Biological Times

Volume No. 4 | Issue No. 11 | Pages 10-11

The Silent Return: Re-emergence of Bacterial Zoonoses in the Anthropocene

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ABSTRACT

Anthropocene, which means humans are changing the environment, and that is increasing the chances of infectious diseases severity. Some bacterial diseases from animals are re-emerging globally. Factors like farms, deforestation, animals grazing around, global trade and changes in weather are all making animals and humans interact more. This enhances the chances of disease transmitting from animals to human. Some of the diseases are re-emerging and sometimes worse than before due to leaving this issue unimportantly and pathogens are becoming drug-resistant such as brucellosis, Q-fever, tuberculosis, plague and leptospirosis. Some of these diseases coming back and sometimes worse than before because we're not giving close attention and germs are becoming drug-resistant like brucellosis, leptospirosis, Q fever, tuberculosis from animals, and plague. All these shifts are challenging public health, especially in minimum resource regions where diagnosis is limited. This review highlights the major fundamental and ecological influences behind the re-emergence of bacterial zoonoses in Anthropocene by representing pathogen of concern, highlighting the key pathogen of concern and need of One Health approach.

Keywords: Anthropocene, Zoonosis, Re-emergence, Drug Resistance, Climate Change

To cite this article: Malik M, R Ahmed, U Nadeem, R Mushtaq & Z Malik. The Silent Return: Re-emergence of Bacterial Zoonoses in the Anthropocene. Biological Times. 2025. November 4(11): 10-11.

Introduction

Anthropocene is really challenging because humans are changing a lot in earth's ecosystem, and it support infectious diseases to emerge. Deforestation, growing cities, farming on a massive scale and being conducted globally has messed with animal habitats [1]. Due to these vast changes, it is now a perfect environment for diseases to transmit from animals to humans. Those diseases that are eradicated are also re-emerging. Those viral diseases that are transmitted from animals and humans are major concern, but bacterial infections remain significant issue due to less coverage. All those animals-oriented diseases like tuberculosis have been shaping the human history by causing huge problems [2]. Treatments through antibiotics have become better and improved hygiene figured out the treatment of animal diseases. Currently, where all the irrational things happening in the environment, there are also bacterial infections re-emerging. Due to climate change, animals moving around, and people travelling all over the world, some diseases are re-emerging which we can see, and others are transmitting to new places. The silent re-emergence of bacterial zoonotic diseases shows the balance that keep human health, animal population, and environmental sustainability. It will be increasingly important to learn the resurgence, as the human-driven changes continue to accelerate. The present review shows a critical overview of the major drivers of re-emergence of bacterial zoonotic diseases in the Anthropocene, it identifies some key pathogens with renewed public health relevance and discuss the challenges to detect, surveillance and prevention, focusing on the acute need for the integrated One Health approach to mitigate future outbreaks in a rapidly changing environment throughout the world [3].

Drivers of R-emerging of Bacterial zoonosis in Anthropocene

The most concerning factor in zoonotic transmission of diseases is that our actions, such as harming nature and deforestation. It directly links the diseases to spread to humans [4]. Bacteria such as Brucella, Salmonella, and Mycobacterium Bovis often appears when farmers are not careful. Moreover, in many underdeveloped countries, people have animals in their yards which means more risk of catching infections. Climate change is also a significant issue. Zoonotic diseases live longer and spread more effectively in warm weather such as plague and leptospirosis [5]. Antibiotic Resistance among microorganisms enhance the re-emergence of bacterial zoonotic infections. Throughout the world, several diseases such as Brucella, Mycobacterium and Salmonella have been reported, complicating treatment protocols [6]. The overflow of antibiotics from farms or pharmaceutical waste areas will enhance the persistence of bacteria in soil and drainage system. The ecological and biological drivers are grouped with socio-economic factors. Fast urbanization has led to inadequate sanitation, poor waste management and high rodent densities in large densely populated areas. Lack of safe drinking water and due to poor drainage, the transmission of bacterium Leptospira, causing leptospirosis, become high. The transportation of livestock across regions without proper screening has facilitated the spread of Q fever, brucellosis and other zoonotic infections [7].

