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Novel Corona Virus and Veterinary Perspective: A Review

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Abstract

The family of RNA viruses, *Coronaviridae* has been responsible for the past two epidemics of many viral related diseases and viral pneumonia. Currently, the covid-19 pandemic is brought about by another member from the *Coronaviridae* family named SARS-CoV-2 (severe acute respiratory syndrome-corona virus), which arose from China in December 2019. Coronavirus was not considered primarily a pathogen in the human population until the outbreak of SARS-CoV-19. Coronavirus causes a variety of infectious diseases in many livestock, poultry, and pet animals resulting in great economic losses. Because of the long-term experience attained with animal CoV, veterinary medication could assist with producing a superior comprehension of the cause and spread of SARS-CoV-2 and could drive future exploration in human medication towards the improvement of safe immunization and successful immunogenic and antiviral medications. This review focuses on general morphological and genomic features, origin of coronaviruses, its specific impacts on animals in relation to zoonotic potential and food chain wrongdoings. In addition, we propose some recommendations and control strategies that could be applied in combating the threats imposed by the covid-19 pandemic.



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Introduction

SARS-CoV-2 (severe acute respiratory syndrome-corona virus) is a highly pathogenic pneumonia epidemic, currently known as the rapid-spreading virus. Novel corona virus-2019 originated from Wuhan, a city in China and later start spreading its wings across the globe [1, 2]. HKU1, OC43, 229E, SARS-CoV and MERS-CoV are the numerous coronaviruses; among which, SARS-COV and MERS-CoV are well known for their zoonotic potentials, resulting in the outbreaks, causing high mortality in the last 2 decades while the rest are simply responsible for upper respiratory tract infections, with exception of complex diseases in immunocompromised patients [1].

The infectious agent of the SARS-CoV outbreak has been discovered as the most powerful causative agent in multiple species and serves as an important economic factor for a long time. This virus mainly affects the intestinal and respiratory tracts while transmission occurs through oronasal routes. In inference to numerous epidemiological investigations, it came to light that initially this coronavirus was subjected to diverse wildlife species like bats, snakes, Chinese bamboo rats and majorly in the species of the felines. Coronavirus was not considered primarily pathogenic in humans until the outbreak of SARS-CoV-19. The surveillance of the disease in the feline is considered as "an adjunct to eliminate Covid-19 in humans" [3]. Here, in this review, we describe morphological features, host range, origin and prevalence of coronaviruses and their impacts in animals in relation to zoonotic potential and food chain wrongdoings.

Morphological features

The SARS genome contains a single standard RNA, and the size of the genome is the largest among all RNA viruses that ranged between 26.4-31.7 kilobases. The genome tail is 3' polyadenylated whereas its cap is 5' methylated [4]. Coronaviruses are spherical-shaped enveloped viruses (Fig. 1) and have a diameter of 80-100 nm with a positive standard of the RNA genome. Also, the surface of this virus possesses spikes and some projections. Coronavirus has a wide spectrum of hosts. The CoV-2 like rat cryo-adenitis coronavirus, Guinea pig coronavirus, mouse hepatitis virus and rabbit coronavirus are some important enlisted coronaviruses that lead to the infection in the animals like hepatitis, enteritis, and many other

respiratory infections. Coronavirus affects the abdominal cavity, central nervous system, gastrointestinal tract and the abdominal tract resultantly causing infectious peritonitis and enteritis [5, 6]. The spread of the novel coronavirus has a large host range due to the instability of enzymes like replicases and RNA polymerase at different sites (polybasic furin cleavage site, glucans of O-linked, etc.) and inability of the proof-reading mechanism. This may be due to the increase in the rate of mutation, specifically in the receptor binding domain (RBD) of the spike gene. In addition, due to the RBD of spike gene protein and receptor of the coronavirus, the host has a wide rangeability to infect many other host species of both animals and humans. The transmissibility and pathogenicity of this coronavirus may change or increase, which is a huge global concern. [5].

Coronavirus host range & COVID-19 origin

Bats are the best reservoir host for COVs [5]. Bats come across the forest in need of food and transmit the virus in a variety of hosts, which later encounter other species. The virus can be transmitted directly by the bat's body fluids. It can also be transmitted through intermediate hosts like wild animals or blood-feeding arthropods. The chances of indirect transmission of the virus through fomites cannot be neglected [5]. As the SARS-CoV-2 is originated from Wuhan city of China, where bats are sold for the purpose of food in the markets of live animals. Also, bats are a keen part of traditional China medicine (TCM) where the wild bats are used to obtain bat-derived compounds. Bats have high

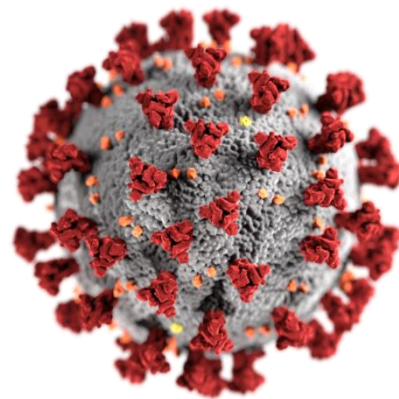


Fig. 1 Illustrations of coronavirus [4]. Grey: lipid bilayer envelope; Yellow: envelope protein; Orange: membrane protein; Red: spike protein

commercial demand, so people have a severe risk of acquiring new zoonotic infections.

