

Fuzzy Logic

Think Like a Veterinarian

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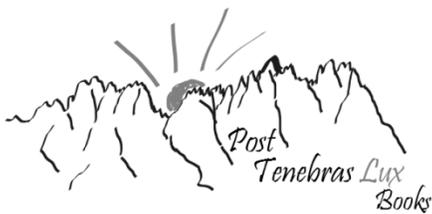
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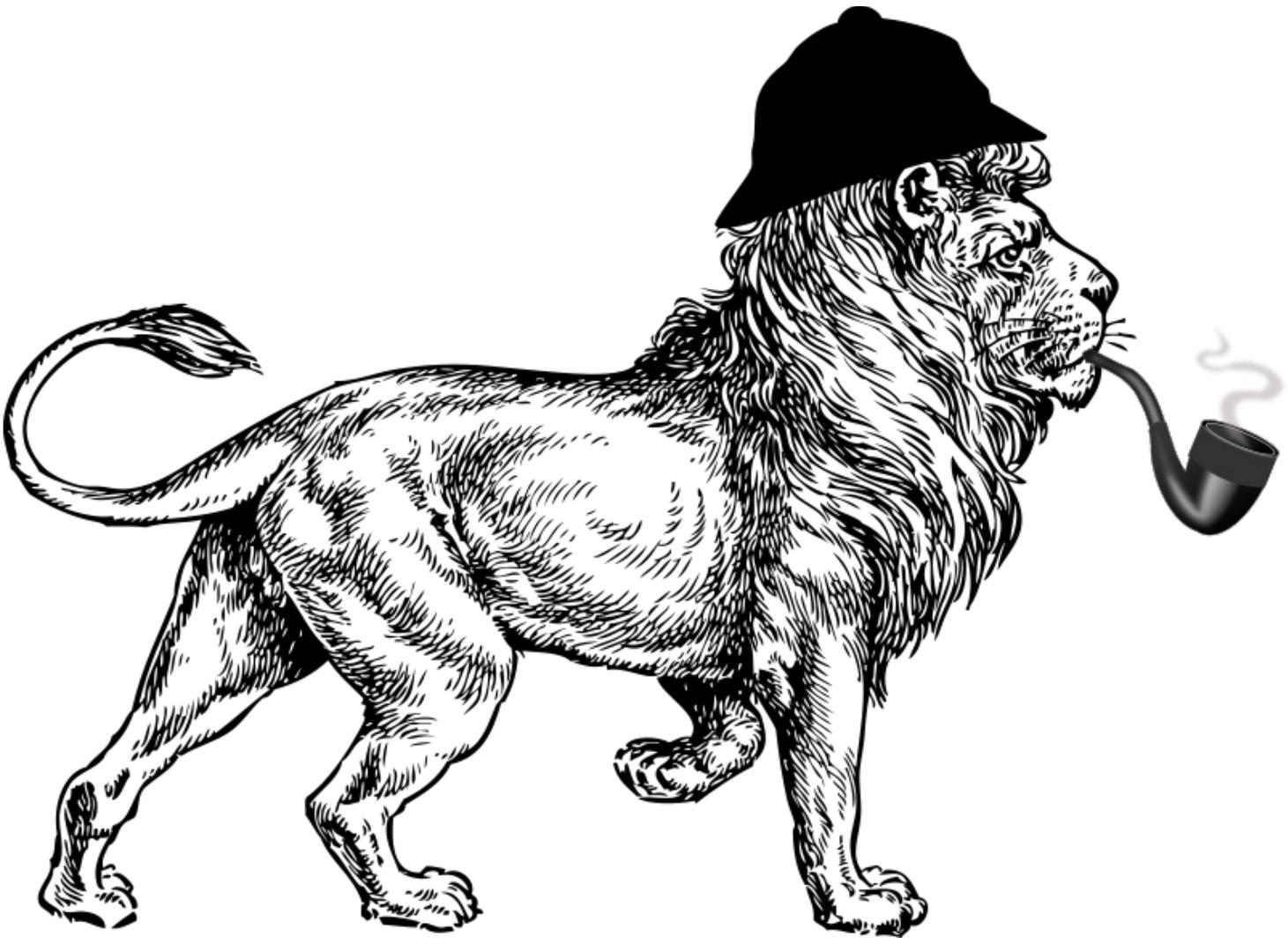
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Fuzzy Logic

Think Like a Veterinarian

J. Aaron Gruben, DVM





WELCOME YOUNG VET!

