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OMGiardia:Worms and Other Bugs?

When to screen, when to treat and when it's important

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Financial Disclosure

- I have financial interest, arrangement or affiliation with:
- This session is sponsored by IDEXX
- Meriam N. Saleh is a sponsored speaker.
- K. Wade Burton is an employee of IDEXX
- In addition, Meriam N. Saleh has received honoraria and research support from multiple veterinary pharmaceutical companies over the past 5 years.
- These activities are unrelated to this presentation.

Agenda

Objectives

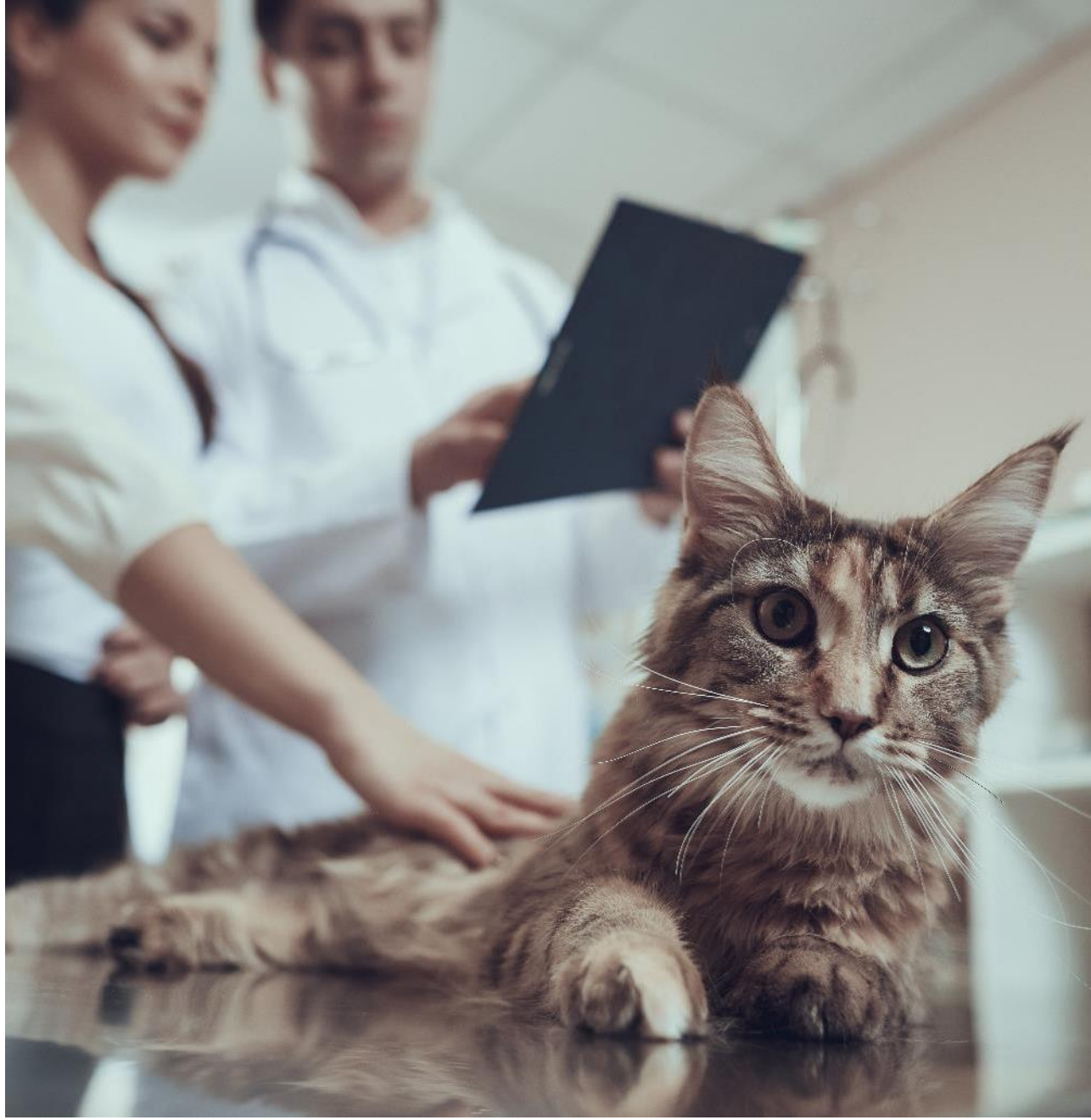
- Understand the risks intestinal parasites, including *Giardia,* may pose to people and their pets.
- Learn why regular screening for parasites is important and how to interpret results from intestinal parasite testing.
- Understand *Giardia* genotyping, clinical management, and recommendations.
- Understand when treatment is recommended and why follow-up testing is critical for successful management of intestinal parasite including *Giardia.*

Why do we perform fecal testing?

- Ensure the health of pets
- Reduce transmission of potentially zoonotic parasites to people
- Evaluate the efficacy for anthelmintic treatment

> Conduct microscopic fecal examinations by centrifugation at least four times during the first year of life, and at least two times per year in adults, depending on patient health and lifestyle factors.
>
> **—CAPC**

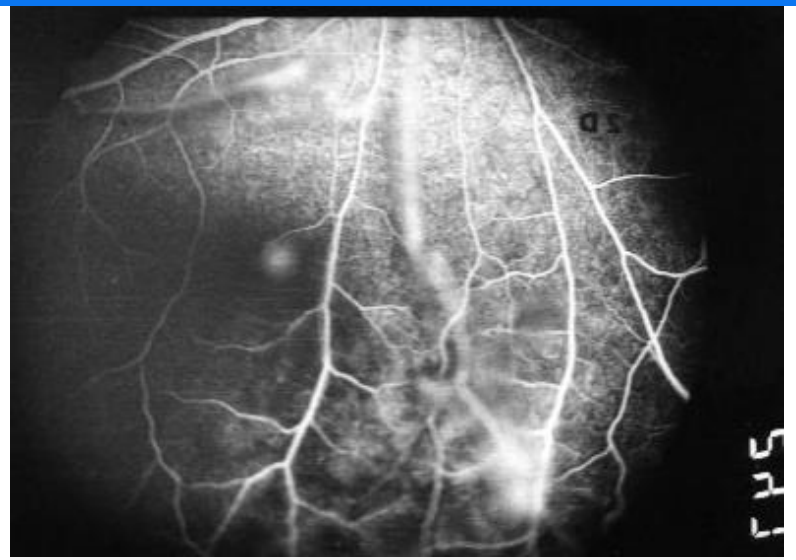
Source: Companion Animal Parasite Council. General guidelines for dogs and cats. September 16, 2022. Accessed February 12, 2024. www.capcvet.org/guidelines/general-guidelines



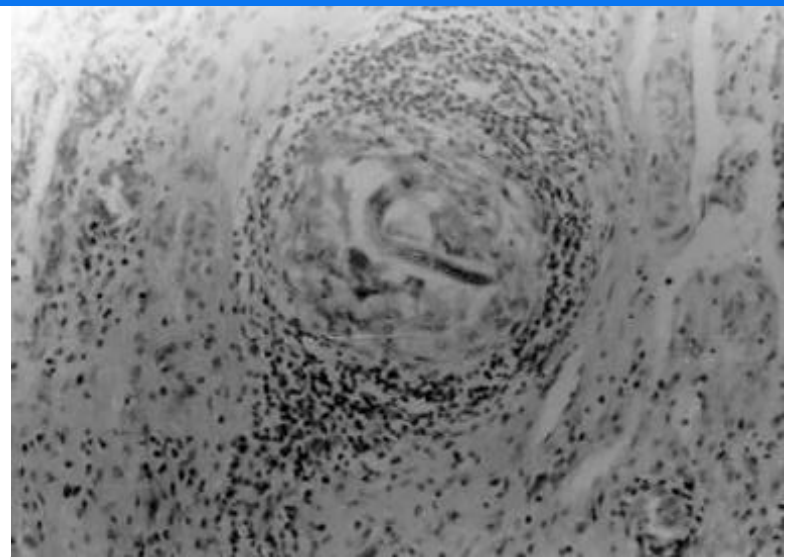
What happens if you miss an infection?

1 in 10 companion animals has gastrointestinal (GI) parasites.[1]
Missed infections can put pets and people at greater risk.

Cutaneous larva migrans (CLM)



Ocular larva migrans (OLM)



Visceral larva migrans (VLM)
in liver tissue

Reference
1. Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

Roundworm

Up to 14% of the U.S. human population has *Toxocara* antibodies.[1]

- Greatest risk: young children and dog and cat owners
- Occurs from accidental ingestion or (less likely) eating undercooked meat
- Clinical disease in people
  - Visceral, ocular, neural larva migrans
  - Covert toxocariasis[2]

> Millions of human cases of ***Toxocara*** larva migrans are ultimately suspected in the United States each year.[3]
>
> **—Dr. Peter Schantz, CDC**

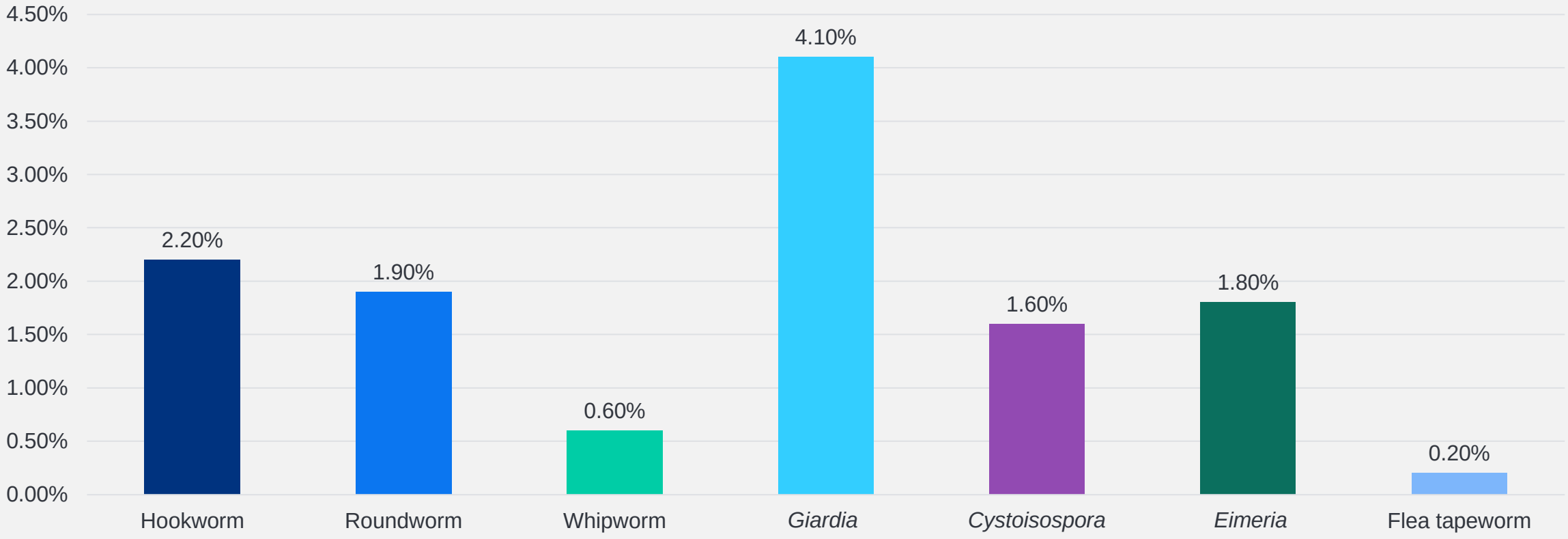
References

1. Won KY, Kruszon-Moran D, Schantz PM, Jones JL. National seroprevalence and risk factors for Zoonotic *Toxocara* spp. infection. *Am J Trop Med Hyg*. 2008;79(4):55–557.
2. Nathwani D, Laing RB, Currie PF. Covert toxocariasis—a cause of recurrent abdominal pain in childhood. *Br J Clin Pract*. 1992;46(4)271.
3. Schantz PM. *Toxocara* larva migrans now. *Am J Trop Med Hyg*. 1989;41(3) (Suppl):21–34. doi:10.4269/ajtmh.1989.41.21

What do we find most commonly in canine wellness fecal flotation?

These represent over **99%** of all positives found on fecal flotation.

Eimeria is a pseudoparasite and acquired via coprophagy



Source: Sweet S, Hegarty E, McCrann DJ, Coyne M, Kincaid D, Szlosek D. A 3-year retrospective analysis of canine intestinal parasites: fecal testing positivity by age, U.S. geographical region and reason for veterinary visit. *Parasit Vectors*. 2021;14(1):173. doi:10.1186/s13071-021-04678-6

Can we improve parasite detection?

What is parasite antigen testing?

- Method for detecting proteins—coproantigens—secreted or excreted by parasites in the intestinal lumen
- Uses unique markers for hookworm, roundworm, whipworm, cystoisospora and flea tapeworm—produced by the worms and not the eggs

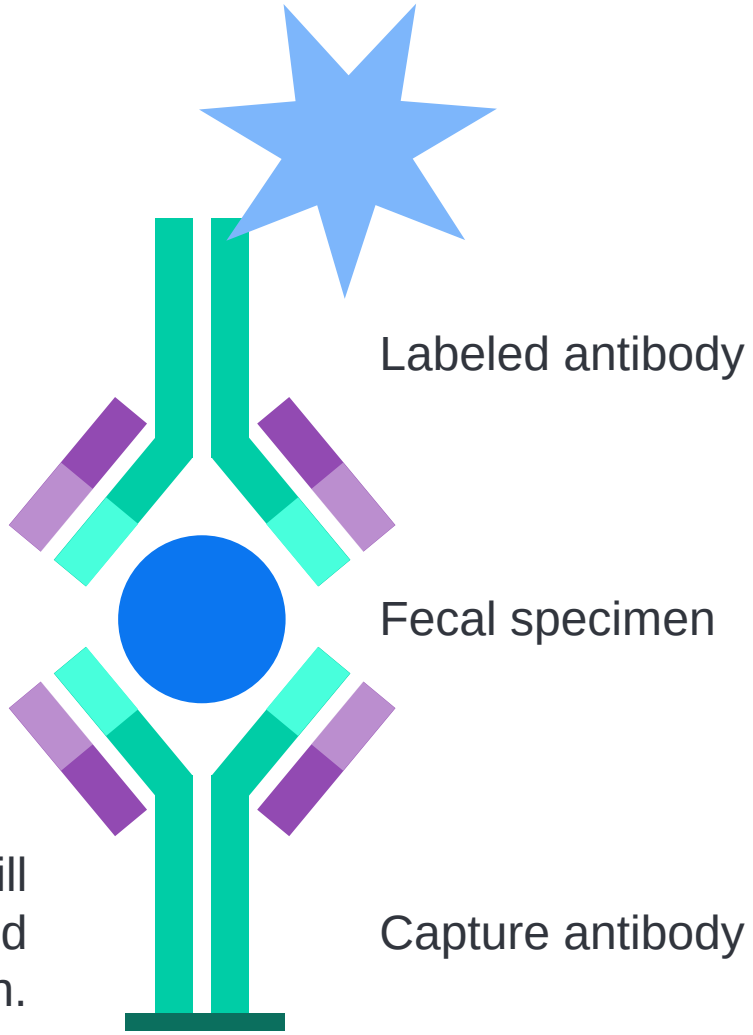


Image © Canva.com

Antigen testing helps to fill some of the gaps associated with egg detection.

