle & transmission, prevention (for that we are currently depending on Vaccination). Dog is most common reservoir host and active transmitter of rabies, that part is well known for everyone but feline rabies is also not a new term. Rabies cases and deaths from the cat bites are noted across the world. General public mostly not aware that cat can also transmitted rabies as same as dog. The main reason for many bite cases leading to death is solely by negligence in getting post bite vaccination and not taking cat bite as serious as dog bite. The knowledge and scientific reports, understanding regarding the feline rabies is minimum than canine rabies.

Key words: Feline, Rabies, Nervous tissue, Urban cycle.

Epidemiology:

The prevalence of feline rabies and human rabies cases by cat is very less and its morbidity limited [to 1.8% (R L Ichhpujani *et al*., 2008)]. although cats are prone to rabies, there are no cat specific strains of virus. Transmission occurs via bite by a rabid dog (mainly), monkey or cat (less common) etc. and can also by spill over to feral cats by contact with the bats. Cat is not a reservoir host for the rabies, that's why cat to human transmission is very much limited but not impossible.

Incubation period depends upon the site and depth of bite, number of bites and load of virus from the bite. The average incubation period in cats is 2 months, but may vary from 2 weeks to several months, or even years. (Tadeusz Frymus *et al.,* 2009).

Description and Importance of Disease:

Rabies is a neurotrophic virus can infect all mammalian species causing fatal encephalomyelitis. This bullet shaped lyssa virus is a single stranded RNA virus belong to the family rhabdoviridae, mononigavirales.

Risk group (Zoonoses): Veterinarians, pet owners and children, animal handlers, animal rescuers and activists.

Human Rabies:

India is endemic for rabies, and accounts for 36% of the world's rabies deaths. True burden of rabies in India is not fully known; although as per available information, it causes 18,000-20,000 deaths every year. About 30-60% of reported rabies cases and deaths in India occur in children under the age of 15 years as bites that occur in children often go unrecognized and unreported. (WHO/India/Health topics/Rabies).

Pathophysiology:

Once the rabid dog/cat or any infected animal bites another host like a cat (Ex// in a fight) initial replication occurs within the local bitten tissue or muscles, then enters the local nerves by centrifugal movement of virus. the treatment is ineffective once the rabies virus reaches the nervous tissue as most drug can't penetrate intact tissue. By retrograde axonal movement from peripheral nervous system reaches the central nervous system causing fatal encephalomyelitis. later by centripetal movement from the CNS virus reaches the salivary glands where the high titre of virus is noticed. Saliva is the important source of rabies transmission in urban cycle.

Clinical Signs:

The clinical signs of rabies are developed in three different stages - prodromal stage, furious stage and paralytic stage.

- ***Prodromal stage*** is seen in initial days of infection (about 3 days), infected cat is seen with altered behaviour, deepening of voice, change in behaviour, continues licking of bite wound, can notice Laryngospasms.
- ***Furious stage*** is seen for next one week, in this stage rabies is actively transmitted. The virus load is very high in saliva, infected cats will be restless, irritable, nervous with hyperesthesia and hyper salivation, dilation of pupils can be also noticed. Animal will vigorously bite the inanimate objects that comes in contact, the animals and humans when interacted.
- ***Paralytic stage*** will be seen for about four days. animal can have seizures; cat shows progressive generalised paralysis, spasmodic paralysis links to dysphasia, respiratory muscle paralysis leads to cessation of breathing and eventually coma - death.

Post Mortem Lesions:

Encephalomyelitis, neural degeneration (with mononuclear infiltration), perivascular cuffing, evincing negri bodies is less in cat than compared to dog.

Diagnosis:

Diagnosis is based on the clinical signs and by laboratory confirmation.

By the clinical signs noticed a physician can diagnose tentatively that cat may be suffering with rabies. Currently there are no tests are available to test live cats for rabies. It can only confirm by sampling brain tissue of dead cat or humanely euthanized one. Brain tissue can be used in testing by immunofluorescence test (produce bright green colour) or by PCR.

Treatment: There is no specific antiviral drug available for Rabies virus.

The current protocol followed when cat is bitten by another animal and brought to physician;

- If cat is bought to physician with the suspicion or history of animal bite, animal should be thoroughly examined, once there is a bite wound on cat's body - depth, location of wound & possible complications should be determined.

- Once bitten, within 24hours of bite cat should get anti-rabies vaccine (inactivated tissue cultured vaccine as post exposure prophylaxis) > 2.5 I.U potency intramuscularly or subcutaneously. This vaccination regimen should be followed on 3rd, 7th, 14th, and 28th day post bite after the day of 1st dose or day cat is bitten.
- Bitten area should be adequately clipped on margins, hair should be removed and thoroughly flushed to clean the debris and painted with antiseptic solution like Povidone Iodine. Wound care should be followed regularly along with strict antibiotic regimen (even every bite may not cause rabies but animal's saliva contains huge load of bacteria can cause local tissue necrosis and even sepsis)
- Regular monitoring of animal, advising the cat's owner regarding the minimalizing the contact to prevent unnecessary bites till completing the Post Exposure Prophylaxis (PEP) regimen to the cat and should be vaccinated regularly on mentioned dates without fail.

If someone suspects a stray cat to be rabid, better not to get in contact with animal without personal safety and should inform the local authorities/municipality regarding the situation and they will handle the rabid cats as per the guidelines and protocols. A cat can be determined as rabid once they are able to catch the cat (very difficult, may escape), can be withhold cat for minimum two to three weeks. if the cat didn't show any progressive rabies symptoms, it can be determined not as rabid cat. If cat shows rabies signs or person who was bitten by rabid cat shows rabies signs that cat should be humanely euthanized and carcass should be properly condemned. (the above process is not a very practical approach and has many constrains in each step)

Prevention and Control:

1. Incidence of rabies is solely controlled by vaccinating the cats. Proper pre-exposure (initial dose is about after 3.5 months of age following FVRCP vaccine 2 doses and ARV should be given as an annual dose) and post-exposure prophylaxis (0,3rd, 7th, 14th, and 28th day) to be followed
2. Bait vaccination for stray and wild animals (breaks sylvatic and urban cycle spills)
3. Animal birth control measures and reducing the population of stray cats.
4. Public awareness and education regarding rabies, bite wound care and vaccination protocols.
5. Advising parents to teach children that to inform them if any accidental animal bites occur (as unaware of animal bites causing more mortality due to rabies in children).

Human-Feline-Rabies:

Pet owners or anyone when got beaten by a cat, regardless animal is vaccinated / unvaccinated should immediately contact a physician, get check-up and should follow proper vaccination regimen (Multiple ARV shots as boosters - 0,3rd, 7th, 14th, and 28th day, 90th day if required and Tetanus Toxoid single shot) along with the antibiotic therapy. Once anyone is got bitten, they should immediately clean the bitten site under the running water with soap for about 15 minutes. If the wound is deep and belongs to grade 2 or grade 3 bite wound Rabies Immunoglobin therapy (RIG) is recommended as per WHO along with continuous monitoring of patient is required.

Conclusion:

Rabies can be prevented by simple regular vaccination, so if the public is aware of vaccinations and bite wound management, they can save them and their beloved pets suffering from this zoonotic virus. Mass vaccinations of stray animals, controlling wildlife rabies and the animal birth control measures are the key to make the Indian Rabies free.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies- A Zoonotic Disease

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Introduction:

Rabies is a viral disease that affects the central nervous system and is preventable by vaccination. Dogs are the source of the virus in up to 99% of instances of human rabies. Youngsters between the ages of five and fourteen are commonly the victims. Mammals, including dogs, cats, cattle, and animals, are susceptible to rabies.

Rabies is mostly transmitted to humans and animals by salivary gland bites, scratches, or direct contact with mucosa, such as the eyes, mouth, or open wounds. After the onset of symptoms, rabies is almost always lethal. An estimated US$ 8.6 billion is spent annually on rabies worldwide, which includes lost lives and livelihoods, medical expenses and related expenditures, and unquantifiable psychological damage.

The average projected cost of rabies post-exposure prophylaxis (PEP) in 2018 was US$ 108, including travel expenses and lost wages. For individuals making US$ 1-2 per person, per day, this might be a financial hardship. Every year, more than 29 million people receive the human rabies vaccine worldwide.

Rabies:

Rabies is a neglected tropical disease (NTD) that primarily affects communities on the margins. While there are effective human rabies vaccines and immunoglobulins available, individuals in need of them sometimes cannot afford or obtain them.

Lyssaviruses:

They are the cause of rabies, an acute, progressive encephalomyelitis. Mammals worldwide are susceptible to this zoonosis, with dogs, bats, and wild predators serving as the main reservoirs. Acute behavioural abnormalities and gradual paralysis are typical clinical symptoms. The rabies virus, which causes zoonotic disease, typically infects people through animal bites.

Epidemiology:

Around 60,000 people die from rabies annually worldwide. More prevalent in less wealthy countries where canines are endemic for rabies.

Signs and Symptoms:

Rabies usually takes two to three months to incubate, although it can take as little as one week or up to a year, depending on the location and viral load of the virus. Common indicators of rabies include fever, discomfort, and strange or inexplicable tingling, prickling, or burning sensations at the location of the wound. The virus causes gradual and lethal inflammation of the brain and spinal cord as it spreads throughout the central nervous system. People with clinical rabies can sometimes be treated, but it is seldom cured and not always without significant brain damage.

Two types of Rabies Exist:

Furious Rabies: Hyperactivity, irritable behaviour, *hallucinations*, poor coordination, *hydrophobia* (a dread of water), and aerophobia (a fear of drafts or of fresh air) are all symptoms of furious rabies. After a few days, cardio-respiratory arrest kills the patient.

Paralytic Rabies: About 20% of all cases of rabies in humans are paralytic episodes. Compared to the furious version, this form of rabies usually has a less dramatic and longer course. Muscles at the site of the wound eventually lose their ability to move. Gradually, a coma sets in, leading to final demise. The underreporting of rabies is partly due to the misdiagnosis of the paralytic form of the disease.

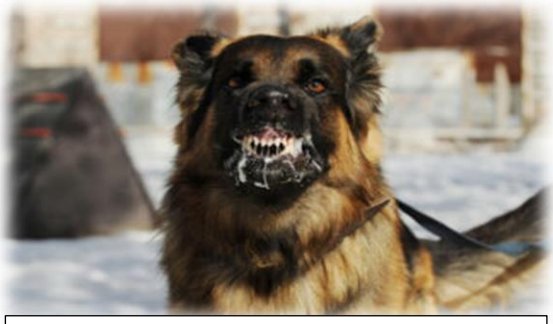

Figure: Ropy salivation of Rabid Dogs

Figure: Aggressiveness in Rabid Dog

Diagnosis:

Without a reliable history of interaction with a rabid animal or distinct signs of hydrophobia or aerophobia, it is challenging to make a clinical diagnosis of rabies. Determining how to administer PEP requires accurate risk assessment. It is advised to provide complete and compassionate palliative care if symptoms appear and death is imminent. Negri bodies in the neurons of affected animals are characteristic of rabies -

- Direct fluorescent antibody test (FAT)
- Virus can be cultured neuroblastoma cells
- RT–PCR used to detect viral RNA in brain sample.

Prevention & Control:

Vaccinating Dogs- The most economical method of preventing rabies in humans is to vaccinate dogs—including puppies—through mass dog vaccination campaigns, as this effectively halts the disease's spread. Rabies cannot be effectively controlled by eliminating free roaming dogs.

Awareness- Essential add-ons to rabies vaccination programs include educating the public, both adults and children, on ethical pet ownership, how to handle potentially dangerous animals, and how to behave around dogs.

Citation: Nikhil Shringi, Yatin Sharma. (2024). Rabies- A Zoonotic Disease. In Bio Vet Innovator Magazine (Vol. 1, Issue Sp 1, pp. 11–13). Bio Vet Innovator Magazine. https://doi.org/10.5281/zenodo.13870794

Control of Rabies – Mission Rabies:

Goa hosted the inauguration of *Mission Rabies* in 2013 after it was determined that the state would be the best place to establish the benchmark for rabies eradication throughout India.

Mission Rabies- is an international NGO working to develop effective methods for rabies control where it is needed most. The charity has been responsible for implementing mass dog vaccination, community education and rabies surveillance activities in Goa under the leadership of the Government of Goa since 2013.

Our initiative has expanded steadily since our first campaign in India, where in just 4 weeks, over 60,000 canines received vaccinations in 14 cities. It began as a local government-led project and has grown to include complete immunization, education, and surveillance components, eventually becoming a state-wide public health campaign.

Mission rabies teams have kept up their relentless effort throughout the pandemic, coming up with innovative strategies to make sure that vulnerable areas are kept free from rabies. While schools were closed, we came up with other strategies to raise public awareness and educate the public, such posting instructional messages online and providing critical staff with COVID-safe training. In 2021, our teams successfully immunized over 75,000 canines throughout the state and equipped over 200,000 youngsters with life-saving knowledge to safeguard themselves against the devastating threat of rabies, even in the face of ongoing hurdles faced by the worldwide pandemic.

The first state in India to receive the official designation of **"Rabies Controlled Area,"** meaning that formal controls over the illness were enforced by the Indian government.

Citation: **Nikhil Shringi, Yatin Sharma. (2024). Rabies- A Zoonotic Disease. In Bio Vet Innovator Magazine (Vol. 1, Issue Sp 1, pp. 11–13). Bio Vet Innovator Magazine. https://doi.org/10.5281/zenodo.13870794**

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

The Role of Community Engagement in Rabies Prevention

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Introduction:

Rabies or hydrophobia is a fatal yet preventable zoonotic disease of viral origin. It mainly attacks the central nervous system and causes progressive inflammation of the brain and spinal cord. It is caused by a RNA virus belonging to genus Lyssavirus in Rhabdoviridae family. It mainly affects mammals, including humans, and is usually spread by the bite of infected animals. The transmission of up to 90% of human rabies cases is attributed to dogs.

The virus spreads from peripheral nerves to the central nervous system, causing inflammation in the brain and spinal cord. Rabies is a zoonotic disease and once the symptoms start to appear, it is completely. The virus persists due to a dearth of awareness in communities where the disease is present, as well as a cycle of transmission between wildlife and dogs. Rabies is not only a public health concern, but it also has social consequences such as poverty and a lack of access to better health and emergency services.

A multisectoral national approach is required, with the communities affected and the knowledge and experience they bring. It must be fully integrated with the authorities, as well as tangentially affected organizations, either by implication or chance, that are working to combat rabies.

Transmission and Symptoms:

Rabies virus infects mammals, including dogs, cats, livestock and wildlife. Rabies is transmitted to humans and animals through saliva, usually through scratches, bites or direct contact with mucosa (e.g., eyes, mouth, or open wounds). The virus cannot penetrate through intact skin. Once clinical symptoms appear, rabies is almost always fatal. Following entry, the virus binds to cell receptors.

Viruses can replicate within striated muscle cells or directly infect nerve cells. The virus then enters the central nervous system through retrograde axoplasmatic transport mechanisms. Depending on the infected animal, both motor and sensory fibers may be affected. Upon reaching the central nervous system (CNS), the virus

propagates quickly, leading to detrimental impacts on the physiology of nerve cells. The virus subsequently migrates to peripheral neurons by anterograde axoplasmic flow, where it infects some neighbouring non-nervous tissues, including the secretory tissues of salivary gland. When clinical symptoms appear, the virus has already spread throughout the body.

The rabies infection cycle is completed with the shedding of the infectious virus in saliva. The incubation period of rabies may range from one week to one year depending on the location of virus entry and viral load. The preliminary manifestations of rabies encompass pyrexia, discomfort, paresthesia, and atypical or unaccounted-for tingling or burning sensations localized at the site of injury.

As the virus reaches the central nervous system, progressive inflammation of the brain and spinal cord occurs. Clinical rabies in humans can be managed, but it is rarely cured, especially without severe neurological deficits. There are two forms of rabies:

i. Furious form: this form of rabies seen in 80% of humans characterized by hyperactivity, hydrophobia, and severe or uncontrollable excitability and impulsive behavior. Death occurs after a few days due to heart failure and respiratory arrest.

ii. Paralytic form: this form accounts for about 20% of all human cases. It is also called dumb form and usually lasts longer than the aggressive type. The patient is calm and lucid throughout Muscles from the wound site become paralyzed. The coma slowly progresses, eventually leading to death. The paralyzing nature of rabies is often misunderstood and involves underdiagnosis.

Prevalence and Impact:

There are notable regional differences in the prevalence of rabies. Rabies is still a serious public health concern worldwide, especially in some regions of Asia and Africa. According to the World Health Organization (WHO), rabies virus accounts for approximately 59,000 human deaths annually, with the majority of these cases occurring in developing countries. In India, rabies is endemic and accounts for 18,000–20,000 deaths annually. The major reservoir for rabies is unvaccinated dogs. Other reservoirs include bats, mongoose, skunks, wolves, antelopes and raccoons. Rabies is endemic in India, contributing to 36% of global rabies fatalities. The complete extent of the rabies problem in India remains unclear. However, based on current data, it results in 18,000-20,000 deaths annually. Children below the age of 15 years old account for 30-60% of documented rabies cases and fatalities in India since bites in children are frequently overlooked and unreported.

Rabies has a profound impact on human health, animal welfare, and public health systems, with effects that can be both immediate and long-lasting. Rabies is nearly 100% fatal once clinical symptoms appear and for those who do survive rabies which is exceedingly rare, the disease can result in severe long-term neurological damage, leading to significant disabilities and diminished quality of life. Delays in Post-Exposure Prophylaxis (PEP) can lead to fatal outcome thus immediate medical intervention is of utmost importance. The cost of PEP can be a significant barrier in low-income regions. Even when vaccines are available, the need for timely administration and the number of doses required can strain health resources. In endemic areas, management of rabies and providing PEP can put strain in health services.

It can be a financial challenge for governments and organizations to invest substantially in implementing and maintaining vaccination and control programs for animals. Surveillance of rabies requires huge tracking and monitoring system posing epidemiological challenges. Rabies has a greater impact in low-income countries,

where there may be limited access to vaccines and healthcare services. This unequal situation emphasizes the importance of global assistance and collaboration in tackling rabies.

Community Engagement in Rabies Prevention:

Even though rabies is a fatal zoonotic disease affecting millions of human and animal population, the impact of this disease can be reduced significantly through community engagement and awareness programs. Initiatives like educational campaigns play a crucial role in enhancing the role of community for rabies prevention. Educating the public about the severity of the diseases, its implication, symptoms and importance of vaccination including pets can have a huge impact in controlling the deadly virus.

The following steps can be taken up as community engagement programs:

i. **Educational Programs:** Dissemination of information with educational campaigns about the health hazard of rabies, its transmission and post exposure prophylaxis in an important part of community engagement. Further, workshops, seminars, and public talks can be organised to provide such valuable information on rabies prevention and treatment options.

ii. **Media Campaigns:** Community-based media campaigns using local radio, television, and newspapers to broadcast information about rabies can highlight preventive measures and available resources to wide audience. Utilizing social media platforms to raise awareness can involve younger demographics and enable the fast distribution of information. Programs should be directed to encourage reporting and prompt medical care. Bite awareness, importance of reporting and complete guidance to where the medical guidance can be sought for can lead to early intervention. Setting up local hotlines or support services for reporting suspected cases of rabies or seeking advice can expedite responses and aid in controlling outbreaks.

iii. **Pet care education** to promote responsible pet ownership: Education about pet care plays a very important role in preventing rabies. Ensuring that pet owners are properly educated helps them understand their duties, identify potential risks, and take necessary steps to safeguard their pets, their loved ones, and their neighborhood. Informing pet owners about the importance of regular rabies vaccinations and how they can access these services is essential.

iv. **Collaboration:** Collaboration with the government veterinary establishments, NGOs, and other local organization to set up free vaccination drive and health check - ups can ensure prevention of the spread of rabies to a great extent. Veterinarians should be encouraged to discuss rabies prevention during routine visits and emphasize the importance of regular vaccinations.

v. **Training and monitoring:** Providing training to local residents on how to identify and communicate about cases of rabies in animals can improve monitoring activities and help manage outbreaks. Engaging community members in surveillance efforts aids in collecting precise information and pinpointing high-risk zones. Encouraging community members to volunteer in rabies prevention programs, such as vaccination drives or educational initiatives, strengthens community involvement.

vi. **Policy making and advocacy:** community should be encouraged to participate in policy making and regulations that promote rabies control, such as mandatory pet vaccinations and animal control measures. Such policies and their advocacy can lead to systemic changes. Community engagement can help attract funding and resources for rabies prevention programs by demonstrating local support and need.

Promoting community-led efforts and empowering local leaders in rabies prevention can help cultivate a feeling of ownership and accountability in neighborhoods.

vii. **Evaluation and feedback mechanism:** Collecting input from community members regarding the effectiveness of rabies prevention programs and making necessary changes according to their feedback can enhance program results. When community is engaged in assessing and refining control and prevention strategies, the local needs can be addressed effectively.

viii. **One Health Approach:** The One Health approach for managing rabies involves incorporating human, animal, and environmental health to develop a thorough plan for prevention and treatment. This approach underscores the importance of working together in surveillance, vaccination, and education due to their interconnectedness. This includes immunizing pets, controlling wildlife populations, and providing prompt medical treatment for human contact. Also, it deals with environmental issues by lowering the number of stray animals and raising public awareness. This comprehensive view promotes cooperation between veterinarians, healthcare professionals, and environmental specialists, ultimately improving rabies control efforts and benefiting the overall ecosystem's health.

Conclusion:

Community involvement is crucial in preventing rabies by increasing awareness, advocating for responsible pet ownership, promoting timely medical treatment, and backing public health efforts. By engaging with local residents in these initiatives, public health initiatives can improve their ability to address rabies more widely and effectively over time. Rabies continues to be a significant worldwide health concern, especially in regions where preventative measures are scarce. Combining vaccination, public education, and surveillance efforts is necessary for effective control in reducing and ultimately eradicating the disease.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Breaking Rabies Boundaries: It's Now or Never

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Abstract:
Breaking rabies boundaries involves overcoming critical barriers to achieve effective and widespread control of this preventable disease. Despite significant advancements, rabies remains a global challenge due to fragmented efforts, limited public awareness, and resource constraints. Key barriers include insufficient understanding of rabies transmission, prevention, and treatment, particularly in rural and underserved areas. Addressing these gaps through comprehensive educational campaigns and targeted training for healthcare professionals and veterinarians is crucial. Expanding successful localized initiatives to national and global scales requires robust infrastructure, coordinated efforts among stakeholders, and sustained funding. Effective rabies control hinges on a unified approach that bridges knowledge gaps and builds capacity at all levels.
Keywords: Rabies, boundaries, innovation, awareness, healthcare.

