Role of Wildlife in Emerging and Re-emerging Viral and Bacterial Zoonosis

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ABSTRACT

Zoonotic diseases highlight the interconnectedness of human, animal, and environmental health. Wildlife has historically served as a significant source of infectious illnesses that have the potential to infect humans. Wildlife account 71.8% of emerging and reemerging zoonosis. Wildlife trafficking and relocation, live animal and bushmeat markets, unusual food consumption, tourist development, access to petting zoos, and exotic pet ownership are the main factors in the emergence and reemergence of wildlife zoonosis. Along with these, anthropogenic activities and their impact on biodiversity, habitat destruction, changes in agricultural methods, and globalization of commercial activity are also major contributors of wildlife zoonosis. Although actual human-pathogen transmission is relatively rare, once it happens, human-to-human transmission can keep the infection going for short period of time or even permanently. Pathogens that exhibit this type of transmission include the Ebola virus, influenza A, severe acute respiratory syndrome, and the human immunodeficiency virus/acquired immune deficiency syndrome. However, some are transmitted via animal-to-human through direct contact or through a vector, which is the actual means of infection transmission to people. Pathogens such as rabies, lyssaviruses, Nipah virus, West Nile virus, Hantavirus, and the agents of Lyme borreliosis, plague, tularemia, leptospirosis, and ehrlichiosis are examples of pathogens having this pattern of transmission. Wildlife zoonosis have impose a substantial burden on healthcare systems, may cause extensive epidemics, and have a likelihood of developing into pandemics. Understanding the epidemiology and risk factors for zoonotic illnesses will assist in the development of effective preventative techniques such as monitoring, early diagnosis, rapid treatment, and vaccinations. This information is vital for taking early preventive measures to safeguard human populations, economic resources and reduce the effect of any possible future disease outbreaks.

Keywords: Wildlife, zoonosis, pathogenic agent, anthropogenic activities, one health, future perspective of zoonosis

CITATION

Zarif I, Riaz A, Yousaf A, Khan IA, Saba E, Hussain SM, Manzoor Z and Tahir AH, 2023. Role of Wildlife in Emerging and Re-emerging Viral and Bacterial Zoonosis. In: Aguilar-Marcelino L, Zafar MA, Abbas RZ and Khan A (eds), Zoonosis, Unique Scientific Publishers, Faisalabad, Pakistan, Vol 3: 240-254. https://doi.org/10.47278/book.zoon/2023.100

CHAPTER HISTORY Received: 04-April-2023 Revised: 17-May-2023 Accepted: 04-July-2023

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1. INTRODUCTION

Zoonotic diseases, also known as zoonosis, are infectious diseases caused by pathogens such as bacteria, viruses, fungi, or parasites that can be transmitted between animals and humans. Emerging zoonosis includes infectious diseases that have recently been identified and evolved, whereas reemerging zoonosis have previously occurred but have recently exhibited an increase in incidence or extension into a new geographic, host, or vector range (Bengis et al. 2004). There are approximately 1500 known human disease-causing agents, and 65-75% of them are associated with zoonotic organisms (Chhabra and Muraleedharan 2016).

Zoonotic diseases often serve as indicators of ecological disruptions and environmental changes. The occurrence of these diseases can reflect alterations in natural habitats, biodiversity loss, climate change impacts, and human activities such as deforestation or wildlife trade.

Zoonotic diseases highlight the interconnectedness of human, animal, and environmental health. They pose a significant burden on healthcare systems, can cause widespread outbreaks, and have the potential to lead to pandemics. Understanding the epidemiology and risk factors associated with zoonotic diseases helps in developing effective prevention strategies, including surveillance, early detection, rapid response, and vaccination programs (Maher et al. 2023). This knowledge is crucial for protecting human populations and minimizing the impact of future disease outbreaks as displayed in Fig. 1.

