A rapid review of evidence of infection of pets and livestock with human-associated coronavirus diseases, SARS, MERS, and COVID-19, and evidence of the fomite potential of pets and livestock

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Impacts

- To date, all reported cases where the SARS-CoV-2 virus has been detected in cats or dogs have been living in close quarters with SARS-CoV-2 infected owners. Two cats and two dogs have been reported to have SARS-CoV-2 virus detected by PCR.
- Eleven of 102 cats in Wuhan China have been reported as positive for antibodies to SARS-CoV-2
- No cases of cat- or dog-to-human transmission have been reported.
- Two SARS-CoV-2 seeder challenge studies have reported no transmission to contact pigs, chickens or ducks.
- One study showed that SARS-CoV can survive on room temperature pig skin in phosphate buffered saline and in stool for >24h. No other studies of hair, skin, feathers, or hides as a source of transmission from domestic animals for SARS, MERS, or SARS-CoV-2 were found.

One page summary
A rapid review was undertaken for two questions of interest to veterinarians related to COVID-19: whether domestic animals can be infected with SARS-CoV-2 and whether they could serve as fomites for SARS-CoV-2. As little evidence is available, we also assessed other human coronaviruses, SARS and MERS. Searches were conducted on 30th March 2020 using all databases in the Michigan State University Web of Science™ Interface, BioRxiv, MedRxiv, and ProMED-mail. This summary focuses on SARS-CoV-2. Details of SARS and MERS are include in the full text.

In the current outbreak of COVID-19, of 17 dogs and 8 cats tested that lived with SARS-CoV-2 infected owners in Hong Kong, two asymptomatic dogs were PCR positive [1]. One of those dogs, a Pomeranian, was positive on serology[2-5]. Virus isolation performed on previous samples taken from the Pomeranian was negative, indicating that no live virus was retrieved. The 2nd dog, a German shepherd (which lived in a different household with a dog that tested negative) was positive based on PCR[6, 7], serology and virus isolation [8].

A cat that lived with SARS-CoV-2 infected owner in Belgium, has been reported as positive, as has a cat in Hong Kong[9, 10]. There was no report of the Hong Kong cat shedding virus. The Belgian cat tested PCR-positive for SARS-CoV-2 from successive feces and gastric fluid samples and antibody tests are pending according a French language report.[11, 12]

A seeder challenge model using SARS-CoV-2 has been able to infect 2 of 6 cats housed with inoculated cats[13]. These cats where positive on PCR and for antibodies. There were no reports of these cats shedding virus. An observational study of 102 cats from Wuhan, China has reported that 11 cats were positive on a virus neutralization assay of the 15 that cats had ELISA positive results [14]. Little detail about the study population of cats in Wuhan is available; however, it includes animals owned by COVID-affected patients (3 cats), stray cats (6 cats) and animals at veterinary hospitals (6 cats)[15].

A seeder challenge model using SARS-CoV-2 has been able to infect ferrets housed with inoculated ferrets, respectively[13, 16].

There is no evidence that livestock are infected with or shed SARS-CoV-2[16].
No studies were found that evaluated fur, hair, skin, or hides as a source of transmission from pets or livestock for SARS-CoV, MERS-CoV, or SARS-CoV-2, with one exception: SARS-CoV has been shown to survive on room temperature pig skin in phosphate buffered saline and in stool for ≥24h. Results were assessed using virus isolation in cell culture.[17]

Keywords
Cat, COVID-19, dog, livestock, SARS, SARS-CoV-2

Rationale

As COVID-19 is a newly emerging disease, information about the causal virus, Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2), and its relationship to domestic animals is

sparse (OIE, 23 March 2020). Veterinarians need the most up-to-date and accurate information on potential transmission of SARS-CoV-2 from pets, livestock, or poultry to people in order to set standards to protect themselves and staff at their own farms or clinics as well as to advise companion animal owners of potential risks to human health.

