

## Emerging and Re-emerging Infectious Zoonotic Diseases: Global Health Threats and Strategies for Prevention

### AUTHORS DETAIL

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### Abstract

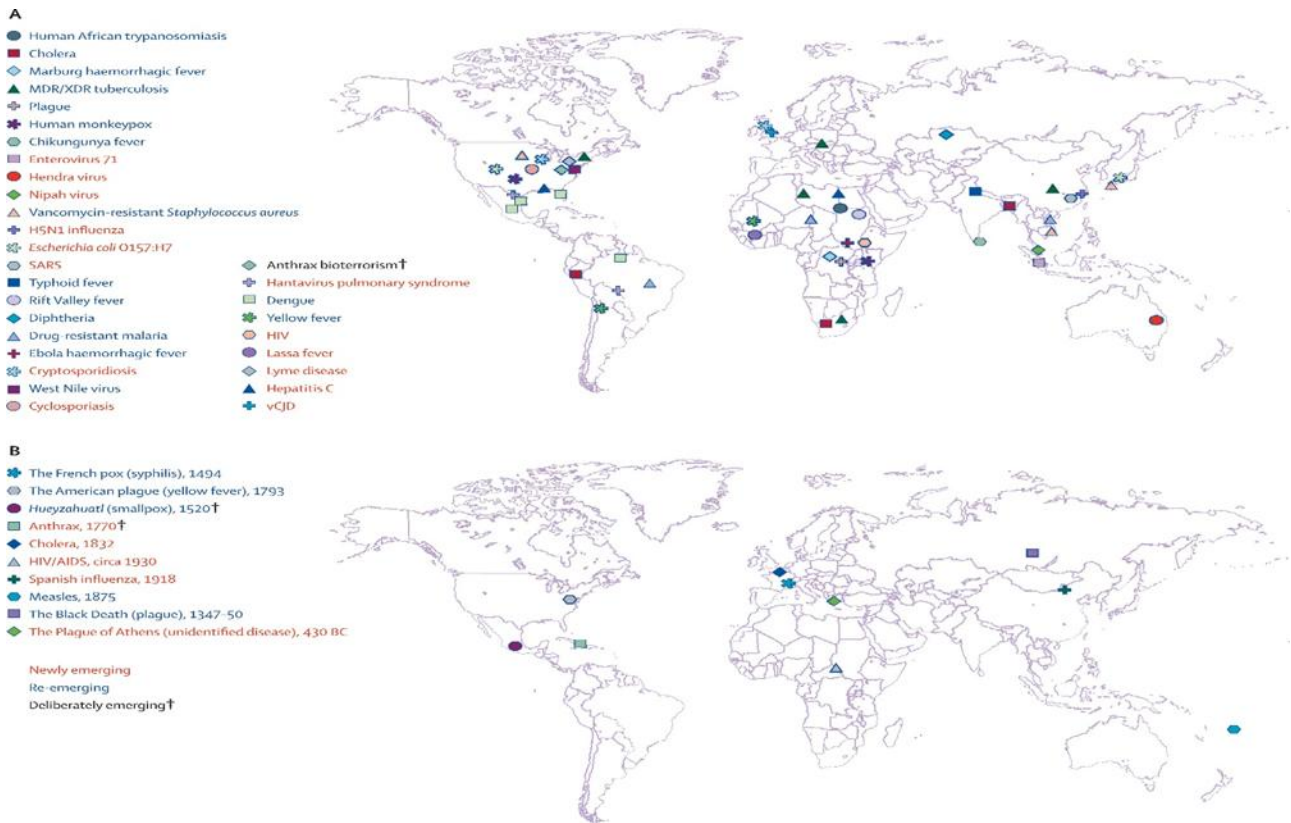
Emerging and reemerging zoonotic infectious diseases are among the most pressing global health challenges of the 21st century, with their origins rooted in the intricate interplay between humans, animals, and the environment. The growing threat posed by these diseases, are being escalated by biodiversity loss, climate change, and intensified human-animal interactions. Notable examples like COVID-19, Rift Valley Fever, Ebola, and avian influenza are highlighted in this chapter and it delves into the profound health, economic, and social impacts of these outbreaks. Furthermore, the critical need for proactive, science-driven prevention strategies that integrate One Health principles to address the interconnectedness of human, animal, and environmental health. Through case studies and evidence-based insights, it underscores the importance of surveillance systems, vaccination programs, community engagement, and international collaboration in mitigating zoonotic disease risks. Readers will be inspired by actionable solutions that empower policymakers, researchers, and practitioners to strengthen resilience against these threats. This chapter showcase a rallying call for innovative approaches that prioritize sustainable health systems and advocate for the harmony between human progress and ecological balance.

