

A Review on Types, Transmission Patterns, and Prevention of Zoonotic Diseases

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ABSTRACT

Zoonotic diseases or Zoonoses are one of the largest health issues in the world, as they bring up the relationship among humans, animals, and the environment. These microbes are the cause of these infections, which are responsible for almost 60 percent of all human infections and 75 percent of new diseases. Pandemics of the past, such as the Black Death, Spanish Flu, and HIV/AIDS, remind us of the destructive ability of zoonoses because of their widespread effects, and recent outbreaks such as

SARS, MERS, Ebola, and COVID-19 are reminding us of this today. Zoonoses are transmitted in a number of ways, such as direct and indirect contact, food contamination, vectors, and aerial routes. Their abundance has been enhanced by human activities such as deforestation, intensive farming, global trade, and climate change reinforcement, which lead to the pathogen spillover. Children, the elderly, immunocompromised, and occupationally exposed to animals are considered the vulnerable groups. One Health paradigm, which is a combination of human health, animal health, and environmental health, has been implemented in an effort to tackle the menace of zoonotic diseases by promoting cross-sector cooperation. Prevention relies on some factors like control of vectors, good hygiene, food safety, immunization, and surveillance. In the future, improvements in technology like genomic sequencing, artificial intelligence, and predictive modeling have the potential to be effective instruments when it comes to the identification and control of risks before the outbreak of a pandemic. Not only are zoonoses crucial in the control of disease, but they are also critical in the structuring of health in general, economic stability, and social welfare against emerging health hazards.

Key word: Zoonoses, Transmission, Spillover, One Health, Prevention

Introduction

Zoonoses (zoonotic diseases) are one of the major and continuous threats to international health, in part because they indicate the fragile and occasionally uncomfortable relationship between humans and nature (Belay et al., 2017). These are pathogenic diseases that have been induced by different pathogens such as bacteria, viruses, parasites, and fungi, which have practically bypassed the biological barrier separating vertebrate animals and human beings (Verhoef, van Kessel, & Snippe, 2019). This transmission is an access point into the animal and human world, and humans are always at risk of being invaded by foreign pathogens. The road is by no means new but has existed the entire time, being the source of some of the most catastrophic pandemics in human history. The example of the Black Death that hit medieval Europe and Asia illustrates that the bacteria responsible were *Yersinia pestis*, which live on rodents and are transmitted by fleas (Ruhaak, 2018). Spanish Flu of 1918 affected almost a third of the world population and is thought to have been transmitted by birds (Agrawal et al., 2021). The threat is evidenced by shocking cases of infection: it is believed that 60 percent of all known human infectious diseases are zoonotic, and 75 percent of new emerging infectious diseases have an animal cause. Examples that crossed to primates include HIV/AIDS; Ebola, related to fruit bats; Severe Acute Respiratory Syndrome (SARS); Middle East Respiratory Syndrome (MERS); and Avian Influenza (Matsuyama, Nishiura, Kutsuna, Hayakawa, & Ohmagari, 2016). The latest and most serious is the SARS-CoV-2-induced COVID-19 pandemic, which is thought to have started in bats, then spread to humans, presumably via an intermediate host, before resulting in a pandemic that revealed the weaknesses of the interconnected systems (Lu et al., 2021). Nonetheless, headlines are not the only cause of danger. We can also see the association between animals and humans in more prevalent health care problems. An example of this is rabies, which is a potentially lethal viral encephalitis transmitted by the saliva of infected mammals.

Lyme disease is a bacterial disease that is carried by ticks, and it is surrounded by intricate relationships between the deer and mice (Steere et al., 2016). Reptiles, poultry, and livestock are thought to be the major contributors to common food-borne illnesses like salmonellosis. The zoonotic diseases are not just a scholarly practice: the knowledge of the problem is vital to the health security of the world, social welfare, and economic stability.

Types of Zoonotic Diseases

The list of zoonotic diseases is rather broad, and the number of pathogens that present a widespread and evolutionary threat to world health is great. To realize more fully the full scope of this threat, it is important to categorize these diseases according to the nature of the infectious agent that induces that disease- bacteria, viruses, or parasites and each has its own unique mechanics, mode of transmission, and clinical outcomes in human populations.