Objectives

The objective of this project is to create a living rapid review to address the possible role of pets and livestock in the transmission of COVID-19. Rapid reviews follow the structured steps of a formal systematic review, with a less comprehensive search to allow an expediated means of acquired evidence-based information. The living review component involves regular updates of the search and data collection to allow inclusion of additional evidence as it becomes available. The purpose of this living rapid review is not to provide policy recommendations, but rather to identify and summarize all of the available evidence, as it becomes available, to provide rapid, evidence-based summaries for use by those who make policy decisions.

There were two research questions:

- **Question 1:** "What is the evidence that domestic animals (cats, ferrets, dogs, swine, cattle, sheep, goats, poultry, horses) can be infected* with, or shed, the human-associated coronaviruses SARS-CoV, MERS-CoV, and SARS-CoV-2, which are associated with the diseases, SARS, MERS, and COVID-19, respectively?"
- **Question 2:** "What is the evidence that domestic animals (cats, ferrets, dogs, swine, cattle, sheep, goats, poultry, horses) can act as a fomite for the human-associated coronaviruses SARS-CoV, MERS-CoV, and SARS-CoV-2, which are associated with the diseases, SARS, MERS, and COVID-19, respectively?"

*Although there are a variety of diagnostic tests available, they can be categorized into one of three approaches: PCR, antibody detection, and virus isolation.
PCR: PCR detects a virus' genetic material. This allows early detection of infection (i.e., before antibodies have developed). A positive result means that viral RNA or DNA is present but does not evaluate whether the animal is shedding live virus. For the purposes of this review, we will refer to PCR-positive animals as "infected".
Antibody detection: A variety of tests, including ELISAs and virus neutralization, can be used to detect the presence of antibody to the virus. It takes time to develop antibodies following exposure to the virus; thus, a positive test implies that the animal was exposed to the virus in the past but does not evaluate whether the animal is currently shedding live virus. For the purposes of this review, we will refer to antibody positive animals as "previously exposed".
Virus isolation: Virus isolation is used to test for the presence of live virus, and a positive test means that an animal is shedding live virus. For the purposes of this review, we will refer to animals positive on virus isolation as "shedding".

Protocol

A protocol was not developed for this review. Instead, in response to the outbreak of COVID-19, a living rapid review on the topic was conducted and made publicly available online on the Systematic Reviews for Animals and Food website (http://www.syreaf.org/covid-19-and-animals/) on 20th March 2020. We disseminated the review using an EpiVet list and Twitter

(@oconnorwalker) and encouraged comments. The modifications to the methods and materials described below due to the comments were as follows:

- The original search used only terms for cats and dogs. Based on feedback, we expanded the search terms to include ferrets, livestock, and poultry.
- We explicitly added the exclusion criteria for animals that were experimentally infected/inoculated with the virus. This was not a change in scope because our original focus was always animals in an ownership relationship with naturally occurring exposure. However, we clarified this concept in our methods section.
- The original search used did not include the following terms "novel coronavirus" OR "2019-novel coronavirus" which we identified in the BioRvix searches.
- The original search did not include the term "fomites", which was added based on feedback from twitter.

Eligibility criteria

The eligibility criteria were:

- Populations: domestic animals designated as cats, dogs, cattle, pigs, sheep, goats, horses, ferrets, and poultry in natural exposure scenarios, not experimental routes of exposure, such as intra-tracheal inoculation. For seeder models, where animals are exposed to experimentally infected animals, information from the naturally exposed animals was eligible, but information from the artificially exposed animals was not.
- Exposure of interest: human-associated coronaviruses: SARS-CoV, MERS-CoV, and SARS-CoV-2.
- Q1 Outcome of interest: Evidence of infection, previous exposure, or viral shedding with SARS-CoV, MERS-CoV, and SARS-CoV-2 based on antibodies, PCR, or virus isolation in saliva, feces, or serum.
- Q2 Outcome of interest: Detection of SARS-CoV, MERS-CoV, and SARS-CoV-2 on the hair, fur, coat, hide, skin, or feathers of cats, dogs, ferrets, swine, cattle, sheep, goats, horses, or poultry.

