WWJMRD 2026; 12(02): 01-03
www.wwjmrd.com
International Journal
Peer Reviewed Journal
Refereed Journal
Indexed Journal
Impact Factor SJIF 2017: 5.182 2018: 5.51, (ISI) 2020-2021: 1.361
E-ISSN: 2454-6615

K. Gayathri
PG and Research Department of Microbiology, Sacred Heart College (Autonomous), Tirupattur, Tamil Nadu, India.

Israa M. Essa
Department of Public Health, College of Veterinary Medicine, University of Basrah, Basrah, Iraq.

Hasanain A.J. Gharban
Department of Internal and Preventive Veterinary Medicine, College of Veterinary Medicine, University of Wasit, Wasit, Iraq.

B. Lokeshwari
PG and Research Department of Microbiology, Sacred Heart College (Autonomous), Tirupattur, Tamil Nadu, India.

P. Saranraj
PG and Research Department of Microbiology, Sacred Heart College (Autonomous), Tirupattur, Tamil Nadu, India.

Correspondence:
P. Saranraj
PG and Research Department of Microbiology, Sacred Heart College (Autonomous), Tirupattur, Tamil Nadu, India.

Understanding Zoonotic Disease Emergence Through Microbial Ecology and Transmission Pathways

K. Gayathri, Israa M. Essa, Hasanain A.J. Gharban, B. Lokeshwari, P. Saranraj

Abstract
Zoonotic diseases are spread by microorganisms transmitted between animals and humans posing a major global health challenge. These microorganisms originate in animal reservoirs, including livestock and wildlife, as well as environmental niches. Zoonotic diseases are driven by factors such as different factors such as changes in the environment, invasion of the habitat, intensive farming, climatic change, globalization, and adaptation of the microbes. Transmission modes include direct contact, food and water, vectors, air and surfaces that have been infected. This review highlights the diversity and transmission pathways of key zoonotic pathogens such as, Ebola, avian influenza, rabies, and Brucella species is demonstrated. Effective prevention and control require an understanding of zoonotic reservoirs, transmission processes, and microbial origins. The One Health approach advocates for integrated strategies to monitor, predict, and control increasing threats of zoonotic pathogens on human and animal health.

Keywords: Zoonotic diseases, Microorganisms, Transmission, Reservoirs and One Health.

1. Introduction

Zoonoses are diseases naturally transmitted between animals and humans. They are also a key reason behind emerging and reoccurring infectious diseases around the world threatening the health, food availability, and economic well-being of the population. It is estimated that approximately 60% of known human infectious diseases and up to 75% of emerging infectious diseases are of zoonotic origin. These diseases are transmitted by microorganisms that survive and change to adapt and overcome barriers between species between animal reservoirs and humans [1]. Zoonotic illnesses are caused and transmitted by bacteria, viruses, parasites, and fungi. In their natural reservoirs, many wild and domestic animals carry these bacteria without developing much disease.

If the ecological, environmental, or social factors are altered, these bacteria may be transmitted to humans and lead to outbreaks, epidemics, or even pandemics. Pathogens like SARS-CoV-2, Ebola virus, avian influenza viruses, *Brucella* spp., and rabies virus that may move across species boundaries and lead to severe human infection. Complex interactions between microbes, animal hosts, human beings and the environment cause Zoonotic diseases. Viruses infect new hosts and evolve to changing conditions with the help of genetic mutations, recombination, and antibiotic resistance. Human-induced changes such as deforestation, agricultural intensification, wildlife trading, urbanization, and global travel have increased the level of contact between humans and animals, creating the potential of microbial transmission [2].

Climate change conditions favor host and vectors distribution, assisting zoonotic bacteria to penetrate new locations. Successful prevention and control programs should have an idea of how microorganisms contribute to the development of zoonotic diseases. The improved detection and characterisation of zoonotic pathogens with the help of molecular biology, genetics, and disease surveillance enables researchers to learn about the threats long in advance. Even after these changes, animal monitoring, disease evolution and resistance to antibiotics are still significant problems [3]. Such problems need to be approached holistically

in a way that focuses on human, animal, and environmental wellbeing.

2. Microorganisms Involved in Zoonotic Diseases

Zoonotic diseases are caused by microorganisms that spread through animals to humans and they are bacteria, viruses, parasites and fungi. These microbes can persist without causing disease in wildlife, cattle and domestic animals. They have the ability to infect human beings across the species boundaries leading to sporadic cases, outbreaks, or epidemics. Viruses are the source of zoonotic diseases because of the presence of high mutation rates and the ability to adapt to novel hosts. They include pig influenza viruses, coronaviruses, and wildlife reservoir viruses such as Ebola and Nipah [4]. Common bacterial zoonotic pathogens include Brucella, Salmonella, Leptospira, Mycobacterium and Yersinia that are transmitted by direct contact with sick animals, contaminated food, contaminated water and soil.

