

Review on Emerging Zoonoses and Factors in the Emergence of Infectious Diseases

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ABSTRACT

In global health, critical challenges have arisen from infectious diseases, including the emergence of infectious diseases. Emerging infectious diseases can be defined as infections that have newly appeared in a population or have existed but are rapidly increasing in incidence or geographic range. Among recent examples are HIV/AIDS, hantavirus pulmonary syndrome, Lyme disease, and hemolytic uremic syndrome. Specific factors precipitating disease emergence can be identified in virtually all cases. These include ecological, environmental, or demographic factors that place people at increased contact with a previously unfamiliar microbe or its natural host or promote dissemination. These factors are increasing in prevalence; this increase, together with the ongoing evolution of viral and microbial variants and selection for drug resistance, suggests that infections will continue to emerge and probably increase and emphasizes the urgent need for effective surveillance and control.

Keywords: Emerging zoonosis; Infectious disease; Factors for the infectious disease emergence; Global burden; Burden in Ethiopia

INTRODUCTION

Emerging zoonotic diseases are those zoonotic diseases that are newly recognized or newly evolved or that have occurred previously but shows an increase in incidence or expansion in geographical, host or vector range. A number of examples from various parts of the world demonstrate that a wide variety of animal species, both domesticated and wild animals act as reservoirs for these pathogens, which may be viruses, bacteria, parasites and other [1]. These infections have clearly shown that new zoonoses are emerging in both the developed and the developing world. A zoonotic agent may be a bacterium, a virus and prion, a fungus and helminthes and protozoa. Of the 1,461 diseases now recognized in humans, around 60% of all human diseases and over the past 30 years, around 75% of emerging infectious diseases are zoonotic [2].

Some pathogens are largely confined to animal reservoirs human cases are infrequent or represent dead-end infections whereas others are well-established in both animals and humans. Others present an intermediate situation with animals as the main hosts, but with occasional outbreaks occurring in humans, but

with a transmission chain leading to eventual extinction. There are also some zoonotic agents that gradually adapted to human-to-human transmission and are now readily transmissible between humans. Finally, there are pathogens of animal origin that suddenly appear in human populations. The more classical zoonotic diseases may still be classified as emerging diseases; Some of these diseases may further evolve and become effectively and essentially transmissible from human to human [3]. Many of the human diseases that are new, emerging at the beginning of the 21st century are caused by pathogens originating from humans animals or from products of animal origin referred to as zoonotic diseases. Of the 1,461 diseases now recognized in humans, around 60% of all human diseases and over the past 30 years, around 75% of emerging infectious diseases are zoonotic. Most of the current emerging diseases are zoonoses and affect both animals and humans [4]. They might be foodborne diseases due to Salmonella or Campylobacter, classic diseases such as tuberculosis or anthrax or “media stars” like Ebola, the High Pathogenic Avian Influenza (HPAI) with the threat of a global pandemic. Zoonotic pathogens have even been used by bioterrorists. Globalization of trade and an increasing and unlimited movement of people contribute to the emergence of

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new diseases and exacerbate its consequences. Therefore, the objective of this paper is to review emerging zoonosis and factors in the emergence of infectious diseases [5].

EMERGING ZONOSSES BURDEN GLOBALLY

In recent years, zoonotic diseases have acquired growing national and international significance with regard to health, food safety, trade, and security and economics due to the increasing awareness about the direct relevance of animal diseases to human health. Further, the increasing population density, intensive livestock production systems and rapid movement of people, animals and animal products have increased the vulnerability to cross-species illnesses [6]. Except for the newly emerging zoonosis such as SARS and highly pathogenic avian influenza H5N1, the vast majorities is not prioritized by health systems at national and international levels and are therefore labeled as neglected. According to a recent study 56 zoonotic diseases selected in the study together are responsible for an estimated 2.7 human million deaths and around 2.5 billion cases of human illness a year. Thirteen most important zoonoses in terms of human health impact, livestock impact, amenability to agricultural interventions, severity of diseases and emergence include in descending order zoonotic gastrointestinal disease, leptospirosis, cysticercosis, zoonotic tuberculosis, rabies, leishmaniasis, brucellosis, echinococcosis, toxoplasmosis, Q fever, zoonotic trypanosomosis, hepatitis E and anthrax. These prioritized zoonoses have been assessed to be responsible for causing 2.2 million human deaths and 2.4 billion cases of illness [7].

EMERGING ZONOSSES BURDEN IN ETHIOPIA

The significance of zoonotic diseases is expanding and their health and socioeconomic impacts are increasingly being experienced by many countries, particularly the developing ones estimated that in least developed countries, 20% of human sickness and death was due to zoonoses or diseases that recently jumped from animal species to people. Zoonotic diseases affect the production and safety of foods of animal origin too and have adverse effect on the international trade in animals and animal products, which negatively influences the overall socio-economic development. In countries such as Ethiopia, the establishment and implementation of adequate measures for livestock and consumer health protection against zoonoses, especially those that are new and emerging, has proven to be very difficult. Thus zoonotic diseases continue to further burden public health systems as well as to undermine efforts to boost livestock production and exports [8].

FACTORS FOR THE EMERGENCE OF INFECTIOUS DISEASES

Emergence of new zoonotic pathogens seems to be accelerating for several reasons

Populations have continued to grow, bringing increasingly larger global human and livestock animal and human pop[ulations are

numbers of people and animals into close contact; transportation has advanced, making it possible to circumnavigate the globe in less than the incubation period of most infectious agents; ecologic and environmental changes brought about by human activity are massive; and bioterroristic activities, supported by rogue governments as well as organized amateurs, are increasing, and in most instances the infectious agents of choice seem to be zoonotic [9]. There are many factors that can lead to the emergence of zoonotic disease. For example microbiological factors associated with the agent, the animal hosts/reservoirs and the human victims can result in a new variant of a pathogen that can jump the species barrier [10]. Environmental changes resulting from environmental degradation, human and animal demography changes in farming densities and practices including climatic variations and change can also play a major role. Social, behavioural and cultural risk factors such as food habits, religious beliefs, risk perception and management patterns can also encourage the emergence of zoonoses as an economic factor such as economic growth or economic hardship. Several of these examples underline the importance of the anthropogenic risk factors for zoonoses emergence (Figure 1).

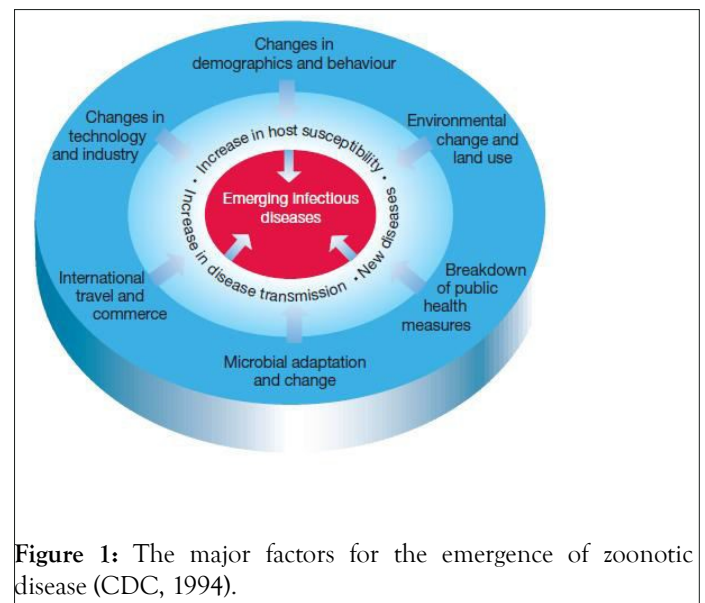


Figure 1: The major factors for the emergence of zoonotic disease (CDC, 1994).

Microbiological factors

Microbes are especially competent at adaptation and change under selective pressures for survival and replication. The remarkable adaptation of microbes to become resistant to antimicrobial products is seen in both human and animal populations and is linked between the two. *S. typhimurium* DT104 was once described as a super bug that had adapted as an antimicrobial resistant pathogen with global distribution in both domestic animals and human populations [11]. The influenza virus is also renowned for its ability to evolve so that new strains emerge annually, giving rise to yearly epidemics in avian and human populations. Many pathogens have developed novel mechanisms to exchange or incorporate new genetic material into their genomes that can alter their survivability and virulence. Other microbes cleverly are capable of defending

themselves or escaping from immune systems, which further demonstrates their extraordinary ability for adaptation [12].

Environmental and climatic risk factors

Disease ecology, defined here as the interplay between pathogens, hosts and environment including also anthropogenic factors, may hold important clues to the understanding of disease emergence. Disease emergence may be viewed as an evolutionary response to novel environments. Understanding this process requires that we identify the links between environmental change, new forms of disease and microbial adaptation. Animal disease emergence mostly concerns increase in disease incidence, invasion into new areas or changes in the host range, rather than a novel disease agent appearing for the first time. It follows that the analysis of disease emergence may benefit from methods used to study the ecology of invasion [13].

Ecology may also explain disease seasonality and annual cycles of retraction and expansion as driven by climatic and geographical factors. Climate change alters vector distribution and abundance, migration patterns of birds and other wildlife, and the survival time of pathogens outside the host. In fact, climate change perhaps more than any other factor is likely to contribute to the emergence of novel forms of disease and pathogens. Ecological factors usually precipitate emergence by placing people in contact with a natural reservoir or host for an infection hitherto unfamiliar but usually already present either by increasing proximity or, often, also by changing conditions so as to favor an increased population of the microbe or its natural host [14]. Global change is increasingly used as collective noun for a wide array of issues believed to contribute to disease emergence in humans. The problem here is that the analysis of risk factors at this aggregate level is not always sensible. Still, it remains that the combination of factors such as globalization, increase in trade and traffic, geography, economic and biotechnological developments, urbanization, land use, climate change, and the “livestock revolution” form causal links with the reported increases in the spread of trans boundary animal diseases, food safety hazards and other veterinary public health risk.

Changes in human demographics and behavior

Human population movements or upheavals, caused by migration or war, are often important factors in disease emergence. In many parts of the world, economic conditions are encouraging the mass movement of workers from rural areas to cities. The United Nations has estimated that, largely as a result of continuing migration, by the year 2025, 65% of the world population, including 61% of the population in developing regions, will live in cities. As discussed above for HIV, rural urbanization allows infections arising in isolated rural areas, which may once have remained obscure and localized, to reach larger populations. Once in a city, the newly introduced infection would have the opportunity to spread locally among the population and could also spread further along highways and interurban transport routes and by airplane. HIV has been, and in Asia is becoming, the best known beneficiary of this dynamic, but many other diseases, such as dengue, stand to

benefit. The frequency of the most severe form, dengue hemorrhagic fever, which is thought to occur when a person is sequentially infected by two types of dengue virus, is increasing as different dengue viruses have extended their range and now overlap [15].

Dengue hemorrhagic fever is now common in some cities in Asia, where the high prevalence of infection is attributed to the proliferation of open containers needed for water storage as the population size exceeds the infrastructure. In urban environments, rain-filled tires or plastic bottles are often breeding grounds of choice for mosquito vectors. The resulting mosquito population boom is complemented by the high human population density in such situations, increasing the chances of stable transmission cycles between infected and susceptible persons. Even in industrialized countries, e.g., the United States, infections such as tuberculosis can spread through high-population density settings. Human behavior can have important effects on disease dissemination. The best known examples are sexually transmitted diseases, and the ways in which such human behavior as sex or intravenous drug use have contributed to the emergence of HIV are now well known. Other factors responsible for disease emergence are influenced by a variety of human actions, so human behavior in the broader sense is also very important. Motivating appropriate individual behavior and constructive action, both locally and in a larger scale, will be essential for controlling emerging infections. Ironically, as AIDS prevention efforts have demonstrated, human behavior remains one of the weakest links in our scientific knowledge.

Economic risk factors

Economic factors arise from insufficient financial investment in research and development to produce interventions, procedures, processes, technology, and training. Additionally, economic factors include insufficient support for a large number of beneficial programs including public-private partnerships, market incentives to develop interventions for “neglected” diseases such as malaria, research into disease pathogenesis, notification of outbreaks, infection control programs and technology, and training of health care professionals and laboratory and field researchers.

International travel and commerce

The dissemination of HIV through travel has already been mentioned. In the past, an infection introduced into people in a geographically isolated area might, on occasion, be brought to a new place through travel, commerce, or war. Trade between Asia and Europe, perhaps beginning with the silk route and continuing with the Crusades, brought the rat and one of its infections, the bubonic plague, to Europe. Beginning in the 16th and 17th centuries, ships bringing slaves from West. In the 19th century, cholera had similar opportunities to spread from its probable origin in the Ganges plain to the Middle East and, from there, to Europe and much of the remaining world. Each of these infections had once been localized and took advantage of opportunities to be carried to previously unfamiliar parts of the world. Similar histories are being repeated today, but

opportunities in recent years have become far richer and more numerous, reflecting the increasing volume, scope, and speed of traffic in an increasingly mobile world. Rats have carried hantaviruses virtually worldwide.

