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ANIMALS AS A RESERVOIR OF HUMAN INFECTIONS

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ABSTRACT

Viruses are Submicroscopic infectious agents that replicate and grow only inside the living cells of an organism. These viruses are important especially when they are capable of infecting humans. Such diseases are called zoonoses. Viral zoonoses include Lassa fever, Ebola fever,SARS,Avian flu etc.The aim of this study is to present a short review of recent literature available on animals as reservoirs for human viruses. A detailed study is done by reviewing several articles on animals as reservoirs for human viruses. Thorough search of articles was carried on the databases Pubmed and Google scholar.Viruses continue to be a major threat in both endemic and pandemic forms.Early diagnosis and treatment plan to be implemented, as it continues to be a major health threat and becomes worse day-by-day. Hence Knowledge and awareness needs to be initiated and implemented.

KEY WORDS: Endemic, human reservoirs, living cells, Microscopic infectious agent, pandemic, transmission, vector-borne, zoonoses.

INTRODUCTION

The World Health Organisationexperts on zoonoses committee defineszoonoses as those diseases and infections naturally transmitted between vertebrae animals and humans (Kahn and Pelgrim, 2010). Zoonotic viral infections occur worldwide and often spread to humans through their companion domestic animals as well as through wild animals. Every zoonosis is a potential threat to human health. The intelligence encyclopaedia also defines zoonoses as a disease of microbiological origin that can be transmitted from animal to person . Black (Black, 2019), identified zoonotic reservoirs to be either uni or bi-directional depending on whether they are transmitted only from non-humans to humans or back and forth between animals and humans. All arthropod-borne diseases with an animal host belong to the group of zoonotic infections.

Virus spreads in many ways, provokes an immune response and eliminates viruses. Most human infections and outbreaks are caused by viruses belonging to G 1, G 2 and G 24 genotype viruses have been particularly prevalent in the past two decades and evolve through accumulation of mutations but also by recombination. Such recombinants and other new genotypes emerge regularly but the origin of these new viruses is not well understood (Siebenga*et al.*, 2009).

Transmission of zoonotic infectious agents can occur through direct contact with human–animal, arthropod vectors, inhalation of infectious drops or aerosolized pathogens in the environment, or through ingestion of contaminated food or water. The resulting disease in a susceptible host may be inappropriate

or manifest, with the latter causing disease. Enteric zoonoses are those that cause gastrointestinal problems, and these mostly include Bacterial zoonoses such as Salmonellosis, Campylobacter, and Giardia infections, and are transmitted through contaminated food or water, whereas the category of 'non-enteric zoonoses' is a multipathway of diseases that can be divided generally into vector-borne diseases (such as Lyme disease, West Nile virus (WNV), plague), directly transmitted zoonoses (such as Brucellosis, rabies, influenza, and Hantaviruses), environmentally mediated zoonoses (such as Anthrax, Echinococcosis, Leptospirosis), and food-borne parasitic infections (such as Toxoplasmosis, Trichinellosis), although some may have more than one pathway of transmission(Schlundt*et al.*, 2004).

Previously our team had conducted numerous clinical trials (Ashwin and Muralidharan, 2015),(Marickar, Geetha and Neelakantan, 2014; Shahana and Muralidharan, 2016; Pratha and Geetha, 2017; Selvakumar and Np, 2017; Girija, VijayashreePriyadharsini and Paramasivam, 2019)(Vaishali and Geetha, 2018) and lab animal studies and in-vitro studies (Girija, Jayaseelan and Arumugam, 2018; Smiline, Vijayashree and Paramasivam, 2018; VijayashreePriyadharsini, SmilineGirija and Paramasivam, 2018a, 2018b; Girija As and Priyadharsini J, 2019; M, Geetha and Thangavelu, 2019; Shahzan*et al.*, 2019; Paramasivam, VijayashreePriyadharsini and Raghunandhakumar, 2020) over the past 5 years. Now we are focusing on epidemiological surveys. The idea for this study stemmed from the current interest in our community.

INTRODUCTION TO DISEASE EMERGENCE

A number of recurring features of emerging disease have been noted. Most of them are zoonotic, thus can infect humans and other animals. Many are viruses, particularly those with RNA genome (Taylor, Latham and Woolhouse, 2001). Above all else, human activities are the most influential factors driving emergence. The act of domesticating animals has been considered one of the major drivers in the emergence of human infectious diseases(Wolfe, Dunavan and Diamond, 2007) .