What protein is detected for each antigen test?

Hookworm[1]

Secreted protein expressed in distal gut of nematode

Whipworm[2]

Protein involved in host attachment

Roundworm[1]

Protein used for parasite maintenance within host

Flea tapeworm[3]

Protein associated with mature proglottid shedding

Cystoisospora

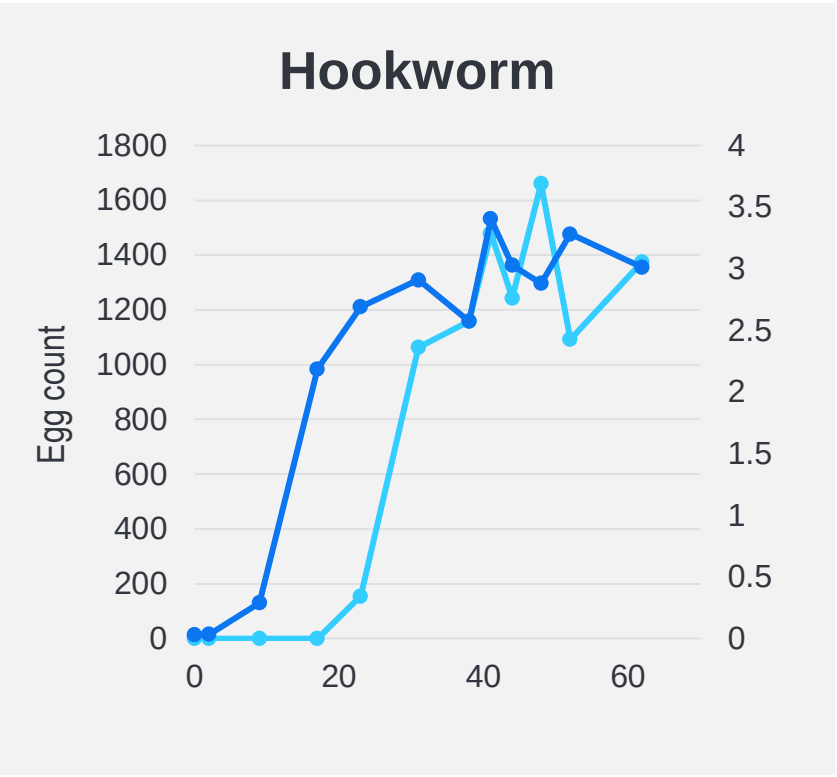
Protein associated with sporozoites, merozoites and oocysts

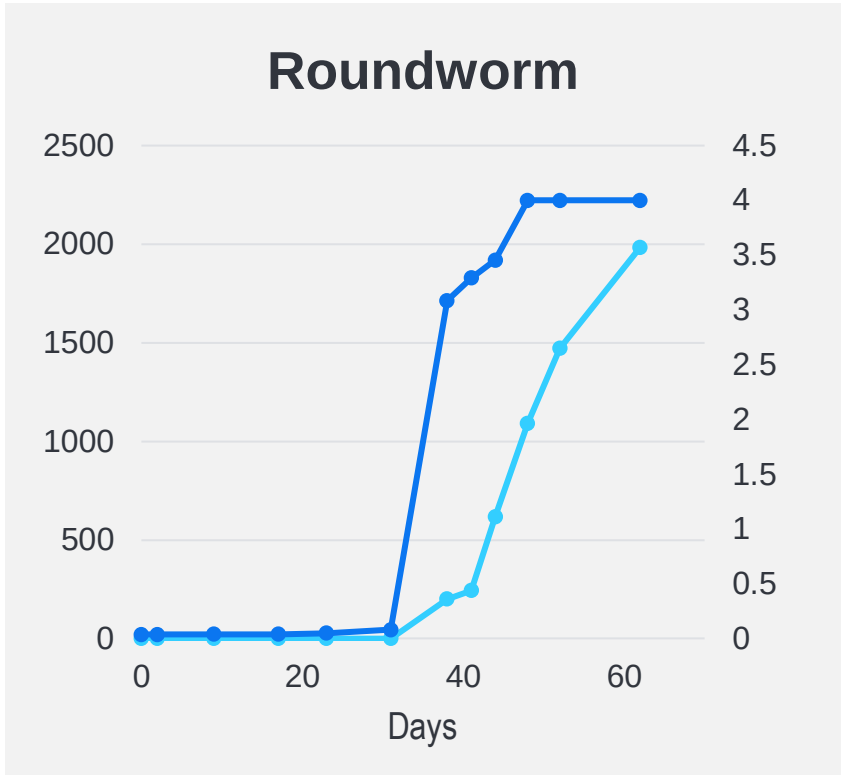
All proteins are secreted by both male and female adult worms.

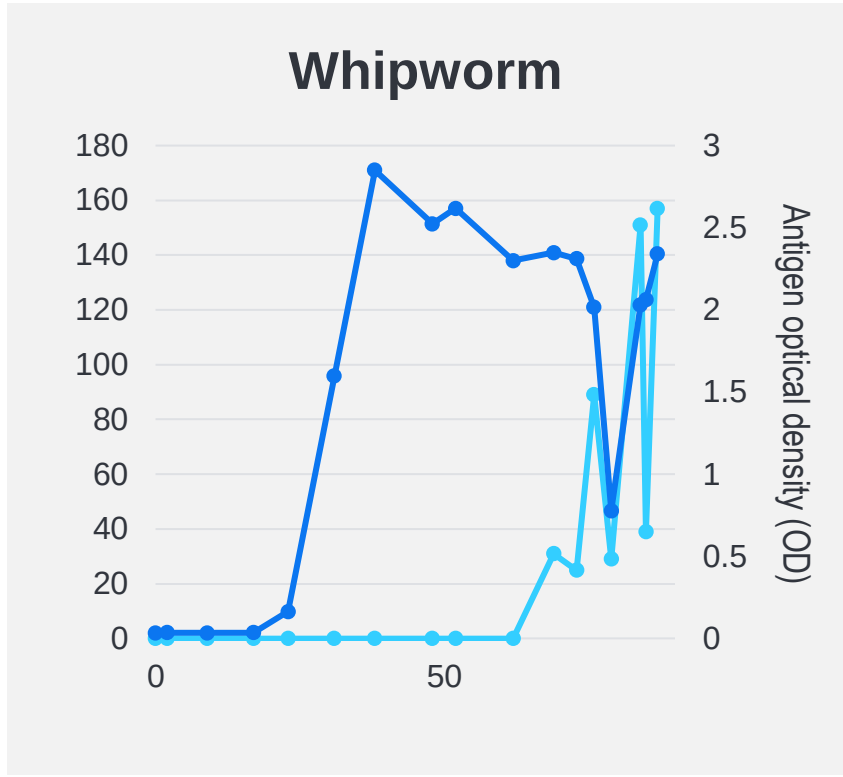
References

1. Elsemore DA, Geng J, Cote J, Hanna R, Lucio-Forster A, Bowman DD. Enzyme-linked immunosorbent assays for coproantigen detection of *Ancylostoma caninum* and *Toxocara canis* in dogs and *Toxocara cati* in cats. *J Vet Diagn Invest*. 2017;29(5):645–653. doi:10.1177/1040638717706098
2. Elsemore DA, Geng J, Flynn L, Cruthers L, Lucio-Forster A, Bowman DD. Enzyme-linked immunosorbent assay for coproantigen detection of *Trichuris vulpis* in dogs. *J Vet Diagn Invest*. 2014;26(3):404–411.
3. Elsemore D, Bezold T, Geng J, Hanna R, Tyrrell P, Beall M. Immunoassay for detection of *Dipylidium caninum* coproantigen in dogs and cats. *J Vet Diagn Invest*. 2023;35(6):671–678. doi:10.1177/10406387231189193

Prepatent infection detection by parasite.







- Experimental infection studies
- Prepatent infections detected
- Prior to contaminating environment with eggs

Egg

immunoassay

Source: Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

CAPC supports O&P plus antigen

Fecal test for hookworm, ascarid, and whipworm antigen

- Commercial assays are available for detection of antigen produced by immature and adult hookworms, ascarids, and whipworms in the lumen of the small intestine. Both male and female worms can be detected, and antigen production is not linked to egg production.[1–3]
- Diagnosis by detection of antigen allows identification of prepatent and single sex infections, supporting use of preventives and allowing earlier treatment.[1–3]
- Both centrifugal fecal flotation and fecal antigen tests have their strengths and weaknesses, however, to ensure the widest breadth of detection of intestinal parasites in dogs, fecal tests for antigen should be combined with microscopic examination of feces for eggs.[1–3]

> …to ensure the widest breadth of detection of intestinal parasites in dogs, fecal tests for antigen should be combined with microscopic examination of feces for eggs.[1–3]

CAPC
Companion Animal Parasite Council

https://capcvet.org

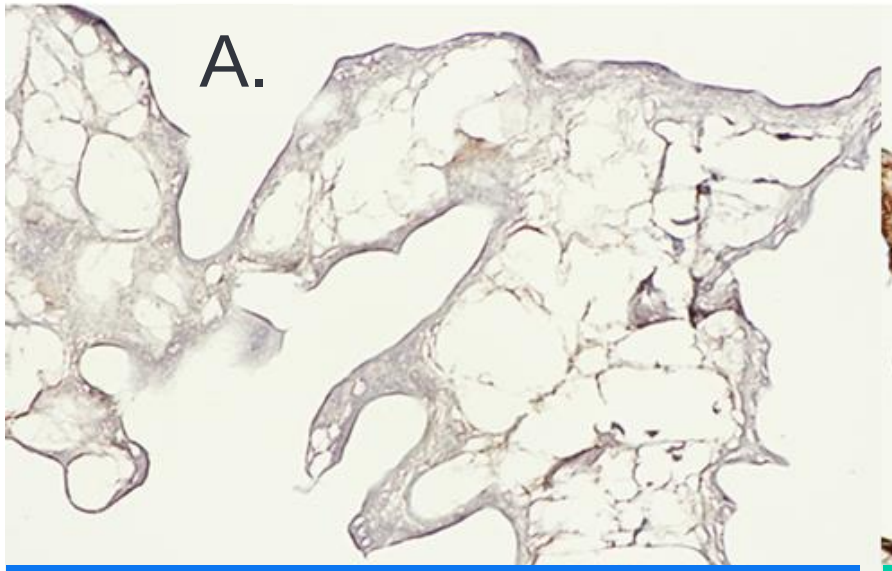
References

1. Companion Animal Parasite Council. CAPC guidelines: hookworms. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/hookworms
2. Companion Animal Parasite Council. CAPC guidelines: ascarid. Updated September 12, 2022. Accessed February 22, 2024. www.capcvet.org/guidelines/ascarid
3. Companion Animal Parasite Council. CAPC guidelines: *Trichuris vulpis*. Updated September 12, 2022. Accessed February 22, 2024. www.capcvet.org/guidelines/trichuris-vulpis

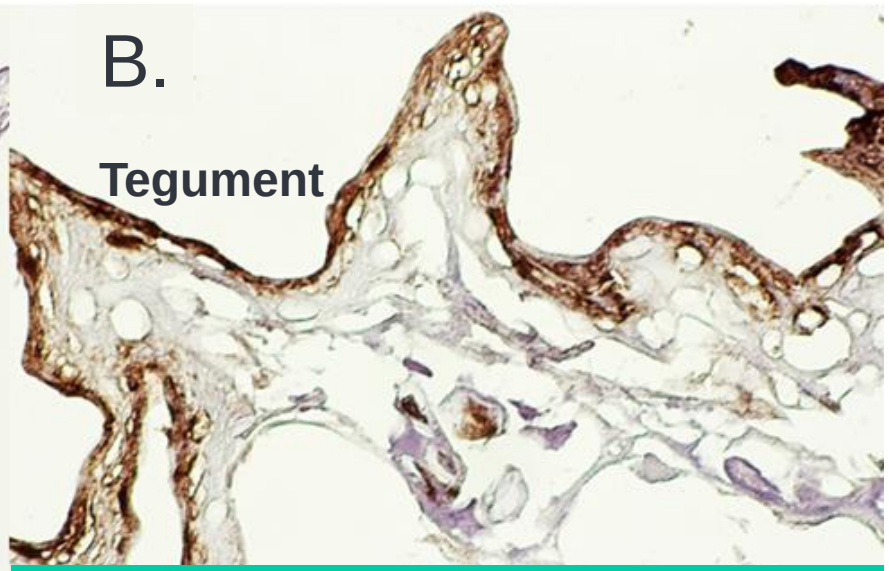
What about common parasites not easily found by fecal flotation?

The flea tapeworm: the parasite no client wants to see.

- Detects ***Dipylidium caninum***, or the “flea tapeworm”
  - Notoriously difficult to detect on flotation
  - Common client dissatisfier when proglottids are seen
- Positive results = proglottid shedding



Immature



Mature

Is there resistance to anthelmintics in ***D. caninum***?

- Case reports of dogs with *D. caninum* refractory to anthelmintics in U.S.
  - Jesudoss Chelladurai J, Kifleyohannes T, Scott J, Brewer MT. Praziquantel resistance in the zoonotic cestode *Dipylidium caninum*. *Am J Trop Med Hyg*. 2018;99(5):1201–1205. doi:10.4269/ajtmh.18-0533.
  - Loftus JP, Acevedo A, Bowman DD, Liotta JL, Wu T, Zhu M. Elimination of probable praziquantel-resistant *Dipylidium caninum* with nitroscanate in a mixed-breed dog: a case report. *Parasit Vectors*. 2022;15(1):438. doi:10.1186/s13071-022-05559-2
- Jesudoss Chelladurai JRJ, Abraham A, Quintana TA, Ritchie D, Smith V. Comparative genomic analysis and species delimitation: a case for two species in the zoonotic cestode *Dipylidium caninum*. *Pathogens*. 2023;12(5):675. doi:10.3390/pathogens12050675.

What’s next in fecal antigen detection?

