Emerging zoonoses and social-economic impact in India – A review

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ABSTRACT

Emerging and re-emerging zoonoses are newly recognized diseases or are newly evolved, or have occurred previously but have more recently shown an increase in incidence or expansion into a new geographic, host or vector range. Many new human pathogens that have emerged or reemerged worldwide originated from animals or from products of animal origin. The emergence of zoonotic diseases is associated with a range of underlying causal factors, represents a global threat to human and animal health. They humper agricultural production, decrease availability of food and create barriers to trade. In India, livestock are important in supporting the livelihoods of poor farmers, consumers, traders and labourers throughout the country. Close association between human population groups and animals, consumption of unpasteurized milk and dairy products, intensification of animal production and increased trade of animals and animal products, the large number of stray dogs, illegal slaughtering and inappropriate waste disposal are some of the principle factors perpetuating infection in humans. Emergence or re-emergence of these diseases requires long-term actions from the veterinary sector to decrease incidence among disease hosts and reduce or interrupt transmission with commitment between health sector and veterinary sector to implement common control programmes. A close collaboration is needed between animal keepers, farmers, veterinarians and other health professionals, including epidemiologists, occupational health workers, food technologists, specialists in environmental control and laboratory personnel.

Key words: Emerging zoonoses, Social impact, Zoonoses

Globalisation is leading to a rise in the emergence of many animal and human diseases posing new challenges for individual countries and the international community. Emerging zoonotic diseases are causing severe problems for animals and humans. They are occurring at an unprecedented rate in animal and human populations and are causing major consternation for both public health and veterinary communities. Two main factors reasons for disease emergence are: expansion of the human population and globalisation of trade. Increasing movement of a variety of animal species, ecological disruption, morphological changes in the organisms, and bioterrorism, all imply that emerging zoonotic diseases will in all probability, not only continue to occur, but will increase in the rate of their emergence (Thiermann 2004). The recurring nature of the diseases warrants for closer integration of veterinary and medical communities, along with improved education of the general public and policy makers. The interaction between human and animal health is not a new phenomenon. However, the scope, scale, and world-wide impact of zoonoses facing today have no historical precedent. The unprecedented impact of globalisation, industrialisation, restructuring of agricultural systems and consumerism, among others, will certainly change the basic foundation and operations of animal health policies.

EMERGING ZOONOSES

Current scenario

The Office International des Epizooties (OIE) defines an emerging disease as a new infection resulting from the evolution or change of an existing pathogenic agent, a known infection spreading to a new geographic area or population, or a previously unrecognised pathogenic agent or disease diagnosed for the first time (OIE 2004).

Emerging and re-emerging zoonoses are infectious diseases that are newly recognized or are newly evolved, or have occurred previously but have more recently shown an increase in incidence or expansion into a new geographic, host or vector range (Bengis et al. 2004). The term emerging disease has a fairly broad definition and in general, encompasses any 1 of 3 disease situations; (i) a known agent appearing in a new geographic area; (ii) a known agent or its close relative occurring in a unsusceptible species; and (iii) a previously unknown agent detected for the first time.
EMERGING ZOONOSES AND SOCIAL-ECONOMIC IMPACT

(Woolhouse 2002) stated that an emerging disease is a new infection resulting from the evolution or change of an existing pathogen or parasite resulting in a change of host range, vector, pathogenicity or strain; or the occurrence of a previously unrecognised infection or disease. A re-emerging disease is considered an already known disease that either shifts its geographical setting or expands its host range, or significantly increases its prevalence. It may be useful to consider that zoonoses generally fall into 1 of the 2 following categories (WHO 2004):

1. diseases of animal origin in which the actual transmission to humans is a rare event but, once it has occurred, human-to-human transmission maintains the infection cycle for some period of time e.g., human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS), certain influenza A strains, Ebola virus and severe acute respiratory syndrome (SARS).

2. diseases of animal origin in which direct or vector mediated animal-to-human transmission is the usual source of human infection. Animal populations are the principal reservoir of the pathogen and horizontal infection in humans is rare, e.g., lyssavirus infections, Lyme borreliosis, plague, tularemia, leptospirosis, ehrlichiosis, Nipah virus, West Nile virus (WNV) and hantavirus infections.

