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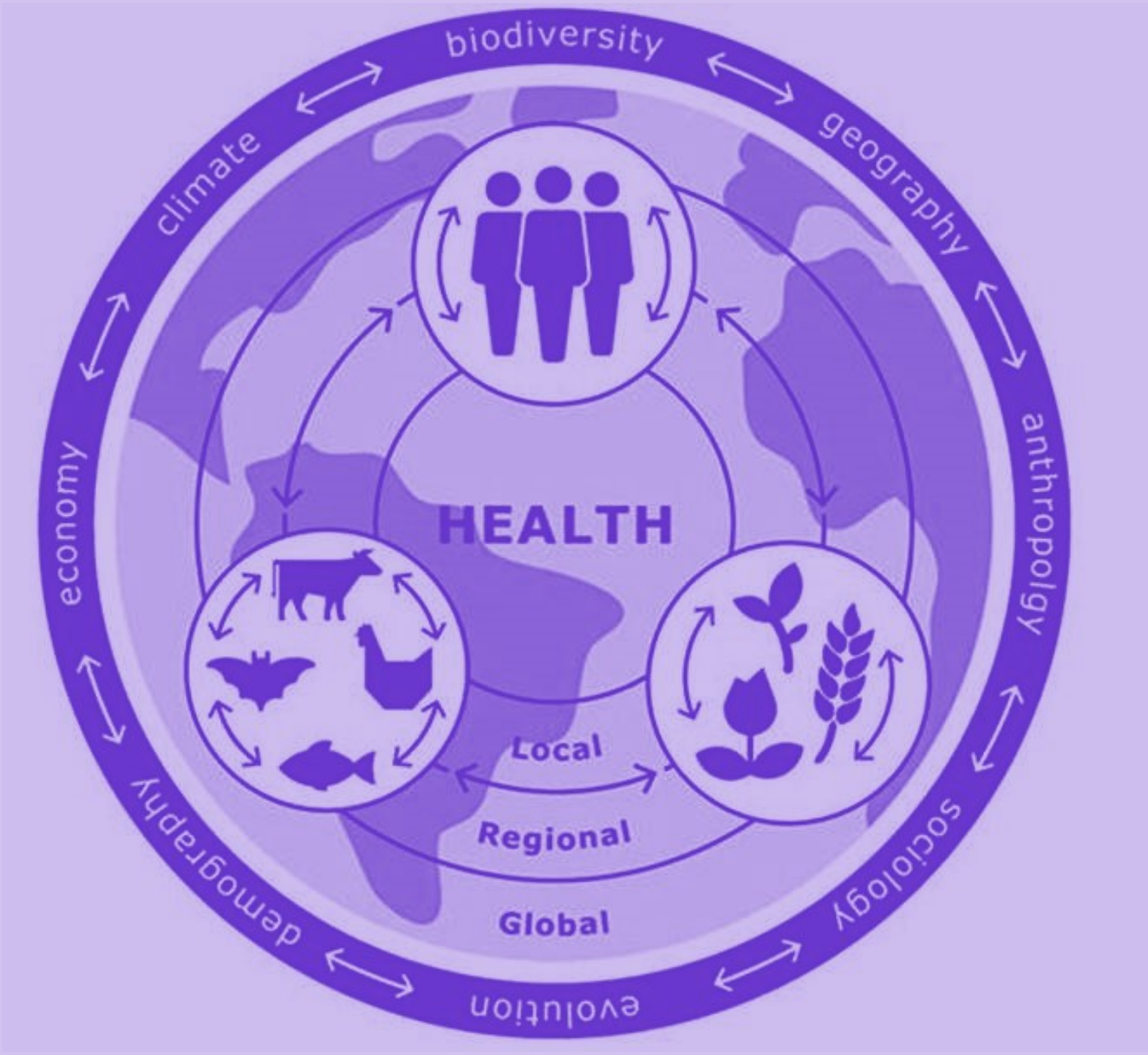

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Emerging Zoonotic Diseases of Public Health Significance in India - An Overview

