General Principles for Treatment, Prevention and Control of Zoonotic Diseases

21

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ABSTACT

Zoonotic diseases are animal-borne and capable of transmission to human, present substantial risks to human health worldwide. In order to identify potential epidemics, effective strategies commence with surveillance and early detection through the utilization of robust monitoring systems. For containment, rapid response mechanisms, such as coordinated efforts between the human and animal health sectors, are indispensable. Interdisciplinary collaboration is critical for prevention, with an emphasis on the one health approach, which unifies the health of humans, animals, and the environment. Vaccination initiatives that target both humans and animals are crucial in disrupting the cycle of transmission. Public awareness campaigns facilitate comprehension of zoonotic hazards by endorsing measures that reduce exposure. Furthermore, disease reduction is aided by stringent regulations governing the trade of high-risk animals. Treatment protocols place emphasis on the importance of timely diagnosis and targeted therapeutics, acknowledge the wide range of zoonotic pathogens. Antimicrobial stewardship is crucial in the fight against the emergence of antibiotic resistance. Strong international cooperation strengthens global defenses against zoonotic threats by facilitating the exchange of information, allocation of resources, and development of capabilities. In essence, the management of zoonotic diseases necessitates a holistic and cooperative approach that incorporates strategies for monitoring, averting, and treating such conditions. By applying these overarching principles, readiness can be improved, hazards can be reduced, and ultimately, global public health can be protected.

Keywords: Treatment, Prevention, Cross-species transmission, Disease management, Epidemiology.

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1. INTRODUCTION

A zoonotic disease is an infectious condition that is transmitted from living animals to humans. Around 1,400 pathogens (viruses, bacteria, fungi, protozoa, and helminths) that may infect people exist, and 60% of them are zoonotic (Microbiology 2011). These figures might alter given that 75% of newly discovered human illnesses are thought to have animal origins. There are several factors that make emerging and reemerging illnesses a growing public health problem. Increased globalization, habitat degradation, climate change, increased tourism and other factors can all make it easier for diseases to spread over species boundaries and into new ecological habitats (Cutler et al. 2010).

Infections that may spread from human to animals are referred to as anthroponosis (sometimes known as reverse zoonosis); Examples include streptococcus and methicillin-resistant Staphylococcus aureus (MRSA) (Kasela et al. 2023). Generally speaking, anthroponotic diseases are less of a concern in shelters, disease prevention methods and associated issues with animal management have a similar impact on shelter operations to zoonotic diseases. Workers in shelters should be aware of the spread of zoonotic (and anthroponotic) diseases can happen in a number of other ways beyond from coming into touch with an affected animal. The ability of diseased animals to spread an illness to a vulnerable host may exist even when they appear to be healthy (Steneroden et al. 2011). The following are the most typical means of pathogen transmission;

i. Direct contact with saliva, blood, urine, mucus, faeces, skin (hair), or other body fluids of an infected animal through bites, scratches, petting, contaminated wounds, or other ways (Rahman et al. 2020).
ii. Indirect contact with pathogen-contaminated soil or other objects, such clothing, equipment, or animal bedding (Rahman et al. 2020).
iii. Inhaling or ingesting infected bodily tissues, aerosols, secretions and excretions (Rahman et al. 2020).
iv. Vector borne zoonosis that spread through ticks, fleas, or mosquitoes, which are arthropods that are infected (Rahman et al. 2020).

The consequences of a zoonotic illness on shelter populations (both human and animal) can be lessened by keeping up with the pathogen transmission pathways and altering shelter operations to decrease the likelihood of infection. A safe working environment that is better suited to fulfil the needs of the animals and locals in the shelter's community may be supported by careful consideration of the environmental features of the shelter, animal handling protocols, human safety measures, and adherence to basic sanitary practices (Fowler et al. 2016).

2. CHALLENGES IN ZOONOTIC DISEASE TREATMENT

There are certain posed challenges in treatments of zoonotic diseases, i.e.

2.1. LIMITED KNOWLEDGE

As zoonotic illnesses frequently arise from new pathogens, thus medical professionals have little understanding of the biology, transmission and behaviour of these infections in human hosts. The creation of efficient therapies is made more challenging by this knowledge gap (Carpenter et al. 2022).

