

Emerging Zoonoses and their Determinants

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Abstract

Zoonotic diseases represent one of the leading causes of illness and death from infectious disease. Worldwide, zoonotic diseases have a negative impact on commerce, travel, and economies. In most developing countries, zoonotic diseases are among those diseases of major public health significance and contribute significantly to an already overly burdened public health system. In industrialized nations, zoonotic diseases are of particular concern for at-risk groups such as the elderly, children, childbearing women, and immunocompromised individuals. The World Health Organization has defined zoonoses as, "diseases and infections naturally transmitted between nonhuman vertebrate animals and humans", and emerging zoonotic disease as a "zoonosis that is newly recognized or newly evolved or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range". However link between humans and animals with respect to diseases could be framed in many but slightly different ways. Strikingly, 75% of emerging infectious diseases have been identified as zoonotic in origin. Moreover if we could link the emergence of some diseases to animals, for e.g. AIDS then the number would be much higher. These agents have included some that maintain an ongoing reservoir life cycle in animals or arthropods, without the permanent establishment of a new life cycle in humans, as well as some "species jumpers" that derive from an ancient reservoir life cycle in animals but have subsequently established a new life cycle in humans that no longer involves an animal reservoir. Zoonotic diseases require rather different prevention and control strategies than diseases of etiologic agents employing only human-to-human transmission. Determinants discussed above have to be understood and dealt in proper perspective when it comes to the problem of zoonotic diseases. Different section of workers should collaborate their efforts against dreaded diseases, which are affecting mankind and animals and are continuously posing challenges. Multidisciplinary teams of ecologists, mammalogists, ornithologists, and entomologists, as well as physicians, epidemiologists, public health workers and veterinarians should join hands for intensive and sure success

Key words: Zoonosis, Transmission, Emerging diseases, Determinants, Economic Impact.

Introduction

In recent years a number of new zoonoses have emerged, in both developing and developed countries, and a number of known zoonoses have reemerged in areas where they have been absent for decades or have spread to animal species in which the pathogens had not previously been detected.

The concept of emerging infectious diseases appeared in late 1980's, when major outbreaks occurred around the globe and surprised many scientists who considered infectious diseases to be the maladies of past or limited to the under-developed world. However Charles Nicolle, in his book, "Infectious Diseases Destiny" wrote more than half a century ago: "If human civilization persists, if it continues to develop and expand, infectious diseases will increase in number in all regions of the earth".

This raises a question that why now emergence of infectious diseases is a cause of great concern these

days and what are the factors for their emergence and re-emergence?. Both the developing and developed world has differences in their socio-economic status. Basically whole world could be divided into either following an agrarian or an industrialized setup. Both these kinds have different factors which will be dealt in following text to develop a basic understanding behind the factors which affect the status of zoonotic diseases.

Characteristics of the agrarian society that favours zoonotic transmission are mainly sharing same environment with livestock, movement of animal population, limited human medical and veterinary medical facilities, low literacy rate, poor sanitation/hygiene, environmental disaster/floods, earthquakes, civil unrest wars, AIDS epidemics and other form of immunosuppression.

Characteristics of the industrialized society that favours zoonotic transmissions are mainly leisure time

activities (camping, hunting), ownership of pets, suburban development intruding on indigenous animal population, intensive animal production, human behavior, cultural trends and socio-economic conditions. These are often as important as animal related factors in determining zoonotic disease pattern in a community. As the role of animals in society changes, so does frequency of many zoonotic diseases. Centralized food processing and distribution system, AIDS and other immune-suppressive diseases also favours an aggravated sprung up of zoonotic diseases.

Determinants in the Emergence of Zoonotic Disease Agents-

Many different determinants act in a very complex way, with hard to predict results.

1) Human demographics and behavioral changes-

Human activities are the most potent factors driving disease emergence. Due to changing socio-economic conditions, human population has interference in almost every sphere of nature. Urbanization leading to mass movement of rural population into cities has led to outbreaks of Lassa fever due to increased rodent host in urban communities and of brucellosis. Population explosion leading to intrusion of human to new areas such as the one that occurred in South America where major outbreaks of vampire bat rabies occurred when people settled in remote jungles. Human mortality followed discontinuation of pig raising project which were destroyed being a threat to the crops. This raised the bat population which started feeding humans as their source of blood was destroyed. Increased population density resulted in greater generation of suitable factors such as unhygienic condition due to lack of proper management, as number of people surpasses the infrastructure facilities and accumulation of water which provides feeding ground for vectors. Examples include outbreaks of Dengue fever due to increased mosquito population and cryptosporidium due to contaminated surface water. Change in lifestyle of people such as close contact with pets along with introduction of new pet animals Examples include outbreaks of Congo-Crimean hemorrhagic fever following introduction of ostriches as game farming animals, tuberculosis from deers, epidemic of chorio—lympho-meningitis in pet hamster owner, iguana related salmonellosis, all with many other factors contribute to spread of zoonotic agents.

2) Ecological Changes-

Changes due to agrarian or industrial development are most important factors which have resulted in modification of natural niches and ecosystems. Several devastating outbreaks could be attributed to the effect of change in ecosystem.

