Emerging and re- emerging zoonotic diseases of bacterial and rickettsial origin: A mini review

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Received: July, 2021 **Accepted:** November, 2021 **Published:** December, 2021

Abstract

Infectious diseases know no barrier and move from one place to another. Emerging and re- emerging infectious diseases have increased due to natural causes as well as anthropogenic activities. Among the emerging and re- emerging diseases, the zoonotic ones are of concern as they cause a huge burden to the human population. Zoonoses can be transmitted via direct or indirect contact. Different emerging and re- emerging bacterial and rickettsial diseases from different parts of the world are discussed in this review. The World Health Organisation (WHO), World Organisation for Animal Health (OIE), World Trade Organisation (WTO), and Food and Agricultural Organisation (FAO) all work in one way or the other in controlling zoonoses but a specific body for controlling zoonoses with the motto 'One Health' is the need of the hour.

Introduction

There is no barrier that can prevent infectious diseases from moving to and fro (Jebara, 2004). An infectious disease agent such as bacteria, virus, parasites, or other unconventional agents that can spread from non- human animals to man through various routes is called zoonosis (WHO). Emerging zoonosis refers to the zoonotic disease that is novel among a human population, or a disease that shifted its geographical area or with increase in incidence, or when the disease affects the formerly unsusceptible population. Zoonotic diseases whose incidence have declined, but has spiked again is termed re-emerging (Taylor *et al*., 2001; Brown, 2004, Morse, 2004). Humans can get exposed to zoonoses through direct or indirect contact between human and animal hosts. Direct contact accounts for 35% of the zoonoses and is commonly from a point source or is vectored by blood feeding arthropods (Bolin *et al*., 2004, Pepper *et al*., 2004, Taylor *et al*., 2001) while indirect contact accounts for majority (61%) of the zoonoses and include the transmission via food, water, and environmental contamination. 22% of the indirect zoonoses are transmitted by vectors while 6% of the transmission route is unknown. Humans act as the main reservoir in only 3% of the zoonotic diseases and 33% of zoonoses can be transmitted from person to person (Taylor *et al*., 2001; Bolin *et al*., 2004).

Natural cause as well as human actions including ecological disturbances and/ or disruption, increased human population, migration and immigration of humans, increased in travel, trade, and commerce, along with the advancement of technology and industries, bioterrorism using the deadly zoonotic diseases like anthrax, plague, tularaemia, and others, and even global warming can all lead to disease emergence (Wanjura, 2007).Some countries

divert from the international health regulations and synthesize their own regulations for monitoring and controlling diseases. If such regulations are not safe enough to control diseases, it may lead to disease emergence.The fear that disease notification will hamper a country's trade, tourism, and economy sometimes force the disease affected countries to keep quiet of the disease which canalso cause disease emergence(Gostin, 2005). Microbes adapt and change overtime with the environment they live in. Antimicrobial resistance increases with the excessive and injudicious use of antimicrobials which increase the rate of transmission of resistant zoonotic diseases and is a major cause of disease re- emergence (Forest, 1999).

Bacterial diseases

Anthrax

Bacillus anthracis, a gram- positive, spore- forming bacteria is a potential biological warfare agent (Spencer, 2003) and causes anthrax in different forms as intestinal, cutaneous, septicaemic, pulmonary, or gastrointestinal. It was the first pathogen grown in vitro by Robert Koch and is transmitted by direct contact of infected animals or via inhalation of spores from contaminated carcass, bones, or hides of animals. It is endemic in some parts of India, Russia, Iran, Pakistan, Central Africa, and Latin America (Chugh, 2008).

Bartonellosis

Bartonella spp. are gram- negative, facultative intracellular bacteria that can invade red blood cells and endothelial cells evading the host's immune response (Gutiérrez *et al.*, 2015). Diseases in humans caused by *B. elizabethae* and *B. grahamii* have been reported from Nigeria, Peru, and Thailand (Kamani*et al.*, 2013; Martin-Alonso *et al.*, 2014; Gutiérrez *et al.*, 2015).

Bovine tuberculosis

*Mycobacterium bovis*are weakly gram- positive, rod shaped bacteria present normally in cattle. They can cause pulmonary lesions in humans upon direct contact with cattle or through milk which is the principal vector of transmission of *M. bovis*(Siddell*et al.*, 2010). Although the human cases in U.S. have declined with the activities of National Tuberculosis Eradication Program, it has re- emerged with sporadic cases in parts of U.S. (Quadri*et al.*, 2020).

