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Zoonotic diseases and its control: A review

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Abstract
The majority of people interact with animals on some level. Any disease or infection that can spread spontaneously from vertebrate animals to humans or from humans to vertebrate animals is referred to be a zoonotic disease. The origin of more than 60% of human infections is zoonotic. This covers a wide range of pathogens, including as bacteria, viruses, fungus, protozoa, parasites, and others. The emergence, re-emergence, distribution, and patterns of zoonoses have been significantly influenced by a number of causes, including climate change, urbanisation, animal movement and travel and tourism, vector biology, anthropogenic influences, and natural factors. More zoonotic diseases are developing and redeveloping throughout time. In this overview, we looked at the causes of the main zoonotic diseases, how they affect human health, and management strategies. COVID-19, a recently discovered zoonotic diseases that is most likely bat-borne and has had terrible effects on millions of people worldwide. One Health initiatives should be put into place for the efficient prevention and management of potential zoonosis.

Keywords: Zoonoses, WHO, classification, rabies, tuberculosis, glanders, anthrax

1. Introduction
The genesis and spread of several infectious diseases are significantly influenced by humans, animals, and the environment (Thompson A & Kutz S., 2019) [62]. The majority of contagious diseases that affect people have animal origins. Around 60% of newly emerging human infections are zoonotic in nature, and more than 70% of these pathogens come from wildlife species, according to the "Asia Pacific strategy for emerging diseases: 2010" report [67]. Recent decades have seen a rise in human diseases that have an animal origin and are directly linked to meals containing animal products (Slingenbergh J, 2013) [58]. Greek words "Zoon", which means animal, and "nosos", which denotes illness, are combined to form the word "zoonoses". The World Health Organization (WHO) defines a zoonosis as any illness or infection that is naturally transferrable from vertebrate animals to humans or from humans to animals [69]. Approximately 61 percent of human diseases are zoonotic in origin (Taylor LH *et al*., 2001) [61]. Zoonoses is a serious threat to human health and a direct risk that could potentially be fatal. The 13 most widespread zoonoses have had a significant influence on human health as well as caused an estimated 2.4 billion cases of disease and 2.7 million human deaths annually (Grace D *et al*., 2012) [23]. They have had the greatest impact on poor livestock workers in low- and middle-income nations worldwide. The majority of these diseases have an impact on animal health and reduce cattle productivity (Grace D *et al*., 2012) [23].

2. Classification of zoonoses
Numerous microorganisms can cause zoonotic diseases. Based on the aetiology, zoonoses are divided into bacterial, viral, parasitic, fungal and microbial zoonoses. Bacterial zoonoses include anthrax, salmonellosis, tuberculosis, Lyme disease, brucellosis, and plague. Viral zoonoses include rabies, acquired immune deficiency. The primary zoonotic diseases are included in Table 1 along with their etiological agents, animal hosts, and key symptoms.

Table 1: The most common zoonotic diseases, along with their hosts, etiological agents and key symptoms in humans

