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Research Article

Combating Zoonotic Diseases: Collaboration of Veterinary and Medical Practitioners

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Abstract | Zoonoses are diseases or infections contracted by people from vertebrate animals naturally. They are caused by a variety of microbes, including bacteria, fungi, viruses, protozoa, and other parasites. These pathogens have the ability to infect both domesticated and wild animals. Zoonoses involve interactions among a minimum of three species: an infectious agent and two host organisms, which can either be humans or animals. They can spread directly through contact with diseased animals, such as rabies, and through bites, or indirectly through exposure to contaminated surroundings and contaminated food. Vectors, such as mosquitoes or ticks, play a role in the transmission of diseases like West Nile fever and Lyme disease, respectively. Several factors impact diseases caused by zoonoses, and the convergence model classifies these components into major areas, including the interaction between domestic animals, wild animals, and human influences; ecological and biological factors; and environmental and socioeconomic factors. Throughout history, wild and domestic animals have consistently contributed to the spread of zoonoses, posing a global hazard to public health. Preventing and controlling zoonoses requires the ability to mobilize resources across various sectors and collaboration with intersectoral strategies, especially between national and international veterinary and public health services. This collaborative approach is crucial for addressing the complex dynamics of zoonotic diseases and mitigating their impact on both human and animal populations.

Keywords | Zoonoses, Collaborations, Public Health, Veterinarian, Physician, Risk Factors

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INTRODUCTION

Zoonoses refer to diseases naturally transmitted between animals and humans (Wong et al., 1999). These diseases are caused by various microorganisms, including bacteria, fungi, protozoa, viruses, and parasites, present in both domestic and wild animals. Globally, 60-70% of newly emerging human diseases is attributed to zoonoses. Many pathogens causing different infections originate from animal livestock and can spread indirectly through vectors like mosquitoes or ticks, as observed in cases like West Nile fever and Lyme disease. Alternatively, they can spread directly through interactions with animals, such as rabies transmitted through bites or contaminated food and environment (Jones et al., 2008). Organisms causing zoonotic diseases may be enzootic (transmitted from animals to humans) or endemic (occurring within populations). Endemic zoonoses pose a substantial threat to human well-being, accounting for almost one billion cases of disease and several million fatalities annually (Bordier et al., 2013). The severity of human diseases varies, ranging from relatively mild conditions like most cases of toxoplasmosis to highly lethal diseases such as Ebola hemorrhagic fever (Arango et al., 2017). The ecological conditions and evolutionary history of hosts play a crucial role in shaping the patterns of zoonotic disease transmission (Kilpatric et al., 2012). Zoonoses with reservoirs in both domestic and wild animal populations exhibit a wide array of transmission patterns (Kilpatric et al., 2012). Key factors influencing zoonoses include host vulnerability, weather and climate conditions, microbial growth and evolution, changes in ecosystems, statistical considerations, population size (including concerns related to fauna and exotic animals), economic growth, land use, global commerce, transportation, technological advancements, the manufacturing sector, declines in livestock, human health amenities or infrastructures, as well as issues related to conflict and eviction (Hamburg et al., 2003). Given that animals are the source of these diseases, it is crucial to implement comprehensive and innovative preventive and control measures, drawing upon diverse areas of expertise (Kahn et al., 2006). Close collaboration between the animal health and medical sectors is crucial through clinics, public health campaigns, and research, as zoonoses can impact both humans and animals. Enhanced collaboration among veterinarians, doctors, and public health experts is essential in the fields of population health, individual health, and comparative medicine research (Kahn et al., 2006). Effective collaboration and prompt reaction are impeded by ongoing gaps in communication between physicians and veterinarians concerning zoonotic diseases. This lack of integration highlights the need for improved interdisciplinary communication and collaboration as it might lead to delays in the identification and management of zoonotic threats (Decker et al., 2011). In individual health settings, both doctors and veterinarians should actively assess the potential transmission of zoonotic diseases from animals to humans, especially for individuals who are immune-compromised or at significant risk. The One Health approach, exemplified by the Tripartite Zoonotic Guide (TZG), recognizes the heightened risk of emerging and reemerging diseases due to extensive interactions among animals, humans, and ecosystems. This multi-sectoral collaboration is supported by the WHO, OIE (formerly WOAH), and FAO and functions as a methodical guide utilizing the Generalized One Health Framework. It aims to reduce health risks at the intersection of the environment, people, animals, and plants through five planned phases, attaining a long-term equilibrium between food security, ecosystem sustainability, animal and public health, and fair trade (Erkyihun et al., 2022). Concerning population health, investigating zoonotic diseases should include monitoring programs that encompass human and wildlife populations, as well as livestock, contributing to effective prevention and control strategies (Kahn et al., 2006). Therefore, the objective of this review is to offer a more comprehensive and thought-provoking examination of zoonoses, explore the roles of doctors and veterinarians in addressing zoonoses, and emphasize the importance of collaborative efforts across multiple sectors in the management of zoonotic diseases.