**Keywords:** Emerging Infectious Diseases, Zoonoses, Environmental distraction and changes, Globalization, One Health, Spillover Prevention.

### 1. Introduction

Emerging and re-emerging infectious diseases are contributing to significant burdens on global economies and public health. By definition, Emerging Infectious Diseases (EIDs) are illnesses that are either appearing in humans for the first time and were previously confined to small populations in isolated areas, or have been historically present but only recently identified as distinct diseases or linked to new mutant strains (Tabish, 2009). In contrast, Re-emerging Infectious Diseases (REIDs) are illnesses that were once significant public health challenges, experienced a dramatic decline, but have recently resurged through posing substantial health concerns to a significant portion of the population (National Institutes of Health (US) 2007). According to (McArthur, 2019), EIDs are infections that are either newly identified in a population or have previously existed but are now rapidly increasing in incidence or spreading to new geographic areas. This category also includes diseases that are deliberately introduced or re-emerged as tools of bioterrorism, such as anthrax (Morens et al., 2004).

The trend of infectious disease emergence is increasing with over 300 distinct emerging disease events been recorded in the last six decades (Smolinski et al. 2003). Between 1980 and 2017, over two dozen EID outbreaks were reported, with some re-emerging pathogens, and more than ten new EIDs were recorded for the first time in humans in this period. Expectantly, most of these newly reported EIDS were new zoonotic viral infections or mutant strains of existing viruses (Jones et al., 2008; Ndow et al., 2019). Currently, nearly 75% of emerging diseases in humans are of zoonotic origin, meaning the pathogen originates in animals and is transmitted to humans (de Melo et al., 2020) Fig.1.



**Fig. 1: Newly emerging, re-emerging/resurging, and deliberately emerging diseases; Adopted from Emerging infections: a perpetual challenge by (Morens et al. 2008)**

Recent evidence underscores the connection between the rising incidences of infectious diseases and factors such as biodiversity loss, changes in land use and habitat fragmentation (Maganga et al., 2014 ; Cleaveland et al., 2007). While further research is necessary to understand fully the link between habitat degradation and EIDs, (Gottdenker et al., 2014) conducted a systematic review of 305 studies covering a wide range of diseases and identified deforestation, habitat fragmentation, agricultural expansion, irrigation, and urbanization as the primary land use changes associated with zoonotic disease transmissions. The mechanisms driving disease spillover include disruptions in food web structure, alteration in host-pathogen interactions, and the mixing of pathogen gene pools leading to increased genetic diversity in pathogens (Jones et al., 2013). Numerous studies have demonstrated that habitat fragmentation and biodiversity loss are linked to increased disease prevalence and a higher abundance and diversity of pathogens with host species (Mills, 2006; Pongsiri et al., 2009; Keesing et al., 2010; Suzán et al., 2012; Loh et al., 2016; Wilkinson et al., 2018). EIDs result in hundreds of thousands of deaths each year and economic losses (Bogich et al., 2012). Certain outbreaks have expanded across regions, escalating into epidemics and pandemics that cost the global economy tens of billions of dollars, (such as the 2014 -2015 West African Ebola) and pushing entire the nations towards economic collapse (Dan et al., 2009; Nyaruaba et al., 2022).

In this chapter, we explore the multifaceted world of emerging and reemerging infectious zoonotic diseases, examining their origins, mechanisms of transmission and the social, economic and environmental contexts that drive their spread. Through case studies and analysis, it highlights the most significant zoonotic threats to global health and economy and the collaborative, interdisciplinary efforts needed to manage them. By integrating insights from microbiology, epidemiology, veterinary and environmental sciences, the chapter underscores the vital role of the One Health approach in preventing and controlling zoonotic diseases. As human and animal populations continue to intersect, our preparedness and response to zoonotic threats will depend on our ability to bridge these disciplines, recognize early warning signals and implement comprehensive prevention strategies that protect the health of all species-