Disease	Etiology	Animal Host	Major Symptoms, System or Organs Involved
Bacterial zoonoses			
Tuberculosis	*Mycobacterium bovis*, *Mycobacterium caprae*, *Mycobacterium avium*	Cattle, pig, dog, horse, sheep, deer, camels and bison	Lungs, bone marrow, Respiratory system
Pasteurellosis	*Pasteurella multocida*	Poultry, pigs, buffaloes, cattle, goats, sheep, deer, cats and dogs	Fever, diarrhea, vomiting, and gangrene
Glanders	*Burkholderia mallei*	Horses, mules and donkeys	Fever, muscle aches, chest pain, sweating, headache, and muscle tightness
Brucellosis	*Brucella abortus* *Brucella melitensis*, *Brucella suis*, *Brucella canis*, *Brucella ovis*	Cattle, dogs, pigs, goats and sheep	Fever, joint pain, poor appetite, retention foetal membranes, abortion and weight loss
Anthrax	*Bacillus anthracis*	Cattle, sheep, horses, pigs, dogs, elephant, tiger and goats	Sudden death, haemorrhagic discharge, skin, respiratory system, or Gastro-Intestinal tract
Leprosy	*Mycobacterium leprae*	Monkeys, mice, rats and cats	Skin lesions
Leptospirosis	*Leptospira interrogans*	Wild and domestic animals including pet dogs	Fever, jaundice, red eye and abdominal pain
Lyme disease	Borrelia burgdorferi	Dogs, cats, and horses	Fever, skin rash, erythema, headache and migrans
Campylobacter enteritis	*Campylobacter jejuni*, *Campylobacter coli*	Cattle, turkeys, chickens, sheep, cats, mink, ferrets dogs, and pigs	Enteric lesion
Salmonellosis	*Salmonella enterica*, *Salmonella bongor*	Domestic birds & animals, dogs	Enteritis, weakness
Corynebacterium ulcerans and Corynebacterium pseudotuberculosis infections	*Corynobacterium ulcerans*, *Corynobacterium pseudotuberculosis*	Cattle, cats and dogs	Diphtheric lesion
Campylobacter fetus infection	*Campylobacter fetus* subsp. fetus, *Campylobacter fetus* subsp. Testudinum	Sheep, cattle and goats	Enteric lesion
Actinomycosis	*Actinomyces bovis*	Cattle, pigs, horses, dogs, sheep and other mammals	Abscess, soft tissues, skin and swelling of lymph nodes
Ehrlichiosis	*Anaplasma phagocytophilum*, *Ehrlichia ewingii*, *Ehrlichia chaeensis*, *Ehrlichia canis*,	Dogs, cattle, sheep, deer and cats	Fever, fatigue, headache, occasionally rash and muscle aches
Enterohemorrhagic Escherichia coli infections	*E. coli* O157:H7	Cattle, dogs, poultry, deer, sheep, and pigs	Hemolytic–uremic syndrome (HUS) & Enteritis
Viral zoonoses			
AIDS	HIV Genus-Lentivirus Family-Retroviridae	Monkeys, apes and chimpanzees	Immunosuppression, swollen lymph nodes, fever, chills, rash, night sweats, muscle aches, fatigue, weakness, influenza-like symptoms
Zika fever	Zika virus Genus-Flavivirus Family-Flaviviridae	Monkeys, apes	Conjunctivitis, fever, back pain
Severe acute respiratory syndrome (SARS)	SARS coronavirus (SARS-CoV) Genus-Coronavirus Family-Coronaviridae	Bats, ferrets, dogs tigers and cats	symptoms like influenza, fever, muscle pain, severe cases progress to a pneumonia and respiratory system
Chikungunya fever	Chikungunya virus Genus-Alphavirus Family-Togaviridae	Rodents, Monkeys and birds	High fever, muscle pain, severe joint pain and skin rash
Newcastle disease	Paramyxovirus, Genus-Avulavirus Family-Paramyxoviridae	Wild birds and poultry	Eye
Dengue fever	Dengue virus Genus-Flavivirus Family-Flaviviridae	Monkeys	Skin hemorrhage, high fever, skin rash and shock
Rabies	Rabies virus, Genus-Lyssavirus Family-Rhabdoviridae	Cattle, monkeys, dogs, bats, horses, wolves, cats and rabbits	Nervous sign
Monkey pox	Monkey pox virus Genus-Orthopoxvirus Family-Poxviridae	Monkeys, squirrels	Pox lesions on skin fever,
Avian influenza	Influenza A virus Genus-Alphainfluenzavirus	Wild birds, Ducks, turkeys, chickens, cats, pigs, horses and	symptoms like flu, pneumonia, diarrhea, Respiratory system