Introduction:

Rabies, a severe viral brain infection caused by the Lyssavirus genus, remains a significant and persistent threat to global public health. The disease, known for its strong affinity for the nervous system and near-certain fatality once symptoms appear, highlights the urgent need for effective control and eradication efforts. Although rabies can be entirely prevented with prompt post-exposure prophylaxis (PEP) and vaccination, its continued presence, especially in low- and middle-income countries (LMICs), points to deeply rooted challenges that obstruct worldwide elimination efforts. Rabies is mainly spread through the bite of an infected animal, typically domestic dogs, and advances through various neurological symptoms leading to severe brain inflammation and death. Once symptoms become visible, the outcome is almost invariably fatal, emphasizing the critical importance of prevention strategies. According to the Global Burden of Disease Study, rabies causes around 60,000 deaths each year, predominantly in LMICs, where the disease burden is highest. This figure is especially concerning given that rabies is preventable with vaccination and timely PEP after exposure.

Lack of Innovation in Rabies Control:

Innovation is essential for improving rabies control, but advancements have been gradual. Traditional rabies

vaccines, which have been effective since the mid-20th century, require multiple doses, posing logistical and financial challenges, especially in resource-limited areas where rabies is most common. Their high cost further exacerbates accessibility issues in endemic regions. Limited progress in enhancing vaccine formulations has hindered advancements. However, new developments in vaccinology, such as single-dose or fewer-booster vaccines, could overcome these obstacles and make vaccination campaigns more viable in underserved areas.

Similarly, diagnostic methods for rabies have seen minimal innovation. Conventional techniques like the direct fluorescent antibody (DFA) test and rabies virus isolation require specialized labs and are impractical for quick field use. Emerging technologies, such as polymerase chain reaction (PCR) and biosensor-based rapid diagnostic tests, offer the potential for more accessible, rapid, and accurate diagnoses. These innovations could facilitate earlier intervention and improve clinical outcomes. Additionally, novel delivery systems, such as drones, could enhance vaccine distribution to remote locations, increasing coverage and lowering logistical costs. This technological approach could streamline vaccine delivery, making rabies management more effective and widespread.

Insufficient Cooperation Among Stakeholders

Controlling rabies demands a holistic and coordinated approach that encompasses human health, veterinary services, wildlife management, and community involvement. A significant challenge is the lack of cooperation among stakeholders, which impedes effective intervention. Successful rabies eradication requires interdisciplinary collaboration across various sectors, yet efforts are often fragmented, with differing strategies that frequently do not align with global objectives. While some nations have effective control programs, others face difficulties due to limited resources or expertise, underscoring the need for a unified global strategy.

Effective rabies control generally involves mass vaccination campaigns for domestic animals, comprehensive surveillance systems, public education, and readily available post-exposure prophylaxis (PEP) services, all supported by substantial financial investment and professional expertise. Regions with fewer resources may struggle to implement even basic strategies, leading to persistent disease risks. A cohesive global strategy is necessary for consistency and effectiveness. National governments play a crucial role in shaping health policies, allocating resources, and coordinating with international organizations. Integrating rabies into national health agendas, supported by legislation and funding, is essential. Organizations such as the World Health Organization (WHO) and the Global Alliance for Rabies Control (GARC) lead global initiatives, offer technical guidance, and mobilize resources. NGOs provide critical support on the ground, such as vaccination campaigns and education, especially in resource-limited areas. The private sector contributes innovations in vaccines, diagnostics, and delivery systems, enhancing control measures.

The One Health approach, which integrates human, animal, and environmental health, is particularly relevant for rabies control. This approach acknowledges the interconnectedness of these domains and tackles the root causes of rabies transmission. Rabies mainly affects humans through contact with infected animals, making timely PEP administration, public awareness, and healthcare access essential. Since domestic dogs are the primary reservoirs, controlling the disease in animals through mass vaccination, managing stray populations, and monitoring animal health is critical. Environmental factors, such as wildlife reservoirs and inadequate waste management, also play a role in transmission. Addressing these through habitat management and reducing wildlife-animal interactions can help mitigate risk.

Implementing the One Health approach requires enhanced cooperation among veterinarians, wildlife experts, and public health professionals. Integrating data from human, animal, and environmental sources improves outbreak detection and response. While international organizations like WHO and GARC have made strides in global collaboration, better coordination and resource mobilization are still needed. Strengthening partnerships, establishing global targets, sharing best practices, and facilitating knowledge exchange are vital. Effective resource mobilization, including funding, research support, and public-private partnerships, is crucial for sustaining control efforts. Improving communication, collaboration, and trust among stakeholders, including local communities, will enhance the effectiveness of interventions.

Limitations of Small-Scale Programs:

Many rabies control initiatives face limitations due to their narrow, localized focus. Although community-based vaccination efforts, targeted educational programs, and area-specific interventions are effective in their respective locales, their overall impact on the global rabies burden is minimal. These localized efforts, while valuable in specific regions, do not address the broader, global issue of rabies comprehensively. Localized rabies control programs are designed to tackle specific challenges within particular areas. Community-based vaccination campaigns can effectively increase immunization rates among domestic animals in targeted locations. Educational initiatives can raise awareness about rabies prevention and encourage behaviors that reduce transmission within these communities. Similarly, localized actions such as managing stray dog populations or conducting public health outreach can yield notable results. However, the benefits of these programs are confined to their specific regions, leaving other areas unaffected. Consequently, while these localized efforts can showcase effective strategies, they are inadequate on their own for achieving substantial reductions in rabies incidence on a larger scale.

Challenges in Expanding Efforts:

1. Resource Allocation: Scaling up a localized program demands significant resources, including financial investment, personnel, and logistical support. Securing these resources can be challenging, particularly in regions with limited funding or infrastructure.

2. Infrastructure and Logistics: Large-scale initiatives require the development of robust infrastructure to support widespread vaccination, surveillance, and public health interventions. This includes establishing vaccine distribution networks, creating surveillance systems, and setting up healthcare facilities.

3. Coordination and Collaboration: Effective scaling necessitates improved coordination among stakeholders, such as governments, international organizations, NGOs, and local communities. Efficiently harmonizing efforts and utilizing resources are key to success.

4. Sustained Engagement: Long-term success depends on continuous engagement and commitment from all parties involved. This includes securing ongoing funding and maintaining public interest and support for rabies control initiatives.

Developing Scalable Frameworks:

1. Vaccination Coverage: Expanding vaccination coverage is crucial for any scalable rabies control program. Mass vaccination campaigns targeting domestic animals, especially dogs, should be implemented in both urban and rural areas. Innovative delivery methods, such as mobile vaccination units or drones, can enhance coverage.

2. Disease Surveillance: Effective disease

surveillance is essential for monitoring control efforts and detecting outbreaks early. Comprehensive surveillance systems should be established to gather data on rabies incidence in both human and animal populations.

3. Public Awareness: Raising public awareness about rabies prevention is critical. Scalable programs should feature broad educational campaigns that address the importance of vaccination. risks of exposure, and the necessity of prompt medical attention. These campaigns should be culturally sensitive and delivered through various channels.

4. Healthcare Infrastructure: Strengthening healthcare infrastructure is vital for large-scale rabies control. This involves equipping healthcare facilities to provide timely post-exposure prophylaxis (PEP) and supporting mass vaccination campaigns. Investments should also focus on training healthcare workers and veterinarians.

Ensuring Sustained Funding and Support:

Sustained funding and support are essential for large-scale rabies control programs. This includes funding for vaccines, diagnostic tools, public education, and healthcare infrastructure. Public-private partnerships can offer additional resources and expertise, while international organizations like WHO and GARC can provide critical support and coordination. Building local capacity and fostering community ownership are crucial for ensuring that programs are effectively designed and implemented at the local level for long-term success.

Lack of Disease Awareness:

A significant obstacle to effective rabies control is the widespread lack of awareness and understanding, especially in rural and underserved areas. Many people are unfamiliar with how rabies is transmitted, prevented, and treated, which leads to delayed interventions and greater disease spread. This lack of knowledge often includes misconceptions such as believing rabies is only spread through animal bites or scratches, a poor understanding of the importance of pet vaccinations, and not recognizing the urgency of seeking medical care after potential exposure.

Educational campaigns are crucial to addressing these gaps by providing clear, actionable information about rabies prevention, including the importance of vaccinating pets, identifying rabies symptoms in animals, and the necessary steps to take if bitten. It is important to engage local communities with culturally relevant messages through various communication channels such as radio, TV, social media, and community events. Additionally, training for healthcare professionals and veterinarians is essential, as knowledgeable practitioners play a critical role in diagnosing and managing rabies cases. Ongoing professional development and specialized training programs tailored to regional needs are necessary.

Combining educational campaigns with community-based interventions and assessing their impact is vital for ensuring effectiveness. Collecting feedback from these efforts helps refine strategies, and advocating for supportive policies can help institutionalize and sustain rabies education and training initiatives.

Insufficient Infrastructure:

In many regions where rabies is endemic, inadequate infrastructure significantly hampers effective control efforts. Both healthcare and veterinary systems are essential for rabies prevention and management but are often severely lacking. Insufficient healthcare infrastructure impacts the timely delivery of post-exposure prophylaxis (PEP), which is critical for preventing clinical rabies. Enhancing healthcare infrastructure includes improving the

availability and distribution of medical supplies, expanding diagnostic capabilities for accurate rabies testing, and increasing the number of facilities that offer PEP. Additionally, training healthcare professionals to recognize rabies symptoms and the importance of PEP is crucial.

Similarly, veterinary infrastructure plays a vital role in the success of dog vaccination campaigns, which are crucial for rabies control. Limited veterinary services can undermine vaccination programs and continue the spread of rabies. To counter this, it is necessary to expand veterinary services, establish mobile vaccination units, and develop comprehensive animal health programs. Moreover, effective disease surveillance systems are essential for tracking rabies trends, detecting outbreaks, and coordinating responses. Robust surveillance involves advanced data collection and reporting systems that provide real-time information on disease incidence. Strengthening these infrastructures is essential for effective rabies control and ensuring that both human and animal health services are adequately equipped to address this public health issue.

Strategic Recommendations for Overcoming Barriers:

To address the multifaceted barriers to rabies control and make significant progress towards eradication, the following strategic recommendations should be considered:

1. Advance Research and Development: Invest in research to create new vaccines, treatments, and diagnostic tools for rabies. Support efforts to develop innovative delivery methods and improve the accessibility and affordability of rabies prevention and control. Collaborate with academic institutions, research organizations, and industry partners to drive innovation and accelerate progress.

2. Enhance Global Cooperation: Improve international collaboration through multi-sectoral partnerships and coordinated strategies. Emphasize One Health approaches to integrate efforts across human, animal, and environmental health sectors. Promote cooperation among governments, international organizations, NGOs, and the private sector to ensure a unified and comprehensive approach to rabies eradication.

3. Broaden and Scale Up Interventions: Move from small-scale programs to large, integrated initiatives that tackle the rabies burden at both national and international levels. Develop frameworks to scale up successful local interventions and secure sustainable funding and support for large-scale programs. Use data-driven methods to refine and implement effective control strategies.

4. Boost Public Awareness and Education: Launch extensive educational campaigns to enhance public understanding of rabies and its prevention. Tailor messages to be culturally relevant and involve community leaders to increase the impact of awareness efforts. Offer targeted training for healthcare professionals and veterinarians to improve their skills in managing and preventing rabies.

5. Invest in Infrastructure: Strengthen healthcare and veterinary infrastructure to support rabies control efforts. Build and enhance systems for disease surveillance, outbreak response, and vaccination coverage. Prioritize infrastructure investments to improve overall capacity for managing and preventing rabies, and ensure resources are effectively allocated to address existing gaps and challenges.

Conclusion:

Breaking the boundaries of rabies requires a concerted and strategic effort to overcome the critical barriers that

impede progress. By addressing the lack of innovation, fostering international collaboration, scaling up interventions, enhancing disease awareness, and investing in infrastructure, significant strides can be made towards the eradication of rabies. The vision of a world free from rabies is attainable, but it demands sustained commitment, coordinated action, and innovative thinking. Through a multifaceted approach and collaborative effort, the global community can overcome the challenges posed by rabies and ensure a healthier future for all.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies: A Global Health Challenge

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Introduction:

Rabies is zoonotic encephalitis caused by the rabies virus. The virus belongs to the Lyssavirus of the family Rhabdoviridae. The primary way that rabies is transmitted is by animal bite. It can directly penetrate the peripheral nerve system and move towards the brain. It can also spread within muscle tissue, where the host's immune system cannot harm it. It then passes through the neuromuscular connections and into the nervous system. The deadly zoonotic illness rabies severely paralyses the central nervous system. The infection is nearly always fatal, resulting in approximately 59,000 deaths worldwide each year. Rabies is prevalent in over 150 countries worldwide, and India alone accounts for one-third of the global rabies cases, resulting in approximately 20,000 deaths annually. The government of India introduced its National Action Plan for the Elimination of Dog-mediated Rabies (NAPRE) in 2021. This is aligned with the global objective of eliminating human deaths caused by dog-mediated rabies by 2030.

Etiology: The genus Lyssavirus, which belongs to the Rhabdoviridae family of bullet-shaped viruses with a single-stranded RNA genome, is the causal agent of rabies [10,15]. The genus Lyssavirus includes the rabies virus as well as viruses that are closely related, such as the Australian bat Lyssavirus, the European bat viruses 1 and 2, the Mokola virus, the Lagos bat virus, and the Duvenhage virus from Africa. It is believed that any of these viruses can infect humans and animals with a condition similar to rabies [15].

Transmission: Any bite, scratch, or another incident in which saliva, CSF fluid, tears, or nerve tissue from a suspected or confirmed rabid animal or human contacts the mucous membranes of another animal or person, gets into an open wound or is transplanted into another animal or person is considered a rabies exposure. Rarely, in caverns home to millions of bats or laboratories using live rabies virus, humans have contracted rabies from inhaling airborne virus. The most common ways for humans to contact rabies are through animal bites or contact with virus-infected saliva that gets into wounds from scratches. [13]

Pathophysiology: The rabies virus enters the body through contact with mucosal surfaces or wounds. It can't pass through skin that is still intact. To join the central nervous system, the rabies virus multiplies locally in non-neural tissue after biting a muscle and attaches itself to motor endplates and axons [17]. Transport vesicles carry

the virions, which are only transported to the central nervous system (CNS) by fast retrograde transport via motor axons [8,9]. Neither sensory endings nor sympathetic endings can absorb the virions. Salivary gland infection results from centrifugal transport via efferent cranial neurons, releasing virus particles into the saliva. Brain infections frequently cause behavioural abnormalities that prompt the host to bite other animals, which spreads the virus. Death from a widespread central nervous system infection almost always results from subsequent circulatory, metabolic, or viral processes, as well as respiratory paralysis [2,6]. Viral penetrations through penetrating injuries can potentially directly penetrate motor axons in peripheral nerves. Depending on the amount of virus in the inoculum, the density of motor endplates at the wound site, and the proximity of virus entry to the central nervous system, the incubation period can range from five days to several years (typically 2-4 months; rarely more than 1 year) [16]. If the patient is bitten on the head or neck, or if several bites, deep wounds, or massive wounds transfer a heavy inoculum, the incubation period is fewer than 50 days. If someone gets a scratch on their hand, it could take them longer to have rabies symptoms than if they get bitten in the head. The incubation period in dogs and cats is 10 days to 6 months; most cases show symptoms between 2 weeks and 3 months. There have been reports of an incubation period for rabies spread by vampire bats in cattle ranging from 25 days to over 5 months. The incubation period in humans can range from a few days to several years. Most instances show symptoms after one to three months [17].

Clinical Indicators:

Within a species, between individuals within the same species, and even during a given individual's sickness, the clinical picture might vary greatly. Whenever the illness worsens, Rabies-infected animals may exhibit odd behaviour. Any clinical indication of rabies needs to be verified by investigation in a lab [3]. The earliest clinical symptoms can include anxiety, restlessness, anorexia, or an increase in hunger, diarrhoea, vomiting, a mild temperature, pupil dilating, hypersensitivity to stimuli, and severe salivation. Lameness in the leg that received the vaccination is typically the initial symptom of post-vaccinal rabies.

Excitement (Furious) phase: The prodromal stage eventually gives way to a time of extreme agitation and aggression. The animal frequently bites through anything. For example, a characteristic high barking sound during intense rabies may develop in rabid canines. Convulsions may result in death even in the absence of the disease's paralytic stage [20]. The restless, roaming, howling, polypnea, drooling, and attacks on humans, other animals, or inanimate objects are the hallmarks of the furious form. Animals that are affected frequently ingest foreign things like sticks and stones. Oftentimes, wild creatures lose their fear of people and turn on them, attacking people or other animals that they would ordinarily avoid (like porcupines). It's possible to see nocturnal animals during the day.

The phase of paralysis (dumb): Progressive paralysis is a characteristic of the "dumb" form of rabies. In this condition, the animal may not be able to swallow and may exhibit excessive salivation due to paralysis of the masseter and throat muscles. Changes in vocalization, such as an unusual bellow in cattle or a raspy howl in dogs, can result from laryngeal paralysis. Additionally, the lower jaw may drop or there may be facial paralysis. Separation from the herd might cause ruminants to become drowsy or melancholic. You might give up ruminating. Additionally observed are ataxia, incoordination, and progressive spinal paresis or paralysis [20]. The difficulty in swallowing is what defines this stage, and foamy saliva around the mouth is a common symptom. Certain animals may experience paralysis

that starts in the rear limbs. Eventually, complete paralysis is followed by death [18].

Diagnosis:

Since the majority of rabies virus diagnostic procedures in animals require brain tissue for detection, they are sometimes only feasible after death [1]. Any portion of the afflicted brain can be used to diagnose rabies in animals. However, the test needs to include tissues from the brain stem and cerebellum, which are the two areas of the brain from which rabies must be ruled out. Numerous diagnostic techniques exist for the identification of rabies in animals, including polymerase chain reaction, mouse inoculation technique, tissue culture infection technique, direct fluorescent antibody [12]. The easiest way to obtain brain samples is to open the skull and collect a direct sample. To detect virus antigens in both human and animal samples, the fluorescent antibody test (FAT) uses brain smears or touch impressions. The direct fluorescent antibody test, or dFAT, is the suggested diagnostic procedure for animals. The purpose of this test is to identify rabies antigens in brain tissue. Additional diagnostic methods consist of serological testing (quick pres fluorescence focus inhibition test, fluorescent antibody neutralization test), reverse transcription polymerase chain reaction (RT-PCR), and direct rapid neurohistochemistry test (dRIT). The preferred test for rabies in humans is dFAT on brain tissue. dRIT and RT-PCR are further diagnostic tests that have been employed [5].

Prevention:

The rabies vaccination is more effective if administered in advance of potential exposure to a rabid animal, but it is typically administered later. The Pre-exposure immunization plus post-exposure booster has shown to be 100% effective.

Pre-exposure vaccination for animals: Several inactivated, thermostable, very effective vaccinations for veterinary usage have been produced recently. The granted immunity lasts somewhere between one and three years. Most veterinary vaccines are only authorized for use in particular species—dogs, for example. Set potency standards must be met by any rabies vaccinations authorized for use in humans and animals. It is required that each dose have a minimum antigenic potency of 2.5 IU [18]. Young puppies may receive the vaccinations, but they need to be supplemented at three months of age and once more in the year that follows. After that, vaccinations have to be administered every three years. Depending on the recommendations of the vaccine producer, sheep and cattle may receive vaccinations every three or two years or once a year. Regardless of the duration of the first vaccination's protection period, all dogs and cats should have a second vaccination 12 months after the first one. It is imperative to have a booster vaccination as soon as possible after coming into contact with a rabid animal to provide sufficient defence against the virus [14].

Treatment for animals after exposure: Results from research by Hanlon et al. (2002) indicated that a previously unvaccinated animal exposed to rabies may be protected by five doses of the canine rabies vaccination given on days 0, 3, 14, 21, and 35 in addition to murine anti-rabies antibody on day 0. A booster shot should be given a year after the original vaccine, regardless of the animal's age at that time [3]. If the animal exhibits symptoms suggestive of rabies, such as paralysis, convulsions, etc., the animal should be put down and the head sent for examination [7].

Final Verdicts and Advice:

A deadly viral zoonotic illness, rabies poses a significant threat to public health. Despite being widespread, it is particularly significant in underdeveloped nations like Ethiopia. This is a result of the abundance of stray dogs

that are present everywhere. This virus poses a hazard to the African wild dog (Lycaon pictus) and Ethiopian wolf (Canis simensis). It can only spread when the virus gets into a bite wound or mucous membrane. Although avoidable, the condition is incurable. The two main methods of preventing rabies in animals are vaccination and avoiding contact with diseased animals. By educating people on the routes by which rabies is spread and avoiding contact with wildlife, most animal and human rabies exposures can be avoided. It is possible to convey the recommendations that follow in light of the conclusions mentioned above. It is crucial to educate the public on the causes, symptoms, and methods of rabies prevention and control. utilizing international law to aid in the prevention and treatment of communicable illnesses. Adopting rules for managing stray dogs is a good idea. Dogs that are allowed to roam freely should be closely supervised, and rabies vaccinations should be required.

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Bio Vet Innovator Magazine

Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies: A Deadly Infection Needs Control

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Introduction:

Rabies has been reported to be the oldest viral infection affecting humans through animal. Although vaccine was developed but due to different reservoirs (wild and domestic animals like dog, foxes, raccoons, skunks, Coyotes, yellow mongoose, Indian mongoose, bats) and different incubation period and new infection pattern, control has become difficult. About 95% human deaths due to rabies have taken place in Asia and Africa.

Pathogenesis:

Human being can become infected by bite of rabid animal or by mucosal exposure. When we are bitten by animal, virus gets entry by muscle endplates or nerve fibres which are unmyelinated and travels by retrograde axonal transport to motor or sensory neurons which are in ganglion dorsal root or spinal cord anterior horn region and replicates there. Later virus returns to site of bite using orthograde axonal transport or goes to brain using corticospinal tract to infect neurons. In case of aerosol infection, virus present in air accidentally enters body using nose olfactory epithelium and gets transported to olfactory bulb neurons to multiply there, spreading further to brain. Later virus returns to periphery through neuronal pathway and so can be detected in skin, adrenals, tears and salivary gland. It's surprising that virus is undetectable in blood cells /blood. The incubation period varies from several days (4 days) to six years. Mostly in infected individual death occur due to cardiac arrest/respiratory failure. Usually, brain inflammation is reported on post mortem of human rabies patient.

