

Rapid evidence checks are based on a simplified review method and may not be entirely exhaustive, but aim to provide a balanced assessment of what is already known about a specific problem or issue. This brief has not been peer-reviewed and should not be a substitute for individual clinical judgement, nor is it an endorsed position of NSW Health.

COVID-19 infection and transmission in domestic animals

Evidence check question

Can domestic animals become infected with COVID-19, and is there evidence of transmission of COVID-19?

In brief

- There have been isolated incidents of domestic animals testing positive for the COVID-19 virus. (1-7) Generally, in these cases, the pet owners have been COVID-19 positive.
- The infected domestic animals reported in the literature are mainly dogs and cats, and studies reported either natural (1, 2) or experimental infection with the SARS-CoV-2.(6, 8, 9)
- Infected pets may show clinical symptoms (2, 3), or they may remain asymptomatic.(4, 10, 11) Most of the pets that were infected with COVID-19 had mild symptoms and fully recovered.
- A large scale epidemiological study designed to assess SARS-CoV-2 infection in 817 companion animals living in Italy demonstrated that only 3.4% of dogs and 3.9% of cats living in areas of high human infection became infected.(12)
- There is currently no evidence that pets transmit SARS-CoV-2 via animal-to-human transmission or via animal interspecies infection. The risk of animals spreading the COVID-19 virus to human is considered low.

Limitations

Around the world, the incidence of domestic animals contracting SARS-CoV-2 is rare. The evidence regarding the infectivity of domestic animals with COVID-19 is emerging.

Background

Available evidence for COVID-19 suggests that SARS-CoV-2 has a zoonotic source with transmissibility from animals to humans under natural conditions. SARS-CoV-2 spreads mainly from person-to-person through respiratory droplets from coughing, sneezing and talking.(13) There has been some evidence that domestic animals got infection by SARS-CoV-2 from their owners who previously were infected or suspected of being infected with SARS-CoV-2. At this time, there is no evidence that animals play a significant role in spreading SARS-CoV-2.(14, 15) Based on the limited

information available to date, the risk of animals spreading COVID-19 to people is considered to be low. More studies are needed to understand if and how different animals could be affected by COVID-19.

Methods (Appendix 1)

PubMed and grey literature searches (via google) were conducted on 28 August 2020.

Results

Table 1

Source	Summary
Peer reviewed sources	
<p>Severe Acute Respiratory Syndrome Coronavirus 2-Specific Antibodies in Pets in Wuhan, China</p> <p>Chen, et al. 2020 (1)</p>	<ul style="list-style-type: none"> • Serological data of pets from 15 communities in Wuhan whose owners were diagnosed with COVID-19. • Swab and whole blood samples were collected from 10 cats (four females, six males) and nine dogs (four females, five males) from 15 owners infected with COVID-19. The mean age of cats and dogs was 1.83 years (range: 0.4 to 4.6 years, median 1.7 years) and 3.07 years (range: 0.9 to 7.4 years, median 2.3 years), respectively. • All cats and dogs were physically normal when sampled. Swab samples were tested for SARS-CoV-2 RNA using real-time reverse transcription polymerase chain reaction. All pet samples were negative for SARS-CoV-2. • Serological data suggested that two cats and one dog had been exposed to the virus, although viral RNA detection was negative.
<p>Companion animals likely do not spread COVID-19 but may get infected themselves</p> <p>Csiszar, et al. 2020 (16)</p>	<ul style="list-style-type: none"> • This review summarised the available evidence about SARS-CoV-2 infection in pets. • In Belgium, it was reported that a pet cat was diagnosed with SARS-CoV-2 in March. This demonstrates that felines living in the household of people with COVID-19 are at risk of contracting the disease. • On 23 April 2020, it was reported that two pet cats in New York tested positive for the SARS-CoV-2, which were the first confirmed COVID-19 cases in companion animals in the USA. • In June 2020, screening of 22 cats and 11 dogs from owners previously infected or suspected of being infected with SARS-CoV-2 in France identified one cat infected with SARS-CoV-2. • In April 2020, a 4-year-old Malayan tiger at the Bronx Zoo in New York City tested positive for the SARS-CoV-2 virus. Six other big cats (another Malayan tiger, two Amur tigers and three African lions) were reported to exhibit symptoms, including dry coughs, which are indicative of SARS-CoV-2 infection. Only one tiger was tested for