Over all, approximately 60% of recognised human pathogens are zoonotic, and many of these relatively recent emerging infections can also be traced back to animals. Approximately 75% of the diseases that have emerged over the past 2 decades may have a wildlife source (Woolhouse 2002).

Causal factors

The processes and factors that may have given rise to emerging or re-emerging infectious and zoonotic diseases are (Williams et al. 2002) expanding human populations and increased contact with animals or their products; ecosystem changes of natural or anthropogenic origin, with climatic and geographic influences on pathogens and vectors; increased human-assisted movement of animals and animal products; wildlife-associated microbes entering in intensive livestock-based agricultural systems; intensive farming of formerly wild species; increased frequency and speed of local and international travel; changes in the microbes or their host spectrum (crossing the species barrier); and improved technical diagnostic and epidemiological techniques, resulting in the recent detection of an existing or novel disease agent.

The emergence of these pathogens as significant health issues is associated with a range of causal factors, most of them linked to the sharp and exponential rise of global human activity. (Morner and Addison 2001).

The emergence of pathogenic infectious diseases, associated with a range of underlying causal factors, represents a global threat to human and animal health. The infectious disease agents causing zoonotic diseases, have the ability to cross the species barrier (Maly and Brown 2000). Many of the new, emerging or re-emerging diseases in humans, at the end of the 20th century and the beginning of the next, are by pathogens which originated from animals or products of animal origin. However, this increase in the incidence of disease may be due to enhanced surveillance and awareness. When one considers the wide range of domestic and wild animal species involved and the pathogens concerned, which may be viruses, bacteria or parasites, then effective surveillance, prevention and control of zoonotic diseases poses a significant challenge to public health (Meslin et al. 2000).

Factors contributing to the emergence of zoonotic diseases: Elements that may contribute to the emergence of a new zoonotic disease are– microbial/virologic determinants, (mutation, natural selection, and evolutionary progression), individual host determinants, (acquired immunity and physiologic factors), host population determinants, (host behavioural characteristics and societal, transport, commercial, and iatrogenic factors), and environmental determinants (ecologic and climatologic influences) (Murphy 1993).

Emergence of new zoonotic pathogens seems to be accelerating Meslin (1997), for several reasons: global human and livestock animal populations have continued to grow, bringing increasingly larger 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 and organized amateurs, are increasing, and in most instances the infectious agents of choice seem to be zoonotic.

Surveillance and detection at international level: The rapid detection of an emerging or re-emerging disease is crucial. From the time this new disease develops until it is detected, a critical period has elapsed. Its rapid detection is therefore a key element for all policies to be developed. It is often the case that the disease will have spread undetected for a significant period before it is detected and reported. With globalization and the increase in speed and volume of international transport and passengers travel, emerging pathogens also begin their global voyage and spread.

Detection of emerging diseases is slow in many developing countries and in some developed countries having poor veterinary infrastructure, expertise, diagnostic laboratories and surveillance capabilities. These facilities decides the preparedness and response capability of a country towards an emerging disease, therefore, methods to control...
emerging diseases in some developing countries are less effective (Chomel 2003). Morens et al. (2004) reported that fight against zoonoses starts by eliminating the pathogen at its animal source. This fact provides veterinary services, veterinarians, farmers, managers of wildlife and the OIE, with a leading role at both national and international level. Strengthening of veterinary services in terms of surveillance, rural network of veterinarians, early detection, warning and response, improved diagnostic capabilities and other resources and the adoption of new legislations giving appropriate capacities to veterinary administrations and their partners will provide the basis for better prevention of bioterrorism.

Surveillance and detection at national level: The importance of having an efficient national surveillance and monitoring system for animal diseases and zoonoses in domestic and wild animals, capable of generating reliable information on the disease situation within the country and rapidly detecting diseases introduced accidentally or deliberately is now well agreed. Each country should have a central epidemiology unit, with trained epidemiologists responsible for coordinating the system with the responsibility for collecting information from field veterinarians, laboratories, etc. and analysing it decision making. Databases, mapping software and geographical information systems for data processing and analysis should be used (Jebara 2004).

Predicting the emergence of zoonotic and species-jumping pathogens

In general, there is no way to predict when or where the next important new zoonotic pathogen will emerge or what its ultimate importance might be. As per Murphy (1998) a pathogen might emerge as the cause of a geographically limited curiosity, intermittent disease outbreaks, or a new, epidemic. No one could have predicted the emergence or zoonotic nature of the bovine spongiform encephalopathy prion in cattle in the United Kingdom in 1986, the emergence or zoonotic potential of Sin Nombre virus as the cause of hantavirus pulmonary syndrome in 1993, and certainly not the species-jumping emergence of HIV as the cause of AIDS in 1981. Consequently, investigation at the first sign of emergence of a new zoonotic disease is particularly important, although the investigation usually resembles a field- and laboratory-based research project rather than a typical case-control-based outbreak investigation (Hoogstrat 1979). This reality must drive strategic planning for dealing with new zoonotic diseases.

Public health implications of emerging zoonoses

Many new, emerging and re-emerging diseases of humans are caused by pathogens which originate from animals or products of animal origin. A wide variety of animal species, both domestic and wild, act as reservoirs for these pathogens, which may be viruses, bacteria or parasites. Given the extensive distribution of the animal species affected, the effective surveillance, prevention and control of zoonotic diseases pose a significant challenge in terms of the direct and indirect implications for public health of emerging zoonoses (Gerber et al. 2004). Direct implications are defined as the consequences for human health in terms of morbidity and mortality. Indirect implications are defined as the effect of the influence of emerging zoonotic disease on health professionals and the general public. Professional assessment of the importance of these diseases influences public health practices and structures, the identification of themes for research and allocation of resources at both national and international levels. The perception of the general public regarding the risks involved considerably influences policy-making in the health field. Extensive outbreaks of zoonotic disease are not uncommon, especially as the disease is often not recognised as zoonotic at the outset and may spread undetected for some time. However, in many instances, direct impact on health of these new, emerging or re-emerging zoonoses has been small compared to that of other infectious diseases affecting humans (Meslin 1997).

Emerging zoonotic diseases have tremendous indirect impact on public health policy and structures and on public perception of health risks, e.g. the Ebola virus, avian influenza, monkeypox and bovine spongiform encephalopathy. Recent epidemics of these diseases have served as a reminder of the existence of infectious diseases and of the capacity of these diseases to occur unexpectedly in new locations and animal species. The need for greater international co-operation, better local, regional and global networks for communicable disease surveillance and pandemic planning is also illustrated by these examples. These diseases have contributed to the definition of new paradigms, especially relating to food safety policies and more generally to the protection of public health (Slingenbergh et al. 2004).

Indian scenario

In India, people have always depended on animals as sources of draught power, transport, food and companionship. However, countless species of animals are also sources of viral, bacterial and parasitic diseases transmitted in many ways, including direct contact from them or water contamination by them. For many years these diseases, with their reservoirs in domestic and wild animals, imposing a very heavy burden, in rural areas. Apart from causing human suffering, morbidity and mortality, they hamper agricultural production, decrease availability of food and create barriers to trade.

A significant number of outbreaks of new and resurging zoonotic diseases have emerged due to both new pathological entities and already known agents appearing in areas where they had not been previously reported (Reuben et al. 1992,
Bharti et al. 2003). The many factors associated with emergence and resurgence of zoonoses can be categorized broadly into 4 groups:

1. Changing livestock farming practices, trade patterns of animals and animal products, changing consumer habits and travel (enteric bacterial pathogens such as Escherichia coli 0157:H7, Salmonella Enteritidis and Listeria monocytogenes).

2. Changing environmental conditions, including climate and disasters which influence reservoirs, vectors, and/or host species and population parameters including increasing urbanization (arthropod-borne pathogens haemorrhagic fever viruses, Japanese B encephalitis and Nipah virus infection).

3. Pathogens acquiring new genetic properties through adaptation, mutation, recombination or adapting to a new species (bovine spongiform encephalitis and variant Creutzfeldt–Jakob disease).


The increasing inadequately planned urbanization, opening up of new areas for food production, increasing trade in meat, milk and other products of animal origin, vastly increasing number and speed of vehicles, have made zoonoses not only rural and characteristic of defined areas but regional and, in some cases, national.