Symptom:

At first symptoms are non-specific including fever, letharginess, tingling occurs at site of exposure, vomiting, anorexia. With advance of time cranial nerve dysfunction, weakness, cerebral dysfunction, ataxia, paralysis, water hydrophobia, breathing and swallowing problems, seizures, excessive salivation, aggression, abnormal behavior and self-mutilation, coma are noted. Violent movements, confusion, loss of consciousness and inability to move body parts are visible. Acute encephalitis is reported in warm blooded hosts. In final stages symptoms progress to delirium, coma and even death. Usually, death occur 2-10 days of first symptom appearance. Even under intensive care, survival chances are rare.

Cause:

Rabies virus, Australian bat lyssavirus are main causative agent. It can spread through infected animal (dog/bat/rodents) bite/scratches on human body or through contact of infected animal saliva with eye, mouth or nose of healthy individual. Duvenhage lyssavirus is also capable of causing rabies like infection.

Diagnosis:

Tissues from brain stem and cerebellum are taken for rabies virus antigen detection in animals using direct fluorescent antibody test (DFA). In humans samples of serum, saliva, skin biopsies, spinal fluid etc. are taken. Virus isolation and RT-PCR is done using saliva while antibodies to rabies virus are tested in serum and spinal cord. Rabies antigen in cutaneous nerves which are present at hair follicle base are examined in skin biopsy specimens.

Treatment:

Once exposed to infection, treatment within ten days may help in prevention of disease. Vaccine is effective 100 % if given at earliest. It is recommended that people should receive human rabies immunoglobulin HRIG (atleast one dose) and rabies vaccine (four doses) over fourteen day's period. Doses needs to be injected around bites while the remainder should be given using deep injection intramuscularly at a distance from vaccination site. If vaccinated earlier only post exposure vaccinations needed on day 0 and 3. Earlier in nerve-tissue based vaccination, multiple injections were required to be put in abdomen using large needle but now World Health Organization intradermal-vaccination are given in deltoid area while in children aged less than a year, injection is given in lateral thigh.

Prevention:

1. Keep your pets (dog, ferret, cat) vaccinated for rabies.
2. Strict supervision and control needed of pets.
3. Stray animal's entry and exposure to pets and humans need to be checked.
4. Immunization of people before exposure to rabies is must in high-risk zones.
5. Washing scratches and bites using soap and water, alcohol, detergent or povidone-iodine help in reducing viral particles and in preventing transmission.

"World Rabies Day" is celebrated every year on 28 September to promote the information, educate people for prevention and elimination of the deadly disease "RABIES"

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Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Current Rabies Status and Upcoming Methods for Eradicating the Disease Worldwide

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Introduction:

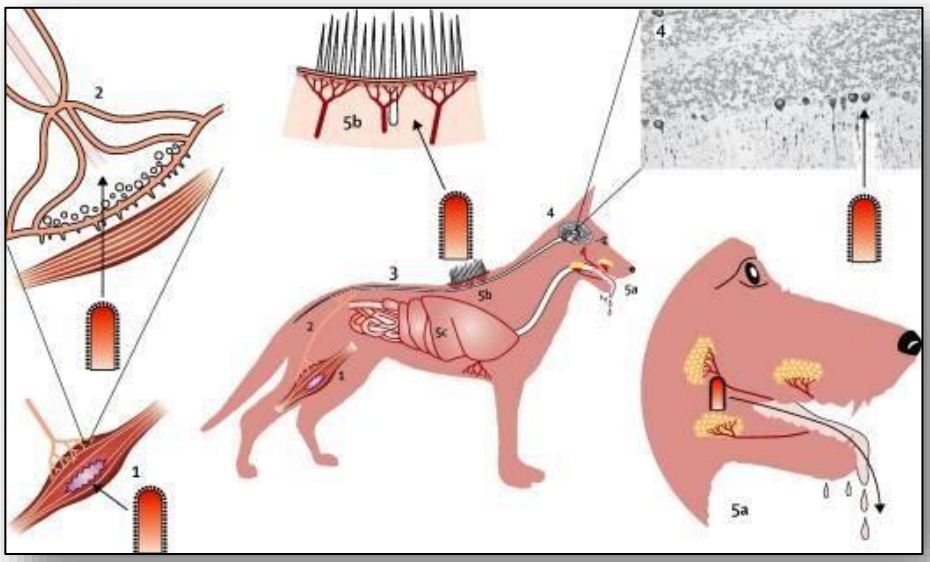
Rabies continues to be a major and much-feared hazard to public health in the 21st century. The disease, which is brought on by neurotropic viruses of the genus Lyssavirus, manifests as a progressive and always deadly encephalomyelitis under treatment. As per Fooks and Jackson (2020), the rabies virus (RABV) is a member of the family Rhabdoviridae, which comprises viruses in the shape of bullets, the genus Lyssavirus, and the order Mononegavirales, which comprises viruses with non-segmented, negative-stranded RNA genomes. Based on preliminary statistics, it appears that rabies causes almost 60,000 deaths worldwide each year, more than any other zoonotic disease combined. The most common way for rabies to spread among animals is by animal bites, although it can also be contracted through licks, scratches, or the infecting of mucosa or open wounds with saliva Nearly all human instances of rabies are transmitted by dogs, who serve as the primary vector for the disease. Therefore, the first line of defense against human rabies is to control rabies in dogs, particularly in stray or free-roaming dogs (Meslin and Briggs, 2013). The World Organization for Animal Health (WOAH), formerly known as the OIE, the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) partnered with the Global Alliance for Rabies Control (GARC) under the United Against Rabies Forum (Tidman *et al*., 2022) to launch Zero by 30, the Global Strategic Plan to End Human Deaths from Dog-mediated Rabies by 2030.

The One-Health Strategy:

- The idea of One Health, which holds that human, animal and environmental health are intricately related, dates to at least ancient Greece. The phrase was first used in 2004 at the Wildlife Conservation Society's "One World, One Health" conference in New York City. The organization then released the "Manhattan Principles," a set of 12 recommendations (Bresalier et al., 2021).

- The current priorities are to give programs the organizational, financial and political stability they require to reach their goals and to strengthen and expand One Health's operationalization. For this next phase, the 4Cs—communication, coordination, collaboration, and capacity building—are essential (OHHLEP et al., 2022).
- The One Health Joint Plan of Action (2022–2026): Health of Humans, Animals, Plants and the Environment was introduced by the Quadripartite in late 2022.

Pathophysiology of Rabies Virus (Singh and Ruzek, 2013)



1. The virus enters the host's muscular tissue through a bite wound.
2. Via the neuromuscular junction, enters the peripheral nervous system (PNS).
3. Proceeds from the brain and spinal cord to the PNS.
4. A virus enters the brain and multiplies greatly, causing neuronal dysfunction (slide displays virus in cerebellar Purkinje cells at a 40x magnification).
5. (a) The virus reproduces in the glands that produce saliva, which is then expelled.
5. (b) Penetrates Purkinje cells and skin's peripheral nerves.
5. (c) Spreads the brain to infect the host's various tissues and organs.

Clinical Signs:

- Rabies usually takes 2-3 months to incubate, although one week or up to a year, depending on the location and viral load of the virus. . Incubation times are often shorter in dogs.
- Fever, discomfort and strange or inexplicable tingling, prickling or burning sensations at the location of the wound.
- Gradual and lethal inflammation of the brain and spinal cord as it spreads throughout the central nervous system.
- Hyperactivity, irritable behaviour, hallucinations, poor coordination, hydrophobia and aerophobia are all symptoms of **furious rabies**.
- Muscles at the site of the wound eventually lose their ability to move. The underreporting of rabies is partly due to the misdiagnosis of the **paralytic form** of the disease.

Diagnosis:

- It can be challenging to diagnose rabies virus infection premortem.
- Hydrophobia is extremely suggestive, although no clinical sign is pathognomonic for rabies.
- The fluorescence antibody test (FAT) is used to detect virus antigen in both human and animal materials through brain smears or touch impressions.
- Direct rapid immunohistochemical test (dRIT).

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- PCR techniques have been used to confirm the origin of viral isolates and molecular-based approaches for the diagnosis of rabies.
- RT-PCR-based procedures and innovative molecular methods created for the diagnostic amplification of lyssavirus genome fragments.

Management:

- Combinations of treatments, immunotherapies, ketamine and the rabies vaccine have all been used in clinical management of the disease.
- A trial-and-error strategy is unlikely to result in the development of a viable rabies therapy in the future, particularly given the large number of neuroprotective medication studies that have failed to demonstrate the efficacy of any one drug.

Prevention and management of human rabies

1. Raising awareness about the rabies virus helps people take the necessary medical attention.
2. Rabies immunoglobulin (RIG) and post-exposure prophylaxis (PEP).
3. Mass canine vaccination campaigns **Vaccination of human beings**

Pre-exposure prophylaxis (PrEP)

- Animal neural tissues were used to make rudimentary rabies vaccinations.
- Pre-exposure vaccine, a three-dose regimen of intramuscular or intradermal injections is administered on days 0, 7, 21 or 28, with day 0 serving as the first dose.

Post-exposure prophylaxis (PEP)

- Treat the wound thoroughly with soap and water for at least 15 minutes, rabies vaccination and inject monoclonal antibodies into the wound.
- Currently, four distinct post-exposure prophylactic vaccination regimens—three administered intramuscularly and one intradermally. Rabies immune globulin (RIG).
- TriGAS, a new prototype vaccination that carries three copies of the glycoprotein gene.

Prevention and Control of Rabies Virus:

- Vaccination coverage approaches 70%, surgical sterilization or capture and killing.
- Gonazon®, is a contraceptive pill that blocks gonadotrophin production. Its active ingredient is azagly-nafarelin (Goericke-Pesch et al., 2010).
- The complete eradication of *canine rabies worldwide* and the avoidance of nearly all future human rabies deaths if they are utilized *One Health methods*.

Future Challenges:

- Childhood vaccination schedule should be a top priority. The current kids Expanded Programme on Immunization (EPI) schedule (Taylor et al., 2013).
- The goal of eliminating human rabies, the *strategic approach for programs* aiming at canine rabies elimination

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should centre on a multidisciplinary core of disparate groups, including representatives from the public and private sectors.

- The *One Health strategy*, which is a joint multidisciplinary endeavour, aims to prevent rabies by immunizing dogs on a large scale and managing dog populations in a humane manner.
- The United Nations Food and Agriculture Organization has put up a Progressive Control Pathway aimed at eradicating rabies.
- The OIE suggested a route that veterinary services must follow to control rabies in dogs in a way that will increase veterinary service compliance over time. Its three main elements are strategy, vision and performance.

Conclusion:

In light of this, the Food and Agriculture Organization, the World Health Organization, and the Organization for International Peace have put forth a plan to eradicate human-to-dog rabies transmission in rabies-endemic nations; they suggest that this be a feasible objective by 2030.

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Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies Day Special: Bridging the Gap between Science and Safety

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Introduction:

Dogs hold significant importance and are revered for their loyalty, protection, and association with various deities. They symbolize fidelity and faithfulness, protection, vigilance, devotion, and unwavering commitment. Therefore, dogs are considered as a member of a family in the present society. To keep them healthy it is mandated to vaccinate as it guards them against several infectious diseases and prevents us from acquiring zoonotic infections. The most important fatal zoonotic disease is rabies, which is mankind's oldest known disease. It is caused by single-stranded, negative-sense RNA viruses of the Lyssavirus genus, family Rhabdoviridae. The term is derived from the Latin rabies, madness. This in turn may be related to the Sanskrit Rabhas, to rage. The Greeks derived the word lyssa from violent; this root is used in the genus name of the rabies virus, Lyssavirus. Rabies has been known since 2000 B.C. Rabies is transmitted through the bite of animals infected with rabies, primarily dogs. All warm-blooded creatures, including humans, dogs, cats, foxes, wolves, vampire bats, cattle, horses, sheep, and goats are the hosts. Symptomless carriers and reservoirs of infection are vampire bats. Before 1885, there was a high mortality rate which was 100% fatal due to rabies. The development of the first efficacious rabies vaccine by French scientist and Microbiologist Louis Pasteur in 1885 revolutionized the prevention and treatment of rabies significantly reducing mortality rates. In recognition of his pioneering work, World Rabies Day is observed worldwide on September 28, the anniversary of Pasteur's death.

According to WHO, globally dog-mediated rabies causes an estimated 59,000 human deaths annually. 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. To safeguard public health, the global community has launched an ambitious initiative, "Zero by 30," aiming to eradicate human deaths from dog-mediated rabies by 2030 through a concerted effort to vaccinate dogs, enhance awareness, and improve access to post-exposure prophylaxis.

The global initiatives to eradicate rabies adopted are;

- World Health Organization's (WHO) Rabies Elimination Program,
- World Organisation for Animal Health (OIE) Rabies Control Program
- Global Alliance for Rabies Control (GARC)
- United Nations Food and Agriculture Organization (FAO) Rabies Control Program

Global initiatives have outlined the following key strategies to achieve worldwide rabies eradication,

- Improve access to rabies vaccines and post-exposure prophylaxis (PEP)
- Enhance surveillance and reporting of rabies cases
- Strengthen animal vaccination programs
- Promote community awareness and education
- Develop and implement effective rabies control policies

The aforementioned efforts have resulted in the total elimination of rabies in various nations, notably:

1. Japan: Rabies-free since 1954
2. Australia: Rabies-free since 1990
3. Mauritius: Rabies-free since 1992
4. Western Europe: Rabies-free since 2001
5. Singapore: Rabies-free since 2003
6. Canada: Rabies-free since 2007
7. Bali, Indonesia: Rabies-free since 2013
8. Sri Lanka: Rabies-free since 2016

National Rabies Eradication Efforts:

In India the two main initiatives taken up by the government to combat rabies are,

1. The National Rabies Control Programme (NRCP)
2. The National Action Plan for Dog Mediated Rabies Elimination by 2030 (NAPRE)

National Rabies Control Programme (NRCP): The NRCP was approved in 2013 to address rabies in India. Its objectives include:

- Training health care professionals on rabies post-exposure prophylaxis and animal bite management
- Strengthening the human rabies surveillance system
- Strengthening regional laboratories for rabies diagnosis
- Creating awareness in the community

National Action Plan for Dog Mediated Rabies Elimination by 2030 (NAPRE): The NAPRE was conceptualized in 2018 and unveiled on September 28, 2023. Through this partnership, 2023 witnessed remarkable achievements in rabies prevention: the vaccination of over 1 million dogs safeguarded human and animal health, while

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investigations into 25,000 suspected rabid animals ensured prompt detection and response.

Rabies has been declared as a Notifiable Disease in Karnataka from December 5, 2022. In this regard, all medical officers are directed to provide ARV and RIG free of cost as per requirement to all animal bite victims.

One Health Approach:

The One Health approach necessitates a tripartite collaboration among veterinarians, healthcare professionals, and environmental experts, encompassing three pivotal components:

(1) Human Health: enhancing public awareness, education, and access to post-exposure prophylaxis (PEP);

(2) Animal Health: implementing mass dog vaccination, animal surveillance, and monitoring; and

(3) Environmental Health: ensuring effective waste management, stray animal control, and ecosystem balance.

In an interview, Professor Loui Nel, GARC's Executive Director, emphasized that World Rabies Day, established by GARC in 2007, has significantly boosted global awareness and facilitated partnerships among diverse organizations, highlighting the critical need for a coordinated, community-driven approach to rabies prevention.

Line of thinking; Ways to reduce the gap between Science and Safety:

The rabies crisis persists in India and other countries due to freely roaming stray dogs and rabid animals. Local authorities need resources and funding to control the situation. Despite laws protecting stray animals, mass killings occur. Stricter policies are necessary to safeguard innocent strays. To interrupt rabies transmission, research recommends vaccinating at least 70% of the canine population. When resources are scarce, a targeted approach focusing on vaccinating in areas with a high incidence of rabies, referred to as corridors or source areas (Compartmentalization system) is effective. A single 3-year vaccination covers a dog's lifetime in endemic zones. Traditionally, puppies under 3 months weren't vaccinated due to maternal antibody interference. However, excluding puppies leaves a significant proportion of dogs susceptible, as they may never receive vaccination otherwise. Failing to vaccinate puppies, which make up to 39% of rural dogs, has severe implications: they may never receive vaccination, leaving them susceptible and contributing to ongoing rabies transmission. Urgent action is required to promote widespread awareness of prompt dog bite reporting and implement a national rabies elimination program, preventing devastating economic consequences and human rabies transmission.

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Bio Vet Innovator Magazine

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

From Awareness to Action: Strengthening The Global Fight Against Rabies

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Abstract:

The world's most diabolical virus; Rabies is one of the oldest recognized diseases affecting warm blooded animals and it remains to be one of the most important zoonotic diseases affecting the developed countries causing heavy losses in human and livestock population. Dogs play an important role in maintenance and spread of rabies across the world resulting in nearly 10,000 human death every year in the country. The widespread of this disease is due to poor implantation of intervention strategies that included dog bite wound management practices, unavailability, and unaffordability of post exposure prophylaxis (PEP), failure to control the disease in free roaming dogs, improper dog population management, weak surveillance and diagnostic facilities and a lack of 'One Health' approach to this disease. The Global Action Plan (GAP) constitutes rabies elimination centered platform supported by the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the World Organization of Animal Health (OIE). Aptly called 'United Against Rabies' (UAR), these three organizations are collaborating towards the fruition of common objectives to eliminate the disease from the world by 2030.

Keywords: Rabies, control, eradication

Introduction:

Rabies is an acute infectious disease of central nervous system having worldwide distribution affecting all warm-blooded animal including man. The disease is propagated by bite from animal to animal and animal to man. The disease is known as Lytta or Lyssa and also ascribed as "Jalatanka" in India most particularly. Disease is noted in most of the tropical countries of the world which is primarily maintained and transmitted through bites of free roaming dogs and is widespread in countries that either do not have proper legislation regulating movement and ownership of dog or do not implement them strictly. In this view, it is imperative to take into the account of the awareness to actions in eradicating dog mediated rabies through One Health Approach.

Know about the virus?

1. Rabies:

It is caused by RNA virus belong to the family *Rhabdoviridae* and genus Lyssa virus. This is a neurotropic virus and which occurs in most concentrated form in the CNS. The virus is bullet shaped and measures about 180-250nm length by 75 nm in diameter. Five additional viruses identified in Africa are classified as rabies related virus (Mokolo, Logos bat, Duvenhage, Kotonkan, Obodhioang virus). The virion of rhabdovirus consist of lipid containing bilayer with glycoprotein peplomers surrounding a helical wound nucleocapsid. This gives the virus a distinct bullet shaped morphology. Until 1970, virus was considered to be a single antigenic group but serologically group of viruses could be demonstrated from rabies (Sikes,1980). Virus is grouped into street virus and fixed virus. The street virus is derived from one that exist in nature in naturally occurring cases and the fixed virus denotes to strain of virus that has been adapted by serial intracranial passage in some animals in the laboratory. Rabies virus haemagglutinates goose R.B.C, which is important from diagnostic point of view. It can affect wide range of host; all warm-blooded animals are susceptible. Animal like, fox, wolf, jackal, skunk, bandicoots, mongoose, cat, rat, squirrel, vampire, bat, are extremely susceptible in the tropical world, but dogs are the greatest source of rabies in the infection for human. Cattle and horses may also be considered as dead-end host. Rabies in human involves either the urban cycle with dog population maintains the infection or the sylvatic form which involves the wildlife (WHO,1966).

2. Epidemiology:

The disease was first recognized in dogs in Hong Kong in the year 1857 and later reported in India in Vedic period (5000 years ago). In 500 BC, Democritus, the Greek Philosopher ascribed the disease in animals and Aristotle (300 BC) drew attention to the danger of biting of rabid dogs. In the year 1967 & 1971, WHO listed rabies as the major zoonotic problem in India. An estimated population of 5000 die due to this disease in each year. Due to possible rigid quarantine measures many of the countries are presently free from rabies e.g. New Zealand, Papua, New Gunea, Bahamas, Turks, Hong Kong, Baharin, Cyprus, Britain, Howei. Rabies is endemic in dogs of Indonesia, Phillipines, Vietnam, Burma, Bangladesh, Pakistan and sporadic in Laos, Cambodia and Korea. Pacific island nations, and Australia have never witnessed Rabies. Japan is the first in Asia to eradicate it.

3. Mode of Transmission:

The natural transmission occurs through bite of reservoir animal. A bite on the face has contagious index of almost 100 % whereas, on the body or leg is about 2%. Other reported routes of infections include aerosol transmission (Tillosten *et al*., 1977), few precedents of infection through unboiled milk or meat of rabid animal of breast-fed children of rabid mother (Manual, N.I.C.D., 1985), or from caving in areas with a large population of bats (Dietzschold *et al*., 2008), direct contact transmission among dogs during breeding season, weaning (Narayan, 1985). Human to human transmission has also been reported in corneal transplant recipients (Crowcroft and Thampi 2015; Helmick *et al*.,1987). The ability of virus to reach the CNS depend on various factors such as age of the animal, distance of bite from CNS, virulence of virus, concentration of virus, presence of hyaluronidase at the time of attack.

4. Pathogenesis:

In man incubation period is exceptionally variable and imposes a problematic range which can vary from days to years approximately 30-90 days in humans. Incubation period in dog, sheep, horse, cattle and pig lie with the

average of 15-60 days. After introduction before entering the peripheral nervous system, it replicates in muscle fibre (amplification step to produce huge quantities of virus). On entering to unmyelinated axon terminals, transportation to nerve cell occurs in retrograde manner. On invading the brain, it damages the brain stem and medulla which leads to degeneration and paralysis of various muscles which leads to drooling of saliva, dropped jaw, inability to swallow, asphyxia and death. After reaching brain it invades ganglion cells and spread centrifugally to peripheral nerves. Mode of propagation (of virus) centripetal retrograde movement is faster than that of centrifugal (Hemachuda *et al*. 2013). Neuronal degeneration and perivascular infiltrations lead to formation of Negri bodies (Dierks,1981). Negri bodies is a acidophilic matrix containing a number of minute bluish granules. Fixed virus does not produce Negri bodies. Negri bodies is present in the hippocampus of carnivores and Purkinje cells of herbivores.

