

# CURRENT PERSPECTIVE ON ZONOTIC DISEASES: TRANSMISSION DYNAMICS AND PHYTOCHEMICAL THERAPEUTIC STRATEGIES FOR RABIES MANAGEMENT

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## ABSTRACT

Zoonotic infections remain to present a remarkable worldwide health burden because of their multifaceted route of spread and intimate link with humans, animals, and their surrounding environments. However, of these infections, rabies ranks among those viral infections that not only remain highly lethal but are preventable. Nevertheless, these are mostly encountered and documented in low- and middle-income nations where canine rabies predominates. In addition, through various evidences presented and discussed in this review, it is seen that rabies and other such infections have continued to persist because of poor surveillance and access to vaccines, public education, and intersectoral struggle connecting human and animal health. In the present day, the efficacy of existing therapeutic interventions such as post-exposure prophylaxis, which entails wound care along with immunization and the administration of immunoglobulin, is very high if done on a prompt basis. Still, cases of delayed interventions have led to increasing mortalities. Although improvements have been made to the efficacy and protect of cell culture-vaccine platforms, availability of such vaccines varies in endemic regions. More so, there is a rise in information pertaining to the possibility of the application of natural products such as nanoparticles of plant origin, which have been recognized to have antimicrobial, antiviral, and immune modulatory activities. Although such interventions deserve a trial from a clinical point of view, just a little validation has been done of such interventions on a live scale. One Health is another topic that has been recognized to effectively address all factors pertaining to zoonotic disease such as Rabies. Despite these advances, there are still many areas to be filled in via further studies with particular emphasis on translating unique developed in the laboratory into community-applicable interventions, optimizing community-based vaccine approaches, and advancing interdisciplinary approaches to community-based disease surveillance. Also important are vaccine distribution systems, rigorous evaluation of innovative plant-based therapy approaches, and policy-driven approaches to One Health. All these areas will ensure not only control and hopefully eradication of rabies but also a lower effect of zoonotic diseases in particular and infections in general worldwide.

**Keywords:** Zoonotic, Rabies, Eradication, Immunoglobulin, Nanoparticle

## INTRODUCTION

Zoonotic disease is also known as zoonosis which is the combination of two Greek words that is zoo means animals and noses means sickness or diseases. The zoonotic disease is the pandemic and an infectious disease which can be transmit in human beings from various animals via biting of infected animals, direct contact with the body fluids like pee, blood and saliva, or bites from vectors like mosquitos, ticks or fleas. According to world health organization (WHO) there are more than 60% of emerging infectious diseases are zoonotic diseases (Khan *et al.*, 2023). Rabies is a viral diseases which is caused by the rabies various spreading via the biting of infected animals like dogs, cats or wild animals and which affects the central nervous system (CNS). There are number of zoonotic diseases including leptospirosis bacterial infectious disease caused by the bacteria *Leptospira* is the parasitic infectious disease which is caused by the larvae of the tapeworm *Taenia solium*, anthrax ia the bacterial infectious disease caused by the bacterium *Bacillus anthracis*, severe acute respiratory syndrome (SARS) is the viral infectious which is caused by coronaviruses and many more zoonotic diseases like fever, Rift Valley fever, type A influenza, Ebola, hemorrhagic fever as well as the original emergence of human immunodeficiency virus (HIV) (Grace *et al.* 2012a,b; Karesh *et al.* 2012). Rabies is the pandemic disease which is basically caused of human deaths due to infected dogs; which account for almost 99% of rabies transmission to humans. Rabies viruses can also be found in wild animals like bats, pigs, and other wild species. (Chhabra and Ichhpujani, 2003) diagnose and understanding the causes and therapies for zoonotic diseases, especially rabies, is crucial for public health and veterinary medicine.

## Causes of Zoonotic Diseases

## Pathogens

Zoonotic disease cannot be caused by specific organisms rather zoonosis can be caused by various number of pathogen like various bacteria's, different viruses, fungi and number of parasites. Rabies is basically caused by the rabies virus and transmit in human via direct bites of stray dogs are contaminated water food or other edible substances by infected dogs, cats or other wild animals (Fatima *et al.*, 2023).