Major Re-emerging Bacterial Zoonotic Diseases

Those pathogens that are exhibiting notable trends of recovery demonstrate the relationship between human behavior and disease ecology by variety of mode of transmission and public health outcomes. One of the most common zoonotic illnesses is still brucellosis, which is brought on by various species of the Brucella virus [8]. In areas with inadequate livestock health systems, low vaccination rates, and high consumption of unpasteurized dairy products, brucellosis persists despite control efforts in many countries. Alongside increased livestock movement, human cases have also increased in areas where pastoralism is the primary source of income. Even in places with strict veterinary regulations, wildlife reservoirs like wild boar and bison have made eradication efforts more difficult and pose a constant risk of reintroduction. Another zoonosis that is gaining international attention again is leptospirosis, which is brought on by pathogenic Leptospira species [9]. Due to changing rainfall patterns and urban flooding, the disease which was previously thought to be exclusive to tropical climates, is now being reported more frequently in temperate regions. Although livestock and companion animals also play a role in transmission, rats are the main reservoirs. Heavy rains are frequently followed by outbreaks, especially in urban slums with poor drainage systems. Because the disease can spread through contaminated environments, water, and soil, it is extremely vulnerable to the environmental disruptions that are a feature of the Anthropocene. *Mycobacterium bovis* is the main cause of zoonotic tuberculosis, which is still a dangerous but frequently misdiagnosed illness. The disease spreads at the interface between humans, livestock, and wildlife. Consuming raw dairy products or coming into close contact with infected cattle are common ways for humans to become infected. The emergence of strains of *M. bovis* that are resistant to antibiotics presents new difficulties for public health monitoring and treatment. Another re-emerging zoonotic disease with a growing worldwide distribution is Q fever, which is brought on by *Coxiella burnetii* [10]. It is highly transmissible due to its long environmental survival and incredibly low infectious dose. Increased goat farming, especially in Europe, has been linked to significant outbreaks. Because bacterial aerosols can travel great distances, containment is challenging. Yersinia pestis, causing plague, is still abundant in rodents in some regions of Asia Africa and America. Climate variability impacts flea and rodent populations significantly by causing plague. Causative agent of tularemia, *Fransisella tularensis*, also depends on wildlife reservoirs and is frequently associated with environmental changes that impact vectors. The persistence of ancient bacterial threats is demonstrated by both diseases, even though contemporary outbreaks are typically [11].

Challenges in Surveillance, Diagnosis, and Control

Bacterial re-emerging zoonotic diseases are frequently overlooked in public health systems, despite their increasing importance. These diseases are hampered by fragmented control strategies, diagnostic limitations and surveillance in effective management system [12]. In many areas, wildlife, livestock and environmental samples are not routinely monitored. Due to

bacterial zoonotic diseases, that are present with vague symptoms like fever, headache, are commonly confused with infections like typhoid or malaria, human cases undergo untreated or undiagnosed. Due to not precisely diagnosing, outbreaks go unnoticed until they go out of control. [13].

Another hurdle for this poor management is less laboratory capacity. Many endemic areas lack the specialized equipment, biosafety facilities, and trained personnel needed for confirmatory testing for diseases like brucellosis, leptospirosis, or Q fever [14]. Although human and domestic animal surveillance is the main focus of traditional public health approaches, many zoonotic bacteria have long-term wildlife reservoirs. Insufficient wildlife monitoring allows outbreaks to spread covertly and unnoticed until they affect people. For example, plague in rodent populations or brucellosis in wild ungulates can last for decades and sometimes unexpectedly spread to livestock or humans.