5. Clinical Overview:

The clinical development of the disease in dogs takes two general forms *a) Furious or mad dog form, b) Dumb or paralytic form.* In furious form infected dogs remain in unusual alert conditions, will show intense irritative sign, aggressiveness, will snap or bite imaginary objects, may hide in dark places due to photophobia, bite inanimate or animate objects, development of change in the bark, change of voice, drooling of saliva, will develop urge to bite and fly away. In dumb form, dog used to seek solitude and appear sluggish and morrosed, owner may suspect that any bone or hard object might have stuck in the throat and try to open mouth of dog for examination but it may lead them to possibility of contracting the infection (Open mouth condition). Ultimately death takes place in 1-7 days. Cat show nervousness, abnormal vocalization, irritability, seizure, paralysis and sudden death. In horses, weakness, period of sexual excitement, pawing and kicking viciously; are some of the clinical signs that are observed. In cattle, bellowing with low pitched voice, excessive salivation, sign of stimulating choke and difficulty in drinking water. Pig, Sheep and Goat shows sign of aggression, restlessness, attempt to bite hard objects and finally death. In man it is initiated with mild fever, sore throat, headache, hypersensitivity, muscular spasm, salivation, spasm may be seen with slight contact with food and fluid, progressively it follows paresis and paralysis and finally death.

Exposure Categories Categorized by WHO (April 2018):

Category 1: Slight or negligible exposure*, i.e.* minimum risk, All cases of licks (except those on fresh cuts).

Category 2: Nibbling of uncovered skin, minor scratches or abrasion without bleeding, *i.e.* definite but moderate risk.

Category 3: Single or multiple transdermal bites or scratches, contamination of mucous membrane or broken skin with saliva from animal licks, exposure due to direct contact with bats, *i.e.* severe exposure.

Seeking Medical Attention After a Potential Rabies Exposure:

The dog suspected to have rabies should be observed for 10 days. However, the treatment of bitten person should start immediately. The post exposure bite wound comprises washing and adequate flushing of bite wound with plenty of soap solution and water, followed by administration of series of post bite vaccine, and infiltration of rabies immunoglobulin to or around the site of bite, as soon as possible after the exposure. There have been significant advances in the development of rabies vaccine from 'Pasteur- treatment' to Cell Culture Vaccine. Different type of rabies vaccine which are in use are Sample Vaccine, Betapropionl Lactone Vaccine (BPL), Mouse Brain Vaccine, Purified Hamster Kidney Cell Vaccine, Rabies Vaccine Adsorbed, Purified chick embryo cell vaccine (Rabipur), Human Diploid Cell Culture Vaccine (Rabivax). To avoid side reaction of vaccine attempts have been made to protect

human by monoclonal antibodies (WHO, 1984). Oral vaccine against wild animals as vaccine baits is recommended (Artois *et al.*,1993).Vaccinia recombinant vaccine is also used to control wild life rabies (Pastoret and Brocher,1996). Some of the vaccines used in animals are Nobivac-R, Durarab, Rabdomun, Antirabies serum (ARs). Vaccination of people against rabies involves pre exposure and post exposure schedules. Pre exposure vaccines are recommended for individuals who are at higher risk of infections such as wildlife professionals, veterinarians, dog catchers. Post exposure vaccination is administered to individuals after they had potential exposure to rabid animal. Post exposure immunization for unprotected individuals are five doses on days 0,3,7,14 and 30 and booster on day 90. Person who has fully received full pre or post exposure treatment with a vaccine of proven potency but whose neutralizing antibody titre has not been determined, should receive 3 doses of a vaccine of proven potency on days 0, 3 and 7 after re-exposure. Systemic passive immunization (with immunoglobulin or antiserum) should not be given when the person has had pre or post exposure vaccination, and will receive booster dose of vaccine.

One Health Approach to Rabies Elimination:

It is rooted in the understanding that human health is closely linked to health of animals and environment. It is well established that rabies is not confined by national boundaries so; One Heath makes a cross disciplinary network that integrates the efforts of physicians, veterinarians, ecologists, public health workers, animal welfare workers, educational institutes, administrative authorities, social scientists to combat dog mediated Rabies. A network of laboratories catering to vulnerable areas, including rural and remote localities, has been suggested as a mandatory requirement for the elimination of rabies.

Global Efforts in Rabies Prevention and Control:

WHO has given statistics on rabies which is very much alarming. WHO says that 25 million of stray dogs in India contributes to 965 of countries and 80% of the world's incidence of rabies. As per WHO, rabies kills at least 30,000 Indians in a year out of which 70% victims are below 15 years of age. Each year, nearly 17.5 million people undergo post exposure rabies treatment.

- **Emphasis on awareness programmes** -It is one of the foundation pillars to eliminate rabies. The educational outreach drive should educate communities about the seriousness of this virus and the measures they can take to protect themselves. World Rabies Day, September 28 has become a essential platform for raising awareness. Trained field personnel of Vetico – Medico giving awareness to people through mass media, group discussion, seminar in both urban and rural areas.
- **Emphasis on Vaccination programmes for Dogs and Canine Rabies Prophylaxis-**To obtain herd immunity and sufficient vaccination coverage, it is suggested that 70% of canine population has to be covered with vaccine. The western country society, they have got a policy to take all the animal in shelter. While they are in shelter, dogs are neutered, vaccinated and then rehomed. A-B-C programme has been implanted in various parts of India which is meant for reducing dog's population and it also includes rabies vaccination. Jaipur in India is one of the cities where eradication of human rabies could be possible through A.B.C programme. In developing countries travelling dogs' control by mass vaccination with a certificate that there exists sufficient antibody titre in blood (Reg no. 998/2003). The person who are exposed to rabid animal require a timely post exposure prophylaxis to prevent the onset of symptoms. Many people in rural areas do not know how to wash the wound following bite, time of initiating treatment; they do not have idea about antiserum treatment. So, it is needed to provide antiserum facilities in all corners of the world.

- **Emphasis on Surveillance and Reporting Systems-** It give emphasis on establishing quality data on animal bite and disease burdens in humans. Recording and reporting of each and every case of animal bite is recorded by Anti -Rabies Clinics. These collected databases help in tracking the spread of disease, provide guidance in conducting campaigns, vaccination programmes, in specific regions, overall helps in managing the outbreak of rabies.
- **Emphasis on investing in Research and Innovation**- India has capability and infrastructure for producing modern rabies cell culture vaccine to meet its own requirement and more. Over 15 million doses of human rabies vaccine are being produced in the country annually. Other countries are importing human rabies vaccine from India. The country is also self-sufficient in production of purified ERIG which is very vital for the treatment of Category 3 bites.
- **Emphasis on intersectoral collaboration shaping One Health in the policy agenda-** There is a need that two or three Ministries should take ownership to deal with rabies viz Ministry of Health, Ministry of Agriculture and Local Civic Bodies. One Health Approach which focus on interconnection of human, animal and environment health has now become a central framework and it invites experts from different field to collaborate in fight against rabies.

Conclusion:

"Ending rabies is not only a public health issue, but a humanitarian imperative" as quoted. The successful elimination of human rabies needs prevention of animal rabies, public awareness and people's access to cost-effective and high-quality rabies vaccines in a coordinated fashion. The multifaceted One Health control model will also enhance the likelihood of achieving the goal of global rabies eradication by 2030.

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Bio Vet Innovator Magazine

Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Review Article

Rabies in Cats: Implications, Diagnosis, and Future Directions

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Introduction:

Rabies is a highly fatal viral disease affecting the central nervous system of mammals, including humans, with global public health significance. Although rabies is most commonly associated with domestic dogs, cats are increasingly recognized as important vectors for the transmission of the rabies virus, particularly in areas where vaccination coverage is inconsistent or limited. As a zoonotic disease, rabies poses a critical risk not only to animals but also to human populations, with domestic cats sometimes acting as intermediaries between wild rabies reservoirs and humans. Despite being less prominently associated with rabies outbreaks compared to dogs, the role of cats in the epidemiology of rabies is significant, especially given the close proximity between domestic cats and human households.

The epidemiology of rabies in cats is shaped by several factors, including the prevalence of rabies in the surrounding wildlife and domestic animal populations, as well as the level of public awareness and control measures in place. In regions where stray or feral cat populations are large and vaccination campaigns are less robust, cats can become reservoirs for the rabies virus, perpetuating the cycle of transmission. Stray cats in urban areas, for instance, frequently come into contact with rabid animals such as raccoons, bats, and foxes, and if infected, can easily transmit the virus to other domestic animals and humans. This underscores the importance of considering cats in rabies control programs, especially in areas where they are often overlooked.

The clinical presentation of rabies in cats is varied, with symptoms ranging from behavioral changes and aggression to paralysis and hypersalivation. Initially, infected cats may exhibit non-specific signs such as lethargy, fever, or subtle changes in behavior. As the disease progresses, neurological symptoms become more pronounced, including disorientation, ataxia, seizures, and progressive paralysis. These symptoms are particularly dangerous in a domestic setting where owners may not immediately recognize the signs of rabies or may misattribute them to less

severe conditions. Given the acute nature of rabies and its near-universal fatality once clinical signs appear, rapid diagnosis and intervention are crucial. However, diagnosing rabies in cats can be challenging, especially in the early stages, due to the overlap of symptoms with other neurological disorders.

The most definitive method for diagnosing rabies remains the post-mortem direct fluorescent antibody (DFA) test on brain tissue, which has limited use for live animals. As such, there is a pressing need for improved diagnostic tools that allow for earlier detection in live animals. Emerging technologies such as PCR-based tests and next-generation sequencing offer promising avenues for more accurate and timely diagnosis. In addition, developing non-invasive methods for rabies diagnosis in live animals could revolutionize how rabies is monitored and controlled in domestic cats.

Public health implications of rabies in cats cannot be understated. While the number of reported rabies cases in cats is generally lower than in dogs, cats are often in close contact with humans, increasing the risk of zoonotic transmission. This is particularly true in urban and suburban environments, where cats frequently interact with children and vulnerable populations who may not recognize the dangers of a bite or scratch from an infected animal. Furthermore, the fact that cats are less likely to be vaccinated against rabies compared to dogs in many regions exacerbates the problem, creating a reservoir of potential rabies cases that can affect both humans and other animals. Therefore, ensuring that cats are included in routine rabies vaccination programs and public health messaging is critical.

The need for enhanced rabies surveillance in domestic and stray cat populations is evident. In areas where rabies is endemic, robust monitoring systems must be in place to track the movement of the virus within both wild and domestic animal populations. Stray cats, in particular, should be a focus of these efforts, given their role in the spread of the virus. Surveillance systems that incorporate molecular techniques for viral tracking, combined with traditional methods of rabies reporting and testing, will allow for more effective control of the disease and prevention of outbreaks in both animals and humans.

From a veterinary perspective, managing rabies in cats presents unique challenges. While vaccination is highly effective at preventing the disease, public compliance with vaccination mandates for cats is often lower than for dogs. Veterinary practices must advocate for routine rabies vaccinations in cats, especially in areas where rabies is endemic. Additionally, veterinarians must be prepared to deal with suspected rabies cases in cats by implementing proper quarantine measures and working closely with public health officials to prevent further spread of the disease.

Future research on rabies in cats should focus on several key areas. First, developing more accessible and non-invasive diagnostic methods will be essential for early detection and intervention. Second, understanding the ecological role of cats in rabies transmission, particularly in relation to wildlife reservoirs, will help refine control strategies. Third, exploring ways to increase public awareness and compliance with rabies vaccination programs for cats is crucial for reducing the risk of outbreaks. Finally, research should investigate the socio-economic impacts of rabies in cats, particularly in regions where livestock or human populations are heavily affected by rabies outbreaks.

Detailed Study:

Epidemiology and Transmission-

Rabies in cats is often underreported, partly due to the lower incidence compared to other domestic animals.

However, cats are crucial vectors for rabies, particularly in areas with high stray cat populations. Transmission occurs primarily through bites from infected animals, with the virus entering the host through broken skin. The disease can also spread through contact with infectious saliva.

Clinical Manifestations-

The clinical presentation of rabies in cats is variable but typically includes behavioral changes, neurological signs, and aggression. Early symptoms may involve fever, lethargy, and changes in appetite, followed by more severe manifestations such as ataxia, seizures, and paralysis. The progression of symptoms often leads to rapid deterioration and death within a few weeks of onset.

Diagnostic Challenges-

Diagnosing rabies in cats poses significant challenges due to the need for specialized laboratory tests and the similarity of symptoms to other neurological conditions. The gold standard for diagnosis is the direct fluorescent antibody test (DFAT) of brain tissue, which is typically performed post-mortem. However, advancements in molecular techniques, such as PCR, are improving early detection and diagnostic accuracy.

Case Studies:

Rabies Outbreak in Stray Cats in Mumbai

In 2021, Mumbai experienced a rabies outbreak among its stray cat population. The outbreak resulted in the death of 10 infected cats, with a significant public health concern due to potential human exposure. The case highlighted the need for improved stray animal management and vaccination programs.

Rabies Transmission in Domestic Cats in Delhi

A 2020 case study in Delhi reported a rabies transmission from an infected stray cat to several domestic cats. The outbreak led to a significant increase in veterinary consultations and required a rapid response involving vaccination of at-risk animals and public awareness campaigns.

Rabies in Cats in Rural Tamil Nadu

In Tamil Nadu, a 2019 outbreak in a rural community affected 15 domestic cats, resulting in three human cases. The incident emphasized the importance of vaccinating pet cats and controlling stray populations to prevent zoonotic transmission.

Urban Rabies in Cats: A Case from Bengaluru

Bengaluru's 2021 rabies outbreak involved five domestic cats, with one case leading to human exposure. The outbreak underscored the necessity for urban rabies control strategies, including regular vaccination and public education.

Rabies in Cats and Human Exposure in Hyderabad

In Hyderabad, a rabies outbreak in 2018 affected seven domestic cats, with two cases leading to human rabies exposure. The case highlighted the urgent need for comprehensive vaccination and immediate medical intervention for exposed individuals.

Rabies in Cats in Kolkata: A Public Health Concern

A 2022 case study in Kolkata reported a rabies outbreak affecting 12 cats, leading to significant concern about potential human cases. The outbreak prompted an increased focus on vaccination programs and stray cat management.

Rabies in Cats in Gujarat: Veterinary Response

In Gujarat, a 2021 rabies outbreak among 20 cats resulted in heightened veterinary response efforts. The case demonstrated the effectiveness of prompt vaccination and public awareness in controlling rabies spread.

Rural Outbreak of Rabies in Cats in Uttar Pradesh

A rural outbreak in Uttar Pradesh in 2020 affected 18 domestic cats, with several human exposures reported. The incident highlighted the need for better surveillance and vaccination strategies in rural areas.

Rabies in Cats in Assam: Challenges in Control

In Assam, a 2019 rabies outbreak among 14 domestic cats led to significant veterinary and public health challenges. The case emphasized the importance of strengthening rabies control measures and improving diagnostic capabilities.

Rabies in Cats and Economic Impact in Rajasthan

A 2021 outbreak in Rajasthan affected 10 domestic cats, causing economic strain due to veterinary costs and potential human exposure. The case underscored the financial burden of rabies control and the need for effective prevention strategies.

Rabies in Cats in Kerala: A Case of Multiple Infections

In Kerala, a 2020 case study reported rabies in 8 domestic cats, with multiple infections leading to public health concerns. The case highlighted the importance of community-based vaccination programs.

Urban Rabies in Cats: A Case from Chennai

Chennai experienced a 2021 rabies outbreak affecting 12 domestic cats, leading to increased public health interventions. The outbreak emphasized the need for urban rabies management and preventive measures.

Rabies in Cats in Andhra Pradesh: A Veterinary Perspective

In Andhra Pradesh, a 2019 outbreak involved 15 domestic cats, highlighting challenges in diagnosing and managing rabies. The case called for enhanced veterinary training and resources for rabies control.

Rabies in Cats in Odisha: Impact on Human Health

A 2018 rabies outbreak in Odisha affected 9 domestic cats, with several human exposures. The case underscored the need for effective vaccination and post-exposure prophylaxis.

Rabies in Cats: A Case from Himachal Pradesh

Himachal Pradesh reported a rabies outbreak in 2021 affecting 11 domestic cats, with significant public health implications. The case highlighted the importance of improving rabies surveillance and control measures.

Future Research and Suggestions:

Future research on rabies in cats should focus on improving diagnostic techniques, enhancing vaccination strategies, and understanding the epidemiology of rabies in feline populations. Investigating the role of stray cats in rabies transmission and developing targeted control measures will be crucial. Additionally, exploring the socio-economic impacts of rabies in feline populations and integrating One Health approaches can offer comprehensive solutions. Collaborative efforts between veterinary professionals, public health authorities, and researchers are essential to advancing rabies control and ensuring effective prevention strategies.

Future Research Areas:

Development of Non-Invasive Diagnostic Methods:

Future research should focus on advancing diagnostic techniques that allow for early and non-invasive detection of rabies in live cats. Innovations in molecular diagnostics, such as improved PCR methods and saliva-based tests,

could provide earlier diagnosis and facilitate more effective management of rabies cases before symptoms become severe.

Enhanced Vaccination Strategies:

Investigating new vaccination approaches tailored specifically for cats, including more effective vaccines with longer-lasting immunity or improved delivery methods, could enhance rabies prevention. Additionally, strategies to increase vaccination rates among domestic and stray cats, particularly in high-risk areas, are crucial.

Ecological and Epidemiological Studies:

Further research is needed to understand the role of cats in the ecology of rabies transmission. Studies should focus on how domestic and stray cats interact with wildlife reservoirs and how these interactions influence rabies spread. This includes mapping rabies incidence in feline populations and correlating it with environmental and socio-economic factors.

Public Health Education and Awareness:

Exploring methods to improve public awareness and compliance with rabies vaccination for cats is vital. Research should assess the effectiveness of educational campaigns, community outreach, and interventions aimed at increasing vaccination coverage and preventing rabies transmission.

Socio-Economic Impact Assessment:

Research into the economic impact of rabies in cats, including costs related to veterinary care, public health interventions, and potential human rabies cases, can provide valuable insights. This includes understanding how rabies outbreaks affect rural and urban communities economically and socially.

One Health Integration:

Future studies should enhance the integration of veterinary, human, and environmental health perspectives in rabies control. Collaborative research efforts that incorporate One Health principles can lead to more comprehensive strategies for managing rabies and reducing its impact across species.

Vaccine Distribution and Access:

Investigating ways to improve the distribution and accessibility of rabies vaccines, especially in underserved areas, can help in preventing outbreaks. Research should focus on logistical and policy aspects of vaccine delivery to ensure that all cats, particularly those in high-risk populations, receive timely vaccinations.

By addressing these research areas, we can improve our understanding of rabies in cats and develop more effective strategies for prevention, diagnosis, and control, ultimately enhancing both animal and human health.

Conclusion:

Rabies in cats poses significant challenges to public health and veterinary practice. Effective management requires a multifaceted approach, including improved diagnostics, comprehensive vaccination programs, and enhanced public education. Addressing these needs through collaborative research and targeted interventions will be essential for controlling rabies and mitigating its impact on both feline and human populations.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Review Article

Rabies in Cattle: The Overlooked Threat and Its Impact on One Health and Farm Economics

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Abstract:

Rabies, a devastating zoonotic disease, continues to exert a profound impact on livestock, particularly cattle, across India. This chapter explores the far-reaching economic consequences of rabies outbreaks, highlighting both direct losses—such as livestock mortality, diminished milk yields, and rising veterinary expenses—and the broader disruption to rural livelihoods. Through detailed case studies from various Indian states, the chapter reveals the heavy financial burden on farmers and the cascading effects on the agricultural economy. It underscores the pressing need for robust rabies control strategies, including widespread vaccination, enhanced disease surveillance, and farmer education, to curb future outbreaks. Embracing the One Health framework, the chapter emphasizes the vital connection between human, animal, and environmental health. A holistic approach to tackling rabies will not only safeguard livestock and farm revenues but also enhance public health resilience. The chapter calls for coordinated efforts between veterinarians, policymakers, and farmers, offering a pathway toward sustainable livestock management and greater economic stability in rabies-prone regions.

Keywords: Rabies control, Cattle health, Economic loss, one Health approach, Livestock disease management, Rabies vaccination and Zoonotic disease prevention

Introduction:

Rabies is a lethal viral zoonosis that affects all warm-blooded animals, including livestock such as cattle, and poses a significant risk to human health. While much attention has been focused on rabies in dogs, which are the primary reservoirs in many regions, rabies in cattle remains an underappreciated concern. Cattle play a crucial role in the rural economies of many developing countries, providing milk, meat, and labor, and contributing to the livelihoods of smallholder farmers. When cattle are infected with rabies, the economic and public health consequences can be severe. Direct losses from animal deaths, decreased milk production, and the cost of post-exposure prophylaxis

(PEP) for those exposed to infected cattle are just a few of the burdens placed on both farmers and health systems. This chapter explores the significance of rabies in cattle, its impact on the economy, and its public health relevance through a One Health approach. The One Health framework, which recognizes the interconnectedness of human, animal, and environmental health, is particularly relevant in understanding and addressing rabies in cattle. Rabies in cattle not only threatens the agricultural sector but also poses a significant risk to those who handle infected animals, including farmers, veterinarians, and meat processors. In addition, the ripple effect of rabies in cattle extends to consumers through disruptions in the supply chain and increased prices for dairy and meat products.

Through a review of rabies transmission in cattle, its economic implications, and the role of One Health in rabies control, this chapter aims to highlight the need for more focused efforts on preventing rabies in livestock populations. Strategies such as vaccination, public awareness campaigns, and improved access to veterinary care are discussed as vital components of rabies control. The objective of this chapter is to provide a comprehensive understanding of the multifaceted nature of rabies in cattle and its implications for animal welfare, public health, and economic stability. In doing so, it seeks to encourage a more integrated and proactive approach to rabies management that considers the needs of both the farming community and the broader public.

Rabies in cattle and its effect in detail:

Rabies in cattle is a significant yet underexplored issue in veterinary medicine, particularly in the context of its economic, public health, and One Health implications. This section delves into the multifaceted aspects of rabies in cattle, discussing its transmission dynamics, impact on farming economies, relevance to the One Health framework, and the current challenges in preventing and controlling the disease.

1. Rabies Transmission in Cattle:

Rabies is caused by the Lyssavirus, primarily transmitted through the saliva of infected animals, most often through bites. In regions where domestic dogs are the main rabies reservoir, cattle frequently become infected due to their proximity to free-roaming or unvaccinated dogs. Cattle can also contract rabies from wildlife, such as bats or foxes, especially in areas where these species are prevalent reservoirs of the disease (Fooks et al., 2014).

Rabies in cattle presents a unique challenge because the symptoms can be confused with other diseases, such as bovine spongiform encephalopathy or other neurological disorders. Infected cattle may exhibit unusual behavioral changes, excessive salivation, aggression, or difficulty swallowing, which can be misinterpreted by farmers or veterinarians (Knobel et al., 2005). This misidentification not only delays appropriate intervention but also increases the risk of human exposure to rabies through close contact with infected animals.

2. Economic Implications of Rabies in Cattle:

The economic consequences of rabies in cattle are profound, particularly for small-scale farmers in rural communities. Rabies outbreaks in livestock lead to direct losses from animal death, which can have devastating effects on a farmer's income. The loss of a single cow may seem minor in large-scale operations, but for many smallholders, a cow represents a significant portion of their livelihood, contributing to milk, meat, and even labor for plowing fields.

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Additionally, the indirect costs associated with rabies are substantial. A rabies outbreak can reduce milk production and cause the culling of infected herds, leading to both immediate and long-term economic impacts. Rabies also necessitates post-exposure prophylaxis (PEP) for anyone exposed to an infected animal, which can be a significant financial burden, particularly in low-income regions.
(Taylor et al., 2009)

The economic ripple effects extend to consumers as well. Outbreaks in cattle disrupt meat and dairy supply chains, driving up prices and reducing access to animal products. This has both nutritional and financial consequences, particularly in regions where animal products are a key source of protein. Moreover, trade restrictions may be imposed on regions experiencing rabies outbreaks, limiting farmers' access to markets and further exacerbating economic losses (Lankester et al., 2014).

3. The One Health Approach: A Holistic Perspective:

The One Health framework, which emphasizes the interconnectedness of human, animal, and environmental health, is crucial for addressing rabies in cattle. Rabies in cattle is not an isolated animal health issue; it poses risks to farmers, veterinarians, and others who come into close contact with infected animals. Infected cattle can transmit rabies to humans through bites or exposure to infected saliva via wounds, which necessitates a collaborative approach to prevention and control (World Health Organization, 2018).

By controlling rabies in cattle through vaccination and improved animal husbandry practices, we not only protect livestock populations but also reduce the incidence of human rabies. This is particularly important in rural areas where cattle serve as a vital part of the economy and food supply. Effective rabies control in cattle requires coordination among veterinarians, public health professionals, and environmental scientists to create comprehensive strategies that address the disease across multiple levels (Fooks et al., 2014).

Moreover, the One Health approach recognizes the environmental factors that influence rabies transmission. In regions where wildlife reservoirs such as bats and foxes are prevalent, it is essential to monitor and manage these populations to reduce spillover events that can infect livestock. Integrating wildlife surveillance into rabies control programs for cattle is therefore an important part of reducing the overall disease burden (Lembo et al., 2008).

4. Current Challenges in Rabies Prevention and Control:

Despite the availability of effective rabies vaccines, preventing and controlling rabies in cattle remains challenging, especially in low- and middle-income countries. One of the primary obstacles is the lack of access to affordable vaccines for livestock. In many regions, veterinary infrastructure is limited, making it difficult to implement widespread vaccination programs. Farmers may also be unaware of the risks of rabies or the importance of vaccinating their cattle, leading to low vaccination rates (Knobel et al., 2005).

Additionally, surveillance and diagnostic challenges complicate efforts to manage rabies in cattle. Rabies is often underreported in livestock populations, particularly in rural areas where veterinary services are scarce. In these regions, rabies cases in cattle may be misdiagnosed as other neurological diseases, leading to delayed intervention and continued transmission (Taylor et al., 2009). Improving diagnostic capabilities and increasing public awareness are therefore critical for better rabies management.

Another challenge is the implementation of effective biosecurity measures on farms. Farmers may be reluctant to

cull infected animals due to the economic losses involved, which can lead to the continued spread of the disease within herds. Strengthening biosecurity practices, including quarantine measures and proper disposal of infected carcasses, is essential for controlling rabies outbreaks in livestock (Lankester et al., 2014).

5. Strategies for Improved Rabies Control in Cattle:

To effectively address rabies in cattle, a multi-faceted approach is necessary. Vaccination remains the most effective preventive measure, and efforts should be made to increase access to rabies vaccines in rural and underserved areas. Governments and international organizations can play a critical role by subsidizing vaccines and supporting veterinary services in regions where rabies is endemic.

Educational campaigns targeted at farmers and rural communities can raise awareness about the risks of rabies and the importance of vaccination. These campaigns should also emphasize the need for early diagnosis and veterinary intervention when rabies is suspected in livestock (World Health Organization, 2018).

In addition to vaccination, improving surveillance systems for rabies in cattle is essential. Investing in diagnostic infrastructure, particularly in rural areas, can help ensure that rabies cases are identified and managed promptly. Strengthening biosecurity measures on farms, including quarantine protocols and safe disposal of infected animals, is also key to preventing the spread of rabies within herds (Fooks et al., 2014).

6. Future Research Directions:

Further research is needed to explore the epidemiology of rabies in cattle and its economic impact on farming communities. Studies on the efficacy of different vaccination strategies in livestock populations, as well as the development of more affordable vaccines, could greatly enhance rabies control efforts. Additionally, research into the role of wildlife reservoirs in cattle rabies outbreaks is crucial for creating more comprehensive rabies management programs that integrate wildlife monitoring and control (Lembo et al., 2008).

The development of rapid diagnostic tests for use in the field could also improve rabies surveillance in livestock. Such tests would allow for quicker identification of rabies cases and more immediate intervention, reducing the risk of transmission to other animals and humans. Finally, future research should continue to explore the One Health approach, focusing on how integrated efforts across human, animal, and environmental health sectors can lead to more effective rabies control strategies.

Case Studies on Rabies in Cattle and Its Economic Impact in India:

1. Rabies Outbreak in Punjab Dairy Farms

In 2020, a significant rabies outbreak occurred in dairy farms in Punjab, primarily affecting crossbred cattle. The outbreak led to the death of 30 cows, causing a direct economic loss of approximately ₹2.5 lakhs due to the loss of milk production and the need for culling. Additionally, farmers faced increased expenses for post-exposure prophylaxis for human contacts. The outbreak highlighted the need for improved vaccination coverage and better veterinary surveillance.

2. Economic Impact of Rabies in Maharashtra Cattle

In Maharashtra, an outbreak of rabies in cattle in 2019 resulted in the loss of 50 cattle from a single farm. The direct economic loss included the value of the dead animals, estimated at ₹4 lakhs, and reduced milk yield from surviving cows. Indirect costs included veterinary care and increased labor costs for managing the outbreak. The economic strain on farmers underscored the need for effective vaccination strategies and public awareness campaigns.

3. Rabies in Cattle: A Case Study from Gujarat

In Gujarat, a rabies outbreak in 2021 affected 20 cattle on a dairy farm. The outbreak resulted in direct losses of ₹1.8 lakhs due to the deaths of affected cattle and the costs associated with vaccination and treatment. The incident led to a temporary halt in milk production, causing financial instability for the farm. Improved vaccination coverage and awareness programs were recommended to mitigate future risks.

4. Rabies-Related Economic Losses in Uttar Pradesh

A rabies outbreak in cattle in Uttar Pradesh in 2018 led to the death of 15 animals, resulting in a direct economic loss of ₹1.2 lakhs. The outbreak also caused significant disruption in milk production and increased veterinary costs. The economic impact highlighted the need for enhanced vaccination programs and better disease surveillance.

5. Rabies in Cattle: Case Study from Karnataka

In Karnataka, an outbreak of rabies in 2020 affected 25 cattle on a farm, resulting in a direct loss of ₹3 lakhs. The outbreak caused a decrease in milk production and increased veterinary expenses. The case underscored the need for better rabies management strategies and public education on vaccination.

6. Economic Consequences of Rabies in Andhra Pradesh Cattle

A rabies outbreak in Andhra Pradesh in 2017 led to the loss of 12 cattle, costing approximately ₹1 lakh. The outbreak also resulted in increased veterinary costs and loss of milk production. The incident highlighted the necessity for effective vaccination programs and better disease management.

7. Rabies and Economic Impact in Tamil Nadu Cattle

In Tamil Nadu, a rabies outbreak in 2021 affected 18 cattle, resulting in a direct economic loss of ₹2.2 lakhs. The farm experienced a reduction in milk yield and faced increased costs for treatment and vaccination. The case emphasized the importance of regular vaccination and awareness campaigns.

8. Impact of Rabies on Cattle in West Bengal

A rabies outbreak in West Bengal in 2019 led to the death of 22 cattle, resulting in a loss of ₹2.7 lakhs. The farm also faced significant veterinary costs and a temporary drop in milk production. This outbreak underscored the need for improved surveillance and vaccination efforts.

9. Rabies Outbreak and Economic Loss in Haryana

In Haryana, a 2020 rabies outbreak in cattle led to the death of 30 animals, causing a direct economic loss of ₹3.5 lakhs. The outbreak disrupted milk production and increased veterinary and treatment costs. The case highlighted the urgent need for comprehensive rabies control measures.

10. Economic Impact of Rabies on Cattle in Odisha

In Odisha, a 2018 rabies outbreak affected 14 cattle, leading to a direct economic loss of ₹1.5 lakhs. The farm experienced reduced milk production and increased veterinary costs. The case highlighted the necessity for effective vaccination programs and better disease management.

11. Rabies and Its Economic Burden on Cattle in Rajasthan

In Rajasthan, a rabies outbreak in 2021 led to the death of 20 cattle, resulting in a direct economic loss of ₹2.4 lakhs. The outbreak caused a decline in milk production and increased veterinary costs. The case emphasized the need for improved vaccination strategies and public education.

12. Impact of Rabies in Cattle: A Case from Bihar

In Bihar, a rabies outbreak in 2020 led to the death of 16 cattle, causing a direct economic loss of ₹1.9 lakhs. The outbreak disrupted milk production and led to increased expenses for veterinary treatment and vaccination. The

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incident highlighted the importance of enhancing rabies control measures and improving farmer awareness.

13. Rabies in Cattle and Economic Impact in Assam

In Assam, an outbreak of rabies in 2019 led to the loss of 25 cattle, resulting in an economic loss of ₹2.8 lakhs. The outbreak caused a significant reduction in milk yield and increased costs for managing the disease. This case underscored the need for improved vaccination coverage and effective disease management strategies.

14. Economic Consequences of Rabies in Cattle in Jharkhand

In Jharkhand, a rabies outbreak in 2018 resulted in the death of 12 cattle, leading to a direct economic loss of ₹1.4 lakhs. The farm faced reduced milk production and increased veterinary costs. The case emphasized the importance of implementing effective vaccination programs and improving disease surveillance.

15. Rabies in Cattle: Economic Impact in Himachal Pradesh

In Himachal Pradesh, a rabies outbreak in 2020 affected 18 cattle, resulting in a direct economic loss of ₹2 lakhs. The outbreak led to decreased milk production and increased veterinary and treatment expenses. This case highlighted the need for better rabies control measures and awareness campaigns for farmers.

These case studies collectively illustrate the profound economic impact of rabies outbreaks on cattle across various states in India. Each instance highlights the direct costs associated with the loss of animals and the associated disruption in milk production, as well as the indirect costs related to veterinary care and disease management. The recurring theme is the urgent need for comprehensive vaccination programs, improved surveillance systems, and enhanced public education to mitigate the economic burden of rabies on farmers.

Conclusion:

Rabies in cattle is an often-overlooked aspect of rabies control, yet its impact on human health, animal health, and the economy is profound. Through a One Health approach, we can address rabies in cattle more effectively, recognizing the interconnectedness of human, animal, and environmental health. By improving vaccination coverage, increasing public awareness, and strengthening biosecurity measures, we can reduce the incidence of rabies in livestock populations and protect both farmers and consumers from the devastating consequences of this preventable disease.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies Day Special: Bridging the Gap between Science and Safety

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Introduction:

In the twenty-first century, rabies remains one of the most feared and serious hazards to public health. Untreated sickness manifests as a progressive encephalomyelitis that is always fatal and is caused by neurotropic viruses of the genus *lyssa virus*. Rabies is a neglected zoonotic disease that affects much of the world, with many human deaths happening in Africa and Asia in children under the age of 15. Rabies is thought to be under-reported in many areas, owing to a lack of surveillance and laboratory infrastructure, which is exacerbated by cultural or societal stigmas. In the absence of good data on disease incidence, policymakers and public health experts tend to prioritize rabies less. A more complete worldwide estimate has been provided by updating and adding country-specific data from published research and online surveys to estimates of the burden that were previously based on models of the incidence of dog bites. Based on preliminary statistics, it is estimated that rabies causes approximately 60,000 deaths worldwide each year, more than any other zoonotic disease combined. Due of the high proportion of children among these deaths, rabies is thought to result in more than 2 million DALYs (disability-adjusted life years) lost annually, at a cost to the economy of more than $4 billion. Estimates of statistical life values have been utilized by other models to forecast the economic impact of rabies. These figures range from $1·8 to $2·2 million per human fatality; however, these figures do not account for livestock losses, post-exposure therapies, or the expense of immunization and diagnostic testing. It is estimated that the annual global expenses associated with canine rabies alone amount to tens of billions of dollars.

Etiology:

There are two components of the bullet-shaped Rhabdoviridae family of viruses that cause rabies. The ribonucleocapsid core is found in the second, more functional portion, whereas the first, which is the viral envelope, is thought to be more structural. The most typical way for the virus to spread is through the bite of an infected mammal, both domestic and wild, however saliva can also transfer the virus through cuts in the skin or mucous membranes. Additional ways to become infected include ingesting the virus, breathing it in aerosolized form, passing it through the placenta, and even receiving an organ transplant.

Epidemiology:

Rabies is thought to be the cause of between 30,000 and 70,000 deaths annually, with less developed nations being more affected. Few human cases are documented in the US, yet it might be because post-exposure prophylaxis is so often used and because there are preventative initiatives in place. Raising domesticated animals has only contributed to roughly 10% of rabies cases in affluent nations. On the other hand, the remaining cases are caused by wild creatures like foxes, bats, raccoons, and skunks. There have been anecdotal reports of rabies caused by transmission from rats, although small rodents and the rabbit family are generally thought to be safe since they are not likely to survive an inoculating wound from a rabid. Any mammal can transmit rabies. Knowing your region's animal carriers might assist you determine who can benefit from prophylaxis, as animal carriers differ by location.

Categories of contact with suspect rabid animal	Post-exposure prophylaxis measures
Category I - touching or feeding animals, animal licks on intact skin (no exposure)	Washing of exposed skin surfaces, no PEP
Category II - nibbling of uncovered skin, 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, exposures due to direct contact with bats (severe exposure)	Wound washing, immediate vaccination and administration of rabies immunoglobulin/monoclonal antibodies

Pathophysiology:

The rhabdovirus targets the central nerves after viral transmission and spreads through the peripheral nervous system to cause encephalomyelitis. The initial signs of a viral illness in humans resemble those of any other nonspecific illness (fever, malaise, headache). After that, these mild symptoms could intensify into agitation, anxiety, and finally open delirium. Within the first several days following a rabid bite, tingling at the bite site is one extremely common symptom. It's interesting to note that the virus returns to the peripheral neurological system (PNS) after first spreading to the central nervous system (CNS), primarily attacking highly innervated tissues (i.e., salivary glands). Hypersalivation causes the "frothing," as seen in the films Cujo and Old Yeller, and individuals may experience severe pharyngeal muscular spasms at the sound, taste, or sight of water. We term this "hydrophobia." The infection eventually causes the entire neurological system to collapse completely, which results in an abrupt death. Animals typically pass away in ten days, but the incubation period after vaccination can extend anywhere from two weeks to six years, with an average of a few months. The site of exposure, the severity of the incision, and the viral load all influence the onset time. Ultimately, the virus damages the central nervous system, with the brainstem typically suffering the most. The inflammatory response triggers the toxic effects, which are accompanied by functional alterations that are not fully understood. Neurotransmission is ultimately thought to be impacted by the virus, and both virus-dependent and cell-dependent pathways may lead to apoptosis. Rabies is always lethal once clinical symptoms are observed.

Histopathology:

Autopsy examinations have shown that the brain is typically enlarged and congested, with an initial inflammatory process. Neuronal death is uncommon in most circumstances. Immunochemical labeling reveals virion deposits in the nerve cytoplasm. Negri bodies are frequently observed under light microscopy, although only in roughly two-

thirds of instances.

Evaluation:

Without a documented history of rabid bites, rabies is frequently an excluding diagnosis. In the early stages, it may seem like influenza, Coxsackie, enterovirus, or herpes. Rabies can show in later stages with symptoms comparable to delirium tremens, tetanus, botulism, diphtheria, tick-borne illnesses, and Guillain Barre. Physicians frequently check CBC, electrolytes, cultures, CT, chest x-ray, and MRI, but are still unaware that rabies is to blame. Unless isolated in a rabies-specific viral culture, detected by polymerase chain reaction (PCR) in saliva, confirmed to have a positive antibody titer, or isolated in cerebrospinal fluid (CSF), the diagnosis may remain difficult until too late. Rabies can be confirmed using CSF, blood, saliva, tears, and tissue biopsies (neck, immunofluorescent stain). CSF investigation can reveal pleocytosis and allow the virus to be identified. According to the Centers for Disease Control and Prevention, no single test is sufficient to diagnose or rule out rabies. Finally, because the disease is rare, developed countries must maintain a high level of suspicion. If the biting animal can be euthanized and examined, post-exposure prophylaxis may be unnecessary. Public health may be able to help with animal experimentation.

Treatment / Management:

There is no effective treatment for rabies. Prevention is the mainstay of treatment, including domestic animal vaccination programs, education, and monitoring. Wound care is the first step in treating any individual with a feared rabies exposure. Appropriate wound care alone is almost 100% effective if initiated within 3 hours of inoculation. Scrubbing the wound and surrounding area with soap and water (solutions include a 20% soap solution, povidone, and alcohol solutions) and soaking for puncture wounds. After carefully cleansing the wound, apply a virucidal agent such benzalkonium chloride or povidone-iodine. When a bite from a recognized bat, skunk, raccoon, or fox occurs in the United States, it is promptly treated with rabies vaccine and rabies immune globulin. Consult the public health agency for any other bites. If a dog bite occurs outside of the US, it should be treated right away with rabies immune globulin and vaccination.

Afterward, the start of treatment is determined by the patient's history of vaccinations. A human diploid cell vaccine or a pure chick embryo cell vaccine administered intramuscularly twice day at a dose of 1 mL is a common course of treatment for patients who have already received vaccinations. Suppose the patient has not already been immunized. In that situation, treatment consists of administering 1 mL of one of the two vaccines described above intramuscularly on days 0, 3, 7, and 14 (and on days 28 if the individual is immunosuppressed). The vaccination dosage should be administered at a location apart from the second stage of treatment (human rabies immune globulin, or HRIG). These unimmunized individuals are also treated with human rabies immune globulin at a dose of 20 IU/kg, with the goal of infiltrating as much of the dose as possible surrounding the lesion. Any residual dose of human rabies immune globulin that has not been infiltrated into the wound is administered intramuscularly, as previously stated, at a distance from the vaccine site. The recommendations have just been modified in the United States. Because bats are the primary source of rabies in this area, everyone who awakens from sleep and discovers a bat in the room should be inoculated right away.

Differential Diagnosis:

- **Poisoning with belladonna alkaloids-** Tachycardia, dilated pupils, blurred vision, urinary retention, altered mental status, and dry and flushed skins are a few of the symptoms evident.
- **Stroke-** vertigo, dizziness, seizures, headaches, bell's palsy, drug withdrawal, dementia, electrolyte disorders,

acute infections, syncope, and alcoholism**.**

- **Jacob Creutzfeldt disease-** difficulty walking caused by problems with balance and co-ordination, slurred speech, numbness or pins and needles in different parts of the body, dizziness, vision problems, such as double vision, hallucinations (seeing or hearing things that aren't really there).
- **Brain tumor**-Brain imaging is always abnormal, and lesions may mimic demyelination, neoplasm, infarction, infection, and others. Such lesions can be faint, diffuse, and coalescent; and the presentation may include infarcts and hemorrhage paired with multifocal stenosis on vascular imaging.
- **Pseudotumor Cerebri**, this condition is not a brain tumor, but its symptoms mimic a brain tumor. Pseudotumor Cerebri most commonly afflicts obese adolescent girls and young women.
- **Encephalitis-**The diagnosis of rabies encephalitis is usually unmistakable and is based on the unique clinical symptoms. Hydrophobia, which is the most characteristic and widely known feature of rabies, was not present in our case. In a study by Chabra, 5% of patients with rabies did not have hydrophobia.
- **Tetanus-** Tetanus must be differentiated from other diseases that present with fever and rigidity such as strychnine poisoning, dental infections, drug reactions, hypocalcemia, meningitis, stroke, and stiff man syndrome.

Complications:

i. **Seizures -** Convulsive concussion, convulsive syncope, movement disorders, rigors, sleep-related events, or psychogenic non-epileptic spells.

ii. **Fasciculations-**Fasciculation (muscle twitching) happens when a single peripheral nerve that controls a muscle is overactive, resulting in involuntary muscle movement.

iii. **Psychosis-** hyperactivity, excitable behavior, hallucinations, lack of coordination, hydrophobia (fear of water) and aerophobia (fear of drafts or of fresh air).

iv. **Aphasia -** It can impact your speech, as well as the way you write and understand both spoken and written language. Aphasia usually happens suddenly after a stroke or a head injury.

v. **Autonomic instability-**

- Balance problems.
- Fainting or passing out (especially when standing up).
- Nausea and vomiting.
- "Brain fog," forgetfulness or trouble focusing.
- Fast heart rate (tachycardia) or slow heart rate (bradycardia).
- Pinpoint eye pupils or unusually wide eye pupils.

vi. **Paralysis-** 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**.**

vii. **Coma-** last Stage of rabies is the coma stage and usually begins within 10 days of stage 3. Patients may have ongoing hydrophobia, develop prolonged apnea periods, and have flaccid paralysis. Without supportive care due to cardiopulmonary failure, most patients experience death within 2 to 3 days after undergoes into coma.