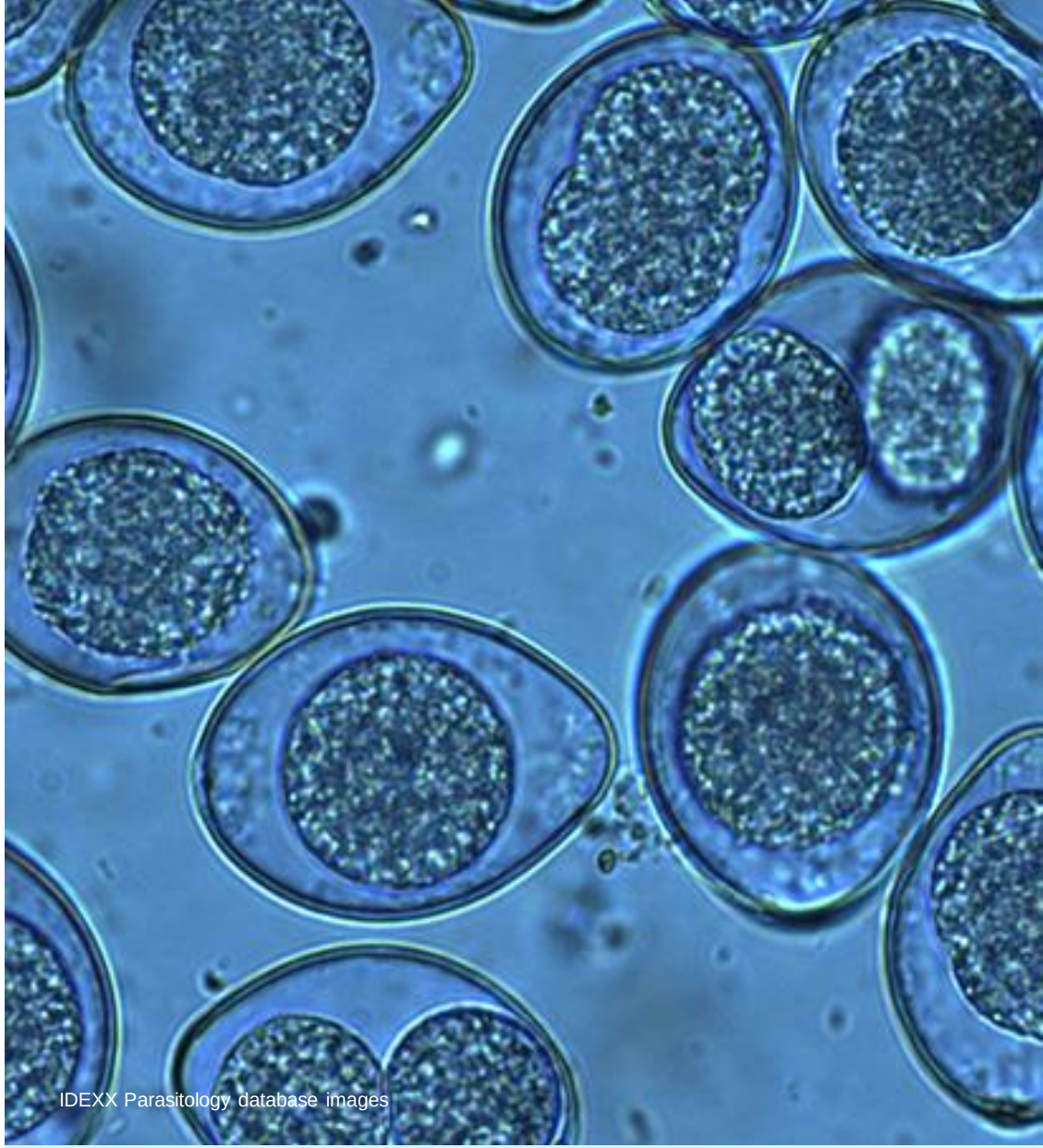
Cystoisospora antigen detection

- Specific to pathogenic *Cystoisospora* spp. of both dogs and cats
  - *C. canis*
  - *C. ohioensis*- like
  - *C. felis*
  - *C. rivolta*
- Does not cross react with other coccidia or protozoa
  - *Eimeria* spp.
  - *Cryptosporidium*
  - *Giardia*
- Coproantigens for the 5 most common intestinal parasites allow for accurate detection of clinically relevant infections, and paired with centrifugal fecal flotation, **provide the most accurate fecal parasite screening for your patients**.

Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

What are *Cystoisospora* spp.?[1]

- Protozoan intestinal parasites that infect cats and dogs
- Previously known as *Isospora* (still commonly used)
- Generically referred to as coccidia
  - Coccidiosis is an infection caused by this parasite
- Acquired by ingestion
- Coccidia are usually host-specific
- Zoonotic potential of *Cystoisospora* is considered minimal to nonexistent[1,2]



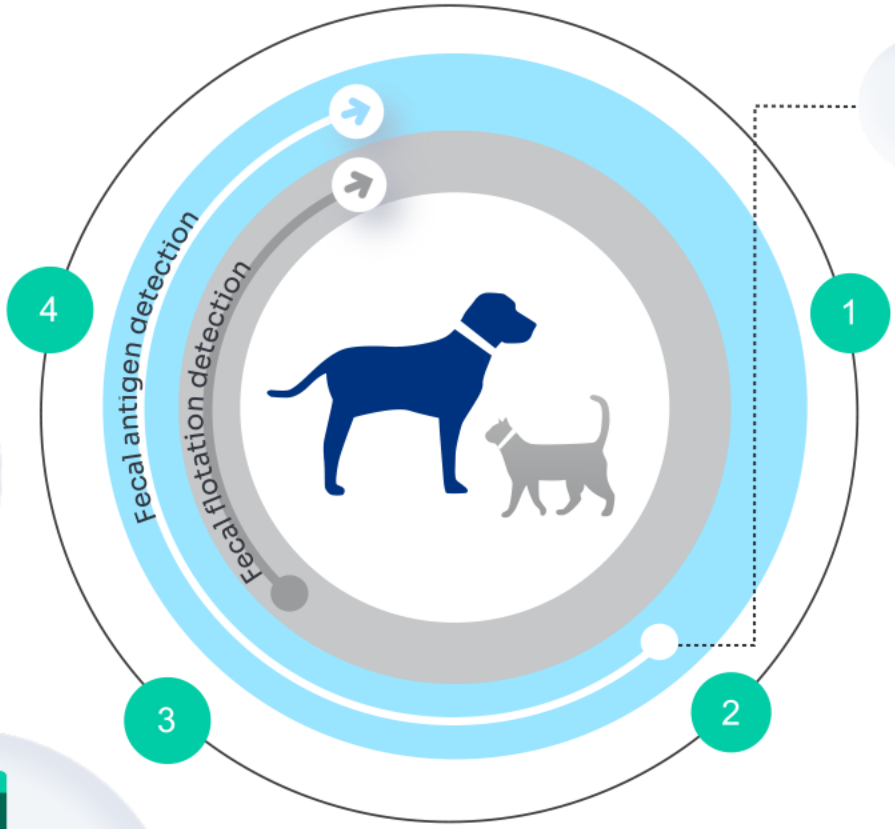
Cystoisospora oocysts 31x42 Feline 2 mos 40x

References

1. CAPC guidelines: coccidia. Companion Animal Parasite Council. Updated October 1, 2016. Accessed January 4, 2024. www.capcvet.org/guidelines/coccidia
2. Sykes JE, Greene CE. Infectious Diseases of the Dog and Cat. 4th ed. Elsevier; 2012.

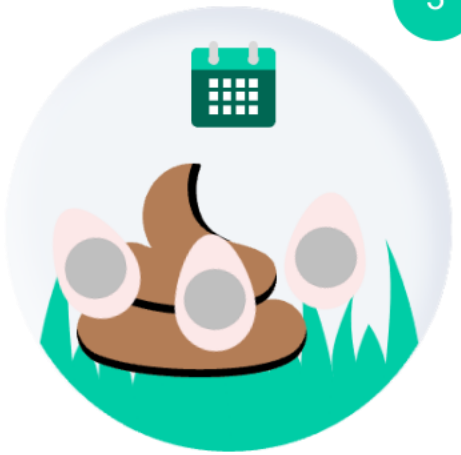
Cystoisospora spp. life cycle

Oocysts sporulate, becoming infective in as little as 12 hours.[2]

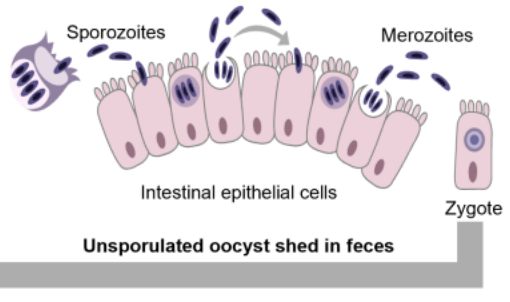


Increased detection with highly specific fecal antigens enables definitive treatment and decreases the likelihood of further environmental contamination.

Sporulated (infective) oocysts with sporozoites ingested directly by animal. Less commonly, infected tissue in a transport host is ingested.



Unsporulated oocysts passed in stool. Oocyst detection possible within 4–13 days of ingestion.[1]



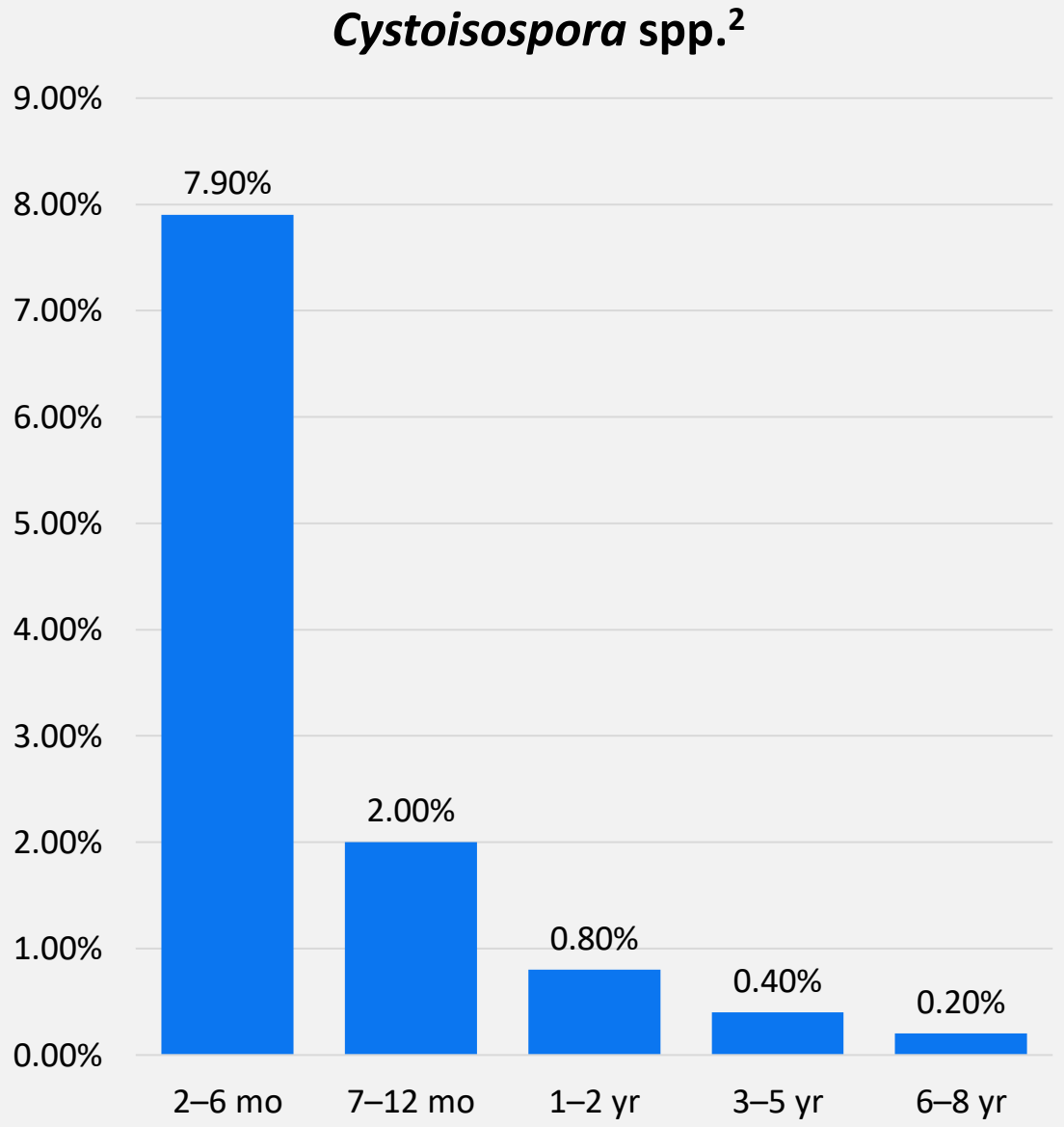
Oocysts hatch and liberated sporozoites invade host epithelial cells; parasites reproduce over several days.

References

1. Companion Animal Parasite Council. CAPC Guidelines: Coccidia. Updated October 1, 2016. Accessed February 5, 2024. www.capcvet.org/guidelines/coccidia
2. Lappin MR. Isosporiasis. In: Sykes JE, ed. *Canine and Feline Infectious Diseases*. WB Saunders; 2014:793–796. doi:10.1016/B978-1-4377-0795-3.00082-X

Cystoisospora prevalence

- Infections are considered common in both cats and dogs[1]
- Various surveys indicate presence in 3%–38% of dogs and 3%–36% of cats in North America[1]
- Found in 1.6% of dogs presented for wellness visits [2]
  - Another coccidia (*Eimeria*) found 1.8%[2]