According to the pandemic covid 19 epidemiologist research, it was found that the genome of SARS-CoV-2 is about 96% like bat CoV, depicting that bats are the primary source of this viral zoonotic spillover [5, 8]. The emergence of the SARS-CoV-2 is a paradigm of the hard relationship between health of humans and the hard relationship between health of humans and animals, their habits and relating habitat (Fig. 2). One's health concept is an effective means to encounter such viral zoonotic diseases. In this way, veterinarians and some virologists are operating and trying to understand the etiology of this SARS-CoV-2 and their impact on the individual health as well as on the population [9].

Canine coronavirus

Canine coronavirus (CCoV) generally causes an infection with high morbidity and low mortality in dogs. In recent years, studies on coronaviruses have gained momentum due to coronavirus outbreaks [10]. Mutations in coronaviruses can result in deadly diseases in new hosts (such as SARS-CoV-2) or cause changes in organ-tissue affinity, as occurred with feline infectious peritonitis virus, exacerbating their pathogenesis. Coronaviruses infect enteric and respiratory system cells of mammals and birds causing mild symptoms [10]. They have enveloped viruses with helical symmetry and a single-stranded RNA genome of positive polarity. They belong to the family *Coronaviridae*

of the order Nidovirales. The molecular determinants that may account for the dramatic difference in pathogenesis between feline enteric coronavirus (FECV) and feline infectious peritonitis virus (FIPV) have been extensively investigated. Today, FIPV is a genetic variant of enteric FECV, and we shall focus on the mutations probably implicated in virulence [11]. It is likely; however, that host immunity also plays a role in the development of feline infectious peritonitis (FIP). The pantropic CCoV has been described only recently, and there is little information about the molecular determinants of its increased virulence [11]. Earlier the infection of SARS has been noticed in two dogs from Hong Kong [12]. One from the 17-year-old Pomeranian dog and the other in German shepherd dog. The interesting fact is that in both cases of canine SARS-CoV-2 infection, dogs were living in close contact with SARS-CoV-2 positive owners [5]. But still, there is no evidence that dogs can act as a carrier for SARS-CoV-2 which may be transmitted to human beings [5, 13]. In dogs, this virus as a canine enteric coronavirus (CECoV) is linked to moderate to worst enteritis in young puppies [13-15].

Feline coronavirus

Feline coronavirus (FCoV) is most knowingly linked to the slight enteric infection and the FIP [13]. This FIP is proved to be fatal for both domestic and wild cats (Table 1). Feline coronavirus differs in two linkages of stereotypes based upon *in vitro* virus neutralization assay by utilizing specific type