Consultations: Consultations that are typically requested for patients with this condition include the following:

a) Neurologist: To evaluate and monitor the patient's neurological symptoms, such as confusion, agitation, paralysis, and seizures, which are characteristic of rabies.

b) Infectious Disease Specialist: To confirm the diagnosis, determine the source of the infection, and guide antimicrobial treatment.

c) Neurosurgeon: In rare cases, surgical intervention may be necessary to alleviate symptoms or manage complications.

d) Public Health Specialist: To investigate the source of the infection, track potential contacts, and implement measures to prevent further transmission.

These consultations enable a comprehensive approach to managing rabies, ensuring timely diagnosis, treatment, and prevention of further spread. Prompt medical attention is critical, as rabies is almost always fatal if left untreated.

Vaccination:

Species	Age at Primary Vaccination	Revaccination
Dog & Cat	After 3 months of age *	3 years**
Cattle, Horse, Sheep & Goat	After 6 months of age *	2 years**
Ferret	After 3 months of age *	1 year**

Vaccination Programme: Post-Bite treatment (Post-exposure Prophylaxis)

In all species, repeated single dose of vaccine should be administrated (by the above recommended route) according to the following schedule-

Dose number	Timing
1st	**Day 0** (as soon as possible following bite/exposure)
2nd	**Day 3**
3rd	**Day 7**
4th	**Day 14**
5th	**Day 28**

Future Challenges:

Because rabies kills so many children, it should be considered a serious pediatrics disease. The combination of an existing rabies human vaccine with a conventional childhood immunization regimen should be prioritized in order to assure universal rabies vaccination of low-income children. This method would include rabies vaccine in the existing childhood Expanded Programme on Immunization (EPI) schedule. As part of a children EPI schedule, the addition of rabies vaccination to an existing multivalent pediatrics vaccine should ideally comprise a single-dose vaccine administered via a non-injectable route. Rabies, unlike other viruses targeted for eradication, will never be eliminated due to the prevalence of lyssaviruses in bats. The realistic goal for the twenty-first century is to increase efforts to eradicate rabies in dogs, resulting in a reduction in human mortality, a goal that has already been met in certain locations. The strategic approach for programs aimed at eliminating canine rabies should focus on a multidisciplinary core of disparate groups, including representatives from the public and private sectors (i.e.,

vaccine manufacturers, policymakers, scientists, veterinarians, and clinicians) with the overarching goal of eliminating human rabies. This joint interdisciplinary program, known as the One Health method, is a step toward rabies prevention through mass dog vaccination and humane dog population control. Financial assistance for these efforts will be required. Currently, philanthropic foundations, sponsors, and financial benefactors collaborate with global institutions to fund such projects. Along with these steps, the OIE has established an animal vaccine bank from which vaccine is distributed to various regions. The Food and Agriculture Organization of the United Nations has proposed a Progressive Control Pathway to Rabies Elimination, with the ultimate goal of maintaining rabies-free humans and animals. This support should extend beyond the community, district, national, and worldwide levels. In endemic areas, the development of novel diagnostic procedures for both ante-mortem and post-mortem diagnostic confirmation is critical to enable epidemiological assessment and, when possible, therapeutic alternatives evaluation. The OIE recommended a pathway for veterinary services to control rabies in dogs in order to increase veterinary services' compliance over time. Performance, vision, and strategy are the three important components. With this in mind, WHO, OIE, and the Food and Agricultural Organisation have suggested a strategy for eliminating human rabies transmitted by dogs in rabies-endemic countries, indicating that this be a feasible objective by 2030.

Summary:

Rabies is one of the worst infectious diseases, with a case fatality rate of nearly 100%. The disease has spread to all continents except Antarctica; the majority of cases are documented in Africa and Asia, with thousands of deaths recorded each year. However, the projected annual cases of nearly 60,000 of human rabies mortality are likely an underestimate. Almost all human rabies cases are caused by bites from infected dogs. Therefore, the most cost-effective method to eliminating the worldwide burden of human rabies is to reduce canine rabies rather than expanding the availability of human prophylaxis. Mass vaccination programs using parenteral vaccinations, as well as advancements in oral vaccines for animals; have enabled the eradication of rabies in terrestrial carnivores in various countries throughout the world. The ensuing decrease in cases of human rabies in such locations recommends the interdisciplinary One Health strategy to rabies control through mass vaccination of dogs and management of canine populations.

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Bio Vet Innovator Magazine

Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Brief review of Rhabdovirus -Rabies Disease

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Abstract:

Rabies is viral disease that causes acute encephalitis seen in warm blooded animals which includes all mammals. Rabies is caused by lyssa virus the disease spreads to people through close contact with rabies infected saliva via bites or scratches. The main symptoms like hydrophobia which is fear for water and convulsions are seen. Fluorescent antibody test (FAT) is the standard diagnostic test for rabies. There is no treatment for rabies only preventive measures are to be followed therefore, awareness campaign, animal vaccination, Pre-exposure prophylaxis for the people who are in higher risk should be done to hinder the spread of disease.

Keywords: Rabies, Viral disease, Hydrophobia, Rabies awareness programmes

Introduction:

Rabies is a zoonotic fatal viral disease that causes acute encephalitis (Inflammation of the brain). It is a disease of warm-blooded animals any mammals can get rabies cats, cattle, and dogs, bats, foxes including humans. It is caused by genus Lyssa Virus Type 1, Rhabdoviridae family of bullet shape virus, enveloped contains ss RNA as gnome. There are two types of virus street type virus and fixed type virus.

- **Street type virus:** It is a naturally occurring virus found in the saliva of the infected animals
- **Fixed type virus:** It has predictable features, including an incubation period and pathological and clinical effects. It is an attenuated virus that has been passage through a laboratory *(Jackson, A. C. 2011).*

How Rabies is transmitted?

Rabies is transmitted through humans mainly by,

- Scratches
- Bites
- Licks from infected animals (saliva)
- Non-bite exposures: Aerosois; generated in labs, bat caves containing millions of bats, corneal transplantation, organ transplantation from donors with rabies. (Leung AK.et.,al 2007)

Symptoms of Rabies:

- **Incubation period:** It takes an incubation period before symptoms manifest. The duration of the illness

often spans between one week and one year, contingent upon the site of viral entry into the body and the quantity of viral particles implicated. The consequences are more likely to appear sooner the closer the bite is to the brain. When symptoms arise, rabies is typically lethal.

- **Prodrome Period (Onset of symptoms):** fever of 100.4°F (38°C) or above, headache, anxiety, feeling generally unwell, sore throat and a cough, nausea and vomiting, discomfort at the site of the bite.
- **Neurological period:** Symptoms may include confusion, aggression, muscle twitching, rigid neck muscles, convulsions, difficulty breathing, hypersalivation, fear of water (hydrophobia), hallucinations, nightmares, insomnia, and photophobia (fear of light).
- **Coma and death:** An individual could go into a coma, and the majority of people die within 2 to 3 days. Even with supportive therapy, almost no one survives rabies while in a coma.

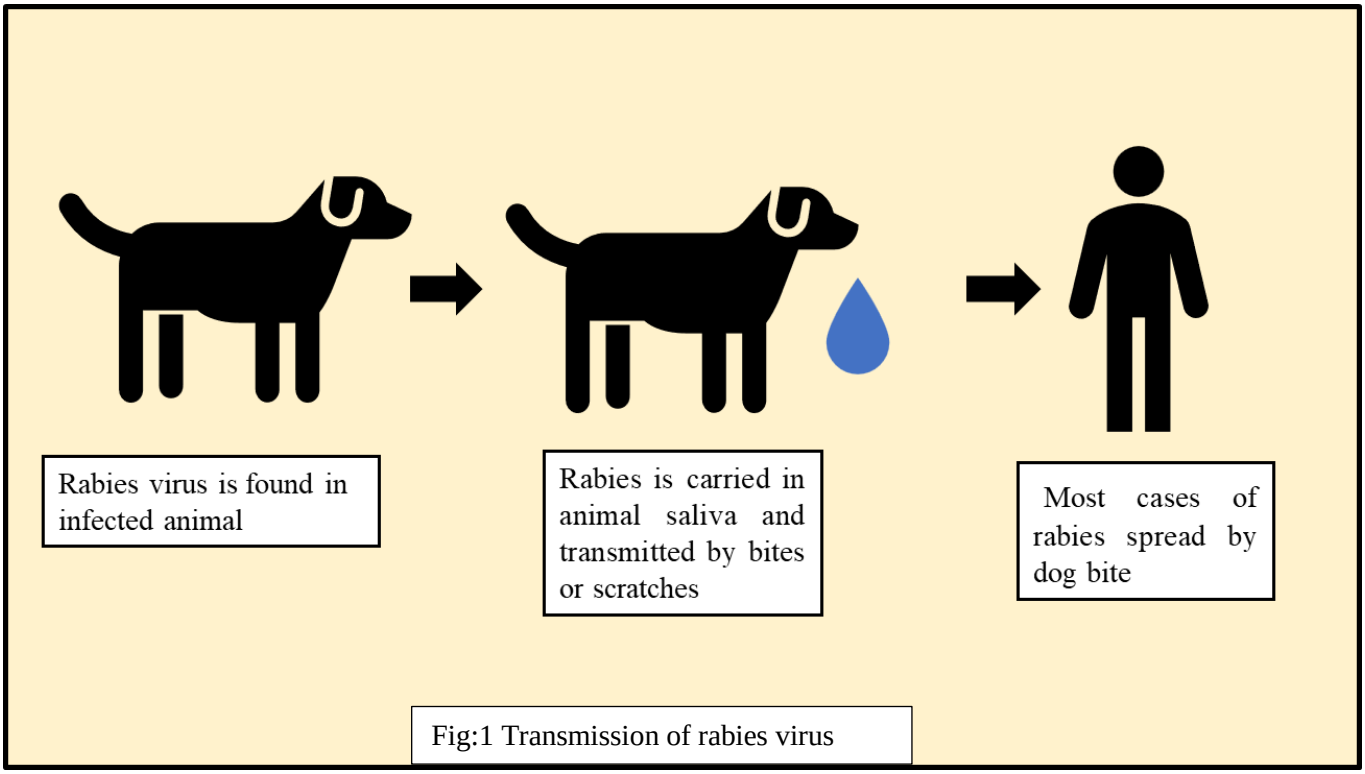


Fig:1 Transmission of rabies virus

Diagnosis of Rabies:

- It is preferable to perform laboratory procedures on central nervous system (CNS) tissue that has been extracted from the brain**.**
- **The fluorescence antibody test** (FAT), **Mouse inoculation test** (MIT)
- **Reverse-transcription polymerase chain reaction** (RT-PCR) These are the diagnostic procedures used to identify rabies in clinical samples. and These techniques cannot distinguish between street and laboratory-fixed viruses; they can only identify the presence of the virus in clinical samples.
- Serological tests include indirect immune-fluorescence, virus neutralization and enzyme-linked immunosorbent (ELISA)

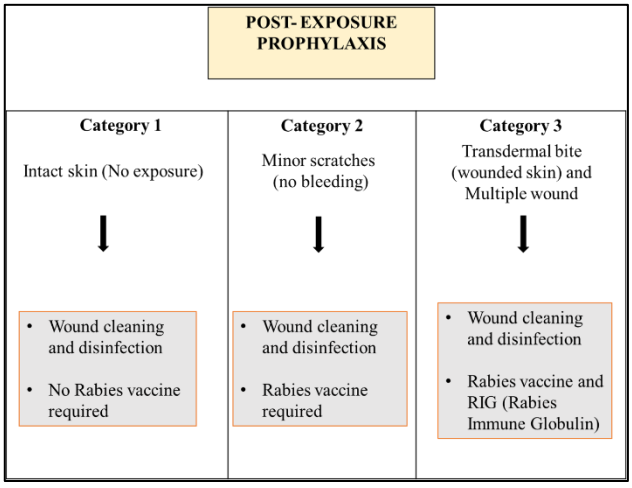
Prevention of Rabies:

Since there is no known cure for rabies, prevention steps must be made. The goal of disease prevention methods is to hinder animals from spreading the rabies virus or to treat humans after they have been exposed to it (Pre and

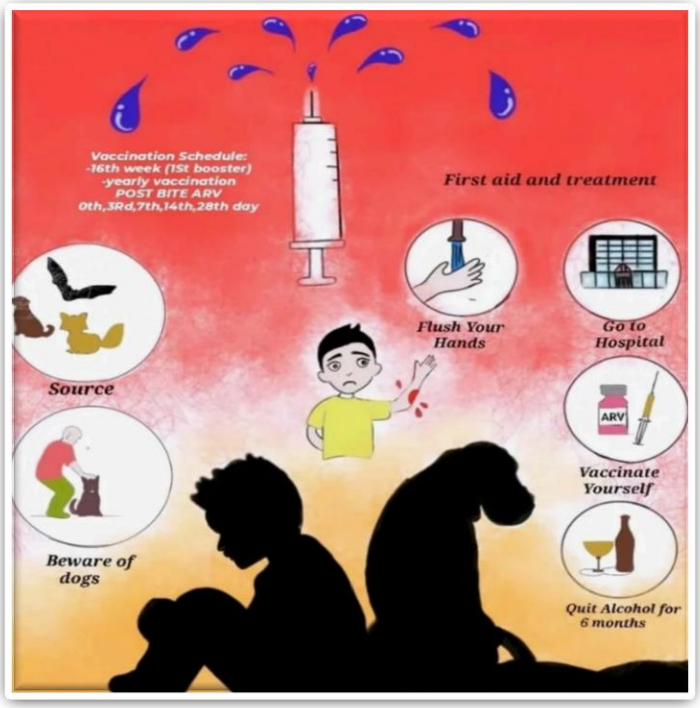
Post exposure prophylaxis in rabies)

- **Post-Exposure Prophylaxis:** Following quick wound cleaning and disinfection, rabies vaccination and human rabies immunoglobulin
- **Pre-Exposure Prophylaxis:** It is done in person who have high risk of repeated exposures like Animal Handlers, Wildlife officers, Veterinarians, Lab; Staffs working with rabies virus.

Vaccine doses 0th day, 3rd day, 7th day and 21st or 28th days and yearly booster of rabies vaccine is recommended. *(Hankins, Daniel G. et al.2004)*



Rabies awareness Programme and rabies awareness posters engages communities and empowers people to save themselves from this fatal disease.



Conclusion:

Rabies is a fatal disease and it emergers as a new major public health problem because of a lack of knowledge regarding rabies risk, and not knowing the proper management. Hence a proper awareness programme and campaign should be conducted to educate the people and vaccinating the animal population against rabies.

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Bio Vet Innovator Magazine

Volume 1 : Special Issue 1 : World Rabies Day - 2024

OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Breaking Rabies Boundaries: Merging Scientific Insights with Practical Safety Measures

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Abstract:

Rabies remains a significant health challenge, claiming thousands of lives annually predominantly in Asia and Africa. The disease caused by Lyssa virus can infect all mammals with mild symptoms initially but progresses to a severe encephalitis and death after onset of symptoms. Transmitted mostly by bites and scratches from infected dogs, rabies is a preventable disease with effective vaccination and community awareness strategies. This article highlights the critical need for community education, timely medical interventions, and public health policies to bridge the gap between scientific knowledge and its practical applicability in combating the disease. Preventive measures include vaccination of pets, stray animals, and individuals at high risk, along with immediate post-exposure prophylaxis (PEP). PEP involves thorough wound cleansing and a vaccination regimen based on the severity of exposure. Collaborative efforts among healthcare workers, policymakers, and communities are essential to achieve the World Health Organization's goal of "Zero human rabies deaths by 2030." By enhancing awareness and implementing comprehensive strategies, we can work towards a future free from rabies, ultimately transforming public health and safeguarding vulnerable populations.

Keywords:

Rabies, Vaccination, Post-Exposure Prophylaxis (PEP), Prevention, Community Awareness

Introduction:

Rabies is a vaccine-preventable, zoonotic, viral disease that still continues to take thousands of lives globally every year. The disease has been predominantly reported in African and Asian countries, with limited access to basic healthcare facilities. According to World Health Organization, 99% of human cases occur as a result of bites and scratches from infected dogs. This article aims to bridge the gap between scientific knowledge and the practical measures, emphasizing the necessary precautions to take before and after potential viral exposure as well as the

importance of community education and vaccination programs. Through comprehensive awareness initiatives, timely medical interventions, and robust public health policies, we can aim to break the cycle of rabies transmission and work towards a future free from the disease.

Understanding Rabies:

1. What is Rabies?

Rabies is a viral, zoonotic, fatal however neglected tropical disease which claims approximately 59,000 lives annually, of which 40% are children aged 5 to 14. In India, the disease fatality rate is around 20,000 annually; that accounts for almost one-third of the global human deaths. The first significant breakthrough in the prevention of this disease in humans, occurred in the year 1885, when Louis Pasteur saved the life of a 9-year-old boy Joseph Meister, who had been bitten by a rabid dog through pre-immunization with the inactivated virus.

Rabies is caused by virus of genus Lyssavirus, family Rhabdoviridae and can infect all mammals, including dogs, cats, human, livestock and wildlife. The virus transmission occurs through bites or scratches from infected dogs, but it can also occur via exposure of open wounds or mucous membranes to the saliva of infected animals. Rarely, rabies can be transmitted through organ transplants, consumption of raw meat/milk and aerosol inhalation, particularly in bat caves.

The development of the disease post exposure can range from 2-3 weeks to as long as a year; however, it is 100% fatal once the virus enters the central nervous system. The onset of symptoms varies based on the location of the virus entry (closer proximity to the CNS) and the viral load. Initial signs include fever, pain, unusual tingling or burn sensations at the wound site. In mammals, rabies manifests in two forms: the furious form, characterized by hyperactivity, excitable behavior, lack of coordination, hydrophobia and aerophobia, often leading to death due to cardio-respiratory arrest; and the paralytic form, which presents as gradual paralysis of muscles, slow developing coma and eventual death.

2. Prevention:

Rabies is a wholly preventable disease, achievable through a multifaceted approach that incorporates pre-exposure prophylaxis and vaccination schedules for both animals and humans. Key strategies encompass trainings for healthcare workers, enhanced surveillance, community awareness initiatives, control of stray animal populations, mass vaccination campaigns for dogs, and educational efforts tailored for both children and adults at various levels. Vaccination of pet dogs and livestock can be started at the age of 3 months, followed by annual booster shots. When combined with mass vaccination efforts for stray dogs, this approach has proven effective in reducing human fatalities from dog-mediated rabies in endemic regions.

Moreover, pre- exposure prophylaxis and vaccination is critical for individuals at heightened risk of exposure to the virus, such as laboratory scientists working with live or attenuated strains, veterinarians, animal handlers and disease control personnels. Currently, three WHO pre-qualified human vaccines are available globally: RABIVAX-S, VaxiRab N and VERORAB.

3. Treatment:

In addition to preventing exposure to the virus, understanding the critical post-exposure measures following an encounter with a potentially rabid animal is essential for preventing the progression of the disease. Post-exposure prophylaxis (PEP) should be initiated immediately after a bite or exposure incident to prevent entry of the virus into the central nervous system (CNS). The bite wounds should be thoroughly washed with soap or povidone-iodine

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and running water for at least 15 minutes. This should be followed by a shortened 2-sites intra-dermal rabies vaccine regimen on days 0, 3 and 7; accompanied by an injection of rabies immunoglobulins (RIGs) for individuals who have never been vaccinated, immunocompromised or those living in rabies endemic regions. For individuals who have been previously vaccinated, only a 4-sites intradermal rabies vaccine shot is required on the day of the bite, as per World Health Organization (WHO) recommendations.

The WHO has specified the need of post-exposure prophylaxis based on three categories of exposure severity to the suspected rabid animal:

Category I- This includes situations where an individual has fed or touched the animal or has had animal lick on intact skin. In such cases, thorough washing with soap and water for 15 minutes suffices, and no PEP is needed.

Category II- Involving minor scratches, abrasions or nibbling of skin, this necessitates wound washing followed by immediate vaccination.

Category III- Characterized by transdermal bites or scratches, contamination of mucous membranes with saliva from animal licks, or exposure to bats, this severe exposure requires immediate wound washing, vaccination and administration of immunoglobulins or monoclonal antibodies.

4. Control:

Effective management of canine rabies is crucial for the elimination of the disease, as it can disrupt the transmission pathways in endemic areas, thereby reducing the reliance on human post-exposure prophylaxis (PEP). This can be achieved through a combination of strategies, including control of stray dog populations, mass vaccination campaigns, proper reporting, and the quarantine and treatment of suspected animals.

Furthermore, preventing the spillover of rabies from wildlife into established areas is essential. Collaborative efforts among researchers, scientists, veterinarians, policymakers, and other stakeholders are necessary to implement effective preventive measures.

Additionally, precautionary vaccinations of individuals working in high-risk environments are vital, along with the development of efficient laboratory diagnostic facilities to ensure early detection of the disease. Lastly, establishing reliable surveillance systems, coupled with educational campaigns and awareness programs, is fundamental in informing the public about rabies—a disease that is both 100% preventable and potentially fatal.

Conclusion:

Considering the dismal fact that rabies is a fully preventable disease thousands of humans succumb to this disease annually. In the light of such pressing needs to eliminate this disease the collective goal achieving “Zero human rabies deaths by 2030” set forth by the WHO, the World Organisation for Animal Health (OIE), the Food and Agriculture Organization of the United Nations (FAO) and the Global Alliance for Rabies Control (GARC) and the theme of “Breaking Rabies Boundaries” for the World Rabies Day 2024 align seamlessly, emphasising the critical importance of collaboration across various sectors to eradicate this disease. India, as well, with its National Action Plan for Dog Mediated Rabies Elimination by 2030 (NAPRE) aims to eradicate human rabies transmitted by dogs through improved public health and veterinary services. It also promotes community engagement in both urban and rural setting across the country.

By implementing comprehensive vaccination strategies, enhancing community awareness, and ensuring timely medical interventions, we can break the cycle of rabies transmission. Together, we can foster a future where rabies is no longer a threat to human health, transforming the landscape of public health for generations to come.

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Bio Vet Innovator Magazine

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Bovine Rabies – an Overview

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Abstract:

Rabies is a zoonotic viral disease affecting cattle and other warm-blooded animals which is fatal in most species. Rabies virus is an enveloped, bullet-shaped RNA virus which belongs to the genus *Lyssavirus* in the family *Rhabdoviridae.* Cattle typically contract rabies from the bite of an infected animal, most frequently a wild animal such as a fox, raccoon, skunk, or a bat. The virus usually attacks the nervous system resulting in fatal neurological signs. Although rabies in cattle is uncommon, there is still a significant concern because of the disease's capacity to spread throughout the herd and potential risk to humans.