	Family-Orthomyxoviridae	dogs	
Parasitic zoonoses			
Fascioliasis	*Fasciola hepatica, Fasciola gigantica*	Ruminants	Swollen liver, extreme abdominal pain, Intense internal bleeding, fever, nausea, skin rashes
Hydatidosis	*Echinococcus granulosus*	Adult stray dog or shepherd dogs, buffaloes, cattle, sheep, goats	Hydatid cysts in lungs, liver, kidneys, bones, spleen, respiratory problem, and abdominal pain
Cryptosporidiosis	*Cryptosporidium parvum*	Sheep, cattle, pigs, goats, horses	3-14 days diarrhea. malaise are frequent, nausea, abdominal pain
Cryptococcosis	*Cryptococcus neoformans*	Wild animals, dogs, cattle, goats, sheep, birds and horses	Respiratory dystress, fever, vomiting and nausea
Fungal zoonoses			
Aspergillosis	*Aspergillus* spp.	Birds and all domestic animals	Respiratory system
Cryptococcosis	*Cryptococcus neoformis*	Wild animals, cats, dogs	Seizures, meningitis, neck stiffness, fever, cough, photophobia, nausea, malaise, headache and vomiting
Blastomycosis	*Blastomyces dermatitidis*	Mainly dogs, cats, and rarely in horses, deer, wolves, African lions	Pneumonia, Fever, malaise, subacute meningitis, skin lesions, abnormal gait and seizures
Coccidioidomycosis	*Coccidioides immitis, Coccidioides posadasii*	Ruminants, dogs, mule, swine	Pleuritic chest pain, hypersensitivity reaction, fever and dry cough
Protozoal zoonoses			
Trypanosomiasis	*Trypanosoma brucei*	Camels, cattle, and horses	Hepatosplenomegaly, lymphadenopathy, chronic and intermittent fever, pruritus, and sleep disturbance headache,
Leishmaniasis	*Leishmania infantum*	Dogs, cats, horses, bats	Hepatosplenomegaly Skin lesions and wasting
African sleeping sickness	*Trypanosoma brucei*	Horses, antelopes, camels, cattle	Erythematous plaque formation, High fever, headache, nausea, vomiting
Toxoplasmosis	*Toxoplasma gondii*	Sheep, pigs, goats, poultry and rabbits	Sore throat, fever, Lymphadenopathy, myalgia, malaise, night sweats and maculopapular rash
Chagas disease	*Trypanosoma cruzi*	Wildlife reservoirs include opossums, armadillos, raccoons, and domestic pigs and cats	Severe myocarditis, swelling or redness of skin, meningoencephalitis,
Toxocariasis	*Toxocara canis*	Dogs	Hepatosplenomegaly, Fever, rash, anorexia, asthma, pneumonitis and visual impairment
Giardiasis	*Giardia lamblia*	Cats, dogs and pigs ruminants	Abdominal cramping, bloating, diarrhea, flatulence, anorexia, nausea and malaise

The words anthropozoonoses, zooanthroponoses, amphixenoses and euzoonoses are part of the earlier taxonomy of zoonoses (Hubálek Z 2003) [28]. Animal diseases called anthropozoonoses, like rabies, can infect humans. Zooanthroponoses is the term used to describe diseases that people spread to animals, such as the tuberculosis that affects cats and monkeys. Amphizoonoses, like staphylococcal infection, are infections that can spread in any direction (from human to animal and from animal to human). Humans serve as the required host for various parasite infections. These parasitic diseases are referred to as euzoonoses and include infections with *Taenia solium* and *Taenia saginata*.

Gram-positive and Gram-negative bacteria can both cause zoonoses. Most zoonotic diseases have bacterial etiologies. According to a study, 42 percent of zoonotic pathogens with bovine origins are bacterial, 22 percent are viral, 29 percent are parasitic, 5 percent are fungal, and 2 percent are prion (McDaniel CJ *et al*., 2014) [38]. Similar to this, it is known that both DNA and RNA viruses can cause zoonoses; however, RNA viruses are more frequently associated with zoonoses than DNA (Bae SE & Son HS, 2011) [4].

