## CORONAVIRUS

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<th>Animal Group(s) Affected</th>
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<td>Multiple mammalian and avian taxa.</td>
<td>Fecal-oral, inhalation, contaminated feed or fomites.</td>
<td>Diarrhea (often mucoid) due to enteritis, respiratory discharge, dyspnea, lethargy, death.</td>
<td>Often very severe.</td>
<td>Supportive, antibiotics to reduce secondary infections.</td>
<td>Vaccines exist for certain species: Recommended for - Avian Infectious Bronchitis Virus, Bovine Coronavirus, Transmissible Gastroenteritis Virus.</td>
<td>Most veterinary pathogens are not zoonotic with two major exceptions: SARS, MERS.</td>
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### Susceptible animal groups:
- **Birds:** Avian Infectious Bronchitis Virus (IBV) – poultry, Turkey Coronavirus Enteritis (TCE) – turkeys  
  Multiple other less pathogenic avian coronaviruses
- **Mammals:** Nearly ever mammal family has associated coronavirus. Those of veterinary import are:
  - Bovine Coronavirus (BCV) – domestic cattle, isolated from multiple ruminant species, including sambar deer (Cervus unicolor), waterbuck (Kobus ellipsiprymnus), sable antelope (Hippotragus niger), white-tailed deer (Odocoileus virginianus), wisent (bison bonasus), Himalayan tahr (Hemitragus jemlahicus), sitatunga (Tragelaphus spekii), nyala (Tragelaphus angasii), and giraffe (Giraffa camelopardalis).
  - Canine Coronavirus (CCoV) – canids
  - Feline Coronavirus (FCoV) – felids, including both wild and captive exotic felids
    - [biotype that develops into feline infectious peritonitis (FIP) covered separately in this manual]
  - Ferret enteric coronavirus (FECV, formerly Epizootic Catarrhal Enteritis or ECE) and Ferret Systemic Coronavirus (FRSCV) – ferrets
  - Middle East respiratory syndrome coronavirus (MERS-CoV) – humans, suspected reservoir in bats, camels
  - Porcine Epidemic Diarrhea Virus (PED), Porcine Respiratory Coronavirus (PRCV), and Transmissible Gastroenteritis (TGE) - suids
  - Severe Acute Respiratory Syndrome-associated Coronavirus (SARS-CoV) – humans, possibly other primates, carnivores—including palm civets, raccoon dogs, ferret badgers and domestic cats—and bats

### Causative organism:
Each disease caused by specific coronavirus (family Coronaviridae)

### Zoonotic potential:
Both SARS and MERS are confirmed zoonotic diseases.

### Distribution:
- Avian coronavirus distribution worldwide.
- BCV, CCoV, FCoV – worldwide
- MERS-CoV – Middle East; SARS - Asia
- TGE – worldwide though less frequently in Europe, epidemic form; its deletion mutant (PCRV) first noted in 1980s, exists in endemic form
- FRECV – first noted in 1993 in US, FRSCV – first noted in Spain in 2004; also present in US

### Incubation period:
generally very short, ranging from 18-24 hours to 3-4 days
**Clinical signs:** One of three disease manifestations:

- Enteric coronaviruses (BCV, CCoV, FCoV, FECV, PED, TGE) with tropism for GI epithelial cells cause malabsorptive, maldigestive diarrhea with possible dehydration, metabolic acidosis, and death. Generally seen in young animals, especially BCV, TGE and PED. In BCV and TGE, the diarrhea is often mucoid and yellow in color with possible milk clots. In FECV, the diarrhea begins as green and mucoid progressing to a rice-water, granular stool.

- Respiratory coronaviruses (PRCV, MERS-CoV, SARS-CoV) are adapted to enter and reproduce in the upper respiratory mucosa causing fever, nasal discharge, cough, pneumonia, and possibly death.

- Systemic coronaviruses infect and persist in macrophages, causing lethargy, weight loss, anorexia, abdominal masses, anemia, peritonitis, vasculitis, peritoneal effusions, and death.

**Post mortem, gross, or histologic findings:**

Enteric coronaviruses – gross lesions include thin-walled, flaccid small intestine, often with yellowish contents; fluid in the colon and/or cecum; microscopically, villous atrophy and blunting, with club-shaped, stumpy villi, often fused; hyperplastic crypt epithelium.