Source	Summary
	<p>the virus, as collection of the samples in big cats requires anaesthesia.</p> <ul style="list-style-type: none"> • In March 2020, 17 dogs and 8 cats, which lived in households with confirmed COVID-19 human cases in Hong Kong were tested for SARS-CoV-2. Two dogs tested positive. Neither of the dogs showed any sign of respiratory disease. One of them, a 17-year-old Pomeranian dog died shortly after the diagnosis was made. • Overall, there are a few rare cases of pets contracting the infection from a SARS-CoV-2-infected human. There is no evidence that pets actively transmit SARS-CoV-2 via animal-to-human transmission.
<p>Serological survey of SARS-CoV-2 for experimental, domestic, companion and wild animals excludes intermediate hosts of 35 different species of animals Deng, et al. 2020 (17)</p>	<ul style="list-style-type: none"> • This study investigated the possibility of 35 animal species as intermediate host for SARS-CoV-2 in China. In addition, the investigators screened a large number of cats and dogs for SARS-CoV-2 specific antibodies using double-antigen ELISA during the outbreak of COVID-19 as follow: <ul style="list-style-type: none"> - 87 cats, including 66 pet cats and 21 street cats - 487 dogs, including 237 pet dogs and 250 street dogs. <p>All of these animals tested negative to SARS-CoV-2.</p>
<p>SARS-CoV-2 Natural Transmission from Human to Cat, Belgium. Garigliany, et al. 2020</p>	<ul style="list-style-type: none"> • This was the first investigation of illness and infection of SARS-CoV-2 in a domestic cat in Belgium on 18 March 2020. • A female domestic shorthair cat, 15 years of age, was asymptomatic while the owner tested positive to SARS-CoV-2. • One week later, the cat suddenly demonstrated clinical signs; vomiting, lethargy, poor appetite, anorexia, and diarrhoea. • Several days later, the clinical signs worsened. The cat demonstrated sneezing, a harsh, productive cough, episodes of paroxysmal reverse sneezing, heavy breathing with increased respiratory effort and frequency and emaciation. • The cat’s condition then gradually improved and fully recovered within two weeks.
<p>Transmission of SARS-CoV-2 in Domestic Cats Halfmann, et al. 2020 (8)</p>	<ul style="list-style-type: none"> • This letter (published on 13 May 2020) provided evidence of experimental transmission of SARS-CoV-2 between domestic cats. • Three domestic cats were inoculated with SARS-CoV-2. • One day after inoculation, a cat with no previous SARS-CoV-2 infection was cohoused with each of the inoculated cats to assess whether transmission of the virus by direct contact would occur between the cats in each of the three pairs. • Five days later, SARS-CoV-2 was detected in all three cats that were cohoused with the inoculated cats. SARS-CoV-2 was detectable in all three inoculated cats, with continued detection of