Environmental factors have played an important role in the spread of zoonoses and the environment itself has suffered, through the alteration of ecological conditions due to this increase. The greater part of the Indian subcontinent share the same conditions for zoonotic infections and food-borne diseases, i.e. brucellosis, rabies, echinococcosis, leishmaniasis, salmonellosis, etc. Some characteristic examples show the present epidemiological situation.

**Brucellosis**: Human brucellosis transmitted from farm animals such as cattle, sheep, goats and pigs, is regarded as one of the most widespread zoonoses. In particular, during the last 10 years a considerable increase in infection has been recorded among the human population.

**Rabies**: This disease occurs on all parts of the country. Rabies risk and infection rates vary from state to state and within each state. Reliable epidemiological information is generally lacking in most developing countries including India.

**Echinococcosis/hydatidosis**: This continues to give rise to high economic losses both in the public health sector and the animal production industry, despite great advances in the health sciences and in technology.

**Leishmaniasis**: This is an important public health problem for India. The leishmaniasis comprise a broad spectrum of human and animal vector-borne diseases due to different species and strains of *Leishmania*. Most of them are characterized by zoonotic life cycles, with wild and/or domestic mammals acting as reservoir hosts and phlebotomine sandflies as vectors. In a few cases, humans constitute the main or sole reservoir. *Leishmania*/HIV co-infection is considered as a major threat as an emerging disease, especially visceral leishmaniasis, which is the most common opportunistic parasitic infection in many parts of the country.

**Food-borne zoonotic infections**: Almost half of the country’s population suffers from diseases associated with contaminated food and water. Their importance as a public health problem is often overlooked because their true incidence is difficult to evaluate and the severity of their health and economic impact is often not fully understood. Moreover, there is a scarcity of reliable information on the spread of food-borne zoonotic infections among the human population and the sources of food contamination. Zoonotic tuberculosis, campylobacteriosis, enterohaemorrhagic *E. coli* infections, listeriosis and salmonellosis are among the most important.

**Socio-economic consequences of emerging zoonoses**

Livestock are important in supporting the livelihoods of poor farmers, consumers, traders and labourers throughout the country. The greatest impact of livestock in sustainable development. Poor farmers have few animals and few reserves on which to survive during lean times and use for recovery, so the loss of individual animals has a proportionally greater impact.

**Emergence of zoonoses and their multiple impacts**

The transmission, effects and control of animal diseases are manifested in a variety of ways. For the purpose of assessing the impacts of animal diseases on the poor, the following four-category classification captures the key disease groups. Some diseases occur in more than one category. The categories are:

**Epidemic diseases**: Such as FMD, peste des petits ruminants (PPR) and Newcastle disease (ND) threaten national livestock industries by direct effects. These include high levels of morbidity and mortality, control or eradication programme costs and restrictions to trade in livestock and livestock products. Livestock producers, workers in livestock industries and consumers are all affected.

**Zoonotic diseases**: Brucellosis, hydatid disease and rabies have impact mainly on human health animal health or on both. The effects of zoonotic infections are usually greatest on livestock keepers, butchers and other workers who handle livestock products.

**Food-borne infections and intoxications**: *E. coli* 0157 and salmonellosis are a particular problem in more industrialized areas. Food-borne diseases affect consumers, food processing workers and livestock producers.

**Endemic diseases**: Mastitis and pneumonia, and parasitic diseases (trypanosomosis and helminthosis) have impact on livestock keepers and consumers because of productivity losses, control costs and indirect losses. For poor livestock
keepers, the effects of endemic diseases, poor nutrition and other livestock-production constraints are intimately linked.

Animal diseases have multiple impacts, which can be highlighted from different perspectives. The impacts of endemic diseases are mainly felt at farm level, while broader economic impacts can occur with epidemic diseases that restrict trade in livestock and livestock products. The impact of animal diseases in terms of effects on livestock and other effects within farming systems are given in Table 1. Disease effects on livestock include direct effects on productivity, disease-control costs and constraints on livestock management including limitations on species and breed.