Respiratory coronaviruses, specifically SARS and MERS – gross lesions include pulmonary edema and consolidation; microscopically, diffuse alveolar damage with acute exudates with edema, hyaline membranes, and fibrosis with mixed cellular infiltration.

Systemic coronaviruses, specifically FSCV – gross lesions include whitish nodules through peritoneal viscera ± peritoneal effusion; microscopically, pyogranulomatous inflammation of visceral peritoneum, mesenteric adipose tissue, liver, lungs, kidneys, lymph nodes, spleen, pancreas, and other peritoneal viscera.

**Diagnosis:**

Avian IBV - ELISA available for flock screening; qPCR also available

Electron microscopy (EM) can be used as screening test for enteric coronaviruses

Molecular diagnostics, like PCR, most widely used for antemortem diagnosis of coronaviruses; PCR generally cross reacts among the alpha-coronaviruses (FCoV, FECV, CCoV, TGE), and beta-coronaviruses (BCV); PCR confirmation in presence of clinical suspicion, performed by CDC approved lab for MERS, SARS

Indirect fluorescent antibodies (IFA) are often used on affected tissue in post-mortem samples, but can be used on antemortem swabs of nasal discharge or feces; IFA available for BCV, TGE, CCoV

**Material required for laboratory analysis:**

ELISA – blood, serum, or eggs (poultry)

EM – feces, tissue

IFA – intestinal or respiratory tissue, nasal/pharyngeal swab or tracheal wash/bronchoalveolar lavage

IHC – formalin-fixed tissue

PCR – blood (serum or EDTA), peritoneal fluid, feces, fresh tissue

**Relevant diagnostic laboratories:**

Many tests widely available in state diagnostic labs in US. Specific testing:

- Cornell Animal Health Diagnostic Laboratory: IFA (BCV, CCoV); PCR (alpha- and beta-), kinetic ELISA (FeCV); viral isolation
  https://ahdc.vet.cornell.edu/

- Iowa State University Veterinary Diagnostic Laboratory: PCR (TGE, PED, PRCV)
  http://vetmed.iastate.edu/diagnostic-lab/

- Michigan State University Diagnostic Center for Population and Animal Health: PCR (FECV, FRSCV)
  http://www.ferrethealth.msu.edu/Diagnostics.php

- Texas A&M Veterinary Medical Diagnostic Laboratory: qPCR (IBV); IFA (CCoV, FeCV, TCE); EM
  http://tvmdl.tamu.edu/
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**Treatment:** Treatment is supportive. In the case of enteric coronaviruses, treatment of the dehydration and electrolyte abnormalities is often accompanied by antibiotics to control opportunistic infections. Respiratory coronaviruses are often self-limiting, except in the case of the rare zoonotic SARS and MERS, where treatment is supportive. Treatment of systemic coronaviruses is generally not successful, but rather focuses on controlling clinical signs.

**Prevention and Control:** All coronaviruses are best prevented in similar fashion: by reducing fecal contamination of environment through routine cleaning and removal of feces, disinfection of enclosures, bowls, and other material with bleach once weekly. Isolation of sick individuals and quarantine of new animals is important to reduce exposure of naïve animals to shed virus. In production animals, the all-in/all-out technique is used to reduce exposure and contamination. Vaccinations are available in many species. They are generally recommended to prevent Avian Infectious Bronchitis Virus, Bovine Coronavirus and Transmissible Gastroenteritis Virus. Vaccines often are combination rotavirus and coronavirus products and have been used in exotic hoofstock, although efficacy is variable and vaccine reactions have been seen after two or more administrations. For canids and felids, vaccinations, although available, are not recommended their coronaviruses.

**Suggested disinfectant for housing facilities:** Coronaviruses are enveloped and labile in the environment. They are generally vulnerable to sunlight and basic disinfectants, like bleach, iodine, and quaternary ammonium compounds.

**Notification:** MERS and SARS are reportable to CDC. TGE reportable to USDA/OIE.

**Measures required under the Animal Disease Surveillance Plan:** None

**Measures required for introducing animals to infected animal:** Asymptomatic carriers are considered common in ferret coronaviruses. Pigs and cattle that have recovered from coronaviruses are not considered at high risk for repeat disease.

**Conditions for restoring disease-free status after an outbreak:** N/A

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References: