

VETERINARY SCIENCES

NEW CORONAVIRUS INFECTION IN ANIMALS

Nikolaeva O.

*The Bashkir State Agrarian University
Russia, Ufa*

Abstract

To write a literary review, data was searched in the databases *Scopus*, *MEDLINE/PubMed Database*, *eLIBRARY*, open Internet sources (www.oie.int; wsava.org; fsvps.gov.ru and others) for 2020-2021. As a result of analysis of literary sources, it was found that domestic cats and dogs are infected *SARS-CoV-2*, but remain asymptomatic virus carriers or they develop mild clinical signs of the disease.

Keywords: new coronavirus infection, *COVID-19*, *SARS-CoV-2*, coronaviruses, infection, minks, cats, tigers, lions.

Introduction.

Currently, when *COVID-19* is widespread among humans, there is a possibility that some animals may be infected through close contact with infected people. Infection of animals with the *COVID-19* virus can have an impact on the health and well-being of animals, as well as on the conservation of wildlife animals.

In this regard, the goal of the research was to analyze literary data on the susceptibility of different species of animals to the *SARS-CoV-2* virus.

Research materials and methods.

To write a literary review, we searched the databases *Scopus*, *MEDLINE/PubMed Database*, *eLIBRARY*, open Internet sources (www.oie.int; wsava.org; fsvps.gov.ru and others) (2020-2021).

Research results.

Currently, according to the World Animal Health Organization, cases of 24 infection among pets have been recorded in *SARS-CoV-2* countries of the world [14].

According to I.M. Donnicks et al. (2021) infection of feline family members with a new coronavirus is possible due to the similarity of the molecular structure of the receptor target of this virus, but only in conditions of very close and repeated contact with an infected person, when the total titer of the virus transmitted by air drop reaches values close to those obtained in experimental modeling. The authors are convinced that if infection of *SARS-CoV-2* cats is confirmed, then these animals will be a biological dead end for this virus. To discuss the fact of carrying the *SARS-CoV-2* and its transmission by cats, a full-scale cohort clinical study, moreover blind and randomized, is critically necessary, which will exclude the influence of the human factor on the results. Also in this study it is necessary to apply methods of virus subgenomic RNA detection, which is most likely to indicate the fact of *SARS-CoV-2* replication in animal cells [6].

In the summer of 2020, the first cases of infection of minks with coronavirus were reported, then the infection on mink farms began to spread rapidly around the world. Today it is known about the infection of minks in many countries: in the Netherlands, Denmark, Spain, the USA, Sweden, Italy, Greece, France, Lithuania, Canada and Poland [15, 27]. Also in June 2020, 214 cases of human disease were detected in Denmark

COVID-19 with *SARS-CoV-2* options associated with grown minks, including 12 cases with a unique option. It has been found that the virus can be transmitted from chickens to humans and vice versa. The transmission of viruses from animals to humans and vice versa is always a concern, since genetic changes of the virus may occur during such transmission. To prevent the further spread of this and other mink-related strains among people, the Danish authorities announced a number of measures and decided to reject more than 17 million minks, including breeding stock. Other public health measures include enhanced *COVID-19* surveillance, increased efforts to genetically sequence strains of *SARS-CoV-2* across Denmark, and extensive health and social measures, including restrictions on movement in seven affected municipalities in northwestern Denmark, to reduce local transmission of the virus [23].

In dogs with both experimental and natural infection, susceptibility to *SARS-CoV-2* was low and no clinical signs were observed [1]. Evidence of this is the report of the OIE on the case of a dog infection in Hong Kong (27.11.2020) from the host with a coronavirus infection, when the laboratory results were positive, but the animal had no signs of the disease [14]. According to I.M. Donnicks et al. (2021) dogs are not involved in the transmission *SARS-CoV-2* and even the possibility of carrying them as a biological dead end is extremely unlikely [6].

According to A. Costagliola et al. (2020) dogs and cats with a positive result on the *COVID-19* cannot infect a person, however, regarding Danish nocs there were cases of infection of people from nocs - this is the first case of transmission of the virus from animal to human [10].

According to Kh. Sharun et al. (2021) clinical and pathologic signs in new coronavirus infection in humans and minks are quite similar. The authors confirm this by comparing changes in the lungs. In humans, the alveolar septum is thickened, a vast purulent infiltrate in the lungs, which indicates acute inflammation of the walls of bronchioles. Small red cusps are found on the lung surface during opening, signs of interstitial pneumonia are visible on the histological medium [25].

In March 2020, cases of infection of tigers and lions were recorded, *COVID-19* the first confirmed cases of natural infection among non-domestic species. D.

McAloose et al. (2020) concluded that epidemiological and genomic data indicate the transmission of SARS-CoV-2 virus from humans to the tiger, it was also revealed that tigers and lions were infected with different genotypes of SARS-CoV-2, which indicates two independent cases of transmission to animals [19]. Currently, cases of infection of tigers and lions continue to be reported in zoos in the USA, Sweden, Estonia [11, 24, 26].

A. S. Abdel-Moneim et al. (2020) examined swabs derived from guinea pig and two rabbits whose hosts confirmed a new coronavirus infection. They showed that no RNA virus was detected in the samples under study. Also, during the experimental infection of SARS-CoV-2 chickens, ducks, turkeys, quails and geese, no clinical signs of infection were recorded and no replication of the virus or the presence of antibodies were found. The authors claim that the poultry is not susceptible to the virus [8].