Viruses come in many different forms, they have nucleic acid genomes. They show a highly diverse range in genomic size and composition. Virus genomes can consist of RNA or DNA, they can be single or double-stranded. Some are enveloped with a host derived lipid bilayer into which virus proteins are inserted, whereas others are not. Critical features of all viruses that are relevant to transmission are the surface proteins that project from the surface of the virion. The primary function of these proteins is to engage with a host receptor and initiate the entry of a virus into the target cells(Shahzan*et al.*, 2019). Viral factors such as persistence of the virus in the host, the duration of immunity to the virus in the host, virus variation in response to host immunity will affect. A further factor that influences birth rate of the host populations (Conlan and Grenfell, 2007). A recent study screening illegally imported products of wildlife origin simultaneously demonstrated the species from which the product originated and detected the presence of retroviruses and herpes viruses within it (Smith *et al.*, 2012). In a comprehensive review of human pathogens Taylor and co-workers identified over 1400 disease-causing agents, over half of which were zoonotic, the majority were viruses (Tesh, 1994).

Virus as a pathogen

Measles virus is a non-segmented negative strand RNA virus (Bartlett, 1957). Measles is transmitted by aerosols with infection initiating in the respiratory tract. This disseminates virus to epithelial tissue in various organs and the skin . Measles is due to human activity, air-borne infections. Factors that affect the transmission are the period over which the infected host sheds virus. This can be acute and chronic. Acute is common cold, Rhinovirus infection. Chronic is Hepatitis B virus, Human Immuno-deficiency virus etc. Vector-borne viruses such as Malaria, Dengue.

Vampire bats - Rabies virus, based on number of biting incidents per number of population (Schneider *et al.*, 1996).

Role of vector

The most common and important vectors transmitting zoonotic diseases are mosquitos, flies, fleas, lice, bugs, ticks, mites, snails, helminths etc. These vectors transmit pathogens from an infected reservoir host animal to another individual. Many of these are exploiters and depend on blood meal, which ingest pathogenic microorganisms during a blood meal from an infected host (human or animal) and later inject it into a new non-infected host during their subsequent blood meal. Mosquitoes are the commonly known vector for transmission of a number of diseases (Samad, 2013). Vector-borne diseases are transmitted in two ways; mechanical and biological. In mechanical transmission, the pathogens are transported to the vertebrate host without any development in the vector, through contaminated legs, wings, mouthparts or through excretory materials (e.g. Anthrax, typhoid, Q fever). In the biological transmission, the pathogen completes a development cycle in the vectors before transmitting it into the vertebrate hosts. Vector-borne diseases are a major threat to humans and animals. Every year more than 1 billion vector-borne diseases develop globally with a case fatality of 1 million lives (Gubler, 2009).

The most common routes of transmission of zoonotic diseases are insect bites, through faeces, urine, saliva, blood, semi- cooked food, milk, aerosole, oral and through direct contact of infected individuals. The common vector-borne zoonotic diseases are:

Ebola :

Ebola disease can be transmitted to humans and animals by 4 species namely: Ebola virus, Sudan virus, Tai Forest virus and Bundibugyo virus. Initially the infection is believed to occur after an Ebola virus transmission into the human host by contact with an infected host's body fluids. However in the animal population (Center For Disease Control and Wilson, 2014) it is through indirect means of transmission. Bats are believed to be the most likely reservoir. This virus enters into the body through the mucosa of the mouth, nose and eyes, or through an open wound. It causes sudden rise in temperature, loss of body fluids, followed by severe vomiting and diarrhoea.

Nipah virus:

Is a newly emerging zoonosis that can cause severe disease in humans and animals. The natural host of these viruses arepteropus genus, pteropodidae family are commonly known as fruit bats. Pigs are the intermediate host. Due to hospital setting human-to-human transmission was also documented. Most pigs developed a febrile respiratory disease with a severe cough and that led to " barking pig syndrome" and "one-mile cough".

Lyme disease:

It is a bacterial vector-borne zoonotic disease caused by Borrelia and is transmitted through the bite of ticks, from an infected deer. Rodents and Deer are the most important reservoirs. The infectious pathogen is ingested into the site of tick bite. A red ring or bull's eye rash appears on the site of tick bite and can spread to other parts of the body.

West Nile virus:

It is a neurotrophic human pathogen that causes West Nile fever and encephalitis. It is mosquito-borne zoonoses. The principal vector is culex mosquitoes. The predominant and preferred reservoir is birds and humans are dead-end hosts. The saliva of these vectors are injected into the skin and the virus is spread to other parts of the body. Infections in humans are sublclinical.

Impact of infections

Three outcomes for the host following infection with a virus (Kahn and Pelgrim, 2010) host dies as a result of the infection ; the host suffers a period of morbidity but produces an effective immune response and eliminates the virus from the body (Black, 2019). The host becomes persistently infectious with intermittent virus shedding.