2.2. DIAGNOSTIC DIFFICULTY

Due to the overlapping symptoms of zoonotic diseases with those of other prevalent diseases, diagnosing zoonotic diseases can be difficult. Additionally, it may be difficult to get diagnostic instruments in environments with a lack of resources, which might delay early diagnosis (Carpenter et al. 2022).

2.3. ANTIMICROBIAL RESISTANCE

The overuse and improper use of antibiotics in both human and veterinary medicine has led to an increase in zoonotic diseases that are resistant to antibiotics, which makes treatment more challenging (Murphy et al. 2019).

2.4. ZOONOTIC SPILLOVER AND EPIDEMICS

Zoonotic illnesses have a random tendency to spread from animal reservoirs to human populations, resulting in epidemics that need quick and effective responses from healthcare systems (Rahman et al. 2020).

2.5. CROSS-SPECIES TRANSMISSION

Some zoonotic illnesses have the capacity to experience genetic alterations that increase their capacity to infect and transfer between various animal and human hosts, complicating treatment efforts (Rahman et al. 2020).

3. STRATEGIES FOR ZOONOTIC DISEASE TREATMENT

Following are the strategies that can be used for treatment of zoonotic diseases;

3.1. EARLY IDENTIFICATION AND MONITORING

Establishing reliable surveillance systems to keep tabs on zoonotic diseases in animal populations can help with early recognition and action. This necessitates close coordination between the human and animal health sectors in order to monitor and report any zoonotic events (Murphy et al. 2019).

3.2. RAPID DIAGNOSTIC TECHNOLOGIES

Zoonotic infections may be identified more quickly and precisely because of improvements in molecular diagnostic methods including PCR-based testing, next-generation sequencing, and point-of-care diagnostics (Carpenter et al. 2022).

3.3. ONE-HEALTH STRATEGY

The complete treatment of zoonotic illnesses can be aided by the adoption of a One Health strategy that combines human, animal, and environmental health. Officials in charge of public health, veterinary professionals, ecologists, and other pertinent parties must work closely together to achieve this (Murphy et al. 2019).

3.4. SPECIFIC THERAPIES

Specific antiviral, antibacterial, or antiparasitic therapies may be offered for some zoonotic infections. These medications aim to stop the causal agent's development or replication. The particular course of action depends on the pathogen that has been identified and how responsive it is to available treatments. To stop the emergence of resistance, it is essential to employ the right dosages and durations (Meng et al. 2023).

3.5. VACCINATION AND PREVENTION

For many zoonotic diseases, vaccination is a very efficient prophylactic approach. In high-risk locations, it is feasible to lessen the spread of the illness between species and stop outbreaks by immunizing both people and animals. Individuals exposed to specific zoonotic infections may occasionally benefit from post-exposure prophylaxis using vaccinations (Meng et al. 2023).

3.6. ANTIMICROBIAL STEWARDSHIP

Implementation of programs will encourage ethical antibiotic use and stop the rise of drug-resistant zoonotic diseases (Murphy et al. 2019).

3.7. EXPERIMENTAL THERAPIES

When there are no effective treatments available then experimental therapies such as monoclonal antibodies, antiviral medications, and immunomodulatory therapy may be tried (Murphy et al. 2019).

3.8. COMMUNITY INVOLVEMENT AND EDUCATION

Increased public awareness of zoonotic diseases and community participation in disease prevention and control programmes can both stop transmission cycles (Carpenter et al. 2022).

3.9. DIAGNOSIS

For effective therapy, a correct diagnosis is essential. Since zoonotic diseases frequently exhibit symptoms that resemble those of other conditions, a comprehensive medical history, clinical examination, and the right diagnostic tests are crucial (Rahman et al. 2020).

3.10. ISOLATION AND PREVENTION

When zoonotic illnesses are extremely infectious, isolation of sick people is crucial to stop the spread of the disease. To avoid infecting healthcare personnel, the proper personal protective equipment (PPE) should be used (Meng et al. 2023).