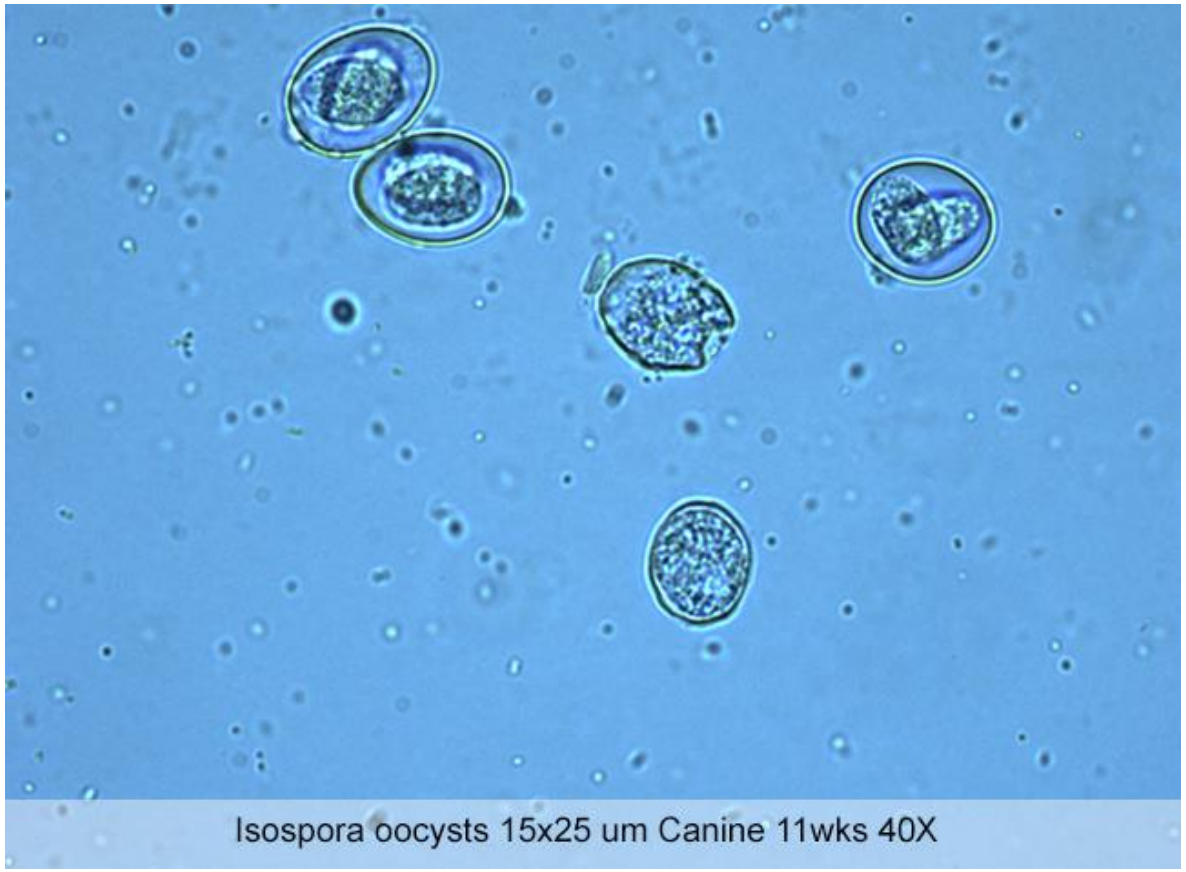


References

1. CAPC guidelines: coccidia. Companion Animal Parasite Council. Updated October 1, 2016. Accessed January 4, 2024. www.capcvet.org/guidelines/coccidia
2. Sweet S, Hegarty E, McCrann DJ, Coyne M, Kincaid D, Szlosek D. A 3-year retrospective analysis of canine intestinal parasites: fecal testing positivity by age, U.S. geographical region and reason for veterinary visit. Parasit Vectors. 2021;14(1):173. doi:10.1186/s13071-021-04678-6

What is *Eimeria*?[1]

Pseudoparasite of dogs and cats



IDEXX Parasitology database image

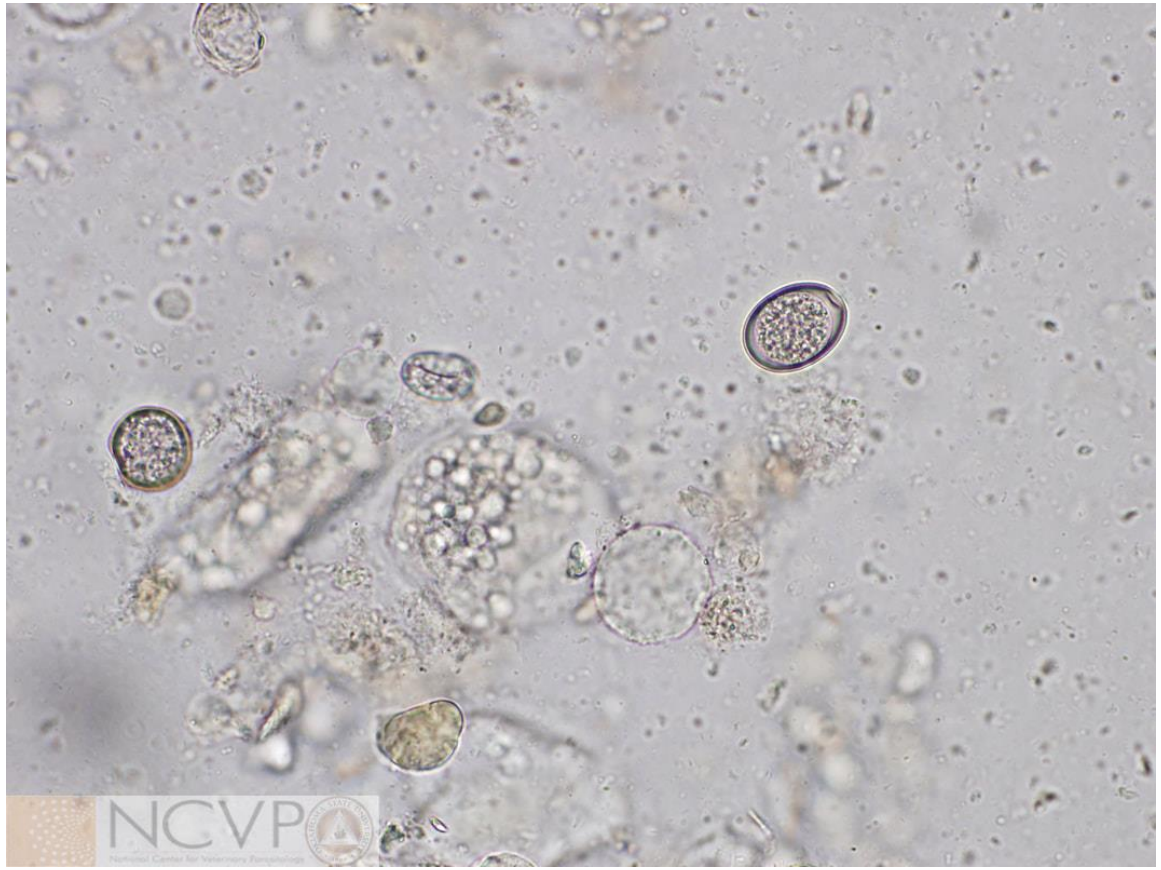
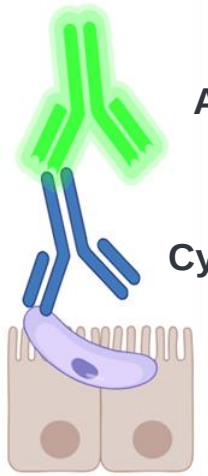


Image courtesy National Center for Veterinary Pathology

References
1. Sykes JE, Greene CE. Infectious Diseases of the Dog and Cat. 4th ed. Elsevier; 2012.

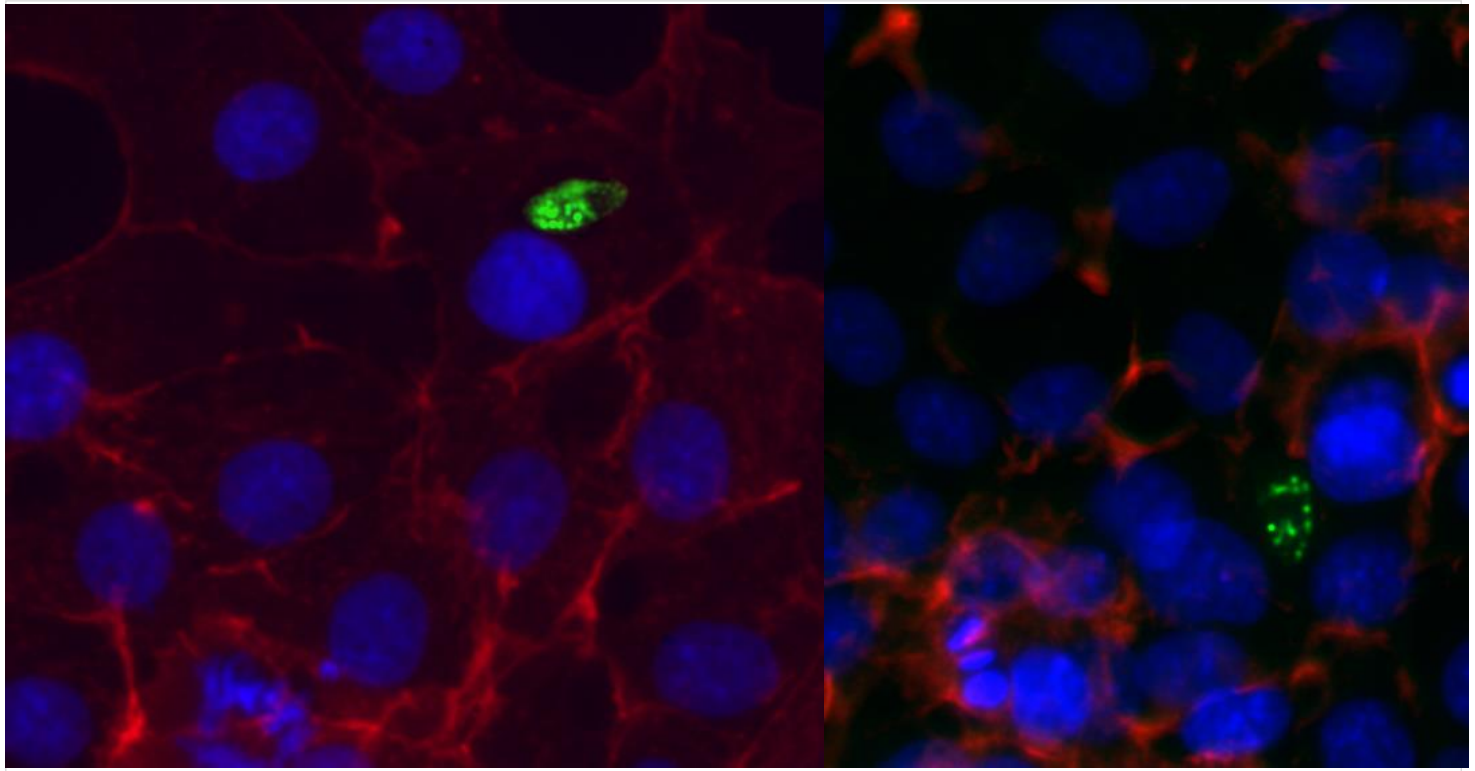
So what does *Cystoisospora* antigen detect?

- *Cystoisospora* antigen detection does not depend on the presence of oocysts in the feces
- Antigen detected from:
  - Sporozoites
  - Merozoites
  - Oocysts



Anti-species IgG::AlexaFluor

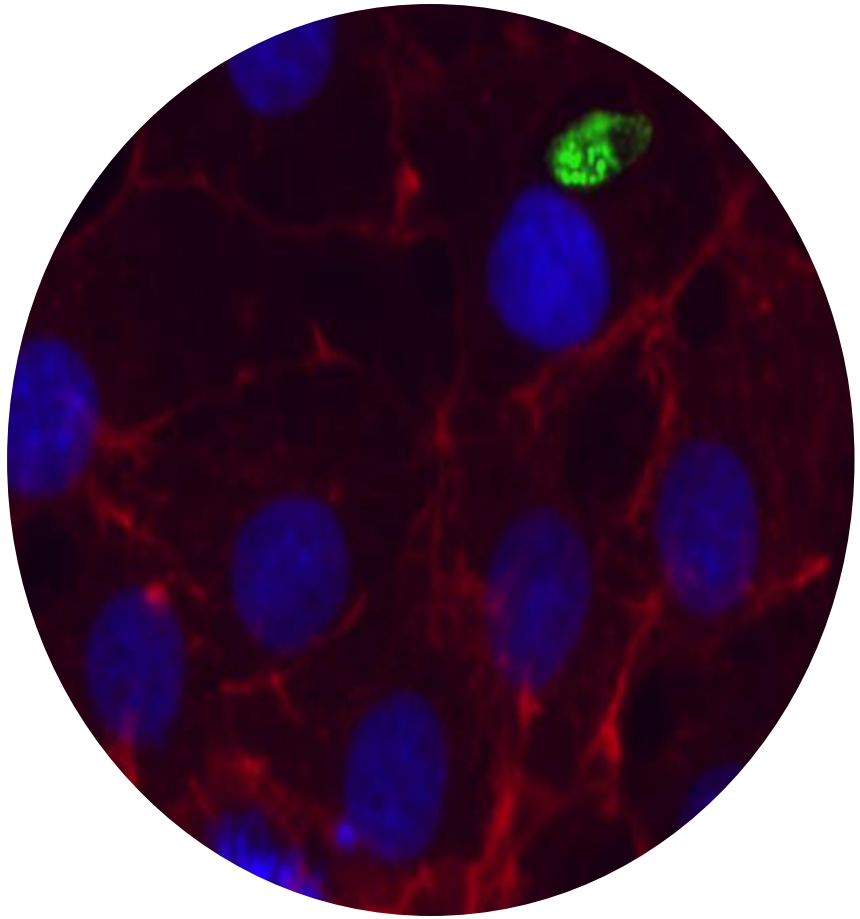
Cysto antigen-specific mAb



IDEXX R&D images

Immunofluorescent images of Cystoisospora-infected canine cell model at 3 days postinfection. Shown in green are antigen-positive Cystoisospora sporozoites embedded in canine cells. Cultures were counterstained to show cytoskeletal architecture in red and nuclei in blue.

Cystoisospora antigen demonstrates excellent diagnostic accuracy



IDEXX R&D image

- In 86,836 fecal samples evaluated in IDEXX Reference Labs vs zinc sulfate fecal flotation
  - **89%** (86-91% CI) Positive agreement
  - **98%** (98.05-98.24% CI) Negative agreement
  - **2.7%** overall positive rate for antigen
    - (>**8.0%** positive in puppies and kittens < 6 months of age)
  - **1.0%** positive for oocysts via flotation.
  - Based on seasonal trends and geographic trends, we expect approximately 2.6-3.7% of samples to be antigen positive

Hypothesis:
To evaluate the utility of fecal antigen in screening for the most common intestinal parasites in dogs and cats

Study design

- Retrospective Study
  - Samples submitted to IDEXX Reference Labs for paired fecal coproantigen and ova and parasite (O&P) fecal testing
  - Study Period
    - March 6, 2024 - June 6, 2024
  - 898,300 samples
    - 767,953 (85.5%) Canine
    - 130,347 (14.5%) Feline
  - Evaluation of fecal coproantigen and O&P results
    - Positivity for any of 6 fecal coproantigens was compared to O&P findings for any parasite observed on O&P.
    - Parasites were grouped into common treatment groups and evaluated

Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

Coproantigen vs. O&P positivity

Any of 6 antigen results compared to any O&P result

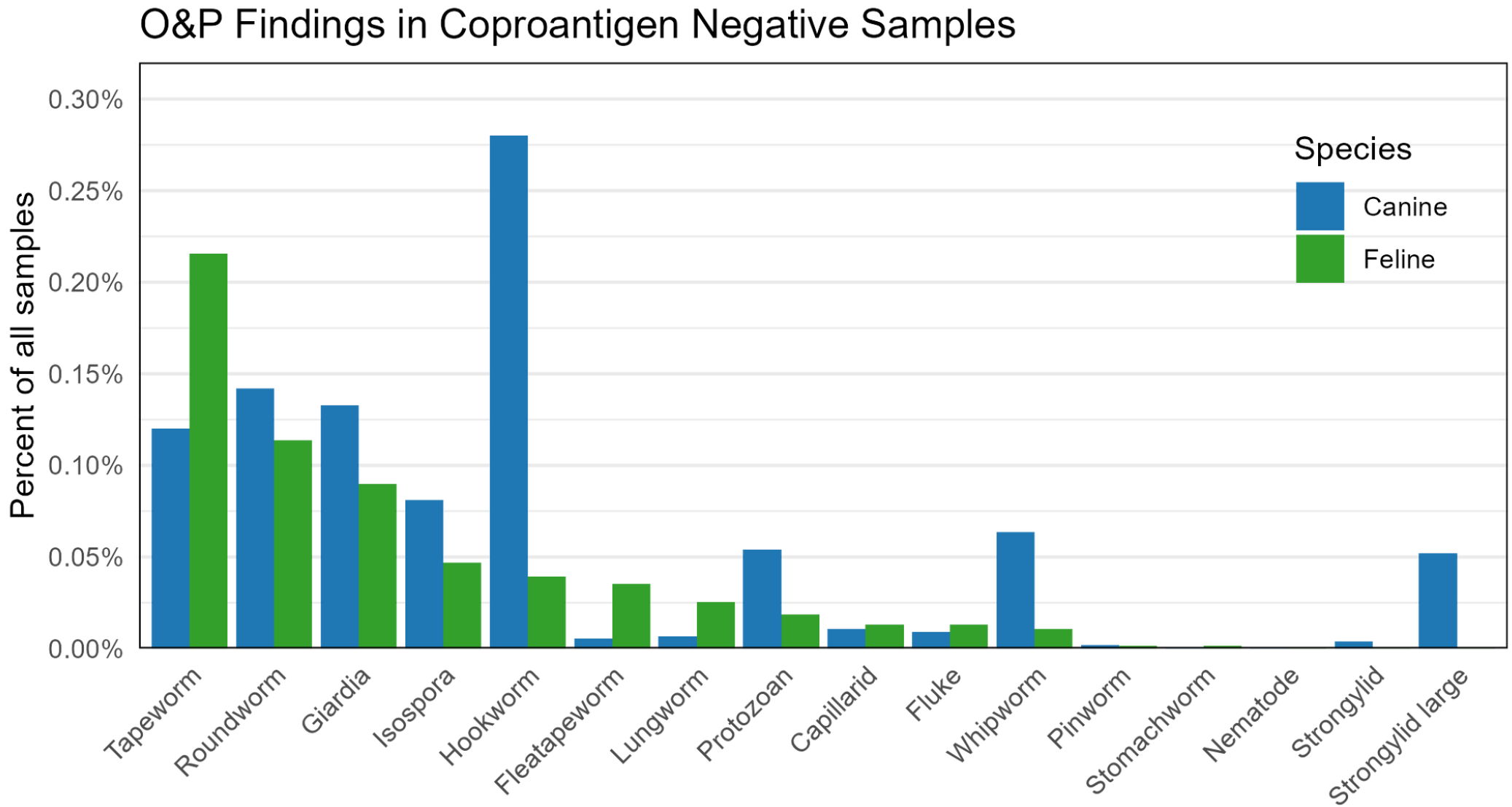
- **82.6%** of samples had no ova or parasites seen by O&P and were negative for any coproantigen
- **6.3%** of all samples were positive for 1 or more coproantigens and had a positive O&P finding
- An additional **9.2%** of all samples were only positive for a coproantigen that indicated treatment could be needed
- Only **1.9%** of O&P results were positive for any parasite & negative for all 6 coproantigens

Antigen \ O & P	Positive	Negative
Positive	**6.3%**	**9.2%**
Negative	**1.9%**	**82.6%**

Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

Analysis of Coproantigen negative vs O&P positive treatment group

Of the parasites found on O&P when all coproantigens were negative, which was found?

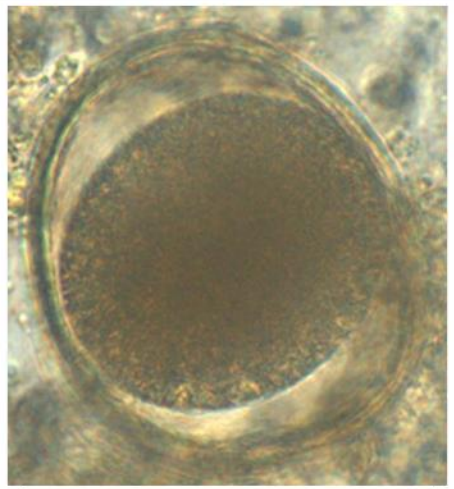


Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

Overall Diagnostic agreement

88.9% overall diagnostic agreement between coproantigen and O&P

- Diagnostic Agreement for each of the 6 coproantigens:
  - *Giardia* – 93.2%
  - *D. caninum* – 99.4%
  - Hookworms – 97.8%
  - Ascarids – 98.7%
  - Whipworms – 99.6%
  - *Cystoisospora* – 98.8%



Data on file at IDEXX Laboratories, Inc.
Westbrook, Maine USA.
Images from IDEXX Parasitology Library

Treatment Group Analysis

Parasites were grouped into 4 treatment groups to further evaluate results of Coproantigen vs O&P results

Parasite Treatment groups

A. Routine Anthelmintics (broad spectrum parasiticides that are labeled for multiple species)
B. Praziquantel
C. Antimicrobials (e.g., Metronidazole, Sulfadimethoxine)
D. Fenbendazole

Any Treatment Group Results

Testing whether both methodologies would result in the same treatment, regardless of findings.

No treatment indicated (Both methods)	Treatment indicated (Both methods)	Treatment indicated (Coproantigen only)	Treatment indicated (O&P only)
83.7%	**6.1%**	**9.4%**	**0.8%**

- **89.8% of samples the coproantigen and O&P resulted in the same treatment recommendation**
  - **6.1%** of all samples positive for 1 or more coproantigens and had a positive O&P finding that would result in the same treatment.
  - **83.7%** of samples would have no treatment indicated
- An additional **9.4%** of all samples were positive for 1 or more coproantigen only which indicated treatment needed and were not detected by O&P.
- Only **0.8%** of the time O&P indicated a need for treatment that was negative for all coproantigens.

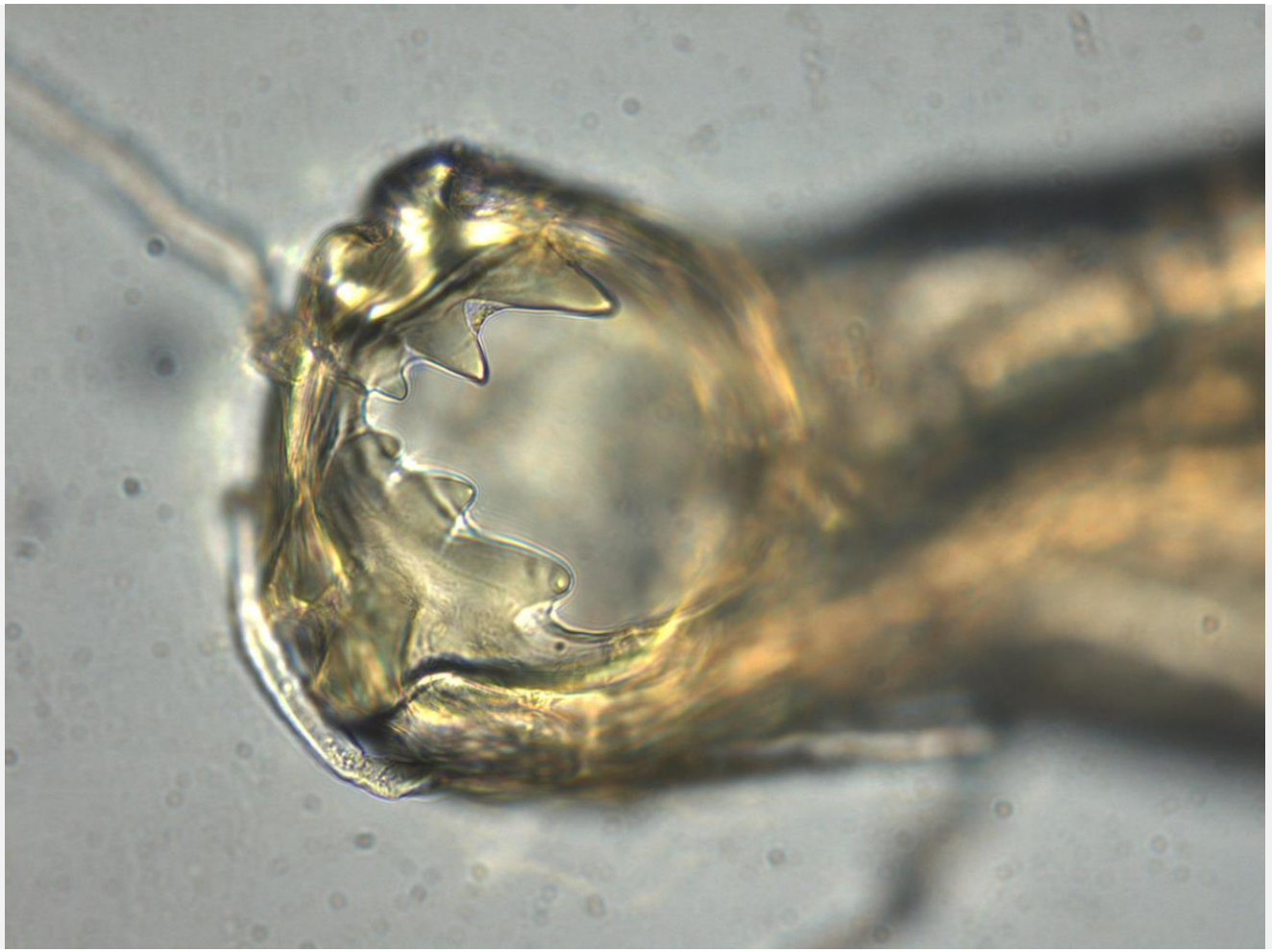
Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

Summary

1. Fecal Antigen (Coproantigen) found an additional **9.2% more positive samples** that were O&P negative
2. Overall, **only 0.8%** of all screening fecal exam findings were coproantigen negative and would have clinically relevant O&P findings that could indicate a unique treatment need.
3. When common treatments are considered, O&P would only uncover that **0.2-0.6%** of all patients could need treatment.
4. Positive samples are most commonly found in patients less than 1 year of age.

Data on file at IDEXX Laboratories, Inc. Westbrook, Maine USA.

What’s going on with hookworms?



A. caninum resistance to common anthelmintics documented.

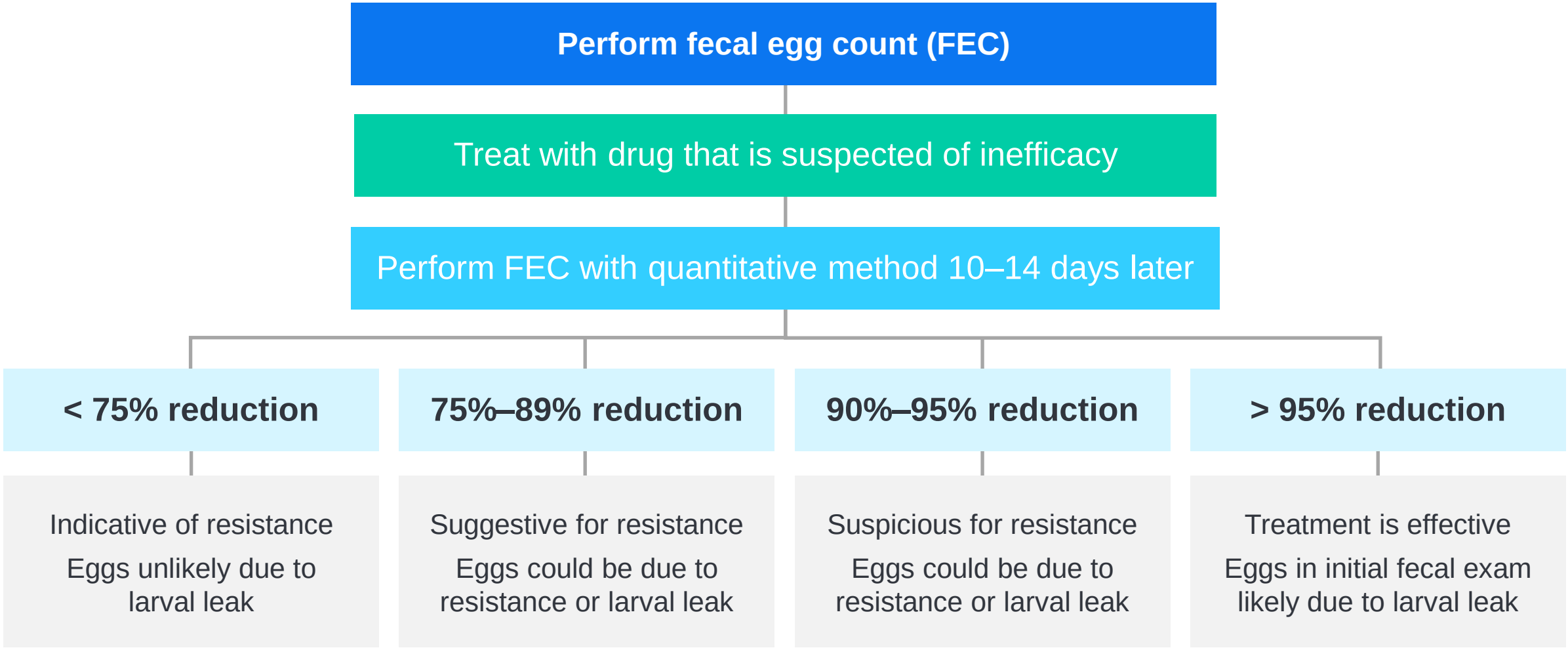
- First reported in greyhounds—15X more likely to have resistant ***A. caninum***[1]
- Jimenez Castro PD, Howell SB, Schaefer JJ, Avramenko RW, Gilleard JS, Kaplan RM. **Multiple drug resistance in the canine hookworm *Ancylostoma caninum*: an emerging threat?** *Parasit Vectors*. 2019;12(1):576. doi:10.1186/s13071-019-3828-6
- Jimenez Castro PD, Mansour A, Charles S, et al. Efficacy evaluation of anthelmintic products against an infection with the canine hookworm (*Ancylostoma caninum*) isolate Worthy 4.1F3P in dogs. *Int J Parasitol Drugs Drug Resist*. 2020;13:22–27. doi:10.1016/j.ijpddr.2020.04.003
  - PCR markers for benzimidazole resistance
    - Shows the eggs shed have the potential for resistance to that class of anthelmintics.
    - Does not mean the worms present are resistant to all available anthelmintics.
    - Still need to perform fecal egg count reduction test to assess level of resistance.