## 2. Factors Driving the Emergence and Re-emergence of Infectious Zoonotic Diseases

The appearance of emerging and re-emerging zoonotic diseases is associated with several drivers and understanding these drivers and processes can help prevent future outbreaks and anticipate related risks (Birhan et al., 2015). The elements that contribute to this include anthropogenic activities, environmental conditions, and the misuse of antibiotics (Yale et al., 2013). Human activities aimed at meeting basic needs and enhancing well-being have driven ecological changes by creating a complex web of interactions with their surroundings that contribute to the emergence and re-emergence of infectious diseases (McMichael, 2004; Yale et al., 2013). These changes, coupled with the rise of antimicrobial resistance, environmental degradation, and the prevalence of multifactorial and chronic diseases, have significantly threatened both human and animal health (Morens et al., 2004). Such challenges highlight the growing health risks and underscore the critical role of the human-animal-environment interface in the development and spread of infections (Chala and Hamde, 2021).

The risk of infectious diseases has evolved significantly due to anthropogenic-driven climatic, demographic, and technological changes (Harrus and Baneth, 2005). These changes have contributed to repeated pathogen outbreaks in human populations, including notable cases such as the 1918 influenza virus, Middle East respiratory syndrome coronavirus, SARS-CoV-2, HIV-1, and HIV-2 (Kubra et al., 2022). For an infectious disease to emerge, three critical factors must be present: interaction between humans and the animal reservoir, the pathogen's ability to transmit between humans or evolve this capacity, and sufficient human-to-human transmission to enable the pathogen's spread (Nii-trebi, 2017).

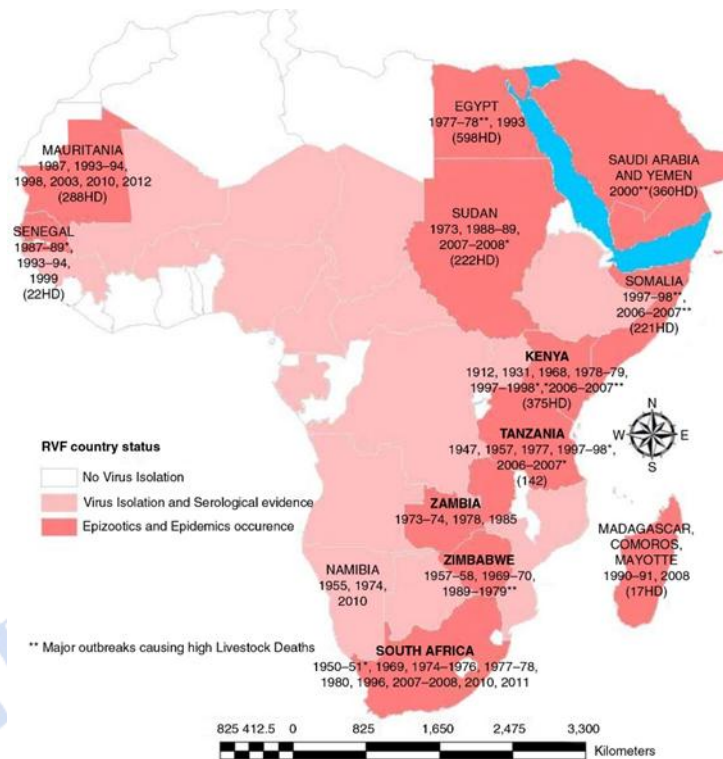
**Antibiotic abuse:** The prolonged and excessive use of antibiotics in food animals for therapeutic purposes has led to the development of antibiotic-resistant organisms. (Consultant and Road, 2008). Antibiotics are administered to livestock and poultry for various purposes, including treatment, preventive care, and growth promotion, which results in a significant presence of these drugs in both the animals and their surroundings (Harrus and Baneth, 2005).

## 3. Some Emerging/Re-emerging Animal Diseases of Zoonotic and Economic Impacts.

Emerging and re-emerging zoonotic diseases are a major threat to farming-based economies, causing devastating economic consequences, threatening global health security, and contributing to food insecurity.

### 3.1 Rift Valley Fever (RVF)

Rift Valley Fever is a mosquito-borne viral zoonosis caused by the RVF virus and is a member of the Phlebovirus genus, Bunyaviridae family (Ikegami, 2012). According to the World Organization for Animal Health (WOAH/OIE), RVFV is a high-impact transboundary pathogen with a bioterrorism potential and a setback on the international livestock trade. The virus was first identified in the Rift Valley of Kenya in 1931 (Nanyingi et al., 2015), and primarily infects animals including cattle, goats, sheep, camels and buffalos but can also affect humans. Humans usually get exposed to the virus through bites from infected mosquitoes mainly *Aedes* and *Culex* genera and contact with blood, body fluids or tissues of infected animals. Since 1931, there have been reported outbreaks in Sub-Saharan Africa, especially in eastern and southern Africa, with outbreaks occurring mainly during unusually heavy rainfall and floods (Nanyingi et al., 2015) (Fig. 2).