Historical impact of zoonotic diseases on human health

Zoonotic diseases have left a profound historical imprint on human health, involving both domestic and wild animals. The transmission of the bubonic plague, a notorious example, occurred through rats and fleas, contributing to a significant surge in global morbidity and mortality rates during the 14th century's devastating "Black Death." Originating in the Far East, this viral illness claimed the lives of approximately one-third of the population across Europe, Asia, and Africa (Benedictow, 2004; Wheelis et al., 2002). Despite these historical outbreaks, zoonotic diseases continue to pose a threat to public health. The World Health Organization (WHO) reports an ongoing incidence of 1,000-3,009 cases of plague-related deaths annually, with persistent infections in regions of Asia, Africa, and the Americas (Heitzinger et al., 2019). In the western United States, instances of human influenza have been linked to pet owners carrying mites transmitting Yersinia pestis, particularly in areas undergoing sylvatic conditions expansion (Perry et al., 1997).

Rabies, a disease affecting both domestic and wild animals, has a rich historical presence, with depictions in figurative art and literature showcasing rabid foxes, wolves, badgers, and bears during medieval Europe. The roots of rabies trace back as far as 2300 BC, with historical records identifying cases among dog hunters in Mesopotamia (Day and Michael, 2011). Rabies virus, which mostly affects domestic and wild carnivores, kills 60,000 people per year globally (Gholami et al., 2014).

In 2002, the zoonotic virus SARS-CoV caused the emergence of SARS in China, followed by MERS-CoV triggering MERS in 2012. Both resulted in severe pneumonia with SARS claiming 774 lives and 8,700 confirmed cases, and MERS leading to 858 deaths and 2,494 cases. In 2019, the zoonotic concern continued with SARS-CoV-2, leading to COVID-19 in Wuhan, China and rapidly spreading worldwide. Though the virus likely originated from bats but human-to-human transmission is now the primary mode. This update emphasizes the zoonotic nature of COVID-19, with over 126,000 global cases and 5,414 deaths reported across 166 countries (Contini et al., 2019).

Magnitude of zoonotic disease

The extent of zoonotic diseases is predominantly attributed to viruses, particularly RNA viruses, as indicated by the recent discovery of numerous zoonotic pathogens. For instance, it is estimated that 4×10^30 viruses exist in seawater alone, surpassing the total number of observable stars in the cosmos. Viral particles are also prolific on land, with a single duck capable of excreting thousands of avian influenza virus particles. Given the scale of newly emerging viruses and the escalating challenges they present, there is a crucial need for collaboration between the medical and veterinary professions (Webster et al., 1992).

Transmission routes of zoonotic diseases

In the United Kingdom, food serves as a significant source of zoonotic diseases (Scanes and Colin, 2018). While the consumption of animal byproducts is at least ten times lower compared to domesticated animals, human-animal contact resulting from hunting, cooking, and consuming animals contributes to the transmission of certain diseases. Examples include HIV/AIDS, linked to the hunting of chimpanzees; SARS, which originated in a wildlife market in southern China and affected workers; and Ebola hemorrhagic fever, associated with hunting or handling infected great apes and other wild animals. Each of these disease outbreaks stems from an organism or pathogen exploiting a newly acquired host due to human behaviors (Defra et al., 2003).