4. ANTIBIOTICS AND ANTIVIRAL DRUGS

These drugs may be provided, depending on the type of disease and the bacterium that is causing it. Antibiotics are used to eradicate or stop the development of germs in bacterial illnesses (Dafale et al. 2020). Antiviral drugs may be used to lessen symptoms and limit viral reproduction in viral infections. Some zoonotic infections, however, are not specifically treated with antiviral medications (Dafale et al. 2020).
Mass therapy for animal reservoirs include the antibiotic treatment of imported parakeets to prevent human psittacosis and the treatment of all dogs in a certain region to avoid echinococcosis and break the cycle between dogs and sheep (Acha and Szyfres 2003). Mass treatment is reducing a lot of the issues related to human intestinal parasites. Fascioliasis is treated with diethylcarbarnazine, while onchocerciasis is treated with ivermectin (Martinma 2007). Schistosomiasis and African trypanosomiasis incidence have decreased thanks to mass treatment combined with vector control (McQuiston and Childs 2002; Rahman et al. 2020). China has declared that venereal disease (pre-AIDS) has been eradicated by mass therapy using syndrome monitoring as a measure of effectiveness (Beers et al. 2006).

5. CONTROL OF ZOONOSES

Zoonoses represent a significant hazard to human health around the globe. According to a study, between 58 and 61 percent of human illnesses are contagious, and up to 75% of diseases that are spread between humans and animals are zoonotic (Al-Tayib 2019). Thus, interactions between people, animals, and the environment must be considered when developing effective zoonosis management strategies (Aenishaenslin et al. 2013). Surveillance is crucial for the prevention and management of zoonotic diseases. It may be used to locate "hotspots" and early infection stages, infected humans and animals, reservoirs, vectors, and endemic locations (Meng et al. 2023).

It helps to reduce human and animal morbidity and mortality, adjust control methods against emerging and reemerging illnesses, and properly manage sickness. The coordinated monitoring measures at the local, regional, national and international levels are essential for the successful management of zoonoses (Meng et al. 2023). Zoonoses (like SARS and HPAI) may spread swiftly throughout the globe and pose a hazard to international communities. It is important to keep an eye on all the potential zoonotic sources, including wild animals, rodents, aquatic life, avians and exotic species. It is necessary to employ a variety of surveillance techniques (Van der Giessen et al. 2010). A well-equipped lab, enough diagnostic tools, experienced employees, and sufficient funding are required for effective and efficient monitoring.

There are four methods of the surveillance used to combat zoonoses;

1. Pathogen detection and identification.
2. Serological surveillance, which involves monitoring immune responses to detect the presence of infections in the blood of humans or animals.
3. Symptom surveillance to detect illness propensity by data analysis. It is impossible to detect the presence of infections with this analysis-based surveillance.
4. Risk surveillance to identify risk variables that contribute to disease transmission. The prevalence of various illnesses and their clinical characteristics cannot be determined using this control technique (Pieracci et al. 2016).

The management of zoonoses can be carried out using the broad concepts of disease control, such as treating sick people, immunizing healthy people and animals, restricting animal migration, regulating animal populations, and test and cull (for anthrax, glanders, and Rift Valley fever). To lower the risk of contracting new diseases, infected items must be decontaminated. For instance, proper abortion disposal can lower the incidence of brucellosis. It is necessary to practice personal hygiene management and the use of personal protective equipment, such as gloves, masks, lab coats, helmets and goggles. To help stop the spread of brucellosis, salmonellosis and tuberculosis, it is necessary, where applicable, to thoroughly disinfect infected items and surroundings (Murphy et al. 2019).

The management of emerging and re-emerging zoonoses necessitates concerted and interdisciplinary efforts. Arboviral infections spread by vectors are the cause of many newly and re-emerging illnesses, including dengue fever, Zika, and chikungunya (Hassell et al. 2017).

Risk variables that contribute to the emergence or reemergence of an organism include vector biology, host dynamics, pathogen niche and virulence, animal distribution, land use, and socioeconomic situation. Controlling pests and vectors is also necessary to fight many bacterial and parasitic zoonoses spread by ticks, lice, and insects that resemble mosquitoes and function as their carriers. Integrated pest management and integrated vector management systems are examples of physical, biological, and/or mechanical methods that should be used in vector control strategies (Rahman 2017).