Search

The search was designed based on three concepts: 1) the animals, 2) the virus, and 3) the outcome. Due to concern about designing the search for an area with few potentially relevant studies, positive control terms were included to provide some validation for the search strategy. For Question 1, because we were aware that literature exists identifying dogs that were antibody positive to Ebola, we included the Ebola term in the search. For Question 2, because there is a strong link between camels and MERS, we anticipated that studies about fomites, if they existed, would be available on this topic, so we included camels. The concept behind these positive controls is to ensure that studies of similar type were captured. In both situations, we confirmed that the searches were effective at identifying relevant articles for the positive control topics. These terms were subsequently dropped from the search. The final search strings are reported in Table 1.

Information sources

The searches reported here were conducted on 31st March and 1st April 2020 using all databases in the Michigan State University Web of Science™ Interface (Table 2). We hand-searched the

titles of pre-prints listed online at BioRxiv and MedRxiv using the search string "(COVID-19 OR SARS-CoV-2 OR SARS OR MERS) AND (cat OR dog OR cow OR pig OR sheep OR goats OR horses OR chicken OR ferrets)" (last searched 1st April 2020). We also hand-searched the report titles for ProMED-mail in the COVID-19 collection (https://promedmail.org/coronavirus/) using the find function (⌘f) and searching for dog, cat, ferret, cow, pig, sheep, poultry, goat, and horse (last searched 1st April 2020). We did not assess ProMED-mail for SARS or MERS, as we consider that enough time has passed since those outbreaks that such reports should be in the indexed literature.

Screening

Study selection: For Question 1, the screening questions asked if the study reported evidence of infection, previous exposure, or viral shedding by natural approaches with the eligible human coronaviruses (SARS-CoV-2, MERS-CoV, or SARS-CoV) in cats, dogs, cattle, ferrets, pigs, sheep, goats, horses or poultry. Natural approaches were defined by exclusion i.e., not an experimentally invasive approach such as intra-tracheal inoculation. The data extracted from relevant studies was the number of animals tested, the number positive and the type of test: PCR, virus isolation, or antibody assay.

For Question 2, the screening question asked if the study reported eligible human coronavirus (SARS-CoV-2, MERS-CoV, or SARS-CoV) on the hair, fur, coat, hide, skin, or feathers of cats, dogs, ferrets, swine, cattle, sheep, goats, horses, or poultry.

Screening of titles and abstracts was initially conducted by two reviewers, with only one person required to reject or accept. We used the Distiller SR® AI tool (Evidence Partners, Ottawa, Canada) to conduct automated screening. The decision rule for using the AI reviewer, was that whenever the AI tool indicated that it had "0 incorrect excludes", it was used based on 80% training set and 20% testing. The AI reviewer excluded studies it considered irrelevant and then a human reviewer evaluated the remaining studies. Eligibility was re-assessed after acquiring and reviewing the full texts of citations deemed eligible based on titles and abstracts.

RESULTS AND DISCUSSION

Question 1: Infection in domestic animals

In the database search conducted on the 26th March 2020, 2392 citations were found. At that time, the AI reviewer was used when, at title and abstract screening, 500 studies had been assessed for eligibility by the human reviewers. The AI tool excluded 1241 citations and left 651 citations for a human reviewer to assess. After that date when the search was updated, screening was conducted by human reviewers. The latest citation database search was conducted on March 30th 2020. The latest BioRxiv and MedRxiv search was conducted on 3rd April 2020 and the last ProMED-mail search was conducted on 3rd April 2020.

