Human and Animals' Health Interactions with Bacterial Diseases: One Health Perspective

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Abstract

Zoonotic diseases, infections transmitted between human and vertebrate animals, pose significant global health challenges. These diseases arise from diverse pathogens, such as bacteria, fungi, viruses and parasites, effects significantly human and animal populations. In history Rudolf Vichow's first use the term "zoonoses" in the 19th century. Current outbreaks, such as avian influenza, swine flu, and SARS, exemplify the dire consequences of zoonoses on public health. The outbreak of these diseases is influenced by factors like human animal and environmental interactions, climate change, and evolving microbial resistance. Interestingly we explore the historical context, bacterial zoonoses like salmonellosis, brucellosis and tuberculosis, outbreaks investigation strategies and the One Health approach to address zoonoses. Additionally, we emphasize the importance of multidisciplinary collaboration in prevention, control, and mitigation efforts. So, this chapter cover the imperative of integrating animal, human, and environmental health sectors to address zoonotic challenges effectively. However, in future promotion of interdisciplinary research, legal frameworks, and proactive measures to protect zoonotic threats, ensure resilient health system worldwide.

Keywords: Zoonotic Diseases, One Health Approach, Antibiotic Resistance, Pathogen Transmission, Public Health Interventions

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Introduction

Zoonosis, termed from a Greek language, refers to infections or disease that are contagious, can be transmitted from vertebral animal to humans in the course of daily life. There are a variety of pathogenic organisms at play, including microbes, parasites, viruses, fungus, and Rocky Mountain Spotted Fever (RMSF) (Dabanch, 2003). An important factor in the formation and spread of several infectious conditions is the interaction between people, animals, and the natural world. According to the "Asia Pacific strategy for emerging diseases 2010 findings, over 70% of the aforementioned infectious agents emerged from exotic animals and account for a little over 60% of new infections in humans (Rahman et al., 2020).

The appellation of the term "zoonosis" can be traced back to the Greek word "zoon" and "nooses," which respectively mean "animal" and "disease" and the term is coined by Rudolph Virchow at the end of 19th millennium. The World Health Organization, also known as the WHO, defines a zoonosis as any illness or infection that can spread spontaneously from vertebral animals to people or from individuals to animal species (Dong and Soong, 2021). Domesticated pets serve as zoonotic agent carriers and commonly spread infections to mankind. Certain zoonotic players, like human TB, may eventually adjust to spread from person to person. The majority of arising infectious diseases caused by animals, such as swine flu, avian flu, Nipah virus infection, Middle East Respiratory Syndrome (MERS), and Severe Acute Respiratory Syndrome (SARS), result in life-threatening conditions in humans around the world, serious problems with global health, and immediate dangers to human beings that might prove fatal (Kheirallah et al., 2021). But towards the culmination of the nineteenth millennium, the German biologist and researcher Rudolf Virchow coined the word "zoonoses" to refer to illnesses that affect both humans and animals. Owing to their etiology (such as viral, bacterial, parasites; or mycotic zoonosis), asymptomatic hosts (either a living being or an animal), or the infections' development stages (epidemiological categorization), zoonosis can be divided into different groups. The complicated effects of changing the climate may influence the health of humans as well as animals.

The emergence of new diseases in recent times has captured the interest of the general public and reignited the field of public health research on infectious diseases. A constantly changing compilation of epidemics that frequently affect breeds of animals as well as cause significant diseases and fatalities in people is available. Certain pathogens have the capacity to develop into significant outbreaks. Many

infectious pathogens have created methods to get around reservoir features including population concentration and magnitude variations. When the recipients are close in proximity, every pathogen transmits more quickly. At the nexus of mankind and animal health, zoonoses should be addressed using every resource at hand (Murphy, 2008).