Despite posing a very serious threat to the public health, particularly in poor nations, many zoonoses are avoidable yet nonetheless go unchecked. Factors pertaining to both people and animals must be taken into consideration while developing zoonoses management programmes. Coordinated strategies must be used for zoonoses management in areas where many neighboring nations are afflicted. Veterinarians,

physicians, occupational health specialists, public health administrators, conservation officers, and environmental officers must all be involved in the development of zoonoses control strategies in order for them to be effective (Hassell et al. 2017). A research project named Integrated Control of Neglected Zoonoses for the control of neglected zoonotic diseases in Africa increased the awareness of academics and professionals from 21 European and African countries of one health-based concept (Pal et al. 2014).
Every disease control method requires a substantial investment, which is frequently unattainable for developing countries. The industrialized nations, international donors and international organizations such as World Health Organization (WHO), must help the impoverished nations for effective zoonoses management. Intergovernmental Research collaboration is one option for obtaining funding (Gibbs 2014).
In order to control food-borne zoonoses, it is essential to offer consumers a large supply of secure food. This might be accomplished by putting into practice the two main methodologies of risk assessment and risk management of food items. Legislation should be passed and objectives should be set in order to exercise risk management. Gathering and interpreting data, as well as making recommendations based on importance, are all methods of risk assessment. Meat, milk, and eggs must be derived from healthy animals that are free of zoonotic infections. An accurate ante- and post-mortem examination of the animals is necessary to ensure the safety of food obtained from them. Every step of the food processing process, including the worker's personal hygiene, must be carried out in a hygienic way (Murphy et al. 2019).

6. PREVENTION OF ZOONOSES:

There is a crucial contrast between the term's preventive and control. Preventing the spread of a disease agent to a region, a particular population, or a person is the definition of prevention. Control measures are actions made to bring a disease condition under control and keep it there. When a certain infectious disease agent is already existing, the word "control" is more applicable. The terms "primary prevention" and "secondary prevention" are occasionally used to describe preventive and control (Sohn et al. 2003). Primary prevention aims to keep the population healthy by halting the spread of illness. After a disease has been diagnosed, secondary prevention works to reduce harm. When rehabilitation is used as a last resort after primary and secondary prevention have failed, the term "tertiary prevention" is used (Martinma 2007).
There are three most fundamental tenets of zoonoses prevention and control programmes center on severing the epidemiological transmission chain (Meng et al. 2023).

a) Reservoir
b) Transmission
c) The predisposed/ susceptible hosts

The principle of control and prevention are described in the following section;

7. RESERVOIR NEUTRALIZATION

The infected reservoir host is the main point of zoonotic infection. Other sources of infection gradually diminish in importance or vanish whenever infection in the reservoir can be lowered or eliminated. The primary site of zoonotic infection is the infected reservoir host. When infection in the reservoir can be reduced or removed, other sources of infection progressively lose their significance or disappear altogether. There are three methods used to neutralize the reservoir (Pieracci et al. 2016);

- Infected individual removal
- Rendering of infection
- Environmental manipulation

Mass treatment or test-and-slaughter are the two methods available to eradicate an infected animal (Martinma 2007). A herd of animals might be cleared of infection by testing them and slaughtering those that test positive for the illness. This method has proven successful in treating cattle brucellosis, horse glanders, and horse dourine. A test must be sensitive and specific enough to identify all infected animals if all infection is to be eradicated without eradicating a sizable percentage of false-positive animals (Schellenberg et al. 2003).

Another method for removing infected persons from the general population is mass treatment. The mass treatment is typically limited to a small area where all possibly infected persons/animals must be going through screening first for the identification of disease (Acha and Szyfres 2003; Martinma 2007; Fowler et al. 2016). It is feasible to avoid the transmission of *Taenia saginata* from feedlot staff to cattle by providing enough toilets and the necessary monitoring and training to assure their usage. Workers may utilize haystacks, feed bunks, or other locations if facilities are inaccessible, which might lead to the contamination of cattle feed (Ibrahim 2010). It has been quite successful to use fermentation lagoons to eliminate infections spread orally by faeces. The survivability of pathogenic organisms found in organic wastes has recently been decreased due to the use of aerobic, thermophilic bacteria in composition. Before applying effluent to pastures, proper sewage treatment is required to stop the spread of viable parasite eggs (Jones et al. 2006). The effectiveness of introducing sterile males to eradicate screwworms depends on how the arthropod reproduces and moves through its life cycle. The use of biological control strategies such as natural predators or vector-borne diseases has reduced the population of mosquitos with moderate success. Examples include the fish gambusia introduction into water to consume the larvae. Removal of the Australorbis spp. snails, which act as an intermediate host for Schistosomes, by Marisa cornuarietis, a rival snail. This approach is dependent on the vector's population density and has ecological drawbacks (Jones et al. 2006; Rahman et al. 2020).