Animals can either directly or indirectly transfer pathogens to humans. Direct zoonoses are diseases that spread from animals to people through a medium like the air (Mortimer PP, 2019) [45]. The viral illness known as avian influenza, which spreads from birds to people via droplets or fomites, is a classic example of a direct zoonose. One of the worst zoonotic disease is rabies, that can be transmitted directly from infected animals to susceptible humans through bites. It is a Rhabdoviridae-related rabies virus. The virus enters the human body through saliva when a rabid animal (such as a dog, bat, monkey, skunk, raccoon, or fox) bites a person. Similarly, vectors can spread infections to people (Dengue fever). Although arthropods like mosquitoes and ticks are sometimes worked as the vectors, any animal that has the capacity to spread infections to people can be regarded as a vector (Huang YJS *et al*., 2019) [27].

Zoonotic diseases can be divided into a number of groups according to the habitat in which they are spread. Zoonoses can be divided into exoanthropic and synanthropic types. Urban rabies and zoonotic ringworm are two examples of synanthropic zoonoses that have a domestic (urban) cycle in domestic and synanthropic animals. Exoanthropic zoonoses, such as arboviroses, wildlife rabies, and Lyme disease, typically have a sylvatic (feral and wild) cycle in natural foci away from human areas (Pavlovsky EN 1966) [51]. However, several zoonoses, including yellow fever, Chagas disease, and dengue fever, can circulate in both urban and natural cycles. There are also several more zoonotic diseases that can be spread by arthropods, food, rodents, and some watery diseases (Beaty BJ & Marquardt WC, 1996) [7].

Sapronoses are diseases brought on by zoonotic pathogens that can reproduce in and survive on dead organic materials like saprophytes. Sapronoses include bacterial diseases like legionellosis (a serious type of pneumonia or lung infection caused by Legionella bacteria) and fungal diseases such coccidioidomycosis, histoplasmosis, and aspergillosis (Somov GP & Litvin VJ 1988) [59]. According to the WHO expert

committee on zoonoses, "saprozoonoses" are described as infections that have both a vertebrate host and a non-animal reservoir or developmental site (soil, plants and organic matter) (Schwabe CW, 1964) [57]. As in human taeniasis, disease transmission frequently requires the more than one vertebrate hosts. These type of zonoses is known as cyclozoooses. Metazoonoses, are zoonoses that involve both vertebrate and invertebrate hosts, like arbovirus infection.

The majority of zoonotic diseases are spread from animals to people. According to certain reports (Olayemi A *et al*., 2020; Cerdà-Cuéllar M *et al*., 2019; Adesokan HK *et al*., 2019; Messenger AM *et al*., 2014) [49, 11, 1, 40] people can also infect animals. These diseases are referred to as reverse zoonoses. MRSA (methicillin-resistant *Staphylococcus aureus*), *Campylobacter* species, *Salmonella enterica* serovar Typhimurium, influenza A virus, *Cryptosporidium parvum*, *Ascaris lumbricoides*, and *Giardia duodenalis* are a few examples of such infections. In addition, reverse zoonoses are diseases caused by microorganisms that infrequently spread from people to animals before returning from animals to humans.

3. Zoonoses of domestic animals

Domestic animals sometimes act as amplifying agents for infections that emerge from wild animals, which has a considerable impact on the transmission of many diseases to people (Morand S *et al*., 2014) [43]. Long ago, it was initially suggested that domestic animals and people have a positive impact on pathogen diversity (McNeill WH 1976) [39]. Human infectious diseases are transmitted by vertebrate animals in about 60% of cases (Klous G *et al*., 2016; Taylor LH *et al*., 2001) [35,61]. The domestication of various vertebrate animals has increased direct human contact with animals (Pearce-Duvet JM, 2006) [52]. Zoonotic bacteria, viruses, parasites, or fungus can spread through direct contact, ingestion, inhalation, conjunctival contact and biting (Klous G *et al*., 2016) [35].