Keywords: Cattle, Rabies, Zoonotic

Introduction:

Rabies is an incurable fatal acute viral encephalitis of zoonotic importance affecting all warm-blooded species including cattle and human beings. The affected animal is typically characterized by an aggressive behaviour, hyperexcitability, drooling of saliva, incoordination, difficulty in swallowing, abnormal vocalization, paralysis of limbs and respiratory muscles, muscle spasms, followed by recumbency and death. Cattle are generally considered the dead-end host for rabies as they do not usually bite. However, transmission through direct contact of mucous membrane with the saliva of rabid animal can still impose risk to humans.

Epidemiology:

Geographic Distribution:

Rabies is prevalent all around the world with the exception of Switzerland, Japan, United Kingdom, New Zealand, Antarctica, Australia, and the Hawaiian Islands. The prevalence is relatively high in India.

Host Susceptibility:

The rabies virus can infect any warm-blooded animal, but the only known natural vectors and reservoirs of the virus are mammals. Susceptibility is influenced by variables such as the variant of virus, the amount of virus inoculated, and the biting site. Moreover, the degree of susceptibility varies among different species with cattle being moderately susceptible.

Virus Transmission and its Zoonotic Potential:

The primary transmission of the disease is through stray dogs which are the predominant animal reservoirs.

Transmission of rabies virus typically occurs through introduction of virus-laden saliva of a rabid animal into tissues usually via a bite or saliva coming into contact with mucous membranes (the mouth, nose, or eyes) or a skin opening. In rural areas, cattle may acquire infection through the bite of an infected stray dog or a wild animal. Though cattle are considered as a dead-end host for rabies, human transmission from rabid cattle can still occur through direct contact with its saliva. The highly risk groups include the farmers and veterinarians who work in close proximity with the cattle.

Incubation Period:

The incubation period can be both prolonged and variable depending on the location of the bite, distance from the CNS, viral load and immune response of the affected animal. However, the incubation period in cattle typically ranges from 3-8 weeks after exposure to the virus.

Pathophysiology:

The virus typically replicates in myocytes after entry into the tissues and it remains at the site of inoculation for a considerable time before entering the nervous system. Virus enters the neuromuscular junctions and neurotendinal spindles after which it spreads rapidly by axonal flow through peripheral nerves to the spinal cord and brain (*Sharma, R.D. et al., 2010*) Replicates within the neurons of CNS and move outwards to the peripheral organs reaching the salivary glands where a large amount of virus is shed which is followed by excretion of virus through saliva and onset of neurological signs.

Clinical Findings:

The clinical course of rabies is divided into three phases namely- prodromal form, furious form and dumb or paralytic form.

Prodromal form: During which the affected animal only shows vague CNS signs which are non-specific usually lasting for 1-3 days, later intensify rapidly.

Furious form: Cattle can be dangerous during this period as it may violently attack humans and other animals. The animal stays alert, restless, extremely sensitive, exhibits characteristic coarse and loud bellowing, aggressive behaviour, sexual excitement and may collapse suddenly.

Paralytic/dumb form: Typical signs include knuckling of the rear fetlocks, walking with sagging and swaying hindquarters and frequent deviation or flaccidity of the tail to one side. The most prominent indication of rabies in cattle include the reduced sensation over the hindquarters. Other signs include hypersalivation, anorexia, lameness, choking, abdominal pain, tenesmus and followed by paralysis of hind quarters and recumbency in later stages. Usually, death occurs within 3-6 days after the onset of illness.

Diagnosis:

Diagnosis can be made based on the history of bite by a stray dog or a wild animal and typical clinical signs of the disease. The other methods include isolation and identification of virus from salivary glands, brain or other nervous tissues and animal inoculation methods. Direct Fluorescent antibody technique is the gold standard test for detection of rabies. Other serological tests for detection of virus antigen include Reverse Transcription Polymerase Chain Reaction (RT-PCR), Enzyme-Linked Immunosorbent Assay (ELISA) and virus neutralization test.

Prevention and Control:

Considering the serious nature of the disease and the challenges associated with its treatment, farmers should invariably focus on the prevention of the disease. Vaccination of cattle against rabies particularly in regions where

the disease is prevalent can help prevent outbreaks. Pre-exposure vaccination can be done by high-risk groups like animal handlers, veterinarians and Forest officers. The Schedule includes doses at 0th day, 3rd day, 7th day and 21st or 28th days with recommendation of yearly booster *(Hankins, Daniel G.et al., 2004).* Furthermore, education of farmers by conducting rabies awareness programmes in rural areas, managing stray dog population, limiting wildlife exposure and oral vaccination of wildlife reservoirs are crucial preventive measures in the transmission of rabies to cattle.

Conclusion:

Rabies is an acute fatal disease of zoonotic importance and major public health concern in many countries across the globe. Though the transmission of virus from cattle to human is a rare occurrence, their infection can still pose a risk to people who handle them closely. Thus, it is important to handle potentially rabid cattle with extreme caution and effective preventative and control strategies should be implemented and followed strictly.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Popular Article

Rabies in the 21st century

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Introduction:

Rabies is a preventable yet neglected tropical disease (NTD) and is the deadliest viral zoonosis in history, with a fatality rate of 100% once symptoms manifest. Over 99% of human rabies cases are caused by dog bites, spreads through the saliva of infected dogs, often through bites, scratches, or contact with mucous membranes like the eyes, mouth, or open wounds. This fatal disease can be effectively prevented through strong political commitment, mass vaccination of dogs, improved access to pre-exposure prophylaxis (PrE) and post-exposure prophylaxis (PEP), and education on responsible dog ownership and bite prevention. Enhanced surveillance systems are also crucial for early detection and response.

Etiology:

Rabies is caused by viruses from the genus *Lyssavirus*, part of the family *Rhabdoviridae*. These viruses are rod-shaped, with rabies virus (RABV) being the primary cause of rabies in humans and animals. The rabies virus is a single-stranded, negative-sense, non-segmented RNA virus that belongs to the order *Mononegavirales*. This order includes viruses with specific characteristics such as their type of nucleic acid, replication strategy, genomic organization, size, and morphology. The rabies virus, for example, measures about 75 nm by 200 nm and has a helical nucleocapsid surrounded by a protein-studded membrane. Rabies virus uses specific cell surface components like nicotinic acetylcholine receptors, low-affinity nerve-growth factor receptors, and gangliosides to enter cells. These viruses are neurotropic, primarily targeting the mammalian central nervous system, though they can be adapted in lab settings to propagate in various cell cultures.

Global Burden of Rabies:

Rabies is found worldwide, except in Australia and Antarctica, where no dog-mediated rabies cases have been reported. Dog-mediated rabies has been eliminated in parts of the world, including western Europe, Canada, the

USA, Japan, and some Latin American countries. However, it remains a serious public health challenge in many Asian and African countries, where tens of thousands of human deaths occur annually. The disease disproportionately affects poor and marginalized populations, particularly children under the age of 15, with an estimated 50,000–60,000 deaths per year, 95% of which occur in Asia and Africa.

The economic burden of rabies is significant, costing an estimated US$8.6 billion annually. In Africa and Asia, where rabies is most prevalent, the cost of prevention and control exceeds US$500 million, mostly for providing PEP. In rural areas of Tanzania, for instance, a person earning less than US$1 a day would need to spend over US$100 to complete the WHO-recommended PEP treatment. The high cost and lack of access to healthcare contribute to the high death rates in Africa.

As interactions between humans, animals, and their environments increase, so does the risk of zoonotic diseases like rabies emerging and spreading. To combat these challenges, there is a growing recognition of the need for a holistic approach to health that addresses the interconnectedness of human, animal, and environmental health. This integrated strategy aims to enhance rabies prevention, particularly in Africa, and aligns with the WHO's vision of eradicating dog-mediated rabies and preventing human deaths by 2023.

Diagnosis:

Rabies diagnosis has advanced significantly, employing various laboratory techniques to ensure accurate detection of the virus. The diagnosis primarily relies on identifying the rabies virus or its components in brain tissues. The fluorescent antibody test (FAT) is the most commonly used and recommended by WHO and OIE. It involves adding a drop of conjugated antibody to a brain tissue smear and observing fluorescence to detect viral antigens. FAT provides reliable results in 95-99% of cases.

Other diagnostic methods include:

- **Histological identification:** This method detects Negri bodies (viral aggregates in neurons), but it is less sensitive and has largely been replaced by immunological techniques.
- **Mouse inoculation test:** This involves inoculating mice with brain tissue samples and observing for symptoms of rabies. While effective, it is slow, costly, and increasingly replaced by cell culture tests.
- **Cell culture test:** Neuroblastoma cell lines are used to culture the virus, providing faster results and avoiding the use of live animals.
- **Polymerase chain reaction (PCR):** Used in specialized laboratories, PCR can detect viral nucleic acids and differentiate between vaccine and field strains.

Advanced techniques like ELISA, monoclonal antibodies, and nucleic acid probes are also used for specific virus identification and to distinguish between different rabies-related viruses.

Public Awareness and Global Efforts to Control Rabies:

The risk of rabies exists globally, whether through dog bites in developing countries or wildlife in developed countries. Communicating the risks and preventive measures effectively is crucial. The World Rabies Day initiative has helped highlight the need for global action, and successful control measures in the U.S. provide a model for other countries.

The global rabies burden remains alarmingly high, with an estimated 50,000–55,000 people dying annually, and around half of these deaths occurring in India alone. This staggering toll is primarily the result of rabid dog bites, particularly in regions like Asia and Africa, where rabies control efforts have lagged. Despite the existence of

effective prevention strategies, over 3 billion people across 100 countries remain at risk of infection. Children make up a significant proportion of rabies victims, highlighting the need for urgent action.

The persistence of canine rabies in many developing countries is a key driver of human rabies deaths. More than 95% of these deaths occur in Asia and Africa, areas where rabies control programs are insufficiently implemented. In contrast, developed countries have successfully eliminated canine rabies, offering models for other regions to follow. These successes demonstrate that mass vaccination of domestic dogs is a cost-effective and practical approach to eliminating rabies, reducing human deaths significantly. However, the spread of rabies in developing regions remains a public health crisis that requires coordinated international efforts to control.

World Rabies Day (WRD), an initiative launched to raise awareness and educate communities about rabies prevention, has successfully reached over 55 million people worldwide. Participants from more than 85 countries, including governments, professionals, media, and the public, are taking steps toward rabies elimination. Educational materials translated into multiple languages have been disseminated, teaching communities the importance of proper medical care after a rabid bite, rather than relying on ineffective traditional treatments.

Recent scientific advancements are paving the way for improved vaccines and treatments. Researchers are working on innovative vaccines that could be more affordable and accessible to populations in developing countries, especially those most affected by rabies. These new-generation vaccines could provide immunity with fewer doses and at a lower cost than current options, making them more feasible for large-scale immunization programs.

For now, post-exposure prophylaxis (PEP) with vaccines and rabies immunoglobulin (RIG) remains critical for those bitten by rabid animals. However, the supply of these life-saving treatments is limited, particularly in developing countries, exacerbating the already high mortality rates. Alternatives, such as monoclonal antibodies, are being explored as cost-effective substitutes for RIG.

The challenges of rabies control also involve wildlife, especially in regions where wildlife species serve as reservoirs for the virus. Strategies like oral rabies vaccination (ORV) programs for wildlife have been successful in countries like the United States, Canada, and Mexico. These programs rely on sophisticated surveillance and interjurisdictional collaboration to detect and control rabies outbreaks.

As diagnostic techniques improve, molecular tools are becoming more accessible, allowing for faster and more accurate detection of rabies virus. These advancements are essential for tracking and controlling rabies, particularly in resource-poor settings. In the coming years, scientists aim to develop novel vaccines and diagnostic methods that will make rabies prevention more efficient and affordable.

Ultimately, eliminating human rabies deaths begins with controlling canine rabies through mass dog vaccination. While the challenges are significant, especially in Africa and Asia, the scientific and public health communities are optimistic that with the right strategies, rabies can be eliminated globally within the 21st century. The progress made in developed countries and the ongoing efforts in developing regions serve as hopeful indicators of what can be achieved with sustained commitment and collaboration.

Challenges and Future Directions:

One major problem is the limited availability of rabies immunoglobulin (RIG), which is crucial for post-exposure treatment after a rabid animal bite. Efforts are underway to find cheaper and more widely available alternatives, such as monoclonal antibodies.

Rabies is difficult to treat once it reaches the central nervous system (CNS). Scientists are studying how rabies evades the immune system and are exploring ways to enhance the body's immune response to the virus. New treatment strategies may emerge from this research.

Conclusion:

To eliminate dog-mediated rabies sustainably, key measures include building partnerships among stakeholders—governments, private sector, NGOs, and communities—and using integrated surveillance data to guide cost-effective strategies. A One Health approach, providing data on dog and human populations, rabies cases, and vaccination status, is crucial for effective control frameworks.

Improved coordination across animal, human, and environmental health sectors, along with expanding access to post-exposure prophylaxis (PEP) and animal vaccinations, are essential. Raising community awareness, enhancing diagnostic capacities, scaling up research, and securing government commitment with sustainable investments are vital to achieving rabies elimination.

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Poster
"Key Aspects of Rabies Prevention, Control, And Public Awareness"

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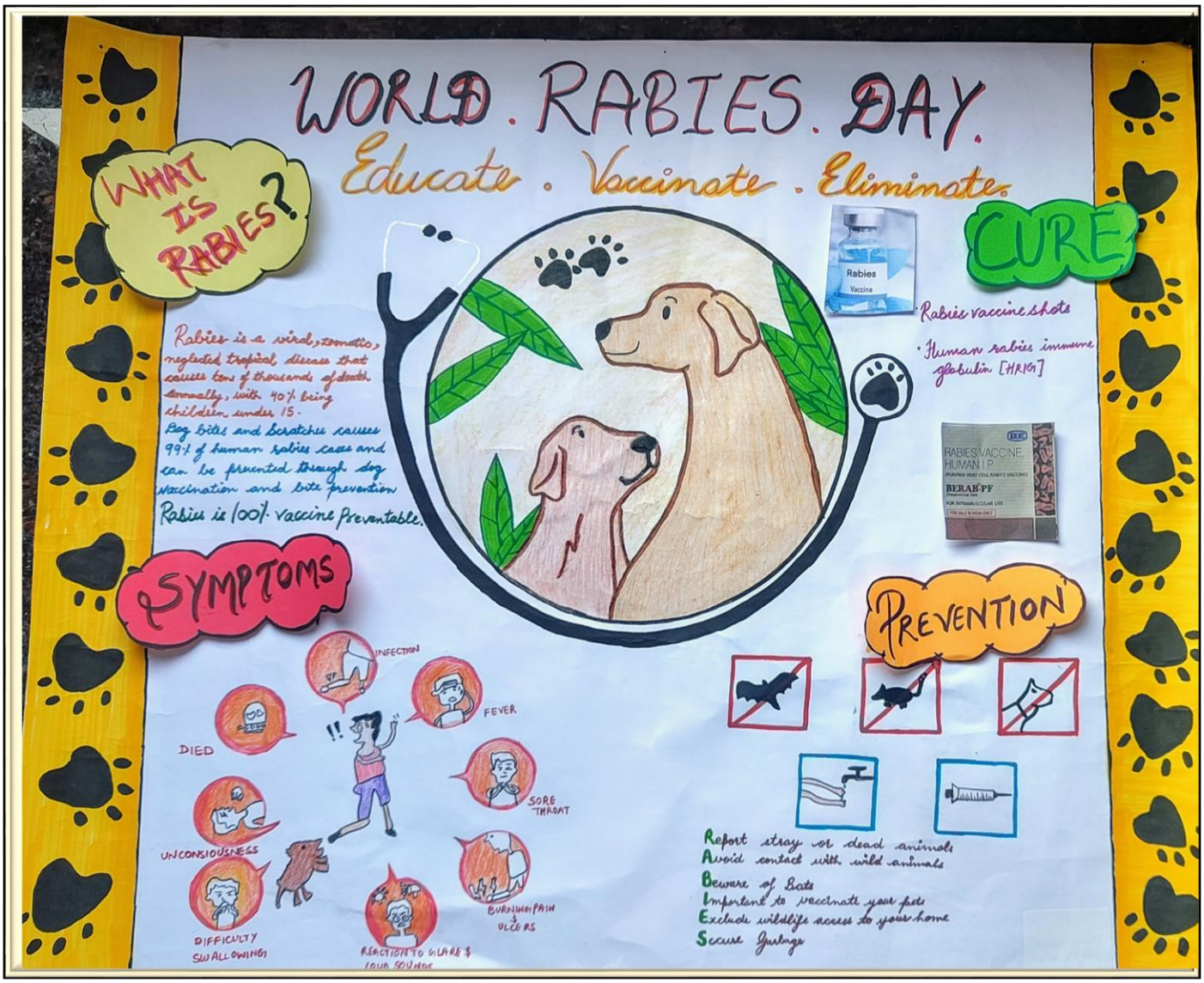

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Poster
World Rabies Day: Do's & Don'ts

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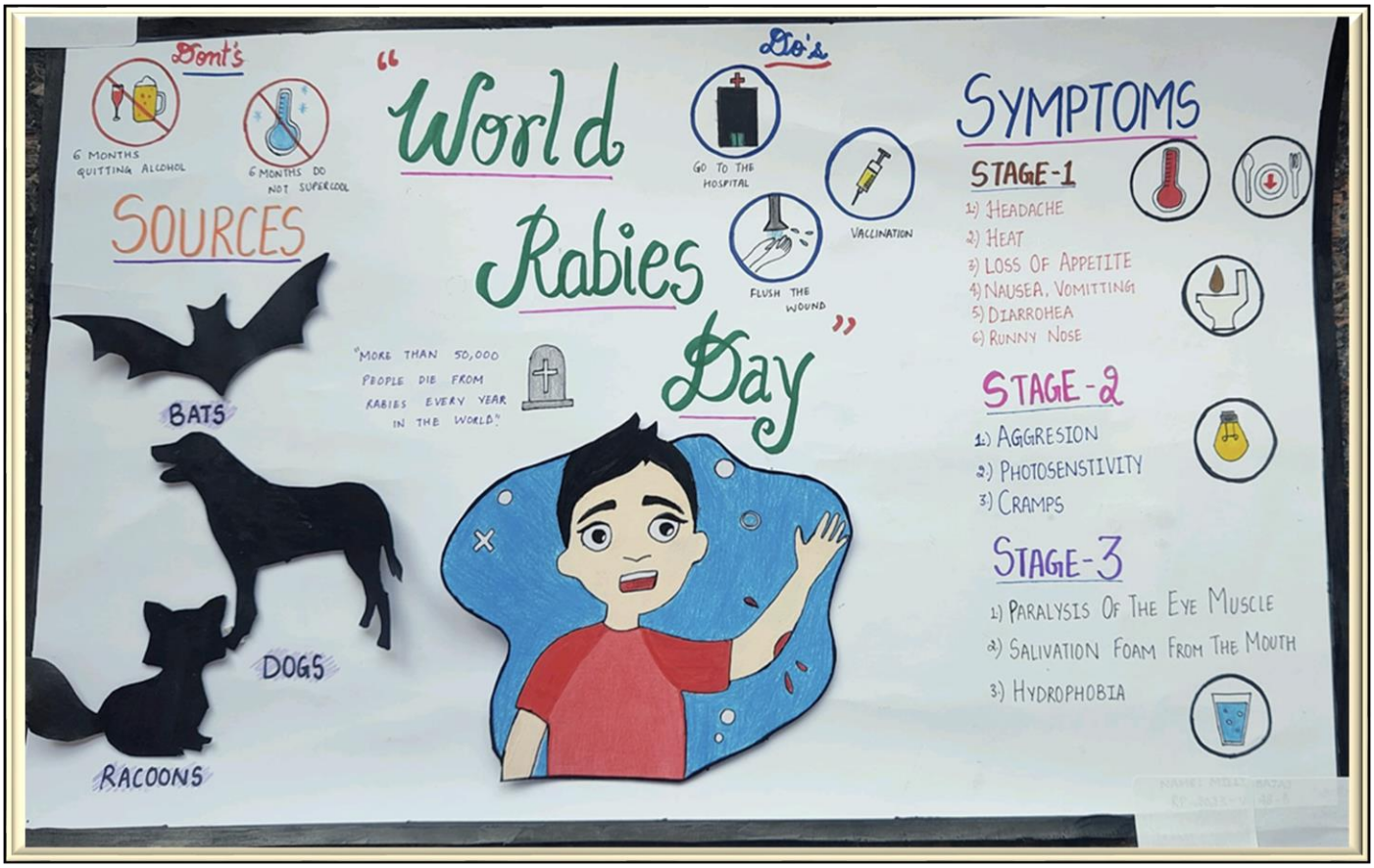

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Rabies: A Global Health Challenge

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Introduction:

Rabies is a severe and highly lethal zoonotic disease that causes viral encephalomyelitis and is present in the saliva of warm-blooded animals such as dogs, cats, jackals, and wolves. The disease is typically transmitted through the bite or lick of an infected animal. Vampire bats also significantly contribute to its spread.

Synonyms: Hydrophobia, Lyssa, Mad dog syndrome

Etiology:

The disease is caused by the rabies virus, a neurotropic virus belonging to the Lyssavirus genus in the Rhabdoviridae family. There are at least seven distinct genotypes of the rabies virus. Classical rabies virus, encompassing both street and fixed strains, is classified as genotype 1, serotype 1, within this genus. The street virus is found in naturally occurring cases, while the fixed virus is a laboratory-passaged, attenuated form used in vaccine production. The rabies virus is an enveloped, bullet-shaped RNA virus, typically measuring 75×180 nm. Its genome is composed of single-stranded, non-segmented, negative-sense RNA, which encodes five structural proteins: nucleocapsid (N) protein, phosphoprotein (P), matrix (M) protein, glycoprotein (G), and RNA-dependent RNA polymerase (L). Since the virus has an envelope, it is easily neutralized by a range of chemical disinfectants, as well as exposure to ultraviolet light, heat, and even sunlight.

Epidemiology:

More than 27,000 cases of animal rabies are reported yearly in the world. World Health Organization estimates that 55,000 to 100,000 human rabies cases occur annually, mostly in tropical countries of Asia and Africa. Rabid dogs are the main source of infection in people. Rabies virus transmission from dogs to people is intensified as the density of susceptible dogs exceeds 4.5 dogs/Km. As a result; approx. 10 million people annually receive post-exposure prophylaxis (PEP). Combined measures of immunocontraception and rabies vaccination have been proposed to help alleviate this zoonotic risk.