Ferrets turned out to be highly susceptible to artificial infection. According to A. S. Abdel-Moneim et al. (2020) animals infected with SARS-CoV-2 showed reduced activity, increased body temperature and sometimes cough. Viral RNA was found in blood serum, nasal flushes, saliva, urine, feces, nasal shells, trachea, lungs, intestines and kidneys. The virus after infection was naturally transmitted to ferrets from each other by airborne drip [8]. According to reports by Y.I. Kim et al. (2020) in infected ferret SARS-CoV-2, body temperature increases. For ferrets, this infection does not end lethally, but the virus is found in nasal flushes, saliva and urine until 8 days after the disease. After contact of infected ferrets with healthy ones, the latter show RNA of the virus two days later. In addition, viral RNAs were also detected in healthy ferrets after indirect contact with infected animals. The authors also concluded that infection occurs by air. Viral antigens were found in the nasal cavity, trachea, lungs and intestines with acute bronchiolitis present in infected lungs. The authors suggest that ferrets may represent an animal model of COVID-19, which may contribute to the development of therapeutic agents and vaccines for SARS-CoV-2 virus [18].

The first known case of natural transmission of SARS-CoV-2 to humanoid monkeys was recorded at the San Diego Zoo (California) on January 25, 2021. Some gorillas showed symptoms such as mild cough, nasal congestion, nasal discharge and periodic lethargy. After consultation with specialists, treatment was initiated, including cardiac drugs, antibiotics and monoclonal antibody therapy. Treatment was successful [22].

C. M. Freuling et al. (2021) carried out experimental infection of raccoon dogs of SARS-CoV-2. Nine raccoon dogs were infected. To control the release of the virus, samples of swabs from the nose, oropharynx and rectum were taken on the 2-, 4-, 8-, 12-, 16-, 21- and 28th days. On the 4th, 8th, 12th and 28th days, the authors of the experiment euthanized and autopsied two animals in sequential order and found a viral load of up to 4.87 log₁₀ copies of the genome/ml in the nasal mucosa on the 4th day. When opening, serious injuries in organs caused by SARS-CoV-2 infection were not

found. On the 4th, 8th and 12th days, all infected animals showed mild rhinitis. Serum samples were taken on days 4-, 8-, 12-, 16-, 21- and 28th. Antibodies to SARS-CoV-2 were detected in 4 (57.1%) of 7 infected animals on day 8 by ELISA and indirect immunofluorescence analysis (> 1:64). Credits increased to 1:1024 on the 28th day. This experimental study demonstrates that raccoon dogs are susceptible to SARS-CoV-2 infection and can transmit the virus to animals in direct contact with them. Raccoon dogs showed only minor clinical signs and tissue lesions only in nasal shells [12].

B. S. Pickering. et al. (2021) in their studies showed that domestic pigs are at low risk of infection with SARS-CoV-2. Among 16 experimentally infected animals, five (31.3%) showed an immune response to the virus. Only one pig was found to have viral particles, two showed RNA of the virus and two more animals - antibodies. One pig showed mild, non-specific clinical signs, including cough and depression. In addition, several pigs recorded ocular and nasal outflows. According to the authors, the results of this study contradict previous reports that pigs are not susceptible to SARS-CoV-2 infection. Previous studies found no RNA in smears or organ samples, and no seroconversion was measured. It should be noted that the authors used a 10 times higher viral dose for experimental infection than used in previous studies. In general, these data suggest that further studies on animal susceptibility should be conducted to assess the risk of infection of pigs with a new coronavirus infection. The authors emphasize that to date, no cases of SARS-CoV-2 disease have been recorded in farm animals; however, more attention should be given to this problem [21].

A. M. Bosco-Lauth et al. (2021) report that white-footed hamsters, lush-tailed forest hamsters and striped skunks were susceptible to the virus SARS-CoV-2 and were contagious within 2-5 days of infection. The animals in the studies were exposed to high doses of the virus, which is hardly possible in the natural habitat. In addition, the authors argue that experimental infections using a small number of apparently healthy, immunocompetent animals do not give a complete characterization of the infection of animals of this species, which may also depend on the age and state of health of animals. However, the results of this work demonstrate that it is possible to infect SARS-CoV-2 in animals in the wild, and this infection can become endemic for non-human species [9].

R. Tiwari et al. (2020) also report that the bat may be a reservoir for SARS-CoV-2. The intermediate host has not yet been clearly elucidated, currently referring to snakes and/or pangolins. There are assumptions about the transfer of SARS-CoV-2 from humans to animals. The study also shows that SARS-CoV-2 is poorly replicated in pigs, chickens and ducks, while ferrets and cats are susceptible to it [27].

The development of a vaccine against COVID-19 for animals is becoming an urgent task of veterinary science. In the Russian Federation, it was developed at the Federal Center for Animal Health. The drug "Karnivak-Kov" is included in the register of medicines for animals of the Rosselkhoz nadzor. It is designed for

vaccination of carnivores: fur animals, dogs and cats [2]. Earlier, specialists of the Center developed animal diagnostic kits for COVID-19 [3].

Conclusion.

Thus, to date, a new coronavirus infection is COVID-19 a pressing problem. Currently, there is no evidence that animals play a significant role in the spread of SARS-CoV-2 among humans. However, reports from contaminated mink farms in the Netherlands and Denmark prove that in these environments there is the possibility of spreading SARS-CoV-2 from minks to people [13]. More research is needed to understand whether COVID-19 can affect different species of animals, but people with suspected infection or confirmed infection should SARS-CoV-2 limit contact with animals, including domestic and agricultural ones. Animals with suspected infection or with confirmed infection SARS-CoV-2 should also be kept separate from other animals and people.

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