The objective of this chapter is the better understanding of zoonotic disease to promote legal action, safeguarding, and proactive measures for the prevention, mitigation and control of zoonosis. Moreover, the timely identification of zoonotic diseases, as well as the establishment of integrated and synchronized monitoring systems. Strengthen the proficiency of laboratories for undertaking collaborative training and exchanging laboratory protocols among One Health sector laboratories is crucial to identify identical pathogens. Disaster management, contingency planning and response readiness of zoonotic diseases. At the international, zonal, and public platforms, it is crucial to have skilled personnel in one health. The team should be made up of people with expertise in public health, domesticated health of animals and fauna, and the surroundings. This combined knowledge is essential for effectively addressing, combating, and managing epidemics of diseases. The strategy for dissemination includes official avenues, initiatives, and contacting to maximize support from the general population and facilitate collaboration regarding resources.

Historical Perspective of Zoonotic Diseases and their Impact on Human Populations

Domestic animals sometimes act as amplifying agents for infections that emerge in animals in the wild, which has a considerable impact on the spread of numerous illnesses to people. In the past, it had been initially hypothesized that domestic pets and human beings have a good impact on pathogenic variability. Anthrax caused by a bacteria called Bacillus anthracis is one of the many zoonotic illnesses spread by pets that has a considerable impact on the general population. The primary zoonotic disease in relation to substantial worldwide health implications amongst cattle zoonoses is TB. While bovine tuberculosis has been almost eradicated in affluent nations, there are still significant zoonotic consequences in various areas of the world. Following HIV/AIDS, human TB ranks as the 2nd most prevalent contributor to mortality. The bacterial infection *M. bovis* is believed to be responsible for the development of between 5 and 10 percent of all cases of human TB (with 25% of those infected being kids). The extra-pulmonary system was found to be the favorable region for TB in almost 53% of all instances. Most cases of TB among people are brought on by cough of diseased livestock or by storing unpasteurized or tainted dairy (Rahman et al., 2020).

Understanding of Zoonotic Diseases

Zoonosis have played a crucial role in history of humans, as well as other organisms and our surroundings. Not only the more severe outbreaks but also the more subtle indigenous illnesses have played a significant role in the emergence of life on Earth. Such transmissible illnesses are made up of intricate phases and processes comprising numerous participants, including humans, animals, and microbes. Bioarcheologists frequently investigated zoonotic illnesses amid challenges with conservation, authentication, and analysis. The likelihood of successfully transmitting an infectious agent from the animal to human host (channeling of illness) and the likelihood that the infection will progress into a medical condition in human hosts (transformation to illness) are two variables that can be used to determine the likelihood of an individual's zoonotic infection (Han et al., 2016). The growing rise in commerce and tourism has been the primary cause of disease invasions during the past half-century, which is widely established. Occasionally mentioned is the fact that four millennia of commerce and tourism prepared the ground for a lot of the current disease incursions.

Although it goes without saying that comprehending the pattern and development of zoonoses requires a knowledge of their animal hosts, there is an obvious disparity among "pathogen-centered" and "host-centered" research that favors the latter approach. However, solely in the environment of an appropriate host, microbial characteristics are recognized as harmful. The contribution of the animal in the spread and ongoing development of the disease must be specified in the description of the recipient of zoonotic players, and the inquiry of host complexity in relation to articulating the boundaries of host. A vertebrate animal is frequently referred to as the host for a certain pathogen that has been identified from the species in question. The practice of using real-time polymerase chain reaction to screen species has produced an additional delicate conundrum: considering all animals that test positively for the genetic code as carrier for specific illnesses (Kosoy and Kosoy, 2018). Rudolph Virchow came up with the term "zoonosis" (plural: zoonoses) at the tail end of the 19th millennium to describe illnesses that affect humans that are brought on by animals. However, the word ought to encompass infections of vertebrates brought on by contact with human beings, such as measles in primates that are not humans, which has become an important issue in any substantial primate center. 'Zoonosis' is also seen to be more brief and handy than 'anthropozoonosis' (animals to humans) and 'zooanthroponosis' (humans to animals), that relies on the predominant route for propagation amongst human beings as well as other vertebrates (Chomel, 2009). The root and method of transferred of zoonotic diseases is shown in figure 1.