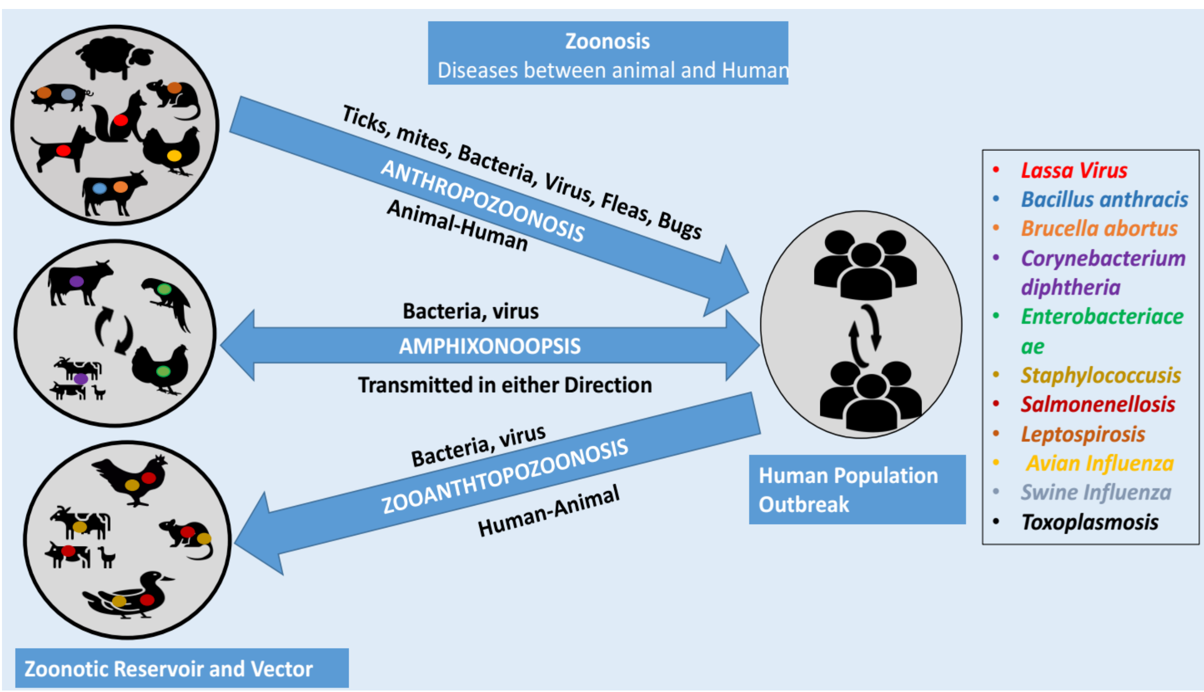

Fig. 1: Wildlife Zoonosis; Zoonosis is always a two-way process i.e., humans to animals and animals to humans, however some may be unidirectional. This figure is showing examples of pathogens (indicated with dots of various colors) along with their reservoir hosts and vectors.

2. Examples of Emerging and Reemerging Zoonotic Diseases

Emerging and re-emerging illnesses have far-reaching consequences not only for public health but also for socioeconomic challenges around the world. There are 132 emerging zoonotic illnesses among the 175 recognized emerging diseases. According to another analysis, zoonosis account for around 60.3% of new diseases. 71.8% of them were derived from wildlife (Jones et al. 2008; Rahman et al. 2020). Table 1 enlists the emerging and re-emerging zoonotic diseases.

Table 1: List of emerging and re-emerging zoonotic diseases

Emerging zoonotic diseases	Re-emerging zoonotic diseases
Ebola	Rabies
Feline Cowpox	Malaria
Avian Influenza	Dengue
West Nile Fever	Brucellosis
MRSA Infection	*Japanese Encephalitis*
Rotavirus Infection	*Schistosoma Japonica*
Hantavirus Infection	Tuberculosis (*M. Bovis*)
Canine Leptospirosis	
Coronavirus Disease 2019 (Covid-19)	
Severe Acute Respiratory Syndrome (SARS)	
Middle East Respiratory Syndrome (MERS)	
Bovine Spongiform Encephalopathy (BSE)	

3. HUMAN AND WILDLIFE COEXISTENCE

Wildlife is crucial for biodiversity, ecosystem services, scientific and medical research, cultural significance, economic benefits, and environmental health (Maher et al. 2023). It supports processes like pollination, seed dispersal, and nutrient cycling, provides essential services like carbon sequestration, water purification, and soil stabilization, and enhances our understanding of biology, behavior, and ecological processes. Wildlife also inspires art, literature, and spiritual beliefs, and generates economic benefits through ecotourism and conservation. Additionally, wildlife serves as an indicator of environmental health, helping us identify and address ecological issues (Burger et al. 2022).

4. HUMAN AND WILDLIFE CONFLICTS

Human-wildlife conflicts arise from competition or negative interactions between humans and wildlife, resulting in crop damage, livestock predation, human safety concerns, resource competition, disease transmission, and illegal wildlife trade (Pozo et al. 2021). These conflicts can lead to economic losses for farmers and herders, as well as human safety concerns. Wildlife also plays a crucial role in zoonotic disease emergence and reemergence, acting as reservoirs for disease transmission (Cupertino et al. 2020). Public health concerns arise from close contact with wildlife, bush meat consumption, or exposure to their habitats can increase the risk of disease transmission, leading to conflicts over public health concerns (van Vliet et al. 2022).

5. FACTOR CONTRIBUTING TO THE EMERGENCE AND REEMERGENCE OF ZOONOTIC DISEASES

The emergence and reemergence of zoonotic diseases can be attributed to various factors. Some of those factors are described as follows:

- Deforestation and animals' habitat destruction for the purpose of expanding agriculture, logging or urbanization has increased the contact between humans, domestic animals, and wildlife, thus, facilitating disease transmission (Goldstein et al. 2022).