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Rapid globalization and urbanization have increased the commercial and technological capabilities worldwide. However, despite the development, it has also contributed to the globalization of emerging zoonotic diseases. Emerging zoonoses are those diseases that are newly recognized or newly evolved or that has occurred previously but shows an increase in incidence or expansion in the geographic, host or vector range. Further, it affects the economy and health of particular region or country and other nations also. These zoonotic diseases are the group of diseases and infections which are naturally transmitted from vertebrate animals to man. In India, zoonotic diseases like tuberculosis, brucellosis, and rabies etc. have caused high economic losses and heavy morbidity/mortality. Out of 1415 identified species of infectious organisms including 217 viruses and prions, 538 bacteria and rickettsia, 307 fungi, 66 protozoa and 287 helminths are known to be pathogenic to humans. Out of this 868 (61%) are identified as zoonotic. Of these 868 pathogens 177 (13%) pathogenic species are considered to be 'emerging' and out of 177 emerging pathogens 132 (75%) are considered to be zoonotic. In the recent past, India has seen outbreaks of eight organisms of emerging and re-emerging diseases in various parts of the country, six of these are of zoonotic origin.

Factors involved in the emergence of zoonotic diseases

The emergence of zoonotic diseases is a complex process which involves interaction among human and animal population and environment. Microbial evolution, social and environmental factors play a major role in the emergence of zoonotic diseases. The increasing human population and its expansion into the new habitats including animal dwellings is one of the important causes for the emergence of new diseases. Various factors may be responsible for the emergence of zoonotic diseases, for example:

Globalization and urbanization

India has rapidly becoming more

urbanized. Recent data reveal that urban population accounts for the 33% of total population of India as compared to only 18% in 1960. This results in the increased occurrence of waterborne and airborne emerging and re-emerging zoonotic diseases. Globalization also promotes population movement and migration, which results in frequent travel between cities. Due to financial constraints and overcrowded and unsanitary living conditions, these people are more vulnerable to infectious diseases.

Population growth: India is the second most populous country in the world with 1.25 billion people living in 3.3 million square kilometers. The average population density in India is 382 people per square kilometer. Aging section of the population is the most vulnerable segment in terms of increased susceptibility to zoonotic diseases.

Deforestation: Rapid growth of human population and over exploitation of land in terms of mining, road construction, and buildings resulted in deforestation. It can cause a cascade of factors that results in the emergence of zoonotic diseases. These include forest fragmentation, population migration, pathogen introduction and environmental pollution. Increased interaction among human, wildlife, and livestock has the potential for the transmission of zoonotic pathogens to humans.

Livestock production system: Livestock production is expanding in India at an exceptional rate. In India majority of the farms are small-scale individual farms. Co-existent rearing of different domestic animals in the same environment provides a dynamic microenvironment that contributes interspecies transmission of deadly zoonotic diseases. Also, overcrowding of animal population precipitate disease in an endemic form.

Increasing microbial resistance: Microbes have short life spans, which allow rapid genetic change. Incorporation of antibiotics in the livestock feed and water at low doses for growth promotion and disease prevention has given rise to the development of multi-drug-resistant (MDR) microbes. Also over the counter and indiscriminate use of antibiotics in medical and veterinary practice respectively has increased the menace of MDR microbes. Further continuous selection pressure of certain classes of antibiotics in food animals has resulted in the development of 'Superbugs'.

Climate change: Global temperature is rising and will increase by 1.8-5.8^{o}C by the end of the 21st century. This can enhance pathogen development, disease transmission, and host susceptibility. Changes in temperature and rainfall directly affect vector-borne zoonotic diseases through pathogen-host interaction and indirectly through ecosystem changes and species composition.

Major emerging zoonotic diseases in India:

Japanese Encephalitis (JE)

JE is the most important cause of epidemic encephalitis and childhood mortality globally, with an estimated 35000 to 50000 cases and 10000 deaths annually (Yadav, 2006). It is enzootic in Asia and most commonly associated with rice growing fields in the rural areas where water logging and irrigation system provide a favorable environment for mosquito breeding. The largest and most severe epidemic was experienced in 2005 in Gorakhpur division, UP, where a total of 5737 cases with 1344 deaths were recorded from 7 districts of eastern UP (WHO, 2006). Till November 2016, total 1327 JE cases have been reported with 224 deaths. Majority of the cases have been reported from Assam (407), Uttar Pradesh (309), Odisha (170), West Bengal (126), Bihar (75) and Tripura (71) (NVBDCP, 2016).