Transmission patterns of zoonotic diseases are influenced by interactions among various reservoir host organisms and vectors, adding complexity to the understanding of these diseases (Kilpatrick et al., 2012). For instance, mosquitoes are widely recognized as vectors for various animal zoonoses, including Japanese encephalitis, horse encephalitis, and Rift Valley fever. Zoonoses originating in wildlife are often transmitted by insects, making it challenging to comprehend the ecology of vector-borne diseases. Ticks play a crucial role in transmitting microbes from the *Ehrlichia/Anaplasma* genus, including *A. marginale*, the causative agent of Anaplasmosis. Fleas can spread *Yersinia pestis*, flies can transmit *Bacillus anthracis* spores, and sand flies are capable of disseminating Leishmania (Dumbler et al., 2001). *Salmonella* serves as a common example of a zoonotic agent with diverse transmission methods. Salmonellosis associated with reptiles is well-documented, particularly in young individuals. Reptiles and other exotic pets pose a health risk to the general population as they can directly or indirectly transmit salmonellosis to humans (Marr and Calisher 2003). In 1987, a statewide outbreak of S. Typhimurium infection was traced back to contaminated chocolate bars during production, with rogue birds identified as the source. This contamination posed a significant public health issue. In 1999, another outbreak of *S. Typhimurium* was linked to a deceased seagull contaminating an underground water source that supplied untreated water (Refsum et al., 2002; Hofshagen et al., 2004). *Bacillus anthracis*, the causative agent of anthrax, is the most common pathogen affecting herbivores. Human contraction of anthrax can occur through skin exposure to contaminated objects or insect bites, inhalation of spores into the lungs, or consumption of meat from infected animals or contaminated water sources. While livestock anthrax is becoming less prevalent globally, it still remains endemic in several national parks, particularly in southern Africa and North America. This presents an ongoing threat to both livestock and public health (Hugh-Jones et al., 2002). The bacteria can be transmitted from animals to humans through various routes. The bacterial spores are remarkably resilient, remaining viable and latent in the environment for over a century (Stewart and George, 2015).

While the translocation of wildlife by humans is a common conservation strategy, it has also been associated with the spread of zoonotic diseases. In the United States, a new enzootic focus for raccoon rabies has emerged due to the relocation of rodents from the southeast to the Mid-Atlantic region and New England (Hanlon et al., 1999). The recreational translocation of foxes and coyotes has also contributed to the spread of rabies. Additionally, animal translocation has implications for Multilocular Echinococcosis, a disease transmitted by the tapeworm *Echinococcus multilocularis*, affecting a significant portion of the Northern Hemisphere (Davidson et al., 2012). In 1999, *E. multilocularis* was first identified in the Norwegian archipelago of Spitzbergen, likely due to the prior relocation of the primary host, the sibling vole, possibly through imported animal feed (Fuglie et al., 2008). In 2000, *E. multilocularis* was discovered in a red fox in Copenhagen, Denmark, believed to have traveled by train from central Europe, an endemic region for the disease (Kruse et al., 2004).

Factors influencing the spread of zoonotic diseases

Microbes influenced by the imperative to survive and reproduce, demonstrate a remarkable proficiency in genetic modification and adaptation. The adaptability of microorganisms to develop resistance to antimicrobial products is evident in both human and animal populations, with a clear connection between them (Gupta et al., 2001). The transmission of genetically modified microbes from animals to humans can occur through direct or indirect contact with domesticated animals. The global wildlife trade, often illicit, plays a significant role in this dynamic. This trade involves the live sale and utilization of wild animals for food in farms, restaurants, and markets, bringing domestic animals and wildlife into close proximity (Bell et al., 2004). A modern example of potential microbial adaptation is severe acute respiratory syndrome (SARS), believed to have originated in Guangdong, China, in November 2002 and caused by the SARS-associated virus. After its initial discovery in Asia in February 2003, the disease rapidly escalated into a global epidemic before being controlled. According to the World Health Organization, this outbreak resulted in 8,098 cases, including 774 fatalities. Although the virus's reservoir is unknown, wildlife is likely the source of infection. Spontaneous infection has been observed in wild dogs, rodents, and other native animals in

