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A Review on Emerging and re Emerging Viral Zoonotic Diseases

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Abstract: Zoonotic disease (zoonosis) is most commonly defined as any disease and/or infection which is naturally transmissible from vertebrate animals to man. This review paper is aimed to provide a compiled and enough information about emerging and re-emerging viral zoonoses diseases, factor of emergences and re emergences of these diseases and prevention and control against emerging and reemerging viral zoonotic diseases. Viral diseases are one of zoonotic diseases that may emerge or re-emerge after once thought to have been controlled. Emerging zoonotic infectious diseases are those infections, in which the incidence of humans and animal have either increased during the last two decades or threaten to increase in the near future. Re-emerging infectious diseases are those that have reappeared after a significant decline in their incidence. Emerging and re-emerging diseases are causing devastating effects internationally, with millions infected and billions spent. The most common events that were contributing to the emergence and re-emergence of zoonotic diseases are microbial adaptation, climatic conditions, international travel and globalization and trade. In order to prevent both human and animal deaths and also to avoid potential economic problems resulted by emerging and re-emerging viral zoonotic diseases, there should be good control and prevention methods of these diseases. So, such strategies require developed epidemiology, improved diagnostic facility, avoid global warming and working in collaboration with others.

Key words: Emerging Disease · Reemerging Disease · Viral Diseases · Zoonosis

INTRODUCTION

Zoonotic disease (zoonosis) is most commonly defined as any disease and/or infection which are naturally transmissible from vertebrate animals to man [1]. Emerging zoonotic infectious diseases are those infections, in which the incidence of humans and animal have either increased during the last two decades or threaten to increase in the near future. This term includes newly appearing infections or those spreading to new geographical areas. It also refers to those diseases which were easily controlled previously by antimicrobials but have developed new resistance to different drugs. Re-emerging infectious diseases are those that have reappeared after a significant decline in their incidence [2]. Of the 1415, microbial diseases affecting humans, 61% are zoonotic and among emerging infectious diseases, 75% are zoonotic with wildlife being one of the major sources of infection. A new virus has been emerging almost every year since last two decades. Of 534 zoonotic viruses (belonging to 8 families) identified 120 cause human illnesses with or without the involvement of intermediate host/vector [3]. Re-emerging viral disease can arise when virus broaden their host range (monkey poxvirus), or can be a consequence of intrinsic properties of the virus itself, such as high mutation rate (influenza A virus). The Re-emergence and increase of these diseases are a consequence of anthropogenic environmental changes, such as distortion of the ecological balances 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 microbial have an even greater opportunity to adapt, change and be transported to new hosts and ecosystems, often with catastrophic result. Change in the weather, climate, ecosystem, animal production system, economic

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development and land use continue to alter the dynamic between hosts, vectors and microbes in novel ways [5]. Viruses with RNA as their genetic material can quickly adapt and exploit these varying conditions because of the high error rates of the virus enzymes (polymerases) that replicate their genomes. It comes as no surprise then that several prominent recent examples of emerging and re-emerging diseases are caused by RNA viruses. However, a complex interplay of factors can influence disease emergence [6].

Emerging and re-emerging diseases are causing devastating effects internationally, with millions infected and billions spent. Different diseases have become pandemic, spreading from one continent to another causing massive mortality rates and affecting global economies and livelihoods [7]. Future occurrences of newly emerging diseases are most likely to erupt at these intensifying interfaces. In less developed countries, the communities most likely to be affected by such outbreaks are, those that are poor or in less accessible areas. Such community's frequently rely on inadequate methods of medical surveillance and diagnostics, as well as traditional treatment methods. As the result, it is unfortunately quite likely that an emerging disease with high epidemic potential may only be detected after it has become established in humans or their livestock and has already spread significantly [8].

Therefore, the aim of this paper is:

- To provide a compiled information about emerging and re-emerging viral zoonoses diseases,
- To review factors of emergences and re emergences of these diseases and
- To provide information on control and prevention of these diseases.