Bacterial Zoonoses

The most common are bacterial causes of Zoonotic diseases (Ziarati et al., 2022). There are numerous environmental and animal reservoirs on which many bacteria survive to inflict zoonotic diseases. A prominent example is Lyme disease, the most common of the vector-borne diseases in the Northern Hemisphere (Balouch & Saeed). It is a highly complex-cycle infectious disease caused by the spirochete bacteria *Borrelia burgdorferi*, and its primary reservoirs include small mammals, especially the white-footed mouse, and tick vectors, including black-legged ticks (*Ixodes scapularis*). People usually become infected when bitten by an infected nymphal tick, which is a tiny one and can be the size of a poppy seed. The characteristic feature is the diffuse spreading erythema migrans rash, which is typically in the shape of the bull's eye, with symptoms of flu, which include fever, chills, and excessive fatigue. Lack of timely administration of antibiotics allows the spread of the bacteria, causing severe and chronic effects, including disabling arthritis, heart attacks (carditis) (Zasowski et al., 2020), and neurological disorders like facial palsy and meningitis. Another risk that *Salmonella* is associated with, which is an example of transmission of foodborne disease, is Salmonellosis (Pal, Merera, Abera, Rahman, & Hazarika, 2015). Although in most cases, the reptiles such as lizards, turtles, or snakes play an asymptomatic role, in some instances, extreme outbreaks have been attributed to the agricultural food chain. Individuals tend to contract the infection through the ingestion of contaminated food, poultry products, eggs, raw milk (or other dairy products), or vegetables to which manure contaminated with the bacteria has been applied. The bacteria penetrate into the gastrointestinal tract, resulting in acute gastroenteritis through severe abdominal cramps, severe diarrhea, and, thereafter, vomiting and fever (Ananthakrishnan & Xavier, 2020). In the majority of cases, the conditions are self-limiting, but the immunocompromised, the very young, and older people are vulnerable to dehydration and systemic infection that necessitate hospitalization.

Viral Zoonoses

The most discussed type of zoonoses is the viral zoonoses due to their marketability to the readers, morbidity and mortality rates, and the possibility of the occurrence of

epidemic outbreaks (Narayan, Sinha, & Singh, 2023). Rabies virus is classified under the genus *Lyssavirus*, which is one of the most lethal diseases to humans. It is caused by a neurotropic virus and is usually contracted by bites of an infected mammal, most commonly domestic dogs (causing 99 percent of human cases), and wild animals, including bats, raccoons, skunks, and foxes. The virus is transferred to the central nervous system via the peripheral nerves and finally leads to acute encephalitis (Michalícova, Bhide, Bhide, & Kovac, 2017). The disease is nearly always lethal once clinical symptoms manifest; some of the most common ones are agitation, hallucinations, hydrophobia (fear of water), and paralysis. Nonetheless, not all of it is inevitable, and it could be avoided to an almost absolute extent with post-exposure prophylaxis (PEP), which includes cleaning up the wounds, the use of rabies immunoglobulin, and a series of vaccinations. The most vital thing to do after a possible exposure is to seek medical attention in time. Moreover, there is the Avian Influenza (Bird Flu), which is a contemporary pandemic menace caused by Type A influenza viruses (Qureshi, Samad, & Muqadas, 2022). Such viruses are endemic in wild aquatic birds, and in most cases, the birds are asymptomatic carriers. They are also able to infect farmed poultry by migration routes and contact with the domestic flocks in farms and live bird markets. Some strains, especially H5N1 and H7N9, have been found to cause respiratory distress and pneumonia in humans, mostly via direct contact with ill birds or their excrement, and are highly lethal (Bui et al., 2016). Virologists are the most worried about the possibility of the virus mutating, swapping its genetic material, and gaining the capacity to propagate effectively and sustainably among humans and trigger an influenza pandemic.

