

Zoonotic Diseases: Disease Transmitted from Animals to Humans

Sangapillai Rajendran and Dr. Devender Kumar

¹Research Scholar, Department of Zoology, SunRise University, Alwar, Rajasthan (India)²Associate Professor, Department of Zoology, SunRise University, Alwar, Rajasthan (India)**Corresponding author Email:** sangapillairajendran2@gmail.com

Abstract: Zoonoses with a wildlife reservoir represent a major public health problem, affecting all continents. Hundreds of pathogens and many different transmission modes are involved, and many factors influence the epidemiology of the various zoonoses. The importance and recognition of wildlife as a reservoir of zoonoses are increasing. Cost-effective prevention and control of these zoonoses necessitate an interdisciplinary and holistic approach and international cooperation. Surveillance, laboratory capability, research, training and education, and communication are key elements. Diseases that are naturally transmitted from animals to humans are called zoonoses or zoonotic diseases. More than 70% of all human infectious diseases came from animals, including Ebola, human immunodeficiency virus (HIV/AIDS), avian influenza and Monkeypox. The COVID-19 pandemic is also a novel zoonosis, caused by a coronavirus that probably came from bats. Zoonoses can happen any time humans come into contact with animals or animal products. Children, people with weakened immune systems or chronic health conditions, and pregnant women are at higher risk of contracting zoonoses. Zoonoses are widespread—not only in forests and wild environments but also in urban areas. This article includes background information on zoonoses and how they move into humans. It also provides helpful tips to avoid infection with these diseases. Finally, it discusses the importance of preventing disease in animals, so that animal diseases are not transmitted to humans.

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Introduction: Zoonoses have affected human health throughout times, and wildlife has always played a role. For example, bubonic plague, a bacterial disease for which rats and fleas play a central role in transmission, has caused substantial illness and death around the world since ancient times (4). A possible epidemic of bubonic plague was described in the Old Testament, in the First Book of Samuel. The so-called Black Death emerged in the 14th century and caused vast losses throughout Asia, Africa, and Europe. The epidemic, which originated in the Far East, killed approximately one third of Europe's population. However, bubonic plague still occurs in Asia, Africa, and the Americas, and the World Health Organization annually reports 1,000–3,000 cases. In the western United States, acquisition of plague in humans is linked to companion animals infested with *Yersinia pestis*-carrying fleas in areas of endemic sylvatic disease (5). Rabies was described in Mesopotamia, in hunting dogs, as early as 2,300 BC. Recognizable descriptions of rabies can also be traced back to early Chinese, Egyptian, Greek, and Roman records (6). In Europe in the medieval age, rabies occurred in both domestic animals and wildlife. Rabid foxes, wolves, badgers, and bears

have been described in the literature as well as in figurative art. Ancient accounts and modern hypotheses suggest that Alexander the Great, who died in Babylon in 323 BC, died of encephalitis caused by West Nile virus (7), a virus that has a wild bird reservoir. Marr and Calisher reported that as Alexander entered Babylon, a flock of ravens exhibiting unusual behavior died at his feet (7). In 1999, West Nile virus was introduced into the United States, where it caused the ongoing epizootic in birds with a spillover of infections to humans and equines. Zoonosis, the transmission of infectious diseases between animals and humans, has been a significant aspect of human-animal interaction throughout history. As our world becomes more interconnected, the risk of zoonotic diseases has increased, emphasizing the need for a One Health approach that recognizes the interdependence of human, animal, and environmental health.

Zoonotic diseases are caused by pathogens, including bacteria, viruses, parasites, and fungi, that can be transmitted between animals and humans. The transmission can occur through direct contact, consumption of contaminated food or water, or exposure to vectors such as ticks and mosquitoes.

Various factors contribute to the emergence and spread of zoonotic diseases. The encroachment of human activities into wildlife habitats, changes in land use, and the global movement of people and goods have created new opportunities for the transmission of pathogens between species.

Common Zoonotic pathogens

Influenza viruses: Influenza A viruses, in particular, have the ability to infect a wide range of animals, including birds, pigs, and humans. The reassortment of genetic material between these viruses can lead to the emergence of new, potentially pandemic strains.

Rabies virus: Transmitted through the saliva of infected animals, usually via bites, rabies is a deadly zoonotic disease that affects mammals, including dogs, bats, and humans.

Salmonella: This bacterium is commonly associated with foodborne illnesses and is often transmitted through the consumption of contaminated meat, eggs, or dairy products.

Lyme disease: Caused by the bacterium *Borrelia burgdorferi* and transmitted through the bite of infected ticks, Lyme disease is a zoonotic illness with reservoir hosts such as mice and deer.

West Nile virus: Mosquitoes, which feed on both birds and humans, can transmit this virus. Birds serve as the primary reservoir hosts, highlighting the complex interplay between different species in the transmission cycle.

Humans Have Important Relationships With Animals
Throughout history, domestic animals have helped humans in their daily activities. Breeding of farm animals has provided milk, meat, and eggs so that humans do not go hungry. Horses and donkeys allowed humans to move over long distances and to conquer new territories. Other species, such as cattle, have helped people to plow the fields and cultivate vegetables more easily, while sheep have provided wool to make warm clothes to protect people from cold winters. For thousands of years, cats and dogs living in our homes have developed special bonds with people, protecting us from possible dangers and keeping us company. However, frequent interactions with animals in shared environments can sometimes lead to the spread of diseases from animals to humans.

What Is a Zoonosis?

Diseases that are naturally transmitted from animals to humans are known as zoonoses

A disease that is naturally transmitted from animals to humans.

or zoonotic diseases

A disease that is naturally transmitted from animals to humans.

. Most of the infectious diseases that affect humans originally came from animals and many of them, like Ebola, human immunodeficiency virus (HIV/AIDS), avian influenza and Monkeypox, have become global emergencies [1]. The COVID-19 pandemic

The worldwide spread of a disease.

is a novel zoonosis caused by a coronavirus that probably came from bats. Important pandemics of the past, like plague and influenza, were also zoonoses.

Some people have a higher risk of acquiring zoonotic diseases, including children, people with weakened immune systems or chronic health conditions, older people, and pregnant women. Pandemics caused by zoonoses can often be attributed to the irresponsible actions of humans, including the creation of enormous animal farms, the overuse of antibiotics on those farms and in pets, the destruction of forests, the illegal animal trade, eating the meat of wild animals, and the movement of people, animals, and animal products across the world. Poor health services also contribute to the spread of zoonotic diseases [2, 3].

Zoonotic diseases can be caused by bacteria, viruses, fungi, and parasites, and the symptoms of zoonoses are therefore quite variable. Many zoonoses can cause flu-like symptoms including fever, headache, fatigue, poor appetite, stomach pain, vomiting, or diarrhea. Many of these symptoms are common across various diseases, so it is important to seek immediate medical attention if they occur.

How do Zoonoses Spread From Animals to People?

Animals, especially domestic

An animal that is not wild and is kept as a pet or to produce food.

ones, are often in contact with humans, and there may be various methods by which transmission (spread) of zoonotic pathogens

Any organism capable of causing disease.

can occur (Figure 1). Direct contact with the saliva, urine, feces, blood, or mucus of animals, including animal bites and scratches, can result in zoonoses. Many people also get sick from eating food or drinking water/milk contaminated with pathogens from infected animals. Infections can occur from breathing air containing pathogens in aerosol

A suspension of tiny particles or droplets in the air that might contain pathogens.

form, or from contact with contaminated areas or surfaces where animals live. Finally, other organisms called vectors

Any living agent that carries and transmits an infectious pathogen to another living organism.

—such as mosquitoes, fleas, or ticks—can transmit pathogens from animals to humans [3].

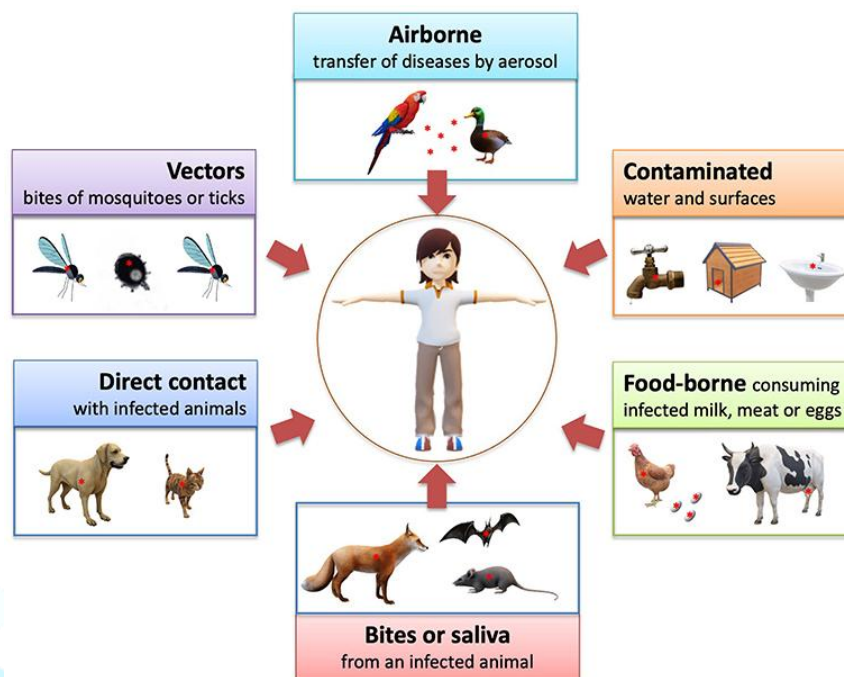


Figure 1 - Zoonoses are diseases naturally transmitted from animals to humans.

- They can pass from animals to humans in several important ways. Zoonoses are widespread—not only in forests and wild environments, but also in urban areas. So, it is important that people everywhere are aware of the precautions they should take to avoid contracting a zoonosis.

How Can we Avoid Zoonoses?

The main thing that can be done to reduce the spread of zoonoses is to prevent animals from being infected. If animals are not infected, they will not be able to transmit the disease to other animals or to humans. For example, the best strategy to prevent **rabies**

It is a deadly disease spread to people from the saliva of infected animals, usually transmitted through a bite.

infections in humans is to vaccinate animals, not humans (Figure 2)!

other steps to avoid infections with zoonotic pathogens (Figure 3). Most importantly, we should wash our hands with soap after being in contact with animals or, if this is not possible, at least disinfect our hands with hand sanitizer. It is also very important to understand animal behavior, to avoid being bitten or scratched. Always avoid touching or picking up wild animals, as they are not used to human contact and they might bite or scratch to protect themselves. In addition, take care not to eat or drink contaminated food or water. Food obtained from animals (meat, eggs) should be cooked well enough to kill pathogens. Finally, prevent bites from mosquitos or other insects by using mosquito repellents and mosquito nets, if available. Here is a little-known fact: the animals that kill the most people every year are not lions or sharks, but mosquitoes! Mosquitoes can transmit serious—even deadly—zoonotic diseases.

Unfortunately, it is not always possible to prevent animals from becoming infected, so we must take

VIRUS TRANSMISSION

Animals carry the rabies virus



In 99% of canine rabies, people get infected by saliva as a result of a dog bite



The virus attacks the brain and 99.9% of human cases are fatal once symptoms appear

RABIES KILLS

Over 120 countries are still affected by canine rabies



Rabies kills more than 59,000 people per year



Every 09 minutes a person dies from rabies



2 in 5 rabies deaths are children < 15 yrs

RABIES PREVENTION

100% of human cases are preventable



Learn dog body language and avoid being bitten



Thorough washing of the wound with soap and vaccine injection can avoid infection and save lives. Seek immediate medical care if bitten

DOG VACCINATION

Vaccinating 70% of dogs breaks rabies transmission cycle in an area at risk, especially in poor rural communities around the world

Figure 2 - Rabies is one of the most dangerous zoonotic diseases, and it can be prevented by vaccinating dogs.

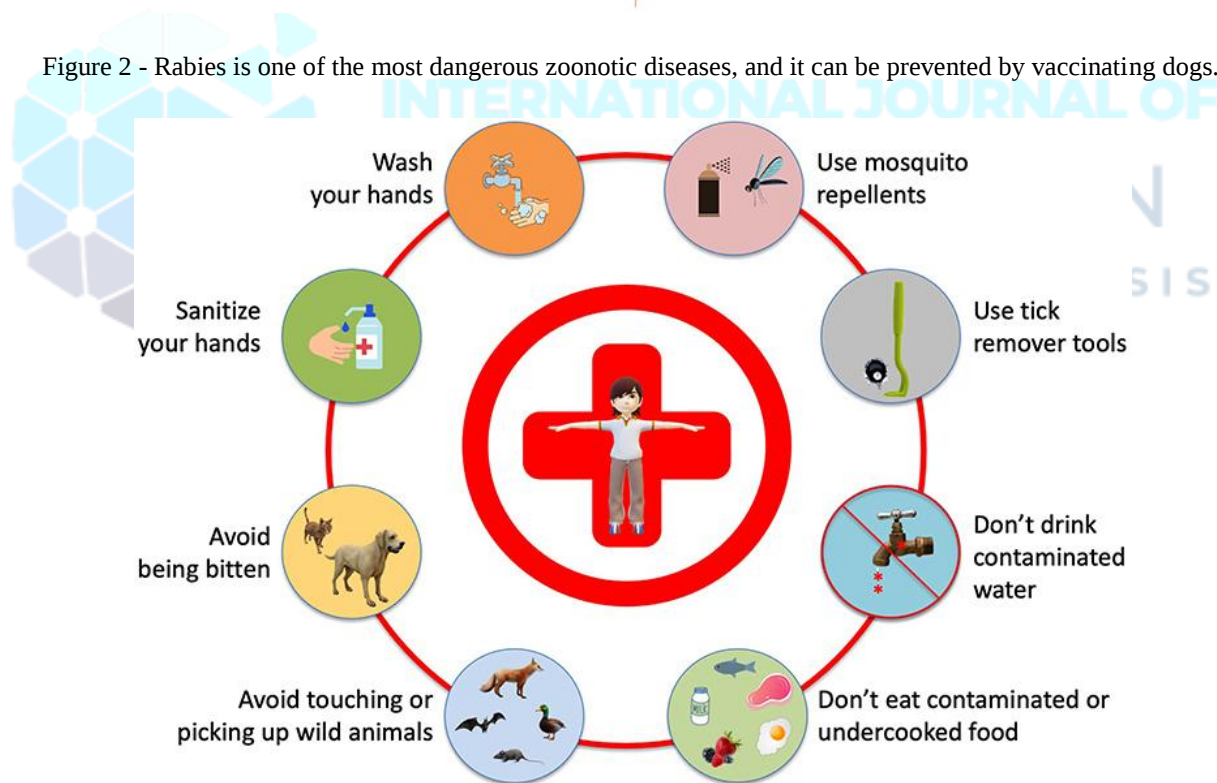


Figure 3 - Helpful tips to avoid infection with zoonoses.

Despite the need for all these precautions, we can not let zoonoses cause us to move away from animals and nature—on the contrary, zoonoses give us one

more reason to develop a stronger bond with nature and animals, because *healthy animals mean healthy people*.

A Rabid Dog and the First Human Rabies Vaccine

As we mentioned, zoonotic infections do not just happen in the wildest places on our planet, such as tropical jungles or rainforests. Many zoonotic diseases can also be caught in cities, as a frightened nine-year-old French boy learned in 1831...

Louis Pasteur was one of the greatest microbe scientists in medical history. Among the many diseases affecting people during his lifetime, why did Pasteur focus on rabies? In October 1831, when he was just 9 years old, Pasteur passed by a blacksmith's shop in Arbois, a village in eastern France, and witnessed a shocking scene. Farmer Nicole had been bitten by a rabid dog, and the blacksmith was trying to treat him by putting a hot iron on the wound. The poor farmer was screaming in pain and Pasteur ran away from the scene in horror. Dogs sick with rabies were often heard howling during the night as they ran through the streets of the village, and little Louis trembled with fear in his bed. Unfortunately, farmer Nicole died—as did eight other unfortunate people from the small village. The dog also died of rabies. Pasteur never forgot this frightening incident and, after many years of study and experiments with rabbits and dogs, he administered the first rabies vaccine to Joseph Meister on July 6, 1885. Meister was a 9-year-old boy who had been bitten by a dog at 8:00 A.M. on July 4. The boy had at least 14 bites and his death from rabies seemed certain. But Pasteur's vaccine saved him and thus changed the history of medicine [4]. Young Pasteur's dream of preventing this terrible disease had come true. For this reason, World Zoonoses Day is celebrated every year on July 6, to commemorate the important scientific advancement represented by the first vaccination of a human against rabies.

Zoonoses Prevention Is Better Than Cure

Zoonotic diseases occur more frequently and are spreading all over the World. It does not serve the purpose to treat the symptoms of a patient without eliminating the causes of the illness at the same time, because we will then be treating the illness superficially and not addressing the root cause of the problem. In the same way, it is quite useless to develop more powerful medicines or sophisticated vaccines unless we reduce also the negative impact caused by our species on the other living beings. This can be done by stopping tropical deforestation and international wildlife trafficking, by reducing the use of medicines in animals' farms and by improving scientific research in wild and domestic animals' diseases. Trying to control zoonotic diseases after they have already spread to humans is very

expensive. Preventing them before they eventually spread from animals to humans is much cheaper than cure and more effective.

Prevention and Control

Although prevention and control strategies for the various zoonoses associated with wildlife share many common aspects, specific strategies are also needed to address the etiology and epidemiology of the disease, characteristics of the pathogen involved, ecologic factors, and the population at risk. As wildlife is an essential component in the epidemiology of many, if not most, zoonoses, wildlife should be taken into account in the risk analysis framework. Consequently, cost-effective prevention and control of zoonoses in humans, including risk communication, necessitate an interdisciplinary and holistic approach that acknowledges the importance of wildlife as a reservoir. To increase the capability of recognizing zoonoses with a wildlife reservoir, better national surveillance systems for humans and animals are needed, as well as better international integration and sharing of information from such systems. Which diseases should be reportable also needs to be evaluated on a continuous basis. Improved reporting systems and screening programs for human infections, including the application of syndromic surveillance, are warranted to detect new and emerging zoonoses. Efficient surveillance is dependent upon a laboratory system that is capable of identifying and characterizing the pathogens in question. More research is needed to better understand the epidemiology and pathogenesis of various zoonoses, to improve diagnostic methods, and to develop cost-effective vaccines and drugs. Training and education are prerequisites to enable the personnel involved at the various stages, from field to laboratory personnel, to detect zoonoses, both new and old. Information and communication are key components in any prevention and control strategy. Public education and behavioral change are also important factors for successful intervention. Implementing restrictions on anthropogenic animal movement is another important preventive measure. For vector-borne zoonoses, vector control should be an integral part of any intervention strategy. Interdisciplinary and international collaboration is necessary for the rapid identification and effective management of outbreaks of zoonoses. The pivotal role of international organizations such as World Health Organization and Office International des Epizooties is becoming clearer, exemplified by the 2004 avian influenza outbreak in Southeast Asia

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