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Emerging Zoonotic Diseases and the Role of Livestock in One Health Perspectives

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Abstract

Zoonotic diseases, transmitted between animals and humans, represent a major global health threat due to their capacity for rapid emergence and cross-species transmission. The intensification of livestock production, expanding human–animal interfaces and environmental disturbances have collectively increased the risk of zoonotic spillovers. Livestock play a pivotal role in the epidemiology of zoonotic diseases as both reservoirs and amplifying hosts. The concept of *One Health* which integrates human, animal and environmental health provides a comprehensive framework for understanding and mitigating these risks. This review explores the emergence of zoonotic diseases from livestock populations, examines key drivers such as intensive farming, wildlife–livestock interactions and antimicrobial resistance and discusses the application of One Health strategies in surveillance, prevention and control. Emphasis is placed on collaborative approaches that bridge veterinary, medical and environmental disciplines to foster global resilience against future zoonotic outbreaks.

Keywords: Zoonosis, Livestock, Surveillance, Biosecurity, OneHealth

Introduction

Emerging zoonotic diseases are among the most pressing challenges confronting global health security in the twenty-first century. More than 60% of all infectious diseases in humans are zoonotic in origin and approximately 75% of emerging infectious diseases arise from animal reservoirs (Jones *et al*., 2008). Livestock species including cattle, pigs, goats, sheep and poultry frequently act as critical intermediaries in the transmission chain from wildlife to humans. The complexity of zoonotic disease dynamics necessitates an integrated, multidisciplinary approach that recognizes the interconnectedness of human, animal and ecosystem health an approach conceptualized as *One Health* (Grace, 2015).

Rapid globalization, agricultural intensification, urbanization and climate change have profoundly altered the interactions between humans and animals (Karesh et al., 2012). These interactions create opportunities for pathogens to cross species barriers, evolve novel virulence mechanisms and establish new transmission cycles. The COVID-19 pandemic has reignited awareness of zoonotic threats, underscoring the need for unified global health systems that transcend disciplinary boundaries. Within this framework, livestock occupy a central position due to their close association with human livelihoods, food production systems and ecological interfaces (Berthe *et al.*, 2018).

Emerging zoonotic diseases and their global impact

The global burden of zoonotic diseases is immense, with millions of human cases annually causing significant mortality and economic loss (Jones *et al.*, 2008). Classic examples include brucellosis, bovine tuberculosis, avian influenza, Rift Valley fever and leptospirosis. Recent decades have witnessed the emergence of novel pathogens such as Nipah Virus, Middle East Respiratory Syndrome Coronavirus (MERS-CoV) and highly pathogenic avian influenza strains that originated in animal reservoirs before spilling into human populations (Karesh *et al.*, 2012).

Zoonotic pathogens can belong to diverse taxonomic groups viruses, bacteria, fungi and parasites and are transmitted through multiple routes such as direct contact, ingestion, inhalation and vector-borne mechanisms. Livestock production systems act as both a source and a bridge in pathogen transmission chains, especially in regions where animal

husbandry is closely integrated with household or community settings.

Role of livestock in the ecology and transmission of zoonotic pathogens

Livestock as reservoirs and amplifiers

Livestock species can serve as primary reservoirs where pathogens maintain natural cycles or as amplifying hosts that facilitate pathogen multiplication and dissemination (Woolhouse & Gowtage-Sequeria, 2005). For example, pigs act as intermediate hosts for the transmission of Nipah virus from fruit bats to humans and also as mixing vessels for influenza A viruses, allowing genetic reassortment and the creation of novel strains (Karesh *et al.*, 2012). Similarly, cattle are major reservoirs of *Mycobacterium bovis*, causing zoonotic tuberculosis, while goats and sheep are involved in the transmission of *Coxiella burnetii* responsible for Q fever.

Intensive farming and disease emergence

The intensification of livestock farming has significantly increased the risk of zoonotic spillovers. High-density animal populations create ideal conditions for pathogen evolution and rapid transmission (Grace, 2015). Poor biosecurity measures, inadequate waste management and frequent use of antimicrobials contribute to disease persistence and antimicrobial resistance. Industrial poultry and swine farms are particularly vulnerable due to their global trade networks and close genetic homogeneity, which enable pathogens to spread across borders (Jones *et al.*, 2008).