**Fig. 2: Map of Africa and Arabian Peninsula illustrating the spatial and temporal distribution of Rift Valley Fever status from the first suspected case in 1912. Total number of human deaths (HD) is indicated for selected countries for all outbreak periods. Adopted from (Nanyingi et al., 2015)**

In most often affected domestic animals, especially livestock, RVFV causes severe illness, high neonatal mortality in ruminants, pregnancy loss/abortion and death, creating a variety of socioeconomic impacts mostly on those who rely on livestock for sustenance and income (Aman et al., 2024; O'Neill et al., 2024). Furthermore, livestock trade disruptions consequently affect local food security as well as local and national economies through market export restrictions (Peyre et al., 2015).

### 3.2 Anthrax

Anthrax, a serious and deadly bacterial disease caused by the ubiquitous *Bacillus anthracis* that affects both humans and animals, particularly grazing livestock and wildlife, with its spores capable of surviving in the soil under extreme weather conditions for up to a hundred years, making eradication impossible (Halvorson, 1997). Humans can contract anthrax through direct contact with infected animals or their products, or by inhaling or ingesting anthrax spores, leading to four types of infections: cutaneous, gastrointestinal, inhalation, and injection (Welde Mariam, 2023). Livestock and wild animals can be infected by breathing in, eating or drinking the spores in contaminated soil, plants or water. Due to its ability to be easily produced and dispersed as a powder or liquid, anthrax is also considered a potential bioterrorism agent (Welde Mariam, 2023). The disease presents a significant public health and economic burden in countries, particularly in rural areas where livestock is the main source of livelihood. In such livestock-dependent communities, a disease outbreak often forces tough choices about disposing of the affected animals and preferring to consume them, exposing the community to the risk of anthrax infection. (Kock et al., 2019).

Anthrax necessitates constant vigilance and preparedness due to its potential for natural and deliberate outbreaks. Enhancing surveillance, outbreak response, and diagnostic capabilities is essential to prevent and control anthrax cases in both animals and humans while mitigating the social and economic impacts of the disease. Normally, veterinarians recommend yearly vaccinations of livestock (Duamor et al., 2021).

## 4. The role of microbiology and life sciences in emerging and reemerging disease management.

Public health microbiology bridges multiple domains, including human, animal, food, water, and environmental microbiology, with a central focus on safeguarding human health and combating diseases, and requires laboratory scientists who can seamlessly collaborate across disciplines, particularly integrating expertise in epidemiology and clinical medicine. Microbiology is pivotal in detecting infectious diseases by monitoring their spread, responding to outbreaks, and generating scientific evidence for disease prevention and control (Greger and Greger, 2008). Over the past decade, evolving healthcare systems and emerging microbial threats in infectious diseases have driven the development of new organizational models for microbiology laboratories (Olatunji et al., 2024). The implementation of rapid response techniques in certain laboratory areas, particularly antimicrobial susceptibility testing and virology, has shown significant clinical and economic benefits for healthcare systems (Anakwenze et al., 2024). Molecular techniques are crucial for rapid response and infectious disease surveillance to enable the identification of emerging pathogens, analysis of their population structure, and characterization of virulence factors and antimicrobial resistant genes (Greger and Greger, 2008). Infectious diseases and clinical microbiology are interconnected complex fields essential for understanding and preventing illnesses caused by microorganisms such as bacteria, viruses, fungi, and parasites, which are responsible for widespread and severe diseases like anthrax, influenza, and tuberculosis (Olatunji et al., 2024).

## 5. Prevention Strategies

The Quadripartite organizations developed the One Health Joint Plan of Action 2022-2026 to collaboratively address health threats, with Action Track 2 specifically targeting the reduction of risks from emerging and re-emerging zoonotic epidemics and pandemics. Implementing a transboundary and multidisciplinary approach, such as One Health, is vital for tackling the complex challenges of containing re-emerging and emerging zoonotic diseases, since this approach integrates laws regulating animal movement with a comprehensive understanding of the ecological dynamics of zoonoses (Teshome and Addis, 2019) as well as the integration of laboratory science, epidemiology, and public health data on emerging diseases from various disciplines (Khoury et al., 2013). Strengthening or establishing surveillance systems is also crucial for monitoring potential zoonotic threats, and enhancing early warning systems to quickly detect epidemics of national and global public health significance (Kumar et al., 2016). To combat antimicrobial resistance, it is vital to enforce international health regulations, foster global collaboration, and use antimicrobials judiciously (Majumder et al., 2020).