Table 1. Multiple impacts of emerging zoonoses

<table>
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<tr>
<th>Direct impacts on livestock productivity</th>
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<tr>
<td>Reduced calving rates: 1-12%</td>
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<td>Increased calf mortality: 10-20%</td>
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<tr>
<td>Small ruminants: lambing/kidding rates decreased by 4-28%</td>
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<td>Decreased milk production: 10-26%</td>
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<td>Decreased animal intake: 5-31%</td>
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<td>Drug use: 5-22% additional cost</td>
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<th>Impacts on agricultural and other products</th>
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<tr>
<td>Decreased draught efficiency: 40%</td>
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<tr>
<td>Decrease in agricultural production in affected areas: 5-10%</td>
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<th>Effects on natural resource use</th>
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<td>Change in migration/settlement patterns: variable effects</td>
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<td>Limited to moderate changes in biodiversity</td>
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<th>Impacts on human welfare</th>
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<tr>
<td>Loss of income and assets related to impacts above</td>
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<td>Limited or reduced livestock reservoir</td>
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<tr>
<th>Ecological impact</th>
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<tr>
<td>Desertification</td>
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<td>Deforestation</td>
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<td>Global warming</td>
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<td>Pollution</td>
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Choices.

In India, livestock are usually the main means of utilizing natural resources and the risk of animal diseases (among other risks) complicates the process. These resources are constantly declining. It has been estimated, for example, that such resources have declined by 30-50% in India from the 1950s to 1982. In temperate highlands, humid and subhumid zones, livestock are recognized as playing a catalytic role in enhanced nutrient cycling.

Zoonotic diseases have significant and measurable effects on human welfare. (Schwabe 1984), particularly the importance of animal products in human nutrition, the social benefits of livestock and the impact of food-borne infections and zoonotic diseases. Animal disease control and livestock products have considerable impact on improving child nutrition among poor people, in which 75% or more of general and child nutrition is based on milk and livestock products.

Poor farmers (small land size or landless labourers) are increasingly relying on livestock as their main source of income, as these provide a safety factor during emergency. The asset-acquisition pathway usually begins with poultry, followed by small ruminants and pigs, and cattle and buffaloes are acquired at later stage. Zoonotic diseases are major constraint to income generation and asset acquisition by the poor, since poor people have limited cash to pay for animal health.

Prevention and control

Prevention and control of emerging zoonoses depend on the firm decision of national authorities to check these diseases and on their capabilities to mobilize resources in different sectors, to establish coordination of activities, promote much needed intersectoral cooperation, especially between national veterinary and public health services in association with public health education campaigns and community involvement. Only comprehensive national approaches supported by inter national technical collaboration will alleviate or eliminate the public health and economic impact of zoonotic diseases.

Control programmes implemented in individual countries have had only partial success or have failed. Besides programme effectiveness requires strong international cooperation, especially between neighbouring countries. Timely exchange of information on zoonotic disease occurrence, intercountry technical cooperation, harmonization of legislation, etc. are all essential for the success of the national zoonoses prevention, surveillance and control programmes.

The activities implemented are directed mainly towards surveillance, prevention and control of major zoonoses i.e. brucellosis (in humans and animals), echinococcosis, leishmaniasis, tabies, salmonellosis and other food-borne zoonotic diseases. Prevention and control strategies for diseases caused by these agents are different from those required for diseases whose etiologic agent has long relied on human-to-human transmission for its survival. Disease prevention and control strategies were largely developed from experiences with vaccine-preventable childhood diseases, sexually transmitted diseases, hepatitis, and other diseases for which traditional clinically based or laboratory-based surveillance can provide the base for intervention activities such as vaccination or antimicrobial chemotherapy. For the zoonoses and for diseases caused by species-jumping agents, prevention and control strategies have come from diverse bases.

Emerging diseases may have a devastating impact on national and international trade unless there is a change in
the traditional approach to disease control and new holistic prevention and control strategies are adopted. Strategies to control emerging diseases will be more effective if competent authorities and veterinary infrastructures in particular, integrate their public and animal health objectives into a single strategy. For India, having an agrarian health issue is more crucial as livelihood of the large segment of population entirely depends upon livestock. Strategic measures of prevention and control at all levels are required to be adopted on priority basis.

REFERENCES