Have you ever wondered what it's like to be a veterinarian? This book will help you answer that question. It is not a book about cute fuzzy animal stories, or anecdotes of the veterinary adventures. You can read about those things somewhere else. This book also isn't just about the facts vets know. In this "information age" facts are always just a click or a page turn away.



This book will introduce you to something much more important: how to think through and solve cases like a veterinarian. Veterinary medicine is in many ways like the noble art of the detective. It is all about using logic and careful observation from a starting point (case history and physical exam), gathering clues (running tests), and piecing those facts and clues together to come up with a solution (diagnosis and treatment). Critical thinking and problem solving in the context of animal illness is the real work of the veterinarian. And now, for the first time ever, you can work your way through actual cases just like a vet does...without getting a drop of blood or slobber on you!¹



Welcome to your first day as a veterinarian at Noah's Haus Veterinary Clinic in Santa Fe, New Mexico! You don your spiffy new lab coat over the blue scrubs you brought with you from vet school, dangle a stethoscope around your neck, and step into the lobby at 7:45 am. Ms. Wellinger, the plucky young receptionist, says a cheery hello, and points you to the coffee pot, which you gratefully resort to. Halfway through filling your travel mug, a technician pops up and says he has a room loaded with a sick cat for you to see.

And so it begins!

You look heroic, Doc! Your momma should be proud. **Be sure to read these gray boxes.** They'll give you instructions and tips to help you through the cases, and mold your young gray cells into tiny but well-tuned detective think tanks!

¹ Unless of course you get a paper cut and then lick it.

CASE #1

Furrbeus McPurr, a 1 year old orange tabby cat, comes into the clinic because he has been throwing up. His owner (an introverted Computer Science undergrad named Barry B. Barlow) noticed him vomiting for the past two days. He vomits several times a day. At first there was food and catnip (which his owner grows in a pot) in the vomit, but now there is just liquid. He seems very tired and lethargic. He has stopped eating today. He has not pooped for a day as well.



Step 1 – Organize the History

Signalment:

Feline, Orange Tabby
Male neutered
1 year old

In this book you'll learn to break down the logic of each case into a few simple steps. **Step 1** is to organize the information (history) so you don't miss anything important. This consists of A) the *signalment*: a fancy word for a description of the patient and B) *presenting complaints*: the problems the patient comes in for.

Presenting Complaints:

Inappetence
Lethargy
Vomiting

Gathering clues will be **Step 2** for each case. Remember that a veterinarian is like a detective, and needs to gather clues early in a case to figure out what disease is making the patient sick. He does this by a *physical exam* (PE) first, then by running tests based on clues from the history and PE.

Step 2 – Gather Clues

Physical Examination (PE):

QAR, mucous membranes are pink and sticky. Elevated body temperature.
Painful on palpation of abdomen (splinting, tried to bite).
Capillary refill time (CRT) of less than 2 seconds.
Unkempt fur, with moderate skin tenting noted.

Don't worry about unfamiliar words. There will be a glossary box for new words on the page that they are introduced. There is also a comprehensive glossary at the back of the book.

Capillary refill time (CRT): a quick, dirty measurement of blood pressure. You press your finger on the patient's gums (hopefully without getting bit!) and take it off. It should take 2 seconds or less for the gums to turn white to pink where your finger was.

Inappetence: refusing to eat.

PE: Physical Examination.

QAR: quiet, alert, and responsive. Medical people like acronyms because they're handy for writing charts fast.

Signalment: the descriptive characteristics of the patient.

Skin tenting: a way to judge if a patient is dehydrated by pulling up a flap or tent of his skin. In a well-hydrated animal it should sink back down right away, in a dehydrated one it will stay up for a few seconds.

Splinting: tensing of the abdomen because of pain or fear.

Thoracic auscultation: listening to a patient's chest (their heart and lung sounds) with a stethoscope.

Thoracic auscultation is WNL.