Aedes albopictus (the Asian tiger mosquito) was introduced into the United States, Brazil, and parts of Africa in shipments of used tires from Asia. Since its introduction in 1982, this mosquito has established itself in at least 18 states of the United States and has acquired local viruses including Eastern equine encephalomyelitis, a cause of serious disease. Another mosquito-borne disease, malaria, is one of the most frequently imported diseases in non-endemic-disease areas, and cases of airport malaria are occasionally identified. A classic bacterial disease, cholera, recently entered both South America and Africa. Molecular typing shows the South American isolates to be of the current pandemic strain supporting the suggestion that the organism was introduced in contaminated bilge water from an Asian freighter. Other evidence indicates that cholera was only one of many organisms to travel in ballast water; dozens, perhaps. The concentrating effects that occur with blood and tissue products have inadvertently disseminated infections unrecognized at the time, such as HIV and hepatitis B and C. Medical settings are also at the front line of exposure to new diseases, and a number of infections, including many emerging infections, have spread nosocomially in health care settings. Among the numerous examples, in the outbreaks of Ebola fever in Africa many of the secondary cases were hospital acquired, most transmitted to other patients through contaminated hypodermic apparatus, and some to the health care staff by contact. Transmission of Lassa fever to health care workers has also been documented.

Breakdown of public health measures and deficiencies in public health infrastructure

Classical public health and sanitation measures have long served to minimize dissemination and human exposure to many pathogens spread by traditional routes such as water or preventable by immunization or vector control. The pathogens themselves often still remain, albeit in reduced numbers, in reservoir hosts or in the environment, or in small pockets of infection and, therefore, are often able to take advantage of the opportunity to reemerge if there are breakdowns in preventive measures. Reemerging diseases are those, like cholera, that were once decreasing but are now rapidly increasing again. These are often conventionally understood and well recognized public health threats for which previously active public health measures had been allowed to lapse, a situation that unfortunately now applies all too often in both developing countries and the inner cities of the industrialized world.

The appearance of reemerging diseases may, therefore, often be a sign of the breakdown of public health measures and should be a warning against complacency in the war against infectious diseases. Cholera, for example, has recently been raging in South America and Africa. The rapid spread of cholera in South America may have been abetted by recent reductions in chlorine levels used to treat water supplies. The success of cholera and other enteric diseases is often due to the lack of a reliable water

supply. These problems are more severe in developing countries, but are not confined to these areas. The U.S. outbreak of waterborne *Cryptosporidium* infection in Milwaukee, Wisconsin, in the spring of 1993, with over 400,000 estimated cases, was in part due to a nonfunctioning water filtration plant similar deficiencies in water purification have been found in other cities in the United States (Table 1).

Agent	Disease condition
<i>Anaplasma phagocytophilum</i>	Human granulocytic anaplasmosis
<i>Bartonella clarridgeae</i>	Cat scratch disease
<i>Bartonella elizabethae</i>	Endocarditis, bacteremia
<i>Brachiola vesicularum</i>	Microsporidiosis
<i>Ehrlichia ewingii</i>	Ehrlichiosis
<i>Encephalitozoon intestinalis</i>	Enteritis, disseminated infection
<i>Gymnophalloides seoi</i>	Gastrointestinal illness
Hendra virus	Encephalitis, respiratory disease
Hepatitis G virus	Hepatitis (suspected)

Table 1: Selected new pathogenic agents/infectious diseases identified since 1992.

CONCLUSION

In both developing and industrialized countries, a number of communicable diseases are transmitted from animals to humans. Changing patterns of farming, life style, and transportation influence the dynamics of pathogen ecology. Pathogens are subjected to changes by many intrinsic and extrinsic factors. Mutation, recombination, selection, and deliberate manipulation can result in new traits acquired by pathogens and result in potential epidemic consequences of emergence of diseases through opportunistic host switching is likely to continue as a major source of human infectious disease. Similar occurrences can be expected in the future mainly continuous alteration of the environment and the establishment of human settlements in formerly uninhabited areas, particularly in the tropics, are factors that favour the emergence of diseases for the future. Even now, there has been a remarkable progress in the prevention, control and even eradication of infectious diseases (Zoonotic disease) with improved hygiene and development of antimicrobials and vaccines. However, an infectious disease (Zoonotic disease) negatively influences the overall human health and animal health that gives global significance. Control measures should focus on reservoirs (slaughter of infected animals and vaccination of healthy animals and humans at risk).

Strengthen international surveillance networks to issue early warning, detect, control and reduce emerging infectious diseases. One safeguard against transmission is keeping water

and food supplies free of pathogens. Improve international capability to respond to disease outbreak with adequate medical and veterinary resources and expertise. Strengthen international, national and regional research efforts on emerging infectious diseases. Encourage national governments to improve public health care system, devote resources to eliminating or control cases of emerging infectious diseases and coordinating public health activities with WHO, OIE and other international communities. Establish Strong interdisciplinary collaboration and joint ventures among medical, Veterinary, environmental health and public health professionals, of paramount importance to control this emerging zoonotic disease that currently perpetuates. Awareness creation in the community about zoonoses and on how to prevent and control emerging zoonotic disease.

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