Source	Summary
	<p>the virus until day five in all cats, and until day six in two of the three cats.</p>
<p>SARS-CoV-2 host diversity: An update of natural infections and experimental evidence Hossain, et al. 2020 (18)</p>	<ul style="list-style-type: none"> • A review study published on 25 June 2020 investigated SARS-CoV-2 natural infections in animals. <ul style="list-style-type: none"> - A dog (German shepherd breed) had been confirmed as weak positive to the COVID-19 virus on 28 February 2020, in Hong Kong. - Another dog in the Netherlands found to be positive for SARS-CoV-2; its owner was a COVID-19 patient. - A cat in Belgium may have been infected with SARS-CoV-2 from its owner, who travelled to Italy and had a history of COVID-19 infection. - A cat tested positive to SARS-CoV-2 in France on 2 May 2020; its owner was suffering from COVID-19. - Three cats tested positive for SARS-CoV-2 in the Netherlands in May 2020. These cats lived on a mink farm; where the minks were previously infected with SARS-CoV-2. - A tiger was infected with SARS-CoV-2 is on 5 April 2020 at Bronx Zoo in New York through a worker of the Zoo. On 22 April 2020, it was confirmed that all tigers and lions at the same Zoo tested positive for SARS-CoV-2. - Several minks of two different farms in the Netherlands were reported to be positive for SARS-CoV-2 on 26 April 2020. • Between January and March 2020, 15 among 102 cats were seropositive for SARS-CoV-2 in Wuhan.
<p>First Reported Cases of SARS-CoV-2 Infection in Companion Animals - New York, March-April 2020 Newman, et al. 2020 (3)</p>	<ul style="list-style-type: none"> • Two cats, owned by people with suspected or confirmed COVID-19, were infected in the USA, and both cats fully recovered after illness which lasted 10 days. • On 24 March 2020, a 4-year-old male domestic shorthair cat developed respiratory illness, characterised by sneezing, clear ocular discharge and mild lethargy. On 1 April 2020, the cat was taken to a veterinary clinic and nasal, oropharyngeal and ocular swabs were collected by veterinary staff members. On April 14, the cat was reported to be positive for SARS-CoV-2. • On 1 April 2020, a 5-year-old female Devon Rex cat, developed respiratory illness, including sneezing, coughing, watery nasal and ocular discharge, loss of appetite and lethargy. On 6 April 2020, conjunctival, nasal, deep oral and faecal specimens were collected. The laboratory result for SARS-CoV-2 came back positive on 14 April. However, the cat had fully recovered by 8 April without any treatment.

Source	Summary
<p>Update on possible animal sources for COVID-19 in humans</p> <p>Opriessnig, et al. 2020 (9)</p>	<ul style="list-style-type: none"> • This situation report published on 17 June 2020 documented naturally acquired SARS-CoV-2 infections in different animal species. <ul style="list-style-type: none"> - Domestic cat: 18 March, Belgium; 2 April, Hong Kong; 22 April, USA; 1 May, France; 8 May, Spain. - Tiger: 27 March, USA. - Lion: 27 March, USA. - Dog: 26 February and 17 March, Hong Kong; 29 April, USA. - Mink: 23 April and 25 April, the Netherlands. • The report included some studies where experimental infection of pets was possible. <ul style="list-style-type: none"> - Experimental infected cats were placed in contact with uninfected cats. SARS-CoV-2 transmission occurred after three days and antibodies against SARS-CoV-2 were detected in infected and exposed cats. - Dogs may become infected experimentally at low level with limited transmission.
<p>Evidence of exposure to SARS-CoV-2 in cats and dogs from households in Italy</p> <p>Patterson, et al. 2020 (12)</p>	<ul style="list-style-type: none"> • Large-scale study in 817 companion animals (540 dogs and 277 cats) living in Italy, sampled at a time of frequent human infection. • Animals were sampled either from regions severely affected by COVID-19 outbreaks in humans or from those that offered convenient access to samples. • Oropharyngeal (306 dogs, 175 cats), nasal (185 dogs, 77 cats), and/or rectal (66 dogs, 30 cats) swabs were collected from the sampled pets. • All collected swab samples tested negative for SARS-CoV-2 RNA, including 38 cats and 38 dogs that showed respiratory symptoms at the time of sampling. In addition, 64 dogs and 57 cats that tested negative were living in households previously confirmed as having had COVID-19. • Overall, 3.4% of dogs and 3.9% of cats had measurable SARS-CoV-2 neutralising antibody titers, with dogs from COVID-19 positive households being significantly more likely to test positive than those from COVID-19 negative households. • This epidemiological survey of SARS-CoV-2 found that dogs and cats living in areas of high human infection can become infected.
<p>Detection of SARS-CoV-2 in pets living with COVID-19 owners diagnosed during the COVID-19 lockdown in Spain: A</p>	<ul style="list-style-type: none"> • The study investigated 23 asymptomatic pets under quarantine (eight cats, one guinea pig, two rabbits and 12 dogs) from 17 households with confirmed human cases of COVID-19 in Spain. • One cat contracted the virus from its infected owner.