Milestones in Public Health Interventions and Control Measures

There is conflicting and disputed information that links the decline of biological diversity to the emergence and propagation of viral illnesses in general. High risk has been associated with regions with both high biodiversity and high populations (controlling for reporting effort) in global spatial evaluations of the earliest introduction of zoonotic infectious illnesses. However, other research suggests that high biodiversity areas (the "dilution effect") inhibit the development of infectious illnesses (once it has already established). It is improbable that infectious nature will react to external stressors or biodiversity loss uniformly as a group. We must first comprehend how the effects of changes in the environment on reserve host species mediate zoonotic illness. The impact on zoonotic disease could depend on the identification of the reservoir host species and their life cycle characteristics since species differ in how they react to outside change. Modelling the presence of species data with associated habitats and ecosystems to create a likelihood distribution or niche model is one of the methods frequently used to forecast implications of global change on biodiversity. To figure out how species distributions and populations may be impacted in the future, starting ecosystems and environments can then be changed in accordance with forecasts of change on a global scale (Keesing et al., 2010; Randolph & Dobson, 2012; Civitello et al., 2015).

Bacterial Diseases

Salmonellosis

Salmonellosis is a major public health concern that affects roughly 1.3 billion people worldwide each year. The vast majority of these incidents are attributable to tainted food. However, despite the fact that the vast majority of Salmonella serovars are known to cause disease in humans, animals may harbor these germs without showing any symptoms. These days, people keep a broad variety of creatures as pets in their homes, including reptiles, amphibians, dogs, cats, decorative birds, and rodents, to mention just a few examples. The germs that pets carry is sometimes expelled via their feces, which might infect the surroundings of the people who keep the pets. As a result of this, it is believed that they may transmit salmonellosis from pets to humans. Each strain of Salmonella, known as a serovar, has a unique zoonotic potential, which is greatly influenced by environmental stressors such as transportation, crowding, insufficient food intake, or temperature (Dróżdż et al., 2021).

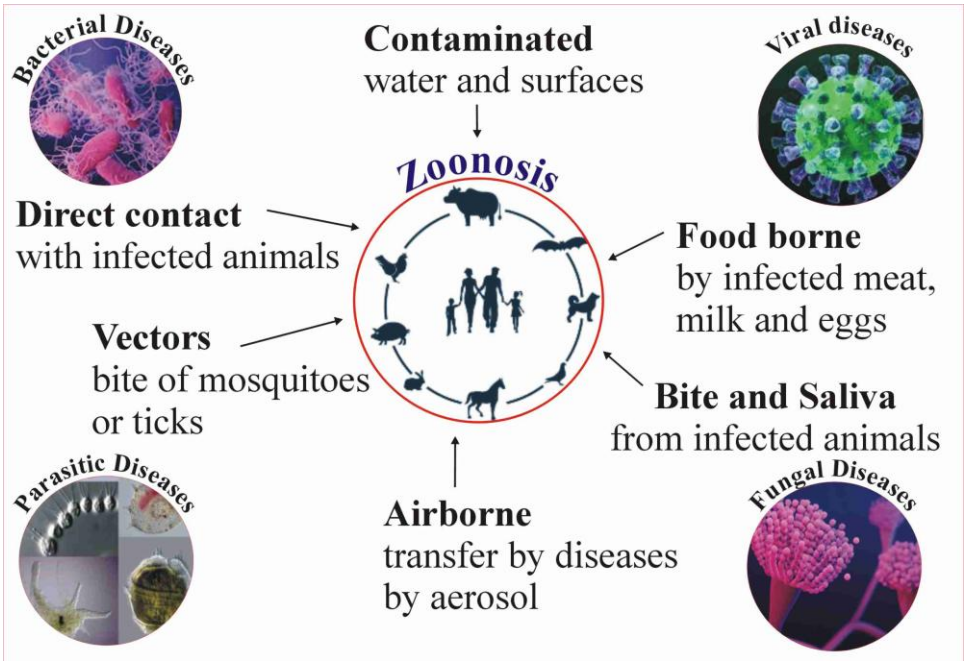

Fig. 1: Zoonotic diseases that transfer form animals to humans.