Zoonotic Diseases	Factors	Transmission route	Evidence and citation
HIV/AIDS	Human-animal contact, hunting of chimpanzees	Direct contact with infected blood or body fluids	Scanes and Colin, 2018
SARS	Wildlife market exposure	Respiratory droplets, direct contact	Scanes and Colin, 2018
Ebola Hemorrhagic Fever	Hunting or handling infected great apes	Direct contact with blood or bodily fluids	Scanes and Colin, 2018
Japanese Encephalitis, Horse Encephalitis, Rift Valley Fever	Mosquito vectors	Mosquito bites	Kilpatrick et al., 2012
Anaplasmosis	Ticks (Ehrlichia/Anaplasma genus)	Tick bites	Dumbler et al., 2001
Yersinia Pestis (Plague)	Fleas	Flea bites	Dumbler et al., 2001
Bacillus Anthracis (Anthrax)	Flies, contaminated objects, insect bites, inhalation, consumption of infected meat or water	Various routes including inhalation and ingestion	Hofshagen et al., 2004; Stewart and George, 2015
Salmonella	Reptiles, contaminated food sources	Direct contact, ingestion	Marr and Calisher, 2003
Raccoon Rabies	Translocation of rodents	Direct contact with saliva	Hanlon et al., 1999
Multilocular Echinococcosis	Translocation of animals, relocation of primary host (sibling vole)	Ingestion of contaminated food, water	Davidson et al., 2012; Fuglie et al., 2008; Kruse et al., 2004

the region where SARS likely emerged, as well as in palm civet cats in marketplaces (Guan et al., 2003).

Genetic alterations often play a crucial role in influencing the prevalence of specific diseases. Various animal species, including birds, humans, pigs, horses, and marine mammals, have been observed naturally acquiring the influenza A virus, with its primary reservoir believed to originate from wild ducks. The virus has two main surface antigens: neuraminidase, with nine serotypes, and hemagglutinin, with fifteen subtypes. While only a limited number of combinations have been identified in mammals, all these subtypes have been found in birds in most cases (Kocer et al., 2014). It is likely that "new" pandemic strains emerge when avian and human virus genomes mix in a suitable host (Webster et al., 1992). In 2004, a severe outbreak of highly virulent avian influenza (H5N1 strains) in poultry in Southeast Asia (Li et al., 2004) demonstrated that the virus could also infect humans. Official records documented 39 cases, including 28 fatalities (WHO, 2004).

Changes in global climate can impact various factors, including host defense, vectors, viruses, and ecosystems, thereby contributing to the spread of diseases. Despite the multiple causes of diseases, the interplay of these elements can lead to the proliferation of diseases, vectors, and animal hosts. Particularly, rainfall events can trigger outbreaks of the mosquito-borne Ross River Virus, which is prevalent in Australia (Koolhof et al., 2020). As the global climate warms, diseases carried by mosquitoes, including malaria and plague fever, are expected to spread significantly (El-Sayed and Kamel 2020). Additionally, zoonotic infections such as leptospirosis and Rift Valley fever, which are sensitive to weather and climate changes, have been associated with numerous epidemics worldwide in the past decade (Epstein 2000).

Zoonotic diseases with animal reservoirs can be significantly influenced by human behavior and demographic considerations. The emergence and re-emergence of such diseases result from the interaction of demographic developments in the latter half of the 20th century, including population increases and the consumption of animals and animal products. Consumption patterns play a crucial role; for example, consuming meat from uncommon animals like bears increases the likelihood of acquiring trichinellosis (Schellenberg et al., 2003). AIDS serves as an example of a disease that has become a global public health concern due to a combination of human behavior and demographic variables. Although the exact source of the HIV virus, which causes AIDS, remains unknown, it likely originated in non-human primates in West Africa before being transmitted to humans (Gao et al., 1999). Engaging in outdoor activities, such as camping, hiking, and hunting, may elevate the risk of acquiring zoonoses like tularemia and tick-borne diseases (Antony and Suresh, 2019).