All warm-blooded animals are susceptible to infection with rabies virus, but mammals are the only known vectors and reservoirs in nature. Foxes, coyotes, jackals, wolves are among the most susceptible animal groups.

Skunks, raccoons, mongooses, bats, rabbits, cattle have a high susceptibility. Domestic dogs, sheep, goats, horses and non-human primates are moderately susceptible. Cats are even more resistant than dogs to canine rabies virus isolates but are much more prone to develop infection with field isolates from wildlife and with vaccine virus. Younger animals are usually more susceptible to rabies infection. Transmission always occurs via introduction of virus-laden saliva into tissues, usually by the bite of a rabid animal. However, the virus from saliva, salivary glands or brain can enter the body through mucous membranes or breaks in the skin; but is not transmitted through intact skin. Usually, saliva is infectious at the time clinical signs occur, but domestic dogs and cats may shed virus for several days even before onset of clinical signs. Hematogenous spread does not occur.

Aerosol transmission can also occur under very specialized conditions in which the air contained a high concentration of suspended particles or droplets carrying viral particles e.g. in a cave inhabited by millions of bats. Aerosol infection occurs via direct attachment of the virus to olfactory nerve endings. Human rabies is usually caused by a bite, but it has been acquired by corneal transplantation.

Incubation Period:

Ranging from week to months but in most cases 21-80 days after exposure. Rabies virus can remain viable in a carcass for several days at 20 ° C, although it may survive much longer when the body of the victim is refrigerated.

Pathogenesis:

Following bite, virus enters body through saliva and replicate in muscle cells or enters directly in peripheral nerves and binds with receptors for acetylcholine. After entry, virus start intra-axonal centripetal spread towards CNS through peripheral nerves. In spinal cord virus replicates in neurons and spreads rapidly throughout the nervous system, causing progressive lower motor neuron paralysis. In brain, virus affects neurons especially of hippocampus, cerebral cortex and brain stem. Then starts centrifugal journey towards salivary glands, skin, mucosal surfaces and most of the organs through peripheral and central nerves. Saliva becomes infective up to 2 weeks before appearance of symptoms.

Clinical Signs:

The incubation period is both prolonged and variable. It has been reported to be 3 to 24 weeks (average, 3 to 8 weeks) in dogs, 2 to 24 weeks (average, 4 to 6 weeks) in cats and 3 weeks to 1 year or more (average, 3 to 6 weeks) in humans. Unvaccinated animals had shorter incubation period and duration of clinical disease. The virus travels via the peripheral nerves (at the rate of up to 100 mm per day) to the spinal cord and ascends to the brain. After reaching the brain, the virus travels via peripheral nerves to the salivary glands from where the virus is shed intermittently in the saliva. Damage to the motor neurons causes progressive lower motor neuron (LMN) disease which produces the typical ascending flaccid paralysis.

Rabid animals of all species usually exhibit typical signs of CNS disturbance, with minor variations among species. The most reliable signs, regardless of species, are acute behavioral changes and unexplained progressive paralysis. Behavioral changes include sudden anorexia, signs of apprehension or nervousness, irritability and hyperexcitability (including priapism). Ataxia, altered phonation and changes in temperament are apparent. Uncharacteristic aggressiveness may develop in normal docile animal. The clinical course may be divided into three general phases – prodromal, acute excitative and paralytic/end stage. During the prodromal

phase, which lasts ~1–3 days, animals show only vague non-specific signs, which intensify rapidly. The term "furious rabies" refers to animals in which aggression (the acute neural excitative phase) is pronounced. "Dumb or paralytic rabies" refers to animals in which the behavioral changes are minimal and the disease is manifested principally by paralysis.

1. **Furious form** –

This is the classic "mad-dog syndrome," although it may be seen in all species. In dogs, this form usually last for 1-7 days. The animal becomes irritable and with the slightest provocation, may viciously and aggressively use its teeth, claws, horns or hooves. The animal is alert and anxious, with pupils dilated. Carnivores frequently roam extensively, attacking other animals including people and any moving object. Dogs may eat unusual objects (pica), especially wood. Young pups seek human companionship and are over-playful and may even bite when petted, usually become vicious in a few hours. As the disease progresses, muscular incoordination, disorientation and generalized seizures follows. If they don't die during seizure, may have a short paralytic stage before death.

2. **Dumb or Paralytic form** –

This usually develops within 1-10 days after first clinical signs noted and lasts 2-4 days which is manifested by ataxia and paralysis of the throat and masticatory muscles, often with profuse salivation and the inability to swallow. A change in the tone of the bark, resulting from laryngeal paralysis, may be observed. Dropping of the lower jaw is common in dogs. Mandibular and laryngeal paralysis is less common in cats. Increased frequency of vocalization is a common sign in cats. These animals may not be vicious and rarely attempt to bite. The paralysis progresses rapidly to all parts of the body, followed by coma and death in a few hours.

Species Variations:

- Among farm animals, **cattle** are most commonly affected. Average incubation period in cattle is 15 days and furious form occurs in 70% of cases. Major clinical signs are excessive salivation, behavioral change, muzzle tremors, bellowing, aggression, hyperesthesia or hyperexcitability and pharyngeal paralysis. In the paralytic form, knuckling of hind fetlocks, swaying of hindquarters while walking, deviation or flaccidity of tail to one side, are common early signs. Tenesmus with paralysis of anus, resulting in sucking in and blowing out of air, occurs late in incoordination stage just before recumbency. Death usually occurs 48 hours after recumbency develops and after a total course of 6-7 days.
- **In sheep**, average incubation period is 10 days and a number of animals are affected at one time due to ease with number of animals bitten by a dog. Clinical signs are similar to that in cattle.
- **Goats** are commonly aggressive and continuous bleating is common while in sheep, excessive bleating does not occur.
- **In horses**, average incubation period is 12 days and cases usually incline to paralytic form of disease. Muzzle tremors are most common initial signs, followed by pharyngeal paresis, ataxia or paresis of hindquarters, lethargy, recumbency and loss of tail and anal sphincter tone.
- **Pigs** manifest excitement, tendency to attack and incoordination. Affected sows show twitching of nose, rapid chewing movements, excessive salivation and colonic convulsions. Terminally, there is paralysis and death occurs 12-48 hours after onset of signs.

Laboratory Diagnosis:

- No ante-mortem diagnostic tests are sensitive enough to be consistently reliable for rabies diagnosis in animals. No hematologic or serum biochemical changes are characteristic for rabies. Increased CSF protein (110 to 150 mg/dl) and leukocytes (120 to 1140 cells/µl), with predominating small lymphocytes, have been reported in dogs with post-vaccinal rabies encephalomyelitis.
- No gross lesion in the CNS is detectable with rabies infection. Acute polioencephalitis is seen very early in the course of the disease, followed by necrotizing encephalitis in next phase of infection. Classic test for rabies is to examine the brain for the presence of intracytoplasmic inclusions, known as Negri bodies, in larger neurons. These are most common in neurons of the hippocampus in carnivores and in Purkinje's cells of herbivores. Negri bodies are best demonstrated with Seller's or Van Gieson's stains, in which they stain magenta.
- The definitive diagnostic test is the demonstration of rabies virus antigen by direct fluorescent antibody test (FAT) in suitable brain tissue. Thin touch impressions of the medulla, cerebellum or hippocampus are used for this test.
- Direct FAT of skin biopsy (nape of neck in humans and maxillary areas in animals) for viral antigen is a useful ante-mortem human diagnostic, but has not approved for diagnosis of rabies in animals.
- Detection of rabies virus antigen in dog's saliva by slide agglutination using latex particles coated with polyclonal immunoglobulin.
- Serological testing is used to determine vaccine immunogenicity. Tests to quantify specific rabies virus antibodies in serum include Rapid fluorescent focus inhibition test (RFFIT), ELISA and Fluorescent antibody virus neutralization (FAVN) test. A titer of 0.5 IU/ml is the standard level expected for an adequate titer in people and animals.

Treatment:

Supportive care for rabies-infected animals is not recommended because no therapy is effective in animals with this fatal encephalitis. An asymptomatic dog or cat suspected of contracting rabies should be quarantined or as for all other species, appropriately euthanized and the brain submitted for examination.

Prevention and Control:

The most appealing and effective control measures of rabies are centered on vaccination of dogs and cats with coverage of minimum 70% of the population. Inactivated tissue/cell culture vaccines are available and recommended for vaccination of animals. The dose in all animal species is 1 ml IM or SC.

Pre-exposure recommendations-

- Dogs and cats – Primary vaccination at 3 months of age; revaccinate annually.
- Other domestic species including cattle, sheep, horses – Primary vaccination at 3 months of age; revaccinate annually.
- Humans – Three dose regimen of an FDA-approved cell culture vaccine @ 1 ml IM in the upper deltoid on days 0, 7, and 21 or 28.

Post-exposure recommendations-

- Dogs and cats

- If previously unvaccinated – euthanize immediately or quarantine in secure enclosure for 6 months; vaccinate 1 month before release.
- Not currently vaccinated – evaluate on case-by-case basis.
- Currently/Routinely vaccinated – revaccinate immediately and keep under owner's control for 45 days.

- Other domestic animals including cattle, sheep, goat, horses
  - If unvaccinated – euthanize immediately or confine for 6 months and observe on case-by-case basis.
  - Currently vaccinated – revaccinate immediately and keep under observation for 45 days.
- Humans
  - Previously unvaccinated – H-RIG (Human rabies immune globulin) 20 IU/Kg, infiltrated at site of bite once on day 0–7; FDA-approved cell culture vaccines IM in upper deltoid on days 0, 3, 7 and 14.
  - Previously vaccinated – Three doses of an approved vaccine IM in upper deltoid on days 0, 7 and 21 or 28 days post-exposure with no H-RIG. With serologic evidence of an adequate titer or previous full PEP series, only two doses are needed on days 0 and 3 with no H-RIG.

Wound Care:

In cases of potential bites/scratches, wounds should be immediately washed thoroughly with 20% aqueous soap solution to reduce the chance of rabies virus infection. Ethanol (≥43%) or povidone-iodine solutions can be applied locally to open wounds.

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Rabies Awareness: Bridging the Global Health Gap

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Introduction:

Rabies is a disease caused by a virus that affects the central nervous system in mammals, including humans. Once symptoms manifest, it is almost always fatal, making it one of the deadliest diseases known. Despite being preventable through vaccination, rabies continues to be a significant public health threat, especially in regions where vaccination coverage is low.

The World Health Organization (WHO) reports that rabies causes thousands of human deaths each year, with most cases occurring in rural areas of Africa and Asia. All warm-blooded animals are vulnerable to infection with rabies virus, but mammals are the only known vectors and reservoirs in nature. Factors such as the viral variant, the quantity of virus inoculated, and the bite site affects susceptibility. In addition, the degree of species susceptibility varies considerably. Foxes, coyotes, jackals, wolves, and certain rodents are among the most susceptible animal groups. Skunks, raccoons, bats, rabbits, cattle, and some members of the families Felidae and Viverridae have a high susceptibility. Groups with only moderate susceptibility include domestic dogs, sheep, goats, horses, and nonhuman primates. Birds and primitive mammals such as the opossum may have low susceptibility. Cats are actually more resistant than dogs are to experimental infection with some canine rabies virus isolates but are much more prone to develop infection with some field isolates from wildlife and with vaccine virus. Younger animals are usually more susceptible to rabies infection than are older ones.

This article explores rabies in detail—its causes, transmission, symptoms, and the critical measures for prevention. It also highlights the role of veterinary professionals in preventing and controlling rabies outbreaks, which is key to reducing both animal and human cases.

Causes and Transmission:

Rabies is caused by the virus named rabies virus, which belongs to the Lyssavirus genus. The virus primarily spreads through the saliva of an infected animal, typically via a bite. In some instances, the virus can also be

transmitted through scratches or when saliva from a rabid animal comes into contact with open wounds or mucous membranes. The primary source of rabies infections in humans is domestic dogs, accounting for the vast majority of rabies cases globally. Wild animals such as bats, raccoons, and foxes also serve as important reservoirs for the virus. In areas where domestic dog vaccination rates are high, these wildlife species may become the main source of rabies infections.

Once the virus enters the body, it travels along the peripheral nerves toward the brain. The time between exposure and the onset of symptoms, known as the incubation period, varies. It can range from several days to a few months, depending on factors such as the location of the bite, the amount of virus introduced, and the immune status of the host.

Clinical Presentation:

Rabies follows a predictable progression through several clinical stages, each with its own set of symptoms.

❖ **Prodromal Stage:**

During this early phase, both humans and animals may exhibit non-specific symptoms like fever, headache, and general discomfort. Behavioral changes may also occur in animals, with normally docile animals becoming unusually aggressive or shy.

❖ **Excitative Stage (Furious Rabies):**

In this stage, animals may become hyperactive and show signs of extreme aggression. Infected dogs and wild animals may appear fearless, often attacking without provocation. Classic signs such as difficulty swallowing and excessive drooling (which leads to "foaming at the mouth") are common. Humans in this stage may experience heightened agitation, hallucinations, and fear of water, a symptom known as hydrophobia, which occurs due to throat muscle spasms.

❖ **Paralytic Stage (Dumb Rabies):**

As the virus advances, paralysis sets in, starting at the bite site and spreading to other parts of the body. Animals may appear lethargic and lose coordination. In the final phase, paralysis affects the muscles used for breathing, leading to respiratory failure and death. In humans, once clinical signs develop, death is inevitable within a few days due to respiratory or cardiac arrest.

Diagnosis:

Diagnosing rabies is difficult, especially during the early stages when symptoms are non-specific. In animals, the most reliable diagnostic method is the direct fluorescent antibody (DFA) test, which is performed post-mortem by examining brain tissue for viral antigens. While this test is highly accurate, it requires that the animal be euthanized. For humans, ante-mortem diagnosis involves testing multiple samples such as saliva, serum, cerebrospinal fluid, and skin biopsies for the presence of the virus. However, rabies diagnosis is often confirmed post-mortem.

Since no cure exists once symptoms have appeared, early diagnosis and immediate post-exposure treatment are crucial to prevent the disease from progressing.

Prevention and Control:

The most effective way to control rabies is through prevention, primarily by vaccinating animals and providing post-exposure prophylaxis (PEP) to humans who are bitten by potentially rabid animals.

✓ **Vaccination of Domestic Animals:**

Mass vaccination of dogs is a cornerstone of rabies prevention programs, as dogs are the primary source of human infections in most parts of the world. Vaccination of at least 70-80% of the dog population in an area can prevent outbreaks and significantly reduce the number of human cases. In countries with effective rabies control programs, vaccinating other animals such as cats, ferrets, and livestock is also recommended, particularly in rabies-endemic regions.

✓ **Public Education and Awareness:**

Public education campaigns are essential for rabies prevention, especially in rural areas where rabies is more prevalent. People must be informed about the importance of vaccinating pets, recognizing rabies symptoms in animals, and seeking immediate medical attention after an animal bite.

✓ **Post-Exposure Prophylaxis (PEP):**

PEP is critical in preventing rabies in humans who have been exposed to the virus. It consists of wound cleaning, administration of a rabies vaccine, and in some cases, rabies immune globulin. PEP is highly effective if administered before the onset of symptoms, but access to these treatments can be limited in certain regions, making rabies control more difficult.

✓ **Wildlife Rabies Control:**

In areas where wildlife species act as major reservoirs for rabies, oral rabies vaccination (ORV) programs have been implemented. These programs involve distributing bait containing rabies vaccines in areas inhabited by wildlife such as raccoons, foxes, and coyotes.

The Role of Veterinary Medicine in Rabies Control:

Veterinarians play a pivotal role in rabies control and prevention efforts. Their responsibilities extend from vaccinating animals to educating the public about the dangers of rabies and how to prevent it.

- **Mass Vaccination Campaigns:**

Veterinary professionals are on the front lines of rabies control, particularly through their involvement in mass vaccination campaigns for domestic dogs and other animals. These campaigns have been instrumental in reducing the spread of rabies in regions with high transmission rates.

- **Public Health Education:**

Veterinarians often serve as educators in their communities, spreading awareness about rabies prevention. By working closely with public health authorities, veterinarians can also assist in developing and implementing rabies control strategies at both local and national levels.

- **Surveillance and Research:**

Veterinarians are involved in monitoring rabies cases and conducting research to improve diagnostic methods, develop better vaccines, and understand the epidemiology of the disease. Surveillance efforts are important for identifying rabies outbreaks before it cases severe damage and performing quick action to prevent them from spreading.

Conclusion:

Rabies remains a global health challenge, particularly in regions where access to vaccines and medical care is limited. However, it is a preventable disease, and significant progress has been made in reducing rabies cases

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through vaccination and public health initiatives. Veterinary medicine plays a key role in controlling rabies, from mass vaccination programs to research and education.

Achieving global rabies control requires a collaborative effort from veterinarians, public health officials, governments, and communities. With continued commitment and resources, rabies can be eliminated, ensuring a future where humans and animals are free from the threat of this deadly disease.

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OPEN ACCESS | Rabies Day Special: Bridging the Gap between Science and Safety | Editorial Article

Breaking Rabies Boundaries to Achieve Zero By 2030

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World Rabies Day is observed every year, on 28th September to commemorate the Death Anniversary of the great microbiologist, Louis Pasteur, who developed the first efficacious rabies vaccine. The Day aims to raise awareness and serves as a reminder of a critical need to tackle one of the most dreadful but preventable diseases – rabies. World Rabies Day 2024 theme, "Breaking Rabies Boundaries", emphasizes the importance of addressing challenges in eliminating rabies globally. Some countries are considered rabies-free, including American Samoa, Aruba, Antigua, Barbados, Australia, Bermuda, Belgium, Fiji, England, Tahiti, Guam, Ireland, Hawaii, Jamaica, Ireland, Malta, Japan, New Zealand, New Caledonia, Northern Ireland, Scotland, Saint Lucia, Sweden, Singapore, St. Kitts and Nevis, Turks and Caicos Islands, St. Vincent and the Grenadines, the UK, and Vatican City. However, up to 95% of human rabies deaths occur in Africa and Asia, regions where dog rabies is inadequately managed. This disproportionately impacts impoverished rural communities, where rabies control programs and access to life-saving post-exposure prophylaxis (PEP) are either severely limited or unavailable.

India bears a significant portion of the global rabies burden, accounting for roughly 36% of worldwide rabies deaths, making it one of the most affected countries. The majority of cases are linked to dog-mediated rabies, with the high stray dog population, playing a major role in the disease's transmission. However, rabies in wild animals is equally important for the transmission and maintenance of rabies in animals. Children under the age of 15 years, are particularly vulnerable, accounting for approximately 40% of rabies cases in the country. To control and eliminate this deadly zoonotic disease, it is essential to target and address it at its animal source.

The National Action Plan for Rabies Elimination (NAPRE) and the State Action Plan for Rabies Elimination (SAPRE) are vital components of India's strategy to eliminate rabies by 2030. The NAPRE is a guidance document prepared by the National Centre for Disease Control (NCDC), Ministry of Health & Family Welfare, Government of India and launched on World Rabies Day 2021, for the states/stakeholders to develop their action plan, specific to their needs and aims at systematic

reduction of rabies risk through sustained mass dog vaccinations, pre and post-exposure prophylaxis and public education until the country is completely free of dog-mediated Rabies. The World Health Organization (WHO) promotes dog vaccination as the primary strategy for eliminating rabies in a country. Vaccinating 70% of the dog population in a specific area is key to achieving effective rabies control.

Yet another strategy of the veterinary component of NAPRE is the strengthening of laboratory diagnosis. Rapid and accurate laboratory diagnosis of rabies is essential for effectively controlling its spread in both humans and animals. The KVAFSU-CVA Rabies Diagnostic Laboratory, Dept. of Veterinary Microbiology, Veterinary College, KVAFSU, Hebbal, Bengaluru caters to the needs of the laboratory confirmation of rabies in animals. In 2020, the laboratory was elevated and designated as a World Organization for Animal Health (WOAH) (Founded as OIE) Reference Laboratory for Rabies in India, becoming the 12th WOAH Reference Laboratory for Rabies in the world. To offer the recommended ante-mortem and post-mortem diagnostic facilities, it is essential to establish referral laboratories for rabies at all levels, including regional, state and national, in accordance with program requirements. The laboratory is also strengthening the capacity building of laboratory diagnosis in other laboratories in India through networking.

In addition to this, the *Network* called *RABLAB* comprises all WOAH Reference Laboratories for *Rabies and* emphasizes the importance of using approved, high-quality rabies vaccines that meet international standards in terms of efficacy, safety, and sterility.

Goa is the "first *rabies*-controlled *state"* in *India*, a milestone achieved through the efforts of the UK-based charity Mission Rabies, initially founded as an initiative by the Worldwide Veterinary Service (WVS). So many challenges arise in the effort to maintain rabies-free status in Goa. One among these is Border Control Issues. Goa borders states where rabies is common, and the movement of unvaccinated animals across these borders threatens the region's rabies-free status. To address these issues, the theme of the World Rabies Day 2024 is very apt, which stresses the importance of collaboration between human health, animal health and environmental sectors. The veterinary public health components of NAPRE include enumerating the population of dogs, mapping risk zones for rabies, a program for mass dog vaccination, effective management and disposal of solid waste, operational research and promotion of responsible dog ownership. The organization has worked in other states like Kerala, Tamil Nadu, Andhra Pradesh, Maharashtra, Orissa, West Bengal, Jharkhand, Rajasthan and Assam. Now, it has joined hands to control rabies in Himachal Pradesh also.

Though we are striving hard and inching towards zero by 2030, the theme of World Rabies Day 2024, "Breaking Rabies Boundaries," is especially relevant for India, where rabies continues to be a major public health concern. India bears a substantial share of global rabies cases, with the majority transmitted by dogs. This year's theme highlights the urgent need to address challenges like inadequate

vaccine access, low public awareness, and gaps in rabies control initiatives. The theme demands a united effort among the government, health sectors, animal welfare organizations and local communities. Enhancing the One Health approach, which connects human, animal, and environmental health, is essential for eliminating rabies. Key steps toward this goal include early and rapid laboratory diagnosis of rabies, large-scale dog vaccination campaigns, increased access to post-exposure prophylaxis (PEP) and improved surveillance systems.

Additionally, educational programs targeting high-risk areas can raise awareness and reduce the stigma surrounding rabies prevention and treatment. By addressing these issues and reinforcing cross-sector collaboration, India can make significant strides toward the global target of zero rabies deaths by 2030. The theme reminds us that breaking these boundaries is not just a goal but a necessity for saving lives and promoting public health.

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