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Emerging Viral Diseases of Zoonotic Importance-Review

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Abstract: Zoonoses are generally defined as animal diseases that are transmissible to humans. They continue to represent an important health hazard in most parts of the world, where they cause considerable expenditure and losses for the health and agricultural sectors. The emergence of these zoonotic diseases are very distinct, hence their prevention and control will require unique strategies, apart from traditional approaches. Such strategies require rebuilding a cadre of trained professionals of several medical and biologic sciences. Since there is no way to predict when or where the next important new zoonotic pathogen will emerge or what its ultimate importance might be, investigation at the first sign of emergence is particularly important. Some of the important viral emerging and reemerging zoonoses are several encephalitis causing viruses, hantaan virus, rift valley fever virus, rabies, influenza, SARS corona virus, nipah virus, hendra virus and hepatitis E virus. The success of detection and control of these emerging zoonoses is largely based on international solidarity and cooperation. In this review article we summarized some of the emerging and reemerging viral zoonotic diseases, their probable cause and importance in the process of causing life threatening pandemics.

Key words: Zoonoses, prevension, viral diease

INTRODUCTION

Zoonoses are generally defined as animal diseases that are transmissible to humans. However, there are several diseases that occur primarily in humans and that may also be transmitted between humans and animals, with some serving as reservoirs for human infection and others not. The emergence and reemergence of zoonotic diseases present challenges not only to veterinarians, but also to all professions concerned with public health. By studying the surviving documents describing surveillance and methods of control of zoonoses, the history of these diseases can be retraced. Prior to the last century, the best known zoonoses were rabies, yellow fever and influenza. Analysis of historical events yields a number of lessons, the positive and negative influences of theories regarding the etiology, contagiousness and control of these diseases[1].

Over the last several decades, there has been an average of almost one new emerging disease each year and approximately 75% of these diseases have been zoonotic[2]. Zoonotic pathogens do represent the most likely source of emerging and reemerging infectious disease, only a small minority has proved capable of causing major epidemics in the human population[2]. Another study reported that the numbers of microbial species that can infect human beings are shown to be 1415, of which 868 species (61%) are zoonotic[3]. Remerging viral diseases can arise when viruses broaden their host-range (monkey poxvirus; equine morbillivirus), or can be a consequence of intrinsic properties of the virus itself, such as high mutation rates (influenza A virus, FMD virus). Most reemerging viral zoonoses are due to infections with hemorrhagic viruses that are arthropod borne (yellow fever virus), by rodents (Hanta viruses), or by nosocomial infections (Ebola virus). The reemergence and increase of these diseases are a consequence of anthropogenic environmental changes, such as distortions of the ecological balance and changes in agriculture[4].

Microbes continue to evolve and adapt. With the tremendous acceleration and expansion of global trade, human movement, travel and the burgeoning global population of both people and animals, the microbes have an even greater opportunity to adapt, change and be transported to new hosts and ecosystems, often with catastrophic results. Changes in the weather, climate, ecosystem, animal production systems, economic development and land use continue to alter the dynamic between hosts, vectors and microbes in novel ways[5]. To

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respond to emerging and re-emerging infections, it is necessary to understand the interactions between microbial pathogens and their hosts and the impact of environmental and social factors on these interactions. The importance of understanding host-pathogen interactions is underscored by the emergence of virulent H5N1 avian influenza viruses and their transmission to humans and the potential pandemic threat they pose[6]. Over the last decade a number of viral respiratory zoonotic pathogens have been recognized, which have the capacity to infect humans directly or via an intermediate host, among them atleast two (severe acute respiratory syndrome-coronavirus and influenza H5N1) have the potential to cause global pandemics[7].

Emerging viral zoonotic diseases

Hantavirus infections: Hantaviruses are newly emerging group of arthropod-borne viruses, belonging to the family *Bunyaviridae*[8,9] that have significant zoonotic potential. These viruses are found in Europe, Asia, the Americas and are maintained by different species of rodents, in which they produce chronic, inapparent infections. Humans get infected by contact with the excretions from infected rodents through aerosol. The disease occurs as in two major syndromes, such as Haemorrhagic Fever with Renal Syndrome (HFRS) which mainly occurs in Europe and Asia and the Hantavirus Pulmonary Syndrome (HPS) described in southern Argentina. Mostly epidemics of HFRS and HPS occur in areas with large populations of rodents with relatively high prevalence of infection[9].

Rift valley fever: Rift Valley fever is an arthropod-borne viral disease of ruminants, camels and humans, one of the most important viral zoonoses in Africa, belonging to the genus *Phlebovirus* in the family *Bunyaviridae*[10]. It is also a significant zoonosis which may also present as a hemorrhagic disease with liver, ocular or neurological lesions, inapparent in non-pregnant adults, but outbreaks are characterized by the onset of abortions and high neonatal mortality which are associated with persistent heavy rainfall with sustained flooding and with large numbers of mosquitoes. After virus amplification in vertebrates, mosquitoes act as secondary vectors to sustain the epidemic[11].