Brucellosis

Brucella spp. are gram- negative, facultative intracellular bacteria that causes debilitating diseases to humans worldwide (Siddell*et al.*, 2010). The zoonotic ones among the *Brucella* spp. include *B. melitensis*, *B. abortus*, *B. suis*, *B. canis*, *B. ceti*, and *B. pinnipedialis* are of concern for humans. Humans can acquire brucellosis via inhalation of aerosols or contaminated dust, consumption of raw or contaminated milk and other dairy products, or

through the skin or mucosal abrasions exposed to tissues or fluid of aborted materials of pregnant animals which were infected (Xavier *et al.*, 2010).

Leptospirosis

Leptospira spp. are gram- negative, obligate aerobe spirochaete that infects human upon direct contact with wild or domestic animals (Omitola and Robinson, 2020), or indirectly from urine contaminated by *L. interrogans* through soil and water that can reach the mucous membrane of humans. Leptospirosis is highly associated with heavy rainfall and flooding (Terpstra, 2006;De Vries*et al.*, 2014; Abiayi*et al.*, 2015). The pathogenic serovars like Hardjo and Canicola have been reported as the cause of human disease in different parts of the world (Ezeh*et al.*, 1991;Onyemelukwe, 1993;Agunloye*et al.*, 2001;Brown and Prescott, 2008; Abiayi*et al.*, 2015).

Q Fever

Coxiellaburnetti, the causative agent of Q fever is a gram- negative bacteria and is a potential bioterrorism agent (Nelder*et al.*, 2008). Several ruminant spp. serve as reservoirs of the bacterium and is transmitted via consumption of raw milk and milk products, or through aerosol (Ogo*et al.*, 2013;Jourdain*et al.*, 2015).

Salmonellosis

Salmonella spp. is a gram- negative, motile bacillus that is an important foodborne pathogen worldwide. In Africa, *Salmonella enterica*serovarsEnteritidis and Typhimurium are the leading cause of human enteric diseases (Omitola and Robinson, 2020). The organism can be transmitted upon direct handling of animals and their excretions, or indirectly via contaminated food and water (Cantas and Suer, 2014).

Tularaemia

Francisellatularensis, a gram- negative, facultatively intracellular bacterium is the cause of tularaemia (Siddell*et al.*, 2010). The occurrence of the disease is seasonal when the outdoor activities are maximum and the reservoir animals are at their peak population. It is evident that tularaemia is re- emerging in Germany (Faber *et al.*, 2018).

Yersiniosis

Yersinia spp. are gram- negative coccobacillus, bipolar organisms (Siddell*et al.*, 2010). *Y. pseudotuberculosis* rarely cause human disease while *Y. enterocolitica*bioserotypes 1B/ O:8, 2/ O:5,27, 2/ O:9, 3/ O:3, and 4/ O:3 are the pathogenic strains that are associated with majority of the human foodborne outbreaks globally (Okwori*et al.*, 2009;Rahman *et al.*, 2011). The deadly plague is caused by *Y. pestis* and occurs in three forms- pulmonary, septicaemic, and bubonic (Cantas and Suer, 2014).

RickettsialDiseases

Rickettsiae are gram- negative, obligate intracellular coccobacilli organisms that cause diseases worldwide. *Ricekttsiamassilae*, *R. conoriiisraelensis*, *R. felis*, *R. aeschlimannii*, and *R. africae*have been implicated as the cause of human diseases in different parts of Africa (Parola*et al.*, 2005, Omitola and Robinson, 2020). Many other diseases caused by rickettsial pathogens are considered emerging including *R. japonica* in Japan, *R. conoriicaspia*in Astrakhan, *R. honei* Australia, *R. slovaca* in Europe, *R. sibricamongolotimonae* and *R. heilongjiangensis* in China, and *R. parkeri* in U.S.A (Parola*et al.*, 2005). There is a suspect that *R. helvetica* is also a human pathogen in Europe and Asia (Fournier *et al.*, 2000, Fournier *et al.*, 2002). Many of these pathogens were isolated from ticks (Parola*et al.*, 2005).

Conclusion

The WHO, OIE, WTO, and FAO all work in one way or the other in controlling zoonoses. But their involvement in addressing zoonoses is either too broad or too compartmentalized and is not effective enough to fight against zoonoses in an effective manner. There is a need to create separate international standards and interdisciplinary researches specific to zoonoses. Development of research centres dedicated to studying zoonoses will encourage interdisciplinary research. The unavailability of proper funding as well as lack of awareness is a significant drawback in dealing with zoonotic diseases. The joint organizations need to have a unified voice in addressing the importance of zoonoses to persuade countries in providing funds for zoonoses control and prevention program. Finally, health education can effectively lower the transmission and spreading of zoonoses (Wanjura, 2007).

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