Parasitic Zoonoses

Even though, as is commonly the case with viruses, they might not be quite as eye-catching as other pathogens, parasitic zoonoses lead to chronic morbidity and other complicated public health problems in the global population (Oliveira, Cruz, Pinheiro, & Caliari, 2022). An example of such a sinister kind of condition is Toxoplasmosis, which is caused by the protozoan *Toxoplasma gondii* (Al-Malki, 2021). Definitive hosts include domestic cats (feral and pet), which shed millions of resistant oocysts in their feces following a contaminated prey. Humans can be infected by simply eating contaminated soil, water, cat litter, or by eating poorly cooked meat that has tissue cysts. Although healthy people may not have any symptoms in approximately 80-90 percent of cases, it is dangerous in pregnancy since it may cross the placenta and cause severe birth defects, such as neurological and eye defects. In immunocompromised patients (like HIV/AIDS patients or chemotherapy patients), infections may re-emerge, resulting in life-threatening toxoplasmic encephalitis (Duffy, 2020). The pork tapeworm, *Taenia solium*, causes another serious parasitic infection. Adult tapeworm (taeniasis) is a disease present in humans that is acquired through ingestion of undercooked infected pork. Human waste contaminated food or water is a more threatening complication, cysticercosis, during which individuals accidentally ingest it and become intermediate hosts (Kusnoto et al., 2025). The larvae may move around the body and develop cysts in body tissues, including muscles, eyes, and, more importantly, in the central nervous system, causing neurocysticercosis. The disease is the major cause of acquired epilepsy in Latin

America, Asia, and Africa, and is associated with severe and long-term disability. This emphasizes the long-term and serious contribution of parasitic zoonoses to the health and society of mankind (Pisarski, 2019).

Transmission Route

The spread is the transmission of a pathogen between two hosts (one animal, the other human) and does not necessarily have to take place easily, but in fact, via certain transmission pathways. Direct contact, which may include the touch of saliva, blood, urine, mucus, feces, or other body fluids of a diseased animal, is one of the easiest ways (Jatav, Pratap, Vaishnav, & Sharma, 2024). Examples of the first are a bite by a rabid animal, a calf born of an animal infected with Brucellosis, which is also a zoonotic disease, and *B. abortus* can cause abortions in humans and animals, or an infected *Salmonella* pet reptile (Abbas, Muqadas, Qureshi, & Fatima, 2024). The indirect contact is with places or objects that are harbored by infected animals, including pet coops, chicken coops, barns, plants, or soil that is contaminated with pathogens. A child in a playground with cats that carry *Toxoplasma gondii* is an example of indirect transmission (Condoleo et al., 2024). Foodborne or zoonotic transmission is another major route. Human beings may be infected by eating infected foodstuffs such as untested milk, under-cooked meat, or raw fruits and vegetables contaminated with feces of infected animals. The most efficient path is a third party, i.e., a mosquito, a tick, or a flea that carries the pathogen with bites (Pustijanac et al., 2024). Although to the naked eye this pathogen may be invisible, once bitten by a vector, it permanently enters the organism of an infected animal and is passed on to a human in another bite. This complicated lifecycle has been exemplified by Lyme disease (mosquitoes carry the bacteria), West Nile virus (carried by mosquitoes), and Plague (carried by fleas) (Mead, Hinckley, & Kugeler, 2024). Finally, it is airborne where human beings inhale pathogens found in the air. This is typical in places with high concentrations of animals, such as farm barns, where dust can have dried feces or dander, causing diseases like Q fever or Hantavirus Pulmonary Syndrome, which can be inhaled when the rodent feces are aerosolized (Nordmann et al., 2024).

The Cause of the Increase in Zoonotic Diseases

A combination of anthropogenic forces is increasing the occurrence and recurrence of zoonoses (Grillet & Vincenti-González, 2024). Among the causes are habitat encroachment and deforestation. With the increase in the human population, we move further into the wilderness to build communities, farmlands, and to extract resources. Not only do these man-made destructions of natural habitats expose wild animals, natural reservoirs of many viruses, to increased direct and closer interaction with people and livestock, but they also provide new avenues of disease transmission (Gordon, 2018). This is further added by deliberate hunting and bushmeat trade, which entail direct exposure to blood and body fluids of wild animals (Jenkins, Lawundeh, Hanson, & Brown, 2024). Another important factor is agricultural intensification. Intensive livestock production, which is motivated by the contemporary consumption of animal protein, entails the crowding of thousands of chickens or pigs (Telles, Bichel, Zanin, Pellini, & Pontes, 2024). Such conditions promote the growth and development of the pathogens and risk the development of

transmission to humans. These circumstances have been associated with outbreaks such as the Nipah virus in pigs and types of avian influenza (Ang, Lim, & Wang, 2018) (Swayne & Sims, 2021). Climate change is a threat multiplier. The increase in global temperatures disturbs the distribution and behavior of animals and their vectors (de Souza & Weaver, 2024). Disease-carrying mosquitoes, such as Dengue and West Nile virus, are now able to survive and breed in previously too cold areas, exposing humans to this threat. Alterations in rainfall may also cause floods that displace rodents, exposing them to people. Lastly, world travel and commerce are significant routes through which pathogens are propagated. One virus emerging in a remote village can be easily spread to major cities in other continents by infected travelers or even by the legal and illegal trade in wild animals, and this may trigger a worldwide outbreak in a single intercontinental flight (Abebe, 2020).