8. ENVIRONMENTAL MANIPULATION

Management of the environment to manage rodents, inhibit the migration of wild animals, and control vectors. Environmental manipulation refers to changing the environment in a way that affects how zoonotic illnesses spread from animals to people. This can include habitat changes as a result of causes like deforestation and urbanization, the influence of climate change on disease vectors and host behaviors, agricultural practices that encourage the spread of illness, and water management practices that provide breeding grounds for disease vectors. The danger of zoonotic disease spread can rise as a result of these changes. Conservation initiatives, sustainable land-use methods, ethical farming, and public health measures are crucial for lowering the likelihood that zoonotic diseases may be spread due to environmental changes (Walter et al. 2022).

8.1. CONSUMER PROTECTION

This stage, which is more crucial in the case of food-borne zoonotic illnesses, is accomplished by stringent pre- and post-harvest inspections, such as meat inspection, adoption of contemporary food preservation techniques, and pasteurization of milk. Controlling foodborne zoonotic illnesses can be accomplished through the use of ISO 9000 and Hazard Analysis and Critical Control Point (HACCP) methods (Pieracci et al. 2016).

8.2. DETECTION OF ZOONOTIC DISEASE

Detection of zoonotic diseases by keeping an eye on human and animal populations, their carriers, the severity of illness, and environmental variables that may be impacting the disease. This will make it

possible to identify the foci of the endemic disease and organize the necessary control measures (Meng et al. 2023).

8.3. REDUCING CONTACT POTENTIAL

A key criterion for minimizing the infection is to restrict the transmission of infectious agent to the healthy individuals, reducing the possibility of interaction by isolating sick animals, protecting against vectors, and taking biosecurity precautions. The known affected and possibly exposed susceptible groups are taken into consideration for controlling illness (Meng et al. 2023).
There are three approaches for controlling illness (Pieracci et al. 2016):

- Case isolation and treatment
- Placing potential infectious people in quarantine
- Population management

A strategy for lowering contact potential is herd immunity, which will be discussed in the section on disease prevention via boosting host resistance. Herd immunity, which will be covered in the section on disease prevention via enhancing host resistance, is a method for reducing contact potential. When there are enough immune animals in a group, less vulnerable animals are likely to come into touch with ill (shedder) animals, reducing the entry and spread of a disease agent spread by direct contact (Acha and Szyfres 2003; Jones et al. 2006; Meng et al. 2023).

8.4. VECTOR CONTROL

Vectors including fleas, ticks, and mosquitoes spread many zoonotic illnesses. Disease transmission can be reduced by limiting these vectors by the use of pesticides, planned insecticide spray campaigns, environmental changes, and public awareness campaigns (Meng et al. 2023).

8.5. HYGIENE AND SANITATION

Encouraging hygienic habits, such as washing hands after coming into touch with animals and their surroundings, might lessen the risk of zoonotic transmission. In cattle and animal production facilities, proper waste disposal and sanitation practices are crucial for preventing the spread of illness (Matilla et al. 2018).

8.6. INCREASING HOST RESISTANCE

Increasing host resistance to infection is another method for controlling zoonoses. The aim is to prevent infection, but in many cases, boosting host resistance may only result in a reduction in the severity of disease without a corresponding boost in infection resistance (Martinma 2007; Dafale et al. 2020). In veterinary medicine, genetic selection for resistance and stress reduction through better nutrition or housing are prevalent practices. Animals that are kept at the right nutritional level have improved resistance to illness as well as improved capacity to react to vaccination. Genetic selection for resistance can happen spontaneously in human medicine, as in sickle cell anemia and malaria resistance, but it is not accepted as a method for applying disease management. By improving nutrition and shelter, we may lessen stress, which serves as a method of lessening the effects of epidemics by improving the population's capacity for survival. This is widely known given the higher case fatality rates during epidemics among malnourished populations (Dafale et al. 2020).

However, there are two methods i.e. chemoprophylaxis and immunization, for boosting host resistance that are suitable for presentation (Beers et al. 2006; Walter et al. 2022).