Emerging and re Emerging Viral Zoonotic Diseases

Emerging Viral Zoonotic Diseases

Avian Influenza: The emergence and re-emergence of influenza viruses with pandemic potential for both human and veterinary public health is of great concern to humans globally. The convergence of factors affecting contemporary human and animal health issues has led to changing roles for veterinarians and public health officials worldwide [9]. Avian influenza or bird flu, caused by the highly pathogenic H_5N_1 influenza virus has affected at least eight countries in Asia leading to outbreaks of severe disease, mass deaths and destruction of chickens. The virus that caused such destruction is known to have the capacity to be transmitted from infected chickens to cause severe disease and high mortality in humans [7].

The evolution of influenza is a continuing process and the increasing of emergence of the highly pathogenic H_5N_1, H_7N_3, H_7N_7 and H_9N_3 viruses are of a great concern to both veterinary and human public health officials. Highly concentrated poultry and pig farming in conjunction with traditional live animal provide optimal condition for increased mutation, reassortement and recombination of influenza virus. Strategies to reduce the evolution of influenza and emergence of pandemics include the separation of species, increased biosecurity and the development of new vaccine strategies and better basic knowledge of the virus [9].

Rabies: It is a disease, one of the members of the family *Rhabdoviridae* is a worldwide zoonosis caused by a *lyssavirus,* with many host species acting as reservoir. Rabies has 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 [10]. In animals rabies cattle and dog accounted for 46.4 and 40.4% of total cases, respectively [4]. The incidence of rabies and the range of species involved, is increasing in Africa and a number of wildlife hosts has been identified, including wild dogs, jackals and mongoose. Because of dislocation of civilian life, rabies in Zimbabwe has increased in prevalence and geographical distribution in recent years. Rabies is now a very serious zoonotic disease in South Darfur, Sudan [11].

Hepatitis: It is a disease which is caused by an emerging pathogen bellowing to a newly recognized family *Hepeviridae* of RNA viruses. HEV is an important enterically transmitted human pathogen with a worldwide distribution [12]. It can cause sporadic cases as well as large epidemics of acute hepatitis. Epidemics are primarily water borne in area 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 recent 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 [13].

Hemorrhagic Fever: Ebola virus, a member of the *Filoviridae*, burst from obscurity with spectacular outbreaks of severe, hemorrhagic fever [7]. Ebola viruses were shown to be the cause of simultaneously occurring hemorrhagic fever outbreaks in 1976 in the Democratic Republic of Congo (DRC, formerly Zaire) and Sudan.

These outbreaks were shown to be caused by two different subtypes of Ebola virus, which became known as the Zaire and Sudan subtypes. Mortality rates of up to 80% were recorded in these and more recent outbreaks in DRC and Gabon in 1995–1996. Epidemiologic data from recent outbreaks indicate that close contact is necessary for efficient transmission of Ebola virus from one individual to another and little evidence can be found for aerosol transmission of the virus [6].

Hantavirus Pulmonary Syndrome: Hantaviruses are newly emerging group of arthropod-borne viruses, belonging to the family *Bunyaviridae* that have significant zoonotic Specific potential [4]. Hanta-viruses transmitted from the contaminated urine and feces of infected rodents cause two important human diseases, hemorrhagic fever with renal syndrome and Hantavirus pulmonary syndrome [14]. Mostly epidemics of HFRS and HPS occur in areas with large populations of rodents with relatively high prevalence of infection [15]. These viruses are excellent examples of zoonoses agents that periodically spill over into human populations, with devastating effects [16].

Sever Acute Respiratory Syndrome: Sever acute respiratory syndrome was caused by previously unrecognized animal corona virus that exploited opportunities provided by wet market in southern china to adapt to become a virus readily transmissible between humans. Hospitals and international travel provide to be 'amplifiers' that permitted a local outbreak to achieve global dimension. The concentrated and coordinated response that contaminated SARS is success for global public health and provides a new paradigm for the detection and control of future emerging infection disease threat [17]. In traditional local markets throughout Asia, intensive and prolonged contacts amongst livestock, poultry, wild animals and humans occur routinely; these places are thus ideal "melting pots" for pathogens transmission and cross-over between species [16].

Monkey Pox: Monkey pox is a zoonotic viral disease that can infect nonhuman primates, rodents and some other mammals. This disease is endemic in western and central Africa, where it circulates in unknown animal hosts and emerges periodically as a zoonosis in humans [17].