Reference

1. Burton KW, Hegarty E, Couto CG. Retrospective analysis of canine fecal flotation and coproantigen immunoassay hookworm positive results in Greyhounds and other dog breeds. Veterinary Parasitology: Regional Studies and Reports. 2024;51:101026. doi:10.1016/j.vprsr.2024.101026

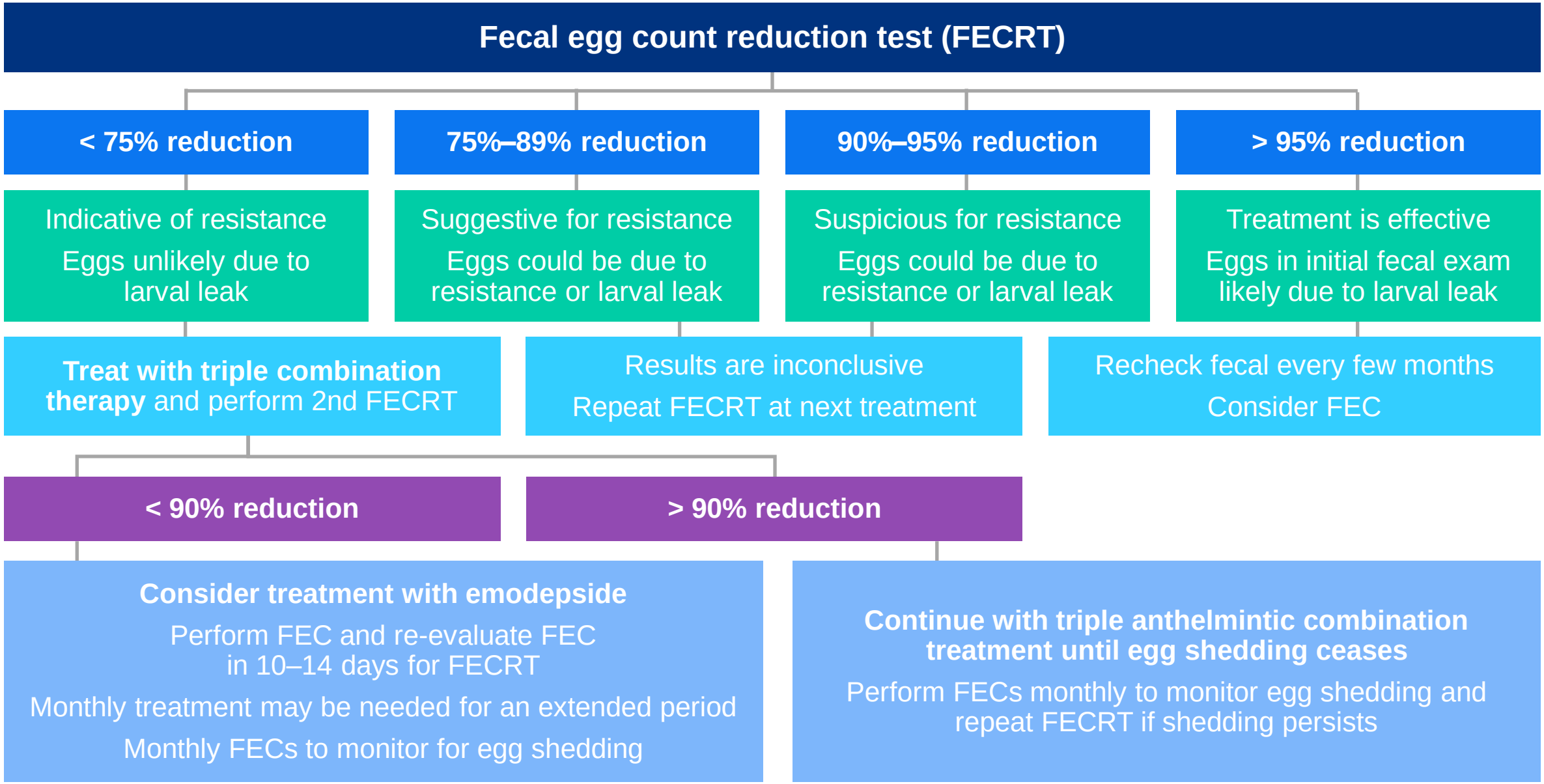
Persistent hookworm infections

> 1 month of anthelmintic therapy



Sources

- Jimenez Castro PD, Kaplan RM. Persistent hookworm infections in dogs. *Clin Brief*. 2020(Aug):59. https://www.cliniciansbrief.com/article/persistent-hookworm-infections-dogs
- Jimenez Castro PD, Kaplan RM. Persistent or suspected-resistant hookworm infections. *Clin Brief*. 2020(Aug):61–68. www.cliniciansbrief.com/article/persistent-or-suspected-resistant-hookworm-infections



Sources

- Jimenez Castro PD, Kaplan RM. Persistent hookworm infections in dogs. *Clin Brief*. 2020(Aug):59. www.cliniciansbrief.com/article/persistent-hookworm-infections-dogs
- Jimenez Castro PD, Kaplan RM. Persistent or suspected-resistant hookworm infections. *Clin Brief*. 2020(Aug):61–68. www.cliniciansbrief.com/article/persistent-or-suspected-resistant-hookworm-infections

“Triple” anthelmintic combination therapies

Febantel (25 mg/kg PO)/
pyrantel pamoate (5 mg/kg PO)/
praziquantel (5 mg/kg PO)
+ moxidectin (2.5 mg/kg topical)

OR

Fenbendazole (50 mg/kg
PO once daily for 3 days)
+ pyrantel pamoate (5 mg/kg PO)
+ moxidectin (2.5 mg/kg topical)

Source: Jimenez Castro PD, Kaplan RM. Persistent or suspected-resistant hookworm infections. *Clin Brief*. 2020(Aug):61–68. www.cliniciansbrief.com/article/persistent-or-suspected-resistant-hookworm-infections

Considerations for extra-label emodepside

Due to limited available data, the authors did not recommend extra-label emodepside treatment; however, clinicians can use this information to evaluate whether use might be appropriate.

+ **Given the potential risks of using this product in dogs, emodepside topical solution for cats should only be used in dogs when the poor effectiveness of the triple anthelmintic combination has been previously confirmed via FECRT.**
+ **Dogs should be screened for *D. immitis* microfilaria prior to administration.**

Emodepside topical solution for cats has no efficacy in dogs when administered topically; it must be administered orally.

+ The suggested dose of **emodepside for dogs** with MDR *A. caninum* isolates is **1 mg/kg PO**.
+ Emodepside is a known substrate for P-glycoprotein, and dogs with a deletion mutation of the multidrug sensitivity gene (MDR1 gene, also known as ABCB1 gene) may be at increased risk for severe adverse effects, especially if they receive incorrect doses of the topical feline product.
+ The 1 mg/kg PO dose of **emodepside for dogs in one-third of the topical labeled dose for cats** and administering more than this dose may increase the likelihood of adverse effects.

Source: Jimenez Castro PD, Kaplan RM. Persistent or suspected-resistant hookworm infections. *Clin Brief*. 2020(Aug):61–68. www.cliniciansbrief.com/article/persistent-or-suspected-resistant-hookworm-infections

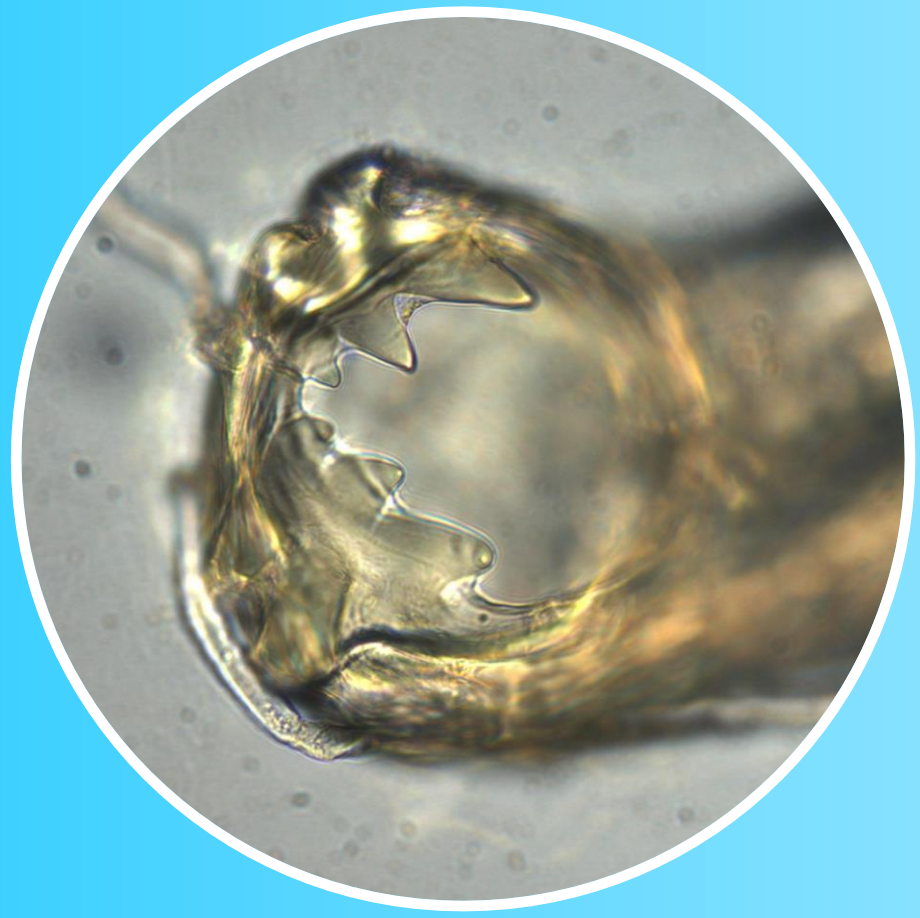
When should we retest for intestinal parasites?

Retesting a **healthy** dog that is maintained on a broad-spectrum monthly control product may not be necessary.

If a follow-up test is deemed necessary

- Retest by antigen and flotation **10–14 days** following the final dose of anthelmintic.
- If the antigen or the float is still positive, this could be because:
  - There was inadequate compliance with the treatment.
  - Lack of efficacy or potential resistance to the anthelmintic.

Key Takeaways



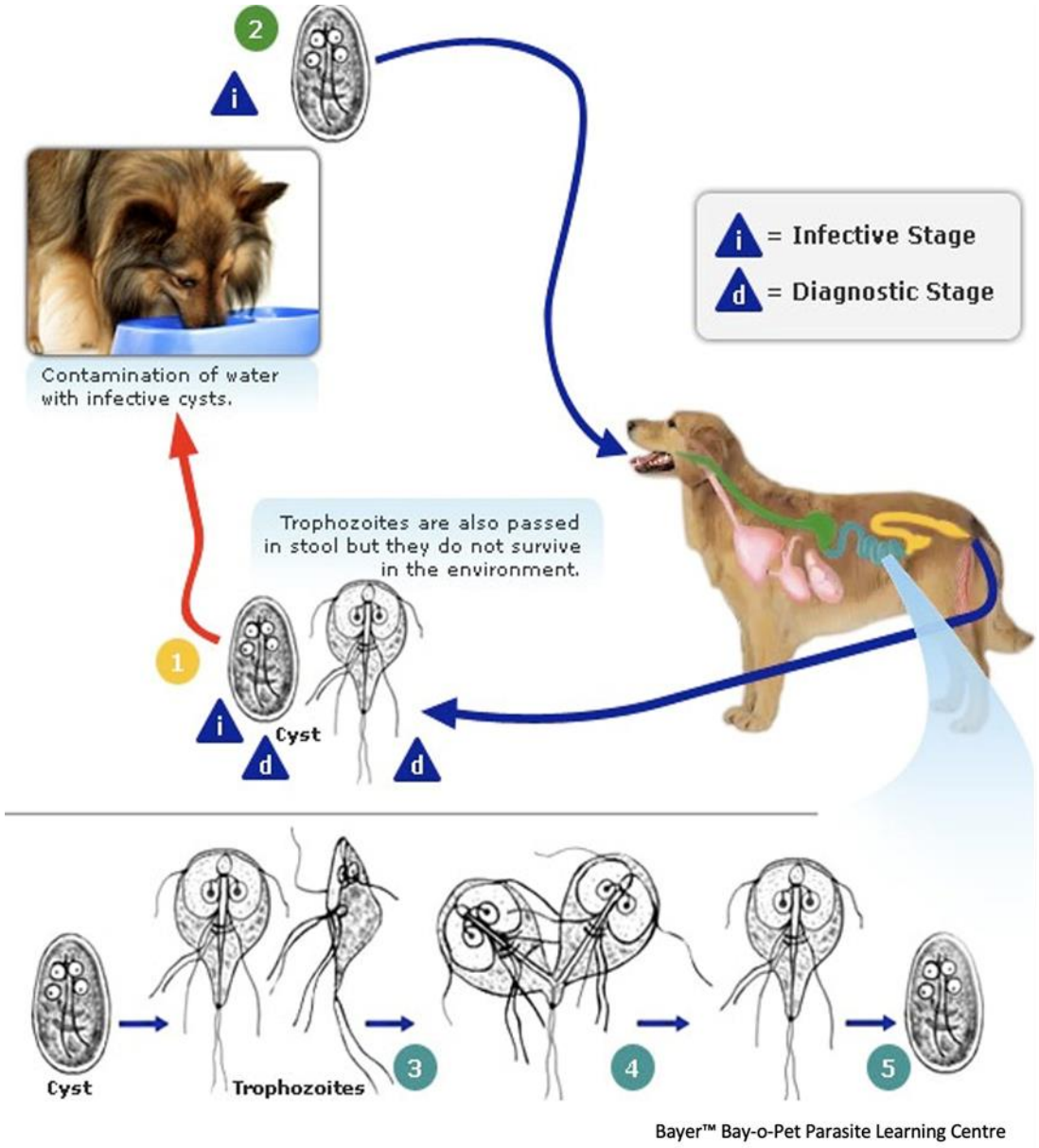
- Hookworm resistance is real.
- Testing 10–14 days following deworming helps uncover potential lack of efficacy in treatment.
- Fecal egg counts are your best method to evaluate anthelmintic efficacy following a positive fecal antigen or O&P result.
- Strict fecal hygiene is key to help prevent transmission to naïve dogs.

What about ***Giardia***?

- Risk to people and pets
- Understand *Giardia* genotyping, clinical management, and recommendations.
- Understand when treatment is recommended and why follow-up testing is critical for successful management of intestinal parasite including *Giardia*.