Differential Diagnoses (the possible diseases):

Allergies
Constipation
Diabetes
Drug side effects
Gastroenteritis
GI foreign body
GI parasites (eww!)
GI ulcers
Hepatic failure
Ileus
Infection (bacterial, viral, fungal)
Intussusception
Neoplasia
Pancreatitis
Peritonitis
Renal failure
Toxins

For every case you must have a running list of possible solutions (diagnoses) that you are working through, to reach the one most likely true diagnosis by process of elimination. In other words, it's a list of every possible cause you can think of for the problems. It essentially makes every case a really big multiple-choice question. This is the basic thought process in medicine. You use clues like tests and observations from PE and history to rule out the possibilities (*differentials*) until there's only one logical one left. And that is your diagnosis.

Differentials: the list of possible causes for the patient's problems. List of disease that might make the patient sick.

Foreign body: a thing that's not where it should be, like something indigestible.

Gastroenteritis: inflammation in the GI track caused by a bacteria or virus.

GI: Gastrointestinal. The stomach and intestines (supported by the spleen, liver, and pancreas).

Hepatic: the liver.

Ileus: sick intestines—moving too slowly.

Intussusception: an intestinal obstruction caused by a piece of intestine telescoping in on itself and getting stuck into a clump.

Neoplasia: cancer.

Pancreatitis: inflammation in the pancreas, which is an organ that makes hormones and helps digestion. "Weird Al" Yankovic wrote a cool song about it.

Peritonitis: an infection inside the abdomen (outside the internal organs), causing inflammation of the peritoneum (the internal lining of the abdomen).

Renal: pertaining to the kidneys.

WNL: within normal limits.

Decision time!

What tests do you want to run first?

Here's what you can do in your clinic:

- ✓ Basic bloodwork (a chemistry panel and CBC)
- ✓ Benchtop Ethylene glycol test
- ✓ Clotting times
- ✓ Cytology
- ✓ Fecal floatation and direct saline exam
- ✓ FeLV/FIV test
- ✓ Heartworm test (with rickettsial diseases)
- ✓ Pancreatic lipase
- ✓ Parvo test
- ✓ Pregnancy test
- ✓ Radiographs (X-rays)
- ✓ Thyroid hormone level (T4)
- ✓ Ultrasound
- ✓ Urinalysis
- ✓ Wood's test or DMT plate

Here's where the rubber meets the road! Veterinarians have to make many choices for every case, each of which will have its own set of side effects and consequences (to the patient, the client, and the vet). If you're the sort of person who can never make a decision, then medicine may not be the career for you!

In this book you will choose two things for each case:

- 1) What tests to run.
- 2) What treatment to start.

Your choices should be based on what you read in the history and Physical Examination (PE), and what diagnoses you deduce from them. The answers (and more importantly, the thought process algorithm) will be presented as you read further in the book.

Don't cheat and look too early!

Benchtop Ethylene glycol test: test for a specific poison.

Chemistry panel: a blood panel that usually has basic information on the function of the liver, the kidneys, electrolyte levels, protein levels, and blood glucose.

Cytology: looking at cells under a microscope. If you pick this you have to pick where to get the cells from. Will it be scrapings from the skin? Or cells from a tumor with a needle (fine needle aspirate)? Or cells from a swab of ear gunk or snot?

DMT plate: a special petri dish that you can grow dermatophytes (ringworm) on.

Ethylene glycol: antifreeze.

FeLV/FIV: feline leukemia virus and feline immunodeficiency virus. Two contagious diseases that suppress the immune system in cats.

Heartworms: worms that live in the right side of an animal's heart and cause heart failure.

Pancreatic Lipase: a test for pancreatitis. There's an fPL (feline pancreatic lipase) and a cPL (canine pancreatic lipase).

Parvo test: a test for canine parvovirus, which is a virus that attacks the GI tract in puppies.

Pregnancy test: a hormone test you can run on dogs at least 30 days pregnant.

Radiographs: X-rays. A way to use radiation to take pictures of an animal's insides.

Rickettsial diseases: some infectious diseases carried by ticks (lyme is one of them).

Ultrasound: a way to use sound in ultrasonic frequencies to view pictures of an animal's insides.

Urinalysis: a test on urine, generally looking for infection or crystals from bladder stones.