Dogs:

SARS-CoV-2: In ProMED-mail, Hong Kong Government officials reported that two dogs from two different households, each living with a COVID-19 infected owner, tested PCR positive to SARS-CoV-2 [2-7]. Neither dog showed clinical signs. One dog, identified as a 17-year-old Pomeranian, was weakly positive on PCR, virus isolation negative, and antibody positive. The second dog, a German shepherd, had nasal, oral, and rectal swabs collected and was positive by

PCR, virus isolation and serology[8]. A dog living in the same household as the German Shepherd has continued to test negative[8]. As of 25th March 2020, the Agriculture, Fisheries and Conservation Department (AFCD), Hong Kong Special Administrative Region Government, Hong Kong, Hong Kong (SAR-PRC) has conducted tests on 17 dogs and 8 cats from households with confirmed COVID-19 cases or persons in close contact with confirmed patients, and only 2 dogs have tested PCR positive (discussed above) for the SARS-CoV-2 virus. [1]One pre-print study assessed exposure to COVID in 2 non-inoculated dogs housed with inoculated dogs in a seeder challenge model [13], and no antibodies or virus were detected in the non-inoculated dogs. Based on the limited evidence to date, dogs may become infected and produce antibodies, but there is no evidence that they develop clinical disease if exposed, or that they shed virus which may pose a risk to humans.

SARS: Wang et al., (2005) sampled 5 dogs from an animal market in China; none of the dogs were infected based on PCR testing (Table 3). There were no dogs infected (14 negative on PCR) or exposed (20 negative for antibodies) from a survey of SARS in animals conducted in China (Chen et al., 2005) (Table 3). Thus, although the sample sizes are small, there is no evidence to date that dogs can be infected with SARS.

Cats:
SARS-CoV-2: In ProMED-mail on the 27th March 2020, a cat living with a SARS-CoV-2 infected owner in Belgium, was reported as SARS-CoV-2 positive [9]. The cat tested PCR-positive for SARS-CoV-2 from successive feces and gastric fluid samples and antibody tests are pending.[11]

On the 2nd April 2020, authorities in Hong Kong reported that a cat living with an owner with COVID-19 was positive for the virus based on sampling of the oral cavity, nasal cavity, and rectum. The type of testing used was not reported. The cat has not shown any signs of disease [10]. As of 25th March 2020, the Agriculture, Fisheries and Conservation Department (AFCD), Hong Kong Special Administrative Region Government, Hong Kong, Hong Kong (SAR-PRC) has conducted tests on 8 cats from households with confirmed COVID-19 cases or persons in close contact with confirmed patients, and 0 cats have tested positive (discussed above) for the SARS-CoV-2 virus[1].

The studies evaluating infection of cats with human-associated coronaviruses are reported in Table 3. One observational study of 102 cats used an ELISA followed by a viral neutralization assay to assess the prevalence of antibodies to SARS-CoV-2. The study population was defined as follows "A total of 102 cats were sampled from animal shelters or pet hospitals of Wuhan between Jan. and Mar., 2020." [14]. One study reported being able to infect cats with SARS-CoV-2 in a seeder challenge model [13]. These cats were housed with cats that had been intranasally inoculated with 10^5 pfu of SARS-CoV-2/CTan/human/2020/Wuhan (CTan-H).

SARS: One study also reported that 2 cats housed with 6 SARS-infected cats had detectable viral titers within 2 days and seroconverted to the virus within 28 days in a seeder challenge model [18] (Table 3). This study was included because, although the 6 cats were inoculated, the other two cats were exposed due to close housing. There was no report of whether there was viral shedding in the two cats co-housed with the infected cats. SARS was detected using PCR in a

longitudinal observational study at an animal market in China, which included sampling of domestic cats [19]. Four of 36 cats tested were PCR positive; all positives were very early in the study period. Another observational study found no positive cats by PCR or by antibody tests from 11 tested [20]. A third study on cats was excluded at full-text review, as it did not assess natural routes of infection but rather described a SARS challenge model [21].

These results suggest that cats can be infected with SARS and SARS-CoV-2 and can produce antibodies to both viruses. There is no evidence of viral shedding after natural infection, although it should be noted that not all the cats that have been identified as infected with PCR were from homes with COVID-19 positive humans. It is important that future studies provide information on whether cats infected with, or with antibodies to, SARS-CoV-2 were in situations with known exposure to humans, or whether there was potential for other sources of exposure.