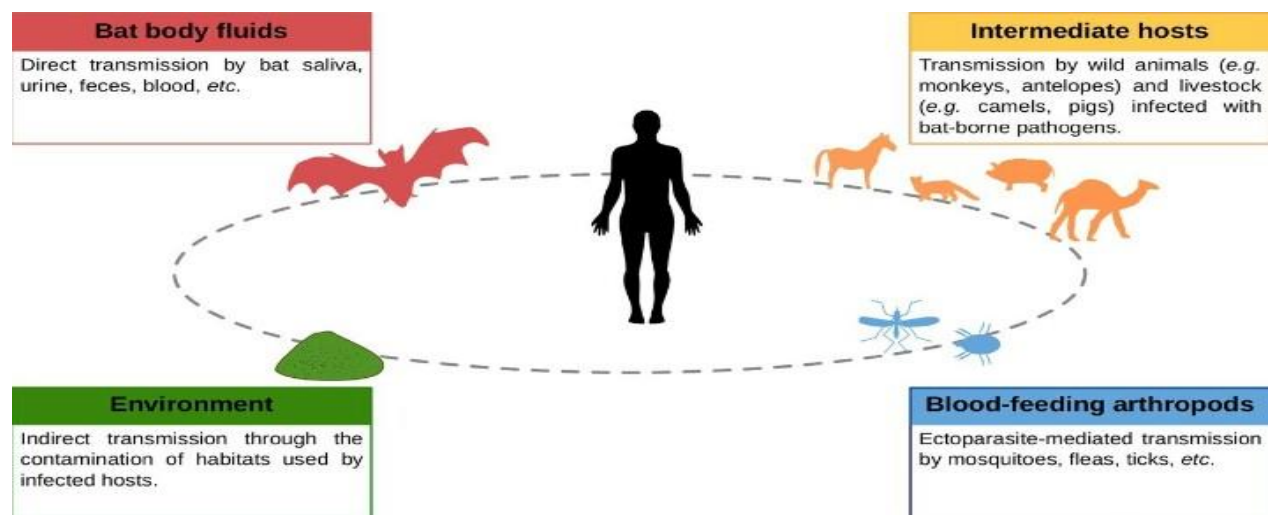


Fig. 2 Possible transmission routes of bat-borne pathogens to humans [7].

Table 1 Animal models for studying SARS-CoV-2.

Animal	Strain	Symptoms	Histopathological features	References
Swine	SADS-CoV	Infection of respiratory tract and GIT causing diarrhea, vomiting and mortality in young ones.	SADS-CoV N protein affects epithelial cells, causing villus shortening.	[26]
Feline	Feline coronavirus	Lethargy sneezing; running nose, excessive eye discharge, vomiting, diarrhea.	patchy interstitial nephritis, & congestion of the interstitial blood vessels	[27] [18]
Canine	Canine enteric coronavirus	Loose stool with blood and mucous. loss of appetite lethargy sneezing; runny nose, eye discharge, vomiting and diarrhea.	Atrophy, fusion of adjacent villi, and sloughing of the mucosal epithelium in duodenum, jejunum, and ileum	[28] [29]
Bovine	Bovine coronavirus	Infections in epithelial cells cause respiratory tract disease, intestinal, diarrhea in calves and winter dysentery in cattle.	Necrosis of epithelial cells of villi into the lumen and congestion in the mucosa and submucosa region in the SI.	[30] [31]

feline sera and the monoclonal antibodies, which is to be used against S protein (protein of Cov-structure) [13]. FCoV type II accounts for 30% of the FIP cases in Felida, Japan, whereas the S protein of the links immune domination and neutralization epitopes have the same protein of canine covid. The symptoms recorded in the early phase are upper respiratory tract infections, watering of eyes and sneezing. The cats are identified as the long-term virus carriers [13, 16]. FCoV belongs to the family *Coronaviridae* and the order *Nidovirales* and affects both wild and domestic cats. FCoV contains a positive polarity RNA genome approximately 29 kb in length, consisting of 11 open reading frames (ORFs) [17]. Two major ORFs encode a replicase, four ORFs encode the structural proteins S (spike), E (envelope), M (membrane), and N (nucleocapsid), and five ORFs encode the nonstructural proteins 3a, 3b, 3c, 7a, and 7b. FCoV can cause a mild or sometimes apparently symptomless enteric infection, especially in kittens, and is also associated with a lethal, systemic disease known as feline infectious peritonitis (FIP) [17]. FIP is characterized by fibrinous, granulomatous serositis, with protein-rich effusions in the body cavities of affected cats (effusive or “wet” FIP), as well as granulomatous-necrotizing lesions and peri phlebitis and granulomatous inflammatory lesions in several organs, especially, liver, kidney, spleen, leptomeninges, and eyes (non-effusive or “dry” FIP). Although it is often stated that lymphopenia and neu-turophilia are typical of FIP, this change can be interpreted as a typical “stress leukogram” that occurs in many severe systemic diseases in cats [18]. Measurements of antibodies in serum are useful diagnostic tools for the detection of FCoV infection. However, since a large percentage of

healthy cats have antibodies against FCoV, antibody testing is more helpful in the management of FCoV infection [19].

Deleterious transmission in birds

The number of avian cases infected with the coronavirus has also increased in the last decade [19]. The coronavirus was first known to be a causative agent of enteric diseases in birds but viruses like infectious bronchitis virus have widened the range of symptoms, causing respiratory diseases as well [20]. In Infectious bronchitis virus, first enters the upper respiratory tract and get confined to cilia and goblet cells and causes the deciliation in trachea and nose, that is usually followed by secondary bacterial infection [20]. Experiments with the different variants of coronavirus have revealed that they are not restricted to a single host. The coronavirus can cause disease in birds from both mammalian as well as avian origin [19]. The ability of the virus to cause novel diseases of any sort in any bird species is an alarming trait of the virus [21]. The extensive rearing systems of the birds and chickens have increased their exposure to the virus of different species, which might end in an unexpected form of virus with overlapping signs and symptoms [21]. When the maintenance of MERS-CoV or SARS-CoV-2 in poultry was observed, it was seen that it did not cause any disease in the birds and no antibodies were detected as there was no virus multiplication. The virus was not even observed in the embryonated eggs, which led to the conclusion that neither of the viruses could be maintained in the poultry [22]. Immunity response to inoculation of SARS-Cov-2 was also tested in chickens and

ferrets. Chicken obtained no disease upon the virus inoculation, while ferrets showed viral spread within intra-nasal tissues, though, it did not spread to the lower respiratory system, which might be due to different surface proteins in the lower respiratory tract of the ferret. The studies also revealed an opportunity to use ferrets as a specimen for the antiviral medication and vaccines against SARS-CoV-2 [23].