Domesticated animals such as pigs, dogs, cats, horses, and cattle serve as reservoirs for the viruses that cause domestic zoonoses and can spread those diseases to people (Samad MA, 2011) [56]. Pathogens can spread by direct contact or eating foods made from animals. Anthrax, rabies, tuberculosis, brucellosis, campylobacteriosis, leptospirosis, toxoplasmosis, balantidiasis, ancylostomiasis, toxocariasis, listeriosis, bovine pustular stomatitis, rotavirus infection and Q fever are a few examples of zoonotic diseases that can be transmitted to humans from domestic animals.

Anthrax caused by *Bacillus anthracis* is one of these zoonotic diseases spread by domestic animals that has a considerable impact on public health. *Bacillus anthracis* is a spore-producing soil-borne bacterium that has the potential to last a very long time in the environment. Close contact with infected animals (such as cattle and goats) or their products can result in the transmission of anthrax to humans (such as meat, skin, hides, or even bones). (Goel AK, 2015) [22]. There is a very small chance of transmission from human to human. Annually 2,000-20,000 people are affected by anthrax around the world (Goel AK, 2015) [22]. Affected individuals have occasionally come from India, Pakistan, Bangladesh, Iran, Iraq, South Africa, Turkey, The United States and Zimbabwe (Goel AK, 2015) [22]. In contrast, sudden death with certain systemic lesions can happen in animals. In human, it might result in malignant pustule, gastroenteritis and pneumonitis. In cases of intestinal anthrax, mortality can range from 25 to 65 percent, whereas in cases of pulmonary anthrax, it can reach 100 percent (Kamal SM, 2011) [32]. The dangers of anthrax are still being felt in developing nations, where agriculture typically makes up the majority of their economies.

Tuberculosis is the most significant zoonotic disease among bovine zoonoses that have substantial public health implications. Significant financial losses in the animal production industry have been attributed to the disease. *Mycobacterium bovis*, *Mycobacterium tuberculosis* are the culprits (Bayraktar B *et al*., 2011; Bayraktar B *et al*., 2011; Torgerson PR & Torgerson DJ, 2010) [5, 6, 63]. It is an acid-fast soil saprophyte, the presence of mycolic acid in their cell walls distinguishes *Mycobacterium*. Even though bovine tuberculosis has mostly been eradicated in developed nations but still other regions of the world are facing major zoonotic impacts. AIDS is the leading cause of death, and human tuberculosis comes close behind. After AIDS, human tuberculosis ranks as the second most common cause of mortality. *Mycobacterium bovis* is responsible for 5–10% of all human tuberculosis cases (25 percent of the patients were children). The extra-pulmonary tract was found to be the favourable site for tuberculosis in about 53% of all cases (Samad MA, 2011) [56]. The majority of tuberculosis cases in humans are caused by coughing of infected animals or by handling or milking unpasteurized contaminated milk or by aerosols (Moda G *el al*., 1996) [42]. Additionally, *Mycobacterium bovis* infection can also affect human urogenital systems, and it can affect animals by functioning as a reverse zoonose through human respiratory secretions (Ocepek M *et al*., 2005) [48]. Direct contact between diseased animals and human, such as farmers, vets, butchers, or villagers, can pose significantly risk.

One of the most prevalent bacterial zoonotic disease is brucellosis, it affects about 500,000 people annually worldwide (Hull NC & Schumaker BA, 2018) [29]. According to the WHO [66], the disease is categorised as a forgotten neglected zoonosis. Out of twelve species of the genus Brucella only four species such as *Brucella melitensis*, *Brucella abortus*, *Brucella suis* and *Brucella canis* are zoonotic in nature. Although human-human transmission of brucellosis is uncommon, the most prevalent method of transmission for humans is through the intake of unpasteurized milk or milk products. There have also been reports of transmission through aerosol inhalation and contact with secretions (Corbel MJ *et al*., 2006) [15]. Infections that resemble the flu, pneumonia and other consequences like meningitis, endocarditis, septicemia, severe weakness, pain in the muscles and joints, excruciating headaches, fever, and night sweats are the most common effects of brucellosis in human. Animals with brucellosis develop abortions, lameness, abscesses, decreased milk supply and decreased infant survival rates (Bae SE & Son HS, 2011; Rahman MS *et al*., 2004) [4, 55]. Dairy farm employees, caretakers, butchers, veterinary professionals and villagers are most vulnerable to getting brucella infection.