Wood's test: shining a blacklight on skin to look for ringworm (a fungal disease of skin). Most cases of ringworm glow.

What tests did you pick? I went with: bloodwork, FeLV/FIV test, fPL, and radiographs.

Don't feel bad if you picked tests I didn't! Testing for something you didn't need to is not such a bad thing (especially in a book where the owner doesn't have to pay for it). That's because you miss things more often by not looking for all the clues than you do by looking and getting a boring result. But *do* feel bad if you did not pick radiographs. This cat needs some X-rays. Following is the quick summary results of the tests run on the cat. The next pages show more detailed test results.

- Bloodwork: Mildly low potassium and chloride, mildly elevated glucose. Mildly elevated WBC and neutrophils, and decreased hematocrit (you can see the results from our in-house ChemBeast Analyzer on the next page). Clotting times were normal.
- FeLV/FIV test: Negative/negative.
- fPL: Normal.
- Radiographs: Gastric distention. A localized gas distended loop of small bowel is visible. Light, pale object (possible foreign body) near distended bowel.



Gastric: related to the stomach. Gastric distention means stomach is dilated and bloated.

Hematocrit: percent of red blood cells in a patient's blood. A low hematocrit is called anemia.

Neutrophils: white blood cells that respond first to infections.

WBC: white blood cell count. This is the overall count of white blood cells (also called leukocytes), which are the cells of the immune system that fight off infection. Many of the other weird names you see on a CBC are different types of WBC's (neutrophils, monocytes, eosinophils, lymphocytes, and others).

Client: Barry B. Barlow

Species: Feline

Sex: M

Patient: Furrbeus McPurr

Breed: DSH

Patient ID: 023568

When you look at bloodwork, run your eyes over this “flag” column first: this cues you into which results were high (above the reference range) and which were low (below the reference range). There is a more detailed explanation of the bloodwork panels in Appendix A.

Chemistry Panel

TEST	RESULT	FLAG	REFERENCE RANGE ¹
ALT	50		28-76 IU/L
ALP	60		0-62 IU/L
GGT	5		1-7 IU/L
tBili	0.3		0-0.4 mg/dL
Glucose	160	H	70-150 mg/dL
Cholesterol	90		82-218 mg/dL
Total Protein	6.3		5.9-8.5 g/dL
Albumin	2.0		2.4-4.1 g/dL
Calcium	9.2		7.5-10.8 mg/dL
BUN	30		15-34 mg/dL
Creatinine	2.1		0.8-2.3 mg/dL
Phosphorus	4		3-7 mg/dL
Sodium	110		147-156 mEq/L
Potassium	3.0	L	3.9-5.3 mEq/L

These values will go up with liver disease or dysfunction (and a few other diseases).

Glucose (sugar) can be elevated slightly from stress, and more dramatically from diabetes.

These are “kidney values”: they go up when the kidneys are failing (though there’s some other stuff that can make them go up as well).

These are electrolytes.

¹ Tilly, Larry P. and Francis Smith Jr. Blackwell’s Five-Minute Veterinary Consult: Canine and Feline, 6th Ed. John Wiley & Sons, Inc. 2016. Pp. 1416-1417

Client: Barry B. Barlow	Species: Feline	Sex: M
Patient: Furrbeus McPurr	Breed: DSH	
Patient ID: 023568		

CBC

Test	Result	Flag	Reference Range ²
WBC	22	H	5.5-19.5 10x3/mm ³
Neutrophils	13	H	2.5-12.5 10x3/mm ³
Monocytes	0.7		0-0.85 10x3/mm ³
Lymphocytes	2		1.5-7 10x3/mm ³
Eosinophils	1		0-1.5 10x3/mm ³
Hematocrit	30		29-45 %
MCV	50		41.0-54 fL
Platelet Count	250		150-600 10x3/mm ³

This is the count of white blood cells, which are the cells that defend the body from disease. The list of cells below it are different types of white blood cells.

² Tilly, Larry P. and Francis Smith Jr. *Blackwell's Five-Minute Veterinary Consult: Canine and Feline*, 6th ed. John Wiley & Sons, Inc. 2016. p1416.