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. Examples are of Japanese encephalitis closely associated with rice field irrigation, creating large bodies of stagnant water. Rift valley fever is associated with dam construction and irrigation in heavily populated areas having naïve ruminant population. Proliferation of the rodent reservoir and phlebotome vector due to dam construction and agriculture development has resulted in outbreak of cutaneous leishmaniasis. Kyasanur forest disease, a tick borne encephalitis emerged due to grazing of deforested areas by cattle. The emergence of Lyme disease was probably due to largely to reforestation, which increased the population of deer and the deer tick, the vector of Lyme disease. The movement of people into these areas placed a larger population in close proximity to the vector. Increased rodent population due to ecological changes has resulted in outbreaks of Hantavirus disease syndrome.

3) Microbial changes-

The concept of the microbe as the cause of disease is inadequate and incomplete. But they are among the most mutable determinants of changing status and pattern of zoonotic changes. Microbe changes to unpredictable forms either due to selective natural or man made factors. Genetic reassortments are more common in world of viruses. This is very well exemplified with influenza in which new variants due to genetic drifts and shifts are causing worldwide pandemics. Another disease agent, i.e. Western equine encephalitis virus is thought of been aroused from recombination of Sindbis-like virus and Eastern equine encephalitis.

Selection for antibiotic-resistant bacteria and drug-resistant parasites has become frequent, driven by the wide and sometimes inappropriate use of antimicrobial drugs in a variety of applications. Pathogens can also acquire new antibiotic resistance genes from other, often nonpathogenic, species in the environment, selected or perhaps even driven by the selection pressure of antibiotics. The food and farming industries increasingly use antimicrobial agents and other types of drugs to boost the efficiency of food-producing animals and to prevent certain troublesome organisms from reaching consumers. Use of these chemicals probably enhances the proliferation of antibiotic-resistant microbes. In this category resistant strains of salmonella and E.coli are causing a major threat in surrounding environment of poultry, piggery and calf industry.

4) Technology changes-

Technology is changing at a very fast pace. Food animal veterinarians and technologists over the past 30 or 40 years have adapted to revolutionary changes, driven by economics and technology, in the structure of animal agriculture right from procurement of raw material from across the globe to processing of food up till its distribution. These changes include increasingly larger herd sizes, intensive production management systems, improvement of but simultaneous narrowing of the animal gene pool, vertical integration, and innovations of housing and physical facilities. The resulting production efficiencies have yielded an increase in global trade of animals and animal products.

Food borne zoonoses are increasing day by day in both developed and developing countries. Mass food processing technology allowing contamination of meat has resulted in outbreaks of hemolytic uremic syndrome caused by E.Coli O157:H7 strain. A change in rendering process of animal feed for short term monetary gains has led to dramatic spread of BSE.

5) International travel and trade-

Globalization has reached a point where technical skills and intellectual capital know no borders-but neither do pathogens. Travel is a potent force in the emergence of disease. Migration of humans has been the pathway for disseminating infectious diseases throughout recorded history and will continue to shape the emergence, frequency, and spread of infections in geographic areas and populations. The current volume, speed, and reach of travel are unprecedented. Introduction of bubonic plague and Hanta viral syndrome through rats and of yellow fever through mosquitoes in ships are very well documented examples of such an event. Importation of monkeys for research was the source of first Ebola-like outbreak. The raccoon rabies epidemic, increase in Lyme disease cases are direct consequences of our expansion. Cyclosporiasis, a parasitic diarrheal infection resulting from drinking contaminated water during travel or eating imported produce washed in contaminated water is also an example of travel related zoonotic disease.

6) Improved research

Some disease agents are widely prevalent and were already present in some or the other form. Although recent advances in diagnostic technology can also lead to new recognition of agents that are already widespread. Recent example is the bacterium *Helicobacter pylori*, a probable cause of gastric ulcers and some cancers. We have lived with these diseases for a long time without knowing their cause. Bacillary angiomatosis, infection known since 1983, the etiology was detected as *Bartonella henselae* in 1990.

This has also resulted in documentation of some

of the diseases as emerging infections. Some of the diseases of humans are being considered to evolve from other species of animals. The "zoonotic pool" i.e. introductions of microbes from other species is an important and potentially rich source of emerging diseases, some of which might become successful if given the right conditions. The human immunodeficiency virus (HIV) is a likely example of a zoonotic introduction meeting this criterion. This virus has a very close resemblance with other primate's lentiviruses. Which among the other primate lentiviruses, including some not yet identified, might have the potential to enter the human population and emerge as yet another HIV? Another example is that of Hanta virus which was present in rat species but possible ecological alteration caused an outbreak in human. Bovine spongiform encephalopathy (BSE) appeared as, probable interspecies transfer of scrapie from sheep to cattle. Changes in rendering processes, allowing incomplete inactivation of scrapie agent in sheep byproducts fed to cattle, may have been responsible. In any case, the use of such byproducts was clearly instrumental in amplifying the infection. Other viruses that have recently emerged in other species by cross-species transmission include seal plague, canine distemper in African lions, canine parvovirus, SIV in captive Asian macaques, and callitrichid hepatitis, an introduction of lymphocytic choriomeningitis virus into captive monkeys fed infected mice.

7) Break down in public health measures-

Curtailed or reduction in preventive programmes, inadequate sanitation and vector control measures is a strong factor for emergence of infectious diseases. Vector borne diseases are important examples in this category.

Some of reported zoonoses are due to careless medical interventions. Examples are recent report of rabies virus transmission through organ transplantation. 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. Xenotransplantation (the transfer of organs or other tissues from animals to humans) is yet another ongoing research which if not carefully executed could pose serious risks.

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