Vulnerability

Even though all people can get a zoonotic infection, certain factors put certain groups at a significantly higher risk, including exposure, immune status, and age (Esposito, Turku, Lehrfield, & Shoman, 2023). Immunocompromised people are the most susceptible. This involves the elderly who might have compromised immunity; children, who are yet to acquire immunity; and the sick who already possess pre-existing medical conditions, undergoing chemotherapy due to cancers, or have undergone some organ transplants and are taking immunosuppressant medications. A mild illness that could be harmless to an adult may be fatal in such groups (Swanson, McGinty, Fazel, & Mays, 2015). Occupational exposure also puts people at higher risk who have frequent exposure to animals and animal products, including those with occupational exposure. These laborers are farmers and ranchers, slaughterhouse employees who deal with animals, veterinarians and veterinary technicians who diagnose and treat ailing animals, wildlife biologists and conservation scientists, and zookeepers. Their everyday life practices put them at risk of exposure to a variety of zoonotic pathogens either directly or indirectly. Also at high risk are the travelers visiting the locations where the zoonotic diseases periodically spread (Esposito et al., 2023). Going to places where sanitation is questionable, animals, or in times of outbreak, without due caution, like vaccinations, repellents, or food and water selections, are all exposures to unknown diseases that the traveler has little immunity to at home.

One Health Approach

One Health approach is an innovative, people-oriented, and collaborative concept, which appreciates the indivisible relationships between the health of humans, animals, plants, and the environment in which they all live (Oktay & Acaralp, 2025). It is not based on the conventional approach to treating health in separate silos, but a multi-sectoral and integrated approach. The central concept is that food safety, zoonotic disease issues, and antimicrobial resistance cannot be effectively addressed by the human health sector. They need multidisciplinary skills of veterinarians, physicians, ecologists, epidemiologists, and local, national, and international public health officials (Shrivastava, Sahoo, & Venkatesh, 2025). As a matter of fact, veterinarians tend to be the line of defense in most cases. They are used to observe the population

of animals so that they can identify any abnormal illnesses and act as an early warning system of possible outbreaks among humans. As an illustration, the detection of West Nile Virus in birds or Rabies in wildlife can be a very important solution to warn people. The environmental scientists also play a role through monitoring of ecological systems, monitoring of climate and land use changes that can change disease distribution, and also finding contaminated soil or water (Likens & Lindenmayer, 2018). Data in the animal and environmental sectors is essential when medical doctors and other health authorities need to be able to diagnose uncharacteristic cases in individuals rapidly, trace outbreaks, and determine control strategies. The One Health approach erases discipline lines and, as such, is a more efficient and proactive program in predicting, preventing, and responding to animal-to-human transmission of diseases (Tiffin, Gordon, & Poh, 2025).

Prevention

Use of common daily hygiene and safety measures is the most significant step towards the prevention of zoonotic diseases (Sharan, Vijay, Yadav, Bedi, & Dhaka, 2023). Among pet owners, these may include periodic visits to the veterinarian, vaccination, and preventive measures against parasites (protection against fleas, ticks, and worms). Public and veterinary health issues have led to the implementation of various measures to reduce ticks and destroy their life cycle pathogen (Desta, 2016). Always wash your hands using a lot of soap and water whenever you come into contact with animals or surfaces that animals touch, their food or feces, and eliminate the waste of animals. Good hygiene is the best thing to do. Frequent and appropriate handwashing can eliminate countless pathogens. Paying attention to hand hygiene after outdoor activities, gardening, or farm work will help kill a great number of germs. The second significant message is food safety: in order to get rid of bacteria causing diseases, cook meat, poultry, and eggs to a checked internal temperature; do not cross-contaminate by using different cutting boards when preparing raw meat and produce, and consume only pasteurized dairy products and milk (Fung, Wang, & Menon, 2018). To ensure you do not get bitten by ticks and mosquitoes, to stay safe and protect your family members when outdoors, use EPA-registered insect repellents that contain either DEET or picaridin. Use long sleeves and trousers in the forests or grassed lands, and then examine your body, kids, and pets properly. And lastly, beware of animals. Do not approach sick or homeless animals, or play with them (Hurley & Miller, 2021). Keep animals at a distance, and leave children alone with animals.