Radiographs (X-rays)

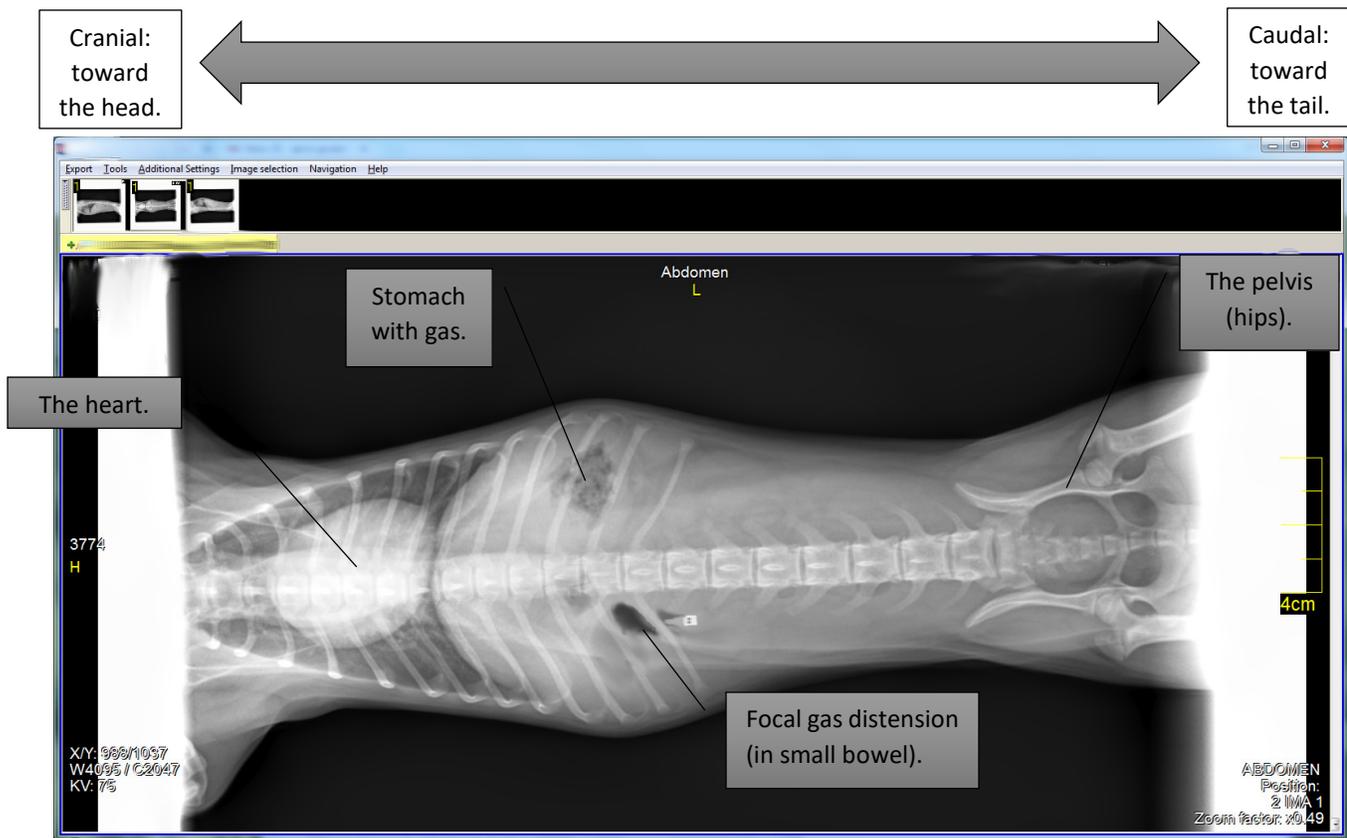


Figure 1: VD view (patient laying on his back) of Furrbeus. There is normal gas in the stomach on left cranial abdomen. Note the abnormal focal gas distention of the right cranial (toward the head) abdomen. It's much easier to see on the next view.

