Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Epizootic Catarrhal Enteritis

BASIC INFORMATION

DEFINITION
Epizootic catarrhal enteritis (ECE) is an enteric viral disease of ferrets that is caused by a novel coronavirus, designated as ferret enteric coronavirus (FECV). In naïve ferrets, infection results in profuse greenish, mucoid diarrhea with high morbidity and low mortality.

SYNONYMS
Green diarrhea, greenies, green slime, ferret enteric coronavirus infection

SPECIAL SPECIES CONSIDERATIONS
FECV has been implicated anecdotally in diarrheal outbreaks in other Mustelid species.

EPIDEMIOLOGY

SPECIES, AGE, SEX
- Ferrets of all ages may be infected with FECV.
- Older animals may have more severe lesions caused by concomitant inflammatory bowel disease or other systemic illness.

RISK FACTORS
- Animals in facilities that routinely introduce new animals, such as shelters, are at risk.
- Older animals with concomitant disease, especially preexistent gastric Helicobacter mustelae infection, are at risk for more significant disease.

CONTAGION AND ZOONOSIS
As with other group A coronaviruses, FECV is extremely contagious. The virus is spread easily in feces but may be spread mechanically by contaminated clothing, shoes, examination tables, and instruments.

GEOGRAPHY AND SEASONALITY
- Because of the immunity generated by previous infection, as well as production of maternal antibodies from jills on many breeding farms, true outbreaks of ECE are extremely rare in the United States.
- Most cases of ECE arise outside of the United States as a result of previously unexposed populations and importation of animals from North America for the pet trade.
- There is no seasonality.

ASSOCIATED CONDITIONS AND DISORDERS
- Acutely ill ferrets may develop gastric ulcers owing to the stress of illness and/or treatment.
- Affected animals may develop inflammatory bowel disease as a sequela of infection by FECV.

INITIAL DATABASE
- Clinicopathologic changes are not specific for ECE.
- Persistent lymphocytosis, hypoalbuminemia, and mild elevations in globulins suggest bowel inflammation but are not specific for this condition.
- Acutely ill animals may show an elevated alanine aminotransferase and rarely alkaline phosphatase as a result of inanition, starvation, and mobilization of fat stores to the liver.
- Rarely, acutely affected animals may exhibit hemoconcentration and mild electrolyte abnormalities, including hypernatremia, hypochloremia, and an increased anion gap.

ADVANCED OR CONFIRMATORY TESTING
- Definitive diagnosis requires biopsy of the intestine and evaluation for characteristic histopathologic lesions.
- Immunohistochemistry for coronaviral antigen in intestinal biopsy
- PCR on fecal samples or intestinal biopsy

TREATMENT

THERAPEUTIC GOALS
- The overall therapeutic goal is to combat dehydration and malabsorption, while preventing secondary bacterial infection.
- In chronic cases, amelioration of the effects of inflammatory bowel disease is required.

ACUTE GENERAL TREATMENT
- In dehydrated animals, volume replacement with up to 90 mL/kg/d of lactated Ringer’s solution may be required.
- Broad-spectrum antibiotics (e.g., enrofloxacin 5 mg/kg bid PO or SC), although not helpful against coronaviral infection itself, are generally recommended to prevent secondary bacterial infection.
- Highly absorbable bland diets, such as Carnivore Care (Oxbow Foods, Inc., Murdock, NE) and Hill’s products (Hill’s Pet Nutrition, Inc., Topeka, KS), or meat-flavored baby foods, should be administered frequently in small amounts.
- If clinical signs of gastric ulcers are noted, palliative therapy is indicated:
  - Sucralfate 75 mg PO 10 min before meals

DIAGNOSIS

DIFFERENTIAL DIAGNOSIS
- The differential diagnosis includes other infectious and noninfectious causes of diarrhea:
  - Coccidiosis
  - Campylobacteriosis
  - Rotavirus infection
  - Cryptosporidiosis
  - Salmonellosis
  - Lymphocytic and eosinophilic forms of inflammatory bowel disease
○ Omeprazole 4 mg/kg PO q 24 h or
○ Cimetidine 10 mg/kg PO q 8 h or
○ Ranitidine bismuth citrate 24 mg/kg PO q 8 h
○ Antibiotic therapy specific for Helicobacter mustelae

CHRONIC TREATMENT
• Animals that have recovered from epizootic catarrhal enteritis may develop “inflammatory bowel disease” after several months.
• These animals will often benefit from a bland diet and 0.5 mg/kg oral prednisone daily.
• Lifelong treatment may be required.

PROGNOSIS AND OUTCOME
• Most young, healthy animals will recover within 21 days.
• Older animals, especially those with other chronic illness, often experience more severe clinical signs and a longer disease course.

PEARLS & CONSIDERATIONS

COMMENTS
• Treatment success should be predicated on improvement of stool character over a period of weeks.
• Stools may vary significantly from day to day.

PREVENTION
Owing to prolonged shedding of the virus by carriers (up to 8 months), isolation of new arrivals is rarely beneficial in preventing epizootic catarrhal enteritis.

SUGGESTED READINGS
Williams BH, et al: Retrospective study: coronavirus-associated epizootic catarrhal enteritis (ECE) in ferrets (Mustela putorius furo). 119 cases (1993-1998), J Am Vet Med Assoc 217:526–530, 2000.
Wise AG, et al: Molecular characterization of a novel coronavirus associated with epizootic catarrhal enteritis (ECE) in ferrets, Virology 349:164–174, 2006.

CROSS-REFERENCES TO OTHER SECTIONS
Campylobacter spp. Infection
Endoparasites
Helicobacter mustelae—Associated Gastritis and Ulcers
Inflammatory Bowel Disease

AUTHOR: BRUCE H. WILLIAMS
EDITORS: JAMES G. FOX AND ROBERT P. MARINI