Tree squirrels and other rodents of the African tropical forests are known reservoirs of this poxvirus. Human cases of monkey pox virus infection have been sporadically reported in West and Central Africa, especially in hunters or in people handling the reservoir species. In most recent years, after smallpox vaccination was globally discontinued, many people from African countries devastate by civil war involved in poaching and subsistence hunting became infected with high fatality rates. In 2003, monkey pox made headlines in North America when exotic pet owners gain the disease from prairie dogs, accidentally infected by imported African rodents. This monkey pox outbreak in humans and prairie dogs is one of the visible results of international pet trade, increased number of people owning exotic animals and captive wildlife [16].

Nipah Virus Infection: Nipah virus is a newly discovered member of the *paramyxovirus* family of non-segmented RNA viruses. This virus was responsible for a viral encephalitis outbreak in Malaysia that was first recognized in October 1998 and ended in midsummer 1999 [6]. 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 of Malaysia announced the mysterious and deadly virus to be a new virus named Nipah virus [20]. Nipah virus was identified and confirmed to be the cause of both human and the pig disease. Human to human transmission has not been documented. Most of the affected pigs had severe lung lesions with varying degree of lung and trachea with or without blood. Brain tissues have generalized congestion and edema [4]. Nipah virus emerged as a new human pathogen under changing ecological conditions that point to a complex interplay of human activities as the ultimate cause of this disease emergence [9]. During 2001-2004, Nipah virus infection was also confirmed in Bangladesh, but in this case patients might have been infected directly through the consumption of fruit contaminated by bats [14].

Hendra Virus Infection: An acute disease of horses which is transmissible to humans and characterized in horses by fever and respiratory distress occurs uncommonly in Northeastern Australia. The disease is associated with the recently recognized equine Hendra virus (Hendravirus in the family *Paramyxoviridae*, formerly equine *morbillivirus*) which is closely related to Nipah virus and more distantly related to Menangle virus, both of which cause disease in pigs and humans [11]. The virus is a lethal zoonotic agent able to cause natural disease in humans and horses and experimentally induced disease in cat, guinea-pigs and mice [4].

Re-emerging Viral Zoonotic Diseases

Rift Valley Fever: Rift valley fever is an arthropod-borne viral disease of ruminants, camels and humans, one of the most important viral zoonosis in Africa, belonging to the genus *phelbovirus* in the family *bunyaviridae*. It is a significant zoonosis which may also present as a hemorrhagic disease with liver, ocular or neurological lesion, in apparent in non-pregnant adults, but outbreak are characterized by the onset of abortion and high neonatal mortality which are associated with persistent heavy rain fall with sustained flooding and with large number of mosquitoes [18]. These recent events have raised a serious concern for a potential risk of RVF expanding its range to most of the Mediterranean Basin [16].

West Nile Fever: West Nile fever which is caused by this *flavivirus* is maintained in a wide range of wild bird species and in Culicidae mosquitoes is known to periodically occur in Europe, Africa and Western Asia. West Nile virus generally causes influenza like illness and encephalitis in some mammalian hosts, including horses and humans. During the period 1999-2003, WNV was involved in an unprecedented number of meningo-encephalitis outbreaks in North America, causing more than 500 human deaths; also horses were affected. WNV has spread from the east coast of the USA to the west, affecting the whole country. High morbidity and mortality rate was observed in many autochthonous bird species, especially in corvids. WNV is now established in North America and may pose a risk for Central, South America and the Caribbean, due to Southwards movements of migratory birds [14]. West Nile virus was also confined to the Eastern Hemisphere [17].

Dengue Fever: Dengue fever and the severe form of the disease, DHF, are caused by the world's most prevalent mosquito-borne virus. DENV is carried by *Aedes aegypti* mosquito, which is strongly affected by ecological and human drivers, but also influenced by climate (temperature, humidity and solar radiation). Although DENV was known to circulate among mosquitoes within limited areas in West Africa and East Africa, dengue fever first emerged among the African population during the epidemic of Nigeria in 1964–1968, then in Senegal in 1980 and Burkina Faso and Kenya in 1982. Since then epidemic manifestations were recorded in East Africa (Mozambique, Sudan, Djibouti, Somalia, Eritrea), in Senegal and more recently in Gabon [15]. With a 30-fold growth in incidence over the past 50 years worldwide, the disease has expanded its geographical distribution to almost all tropical and subtropical countries. Recently, the virus has spread to the Middle East and the US states of Hawaii and Texas [19].

