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CORONAVIRUS: AN EVALUATION ON AN INITIAL NEW VIRAL DISEASE IN THE VERTEBRATES

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Abstract

Viruses are responsible for a wide range of diseases both in humans and animals. Each viruses can causes specific form of clinical problems in specific host depending upon host range, level of infection and environmental condition. Viruses can cause fetal diseases by transmission through respiratory route (spread of droplets of infected person via coughs in air); faecal-oral route (faecal from infected person cause contaminate consumable products); sexual intercourse; direct contact with contaminated blood products; direct or indirect infection from infected animals (zoonotic viruses) and arthropods vectors like mosquito or tick etc. Viruses are highly tolerance according to environment, which make them to survive in any weather and they regularly circulate in invertebrate and vertebrates (mammals and birds). Due to which they are highly dangerous to livestock and humans.

Key words: Virus, Humans, Respiratory Route, Zoonotic, Livestock

Introduction

In the Wild habitat, several species of vertebrates like fishes, amphibians, snakes, bird and mammals of different classes or order serve as a natural reservoir of many new emerging zoonotic pathogens. These pathogens are dangerous for domestic animals or animal husbandry and responsible for high damage in economic sector. These pathogens have a significant impact on public health also.

Viruses are very minute microorganisms, cannot visible through naked eyes. Its size ranging from 0.02 to 0.4 micrometres in diameter, while bacterial size ranging from 0.5 to 5 micrometres. In many ways, viruses may vary among viruses and from bacteria in both structural and biological properties. Generally bacterial can survive freely in environment for long period and also replicate with our host but viruses cannot survive freely in environment for long period therefore need the host tissue or cells for replication. On the basis of genome viruses are two type's viz. DNA viruses (double stranded form) and RNA viruses (single stranded form). The viruses can be simple with non-enveloped genome with a single protein layer (coat) and complex with enveloped protein coat. The structure of viruses may vary due to environmental resistance.

Corona refers to the characteristic appearance of surface projections (spike) that create an image of crown. Coronaviruses are large in size, covered with protective enveloped and contain positive-single stranded RNA with a spike gives crown-like appearance. The Coronaviruses genomes are the largest among all known RNA viruses.

Taxonomy

The word "coronavirus," coined in 1968, is come from the "corona"-like or crown-like structural morphology observed in the electron microscope. Coronaviruses are complex group of fatal viruses and belonging to the order Nidovirales. Nidovirales includes three families viz. Coronaviridae, Arteriviridae, and Roniviridae. In 1975, the International Committee on the Taxonomy of Viruses was established the Coronaviridae family. In June 2005, at the 10th International Nidovirus Symposium in Colorado Springs researcher divided the Coronaviridae family into two subfamilies, the coronaviruses and the toroviruses. The Coronavirinae are subdivided into four groups, the alpha, beta, gamma and delta Coronaviruses, depend upon serology but are now divided by phylogenetic clustering. The Arteviridae family causes infection in vertebrate (includes swine and equine) whereas the Roniviridae family causes infection in invertebrate (Enjuanes et.al., 2000). Depend upon the genetic and serological relationships; coronaviruses can be classified into four groups.

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Table 1
List of coronavirus species
(As per virus taxonomy released in 2016)

Genus	Species
Alphacoronavirus	Bat coronavirus CDPHE15 Bat coronavirus HKU10 Human coronavirus 229E Human coronavirus NL63 Miniopterus bat coronavirus 1 Miniopterus bat coronavirus HKU8 Mink coronavirus Porcine epidemic diarrhoea virus Rhinolophus bat coronavirus HKU2 Scotophilus bat coronavirus 512
Betacoronavirus	Betacoronavirus 1 Hedgehog coronavirus 1 Human coronavirus HKU1 Middle East respiratory syndrome-related coronavirus Murine coronavirus Pipistrellus bat coronavirus HKU5 Rousettus bat coronavirus HKU9 Severe acute respiratory syndrome-related coronavirus Tylonycteris bat coronavirus HKU4
Deltacoronavirus	Bulbul coronavirus HKU11 Common moorhen coronavirus HKU21 Coronavirus HKU15 Munia coronavirus HKU13 Night heron coronavirus HKU19 Thrush coronavirus HKU12 White-eye coronavirus HKU16 Wigeon coronavirus HKU20
Gammacoronavirus	Avian coronavirus Beluga whale coronavirus SW1