Rabies: Rabies, one of the members of the family *Rhabdoviridae* is a worldwide zoonosis caused by a *lyssavirus*, with many host species acting as reservoirs. This virus have been isolated from bats and is still a significant public health problem, particularly in areas where canine rabies is still endemic, such as countries in Africa and Asia[12]. In animal rabies cattle and dogs accounted for 46.4 and 40.4% of total cases, respectively[13]. During 2004, 49 US states and Puerto Rico reported 6,836 cases of rabies in animals and 8 cases in human beings, representing a 4.6% decrease from the cases reported in the previous year. Compared with the numbers of reported cases in 2003, cases in 2004 decreased among all groups, except in bats, cattle and human beings[14].

Nipah virus: A new pig disease characterized by pronounced respiratory and neurologic syndrome and sometimes with sudden death of sows and boars spread among pig farms in Peninsular Malaysia during late 1998 to 1999[15]. Initially, the disease was considered to be Japanese encephalitis. Subsequently, it was thought to be Hendra-like viral encephalitis, but by April, 1999 the Minister of Health announced the mysterious and deadly virus to be a new virus named Nipah virus[16]. Nipah Virus (NiV) was identified and confirmed to be the cause of both human and the pig disease[17]. Human to human transmission has not been documented. Most of the affected pigs had severe lung lesions with varying degree of lung consolidation, emphysema and hemorrhages, fluid filled bronchi and trachea with or without blood. Brain tissues have generalized congestion and edema[18].

Hendra virus: In 1994, an outbreak of severe and fatal respiratory disease occurred in Brisbane, Australia, killing 13 infected race horses and also a horse trainer. The causative agent, Hendra virus is the type species of a new genus within the sub-family *Paramyxovirinae*, though at first the virus was denoted as Australian equine morbillivirus and only later named Hendra[19]. The virus is a lethal zoonotic agent able to cause natural disease in humans and horses and experimentally induced disease in cats, guinea-pigs and mice. Hendra virus is related to Nipah virus, the virus that caused disease and mortality in humans, pigs, dogs and cats in Malaysia during 1998 and 1999[20].

Avian influenza: Influenza is a zoonotic disease caused by a constantly varying RNA virus resulting in a need for continuous surveillance to update human vaccines[21]. The evolution of influenza is a continuing process and the increasing frequency of emergence of the highly pathogenic H5N1, H7N3 and H7N7 influenza viruses and the panzootic spread of H9N2 influenza virus, are of great concern to both veterinary and human public health officials. Highly concentrated poultry and pig farming, in conjunction with traditional live animal provide optimal conditions for increased mutation, reassortment and recombination of influenza viruses. Strategies to reduce

the evolution of influenza and the emergence of pandemics include the separation of species, increased bio-security and the development of new vaccine strategies and better basic knowledge of the virus[22].

Hepatitis E Virus (HEV): This is an emerging pathogen belonging to a newly recognized family *Hepeviridae* of RNA viruses. HEV is an important enterically transmitted human pathogen with a worldwide distribution. It can cause sporadic cases as well as large epidemics of acute hepatitis. Epidemics are primarily waterborne in areas where water supplies are contaminated with HEV of human origin. There is increasing evidence, however, that many animal species are infected with an antigenically similar virus. A recently isolated swine virus is the best candidate for causing a zoonotic form of hepatitis E. Very recent evidence has also shown that swine HEV and possibly a deer strain of HEV, can be transmitted to humans by consumption of contaminated meat[23].

Severe Acute Respiratory Syndrome (SARS): SARS was caused by a previously unrecognized animal coronavirus (CoVs) that exploited opportunities provided by wet markets in southern China to adapt to become a virus readily transmissible between humans. Hospitals and international travel proved to be 'amplifiers' that permitted a local outbreak to achieve global dimensions. The concerted and coordinated response that contained SARS is a triumph for global public health and provides a new paradigm for the detection and control of future emerging infectious disease threats[24]. In livestock and poultry, CoVs are recognized as causes for enteric and respiratory infections that are often fatal in young animals. The virus is thought to be of zoonotic origin from wild animal reservoir Himalayan palm civets and has been proved experimentally the transmission to rodents or domestic cats[24].