Lassa Fever: Lassa fever is an acute viral zoonotic illness caused by Lassa virus, an Arena virus known to be responsible for a severe hemorrhagic fever characterized by fever, muscle aches, sore throat, nausea, vomiting and chest and abdominal pain. The virus exhibits persistent, asymptomatic infection, with profuse urinary virus excretion in Mastomys natalensis, the ubiquitous and highly commensal rodent host. Lassa fever is endemic in West Africa and has been reported from Sierra Leone, Guinea, Liberia and Nigeria. Some studies indicate that 300,000 to 500,000 cases of Lassa fever and 5000 deaths occur yearly across West Africa. Humans presumably become infected through contact with infected rodent excreta, urine, tissues, or blood [21].

Marburg Hemorrhagic Fever: Marburg virus first appeared in August 1967, when laboratory workers in Marburg and Frankfurt, Germany and Belgrade, Yugoslavia (now Serbia) were infected with a previously unknown infectious agent. The source of infection was traced back to African green monkeys (*Chlorocebus aethiops*) that had been imported from Uganda and were shipped to all three locations. The primary infections ironically occurred when the monkeys were necropsied for the purpose of obtaining kidney cells to culture poliomyelitis vaccine strains [22].

The last outbreak of Marburg virus hemorrhagic fever was recorded in Angola in 2005; however early in 2008 the disease was again diagnosed in a Dutch woman who recently returned from a visit to Uganda. Throughout the years in Kenya, South Africa, the Democratic Republic of Congo and most recently, Angola and Uganda, the virus has reemerged [7].

Factors of Emergince and Re-emerging of Viral Zoonotic Diseases: The complex interaction between environment/ecology, social, health care, human demographics and behavior influences the emergence and re emergence of zoonotic viral disease [3].

The critical factors consist of microbial adaptation and change; host susceptibility; climate and weather; changing ecosystems, demographics and populations, including issues of wildlife and exotic animals; economic development and land use; international trade and travel; technology and industry; reduction in animal and public

health services or infrastructure; poverty and social inequity; war and dislocation; lack of political will; and intent to harm [23]. However, the questionnaire response from different countries officials identified microbial adaptation, climatic conditions, international travel and globalization and trade as the most common events that were contributing to the emergence and re-emergence of zoonotic diseases [24].

Climatic Conditions: Although the spread of disease is multi causal, global climate change may be a significant contributor. Weather and climate can influence host defenses, vectors, pathogens and habitats [24].

Vector-borne and water-borne diseases are both strongly affected by climate. Since arthropod vectors tend to be most active at high temperatures and because water scarcity during droughts often leads to poor sanitation, climate change can be expected to drive the spread of vector-borne diseases and diarrhoeal illnesses in south East Asia [25].

International Travel: The ever increasing world population and migration of masses in search of job to urban areas, lead to overcrowding, inadequate sanitation and hygiene, which provide an ideal breeding ground for infectious agents. Increased international travel, especially without taking appropriate vaccine and other protective measures, lead to increased infection in travelers, who subsequently bring the infection back own homes on their return [7]. In addition to human movements, increased cross-border trade of livestock and wildlife is also a concern. Trading centers, for example, can act as mixing bowls for "humans and dozens of other species before they are shipped to other markets, sold locally, or even freed and sent back into the wild" [25].

Globalization and Trade: The phenomenon of globalization has been one of the most remarkable changes in our lives over the last quarter of a century. Globalization has been the driving force that has profoundly impacted international trade, economics and cultural interactions. The spatial mobility of the average human has increased more than 1,000 folds since 1800. At the turn of this century almost 700 million people travelled internationally and this number is expected to reach 1 billion by 2010 [26]. Not only are more people travelling, but travel is faster and more culturally widespread and permeates into areas of the world not readily accessible in the past. People, animals and products can circumvent the globe faster than the incubation period of almost every pathogen known today [24].