Source	Summary
<p>case of an asymptomatic cat with SARS-CoV-2 in Europe</p> <p>Ruiz-Arrondo, et al. 2020 (4)</p>	<ul style="list-style-type: none"> • It was an eight-year-old female domestic European cat without clinical signs related to coronavirus disease, although it had chronic feline gingivostomatitis, treated feline idiopathic cystitis, treated chronic kidney disease and treated feline asthmatic bronchitis. • The oropharyngeal swab sample was positive for SARS-CoV-2, however viral RNA was not detected in the rectal swab sample from this animal and it remained asymptomatic to respiratory infection. • The role of pets in carrying live or infectious SARS-CoV-2 and disseminating it was not established.
<p>First detection and genome sequencing of SARS-CoV-2 in an infected cat in France</p> <p>Sailleau, et al. 2020</p>	<ul style="list-style-type: none"> • This study investigated the possibility of an infection by SARS-CoV-2 in 22 cats and 11 dogs from owners previously infected or suspected of being infected by SARS-CoV-2 in France. • For each animal, rectal, nasopharyngeal swabs and serum were collected. • All dogs tested negative to SARS-CoV-2. • One cat was tested positive by RT-qPCR on rectal swab. Nasopharyngeal swabs from this cat were tested negative. The cat showed mild respiratory and digestive signs. • This study confirmed the natural infection of a cat in France probably through its owner. • There was no evidence that cats can spread COVID-19.
<p>Infection of dogs with SARS-CoV-2</p> <p>Sit, et al. 2020 (10)</p>	<ul style="list-style-type: none"> • Fifteen dogs and seven cats from households with known COVID-19 cases had been quarantined and tested as of 27 March 2020 in Hong Kong. • During this period, two dogs returned virological test results demonstrating that they were infected. • SARS-CoV-2 RNA was detected in five nasal swabs collected over a 13-day period from a 17-year-old neutered male Pomeranian. • A 2.5-year-old male German shepherd was positive for SARS-CoV-2 RNA on two occasions and virus was isolated from nasal and oral swabs. • Antibody responses were detected in both dogs using plaque-reduction-neutralisation assays. Viral genetic sequences of viruses from the two dogs were identical to the virus detected in the respective human cases. • The dogs remained asymptomatic during quarantine. • The evidence suggests that these are instances of human-to-animal transmission of SARS-CoV-2. It is unclear whether infected dogs can transmit the virus to other animals or back to humans.

Source	Summary
<p>Coronaviruses in cats and other companion animals: Where does SARS-CoV-2/COVID-19 fit?</p> <p>Stout, et al. 2020 (6)</p>	<ul style="list-style-type: none"> • This review discussed the community and experimental SARS-CoV-2 infection prior to COVID-19 and briefly summarised incidents of SARS-CoV-2 infection of companion animals to-date. • A number of reports confirmed SARS-CoV-2 viral RNA in two dogs from Hong Kong, a cat in Belgium, a tiger at the Bronx Zoo in New York City and a number of positive cases in cats in different locations in New York State. • In all infection cases, infection appears to be limited to the upper respiratory tract, although viral shedding in the faeces was apparent. • It has been suggested that these species became infected by their owners or handlers. • No evidence of transmission to other animals or to humans has been reported.
<p>Potential infectious risk from the pets carrying SARS-CoV-2</p> <p>Wang, et al. 2020 (19)</p>	<ul style="list-style-type: none"> • This letter to the editor of Travel Medicine and Infectious Disease Journal, published on 5 May 2020, discussed the susceptibility of ferrets and domestic cats to the infection by SARS coronavirus from a pre-COVID-19 studies.(20) The evidence emerged that asymptomatic cats can efficiently transmit the virus to previously uninfected animals that are housed with them. • Findings suggested that cats may be involved in SARS-CoV-2 interspecies infection.
<p>Can cats become infected by COVID-19</p> <p>Zhai, et al. 2020 (7)</p>	<ul style="list-style-type: none"> • On 28 February and 19 March 2020, two asymptomatic dogs had tested positive to SARS-CoV-2 in Hong Kong. The dog owners both had COVID-19, which suggested potential transmission of SARS-CoV-2 from people to dogs. • On 31 March 2020, a case of a cat with SARS-CoV-2 was reported in Hong Kong. The cat owner was confirmed with SARS-CoV-2 infection but the cat did not show any clinical signs of the disease. • In March, SARS-CoV-2 genes was found in vomit and faeces from a cat in Belgium. • Overall, the evidence suggested true infection of SARS-CoV-2 in cats and dogs, but whether pets with SARS-CoV-2 infection can transmit the virus to humans was not evident.
<p>SARS-CoV-2 neutralizing serum antibodies in cats: a serological investigation</p> <p>Zhang, et al. 2020 (11)</p>	<ul style="list-style-type: none"> • This study investigated the infection of SARS-CoV-2 in cats in Wuhan during the COVID-19 outbreak by detecting specific serum antibodies using indirect enzyme linked immunosorbent assay (ELISA). • A cohort of serum samples were collected from 102 cats after the COVID-19 outbreak and 39 prior to the outbreak. • Fifteen of the 102 (14.7%) cat sera collected after the outbreak were positive for the receptor binding domain of SARS-CoV-2.