Sector-to-sector data sharing is still inadequate. Information systems are often fragmented as a result of the independent operations of environmental agencies, veterinary authorities, and human health departments. It is also more difficult to monitor the temporal and geographic trends of re-emerging zoonoses due to the lack of standardized disease reporting frameworks. Disease control becomes even more complicated as a result of AMR [15]. In addition to making treatment procedures more difficult, resistant bacterial strains lengthen the time that infected human or animals can spread the infection. When antibiotics are widely available without a prescription, misuse speeds up the development of resistance, making outbreaks more difficult to control [16].

One Health Approaches for Future Preparedness

One Health is the best approach to deal with the issues like Viral or bacterial zoonoses by surveillance. Detection of zoonotic threats at early stages is possible by monitoring veterinary clinics, human healthcare facilities and wildlife population [17]. Molecular technique can be used to track the evolution of bacteria, find new strains of bacteria and spot AMR patterns by genomic sequencing. In backyard areas, early reporting can improve community-based surveillance. By improving hygiene, animal density, and vaccination for leptospirosis, Q fever and leptospirosis, can reduce the transmission of these diseases [18]. Biosecurity enhancement can reduce the risk of bacterial contamination and further transmission of disease by controlling animal movements and proper waste management. Rural and urban areas will contribute to reduction in the reservoir of zoonotic bacteria by involving environmental management, protection of natural habitats and rodent control. Awareness campaigns targeted at veterinarians, farmers, and the public increase the adoption of preventive practices [19]. Principles of One Health should be included in the national health policies of countries by participating from different sectors and appropriate distribution of resources. Spillover reduction, building preparedness, and resilience can enhance the continued re-emergence of bacterial zoonoses by embracing One Health [20].

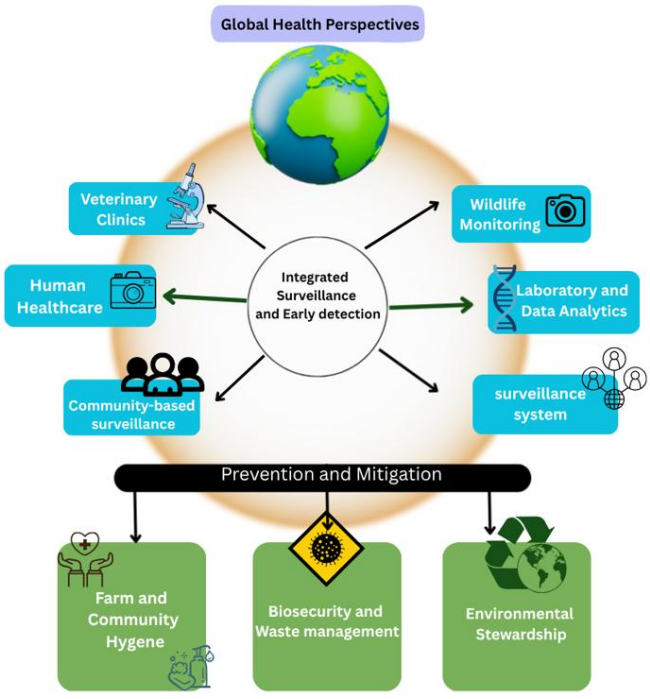

Fig. 1: One Health-based model illustrating surveillance, prevention, and policy collaboration to reduce the risk of zoonotic diseases.

Conclusion

Environmental changes brought on by humans are reflected in the resurgence of bacterial zoonoses in the Anthropocene show significant effect. The re-emergence of bacterial pathogens once considers controlled reflects the compounded effect of ecosystem disturbance, agricultural intensification, climate variability, and global movement. Zoonotic tuberculosis, leptospirosis, Q fever, brucellosis and plague show ancient threats can change in response to stresses. The present stress is exacerbated by inadequate surveillance system, diagnostic gaps, and widespread antimicrobial resistance, which make detection and control difficult. Out of this issue, many necessitate from disjointed to cooperative approaches. To investigate the environmental management, responsible antibiotic use, and cross-sectional coordination, societies can mitigate spillover in future. Controlling the silent re-emergence of bacterial zoonoses demands sustain commitment to protect population health.

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