8.6.1. CHEMOPROPHYLAXIS

When workers are unintentionally exposed to a drug-susceptible agent (including certain zoonotic pathogens), chemoprophylaxis is used in laboratories. In contrast to mass treatment, which is intended to eradicate infection, this is done to avoid infection. However, people who have already been exposed to the disease may retain some immunity after receiving mass treatment. Chemoprophylaxis may entail a negative medication response. The agent may occasionally be resistant (Taylor et al. 2007; Murphy et al. 2019). Chemoprophylaxis is typically used when there are no better methods to safeguard the host. Chemoprophylaxis is a choice for any high-risk populations when an efficient medication is available but a sufficient vaccination or appropriate protective equipment is not available. (Bereket 2008). Some of the most often used chemoprophylactic items for domestic animals are insect repellents to ward off arthropod vectors and anti-heart worm medications for dogs. Both approaches come with risks, therefore they are two-edged swords. Exposure to some chemical repellents can quickly make cats unwell. An anti-heartworm medicine given as a preventative dosage to a dog that has previously been parasitic infected can be lethal as worms (adults) are killed and then displaced towards heart which results in emboli (Jones et al. 2006; Murphy et al. 2019).

8.6.2. IMMUNIZATION

Vaccines are used to both limit the transmission of infectious agents by strengthening the immune system and to safeguard those who are vulnerable to illness or disease. The immunization stimulus must be adequate to prevent both infection and illness in order to be most successful in managing disease. If just sickness is stopped, there is no decrease in the reservoir of infection in maintenance hosts. If carriers continue to exist, the danger of infection still exists from any vulnerable individuals who are brought into the community. Immunity levels required for disease prevention and infection prevention are not always the same. The percentage of the population that attains the required degree of immunity is used to determine how effective vaccination is as a disease prevention measure (Martinma 2007). The first step in the design of any immunization programme is to identify the population at risk (those who are vulnerable and likely to be exposed). The next phase is to choose the specific disease control target, such as decreasing the incidence of the illness to only a few rare instances or eliminating the agent. Relative risk is used to determine whether or not to vaccinate (Beers et al. 2006; Carpenter et al. 2022). The various factors involved with the processes are far too frequently overlooked because immunization is typically so successful and widespread as a disease management strategy (Taylor et al. 2007). Failures in the immune response or the delivery method for the immunization might also result in failures (Carpenter et al. 2022).

9. HEALTH EDUCATION AND PUBLIC KNOWLEDGE

To enable people and communities to take care of themselves, it is essential to raise knowledge of zoonotic illnesses, their modes of transmission, and the precautions that may be taken. Urban and rural populations can benefit from education initiatives that aim to reduce risk factors and encourage behavior modification. Health education of general public by public health workers, private practitioners, doctors and veterinarians and non-governmental organizations would also help in controlling zoonotic diseases particularly in rural areas (Pieracci et al. 2016).

10. INTERNATIONAL COLLABORATION AND SURVEILLANCE

Zoonotic diseases do not respect national boundaries. Countries can respond collectively to new zoonotic risks by exchanging knowledge and skills (Pieracci et al. 2016).

10.1. RESEARCH AND INNOVATION

To remain ahead of new hazards, ongoing research into zoonotic illnesses, their transmission, and potential cures is essential. Investing in cutting-edge research and development can enhance disease prevention plans (Pieracci et al. 2016).

11. CONCLUSION

Zoonoses are diseases that naturally transfer from vertebrate animals to humans. Bacteria, viruses, parasites, or other uncommon agents may be the cause of zoonoses. Zoonotic illnesses are brought on by three factors: the type of the etiologic agent, the life cycle of the reservoir host, and the life cycle of the infecting organism. Disease, monetary loss, a detrimental impact on staff morale, unwelcome publicity, and medico-legal repercussions are only a few of the major outcomes of zoonoses. Reservoir neutralization, contact potential reduction, and host resistance are the three main tenets of zoonoses prevention, control, and eradication.

REFERENCES

Aenishaenslin C et al., 2013. Multi-criteria decision analysis as an innovative approach to managing zoonoses: Results from a study on Lyme disease in Canada. BMC Public Health 13: 897.

Acha P and Szyfres B, 2003. Zoonoses and communicable disease common to man and animals Volume 2: chlamydioses, rickettsioses and viruses (3rd edn). Pan American Health Organization, Washington, USA.

Al-Tayib OA, 2019. An overview of the most significant zoonotic viral pathogens transmitted from animal to human in Saudi Arabia. Pathogens 8: 25.

Beers MA et al., 2006. The Merck Bailleir Tindall, London, UK 809.