Increased contacts between humans and different species resulting from human intrusion into natural areas have raised concerns about the spread of diseases. The transmission of infections such as AIDS and Ebola from chimpanzees to humans is attributed to demographic factors like population growth, consumption of animal products, and contact with contaminated blood and tissues during slaughtering. This interaction also poses risks to the health of wildlife, as native species can be exposed to diseases affecting domestic animals and humans (Defra et al., 2003). Furthermore, deforestation brings potential sources of zoonotic diseases in wildlife closer to human settlements. The rapid destruction of forests for lumber production in Southeast Asia during the 1990s is believed to have contributed to the sudden outbreak of Nipah virus disease in swine and humans. Fruit-eating bats, specifically flying foxes in the *Pteropus* genus, appear to be the primary reservoir for the Nipah virus. Deforestation limited their natural food sources, forcing these bats into increased contact with industrial orchards and fruit trees on swine farms. This proximity has facilitated the transmission of viruses from pigs to humans (Chua et al., 2002).

The migration of infections, vectors, and animal hosts significantly influences the incidence of zoonoses with animal reservoirs. Various factors contribute to these movements, including human travel, commerce, anthropogenic wildlife displacement, and ecological animal migration, particularly by birds. Consequently, pathogenic organisms can rapidly spread to distant regions, surpassing the typical incubation periods of many diseases. The expansion of rabies into new areas is primarily facilitated by the movement of infected domestic and wild animals (Fisher et al., 2018). A notable example is the introduction and establishment of the West Nile virus in the United States, originating in the Middle East and first detected in New York around 1999, subsequently spreading across the entire country (Rappole et al., 2000).

The role of physicians and veterinarians in zoonotic disease management

Collaboration between physicians and veterinarians is crucial across various domains, such as research, public health, and clinical care, given the potential transmission of zoonoses from animals to humans. Ensuring a comprehensive understanding of associated risks and benefits requires input from both professions. Evaluating risk-benefit ratios, especially in medical settings and for individuals with compromised immune systems, is critical (Shanko et al., 2015). Despite scientifically proven benefits of pet ownership, acknowledging and addressing potential health risks linked to zoonotic infections is imperative. Recognizing these risks emphasizes the need for collaborative efforts between veterinary and medical professionals to safeguard public health and promote responsible pet ownership. Robust systems for monitoring and controlling both animal and human diseases play a pivotal role in addressing the challenges posed by zoonoses in the realm of public health (Shanko et al., 2015).

Moreover, veterinary care does not address the clinical features of human diseases, and medical treatments for humans often do not thoroughly explore the role that animals play in the transmission of zoonotic disease agents. Therefore, effective control of zoonotic diseases requires collaboration between both professions (Glaser et al., 1994). The involvement of both veterinarians and physicians in the management of zoonotic diseases is particularly crucial due to the lack of comprehensive training in the clinical manifestations of human diseases and the tendency of the latter to overlook the role of animals in disease transmission (Grant et al., 1999). To foster a broader consensus on the hazards and mitigation of zoonotic diseases, it is advisable to strengthen the connections between these two experts on a larger scale. Veterinarians, uniquely positioned, can provide pet owners with reliable information on prevention and recommend timely preventive therapies for pets to reduce risks, given their awareness of potential hazards associated with zoonotic diseases and ways of their mitigation (Robertson et al., 2000).

The management of a number of zoonotic diseases has also resulted in remarkable outcomes through collaboration between physicians and veterinarians, demonstrating the efficacy of a One Health strategy. Veterinarians are essential to the prevention of rabies because they oversee large-scale canine vaccination efforts, whereas physicians concentrate on post-exposure prophylaxis and raising public awareness of vaccination (Cleaveland et al., 2014). Avian influenza surveillance and prevention benefit from veterinarians monitoring and culling infected poultry, complemented by physicians who detect and treat human cases, emphasizing the interdependence between animal and human health (Wang et al., 2017). Veterinarians carry out surveillance and vaccination programs for cattle against brucellosis, whereas physicians focus on diagnosis, treatment, and public health education (Ducrotoy et al., 2017). The integrated response to Ebola involves veterinarians identifying animal reservoirs and implementing control measures, while physicians manage human cases and institute public health interventions (Maruyama et al., 1999). Veterinarians help manage leishmaniasis in animals by decreasing reservoirs, whereas physicians concentrate on diagnosis, treatment, and public health initiatives (Palatnik-de-Sousa et al., 2012). In order to effectively manage infections, these success stories highlight the value of interdisciplinary collaboration in the treatment of zoonotic diseases and the necessity of ongoing collaboration between the veterinary and medical disciplines.