Giardia

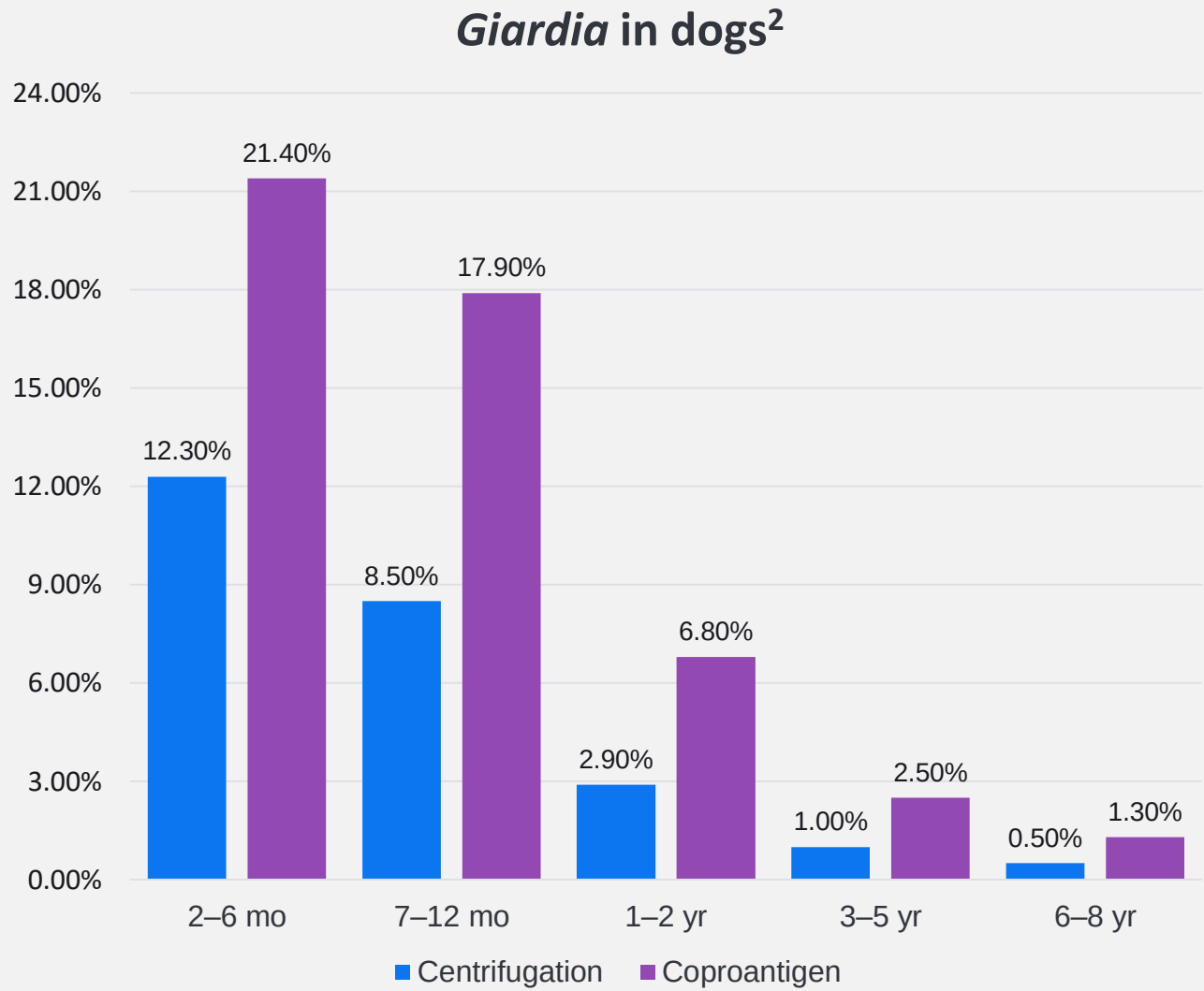
- Flagellated intestinal protozoan parasite Worldwide distribution
  - Infects people, dogs, cats, and many other animals
- Potentially zoonotic
  - ***Varies by assemblage***
- Transmission via ingestion of cysts
  - ***Immediately infective*** when passed
- Prepatent period 5-6 days
  - Reinfection ***very*** common



Source: Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia

Giardia prevalence

- Infections are considered common in both cats and dogs[1]
- Various surveys in North America indicate presence ranges from 3.5%–28% of dogs[1-3], and in shelter or kennel housing up to 100% of dogs can be infected[4]

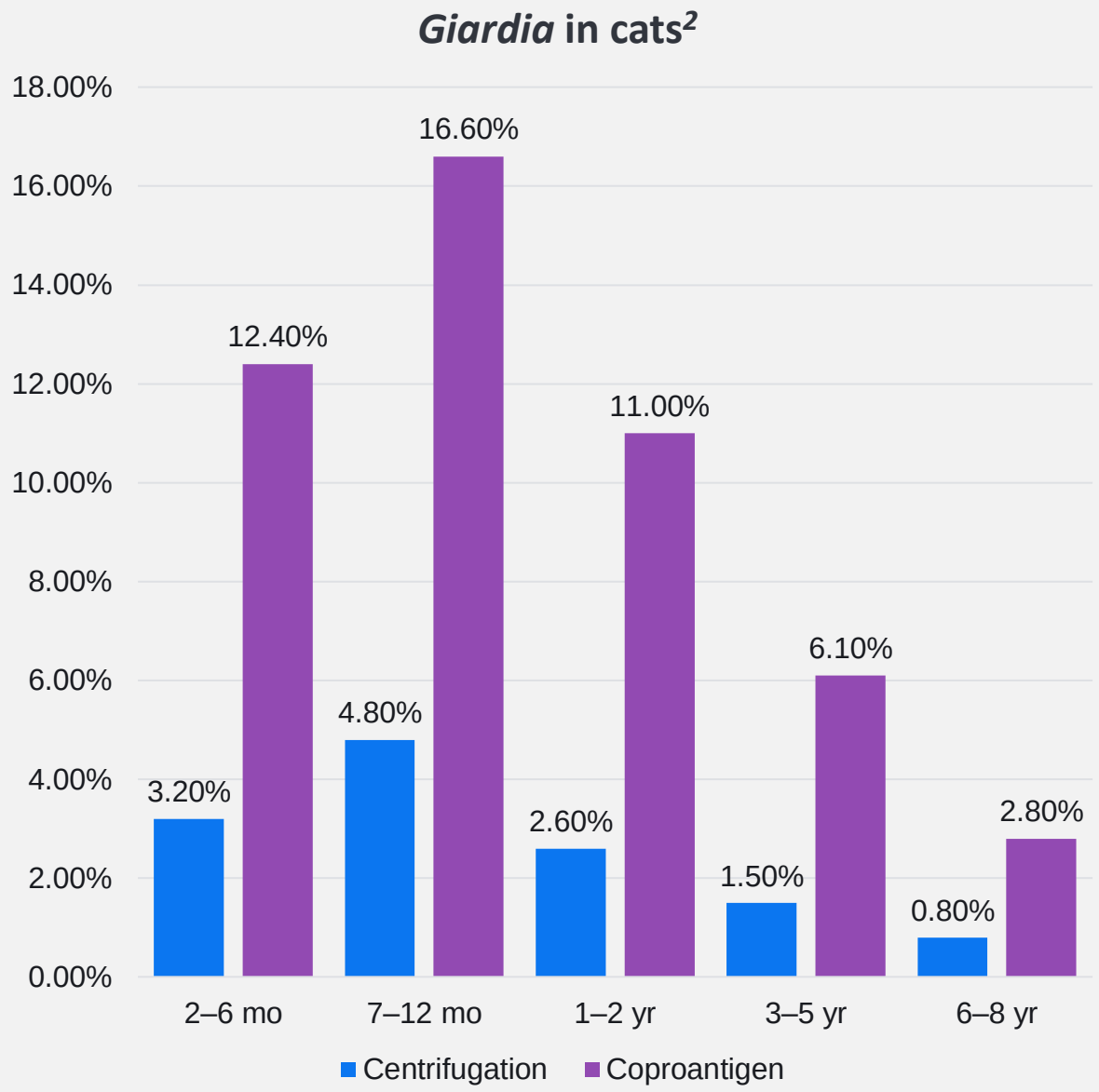


References

1. CAPC guidelines: coccidia. Companion Animal Parasite Council. Updated October 1, 2016. Accessed January 4, 2024. www.capcvet.org/guidelines/coccidia
2. Sweet S, Hegarty E, McCrann DJ, Coyne M, Kincaid D, Szlosek D. A 3-year retrospective analysis of canine intestinal parasites: fecal testing positivity by age, U.S. geographical region and reason for veterinary visit. Parasit Vectors. 2021;14(1):173. doi:10.1186/s13071-021-04678-6
3. Sobotyk C, Upton KE, Lejeune M, et. al. Retrospective study of canine endoparasites diagnosed by fecal flotation methods analyzed across veterinary parasitology diagnostic laboratories, United States, 2018. Parasit Vectors. 2021;14(1):439. Published 2021 Aug 31. doi:10.1186/s13071-021-04960-7
4. Rishniw, M., et al. Comparison of 4 Giardia diagnostic tests in diagnosis of naturally acquired canine chronic subclinical giardiasis. J Vet Int Med. 24.2 (2010): 293-297.

Giardia prevalence

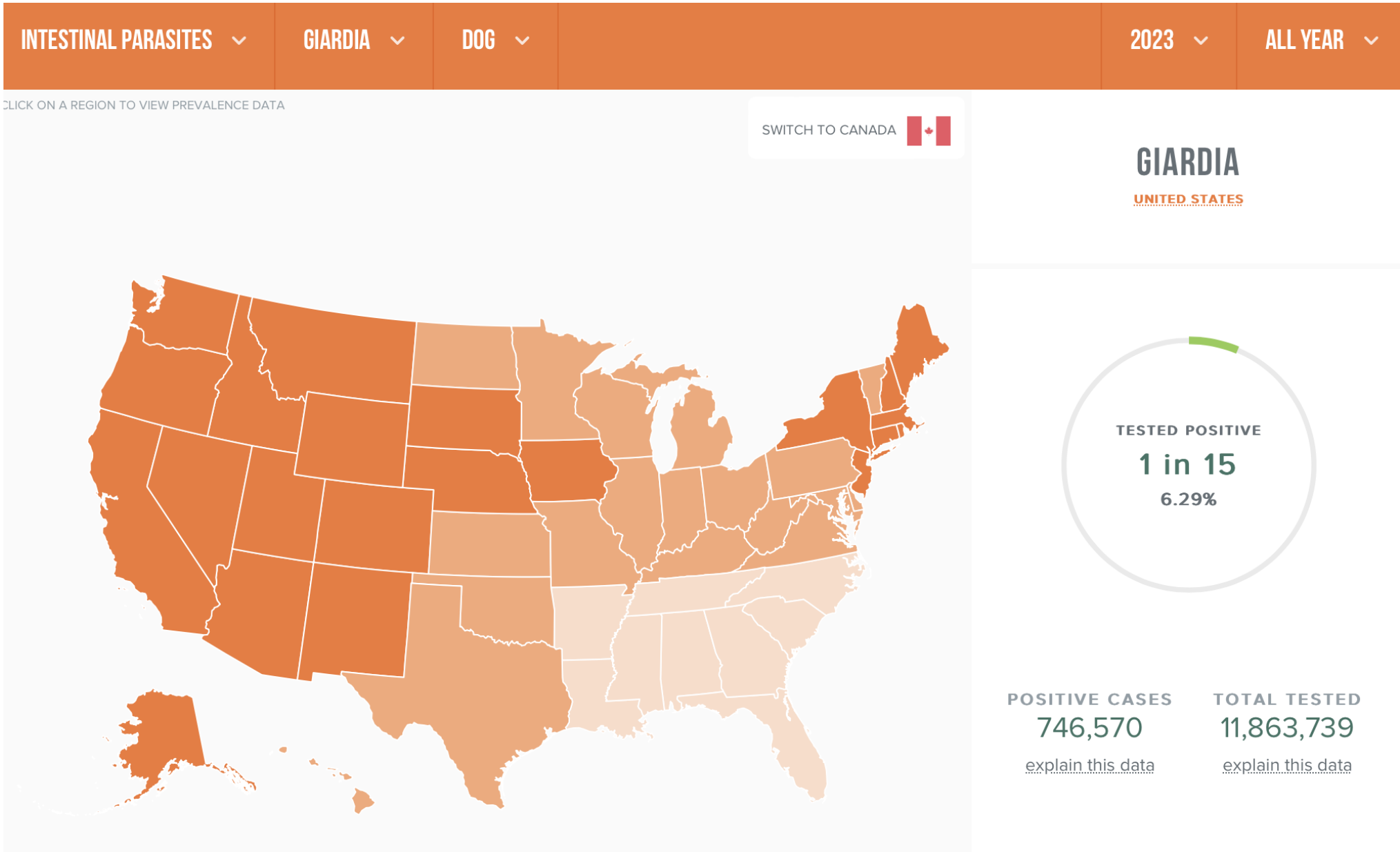
- Infections are considered common in both cats and dogs[1]
- Various surveys indicate presence in 0.2%–10.3% of cats in North America[1,2]



References

1. CAPC guidelines: coccidia. Companion Animal Parasite Council. Updated October 1, 2016. Accessed January 4, 2024. www.capcvet.org/guidelines/coccidia
2. Sweet S, Szlosek D, McCrann D, Coyne M, Kincaid D, Hegarty E. Retrospective analysis of feline intestinal parasites: trends in testing positivity by age, USA geographical region and reason for veterinary visit. *Parasit Vectors*. 2020;13(1):473. doi:10.1186/s13071-020-04319-4

Giardia prevalence

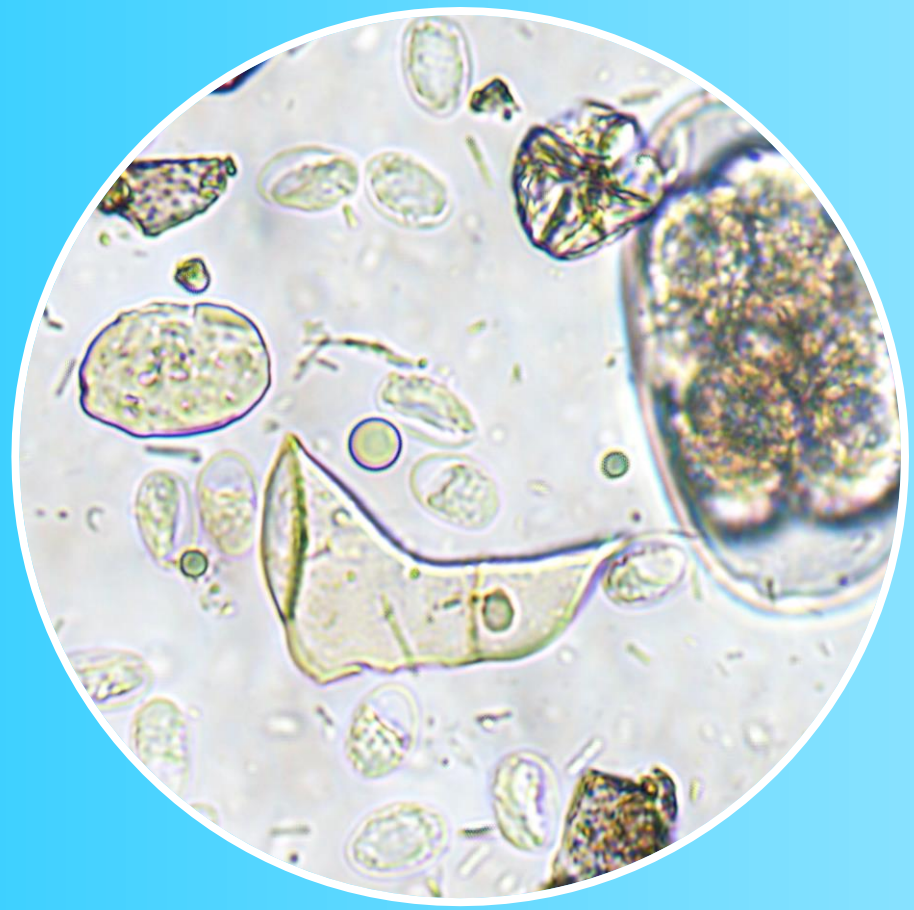


CAPC
Companion Animal Parasite Council

When should I test for *Giardia*?