Kyasanur Forest Disease (KFD)

It is a viral hemorrhagic fever caused by the bite of infected ticks. KFD virus is enzootic in India and maintained in ticks, mammals, and birds. It causes severe febrile illness in humans. KFD was first recognized in Kyasanur forest of Shimoga district of Karnataka state, India. Its natural cycle involves two species of monkey – the black-faced langur (Presbytis *entellus*) and the red-faced bonnet monkey (*Macaca radiata*) and various tick species, particularly those belongs to genus *Haemaphysalis*. Morbidity rate ranging from 2-20% and an incidence of 100-600 cases annually in five districts of Karnataka (Mourya, 2016). However, the geographic distribution of this group of virus is not restricted to Karnataka.

Campylobacteriosis

Campylobacteriosis is emerging as a major cause of bacterial gastrointestinal infections worldwide (Moore *et al*., 2005). In India, campylobacteriosis still remains under-diagnosed and ignored with very scarce data available on its prevalence and epidemiology. Among all the members, *C.jejuni* and *C.coli* cause most of the infections but *C.lari* and *C.upsaliensis* are also important species. The disease is more common in children and there is an emergence of fluoroquinolone resistance. The most important source of infection for humans is contaminated poultry meat and swine.

Leptospirosis

Due to its increasing prevalence in developed and developing nations, is considered as an emerging public health problem. Man and cattle are incidental hosts and they get infected by contact with water or soil contaminated with infected rat urine. Most countries in South East Asia are endemic to leptospirosis. It has been reported to be a common cause of acute renal failure in south India (Sehgal *et al*., 2003).

Listeriosis

Listeriosis is an emerging zoonotic disease caused by pathogenic species of genus *Listeria*. *Listeria monocytogenes* accounts for approximately 95% of human and 85% of animal cases of listeriosis. The organism is ubiq-

uitous in nature and can thus survive food processing and refrigeration in contaminated meat and dairy products. In case of humans, the prevalence of listeriosis is higher among individuals with immunocompromised status, young age group, and elderly people.

Swine influenza

Influenza viruses have a capacity of genetic re-assortment and as a consequence of such re-assortment influenza A virus (H1N1) emerged among humans in Mexico in April 2009, quickly spread worldwide through human to human transmission, and generating the first influenza pandemic of the 21st century (Murphy 2008). The mode of transmission of the pandemic influenza A virus (H1N1) is primarily close unprotected contact with respiratory droplets. The virus is also likely transmitted through contact with fomites that are contaminated with respiratory or possibly gastrointestinal fluids (Dhama *et al.*, 2009).

Prevention/ control strategies

Despite the huge economic losses incurred due to zoonotic diseases, very little has been done to address prevention and control strategies to combat the emergence of novel zoonotic pathogens. Animal populations are considered the main reservoir for emerging zoonotic diseases. In India, we urgently need coordinated efforts to address the health issues in humans, domestic animals, wild animals, and environment. In order to combat the emerging and re-emerging zoonotic diseases, the

following points should be considered:

Efficient disease reporting system

A web-based disease reporting system should be established for disease related to humans, domestic animals, and wild animals. Adequate cooperation and sharing of information between different agencies and research institutions are needed. This set up will help us to respond effectively to any emerging crises.

Creation of early warning systems

Creation of early warning and surveillance systems will improve our preparedness and response to emerging diseases. Further, the work should be done to develop international early warning systems through international collaboration and coordination for detection of unknown infectious diseases.

Early detection of pathogens

Research and surveillance can map the global movement and evolution of microbes and guide interventions. Laboratory capabilities should be upgraded and a large number of laboratories should be established across the country. Application of recent discoveries and new technologies will aid in early detection of threats.

Emphasis on intersectoral collaboration

Establishment of intersectoral cooperation among different health authorities and sections nationally and globally is needed to effectively respond to upcoming zoonotic diseases. Intersectoral collaboration and sharing of data among animal, human and environmental health services are needed to control emerging zoonotic diseases.

Surveillance:

Diseases such as KFD, West Nile Fever, and Nipah virus encephalitis etc. have been linked with wildlife. So it is important to strengthen the disease surveillance on wildlife diseases to control transboundary and exotic diseases. It must be included with the establishment of coordination mechanism and sharing of disease information among medical and veterinary professionals and wildlife authorities at national level.

Conclusion

For a country of size and population of India, the emerging infections remain a real challenge. A comprehensive national strategy on infectious diseases addressing the challenges of emerging and re-emerging infections cutting across all relevant sectors, both governmental and non-governmental, should be in place. Identification of national centers of excellence and their capacity building is of critical importance. Efficient disease reporting system accompanied with good multidisciplinary cooperation among health agencies and public awareness will help us to fight against emerging diseases.

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