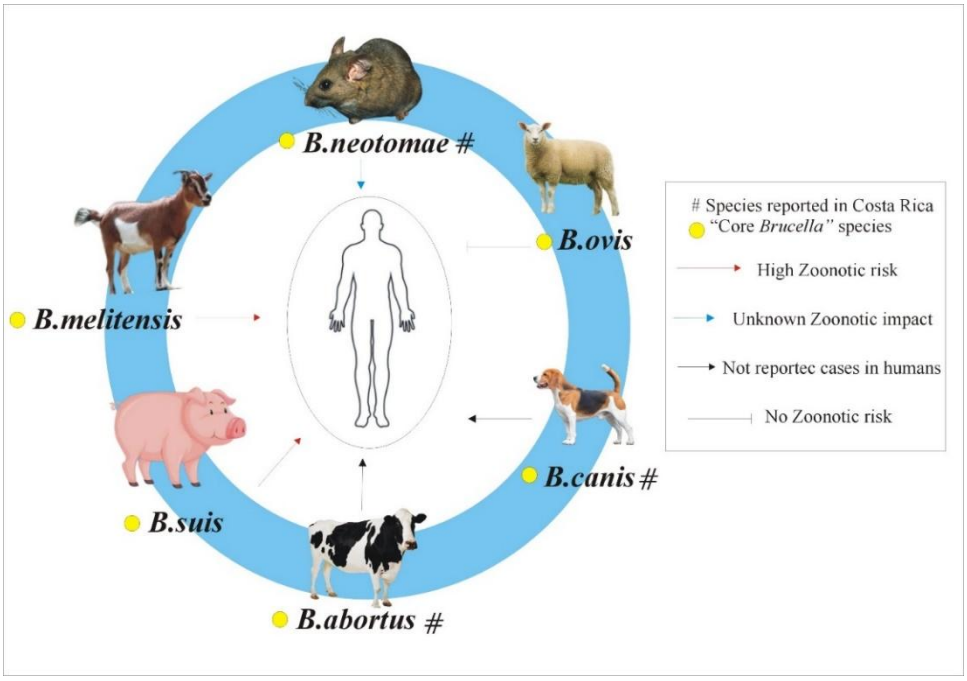

Fig. 2: Diagram illustrated the different species effecting human their host and zoonotic risk.

Brucellosis

From a public health and an economic point of view, brucellosis is significant since it is a highly contagious, re-emerging bacterial anthropozoonotic illness of worldwide relevance. Although the illness may be found in every part of the globe, it is well managed in most of

the world's affluent nations. Brucellosis is a disease that may be subacute or chronic, and it can affect a wide variety of animal species. Brucellosis is caused by numerous different species of Brucella. Pigs, cattle, sheep, goats, and other ruminants often do not exhibit any signs of the infection's early phase once it has taken hold. The sickness that affects animals results in catastrophic damages to the economy. In most cases, the illness is passed from infected animals to people either by direct contact with the animals or through the eating of goods derived from the animals, most often dairy products manufactured from unpasteurized milk. It also poses a risk to the people whose jobs require them to handle diseased animals and the goods derived from them, making it a potential occupational hazard (Hadush and Pal, 2013). The summary of brucellosis animals to human and their species are represented in figure 2

Lyme Disease

Lyme borreliosis, often known as Lyme disease, is an infection that is caused by spirochaetes that are part of the Borrelia burgdorferi sensu lato species complex. These spirochaetes are passed on to humans by ticks. The erythema migrans is the most frequent clinical symptom, and it goes away on its own in time, even in the absence of antibiotic therapy. However, the invading bacteria may spread to other tissues and organs, resulting in more severe symptoms that might impact a patient's skin, neurological system, joints, or heart. These manifestations can be caused by a more severe form of the disease. The number of cases of this illness has been rising in a great number of nations (Stanek et al., 2012).