Antibiotic resistance complicates many bacterial zoonoses of many bacterial zoonoses making the management and treatments. Parasitic zoonoses include protozoa and helminths which are transmitted in food, water or through vectors. Such helminths as Echinococcus and Trichinella are harbored by livestock and wild animals and can be transmitted by undercooked meat, whereas protozoan parasites, such as *Toxoplasma gondii*, Cryptosporidium, and Giardia, are widespread and may pose a risk to immunocompromised individuals. Zoonotic infections caused by fungi are rare but pose a risk of getting infected particularly among immunocompromised groups. Animals or contaminated environments may transmit Histoplasma, Cryptococcus and dermatophytes [5]. Zoonotic disease microorganisms are the complexity of animal-human contacts and the complexity of ecological systems. They contribute significantly to the occurrence and recurrence of zoonotic diseases around the world because of their adaptability to new hosts, adaptation to new environments, and manipulation of human behavior and environmental modifications.

3. Sources and Reservoirs of Zoonotic Microorganisms

Zoonotic pathogens originate from diverse sources and abodes contribute towards the transmission of animal infectious diseases to humans. Wildlife, domestic animals, and environmental reservoirs contribute to their prevalence and spread include wildlife, domestic, and environmental environments. Zoonotic pathogens are highly diverse in wildlife in the wildlife because of the assortment and close ecological factors [6]. Wild animals naturally Harbour by many viruses, germs, and parasites. The coronaviruses, hantaviruses, rabies, and avian influenza viruses have a significant reservoir in bats, rodents, and birds. Poaching and deforestation in the habitats of wildlife, as well as urbanization, have raised the interaction and spillover of the reservoir. Domesticated livestock and pets serve as major reservoirs of zoonotic germs.

Cow, sheep, goats, pigs, and poultry may cause Brucella, Salmonella, Campylobacter, and Mycobacterium to human beings either through direct contact, occupational exposure, or animal products [7]. Pathogens such as rabies virus, *Toxoplasma gondii*, and dermatophytes can be present in dogs and cats. Environmental reservoirs store and distribute Zoonotic microorganisms. Leptospira, *Bacillus anthracis* and Cryptosporidium may be contained in soil, water, and contaminated surfaces, and can be indirectly transmitted to humans and animals. Plasmodium, Borrelia and Yersinia pestis can be transmitted by the animals to the people through mosquitoes and ticks as well as fleas [8]. Zoonotic microbe origin and reservoir knowledge is needed in disease surveillance, risk assessment and prevention. The detection and observation of these reservoirs are useful in the detection of new diseases and the development of specific management strategies. To reduce zoonotic diseases worldwide and prevent outbreaks, a One Health strategy, where wildlife, domestic animals, and environmental reservoirs are taken into account, is needed.

4. Modes of Transmission of Zoonotic Microorganisms

Zoonotic pathogens are transmitted by animals to human beings through numerous pathways that are indicative of human-animal-environment interplay. Direct contact transmission occurs when individuals touch or have close contact with infected animals, their body fluids, tissues or excretions. This includes bites (e.g., rabies) or contact with secretions (e.g., brucellosis) from infected animals [9]. Another significant route is the consumption of infected meat, milk or eggs. Waterborne transmission is significant in areas where animal feces containing pathogens like Leptospira, Cryptosporidium or Giardia. Humans can be infected by ingesting, with the use of contaminated water. Zoonotic diseases which require the use of mosquitoes, ticks, fleas and mites must be transmitted through vectors [10].

During feeding, these vectors infect human beings with diseases that sick animals are infected with. The ecology of vectors and the dynamics of population expose humans to Lyme disease, plague and Valley fever, although this is rare, airborne transmission can occur through infections in aerosols or dust particles by diseased animals or contaminated environments [11]. Such transmission pathways need to be known in order to develop effective vaccine, vectors control, food safety, sanitation of the environment, and population education initiatives. Mapping the channels of transmission of zoonotic diseases and new pathogens can help prevent such diseases by the authorities of the public health.