Viral zoonotic encephalitis: Some of the recently recognized viruses causing encephalitis in humans and livestock, include Hendra and Nipah viruses. Viral diseases, because of their rapidity of spread, feature prominently in any listing of emerging diseases. The predominance of viral diseases has been highlighted by recognition of Ebola hemorrhagic fever epidemics in central Africa during 1990s, a new disease in horses and humans in Australia by 1994 caused by a Hendra virus and the zoonotic outbreak of H5N1 avian influenza in Hong Kong during 1997[25].

Emerging food-borne zoonoses: Almost all diarrhoeal diseases are caused by food-borne microbes leading to illness and death in under developed countries[26]. The majority of the pathogens causing this significant disease burden are now considered to be zoonotic. The occurrence of some of these zoonotic pathogens seems to have increased significantly over recent years.

Ecology and zoonotic diseases: Pathogens or infections causing zoonotic threat to humans such as human immunodeficiency virus, severe acute respiratory syndrome or emerging influenza type A viruses may underwent a transient zoonotic stage before adapting to humans. Disease emergence can be depicted as an evolutionary response to changes in the environment, including anthropogenic factors such as new agricultural practices, urbanization, globalization and climate change. Animal pathogens are subjected to pressures resulting from the production, processing and retail environment which together alter host contact rate, population size and/or microbial traffic flows in the food chain[27].

Wildlife role in zoonoses: Pathogenic microorganisms originating in wild animals has become increasingly important in recent years, as they have substantial impacts on human health, agricultural production, wildlife-based economies and conservation. The emergence of these pathogens as significant health issues as most of them linked to the sharp and exponential rise of global human activity. There are two different patterns of transmission of pathogens from wild animals to humans are evident among these emerging zoonotic diseases. First, actual transmission of the pathogen to humans is a rare event but, once it has occurred, human-to-human transmission maintains the infection for some period of time or permanently[28]. Some examples of pathogens with this pattern of transmission are human immunodeficiency virus/acquired immune deficiency syndrome, influenza A, Ebola virus and severe acute respiratory syndrome. Secondly, direct or arthropod/vector-mediated animal to human transmission, the usual source of human infection. Examples of pathogens with this pattern of transmission include rabies virus, Nipah virus, West Nile virus and Hantavirus.

Veterinary public health: It is a component of public health activities involving their application of professional veterinary skills, knowledge and resources for the protection and improvement of public health. Its activities involve a very diverse range of functions within public health which reflect the broad community of interests between veterinary and human medicine. Recent observations in the developing countries show that expenses related to the prevention of zoonotic diseases in humans are likely to increase dramatically in the near

future. The technical knowledge exists to bring diseases such as rabies, under control during the first decade of the next century. In addition, as trade in animal products and the movement of human populations continues to increase, the risk that zoonotic diseases will be introduced or reintroduced into certain areas is likewise increasing. Through its coordinating and information gathering functions, the WHO Emerging Disease Surveillance and Control Division provides a source of both practical and technical guidance that can help solve the zoonotic diseases and other threats to human health posed by animals[29].

Control and prevention strategies: Control of these emerging and reemerging zoonotic diseases and protection of the public health will become even more challenging as world population increases. When overpopulation and crowding occur, there will be water shortages, improper maintenance of hygiene and malnutrition leading to disease and epidemics. The first line of defense is the surveillance and reporting of disease now and then. Knowledge of the epidemiology of the disease organisms is the first step in initiating a control program. These trends have lead to increased public awareness of disease risks and to the expectation that the veterinary profession should become the global steward of animal health, environmental quality, food safety, animal welfare and zoonotic disease control. All these responsibilities will require the application of the principles of preventive medicine, surveillance, international collaboration and disease prevention and control. Prevention and control strategies chosen must be in keeping with the characteristics of the virus, its transmission patterns and environmental stability, its pathogenesis and threat to animal health, productivity and profitability, zoonotic risk etc. When available and legally permitted, the most valuable preventive measure is vaccination, not merely for the protection of the individual animal, but to build up a level of population immunity sufficient to break chains of transmission. The importation of exotic diseases into countries is prevented by surveillance and quarantine programs.

CONCLUSION

As the result of global warming and population bursting, many diseases get emerged along with reemergence of some new viruses that pose threat of pandemics. Timely prevention and control of these zoonotic diseases are priorities since the emergence of these diseases are very distinct and there is no way to predict when or where the next new zoonotic pathogen will emerge or what its ultimate importance might be. Since zoonoses can infect both animals and humans, the medical and veterinary communities should work closely together in clinical, public health and research settings. Due to continued pathogen discovery, improved detection of agents with sensitive, specific and reproducible assays are crucial. Combining proteomics, genomics, microarrays, nanotechnology and mass spectrometry with traditional detection tools such as histopathology may better confirm or refute hypotheses of disease causation.