Tuberculosis

The illness known as tuberculosis, which is caused by bacteria that are part of the Mycobacterium tuberculosis complex, is one of the earliest recognized diseases that may affect people. It is also one of the leading causes of mortality on a global scale. To this day, TB poses a significant threat to the world's population, and the World Health Organization (WHO) cites the illness as the second leading cause of death worldwide, behind only AIDS and HIV. Tuberculosis has a disproportionately high incidence rate in the low socioeconomic sector of the population as well as in the marginalized parts of the society (Natarajan et al., 2020).

Outbreak Investigation and Response Strategies

One of the first stages towards collaboration and agreement on launching a collaborative, multisectoral, One Health strategy might be the setting of priorities for zoonotic illnesses in countries where there may not be active contact across Ministries. This can be one of the first moves towards zoonotic diseases. In Ethiopia, the prevention, control, and monitoring of zoonotic diseases, as well as the investigation and treatment of outbreaks, include a large number of national government players. The Ethiopian Wildlife Conservation Authority (EWCA), the Ministry of Health (MOH), and the Ministry of Agriculture (MOA) are the three government agencies that are primarily responsible for the monitoring of zoonotic diseases. The Ethiopian Public Health Institute (EPHI) is a division of the Ministry of Health that is responsible for leading human outbreak investigations, the monitoring of reportable illnesses, laboratory diagnostics for people, as well as diagnostics for rabies in animals (Epiz, 2019).

Animal Health Sectors and Public Collaboration

In terms of the danger they provide to people's health, zoonoses that are transmitted from cattle, from people who live with animals, and from domestic fowl are likewise in the lead. It would seem that all three components of the human–animal–environment triangle are constantly present, and any effective preventative approach must always take into consideration the interactions that are created between these three components. Recently, significant steps have been agreed upon and put into place on a global scale; nevertheless, the correct deployment of these measures is contingent on the full cooperation of state authorities. These policies were established as part of a globalized strategy, which was then formalized and institutionalized by the global community via the "One Health, One World" initiative (El Amri et al., 2020).

Benefits and Challenges of a One Health Approach

The potential financial benefits of a One Health approach have been supported by some data, both qualitative and quantitative. Programs to reduce the likelihood of harm from endemic zoonotic illnesses and reduce associated costs are the primary emphasis of this study. Funding for disease management throughout the cattle value chain is provided in these initiatives thanks to a purposeful increase in budgetary and other resources, which eventually benefits human beings. Despite this, there is a dearth of data on the cost-effectiveness of One Health monitoring systems, whether as standalone methods or as incremental additions; or in terms of sickness prevention. Economic analyses showing the benefits to One Health from adopting strategies to reduce poverty and increase nutrition may be hard to come by (Häsler et al., 2014).

One Health requires a process of reframing, where the most significant obstacle will be the shifting of priorities away from the existing human-centric direction and toward a holistic approach that gives equal weight to all three pillars of health care. This will need a realignment of professional values, objectives, and goals amongst the three disciplines, which will be supported by institutional variables such as authority and the distribution of resources (Lee and Brumme, 2013).

Antibiotic Resistance in Zoonosis

The widespread and indiscriminate use of antibiotics in animal husbandry creates tremendous pressure on the gut microbiota for the development of resistance because of the shorter generation period and high density. The stomach acts as a bioreactor, producing ARBs that are subsequently routinely expelled to new environments. These ARBs disseminate resistance genes across the ecosystem through quorum sensing, horizontal gene transfer, and vectors. Sixty percent of human infectious diseases are spread by zoonotic pathogens that can also infect humans. The increasing devastation to the planet's ecosystems is a pressing global issue. Careless use of antibiotics in the livestock industry

creates resistant microbes in the gut microbiome, which serves as a bioreactor for the reproduction of infections and increases the likelihood of the development and spread of new ARGs. In the same way that unmetabolized antibiotics pollute the environment, their presence in the food chain causes havoc in the biogeochemical cycle. The microbial ecology, enzyme activity, nitrogen cycle, and carbon absorption all change when antibiotic-resistant bacteria proliferate and native microbes are eradicated (Dafale et al., 2020).