Source: Justyna and Katarzyna (2018)

Coronavirus Diseases

Coronaviruses causes deadly infection in many species of animals and humans. Many investigators reported that Coronaviruses cause both acute and chronic disease in different area of animals and humans bodies like respiratory organs (lungs), enteric (digestive system), and neural network (central nervous system) and their pathogenesis varies according to general to genera. The prototype murine coronavirus strain was reported in 1949 (Cheever et.al., 1949). In 1970s researchers actively studied the molecular mechanisms of replication and pathogenesis of different Coronaviruses. Some viruses reported in animals such as porcine transmissible gastroenteritis virus, bovine coronavirus, and avian infectious bronchitis viruses; develop the importance of veterinary science due to economic value of these animals.

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1. Human coronavirus.

The human coronaviruses are mainly associated with serious human diseases like multiple sclerosis, hepatitis or enteric disease in newborns (Resta et.al., 1985) but mainly in humans the coronaviruses (CoV) are mainly associated with respiratory tract related medical problems. The most dangerous human coronavirus is Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) which causes Severe Acute Respiratory Syndrome (SARS), a deadly lung related disease in humans (Osterhaus et.al., 2004). It was reported that Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) emerge from a wild animal reservoir like bats (Lau et.al.,2005) and it was primarily transmitted to humans via infected civet cats.

Tyrrell and Bynoe isolated the virus from a boy in 1965. It is estimated that there are four strains of human coronaviruses (HCoVs) circulating globally among the human. In 1960s researches identify two strain, named human coronaviruses- OC43 (HCoV-OC43) and human coronaviruses-229E (HCoV-229E) and other two were discovered recently named, human coronaviruses-NL63 (HCoV-NL63) and human coronaviruses-HKU1 (HCoV-HKU1) (Woo et.al., 2005).

Studies confirm that human coronaviruses- OC43 (HCoV-OC43) and human coronaviruses-229E (HCoV-229E) infect both lower and upper respiratory tract infections in humans (manly in children and young boy). It also causes gastrointestinal disease in children (Gerna et.al., 1984). In an Amsterdam hospital, 7-month-old child admitted suffering from bronchiolitis and conjunctivitis, Diagnostic tests reveal discovery of new stain of novel virus named human coronaviruses-NL63 by using VIDISCA method (Virus Discovery cDNA-AFLP) in 2003 (Fouchier et.al., 2004). HCoV-NL63 is a causing agent of serious respiratory symptoms, including upper respiratory infection, bronchiolitis, and pneumonia (Ebihara et.al., 2005). The human coronaviruses-HKU1 was identified in a 71 year old Chinese man patient with pneumonia, who was admitted in a Hong Kong hospital due to fever, cough and problem in respiration in 2004 (Woo et.al., 2005).

2. Murine coronavirus.

In the family of coronaviruses, mouse hepatitis virus (MHV) is one of the serious diseases casing virus which is well studied in terms of its biology and pathogenesis. Mouse hepatitis virus (MHV) contains a 32 kb long positive-sense, single-stranded RNA genome (Lee et.al. 1991). There are many strains of mouse hepatitis virus (MHV) shows different levels of virulence in rodents. (Perlman, 1998). Mouse hepatitis virus (MHV) causes several diseases, like hepatitis, enteritis, and encephalitis in all ages of rodents (Compton et.al., 1993). Some strain mouse hepatitis virus (MHV) cause enteric disease which transmitted through oral-fecal route in rodent's colonies and specially danger for immunocompromised rodents (Barthold et.al., 1993). Mouse hepatitis virus (MHV) infection of the mouse is considered as one of the best animal models for the study of demyelinating diseases humans like multiple sclerosis.