Source	Summary
	<ul style="list-style-type: none"> • Among the positive samples, 11 had SARS-CoV-2 neutralising antibodies with a titer ranging from 1/20 to 1/1080. Three of these cats that were owned by COVID-19 patients had the highest neutralisation titer. • No serological cross-reactivity was detected between the SARS-CoV-2 and type I or II feline infectious peritonitis virus. • The findings demonstrated that SARS-CoV-2 has infected cat population in Wuhan during the outbreak.
Grey literature	
<p>Risk of people spreading the virus that causes COVID-19 to pets</p> <p>Centre of Disease Control and Prevention July 2020 (14)</p>	<ul style="list-style-type: none"> • A small number of pets worldwide, including cats and dogs, have been reported to be infected with the SARS-CoV-2, mostly after close contact with people with COVID-19. • It was evident that infected pets might get sick or they might not have any symptoms. Of the pets that have gotten sick, most only had mild illness and fully recovered. • The US Centre of Disease Control and Prevention recommends that pet owners limit their pet’s interaction with people outside their household, mainly because there is a small risk that people with COVID-19 could spread the virus to animals.
<p>COVID-19 and pets: Can dogs and cats get coronavirus?</p> <p>Mayo Clinic June 2020 (15)</p>	<ul style="list-style-type: none"> • This report referred to the US Centre of Disease Control and Prevention’s position, which stated that few pets (including cats and dogs) can be infected with the virus that causes COVID-19. This happened mostly after the animals were in close contact with people infected with the COVID-19 virus. • The advice to pet owners is to limit their dog or cat from interacting with people or animals outside their household.
<p>Do domestic animals spread novel coronavirus disease (COVID-19)?</p> <p>RSPCA July 2020 (21)</p>	<ul style="list-style-type: none"> • The risk of animals spreading the COVID-19 virus to humans is considered low. • Animals don't appear to play a significant role in spreading the virus that causes COVID-19.
<p>COVID-19 in animals</p> <p>World Organisation for Animal Health June 2020 (13)</p>	<ul style="list-style-type: none"> • Cats (domestic and large cats), mink, and dogs have tested positive for SARS-CoV-2 in the field setting, following contact with humans known or suspected to be infected with SARS-CoV-2. • In the field setting, cats have shown clinical signs of disease including respiratory and gastrointestinal signs. SARS-CoV-2 infection in farmed mink has been characterised by respiratory disease and an increased mortality rate.

Source	Summary
	<ul style="list-style-type: none"> Although several animal species have been infected with SARS-CoV-2, these infections are not a driver of the COVID-19 pandemic; the pandemic is driven by human-to-human transmission.

Appendix

PubMed search terms

(2019-nCoV[title/abstract] or nCoV*[title/abstract] or covid-19[title/abstract] or covid19[title/abstract] OR "covid 19"[title/abstract] OR "coronavirus"[MeSH Terms] OR "coronavirus"[title/abstract] OR sars-cov-2[title/abstract] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) AND (animal, domestic[MeSH Terms] OR pets[MeSH Terms] OR Pets[title/abstract] OR "domestic animal"[title/abstract] OR dogs[MeSH Terms] OR cats[MeSH Terms] OR dog[title] OR dogs[title] OR cat[title] OR cats[title]) AND (2019:2020[pdat]) AND (2019/12/01:2020/12/31[pdat])

Google and Twitter search terms

Can animals be infected with SARS-CoV-2, COVID-19 in pets/companion animals/domestic animals/cat/dog/do animals spread COVID-19.

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