Future of Zoonotic Diseases

Combining three forces, namely, improved surveillance, improved scientific research and innovation, and preparedness planning, is the future of controlling zoonotic threats (Sharan et al., 2023). The early warning networks are based on international surveillance systems. It is of paramount importance to track animal health in farms, as well as in the wild, and also in the medical system, to detect pathogens that can lead to pandemics before they spread widely to the human population. The dissemination of such information to the world, via coordinated systems, allows quicker and more coordinated responses. There is also scientific and technological development that

gives new equipment; genomic sequencing enables scientists to rapidly detect pathogens, monitor their evolution, and detect alterations in patterns of transmission (Goldberg, Sichtig, Geyer, Ledebor, & Weinstock, 2015). Large datasets (satellite pictures of deforestation, climate change, and animal tracks) can be analyzed by machine learning and artificial intelligence (AI) to identify hotspots at the greatest risk of their further transmission. This is a big step towards predictive science as opposed to reactive science. Also, the experience of outbreaks such as COVID-19, Ebola, and Zika has underlined that pandemic preparedness is crucial (Lal, Ashworth, Dada, Hoemeke, & Tambo, 2022). This does not just mean hoarding of medical supplies but investment in the public health infrastructure, preparing the rapid response plans, establishing international liaisons, and conducting a regular simulation to ensure the system and its cadres are prepared to respond with prompt effectiveness when the next potential attack comes (Mwila, 2020).

Conclusion

Zoonotic diseases are a big problem. This issue has been around for a long time. These illnesses also keep changing. They come from animals. They spread to people. This happens when humans interact with animals. It also happens when people interact with their environments. History shows us this. Such diseases can cause small outbreaks. They may also cause global sickness. These events cause serious problems. Our actions make these diseases spread more. We cut down forests. Cities grow larger. We raise many animals on farms. People also trade wild animals. Climate change adds to the issue. These changes make it easier. Germs can jump from animals to us. These tiny bugs then learn to live in human bodies. Global travel makes the situation worse. Illnesses can now spread worldwide very fast. This can happen in just hours. Everyone can get sick. But some groups are more at risk. These include people with weak immune systems. Young children are also at risk. Older people face danger. Workers who are often around animals also face higher risks. Experts say we need a special plan. This plan should cover everything. It is called the One Health idea. This idea helps solve the problem. We need to watch for diseases from many angles. We also need systems that warn us early. Experts must work together. This includes animal doctors, human doctors, and scientists who study nature. Public health workers are also key. Their teamwork is very important. We need ways to stop illnesses. These include staying clean. We must handle food safely. We also need to control insects that spread germs. Shots can help. Teaching people about diseases is also important. These steps are vital to slow the spread. New ideas are very important for the future. For example, we can use genomic sequencing. This helps us understand germs better. AI can predict outbreaks. We also need new types of vaccines. It is also vital to make our health systems stronger. Countries must work together to fight global outbreaks. We also need plans ready for emergencies. This can stop problems before they get bad. To protect everyone from these diseases, we need to do many things. We must always be watchful. Experts from different fields must work together. We also need to act early. This means stopping the causes. It also means dealing with the effects.

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

DECLARATION

Funding:

Not Available

Acknowledgement:

The authors are thankful to Multan University of Science and Technology for providing technical support and guidance.

Conflicts of Interest:

All authors of the manuscript declare that they have no financial or personal interests.

Data Availability:

Raw data may be available on request.

Ethical Statement:

The article is purely manuscript, and no animals were harmed.

Author's Contributions:

AM, QMA, KK, MZ, AA, and MO wrote the manuscript, NA, YN, MK, NR, and ZS managed references, and RAB revised the article.

Generative AI Statement:

The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

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