Bereket T, 2008. Prevalence and economic impact of bovine hydatidosis at AA abattoir. DVM Thesis FVM DZ Ethiopia 12.

Carpenter A et al., 2022. The Vaccine Preventable Zoonotic Disease Working Group. Vaccine Preventable Zoonotic Diseases: Challenges and Opportunities for Public Health Progress. Vaccines (Basel) 10(7): 993.

Cutler SJ et al., 2010. Public health threat of new, reemerging, and neglected zoonoses in the industrialized world. Emerging Infectious Diseases 16(1): 1-7.

Dafale NA et al., 2020. Zoonosis: An Emerging Link to Antibiotic Resistance Under "One Health Approach". Indian Journal of Microbiology 60(2):139-152.

Fowler H et al., 2016. Work-related injuries to animal care workers Washington 2007-2011. American Journal of Industrial Medicine 59: 236-244.

Gibbs EPJ, 2014. The evolution of One Health: A decade of progress and challenges for the future. Veterinary Record 174: 85-91.

Han BA et al., 2016. Global patterns of zoonotic disease in mammals. Trends in Parasitology 32(7): 565-577.

Hassell JM et al., 2017. Urbanization and disease emergence: Dynamics at the wildlife–livestock–human interface. Trends in Ecology and Evolution 32: 55-67.

Ibrahim MM, 2010. Study of cystic echinococcosis in slaughtered animals in Al Baha region, SaudiArabia: interaction between some biotic and abiotic factors. Acta Tropica, 113(1) :26-33.

Jones TC et al., 2006. Veterinary Pathology. (6th Edn), Blackwell Publishing, USA 655-656.

Kasela M et al., 2023. The Epidemiology of Animal-Associated Methicillin-Resistant *Staphylococcus aureus*. Antibiotics (Basel) 12(6):1079.

Microbiology NR, 2011. Microbiology by numbers. Nature Reviews Microbiology 9: 628.

McQuiston J and Childs J, 2002. Q Fever in human and animals in the United State. Vector Borne Zoonotic Diseases 2: 179-191.

Martinma EA, 2007. Oxford Concise Medical Dictionary. (7th Edn). Oxford University Press, Bungar, UK 342-343.

Murphy SC et al., 2019. One Health collaborations for zoonotic disease control in Ethiopia. Revue scientifique et technique 38: 51-60.

Matilla F et al., 2018. Animal influence on water, sanitation and hygiene measures for zoonosis control at the household level: A systematic literature review. PLOS Neglected Tropical Diseases 12(7): e0006619.

Meng LW et al., 2023. Perspectives of vector management in the control and elimination of vector-borne zoonoses. Frontiers in Microbiology 14: 1135977

Pal M et al., 2014. The roles of veterinary, medical and environmental professionals to achieve One Health. Journal of Advanced Veterinary and Animal Research 1: 148-155.

Rahman MT, 2017. Chikungunya virus infection in developing countries-What should we do? Journal of Advanced Veterinary and Animal Research 4: 125-131.

Rahman MT et al., 2020. Zoonotic Diseases: Etiology, Impact, and Control. Microorganisms 8(9):1405.

Schellenberg R et al., 2003. An outbreak of trichinellids due to consumption of bear meat infected with Trichinella nativa, in 2 northern Saskatchewan communities. Journal of Infectious Diseases 188(6): 835-843.

Sohn Het al., 2003. Human neurobrucellosis with intracerebral granuloma caused by a marine mammal Brucella spp. Emerging Infectious Diseases 9(4): 485-488.

Steneroden KK et al., 2011. Zoonotic disease awareness in animal shelter workers and volunteers and the effect of training. Zoonoses Public Health 58(7): 449-53.

Pieracci EG et al., 2016. Prioritizing zoonotic diseases in Ethiopia using a one health approach. One Health 2: 131-135.

Walter LF et al., 2022. Climate Change and Zoonoses: A Review of Concepts, Definitions, and Bibliometrics. International Journal of Environmental Research and Public Health 19(2): 893.

Taylor MA et al., 2007. Veterinary Parasitology. (3rd edn). Blackwell publishing Iowa. USA: 337-339.

Van der Giessen JWB et al., 2010. Emerging Zoonoses: Early Warning and Surveillance in the Netherlands; RIVM: Utrecht, The Netherlands.