Ferrets:
SARS-CoV-2: A seeder challenge study reports that three non-inoculated contact ferrets became infected with viral RNA present in nasal washing fluids[16]. SARS-CoV-2 reactive antibodies were detected in one non-inoculated contact ferret. The contact model used for the ferrets was not reported.

SARS: One seeder challenge model study investigated whether inoculated ferrets can transmit SARS to co-housed non-inoculated ferrets and reported that the non-inoculated animals were PCR virus positive [18].

Livestock:

SARS-CoV-2: Two studies to date have evaluated SARS-CoV-2 in pigs and chickens [13, 16], and one study in ducks [13] by inoculating animals and then co-housing these animals with non-inoculated animals. None of the contact animals in the study by Shi, Wen [13] (3 pigs, 3 chickens, 3 ducks) were positive for SARS-CoV-2 on PCR or antibody tests (Table 4). The study reported from the Friedrich-Loeffler-Institut reported that contact animals (pigs and chickens) remained negative for SARS-CoV-2-RNA, but the number of contact and inoculated animals was not clear in the report[16]. These data suggest that these species are not susceptible, although with the caveat that this is based on two studies with a small sample size, and it is not known how well the contact model represents field exposure conditions.

Three studies evaluated whether livestock could be infected with MERS-CoV [22-24]. El-Duah, Sylverken [22] collected 579 fecal samples from various livestock species on 35 farms and 4216 serum samples from 24 farms in Ghana between June 2015 and May 2016 to test for MERS-CoV. Fecal samples were tested using PCR, and serum samples were screened for antibodies using an immunofluorescence assay. The species evaluated included pigs, cattle, sheep, goats, and donkeys. None of the samples were positive on either diagnostic test (Table 4). Virus isolation was not evaluated in any of the samples. Kandeil, Gomaa [23] evaluated non-camelid domestic mammals in Egypt, Tunisia, and Senegal for MERS-CoV. The authors used PCR on 823 nasal swabs and antibody tests on 820 sera samples from cattle, sheep, goats, donkeys, buffaloes, mules, donkeys, and horses. Virus RNA was detected by PCR in three sheep, five goats, three donkeys, and one cow from Egypt or Senegal (Table 4). There was detectable

antibody in 56 serum samples, from sheep (39/372), cattle (4/67), goats (9/320), and equids (4/56) (Table 4). Kasem, Qasim [24] evaluated serum samples and nasal swabs for MERS-CoV from 39 sheep, 51 goats, and 2 cattle with a history of contact with MERS patients in Saudi Arabia. None of the samples were positive for antibodies for MERS-CoV or positive on PCR (Table 4). Virus isolation was not conducted. Thus, there is some evidence that domestic animals may be infected with MERS, but it is not known whether these animals shed live virus.

Two studies evaluated SARs-CoV-1 in livestock or poultry species [19, 20]. Wang, Jing [19] sampled animals at a live market in Guanzhou in 2004. There was one positive sample from the 19 wild boar (*Sus scrofa*) tested and no positive samples from the three goats that were tested (Table 4). Using both antibody tests and PCR to test for SARS-CoV-1, Chen, Yan [20] identified 2 pigs of 110 tested as antibody positive (Table 4). One of the antibody positive pigs also was positive on PCR and virus isolation. Based on sequence and epidemiological analysis, the authors suggested that the pig was infected by a SARS-CoV of human origin. There were no positive samples from cattle based on PCR (n=22) or antibody tests (n=60).