- Wildlife trade, especially the illegal trade of exotic animals, can introduce unknown pathogens to humans (Hughes 2021).
- Intensive farming practices, such as factory farming create crowded and stressful conditions for animals, promoting disease spread (Marchese and Hovorka 2022).
- Climate change can alter the distribution and behavior of animals, insects, and vectors that carry diseases. It can also affect the survival and reproduction of pathogens, leading to changes in the prevalence and geographic range of zoonotic diseases (Bartlow et al. 2019).
- Changes in agricultural practices and global travel/trade also contribute to disease spread (Hughes 2021).
- Modifications to the microorganisms themselves or their host range (passing species barriers) also plays an important role in emergence and reemergence of zoonotic diseases (Rehman et al. 2020).
- Improved technological diagnostic and epidemiological methods that recently led to the discovery of a previously unknown or existing disease agent (Morse et al. 2012).
- Furthermore, both human and animal antibiotic abuse and misuse can contribute to the evolution of antibiotic-resistant microorganisms, making it more difficult to treat zoonotic diseases (Williams et al. 2002; Cutler et al. 2010).

6. WILDLIFE CONNECTION WITH ZOONOTIC DISEASES

History told us that human health has always been affected by zoonotic diseases and wildlife played a significant role in those illnesses (Cleaveland et al. 2007). The connection between wildlife and emerging and reemerging zoonotic diseases is increasingly being recognized. Following factors has been found to have an important role:

- Many of the wild animal species act as “reservoirs” for zoonosis, which make them capable of harboring virulent strains of disease without becoming ill themselves and thereby allowing contaminated particles to circulate for long periods before being detected in humans or domesticated animals (Aguirre 2017).
- The high degree of mobility associated with some wildlife species makes them efficient vectors/carriers for infectious agents –many wild birds migrate far distances across continents each year–potentially spreading transmission over large geographical areas quickly (especially if there has been recent contact with animal products like raw meat) (Akter et al. 2020).
- Changes in wildlife habitats caused by human activity have increased the contact between wild species and domestic animals, which has increased the likelihood of disease transmission from one species to another (and sometimes from one species to humans) (Thompson 2013).

7. ANTHROPOGENIC ACTIVITIES AND WILDLIFE ZOONOSIS

7.1. HUMAN Activity and Demographic Factors

Human activity and demographic factors impact the epidemiology of zoonosis having wildlife reservoirs. Activities like hiking, camping, and hunting increase the risk of tick-borne zoonosis and tularemia. Eating habits, such as consuming meat from unusual animals, such as bear, also increase the probability of developing trichinellosis (Gao et al. 1999).

7.2. GLOBAL WARMING

Global warming damage increases pathogen exchange between wild species and domesticated ones (like pigs), leading to public health threats like bird flu strains H7N9. This "pathogen bridge", which occurs from ducks to poultry farms, then subsequently reach local populations through direct consumption (Reperant et al. 2016).

7.3. MICROBIAL ALTERATIONS OR ADAPTABILITY

The epidemiology of zoonosis with a wildlife reservoir is also influenced by microbial alterations or adaptability. Mutations, such as genetic drift in viruses, gene activation and silencing, genetic recombination, conjugation, transformation, and transduction in bacteria are examples of these alterations (Bengis et al. 2004).

7.4. NATURAL SELECTION AND EVOLUTION

Natural selection and evolution are also key factors and there are numerous routes for adaptive or genetically changed microorganisms to get from wildlife to humans, either directly or indirectly through domestic animals. A worldwide wildlife trade, which is frequently illegal and involves the placement of wild animals in live-animal markets, restaurants, and farms, is crucial in this regard because these activities foster more compact relationships between wildlife, domestic animals, and people (Bell et al. 2004).

8. ROUTES OF TRANSMISSION

8.1. DIRECT TRANSMISSION

Zoonotic diseases can be transmitted from wildlife to humans through direct contact; the primary route of most infections, that involves direct handling of infected wildlife animals or their products for consumption. This includes activities like petting zoo visits, holding and feeding wild mammals, handling amphibians or reptiles, participating in hunting trips, slaughtering diseased animals found on game farms (i.e., fowl cholangio-hepaticosis) etc. Additionally, some virus particles may be resistant to cold temperatures, making it possible for them to remain viable at surfaces likely to cause human infection if they are previously exposed to another infected person. Francisella tularensis, the causative agent of tularemia, is one example of a zoonotic pathogen that can be directly transmitted from wildlife to humans through skin contact with an infected, sick, or dead hare or rodent. Rabies virus, on the other hand, is transmitted through a rabid animal's bite (saliva). Aerosols in dust from rodent excreta transfer Hantaviruses from rats to humans (Kruse et al. 2004).

8.2. INDIRECT TRANSMISSION

Indirect transmission route involves encountering materials that have become contaminated by these animal hosts - either directly due to open bleeding wounds while killing the animal host or externally due veterinary examination techniques (vaccination), medical procedures (needle prick injury during drawing blood sample) etc. Indirect disease transmission occurs also through vectors like ticks and mosquitoes, airborne exposure (e.g., inhalation of aerosolized particles containing zoonotic agents released by coughing or sneezing near an infected animal or human host), fecal-oral contamination, consumption contaminated water or food sources, injury due to bites or scratches from an infected animal/host species. For instance, mosquitoes are well-known carriers of several zoonotic diseases, such as Rift Valley sickness, equine encephalitis, and Japanese encephalitis. Fleas can transfer Yersinia pestis, flies can spread Bacillus anthracis spores, and sandflies can disseminate Leishmania, whilst ticks are vital in the spread of Borrelia burgdorferi and Ehrlichia/Anaplasma (Kruse et al. 2004).

Numerous elements, such as the host's susceptibility, potential transmission pathways, the number of microbes an animal sheds, the severity of infection, and the pathogenic agent's ability to cross species barriers, might affect the likelihood of transmitting and developing a zoonosis (Bengis et al. 2004).

Zoonotic diseases can be transmitted from the mother to fetus during gestation through transfusion or organ transplantation. Organ transplants can contain various agents, including encysted parasites and latent viruses, which can be reactivated in immunocompromised recipients. The bovine spongiform encephalopathy agent, for example, is normally transmitted solely through tissue ingestion; however, it can be acquired through transfused blood (Bengis et al. 2004). Various routes of transmission of zoonotic diseases are shown in Fig. 2.

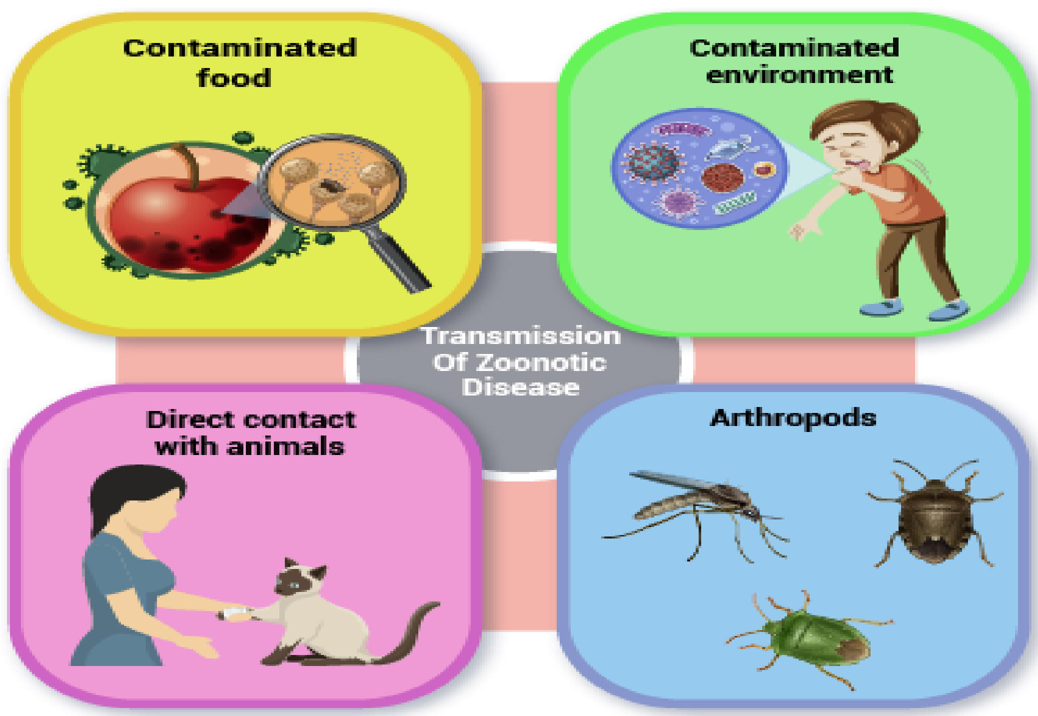

Fig 2: Various routes of zoonotic disease transmission

9. EXAMPLES OF WILDLIFE-TO HUMAN DISEASE TRANSMISSION (FROM PAST AND PRESENT

Zoonotic diseases have been a part of human history for thousands of years. Throughout history, zoonotic diseases have caused devastating epidemics. For example, the bubonic plague, often known as the Black Death, was caused by the bacteria *Yersinia pestis* and transmitted by fleas that infested rats. This 14th-century pandemic killed millions of people in Asia, Africa, and Europe. The outbreak, which began in the Far East, killed almost one-third of Europe's population. However, bubonic plague still exists throughout Asia, Africa, and the Americas, with the World Health Organization reporting 1,000-3,000 cases each year (Perry and Fetherston 1997).

According to ancient stories and current speculations, Alexander the Great died in Babylon in 323 BC of Encephalitis caused by the West Nile virus, a virus that inhabits wild birds. In 1999, the West Nile virus was introduced into the United States, resulting in a recurrent bird epidemic with infections expanding to humans and horses (Marr and Calisher 2003).

Lyme borreliosis, caused by *B. burgdorferi*, is a spirochete found in rodents and *Ixodes* species. Initially identified in 1975, the disease has spread globally. Reforestation in the northeastern US has increased disease transmission through white-tailed deer and deer mice, and the abundance of *Ixodes scapularis* tick vector (Barbour and Fish 1993).

Another zoonosis influenced by both natural and manmade animal migration is bovine tuberculosis caused by *Mycobacterium bovis*. During the colonial era, imported cattle are most likely initially brought bovine tuberculosis to Africa, where it later expanded to and became endemic in animals. (Cosivi et al. 1995).

Human tickborne ehrlichiosis has been recognized and spread recently, commencing with human monocytic ehrlichiosis and human *Granulocytic ehrlichiosis*, which were initially documented in the United States in 1987 and 1994, respectively. The pathogens, *Ehrlichia chaffeensis* and *Anaplasma phagocytophilum*, are intracellular bacteria that survive in zoonotic cycles involving sick deer and rats (Dumler and Walker 2001).

In 1999, *E. multilocularis* was found for the first time in Norway. Due to the parasite's primary host, the Arctic fox, which is naturally mobile, the parasite most likely originated in Russia. Moreover, the sibling vole, the intermediary host, had previously been transported to Norway, probably via imported animal feed. The parasite was able to establish itself. *E. multilocularis* was discovered in a traffic-killed red fox in Copenhagen, Denmark, in 2000. According to the notion, the fox traveled by rail from Central Europe, where infectious disease become prevalent.

A poxvirus that is largely found in Africa is the source of the uncommon zoonosis known as monkeypox. It spreads to rodents and was initially identified in 1958 in monkeys; the African squirrel is its natural host (Reed et al. 2003). In 2003, the virus was introduced to prairie dogs in the US by imported African mice from Ghana and the outcome was an outbreak in the USA resulted in 37 confirmed human cases. By introducing a disease into native animal and human populations, this spread is an example of how non-native animal species can seriously harm public health. Consequently, the likelihood of zoonosis spreading can be increased by animal transportation, commerce, or distribution and by releasing animals into the environment **(**Kruse et al. 2004).

Three zoonotic paramyxoviruses, Hendra, Menangle, and Nipah, were discovered between 1994 and 2004 in wildlife. These viruses have a fruit bat reservoir and can cause human infection when close contact with diseased pigs or horses. Infection with the hendra virus in Australia in1994 led to lethal respiratory illness in horses and humans. The Menangle virus caused influenza-like illness and reproductive issues in pigs in 1996 in Australia, while the Nipah virus in 1998 in Malaysia caused encephalitis in Malaysia, killing 40% of humans and causing severe illness in pigs (Brown 2003).

The present-day example of potential microbial transformation is severe acute respiratory syndrome (SARS). This viral respiratory infection, caused by SARS-associated coronavirus, is thought to have first appeared in November 2002 in Guangdong, China. SARS was initially identified in Asia in February 2003, and the virus quickly expanded to a global epidemic before being halted. Although the reservoir of the virus is unknown, wildlife is a likely source of infection. Animals local to the region where SARS is assumed to have originated, including raccoon dogs, rats, and palm civet cats, have shown signs of natural infection (Guan et al. 2003).

Table 2: Specific Zoonotic Diseases Associated with Wild life Species.

Sr. No	Disease	Reservoir	Agent	Transmission/Vector	Complications	Distribution	Mortality Rate	References
				Viral Agent				
1.	SARS-Cov-1	Bats	SARS-coronavirus	Aerosol dissemination	Respiratory track	Worldwide	9.6%	(Wang and Crameri, 2014)
2.	SARS-CoV-2	Bats	SARS-coronavirus	Aerosol dissemination	Respiratory and intestinal infection	Worldwide	2%	(Wang and Crameri, 2014)
3.	MERS	Camel	MERS-Coronavirus	Aerosol dissemination	Pneumonia	Middle East, Saudi Arabia, worldwide	34%	(Wang and Crameri 2014),
4.	Dengue Fever	Monkey	Dengue Virus	Bites of *Aedes aegypti*	Internal Bleeding, Organ Damage	Africa, Southeast Asia, America, Caribbean, Pacific	<1-20%	(Kularatne 2015).
5.	Highly Pathogenic Avian Influenza (H5N1)	Birds	Influenza viruses	Direct contact with feces, saliva, or mucosa of infected bird	Respiratory track	China, Hong Kong Europe, Africa, China, Russia, Kazakhstan	50%	(Van Kerkhove et al., 2011)
6.	Swine Flu Influenza (H1N1)	Swine	Swine Flu Influenza virus	Aerosol dissemination	Respiratory track	Uk, Mexico	0.001%-0.007%	(Klemm et al. 2016)
7.	Ebola Hemorrhagic Fever	Bats/Apes and Monkey	Ebola virus	Direct contact	multiple organ systems of the body are affected+ extensive internal breeding	Democratic Republic of Congo, Sudan, Uganda, Gabon	50%	(Wang and Crameri 2014)
8.	Hantavirus p Pulmonary Syndrome	Rodents	Hanta virus	Contact with rodent's. Feces	Hemorrhagic Fever Renal syndrome (HFRS)	America, Asia, Europe	38%	(Wang and Crameri, 2014)

9.	Zika Fever	Monkey	Zika virus	Bite of *Aedes* mosquito hemotransfusion, organ transfusion, sexual contact, vertical transmission	Microcephaly, congenital malformations, Guillain-Barre syndrome, neuropathy, myelitis	Africa, America, Southern Asia, Western Pacific	>50%	(Wang, et al. 2016).
10.	Nipah Virus Diseases	Pigs, Bats	Paramyxo-virus	Direct contact or consuming contaminated food products	neurological disorder Systemic vasculitis, thrombosis and parenchymal necrosis	Malaysia, Singapore, India, Bangladesh	40-75%	(Wang and Crameri 2014)
11.	Rabies	Raccoons, Skunks, Bat, Foxes	Lyssa viruses	Direct contact (skin, mucous. tissues)/bite of rabid animal	Cerebral Dysfunction, anxiety, agitation	All Continents Except Antarctica	100%	(Wang et al. 2016).
12.	Rift Vally Fever	Cattle, Buffalo, Sheep Goat, Camel	Rift Valley Fever Virus	Direct contact or bite of infected mosquitos	Inflammation of retina	African Madagascar, Saudi Arabia, Yemen	1-10% Vision loss	(Jelinek, 2016).
13.	Japanese Encephalitis	Pigs And Water Birds	Japanese encephalitis virus	Bite of *Culex tritaenniorhynchus*	Encephalitis syndrome	Asia. North And South Korea, Japan	20-30%	(Gerdes, 2004).
				Bacterial Agent				
1.	Septicemia Plague	Rodents	*Yersinia pestis*	Flea Bites or via skin Lesion	Gangrene and organ Failure	Hong Kong Africa, Asia, South America	40%	(Higgins 2004)
2.	Pneumonic Plague	Rodents. Rabbits, And Large Animal	*Yersinia pestis*	Aerosol Dissemination	Lung infection	Manchuria, Congo, Madagascar, Peru	100%	(Higgin, 2004)
3.	Bubonic Plague (Black death)	Rodents	*Yersinia pestis*	Flea bites	Infect Lymph nodes	Europe Africa, Asia, South America	30-60%	(Higgins 2004)
4.	Leptospirosis	Rodents, Dogs	*Leptosporria interogance*	Direct Contact with infected animal feces/or contaminated soil or water.	Weil's syndrome	Germany, Cosmopolitan Distribution (Tropical and Subtropical Climate)	5-15%	(Ellis 2015)
5.	Anthrax	Cattle, Sheep, Goats, Horses and Swine.	*Bacillus anthracis*	Inhaling /ingesting food contaminated with spores	Cutaneous, gastrointestinal and respiratory tract infection, meningoencephalitis	Asia, Europe, Africa, Australia.	20-50%	(Doron and Gorbach 2008).

6.	Campylo-bacteriosis	Poultry, Cattle, Pigs, Sheep, Cats, Dogs	*Campylobacter* spp.	International travel, eating uncooked/raw meat, dinking unpasteurized milk, etc.	Arthritis, Reiter's Syndrome, Conjunctivitis	Worldwide	<1%or rarely	(Doron and Gorbach, 2008).
7.	Cowpox	Rodents, Cats	Orthropox virus	Direct contact with infected animal	Keratitis, Corneal Erosion	Europe, Russia	1-3%	(Vorou et al. 2008)
8.	Q Fever	Goat, Cattle, Sheep	*Coxiella burnetii*	Contact with urine, blood, milk of infected animal	Organ dysfunctioning, Aortic aneurism, spondylitis	Worldwide Distribution Except New Zealand	1-2%	(Doron and Gorbach 2008).
9.	Tularemia (Rabbit fever)	Hares, Rodents,Ticks	*Francisella tularensis*	Hunting, skinning infected rabbits, ingestion of contaminated food/water	Meningitis, endocarditis, hepatitis	Europe, Asia	30-60%	(Gilland and Cunha 1997)
				Parasitic Agent				
1.	Malaria	Monkey	Plasmodium	Bite of female Anopheles mosquito	Acidosis, hypoglycemia	Worldwide	0.05-0.0-8%	(Youssef and Uga 2014)
2.	Toxoplasmosis	Cats, Beef, Lamb or Pork	*Toxoplasma gondii*	Ingestion of oocytes from soil, water, milk, or vegetables	encephalitis or retinochoroiditis	All Continents Except South America	35%	(Youssef and Uga 2014)
3.	Chagas Disease	Dogs, Cats and Opossum	*Trypanosoma cruzi*	Triatomine bugs	Sleeping sickness	Africa, America and Asia	5-10%	(Rassi and Marin-Neto 2010)
4.	Taeniasis and Cysticerosis	Beef, Pork, Pigs	*Taenia solium*	Direct contact/ ingesting contaminated food/water	Intestinal infection, tissue infection	Africa, Asia, Latin America	1.4%	(Youssef and Uga 2014)
5.	Alveolar Echinococcossis	Sheep, Cattle, Camel, Pig, Moose, Rodents, Dogs	Echinococcus spp.	Ingesting/ Inhaling contaminated food/ water	Rupturing of peritoneal cavity and pleural cavity	Worldwide	50-75%	(Kern 2010)
6.	Fascioliasis	Horses, Pigs	*Fasciola hepatica, F. gigantica*	Drinking contaminated water	Infection of bile duct and liver	America, Asia, Africa	Seldom fatal	(Mas-Coma et al. 2014)
				Fungal Agent				

1.	Sporotrichosis	Cats,	Sporothrix	Cutaneous skin infection/direct contact with spores	Respiratory tract infection, arthritis, Nervous system infection	South America, Asia, Europe	40%	(Mahajan 2014)
2.	Dermatophytosis	Cats, Dogs Cows, Horses	Dermatophytes	Inhalation, direct contact with infected animal	Hair loss, scaring	Worldwide	7.9%	(Mahajan 2014)
				Prion				
3.	Creutzfeldt-Jakob disease (CJD)/ Bovine Spongiform Encephalopathy	Cattle	Prion	Consuming contaminated beef	Fatal neurodegenerative disease	United Kingdom	100%	(Iwasaki 2017)

The era of exploration and trade in the 15th to 18th centuries facilitated the global spread of zoonotic diseases. European explorers and colonizers unknowingly introduced diseases like smallpox, measles, and influenza to indigenous populations in the Americas, resulting in devastating consequences (Kruse et al. 2004).

10. ZOONOSIS CLASSIFICATION

Numerous microorganisms can cause zoonotic illnesses. Zoonosis is divided into bacterial, viral, parasitic, fungal, and protozoa zoonosis types based on the etiology (Schaechter 2009). The primary zoonotic illnesses are included in Table 2, together with information about their etiological agents, animal hosts, key symptoms, geographic distribution, and fatality rates.

11. IMPACT OF ZOONOSIS ON HUMAN AND ANIMAL HEALTH

Zoonosis significantly impact human and animal health. They negatively affect human livelihoods and well-being, particularly in developing countries. Individuals may face obstacles in work performance and family support, and may become isolated, increasing their vulnerability to mental health issues. Similarly, Zoonotic diseases cause animal deaths, leading to significant economic losses in the livestock sector. This can negatively impact animal health and productivity, leading to a 70% drop in livestock products (Hashem et al. 2020).

Zoonotic diseases that impact animal goods and byproducts, such as BSE, avian influenza, and anthrax, cause disruptions in global trade and the economy. Zoonotic epidemics had an overall economic impact of more than 120 billion USD between 1995 and 2008 (Bernstein et al. 2022). The value of Australia's livestock decreased by 16% because of epidemics affecting sheep and cattle (Ijaz et al. 2021).

The SARS outbreak severely affected the global economy, including the tourism sector. Singapore, China, Hong Kong, and Taiwan experienced severe economic effects. Mexico, India, Chile, and the European

Union also suffered economic losses because of restricted tourism and poultry export markets (Rahman et al. 2020).

12. CONTROL OF WILDLIFE ZOONOSIS

Surveillance is crucial for the purpose of preventing and controlling zoonotic illnesses, early infection detection, identifying infected individuals and animals, reservoirs, vectors, and endemic areas. It aids in the proper management of disease, the improvement of human health, and the reduction of morbidity and death. Controlling zoonosis requires integrated monitoring systems strategies at the local, provincial, national, and global levels. In order to perform surveillance effectively, it is necessary to have sufficient diagnostic resources, competent labor, and financing (Giessen et al. 2010).

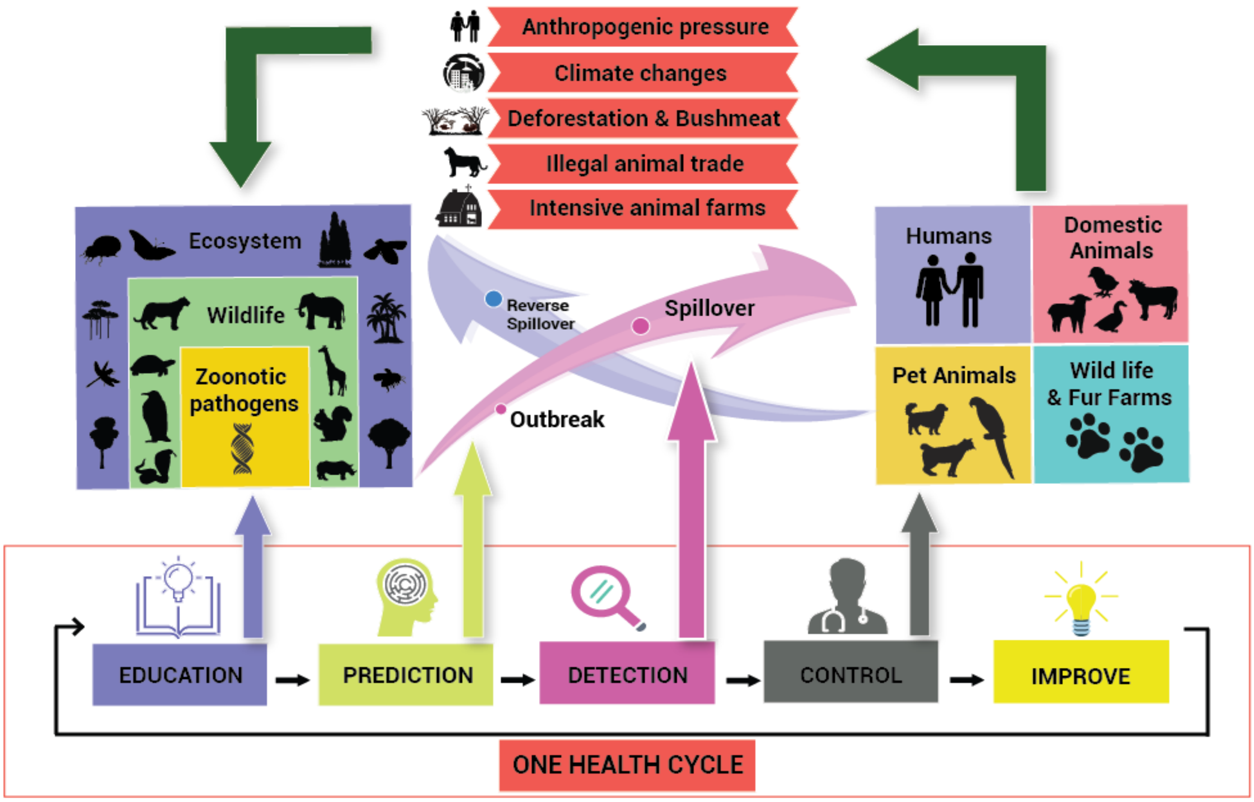

Fig. 3: Control of Wild Zoonosis and One Health.

Zoonosis can also be controlled through general principles of disease control like treating sick people, immunizing healthy people and animals, limiting animal movement, managing animal populations, performing tests, and culling (selective slaughtering). Pest and vector control are also necessary for several parasitic and bacterial zoonoses that are transmitted by insects including ticks, lice, and mosquitoes. Successful vector control strategies should employ physical, biological, and/or mechanical techniques, such as integrated pest management and integrated vector management systems (Rahman et al. 2020).

Further zoonosis management measures include the adoption of rules and regulations governing isolation and quarantine, the development of reliable disease reporting (notification) systems, agricultural biosecurity, mass immunization, test and slaughter, public awareness, and health education. Public awareness of zoonosis can be increased through the use of mass media, electronic information systems, social networking sites, text messages, and other forms of communication (Artois et al. 2011). Fig. 3 illustrates various causes of wildlife zoonosis and ways to control them.

13. ZOONOSIS AND ONE HEALTH

The "One Health Approach" was established to adequately address global health concerns, and it has widespread consequences on poverty, food security, and health security, mostly in poor nations, through zoonosis prevention and control. It is essential in combating newly emerging and re-emerging zoonoses, managing the effects of zoonotic diseases on people, animals, and the environment, and eliminating threats from zoonotic diseases (Rahman et al. 2020).

14. CONCLUSION

A significant number of human infectious diseases are derived from animals, posing a substantial threat to human health. Changes in food trend, climatic pattern, and environmentally unfriendly human operations all have a direct effect on the emergence and reemergence of zoonotic illnesses. The COVID-19 pandemic illustrates the human population's vulnerability to zoonosis. Prioritizing research on one health approach is vital for identifying urgent preventative steps and implementing strong active monitoring for zoonosis detection and management.

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