Ensuring proper environmental sanitation, including access to sewage systems and clean water, is crucial for reducing the risk of disease transmission (Cairncross and Feachem, 2018). Preserving biodiversity is also vital for maintaining the balance of host-pathogen ecosystems, which helps minimize the likelihood of new infectious diseases emerging (Pongsiri et al., 2009).

Promoting personal hygiene practices is essential, particularly in resource-limited areas, and requires extensive awareness campaigns along with accessible medical and diagnostic facilities at local and national levels (Chomel, 2003). Immunization and vaccination against vaccine-preventable diseases (VPDs) are highly effective preventive measures, as well as reducing human contact with both domestic and wild animals can significantly lower the risk of emerging infectious diseases (Lubanga et al., 2024).

## 6. The Significance of the One Health Approach in Tackling Emerging and Re-emerging Zoonotic Diseases

Given the multitude of drivers involved in the dynamics of emerging and re-emerging zoonotic diseases, the One Health approach is essential for managing and preventing disease outbreaks (Kakkar and Abbas, 2011). One Health is a collaborative approach that focuses on balancing and optimizing the health of humans, animals, and ecosystems sustainably (Mackenzie and Jeggo, 2019). It recognizes that the health and well-being of these three components are interconnected and interdependent and aims to bring together individuals with diverse knowledge and skills from different disciplines to solve specific problems including strategies to control infectious diseases (Yeh et al., 2018; Banović et al., 2021).

The One Health approach acknowledges the complexities of disease ecology and prevents the spillover of pathogens by addressing the root causes and risk factors of zoonotic disease emergence (Zinsstag et al., 2011; OHHLEP et al., 2023) through; (a) developing and implementing risk mitigation measures, such as maintaining resilient and healthy ecosystems, initiating early interventions to reverse or halt environmental degradation and biodiversity loss, regulating farming practices and wildlife trade, and reducing spillover risks at critical points in the animal value chain and the wildlife-domestic animal-human interface, such as live animal markets (Munyua et al., 2019), and (b) strengthening sustainable and targeted One Health surveillance, early warning, and response systems in ecosystems, focusing on animal-human-environment interfaces and critical points within the animal value chain.

One Health approach has proven to be more cost-effective than relying on disease response activities and through it, significant substantial economic co-benefits could be achieved (Bernstein et al., 2022). For example, reducing deforestation is estimated to generate 4 billion US dollars yearly in social benefits from reduced greenhouse gas emissions (Dobson et al., 2020). The COVID-19 outbreak highlighted the socio-economic burden of a pandemic, and it has been estimated that the outbreak would cause nearly 14 trillion US dollars in economic losses until 2024. These losses are comparable to those from other infectious disease emergencies, such as the 2003 SARS pandemic, with an estimated negative economic impact of 52 billion US dollars; the 2014 to 2016 Ebola outbreak in West Africa, caused a GDP loss of 2.8 to 32.6 billion US dollars and a total economic and social burden of approximately 53.19 billion US dollars (Huber et al., 2018). The 2015 to 2016 Zika virus outbreak, led to an estimated loss of above 2 billion US dollars across six states in the United States (Lee et al., 2017). Investing in prevention strategies could significantly lower the risk of future pandemics, likely provide a strong return on investment over time, and yield substantial co-benefits (Bernstein et al., 2022).

## 7. Conclusion

Emerging and reemerging zoonotic infectious diseases are profound global challenges that underscore the interconnectedness of human, animal, and environmental health. As their frequency and impact escalate, the need for innovative, collaborative, and proactive strategies has never been more urgent. By addressing root causes such as habitat destruction, unsustainable agricultural practices, and inadequate health systems, we can break the cycle of zoonotic spillovers and build resilience against future outbreaks. The transition from reactive crisis management to proactive prevention requires investment in research, enhanced surveillance, interdisciplinary collaboration, and active community engagement. Let this serve as a call to action for policymakers, researchers, and practitioners to work together toward a healthier, more harmonious world where zoonotic diseases no longer hinder global progress.

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