Disease surveillance collaborations, exemplified by initiatives like ArboNet for WNV surveillance, the National Antimicrobial Resistance Monitoring System for enteric bacteria surveillance, and FoodNet for population-based surveillance of food borne pathogens, have demonstrated their efficacy in monitoring zoonotic diseases (CDC 2006; CDC 2006). Establishing and sustaining new monitoring programs for emerging zoonoses is crucial, and these initiatives should be integrated into comprehensive courses on zoonotic threats to human health, offered by medical, veterinary, and public health schools.

Role of multi-sector collaboration in zoonotic disease control

The control of zoonoses requires a multi-sectoral partnership to address the global threat to public health comprehensively. A successful zoonoses control program necessitates a robust collaborative network among various entities, including medical facilities, government agencies, diagnostic centers, the medical community, and the veterinary sector (Bogel et al., 1990). Given that numerous diseases can be transmitted by animals, it is imperative to develop innovative preventive and control measures that involve the cooperation of diverse disciplines. Enhancing collaboration between doctors, veterinary practitioners, and public health experts is particularly crucial in three key areas: population health, individual health, and research in relative medicine (Kahn et al., 2006). In certain states, the supervision and monitoring of animal diseases are fragmented across various agencies. Recognizing the need for improved coordination and collaboration at the federal level, a recent report from the National Academy of Sciences has proposed the creation of a centralized federal coordinating mechanism. This mechanism aims to enhance coordination and collaboration among all stakeholders involved in overseeing animal welfare, including federal, state, and local governments, as well as industry (Shanko et al., 2015).

Collaborative strategies in Individual Health

Individuals who work or live closely with animals need to be aware of the potential risks of zoonotic illnesses to their personal health. Doctors may feel uneasy discussing how animals contribute to the spread of zoonoses and often prefer the involvement of veterinarians. However, the majority of patients do not consider veterinarians as reliable sources of information about human health (Friedmann et al., 2009). Research indicates that only 21% of HIV patients sought information from their veterinarians regarding the health hazards associated with owning pets (Grant et al., 1999).

Individuals engaged in animal-related occupations, such as farmers, meat packers, and pet shop personnel, express concerns about the potential for acquiring zoonotic infections in the workplace. For example, pig farmers may face the risk of *Streptococcus suis*, leading to conditions such as meningitis or fulminant sepsis in rare cases (Perseghin et al., 1995). Pet store workers could be exposed to *Streptobacillus moniliformis*, while chicken factory packers may be susceptible to *Campylobacter* infection. These examples highlight the personal health impact of owning and working with animals (Wilson et al., 2004).

Regular veterinary examinations would ensure the ongoing health monitoring of companion animals. Organizing workshops on zoonotic threats to human health that bring together veterinarians and medical professionals could foster relationships and open up opportunities for collaborative efforts (Tannenbaum et al., 1991).

Cooperative responses to Population Health

Outbreaks of water-borne, food-borne, and arthropod-borne diseases are often attributed to zoonotic diseases at the community level. To identify the causative agent and implement preventive measures, it is essential to determine whether outbreaks in humans and animals occurred concurrently. This information is vital for facilitating communication among veterinarians, public health officials, and physicians involved in the local outbreak response (Travejo and Rosalie, 2009). Effective communication between veterinarians and medical epidemiologists becomes especially crucial in states where regional health departments are either non-existent or not actively engaged in reporting or monitoring zoonotic diseases. Veterinarians should take immediate action by expressing their concerns directly to epidemiology experts at local hospitals, urging them to be vigilant for any potential impact on humans resulting from an unidentified disease that has been causing significant neurological symptoms and wildlife deaths, particularly among birds (Thrusfield and Michael, 2018). This collaborative approach enhances the overall response to outbreaks, ensuring a coordinated effort in addressing and mitigating potential health risks at both the animal and human levels. The severity of the zoonotic challenge underscores the imperative for collaboration across the domains of public health, veterinary medicine, and human medicine (Corrales, 2023).