- When you have clinical suspicion of infection
  - Patient with current symptoms or history of soft or diarrheic stools
- CAPC recommends testing symptomatic dogs and cats with a combination of
  - direct smear,
  - fecal flotation with centrifugation, and a
  - sensitive, specific fecal ELISA *or* by PCR optimized for use in companion animals
- Repeat testing performed over several (usually alternating) days may be necessary to identify infection

Source: Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia



"*Giardia* is one of the most commonly mis-diagnosed, underdiagnosed, and overdiagnosed parasites."
–Dryden, Payne, and Smith

Source: Dryden MW, Payne PA, Smith V. 2006. Accurate Diagnosis of *Giardia* spp and Proper Fecal Examination Procedures. *Vet Ther.* Vol. 7, No. 1

What do the SNAP® ***Giardia*** Test and ***Giardia*** immunoassay detect?

+ ***Giardia*** trophozoites.[1]
+ ***Giardia*** cysts.[2]
+ Pets with diarrhea often pass both cysts and trophozoites.
+ Both tests detect soluble cyst-wall antigen produced when the trophozoite begins to encyst.
+ The antigen is free-floating and dispersed in the fecal matter.

References
1. Bowman DD. *Georgis' Parasitology for Veterinarians*. 8th ed. St. Louis, MO: Elsevier Saunders; 2002:88.
2. Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia

Giardia genotyping

- Divided into 8 assemblages
  - Genetically distinct but morphologically identical
  - Sub-assemblages (or subtypes) present in Assemblages A and B
  - Varying zoonotic potential and host preference
  - Requires PCR targeting multiple genes
    - Multilocus genotyping (MLG)
    - Not all PCRs are equivalent

Assemblage	Host(s)
A (subtypes AI-AIII)	Humans and other primates; reported from dogs, cats, domestic and wild ruminants, pigs, horses, ferrets, marsupials, and other wild mammals
B (some subtypes*)	Humans and other primates, cattle, dogs, horses, rabbits, beavers, muskrats
C and D	Dogs, other canids
E	Cattle and other hooved livestock
F	Cats
G	Rats
H	Seals and other marine mammals

References
1. Bowman DD. 2021. The Challenges with Canine *Giardia.* Parasitology Research Monographs, vol 13. Springer,
2. Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia
3. Saleh MN, Lindsay DS, Leib MS, Zajac AM. 2019. *Giardia duodenalis* assemblages in cats from Virginia, USA. Vet Parasitol Reg Stud Reports.

Giardia sub-assemblages

- Requires PCR targeting multiple genes
  - Multilocus genotyping (MLG)
- Assemblage A
  - 3 well accepted sub-assemblages
  - AI, AII, and AIII
  - Varying zoonotic potential and host preferences
- Assemblage B
  - Many subtypes that do not form genetically authentic sub-assemblages

Subtypes	Host(s)
AI	Humans and other primates, dogs, cats, ruminants, pigs, horses, ferrets, marsupials, and other wild mammals
AII	Humans*
AIII	Wild hoofed stock

References
1. Bowman DD. 2021. The Challenges with Canine *Giardia.* Parasitology Research Monographs, vol 13. Springer,
2. Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia
3. Saleh MN, Lindsay DS, Leib MS, Zajac AM. 2019. *Giardia duodenalis* assemblages in cats from Virginia, USA. Vet Parasitol Reg Stud Reports.
4. Adam, R.D. *Giardia duodenalis*: Biology and Pathogenesis. *Clin. Microbiol. Rev.* 2021, *34*, e00024-19.

Key Takeaways

What does that boil down to?

AI and AIII are found primarily in animals, and AII is *mostly* detected in humans.

Giardia genotyping

- Different assemblages based on genetics ***not*** host
- Dogs (C, D) and cats (F) may carry zoonotic assemblages (A, B)
  - More common in the US for dogs and cats to have their own host-adapted assemblage
- Assemblage determination not ***usually*** done clinically
  - Requires multilocus genotyping
    - Multiple gene targets
  - Subtypes have different host specificity
  - Varying zoonotic potential

References

1. Bowman DD. 2021. The Challenges with Canine *Giardia.* Parasitology Research Monographs, vol 13. Springer,
2. Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia
3. Saleh MN, Lindsay DS, Leib MS, Zajac AM. 2019. *Giardia duodenalis* assemblages in cats from Virginia, USA. Vet Parasitol Reg Stud Reports.
4. Scorza AV, Buch J, Franco P, et al. 2021. Evaluation of associations amongst *Giardia duodenalis* assemblages and diarrhea in dogs. Vet Parasitol.

Giardia genotyping

- Surveys of canine and feline fecal samples by qPCR
  - *Giardia* positive in 26.1% (243/931) of samples[1]
    - 9.1% (22/243) typed to potentially zoonotic Assemblages A or B
      - 2.3% of all samples (22/931)
  - Larger study size
  - *Giardia* positive in 13.4% (42,238/315,953)[2]
    - 3.8% (1,610/42,238) typed to potentially zoonotic Assemblages A or B
      - 0.51% of all samples (1,610/315,953)

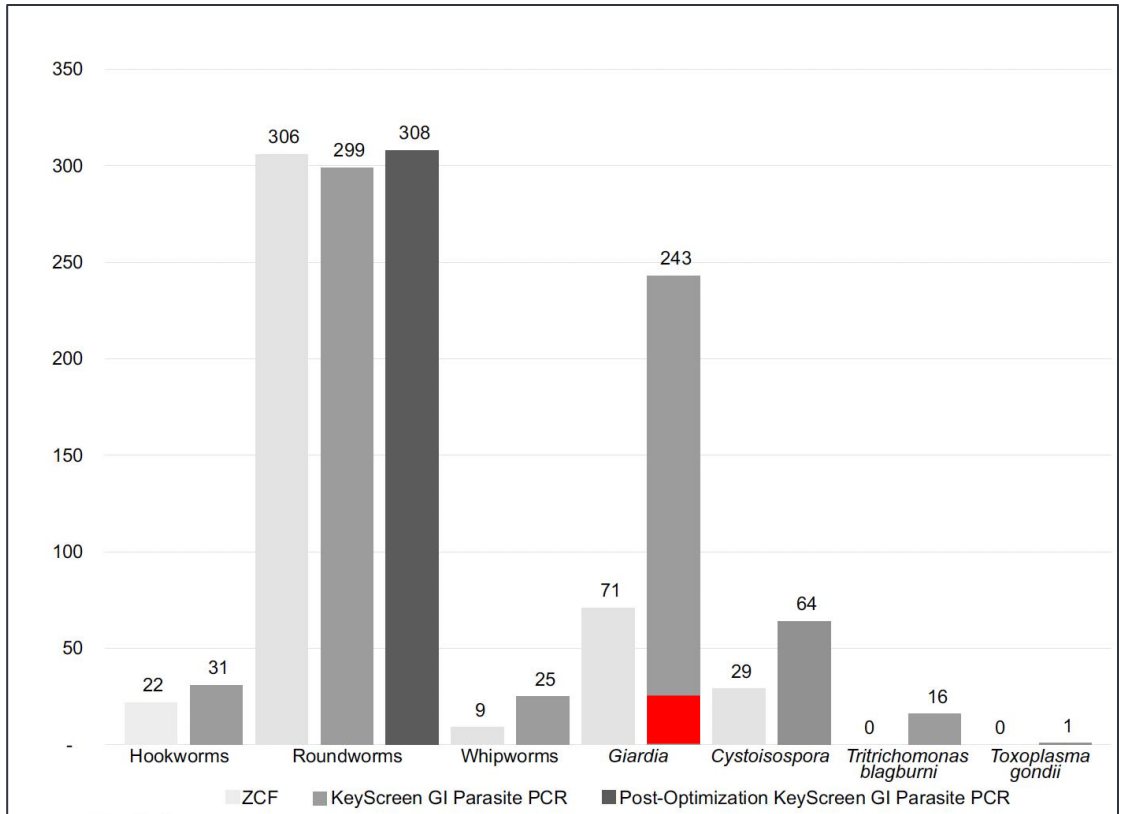


Fig. 1 Method comparison overview of zinc sulfate centrifugation flotation (ZCF) and qPCR frequency detection (*n*) for hook-, round-, and whipworms, along with *Giardia*, *Cystoisospora* spp., *Tritrichomonas blagburni*, and *Toxoplasma gondii*. The roundworm totals have an add bar corresponding to the results of the optimized qPCR test

References

1. Leutenegger CM. Kozoya CE, Tereski J, et al., 2023. Comparative study of broad qPCR panel and centrifugal fecal flotation for the detection of gastrointestinal parasites in fecal samples from dogs and cats in the United States. Parasit & Vectors. 16:288 https://creativecommons.org/licenses/by/4.0/ open access
2. Leutenegger CM. 2023. Frequency of intestinal parasites in dogs and cats identified by molecular diagnostics. ACVIM, Philadelphia, 15-17 June 2023

Giardia in pets: potentially zoonotic

- Human infection from a dog or cat source has not been conclusively demonstrated in North America. Canine strains of *Giardia duodenalis* are not known to be infective to immunocompetent human hosts. However, people with increased susceptibility to infection due to underlying disease should consider limiting their exposure to *Giardia*-infected pets.
- Advise clients to seek medical attention if they develop gastrointestinal symptoms following exposure to an infected pet.
- If both people and pets in the same household are infected, it does not necessarily imply zoonotic transmission.
- An infected person should wash hands after using the toilet and before feeding or handling animals.
- **Infection of pets with assemblages associated with human giardiasis may indicate source of infection rather than the risk to people.**

Source: Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia

Giardia genotyping: interpreting the results

- **Assemblage determination that is not MLG based does not tell you the whole story**
  - Incomplete information
  - Does not change my recommendation
- Does knowing if a dog or cat has *Giardia* versus *Giardia* Assemblage A or B change how you treat and manage the patient?
- What if we know it's *Giardia* Assemblage AI, or AII, etc.?
  - Still does not change my recommendation

- Treat and manage it the same way in both cases
  - Taking extra precautions if people in the pet's home are immunocompromised

Giardia Treatment

- Until very recently nothing labeled in the US
- Fenbendazole labeled for dogs in Europe
- Fenbendazole (50 mg/kg SID for 3 to 5 days)
  - Available experimental evidence suggests more effective than metronidazole in treating *Giardia* in dogs
- Metronidazole (10-25 mg/kg BID 5-8 days) most commonly used extra-label therapy
  - Efficacies as low as 50% to 60% are reported

References
1. Bowman DD. *Georgis' Parasitology for Veterinarians*. 8th ed. St. Louis, MO: Elsevier Saunders; 2002:88.
2. Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia

Giardia Treatment

- Fenbendazole (50 mg/kg SID)
  - at least 5-7 day course
    - up to 10 days in persistent cases
  - Timing of retest if continued clinical signs is very important!
- Treatment should include: sanitation to prevent reinfection
  - clean premises, remove feces, bathing
  - environment and fur contaminated with cysts

References
1. Saleh MN, Gilley AD, Byrnes MK, Zajac AM. 2016. Development and evaluation of a protocol for control of Giardia duodenalis in a colony of group-housed dogs at a veterinary medical college. JAVMA 15;249(6):644-9

How soon after treatment for ***Giardia*** can I expect to see negative results?

- Follow-up testing for ***Giardia*** may be done 24–48 hours after treatment if clinical signs have not resolved
  - CAPC recommends retesting via centrifugal fecal flotation
- ***Giardia*** antigen tests may remain positive for variable amounts of time and are not ideal for determining treatment success.
- Reinfection is common; prepatent period is only 5-6 days
- It is not necessary to retest for ***Giardia*** antigen if the patient demonstrates improvement in clinical signs following treatment.

Source: Companion Animal Parasite Council. CAPC guidelines: *Giardia*. Updated March 29, 2023. Accessed February 22, 2024. www.capcvet.org/guidelines/giardia

Other thoughts…

Why not metronidazole?

+ Antimicrobial stewardship
+ Dysbiosis and alterations to microbiome
+ Can exacerbate diarrhea
+ Safety concerns in cats

Resistance/refractory cases

+ Most often reinfection
  + Timing of retest
+ Treatment is not 100% effective
  + Efficacy as low as 50-60% reported

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STANDARD ARTICLE

Journal of Veterinary Internal Medicine Open Access ACVIM American College of Veterinary Internal Medicine

Effects of metronidazole on the fecal microbiome and metabolome in healthy dogs

Rachel Pilla[1] | Frederic P. Gaschen[2] | James W. Barr[1] | Erin Olson[2] | Julia Honneffer[1] | Blake C. Guard[1] | Amanda B. Blake[1] | Dean Villanueva[1] | Mohammad R. Khattab[1] | Mustafa K. AlShawaqfeh[3] | Jonathan A. Lidbury[1] | Jörg M. Steiner[1] | Jan S. Suchodolski[1]

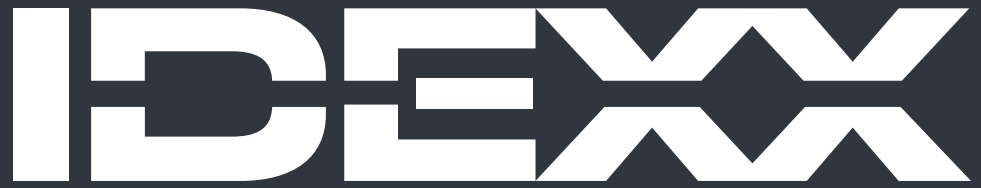
IDEXX

Keeping your team and clients safe

Best practices in the clinic and at home

- Treatment should always include environmental hygiene and management
  - Promptly removing feces
  - Cleaning and disinfection of soiled areas
    - Heat (desiccation) and quaternary ammonium or bleach products indoors
  - Wash hands after handling pets, their toys/supplies
- What about immunocompromised folks?
  - Risk is very low

Questions?


IDEXX

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