One of the deadliest zoonotic diseases, rabies is brought on by the Rhabdoviridae-related rabies virus. Between 30,000-70,000 people die per year worldwide (Krebs JW *et al*., 2004) [36]. Although dogs are the primary rabies virus carriers, other wild animals such as cats and jackals also serve as rabies virus transmitters. Because of the stray dog issue, people in poor nations are exposed to rabies through dog bites (Tang X *et al*., 2005) [60]. The spread of rabies in civilised nations is

caused by foxes, bats, and other wild animals (Tang X *et al*., 2005) [60]. The incubation period for rabies can be from four days to many years, depending on the type and severity of the wound, its anatomical location and the viral load (Ghosh S *et al*., 2020; Liu Q *et al*., 2017; World Health Organization, 2018) [20, 37, 68]. The varied clinical characteristics of rabies disease include the classical or furious or encephalitic form and the paralytic or dumb form, though they are typically predominated by viral tropisms (Dimaano EM *et al*., 2011; Ghosh S *et al*., 2020; Hemachudha T *et al*., 2002; Jackson AC, 2016; Mitrabhakdi E *et al*., 2005; Plotkin S *et al*., 2017;) [16, 20, 26, 30, 41,53]. Excitation, solicitude, anxiety, confusion, hallucinations, and hydrophobia are the most typical symptoms of this disease (Ghasemzadeh I & Namazi SH, 2015) [19].

4. Zoonoses of pets, companion animals and birds

The presence of zoonoses may be facilitated by the 14-62% of pet owners who let their animals into their bedrooms (Chomel BB & Sun B, 2011) [12]. Over the past few decades, the number of companion and pet animals has expanded, but they are also a major source of disease-causing pathogens. Due to the potential for disease spread, the popularity of pets and companion animals has put human health at risk. Nowadays exotic pets are commonly kept with domestic pets in many houses. Therefore, the risk of spreading new zoonotic diseases to humans through pets, companion animals, exotic birds and animals is extremely high.

Pets and companion animals are linked to a number of infectious diseases (viral, bacterial, parasitic, and fungal) (Halsby KD *et al*., 2014) [24]. The zoonotic diseases that are frequently linked to pets and companion animals include brucellosis, campylobacteriosis, chlamydiosis, catch scratch fever (*Bartonella henselae*), ehrlichiosis, giardiasis, hantavirus, hookworms, influenza, rabies, Lyme disease, rocky mountain spotted fever, leptospirosis, monkey pox, pasteurellosis, Q fever, Plague, salmonellosis, staphylococcosis, streptococcosis, toxoplasmosis.

In both developed and developing nations, birds including canaries, finches, sparrows, parrots, parakeets and budgerigars are becoming increasingly prevalent (Boseret G *et al*., 2013) [9]. Like pet animal, these game and ornamental birds are also potential carriers of zoonotic diseases like *Coxiella burnetii*, *Coxiella psittaci*, *Salmonella* spp., *Listeria monocytogenes*, *Erysipelothrix rhusiopathiae*, *Mycobacterium* spp., Lyme disease and various viruses like fowl pox virus and Newcastle disease virus (Moro CV *et al*., 2005) [44]. Salmonellosis, chlamydiosis, and avian influenza A H_5N_1 are just a few devastating diseases that could possibly cause infection in human (Boseret G *et al*., 2013) [9]. Additionally, a variety of additional bacterial zoonoses, such as *Pasteurella* spp., *Klebsiella* spp., *Yersinia* spp., *Pseudomonas* spp., *Staphylococcus aureus*, and *E. coli*, have been linked to game and ornamental birds (Dorrestein GM, 2009; Jorn KS *et al*., 2009; Zaman SB *et al*., 2020) [17, 31, 70]. In fact, there is proof that humans can get *Escherichia coli* O157:H7 (enterohaemorrhagic) infection from eating animals origin food that came from European starlings (Kauffman MD & LeJeune J, 2011) [33].