Virus infections can trigger oncogenesis and can cause cancer in the host ((DiMaio and Liao, 2006). Hepatitis B Virus causes hepatocellular carcinoma (Tan, 2011). Epstein Barr virus causes Burkett and Hodgkin lymphoma (Brady, MacArthur and Farrell, 2008), (Kapatai and Murray, 2006). Human papillomavirus causes cervical cancer (Gravitt, 2011).

Animal spread of infection

Because of their high mobility, animals such as bats and birds may present a greater risk of zoonotic transmission than other animals due to the ease with which they can move into areas of human habitations. In recent times, avian influenza and West Nile virus have spilled into the human population probably due to interactions between the carrier hosts and domestic animals (Preiser, 2007).
Outbreaks of disease for which bats serve as reservoirs include Hendra virus, Nipah virus, Ebola virus and Lassa fever (Hayman *et al.*, 2008).
Rodents:
Campylobacteriosis, Hantavirus infection, these infect both pet and laboratory animal species.
Transmission to humans through feco-oral route.

Rabies:
Rabies is a viral encephalitis transmitted from animals to animals or from animals to humans through infective saliva.
This virus is introduced into muscle and nerve-ending rich tissues following animal bite. It then penetrates into nerve cells where it replicates and progressively travels through the spinal cord to the brain causing hydrophobia, hallucinations, aggressive behaviour and paralysis. This virus also spreads to salivary glands, cornea, skin, nasal mucosa and other organs.
Rabies is a viral zoonotic disease and is spread through many wild animals such as foxes and racoons and many bat species. The most commonest reservoir in human disease causing organisms is domestic dogs. And these reservoirs vary depending on geographic location. Rabies is mostly transmitted through a bite, rarely exposures can also occur through a contact between infected saliva, open wounds, mucous membranes of the eyes, nose or mouth. Recent reports have modified the epidemiology of the diseases, following transmission from transplantation of infected organs (Higgins, 2004)

Man can not completely avoid contact with animals. It is therefore the duty of the veterinarians, medical practitioners and public health personnel to provide the necessary education for safe handling of animals to minimize the risk of zoonotic disease transmission.One of the most important public health protective measures is the removal of animals from the human food supply of specified risk foods. Good personal hygiene and bio securities. Effective control of zoonoses will best be tackled from the angles of appropriate and timely management of industrialization, deforestation, agriculture, development of drug resistance (Wolfe *et al.*, 2005). Zoonoses have a negative impact on both human health and economic development through reduced production (Torgerson, 2013).

The control of such zoonotic-disease requires both medical and veterinary interventions, it is an emerging interdisciplinary field of conservation medicine. The emergence or re-emergence of zoonotic disease poses a serious threat to public health on a global scale (Morens, Folkers and Fauci, 2004). Improved sanitary conditions such as proper medical treatment and disposal of human waste, higher standard quality of public water supplies, improved personal hygiene procedures and sanitary measures in food preparation are of greater importance to strengthen the control measures. A clear knowledge and awareness of epidemiology of the zoonotic diseases and their reservoirs, virulence and transmissibility of many diseases (human monkeypox, Tana pox and Yaba pox) could help in understanding the severity and thereby to take appropriate measures in eradication of such dreadful diseases.

The early diagnosis of viral zoonoses are of great importance with respect to treatment, containment and public health control. The infectious disease mechanisms of viral zoonoses are very vast and each will have unique prevention and control strategies. Common diseases such as rabies need careful monitoring of natural reservoirs, and implementation of prophylactic vaccinations. Early diagnosis of the risk of infection and clinical controls are effective in limiting the number of fatal case consequences. On the other extreme are the highly contagious viral pathogens which cause some serious illness such as the respiratory, neurologic and haemorrhagic fever diseases are reviewed here(Wolfe *et al.*, 2005). The viral agents which cause these diseases have an unique aetiology with their natural host. Vaccines have been very successful at eradicating devastating human diseases such as smallpox.

CONCLUSION

The early identification, control and prevention of re-emerging viral zoonotics lies not only with clinicians and public health experts, but importantly with veterinarians, animal scientists and wildlife ecologists. Early diagnosis and treatment plan should be implemented for such zoonotic-disease. Hence knowledge and awareness to be initiated in safe handling of animals and their spreads are to be implemented.

AUTHOR CONTRIBUTION

The first author Vindhiyavarshini. V, has contributed for the conception of the study, carried out by collecting data, acquisition of data and drafting the manuscript after performing the necessary statistical analysis.The second author N.P. Muralidharan, contributed for guidance, supervision, aided in study design and revising it critically for important intellectual content.The third author JayalakshmiSomasundaram, made formatting and other alignment corrections and contributed in the final approval of the submitted version of the manuscript.

CONFLICT of interest:

No potential conflict of interest relevant to this article was reported.

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