REFERENCES

1. Blancou, J. and F.X. Meslin, 2000. Brief review of the history of zoonoses. Rev. Sci. Tech., 19: 15-22.
2. Woolhouse, M.E. and S. Gowtage-Sequeria, 2005. Host range and emerging and reemerging pathogens. Emerg. Infect. Dis., 11: 1842-1847.
3. Yamada, A., 2004. Zoonoses. Uirusu, 54: 17-22.
4. Greiser-Wilke, I. and L. Haas, 1999. Emerging of new viral zoonoses. Dtsch. Tierarztl. Wochenschr., 106: 332-338.
5. King, L.J., 2004. Emerging zoonoses and pathogens of public health significance. Rev. Sci. Tech. Off. Int. Epiz., 23: 429-433.
6. Fauci, A.S., 2006. Emerging and re-emergence infectious diseases: influenza as a prototype of the host-pathogen balancing act. Cell, 124: 665-670.
7. Snell, N.J., 2004. Novel and re-emerging respiratory infections. Expert Rev. Anti. Infect. Ther., 2: 405-412.
8. Simmons, J.H. and L.K. Riley, 2002. Hantaviruses: An overview. Comp. Med., 52: 97-110.
9. Enria, D.A.M. and S.C. Levis, 2004. Hantavirus infections. Rev. Sci. Tech. Off. Int. Epiz., 23: 595-611.
10. Flick, R. and M. Bouloy, 2005. Rift valley fever virus. Curr. Mol. Med., 5: 827-834.
11. Gerdes, G.H., 2004. Rift valley fever. Rev. Sci. Tech. Off. Int. Epiz., 23: 613-623.
12. Cliquet, F. and E. Picard-Meyer, 2004. Rabies. Rev. Sci. Tech. Off. Int. Epiz., 23: 625-642.
13. Kim, C.H., C.G. Lee, H.C. Yoon, H.M. Nam, C.K. Park, J.C. Lee, M.I. Kang and S.H. Wee, 2006. Rabies, an emerging disease in Korea. J. Vet. Med. B. Infect. Dis. Vet. Public Health, 53: 111-115.
14. Krebs, J.W., E.J. Mandel, D.L. Swerdlow and C.E. Rupprecht, 2005. Rabies surveillance in the United States. J. Am. Vet. Med. Assoc., 227: 1912-1925.
15. Chua, K.B., W.J. Bellini, P.A. Rota and B.H. Harcourt *et al*., 2000. Nipah virus: A recently emergent deadly paramyxovirus. Sci., 288: 1432-1435.

16. Uppal, P.K., 2000. Emergence of Nipah virus in Malaysia. Ann. NY Acad. Sci., 916: 354-357.
17. Kerr, J.R., 2000. Nipah virus. Infect. Dis. Rev., 2: 53-54.
18. Chua, K.B., K.J. Goh, K.T. Wong and A. Kamarulzaman *et al*., 1999. Fatal encephalitis due to Nipah virus among pig-farmers in Malaysia. Lancet, 9: 1257-1259.
19. Barclay, A.J and D.J. Paton, 2000. Hendra (equine morbillivirus). Vet. J., 160: 169-76.
20. Westbury, H.A., 2000. Hendra virus disease in horses. Rev. Sci. Tech., 19: 151-159.
21. Webster, R.G., 2002. The importance of animal influenza for human disease. Vaccine, 20: 16-20.
22. Webster, R.G. and D.J. Hulse, 2004. Microbial adaptation and change: Avian influenza. Rev. Sci. Tech. Off. Int. Epiz., 23: 453-465
23. Goens, S.D and M.L. Perdue, 2004. Hepatitis E viruses in humans and animals. Anim. Health Res. Rev., 5: 145-156.
24. Peiris, J.S., Y. Guan and K.Y. Yuen, 2004. Severe acute respiratory syndrome. Nat. Med., 10: S88-97.
25. Mackenzie, J.S., 2005. Emerging zoonotic encephalitis viruses: Lessons from Southeast Asia and Oceania. J. Neurovirol, 11: 434-440.
26. Schlundt, J., H. Toyofuku, J. Jansen and S.A. Herbst, 2004. Emerging food-borne zoonoses. Rev. Sci. Tech. Off. Int. Epiz., 23: 513-533.
27. Slingenbergh, J., M. Gilbert, K. de Balogh and W. Wint, 2004. Ecology and zoonotic diseases, Rev. Sci. Tech. Off. Int. Epiz., 23: 467-484.
28. Bengis, R.G., F.A. Leighton, J.R. Fischer, M. Artois, T. Mörner and C.M. Tate, 2004. Wildlife Role zoonoses. Rev. Sci. Tech. Off. Int. Epiz., 23: 497-511.
29. Stohr, K. and F.X. Meslin, 1997. The role of veterinary public health in the prevention of zoonoses. Arch. Virol., 13: 207-218.