Animals as fomites

The search for literature about domestic animals as fomites found 865 citations. AI was utilized after the human reviewers screened 500 citations. The AI reviewer excluded all but 98 citations, which then were evaluated by a human; none of these were relevant. In total, 1 relevant study was identified. SARS-CoV has been shown to survive on room temperature pig skin in phosphate buffered saline and in stool for >24h. Results were assessed using virus isolation in cell culture.[17]

Accessed April 9th, 2020No other studies were found that evaluated fur, hair, skin, feathers, or hides as a source of transmission from domestic animals for SARS-CoV-2, MERS-CoV or SARS-CoV. It is interesting that we did not identify any studies describing camels as fomites for MERS, as the relationship between camels and MERS is well investigated.

Summary:

There is evidence from seeder models that cats and ferrets can become infected with SARS-CoV-2 and this is detectable using PCR. However, it is unclear if the doses these animals are exposed to represent a realistic exposure that could be extrapolated to exposures that would occur in households. All other species evaluated were rarely, if ever, positive for the human coronaviruses and do not appear to shed the viruses. There is evidence that cats in Wuhan, China have antibodies to SARS-CoV-2 which appears to have developed after the outbreak.

CONFLICT OF INTEREST

AOC, JS and ST have no conflicts of interest to declare.

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Table 1: Search strategy details used for the rapid review in Michigan State University Web of Science™

Question 1	#3 AND #2 AND #1 (conducted:31st March 2020)	2,392
	#3: TS=(serology OR serum OR antibodies OR titre OR ELISA OR PCR OR detection OR serological OR sample OR sampling OR "virus isolation" OR assay)	16,196,022
	#2: TS = (dog OR canine OR cat OR feline OR cattle OR bovine OR pig OR swine OR hog OR porcine OR sheep OR ovine OR goat OR caprine OR hen OR poultry OR horse OR equine OR ferret)	4,808,882
	#1: TS=(COVID OR SARS-CoV-2 OR COVID OR COVID-19 OR 2019-nCoV OR "novel coronavirus" OR "2019-novel coronavirus" OR "Middle east respiratory syndrome" OR MERS OR MERS-CoV OR SARS OR SARS-CoV OR "severe acute respiratory syndrome" or EBOLA OR EVD)	97,392
Question 2	#4 AND #3 AND #2 AND #1 (conducted:1st April 2020)	865
	#4 TS = (dog OR canine OR cat OR feline OR cattle OR bovine OR pig OR swine OR hog OR porcine OR sheep OR ovine OR goat OR caprine OR hen OR poultry OR horse OR equine OR animal OR camel PR ferret)	28,450,393
	#3 TS=(transmission OR zoonotic OR exposure OR infection OR contamination OR transfer)	16,057,965
	#2 TS=(skin OR fur OR hair OR fomite OR "direct contact" OR petting OR Patting OR brushing OR saliva OR hide OR leather OR grooming OR fomites OR feather OR feathers)	4,030,460
	#1 TS=(COVID OR SARS-CoV-2 OR COVID OR COVID-19 OR 2019-nCoV OR "novel coronavirus" OR "2019-novel coronavirus" OR "Middle east respiratory syndrome" OR MERS OR MERS-CoV OR SARS OR SARS-CoV OR "severe acute respiratory syndrome" or EBOLA OR EVD)	97,480

Table 2: Citations Databases in the Michigan State University Library Collection in the Web of Science™ interface

Web of Science Core Collection (1900-present)
Science Citation Index Expanded (1900-present)
Social Sciences Citation Index (1900-present)
Arts & Humanities Citation Index (1975-present)
Conference Proceedings Citation Index- Science (1990-present)
Conference Proceedings Citation Index- Social Science & Humanities (1990-present)
Book Citation Index– Science (2005-present)
Book Citation Index– Social Sciences & Humanities (2005-present)
Emerging Sources Citation Index (2005-present)
Current Chemical Reactions (1985-present)
(Includes Institut National de la Propriete Industrielle structure data back to 1840)
Index Chemicus (1993-present)
Biological Abstracts (1926-present)
BIOSIS Citation Index (1926-present)
CABI: CAB Abstracts® (1910-present)
Current Contents Connect (1998-present)
Data Citation Index (1900-present)
Derwent Innovations Index (1963-present)
FSTA® - the food science resource (1969-present)
KCI-Korean Journal Database (1980-present)
MEDLINE® (1950-present)
Russian Scie nce Citation Index (2005-present)
SciELO Citation Index (2002-present)
Zoological Record (1864-present)