Bovine coronavirus

Bovine coronavirus (BCoV) in 1972 was recognized as a cause of diarrhea. It is now known as the primary pathogen in the diarrhea of neonatal calves and epizootic diarrhea in cattle [24]. The replicating site of the BCoV is the epithelium of large and small intestine and the respiratory tract [25]. By some epidemiological studies, detection, and isolation of BCoV from the nasal secretion obtained from the feedlot cattle was made possible (Table 1). According to a survey, some fecal samples collected from the cattle having the complaint of diarrhea were positive for BCoV antigen tested by ELISA. Few samples gave a result of mixed infections of such viruses. According to the obtained results, diarrhea observed was attributed to the infection with coronavirus and some other enteric pathogen or combination of both [24, 25]. On the other hand, of the total fecal samples collected, about 22% were negative for diarrhea but positive for BCoV antigen. It is presumed that diarrhea maybe because of shipping or at the auction barn and were shedding BCoV still. Another chance may be due to stress-induced shedding of BCoV in the feces of cattle, which caused diarrhea associated with reduced weight gain [24].

COVID-19: emerging zoonotic threat

In human beings, it was introduced as the sporadic and clustered incidences of pneumonia of unknown origin. After a month, the very first case of infection coronavirus was reported in December 2019. Its causative agent was recognized as a member of the *Coronaviridae* family in January by WHO [1, 5]. Coronavirus covers approximately all countries of the world. This COV-2 outbreak enhances the stamina of the animal-human interface, which acts as the basic source of the emerging zoonotic diseases. This is not all alone, along with this coronaviral pneumonia and other covid associated diseases also referred to as covid-19 in February by

World Health Organization [5]. Based on the finding and the probability depending on zoonosis, this virus continues to spread between various animal species or even animals to humans and humans to animals (Table 2) [32]. In large animals, the BCoV was found infectious to the domesticated and wild ruminants, having strong zoonotic potential. Among all the coronaviruses known, the most zoonotic are SARS-CoV-2 and MERS-CoV, which have a high mortality rate and severity of infection in humans [5]. It spread globally and gained very rapid importance [33].

Table 2 Covid-19 veterinary survey results as employee concern results from the American Veterinary Medical Association (AVMA, 2020) [32].

Source of transmission	Chances
Transmission from clients	41%
Transmission from other employees	38%
Animal to human transmission of COVID-19	22%
Human to animal transmission of COVID- 19	21%

Conclusions

As coronavirus causes a variety of infections in many livestock animals, poultry and pet animals resulting in great economic losses. This leads to infections mainly in the gastrointestinal and respiratory tract. Some enteropathogenic coronaviruses infect the enterocytes, which result in atrophy of villi causing diarrhea [1, 34]. This kind of enteropathogenic coronavirus causes severe infection in young animals causing bloody diarrhea, which is linked to coronavirus shedding in feces, especially in adult bovines [34]. Given the long-term experience attained with animal CoV, veterinary medication could assist with producing a superior comprehension of the cause and spread of SARS-CoV-2 and drive future exploration in human medication towards the improvement of immunogenic, safe immunizations and successful antiviral medications. The achievements and disappointments experienced with prophylaxis and treatment of individual CoV illnesses, like FIP, may be valuable to deliver issues identified with COVID-19 out of a One-Health approach. BCoV intricates with respiratory microbes and the stress of transportation may give models to comprehend the factors that encourage serious pneumonia in COVID-19 infections [35]. Reformist deforestation and anthropization of regular habitats have to a greater extent some undermined biological niches where CoVs of natural life are typically bound.

Likewise, human utilization of imperiled wildlife, regardless of whether not shown to assume a part in the beginning of SARS-CoV-2, ought to be limited or prohibited, especially in the unsanitary conditions predominant in live creature markets [36]. Considering a more respectful administration of the climate will be crucial to forestall the future emergence of pandemic CoVs. Under these conditions, veterinary medication should uphold strategy producers to embrace and advance the sound and maintainable measures for the executives of the climate, biodiversity and advance the worldwide 'One-Health' development.

Conflict of interest

The authors declare no conflict of interest.

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