Research has identified that 868 (61%) of the 1,415 infectious agents studied have the potential to be transmitted from animals to humans (Taylor et al., 2001). Viruses and protozoa emerged as the most prevalent zoonotic pathogens, with zoonotic diseases being associated with newly identified or emerging infections compared to non-zoonotic pathogens. These agents encompass viruses associated with severe acute respiratory syndrome such as SARS-CoV-2, the Hantavirus, avian influenza virus, and West Nile Virus (Cleaveland et al., 2001). Improving our understanding of virus epidemiology may involve surveillance investigations into the role of both immunized and uninfected horses in amplifying West Nile virus transmission to humans (Castillo-Olivares et al., 2004).

Collaborative efforts between researchers are essential for conducting applied public health studies, particularly in conjunction with ongoing monitoring initiatives. To assess the risk of zoonotic transmission, medical and veterinary teams can perform sero-surveys on individuals residing or working in close proximity to animal populations that pose a public health threat. For example, individuals in areas of Colorado, Wyoming, and Nebraska where chronic wasting disease is endemic among elk and deer could undergo extended surveillance studies (Belay et al., 2004). Collaborations in comparative medicine research play a crucial role in addressing the challenges faced by doctors and veterinarians in controlling zoonoses, as their requirements extend beyond individual and population health settings. Comparative medicine involves the examination of anatomical, physiological, and pathophysiological processes across humans and other species (Wilkinson et al., 1992).

In response to public demand, veterinary educational institutions have shifted their emphasis from livestock and medicine research to pet animal medicine. This change has resulted in a growing number of veterinary students pursuing careers in research. However, alongside medical institutions, many veterinary programs in comparative medicine have transitioned from a research-centric approach to a service-oriented one. This shift limits veterinarians' involvement in research to roles such as laboratory animal caretakers. Unfortunately, this change in the focus of comparative medicine has impeded research on new zoonoses originating from various host animals. Consequently, many veterinary students are discouraged from considering research professions (Barthold et al., 2005).

Funding for collaborative research in veterinary and medical investigations focusing on zoonoses is crucial. It is essential to establish initiatives that are comprehensively and cohesively funded, ensuring that animal health research is conducted through national and international collaboration among veterinary and medical professionals (Kahn et al., 2006).

CONCLUSION AND RECOMMENDATIONS

Zoonoses, diseases and infections naturally transmitted between humans and vertebrate animals, constitute a substantial portion approximately 60-70% of newly identified infectious diseases worldwide. A significant number of these diseases originate in wildlife. The periodic escalation of the risk of zoonoses globally is a consequence of shifts in human behavior and demographics. These diseases not only pose threats to human and animal health but also entail serious socioeconomic consequences. Effectively managing zoonotic infections necessitates enhanced collaboration and communication among medical professionals, veterinary experts, and public health officials. Overall, there is a growing prevalence of zoonoses, accompanied by a remarkable increase in the severity of health issues impacting both humans and animals over time.

Health institutions, government entities, diagnostic centers, the medical industry, and veterinary services need to forge stronger collaborations. Particularly during zoonotic outbreaks, it is crucial for doctors and veterinarians to engage in close cooperation with state and local public health officials. To ensure effective collaboration between veterinary and medical practitioners on both domestic and global levels, it is imperative to establish jointly funded, comprehensive, and unified programs for animal health research. The enhancement of coordination and communication between state agencies, especially between public health and animal health, is vital. Therefore, it is recommended that public health specialists, physicians, and veterinarians intensify their collaborative efforts. The implementation of federal-level systems is necessary to foster better cooperation among all stakeholders in human and animal health. Additionally, exploring state-level execution of such systems could further contribute to this goal. To encourage the formation of collaborative relationships, more graduates from veterinary institutions should be inspired to pursue careers in research. Courses on zoonotic threats to human health offered by medical, veterinary, and public health schools should integrate all three perspectives for a more comprehensive understanding.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

NOVELTY STATEMENT

This article sheds light on the intricate dynamics of zoonotic diseases, emphasizing the critical need for collaborative strategies across diverse sectors to effectively prevent and control the global hazards posed by these diseases.

AUTHOR CONTRIBUTION

The conception of the review paper was contributed by Kalsoom Abdulrazaq and Rimsha Mehboob. Data collection was undertaken by Bisma Arif and Rimsha Mehboob. The drafting process involved contributions from Kalsoom Abdulrazaq and Asma Mehboob. All authors participated in reviewing the final draft.

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