Microbial Adaptation: In addition to the climatic conditions, international travel and globalization and trade of demographic and environmental factors, which can drive the emergence of novel diseases and increase the incidence, prevalence, or geographic scope of existing ones, the importance of public health system factors as influences, in particular for the emergence of newly resistant strains, should not be underestimated [25]. 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 [24].

Mechanism of Viral Emergence: A number of virological and environmental factors are involved in the emergence and re-emergence of viral diseases. Viruses do not conservatively occupy a single and permanent ecological niche. Rather, due to their intrinsic capacity for genetic change and to the ability of fitness levels, viruses display a potential to parasitize alternative host species. Mutation, recombination, genome segment reassortment and combination of these molecular events, produce complex and phenotypically diverse populations of viruses, which constitute the raw material on which selection acts [27].

Prevention and Cotrol: Control of emerging and re-emerging zoonotic diseases and protection of the public health will become even more challenging as world population increases. When over population and crowding occur there will be water shortages, improper maintenance of hygiene and malnutrition leading to disease and epidemics [4]. The control measures for zoonotic disease requires the proper surveillance of the disease, control of the disease in animals, control of vectors or vehicles, preventing the disease in human and selecting controlling program [2].

Prevention and control strategies must be chosen 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. When available and legally permitted, the most valuable preventive measure is vaccination, not merely for protection of individual animal, but to build up a level of population immunity sufficient to break chains of transmission [4].

In order to prevent and control emerging zoonoses, several major steps need to be taken, including recognition, investigation and collaboration, the development of advanced structures for diagnosis and

surveillance, international and interdisciplinary interventions, applied epidemiological and ecological research, education (training and technology transfer) and information/communication. What have made possible the identification of new and emerging zoonoses are the better tools for identification of these agents, a better awareness in the scientific community and in the general population and a recent interest in exploring the interactions among wildlife, domestic animals and humans through an interdisciplinary approach. The future lies in well-trained field investigators who will know how to look for the unexpected [28]. These new animal and human health challenges will require innovative measures to improve awareness. International hazard identification, risk communication and risk management strategies will become increasingly important as new diseases emerge in the future. Organizations such as the World Organization for Animal Health (OIE), the Food and Agriculture Organization of the UN and the World Health Organization will have a decisive role to play in the detection and management of emerging diseases [12].

CONCLUSION AND RECOMMENDATIONS

Emerging and re-emerging diseases have caused devastating effects internationally, with millions infected and billions spent. Some diseases have become pandemic, spreading from one continent to another causing massive mortality rates and affecting global economies and livelihoods. Changes in pathogens and/or their vectors appear to have expanded their geographic or host range as a result of global warming and other associated climatic changes. Other contributing factors may include habitat changes caused by humans; the complex interaction between environment/ecology, social and health care; spread of antimicrobial resistance; unhygienic living conditions; human demographics and behavior influences the emergence and re emergence of zoonotic viral disease.

Therefore, based on these facts, the following recommendations are forwarded:

- There is need to develop epidemiology at the community level,
- Keeping the natural environment from disasters (avoiding the global warm),
- Since no one knows what new diseases will emerge and what old ones will re-emerge, the public health system must be prepared for the unexpected and
- Since zoonosis can infect both animal and humans, the medical and veterinary communities should work closely together in clinical, public health and research settings.