3. Porcine coronavirus.

There are several porcine coronaviruses have been reported in the past studies. Coronavirus cause disease in pigs (viral enteritis and fetal diarrhea) commonly known as porcine epidemic diarrhoea (PED). The disease characterised by watery loos motion (severe diarrhoea) and weight loss. The first case reported in 1971 in swine populations. The virus cause infection in all ages of pigs and most serious in neonatal piglets causing mortality 100% but decreases as the age increase after which causes significant economic loss. It is highly contagious infection transmits through faecal –oral route (Susanna and Chan, 2015).

The virus is responsible for transmissible gastroenteritis (TGE). Transmissible gastroenteritis virus (TGEV) was recognized in 1946 (Doyle and Hutchins, 1995). In neonates, transmissible gastroenteritis virus causes infection in the epithelial cells of small intestine and lead to fatal gastroenteritis. Due to infection, virus in the upper respiratory tract and

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lungs also cause mild disease. Porcine respiratory virus (PRCoV) infects lungs epithelial cells and lead to interstitial pneumonia. Porcine respiratory virus (PRCoV) is an attenuated variant of transmissible gastroenteritis virus (TGEV). The genetic material of both Transmissible gastroenteritis virus (TGEV) and porcine respiratory virus (PRCoV) are almost 96% identical except difference in the 5 region of the spike gene, and in pathogenic outcome. (Saif, 2004).

The clinical symptoms of diseases are anorexia, vomiting, diarrhoea and dehydration. There is no specific medicine to cure such disease but early detection of disease show positive significance in treatment. Several vaccines show positive results against Transmissible gastroenteritis virus (TGEV) (Saif, 2004 and Saif, 2004).

4. Avian coronavirus.

Coronaviruses thrive well in avian species and classified in to the genera gammacoronaviruses and deltacoronaviruses. In gammacoronaviruses, the common representative is avian coronavirus. Taxonomically it is known as infectious bronchitis viruses (IBVs) due to highly contagious in chickens and also other similar viruses infect other domestic birds like turkeys (turkey coronavirus –TcoV cause enteritis infection), guinea fowls (guinea fowl coronavirus-GfCoV-)), pheasants, peafowl, and quails etc. The avian coronavirus is reported in domestic galliformes and also in non-galliformes, viz. Columbiformes, Pelecaniformes, Ciconiiformes, Psittaciformes, Anseriformes and Passeriformes (munia, bulbul, and thrush). (Woo et.al., 2012). The infection spread by aerosol and cause considerable economic loss to the poultry industry.

Viruses are reported in pheasants and turkeys, multiply or proliferate in upper tract of respiratory tissues and then infect area of bronchi and responsible for severe disease in young animals. Other Some strains of infectious bronchitis viruses (IBV) cause more systemic infections and replicate in the tissues, like the kidney (causing nephritis), the oviduct (causing decreased egg production), and the gut (Saif, 2004 and Saif, 2004).

The infectious bronchitis viruses are ubiquitous in nature found in several region of world. The infectious bronchitis viruses' strains are mainly responsible for infection in the respiratory, urogenital, and digestive tracts of domestic fowl.

The protection mechanisms against IBV induced disease in the tissue are not completely clear. Vaccines have been developed to protect against infectious bronchitis viruses (IBV) both live attenuated and inactivated. Live vaccines may be short lived protection and inactivated vaccines alone are unable to protect chicken from disease. But the inactivated vaccines may be used with live attenuated vaccine to boost immunity of birds.