In reaction to the use of antibiotics on animals raised for food, zoonotic bacteria become resistant to antibiotics. Antibiotic usage and degrees of resistance are closely correlated with one another. Animals are treated with the same types of antibiotics that humans regularly use to treat infections, either for therapy or to promote growth. Due to the increased likelihood of unsuccessful treatments, antibiotic resistance in zoonotic bacteria poses a threat to the public's health (Wegener et al., 1999).

Promoting Interdisciplinary Research and Collaboration in Zoonosis

There is a common belief that societal and ecological change is a primary cause of the genesis of new diseases. However, a relatively recent area of research has been the analysis of how the interactions between nature, society, and the environment impact the formation of disease. A disciplinary approach that is focused on etiology continues to be prioritized in the majority of research on infectious diseases. A great deal of significant discoveries that are advantageous to both human and animal health have been discovered thanks to the disciplinary approach. The prevention of several infectious illnesses has been significantly aided by vaccines, better pharmacological regimens, and improvements in sanitation. Even with these advancements, infectious illnesses continue to be a major global source of illness and demise. Emerging, re-emerging, and more resistant infections impose substantial societal and ecological costs even in nations with appropriate sanitation, vaccinations, and pharmacological therapy. A new medical paradigm that is "rooted in an older and more global framework" is required, according to (Greaves, 2002). The future paradigm for research that will be required to meet the problem of new infectious illnesses has been suggested as multidisciplinary collaboration spanning the cellular and molecular to ecology, climatology, sociology, and political sciences (Anholt et al., 2012).

The goal of adopting an effective cooperation between human and veterinary care, environmental preservation, and public health is not yet entirely achieved, despite the fact that different instances of integrated systems have been recorded in Europe. The concept of "one world, one health" has recently emerged, suggesting that people are more acutely aware of the interconnectedness of animal diseases, human health, and environmental factors. Cooperation across human, animal, and environmental health sectors is necessary due to the increase in zoonotic human infectious diseases and the development of microbial drug resistance. The key areas where this new concept of cooperation has been applied through the formation of professional networks include zoonoses and zooprophylaxis, vaccines, and antibiotic resistance (De Giusti et al., 2019).

Conclusion and Future Aspects

The relationship between public health and zoonotic diseases highlights the importance of taking a comprehensive strategy. There has been a lot of difficulty brought on by zoonotic illnesses, but there has also been a lot of progress made in terms of surveillance, prevention, and worldwide collaboration. If we adopt the concept of One Health, we will be able to bolster our defenses against newly developing dangers. In order to protect communities, vigilance, research, and communication will continue to be extremely important. As we move forward, the persistent efforts that are being made to combat zoonoses need to prioritize early identification, quick response, and collaboration across a variety of disciplines. We can make the world a more secure and healthier place for people and animals alike if we work together to forge a unified front. There is reason to be optimistic about our ability to improve both our understanding of and our ability to manage zoonotic illnesses in the future. Integrated policies that focus on one's whole health can lead to improved readiness and reaction. Individuals will be given the ability to take initiative if knowledge and awareness are encouraged and promoted. Utilizing artificial intelligence and large amounts of data will be helpful in both the prediction of epidemics and the improvement of intervention strategies. Global health security may be improved by the harmonization of methods achieved through international cooperation. We pave the road for a resilient future by embracing innovation and using collective expertise. This will minimize the effect of zoonoses and ensure the well-being of all living species.

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