REFERENCES

1. WHO, 2010. Attributed to PAHO. Zoonoses and communicable diseases common to man and animals. World Health Organization. Zoonoses and veterinary public health. http://www.who.int/zoonoses.
2. Alula, A., 2012. Review on Emerging and Re-Emerging Bacterial Zoonotic Diseases. American-Eurasian Journal of Scientific Research, 7(4): 176-186.
3. Venkatesan, G., V. Balamurugan, P.N. Gandhale, R.K. Singh and V. Bhanuprakash, 2010. Viral zoonosis: A comprehensive Review. Asian Journal of Animal and Veterinary Advances, 5(2): 77-92.
4. Manojkumar, R. and V. Mrudula, 2006. Emerging Viral Disease of Zoonotic Importance-Review. International Journal of Tropical Medicine, 1(4): 162-166.
5. King, L.J., 2004. Emerging zoonoses and pathogens of public health significance. Rev. Sci. Tech. Off. Int. Epiz., 23: 429-433.
6. Stuart, T.N., J. Arikawa and Y. Kawaoka, 2000. Emerging viral disease. Proc. Natl. Acad. Sci. USA., 97: 12411-12412.
7. Obi, R.K., N.M. Orji, F.C. Nwanebu, C.C. Okangba and U.U. Ndubuisi, 2010. Emerging and Re-Emerging Infectious Diseases: The Perpetual Menace. Asian J. Exp. Biol. Sci., 1(2): 271-282.
8. Westbury, H.A., 2000. Hendera virus disease in horses. Rev. Sci. Tech., 19: 151-159.
9. Webster, R.G. and D.J. Hulse, 2004. Microbial adaptation and change: Avian influenza. Rev. Sci. Tech. Off. Int. Epiz., 23: 453-465.
10. 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.
11. Radostits, O.M., C.C. Gay, K.W. Hinchcliff and P.D. Constable, 2006. Veterinary Medicine, a text book of the disease of cattle, horses, sheep, pig and goat. 10th Ed, London: Saunders Elsevier, pp: 1384-1394.
12. Bengis, R.G., F.A. Leighton, J.R. Fischer, M.T. Artois and C.M. Tate, 2004. The role of wildlife in emerging and re-emerging zoonoses. Rev. Sci. Tech. Off. Int. Epiz., 23(2): 497-511.
13. Goens, S.D. and M.L. Perdue, 2004. Hepatitis E viruses in human and animal. Anim. Health res. Rev., 5: 145-156.
14. Desselberger, U., 2000. Emerging and Re-emerging infectious disease. Journal of infection, 40: 3-15.

15. Bourgarel, M., N. Wauquier and J.P. Gonzalez, 2010. Emerging viral threats in Gabon: health capacities and response to the risk of emerging zoonotic diseases in Central Africa. Emerging Health Threats Journal, 3: 1-11.
16. Daniel, D.M., 2006. Wildlife, environment and (re)-emerging zoonoses, with special reference to sylvatic tick-borne zoonoses in North-western Italy. Ann I st super SAnItà, 42: 405-409.
17. Institute for International Cooperation in Animal Biologics (IICAB) and The center for food security and public health. 2009. Monkey pox, (2): 1-9.
18. Gerdes, G.H., 2004. Rift valley fever. Rev. Sci. Tech. Off. Int. Epiz., 23: 613-623.
19. Ole, W., G. Joaquim, S. Mirjam, P. Sabino, S. Heli, G. Ida, L. Rogelio, C. Joannes, P. Gabriele, S. Anders, G. Blaise, K. Peter, C. Guido, G. Miguel, M. Nikolai and J. Tomas, 2007. Severe Dengue Virus Infection in Travelers: Risk Factors and Laboratory Indicators. Journal of infectious disease, 195: 1089-1095.
20. Uppal, P.K., 2000. Emergence of Nipah virus in Malaysia. Ann. NY Acad. Sci., 916: 354-357.
21. Ogbu, O., E. Ajuluchukwu and C.J. Uneke, 2007. Lassa fever in West African sub-region: an overview. Journal of vector borne disease, 44: 1-11.
22. Kristina, B., J.H. Adam, M. Elke and O. Judith, 2012. Forty-Five Years of Marburg Virus Research. Viruses, 4: 1878-1927.
23. Hamburgm, A. and J. Lederberg, 2003. Microbial threats to health. Institute of Medicine of the National Academies. National Academy Press, Washington DC, USA, pp: 53-55.
24. Lonnie, J.K., 2004. Emerging and Re-emerging Zoonotic Disease: Challenges and Opportunities. 72nd General Session international Committee World organization for animal health, 72: 1-8.
25. Richard, J.C., M.H. Benjamin, W.R. James, L. Marco and H. Piya, 2011. Emerging infectious diseases in Southeast Asia: regional challenges to control. Health in Southeast Asia, 337: 599-609.
26. Eberharp, P.J., 2000. Diseases delivered in human cargo. In: Outbreak Alert. New Harbinger Publications, 12: 62-64.
27. Esteban, D., 2010. Mechanisms of viral emergence. EDP Sciences, 41: 1-14.
28. Chomel, B.B., 2003. Control and Prevention of Emerging Zoonoses. JVME., 30(2): 145-147.