

Zoonotic Threats: Climate, One Health, Prevention

Kwame J. Adusei*

Department of Pathobiology and Diagnostics, University of Nairobi, Kenya

Introduction

Zoonotic diseases represent a significant and ongoing global health concern, necessitating comprehensive and integrated strategies for effective management and mitigation. These diseases, originating from animals, have a profound impact on human health, economies, and ecosystems worldwide. Understanding the complex interplay of factors that drive their emergence and spread is crucial for global preparedness and response.

Here's the thing: A systematic review explores global trends in zoonotic diseases and underscores the critical role of the One Health approach. It highlights how factors such as climate change, urbanization, and agricultural practices are increasing the incidence and spread of zoonoses, stressing that integrated surveillance, interdisciplinary collaboration, and proactive prevention strategies are essential for effective global management [1].

This review delves into One Health approaches specifically for zoonotic disease surveillance, examining integrated surveillance systems. It discusses the benefits of combining human, animal, and environmental health data to detect, assess, and respond to zoonotic threats more effectively, emphasizing the need for robust data sharing platforms and collaborative frameworks to implement these systems successfully on a global scale [2].

What this really means is that climate change profoundly impacts the emergence and spread of zoonotic diseases. This systematic review explores the various pathways through which environmental shifts, such as altered temperatures and precipitation patterns, influence vector distribution, host migration, and pathogen survival, noting that understanding these dynamics is crucial for predicting future outbreaks and developing adaptation strategies [3].

Another article addresses the global health challenge posed by emerging and re-emerging zoonotic diseases, outlining key prevention strategies. It covers factors contributing to their emergence, including human-wildlife interaction, deforestation, and inadequate public health infrastructure, advocating for enhanced surveillance, early warning systems, and intersectoral collaboration to mitigate risks and protect populations from future pandemics [4].

Let's break it down: accurately diagnosing zoonotic viral diseases is a cornerstone of effective control. This review explores recent advancements in diagnostic technologies, including molecular methods and immunological assays, emphasizing their role in rapid and precise pathogen identification. It also discusses challenges and future perspectives in developing more sensitive, specific, and field-deployable diagnostic tools, which is critical for early detection and intervention [5].

This comprehensive review examines the 'One Health' concept, shedding light on

its challenges and opportunities for controlling zoonotic diseases. It argues that a holistic approach integrating human, animal, and environmental health sectors is vital for addressing complex zoonotic threats, discussing the importance of cross-sectoral collaboration, policy development, and community engagement to build resilient health systems against future outbreaks [6].

Viral zoonoses, originating from animal hosts, pose a significant risk for spillover events and potential pandemics. This review explores the mechanisms of viral spillover, factors influencing host shifts, and the evolutionary pathways that allow these viruses to adapt to human populations, noting that understanding these processes is key to predicting which viral threats are most likely to emerge and how to best prepare for them [7].

Changes in land use, such as deforestation and urbanization, are major drivers of zoonotic disease emergence. This review analyzes how habitat fragmentation, increased human-wildlife interfaces, and altered ecological dynamics contribute to pathogen spillover, arguing for sustainable land management practices and conservation efforts as essential components of a proactive strategy to reduce the risk of future zoonotic outbreaks [8].

Antimicrobial resistance (AMR) in zoonotic bacteria presents a significant global public health concern, complicating treatment and control efforts. This review explores the current status of AMR in bacteria that can spread between animals and humans, discussing drivers such as antimicrobial use in agriculture and healthcare, and emphasizing the need for a One Health approach to surveillance, stewardship, and intervention strategies to combat this growing threat effectively [9].

The economic impact of zoonotic diseases extends beyond direct healthcare costs to include lost productivity, trade disruptions, and impacts on livelihoods. This review provides an overview of recent estimates and methodologies used to quantify these burdens, highlighting the significant financial strain zoonoses place on national economies and global health systems, underscoring the value of preventive investments under a One Health framework [10].

Description

Zoonotic diseases are a pervasive threat, intricately linked with environmental changes and human activities. The systematic exploration of global trends consistently points to climate change, urbanization, and evolving agricultural practices as major accelerators in the incidence and geographic spread of these diseases [C001]. What this really means is that as our planet changes, so do the dynamics of disease transmission, necessitating integrated surveillance and proactive prevention [C001]. For instance, climate change directly influences vector distribution and host migration, thereby altering the landscape for pathogen survival

and emergence [C003]. Predicting future outbreaks hinges on a deep understanding of these environmental shifts and their downstream effects on disease ecology [C003]. Similarly, land use transformations, especially deforestation and the growth of urban areas, create more interfaces between humans and wildlife, amplifying the chances of pathogen spillover [C008]. Sustainable land management and robust conservation efforts are therefore not just environmental concerns, but crucial components of public health strategy to curb zoonotic outbreaks [C008].