Diseases from these animals can be spread through direct or indirect contact. The transfer might occur indoors, outdoors, at pet stores, hospitals, or other locations. When these animals and birds are taken to exhibitions and competitions, the transmission of infection frequently occurs (Belchior E *et al*., 2011; Vanrompay D *et al*., 2007) [8, 65]. Humans getting infections like pasteurellosis and cat scratch illness through animal bites or scratches (Chomel BB, 2014) [14].

It is interesting that the rabies virus, which kills tens of thousands of people annually, is the most prevalent zoonotic disease linked with dogs (Burgos-Cáceres S, 2011) [10]. Similar to how pet-associated MRSA is a significant global health issue for humans (Faires MC *et al*., 2009) [18].

The cat scratch disease is a significant zoonose that is connected to pets. *Bartonella henselae* is the disease's etiological agent. Cat scratch disease is a typical benign infectious disease. The disease is horizontally transmitted from cat to cat, but humans can gets infection occasionally through arthropod vectors like fleas and ticks. Additionally, cat licking of a person's open wounds or bites and scratches that result in wounds are the most common human transmission mechanisms. The sickness takes three to fourteen days to incubate. There may be several lesions, including redness, swelling, and elevated, rounded areas. Pus may also occur at the infection site. In addition, lymph nodes close to bitten or scratched areas as well as those on the neck are frequently inflamed (Klotz SA *et al*., 2011) [34]. Pets must be raised with appropriate cleanliness habits, regular vaccinations, and medical check-ups to ensure their immunity to these zoonotic diseases.

5. Control of zoonoses

The global community faces a major threat to its health from zoonoses. Up to 75% of human diseases are zoonotic, or animal-transmitted and 58-61 percent of human diseases are communicable (Al-Tayib OA, 2019; Ng V & Sargeant JM, 2013) [3, 47]. Effective control methods for zoonosis must therefore take into account interactions between humans, animals, and the environment (Aenishaenslin C *et al*., 2013) [2]. For control and prevention of zoonotic diseases, surveillance is essential. Surveillance can be used to detect early infection, affected persons and animals, reservoirs, vectors, and endemic locations, including the "hotspots". It assists with the proper management of disease, the adaption of control measures against newly emerging and reemerging diseases and the reduction of human and animal morbidity and mortality. In order to effectively control zoonoses, coordinated monitoring strategies at the local, regional, national and worldwide levels are crucial. Zoonoses (like SARS) can quickly travel throughout the world and threaten global societies. All potential zoonoses sources, including rodents, aquatic animals, wild animals, exotic animals and birds, pet and companion animals, need to be monitored. There are several surveillance methods that must be used (Van der Giessen JWB *et al*., 2013) [64]. Effective and functioning surveillance requirs a well-equipped lab, sufficient diagnostic resources, qualified personnel, and funds. The four methods of surveillance listed below can be used to combat zoonoses:

1. Pathogen detection and identification through pathogen surveillance.
2. Using immune response monitoring, serological surveillance can find the presence of infections in the blood of people or other animals.
3. Using data analysis based on symptoms, syndrome surveillance can identify diseases that are more likely to occur. The presence of pathogens cannot be determined using this analysis-based surveillance.
4. Risk monitoring to find the risk factors behind disease

spread. The prevalence of various diseases and their clinical characteristics cannot be determined using this control technique.

Zoonoses can also be managed using general principles of disease control such treating sick people, immunising healthy people and animals, limiting animal migration, managing animal populations and test and cull (anthrax, glanders and Rift Valley fever). Infected materials must be decontaminated in order to lower the risk of getting new diseases. For instance, brucellosis can be less common if aborted foetuses are properly disposed of. It is important to practise maintaining personal hygiene and using personal protection equipment such gloves, masks, lab coats, helmets, and goggles.