5. Factors Contributing to the Emergence of Zoonotic Diseases

The emergence of zoonotic diseases results from a complex interplay between the diseases. Of significant causes are environmental and ecological change. Deforestation and habitat fragmentation, as well as, land-use changes disrupt ecosystems, exposing humans to proximity to wildlife reservoirs and enhancing the spread of zoonotic infections. Deforestation of the tropical forests has been linked to the Ebola virus and other diseases related with wildlife. Human activities such as intensive agriculture, livestock production, and worldwide animal and product trade are also important. Salmonella, Brucella, and avian influenza viruses are transmitted in high-density livestock production, whereas new infections can overcome species barriers in wildlife markets and exotic pet trade [12]. Climate change is another major factor, altering the distribution of vectors and hosts. Furthermore, urbanization increases human-animal contact and often strains sanitation systems, elevating transmission risks. Vectors, hosts, and pathogens

are susceptible to temperature, rainfall, and extreme weather. Pathogen survival and replication may also increase human exposure to global warming [13]. Higher mutation rate, genetic recombination and antibiotic resistance may allow the microorganism to adapt the hosts and cross species barriers more quickly. Infections may also occur in humans and animals due to reduced immunity caused by vaccination or prior exposure to the infections.

6. Conclusion

Zoonotic diseases pose a growing threat to the health of the world population, which is a complex interaction between ecological, environmental, and socio-economic factors. Microorganisms such as viruses, bacteria, parasites and fungi take advantage of changes in conditions such as encroachment of habitat, intensive farming, climate variations and travel of people across the world to break through species barriers and infect human populations. These pathogen reservoirs and transmission pathways, as well as the surveillance, prevention and control measures, the One Health approach, which integrates human, animal, and environmental health, is indispensable. Mitigating these threats requires international cooperation, advanced pathogen detection technologies, and sustainable practices. Through the interdisciplinary approach, including dealing with the underlying factors of zoonotic outbreaks and improving preparedness, the global community can become more effective in protecting health, improving food security, and becoming more resilient to future pandemics.

References

1. Ortiz-Prado E, Yeager J, Vásconez-González J, Culqui-Sánchez M, Izquierdo-Condoy JS. Integrating environmental conservation and public health strategies to combat zoonotic disease emergence: A call to action from the Amazon rainforest. Frontiers in Cellular and Infection Microbiology, 2024; 14.
2. Bichara D, Iggidr A, Smith L. Multi-stage Vector-Borne Zoonoses Models: A Global Analysis. Bulletin of Mathematical Biology, 2018; 80(7): 1810–1848.
3. Fiegler-Rudol J, Lau KM, Kasperczyk JM. Public health threat of novel zoonotic diseases: literature review. Przeglad Epidemiologiczny, 2024; 78(1): 69–80.
4. Omar S, Jalaludin FA, Yee JM, Kamarudin Z, Kavitha J, Khlubi ANM. Mycological isolation from animal enclosures and environments in National Wildlife Rescue Centre and National Zoo, Malaysia. Journal of Veterinary Medical Science, 2020; 82(8): 1336–1339.
5. Ahmed MM, Okesanya OJ, Othman ZK, Ibrahim AM, Adigun OA, Ukoaka BM. Holistic Approaches to Zoonoses: Integrating Public Health, Policy, and One Health in a Dynamic Global Context. Zoonotic Diseases, 2025; 5(1): 5.
6. Skowron K, Grudlewska-Buda K, Khamesipour F. Zoonoses and emerging pathogens. BMC Microbiology, 2023; 23(1): 237.
7. Sharan M, Vijay D, Yadav JP, Bedi JS, Dhaka P. Surveillance and response strategies for zoonotic diseases: A comprehensive review. Science of One Health, 2023; 2: 100050.
8. Elsohaby I, Villa L. Zoonotic diseases: understanding the risks and mitigating the threats. BMC Veterinary Research, 2023; 19(1): 186.
9. Teshome H. Review on principles of zoonoses prevention, control and eradication. American Journal of Biomedical Science and Research, 2019; 3(2): 188–195.
10. Esposito MM, Turku S, Lehrfield L, Shoman A. The Impact of Human Activities on Zoonotic Infection Transmissions. Animals, 2023; 13(10): 1646.
11. Ojeyinka OT, Omaghomi TT. Wildlife as sentinels for emerging zoonotic diseases: A review. World Journal of Advanced Research and Reviews, 2024; 21(3): 768–776.
12. Desvars-Larrive A, Vogl A, Puspitarani GA, Yang L, Joachim A, Käsbohrer A. A One Health framework for exploring zoonotic interactions demonstrated through a case study. Nature Communications, 2024; 15(1): 5650.
13. Loh EH, Zambrana-Torrelio C, Olival KJ, Bogich TL, Johnson CK, Mazet JAK. Targeting Transmission Pathways for Emerging Zoonotic Disease Surveillance and Control. Vector-Borne and Zoonotic Diseases, 2015; 15(7): 432–437.