The "One Health" approach emerges as a foundational concept for tackling these complex challenges, promoting a holistic integration of human, animal, and environmental health sectors [C006]. This framework is not merely theoretical; it underpins effective surveillance systems where data from various sectors are combined to enhance the detection, assessment, and response to zoonotic threats [C002]. Collaborative frameworks and robust data-sharing platforms are essential to make these integrated systems operational on a global scale, moving beyond siloed approaches to a truly synergistic effort [C002]. Such cross-sectoral collaboration, coupled with informed policy development and active community engagement, is vital for building health systems resilient enough to withstand future outbreaks [C006]. The concept extends to practical prevention strategies for emerging and re-emerging zoonoses, which include strengthening surveillance systems, implementing early warning mechanisms, and fostering intersectoral cooperation to address vulnerabilities like inadequate public health infrastructure [C004].

Beyond prevention and surveillance, accurate diagnosis plays a critical role in controlling zoonotic diseases, particularly those of viral origin. Recent advancements in diagnostic technologies, encompassing molecular methods and immunological assays, offer more rapid and precise pathogen identification [C005]. Let's break it down: these tools are pivotal for early detection and intervention, though there are ongoing challenges and a need for even more sensitive, specific, and field-deployable diagnostic solutions [C005]. Furthermore, the economic ramifications of zoonotic diseases are far-reaching, extending well beyond immediate healthcare expenditures. They include substantial costs from lost productivity, disruptions to trade, and severe impacts on livelihoods [C010]. Quantifying these burdens reveals the considerable financial strain placed on national economies and global health systems, reinforcing the argument for significant preventive investments under a One Health framework [C010].

Another pressing concern within the zoonotic disease landscape is antimicrobial resistance (AMR) in zoonotic bacteria. This presents a significant global public health issue, making treatment and control efforts increasingly difficult [C009]. Drivers such as the widespread use of antimicrobials in both agriculture and human healthcare contribute to this resistance [C009]. A One Health approach is absolutely necessary here, guiding surveillance, antimicrobial stewardship, and intervention strategies to effectively combat this growing and multifaceted threat [C009]. Finally, understanding viral zoonoses involves exploring the intricate mechanisms of viral spillover, the factors that prompt host shifts, and the evolutionary pathways that enable these viruses to adapt to human populations, ultimately determining their pandemic potential [C007]. Recognizing these processes is fundamental for anticipating which viral threats are most likely to emerge and for preparing adequately to mitigate their impact [C007].

Conclusion

Zoonotic diseases present a complex and evolving global health challenge, driven by a combination of environmental, social, and economic factors. Climate change significantly influences the emergence and spread of these diseases by altering vector distributions, host migration patterns, and pathogen survival rates, making it critical to understand these dynamics for outbreak prediction and adaptation. Land use changes like deforestation and urbanization also directly contribute to

increased human-wildlife interfaces, facilitating pathogen spillover. The economic repercussions of zoonoses are substantial, encompassing not just healthcare costs but also lost productivity and trade disruptions, highlighting the importance of preventive investments.

A holistic "One Health" approach is consistently highlighted as essential for managing these threats. This framework advocates for integrated surveillance systems that combine human, animal, and environmental health data to enhance detection, assessment, and response capabilities. Effective prevention strategies against emerging and re-emerging zoonoses require enhanced surveillance, early warning systems, and robust intersectoral collaboration, especially considering factors like inadequate public health infrastructure. Furthermore, advancements in diagnostic technologies, including molecular and immunological assays, are crucial for rapid and accurate identification of zoonotic viral diseases, enabling earlier intervention. Addressing challenges like antimicrobial resistance (AMR) in zoonotic bacteria also necessitates a One Health approach, focusing on surveillance, stewardship, and intervention across sectors. Understanding the mechanisms of viral spillover and the evolutionary pathways viruses take to adapt to human populations is key to preparing for potential pandemics from viral zoonoses. Ultimately, comprehensive strategies involving integrated health approaches, sustainable practices, and advanced diagnostics are fundamental to mitigating the multifaceted risks posed by zoonotic diseases.

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Conflict of Interest

None.

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***Address for Correspondence:** Kwame, J. Adusei, Department of Pathobiology and Diagnostics, University of Nairobi, Kenya, E-mail: k.adusei@uonbi.ac.ke

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