The management of newly emerging and reemerging zoonoses calls for coordinated and multidisciplinary methods (Chomel BB, 2008) [13]. Many newly and re-emerging diseases are vector-borne arboviral infections, including dengue fever, Zika, and chikungunya. As a result, in addition to vector management, an efficient epidemiological surveillance of these diseases is required for their effective control (Hassell JM *et al*., 2017) [25]. This surveillance encompasses risk factors such vector biology, host dynamics, pathogen niche and virulence, wildlife distribution, land use and socioeconomic position that are accountable for emergence or re-emergence. Controlling pests and vectors is also necessary to combat several parasitic and bacterial zoonoses spread by ticks, lice, and mosquito-like insects that resemble vectors. A combination of physical, biological and mechanical techniques, such as integrated pest management and integrated vector management systems, should be used in successful vector control strategies (Rahman MT, 2017) [54].

Even though many zoonoses pose a serious risk to public health, especially in impoverished nations, they are frequently ignored and go unchecked. Programs to control zoonoses must take into account both human and animal-related issues. When multiple bordering nations are affected, coordinated zoonoses management strategies must be used. For efficient zoonoses control, methods based on the principles of one health policies must be developed and engage veterinarians, medical professionals, occupational health physicians, public health operators, conservation officers, and environmental officers (Murphy SC *et al*., 2019) [46]. One health-based idea was reinforced among academics and professionals from 21 European and African nations through a research initiative called Integrated Control of Neglected Zoonoses for the control of neglected zoonotic diseases in Africa (Pal M *et al*., 2014) [50].

Every disease management strategy needs a substantial financial investment, which is typically not available to developing nations. For effective zoonoses control, the developed nations and international donors must assist the poor nations. One option for funding is to approach donor organisations like the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE), the US Agency for International Development (USAID), the US Department of Agriculture (USDA), the European Union (EU), the Department for International Development (DFID), the Biotechnology and Biological Sciences Research Council (BBSRC), and the Danish International Development Agency (DANIDA). Similar to public funding organisations, private funding organisations can also be contacted for funds to implement zoonoses control projects (Gibbs EPJ, 2014) [21].

It is necessary to provide customers with a plentiful supply of safe food in order to control food-borne zoonoses. Implementing the two major strategies of risk assessment and risk management of food products could help achieve this. Risk management should be practised by passing legislation and establishing goals to lower the risk. Risk assessment can be done by gathering and analysing data, and by offering recommendations based on importance. Foods of animal origin including meat, milk, and eggs must come from healthy animals free of zoonotic viruses. To guarantee the safety of food derived from animals, proper ante- and post-mortem assessment of the animals is essential. For the manufacture of safe food, it is important to provide hygienic conditions in every stage of food processing, including staff members' personal cleanliness.

The creation of laws and regulations governing isolation and quarantine, the establishment of robust and efficient disease reporting (notification) systems, farm biosecurity, mass vaccination, testing and slaughter or culling, public awareness campaigns, and health education are additional zoonoses control measures. To better educate the public about zoonoses, mass media, electronic information systems, social networks, text messages, and other communication channels can all be very helpful.

7. Conclusions

The majority of infectious diseases that affect people are animal-borne. These pathogens not only infect animals with diseases but also provide a major risk to human health. Because of the increased contact between people and wild animals, it is often the case that altered eating habits, climate change, and environmentally unfavourable human activities impact the establishment and re-emergence of many zoonotic diseases. The present COVID-19 epidemic makes clear how catastrophic zoonosis is for the human population. Research concentrating on the one health approach needs to be prioritised in order to uncover crucial intervention steps in the transmission of infections because of the close ties between animals, humans, and the environment. To effectively detect zoonoses and conduct effective control actions, robust active surveillance encompassing all one health approach components must be deployed.

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