## Transmission Dynamics

Rabies virus mostly transmitted via the bites of domesticated dogs or other infected animals, especially domestic dogs are the main rabies transmitter in majority of the areas (Fatima *et al.*, 2023). The pandemic virus can also be transmitted through other animals including bats and wild carnivores. The incubation duration of rabies may differ it rely up on the viral load and on bits level but mostly a few week to a couple of months (Fatima *et al.*, 2023).

## Clinical feature of Rabies

There are various symptom of rabies starting with fever, headache and malaise and with different neurological symptoms like hydrophobia, paralysis and death (Fatima *et al.*, 2023). But the rapid growth of the virus in body is therefore necessary it is to intervene quickly after exposure.

## Rabies Therapy and Management

### Post-Exposure Prophylaxis (PEP)

PEP is necessary for the inhibition and protection of rabies after exposure. It includes:

Rapid wound protect: via washing of the bite area of the body with soap and clean water.

**Vaccination:** immediate vaccination is necessary.

**Rabies immunoglobulin (RIG):** RIG is given in most cases for strong and passive immunity (Fatima *et al.*, 2023).

## Vaccine Development

Cell culture rabies vaccines (CCRV) are the advanced vaccine for rabies which improve the immunogenicity and inhibit the spread of virus with in the body (Najam *et al.*, 2023). Dietary supplements that have been found to improve and strong the immune system response to the rabies vaccine include vitamin A and probiotics (Najam *et al.*, 2023).

## Role of Natural Products

Natural products play a vital role to combat the zoonotic disease, including plant-derived nanoparticles (PDNPs), which offer therapeutic options for overcome zoonotic diseases. PDNPs expose a variety of antimicrobial, antiviral, antibacterial and antifungal properties, making them beneficial for treating infectious diseases in animals (Ahmed *et al.*, 2024). They can increase the drug supply systems, improve and promote therapeutic results and overcome the resistance in zoonotic pathogens (Ahmed *et al.*, 2024; Rasheed *et al.*, 2023).

## One Health Approach

The one health framework means by the integration of animals, human beings and environmental health. This approach is vital for addressing the zoonosis. Because this bonding encourages the collaboration public health sector, veterinary medicine and environmental sectors (Cunningham *et al.*, 2017). The proper management of zoonosis needs the effective monitoring Programme for inhibition the zoonosis including the public awareness program and proper vaccination (Khan *et al.*, 2023).

## Challenges and Future Perspectives

Despite the development in the advancement of zoonosis there are lot of challenges which are facing the public the related vaccine availability, accessibility and regulatory approval (Ahmed *et al.*, 2024) future research must be aimed at improving synthesis methods for plants derived natural products (PDNPs) and integrating them into routine veterinary practice (Ahmed *et al.*, 2024). Despite that public awareness and educated people about the zoonotic disease is vital for the prevention and control of zoonosis (Khan *et al.*, 2023).

## Conclusion

Zoonotic diseases remain a critical threat to world health due in part to their complex mode of transmission, various forms of pathogens, and their intimate interaction with animals and their interface with the environment of specific concern is the disease known as rabies, which is considered a critical threat due in part to 100 percent fatality rates upon appearance of any symptoms. However, this is a disease that is completely preventable. As was

mentioned through the previously discussed forms of evidence, domestic dogs are the main component for the transmission of rabies. Because of this, there is a sense of urgency in needing animal vaccination programs. Although cell-culture rabies vaccine development and post-exposure prophylactic measures are a crucial advancement in disease prevention, inequalities exist in vaccine availability, which hinder their effectiveness, especially in low- and middle-income nations. With the increasing trend of exploring natural products such as plant-derived nanoparticles against infectious agents, some promising alternate methods for effectively managing zoonotic diseases could result. With regards to this, One Health is theoretically proposed as a crucial approach for managing zoonotic diseases. With this approach, interdisciplinary coordination among various health domains such as human health, veterinary health, and environmental health needs to be addressed. For this purpose, effective surveillance programs and education programs at the community level should be conducted.

Looking forward, future interventions will have to focus on improving immunization systems, increasing regulations on new therapeutic agents, and raising awareness within society to combat disease spread in animal–human interactions. Research findings will also have to be built upon to achieve optimal natural product interventions, which can be used in veterinary and human medicine as standard practice in handling animal–human interactions. The world will have to look forward to a coordinated, science-driven, and inclusive approach to combating and overcome zoonotic diseases and their future epidemics.

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