Livestock–wildlife interface

Encroachment of agriculture into wildlife habitats facilitates pathogen exchange at the wildlife–livestock interface (Karesh *et al.*, 2012). Pastoral and mixed farming systems often share water sources and grazing areas with wildlife, increasing the likelihood of cross-species transmission. For instance, African buffalo act as reservoirs of *Mycobacterium bovis* and can transmit infection to cattle in shared ecosystems. Similarly, contact between wild birds and domestic poultry promotes the circulation of avian influenza viruses (Woolhouse & Gowtage-Sequeria, 2005).

Socioeconomic and cultural dimensions

In many developing countries, livestock form an integral part of rural livelihoods and social structures. Practices such as backyard farming, traditional slaughtering and informal milk or meat trade increase human exposure to animal pathogens (Grace, 2015). Moreover, inadequate veterinary infrastructure and limited public health awareness further exacerbate disease risks. Addressing these issues requires culturally sensitive, community-based interventions within the One Health framework (Berthe *et al.*, 2018).

One health approach to zoonotic disease prevention and control

The concept and framework of one health

One Health is an integrative approach that recognizes the interdependence of human, animal and environmental health (Grace, 2015). It promotes interdisciplinary collaboration among veterinarians, physicians, ecologists, epidemiologists and social scientists to design holistic interventions. The One Health paradigm focuses on surveillance, risk assessment, prevention and control strategies that operate across sectors and scales.

Surveillance and Early Warning Systems

Effective zoonotic disease management relies on robust surveillance systems that can detect early signs of pathogen emergence. Integrated surveillance linking veterinary and human health sectors enables timely identification of outbreaks and facilitates rapid response (Karesh *et al.*, 2012). Molecular diagnostics, genomic sequencing and data-sharing platforms such as the Global Early Warning System for Major Animal Diseases (GLEWS+) are key components of this effort.

Antimicrobial Resistance and Livestock

The misuse of antibiotics in livestock production contributes to the emergence of antimicrobial resistance (AMR), which poses a grave threat to both animal and human health (Grace, 2015). Resistant bacteria such as *Salmonella*, *Campylobacter* and *Escherichia coli* can transfer resistance genes through the food chain or environmental contamination. One Health strategies advocate for rational antimicrobial use, improved animal husbandry practices and alternatives such as vaccination and probiotics to reduce dependence on antibiotics.

Biosecurity and farm management

Enhanced biosecurity measures are essential to limit disease introduction and spread. These include controlling animal movement, maintaining hygiene standards, segregating healthy and sick animals and implementing vaccination programs. Farmer education and capacity building are vital for sustaining these practices, especially in resource-limited settings (Berthe *et al.*, 2018).

Policy and intersectoral collaboration

Governments and international organizations play a crucial role in fostering One Health implementation through policy integration and resource allocation. The tripartite collaboration among the World Health Organization (WHO),

Food and Agriculture Organization (FAO) and World Organisation for Animal Health (WOAH) exemplifies global cooperation in addressing zoonotic threats. National One Health frameworks must align veterinary services with public health and environmental sectors to build resilient systems (Berthe *et al.*, 2018).

Environmental and climate dimensions

Environmental changes such as deforestation, pollution and climate variability modify pathogen ecology and vector distribution (Karesh *et al.*, 2012). Warmer temperatures and altered precipitation patterns influence the range of vector-borne zoonoses like Rift Valley fever and tick-borne diseases. Livestock contribute to greenhouse gas emissions and land-use change, which in turn feed back into environmental conditions favoring disease emergence. Thus, sustainable livestock systems that minimize environmental impacts are integral to the One Health approach.

Capacity building and community engagement

Community engagement is central to One Health success (Grace, 2015). Awareness campaigns, participatory disease surveillance and training of local animal health workers strengthen grassroots-level preparedness. Integrating indigenous knowledge with modern epidemiological tools can enhance understanding of local disease dynamics. Furthermore, cross-sectoral education at university and professional levels can cultivate a new generation of One Health practitioners equipped to address complex zoonotic challenges.

Conclusion

The growing incidence of emerging zoonotic diseases underscores the critical role of livestock in global health systems. As both reservoirs and amplifiers, livestock serve as key nodes linking human and environmental health. The One Health approach offers a transformative framework to address these challenges through integrated surveillance, sustainable livestock management and intersectoral collaboration. Strengthening biosecurity, controlling antimicrobial resistance and promoting ecosystem sustainability are essential for breaking the chain of zoonotic transmission. Ultimately, safeguarding human health requires recognizing that the health of animals and ecosystems is inseparable from our own.

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