5. Feline coronavirus.

Feline coronaviruses (FCoVs) are covered by protective enveloped with a large, capped, polyadenylated RNA genome (29,190 nucleotides). There are two biotype of feline coronavirus reported known as feline infectious peritonitis virus (FIPV) and feline enteric coronavirus (FECV) (Saeed et.al., 2010). There are four subgroups of Feline coronaviruses named transmissible gastroenteritis virus (TGEV), canine coronavirus (CCV), raccoon dog coronavirus (RDCoV), and Chinese ferret badger coronavirus (CFBCoV) (Vijaykrishna et.al., 2007). The structural protein (spike, envelope, membrane, and nucleocapsid proteins) and the order of genes that encoding the viral polymerase is 5 -Pol-S-E-M-N3. The feline coronavirus genome also contains additional genes like 3a, 3b, 3c, 7a, and 7b that encode non-structural proteins. The functions of these genes are not clear (Lai et.al., 2007).

Feline coronaviruses infection is very common in cats. Feline coronaviruses are highly infectious and spread contamination by the faecal-oral way. Depend upon antigenic relationship with canine coronavirus, Feline coronaviruses strains can be grouped into serotypes I and II. Feline coronaviruses serotype I strains are totally feline (cat). They are hardly to grow in cell culture and responsible for slowly cytopathic effect. Whereas Feline coronaviruses serotype II strains develop from the recombination of Feline coronaviruses serotype I and canine coronavirus CCV. They can grow quickly than serotype I viruses and produce a lytic cytopathic effect. Feline infectious peritonitis virus proliferates primarily in

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pharyngeal respiratory or intestinal epithelial cells. Macrophage infection leads to spread of viruses through blood circulation (systemic), causing inflammation of the abdominal and thoracic cavities and also responsible for ocular and neurological disorders (De Groot and Horzinek 1995; Vijaykrishna et.al., 2007). Feline infectious peritonitis virus infection involves immune-mediated pathology (Hohdatsu et.al. 1998) due to which scientist has great challenge to develop vaccine against FIPV. It has been reported that after vaccination, spike protein of virus and cat with FIPV develop an early death condition caused by antibody- dependent enhancement of virus. (Saif, 2004).

6. Bovine coronavirus

The virus is ubiquitous in nature distributed throughout world and detected by serology test. It causes both respiratory (lung) and enteric medical complications. The enteric disease includes diarrhea young once calf and in adults cause dysentery in winter and the respiratory infections occur in all aged cattle with shipping fever. Both viruses isolated from respiratory and enteric infection are similar. Investigation suggests that serum antibody correlates with immunity. The severe infection in cattle causes large economical loos to owner of cattle or animal husbandry industry due no vaccines available to prevent Bovine coronavirus associated medical problems in cattle. (Saif, 2004 and Saif, 2004).

Diagnosis

Primarily notice the symptoms like fever, cough and shortness of breath. After that samples are examine by serological test (presence of antibodies indicates infection), culture of sample to detect virus in it, electron microscopy to get clear structure of virus , histopathology and molecular study of organs of individual methods for the confirmation of virus infection in individuals.

Prevention

Awareness or information of virus is very important, through which any one can face the problem safely. As the vaccine is under examination and there is no such medicine to prevent infection, Isolation of an infected individual is the only signified method for restriction and spreading of viral infection among the populations.

Conclusion

Coronaviruses are very common viruses live in wild animals without affecting human population but when human come in contact of wild animals, harbour of coronavirus causes dangerous medical complication (viruses may mutate). They usually target the respiratory tract because any one who touches these animals always put their hands on their faces from where they easily reach to the respiratory route. The coronaviruses causes very severe life threatening disease in human population like Middle East Respiratory Syndrome (MERS) in Saudi Arabia or visitors to that area and Severe Acute Respiratory Syndrome (SARS) in China and travellers who travel in and from there. Coronavirus mainly transmitted through oral-faecal route; salivary route and respiratory route. Person, who living with or carrying a coronavirus infection are more dangerous for spreading infection through small droplets of saliva or sputum in and around area where they live among the population. Kissing is also a route for transmission, spread virus from person-to-person. Therefore it is necessary to make distance during interaction with animals like cats, dogs etc. and communications with human after that wash face and hands with soap thoroughly to prevent infection.

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