Table 3: Test results for published studiesor pre-prints that have assessed dogs, cats, and ferrets with non-inoculated approaches to infection with human coronavirus. This table does not include Promed-mail reports

	Martina, Haagmans [18]	Wang, Jing [19].	Chen, Yan [20]	[13]	[14]
	SARS-CoV-1*	SARS-CoV-1	SARS-CoV-1	SARS-CoV-2*	SARS-CoV-2
Dogs					
Tested for PCR		5	14	2	
Positive for PCR		0	0	0	
Tested for virus isolation		0	0	0	
Positive for virus isolation		0	0	0	
Tested for antibodies		0	20	2	
Positive for antibodies		0	0	0	
Cats					
Tested for PCR	2	36	11	6	102
Positive for PCR	2	4	0	2	0
Tested for virus isolation	2	0	0	0	0
Positive for virus isolation	1	0	0	0	0
Tested for antibodies	2	0	11	6	102
Positive for antibodies	0	0	0	2	11
Ferrets					
Tested for PCR	2				
Positive for PCR	2				
Tested for virus isolation	0				
Positive for virus isolation	0				
Tested for antibodies	0				
Positive for antibodies	0				

*Seeder challenge model was used. Data were extracted from cats, dogs, and ferrets exposed to the seeders, not directly inoculated with virus.

Table 4: Test results for published studiesor pre-prints that have assessed livestock with non-inoculated approaches to infection with human corona viruses. This table does not include Promed-mail reports

Authors	El-Duah, Sylverken [22]	Kandeil, Gomaa [23]	Kasem, Qasim [24]	Wang, Jing [19].	Chen, Yan [20]	Shi, Wen [13]
Virus	MERS*	MERS**	MERS	SARS-CoV-1[#]	SARS-CoV-1	SARS-CoV-2
Pigs						
Tested for PCR	716			19	14	3
Positive for PCR	0			1	1	0
Tested for virus isolation	0			0	6	0
Positive for virus isolation	0			0	1	0
Tested for antibodies	150			0	110	3
Positive for antibodies	0			0	2	0
Cattle						
Tested for PCR	1230	68	2		22	
Positive for PCR	0	1	0		0	
Tested for virus isolation	0	0	0		0	
Positive for virus isolation	0	0	0		0	
Tested for antibodies	212	67	0		60	
Positive for antibodies	0	4	0		0	
Sheep						
Tested for PCR	1136	368	93			
Positive for PCR	0	3	0			
Tested for virus isolation	0	0	0			
Positive for virus isolation	0	0	0			
Tested for antibodies	66	372	0			
Positive for antibodies	0	39	0			
Goats						
Tested for PCR	1026	325	90	3		
Positive for PCR	0	5	0	0		
Tested for virus isolation	0	0	0	0		
Positive for virus isolation	0	0	0	0		
Tested for antibodies	132	320	0	0		
Positive for antibodies	0	9	0	0		
Horse, donkey, mule						
Tested for PCR	108	57				
Positive for PCR	0	3				
Tested for virus isolation	0	0				
Positive for virus isolation	0	0				

Tested for antibodies	19	56				
Positive for antibodies	0	4				
Poultry (chickens, ducks, turkeys)	No	No	No	No	Yes	Yes
Tested for PCR					31	6
Positive for PCR					0	0
Tested for virus isolation					0	0
Positive for virus isolation					0	0
Tested for antibodies					41	6
Positive for antibodies					0	0

*No horses were tested. Donkey data was extracted under "horses" in this form.

**Horses, donkeys and mules were all extracted under "Horses"

Full text is in Chinese. Data were therefore extracted based on the abstract. Pigs tested were wild boar.