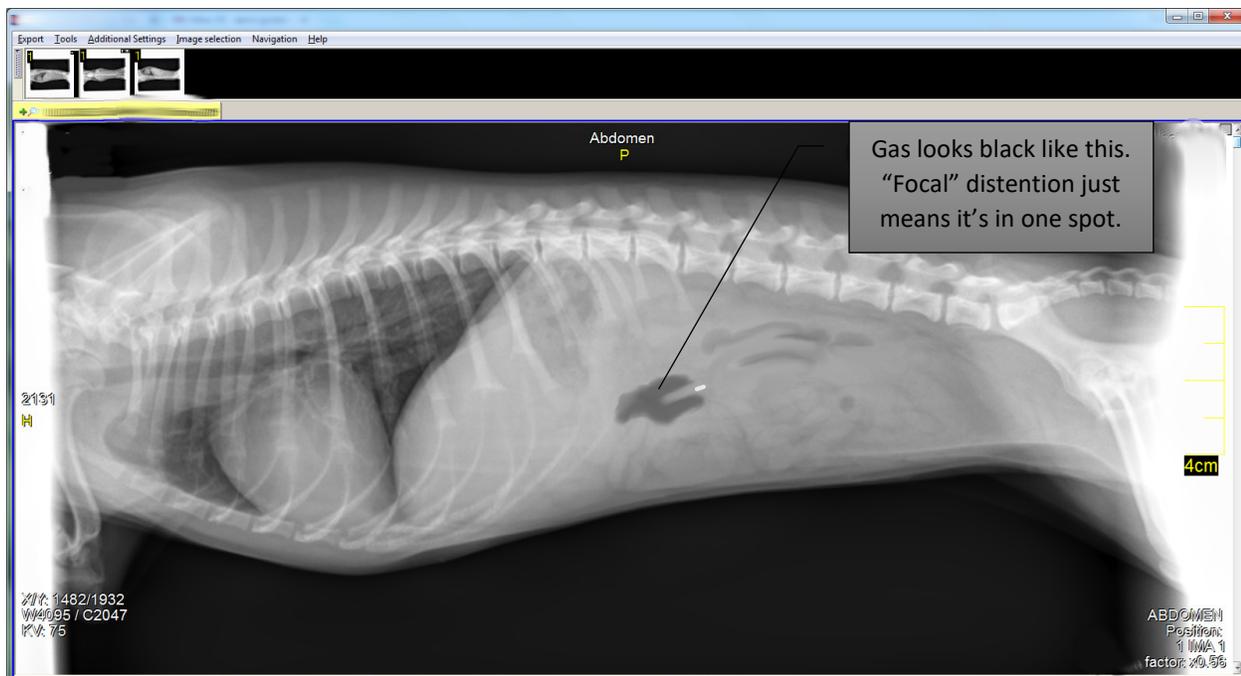


Figure 2: Lateral view (patient laying on his side) of Furrbeus. Note the focal gas distended loop of bowel.

OK! Great job running some tests and gathering clues.

Now... What's going on with Furrbeus? What is your diagnosis?

Go back and look at your list of differentials (the possible diseases) and cross off anything that doesn't fit the clues from your history, physical exam, and tests.

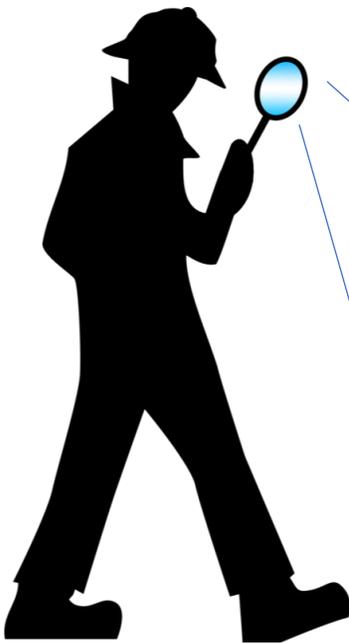
Because this is your first case, I'll be super nice and ask a few leading questions to help you get to a diagnosis...

- What would cause Furrbeus to have a distended stomach and a distended small bowel segment, along with pain on palpation of his abdomen, vomiting, and not pooping?
- What would cause elevated white blood cell counts and neutrophils?

Uh oh! This sounds we need like another differential list (other than the original one we wrote). Technically you should make a differential list for each problem you find. But we'll usually just have a couple per case in this book. In "western" medicine we generally start with a big initial differential list based on history and PE. As we run tests we rule stuff off the list. But as we find other problems we make differential lists for those problems to figure out the real diagnosis. Medicine is HARD!

Differentials for high neutrophils include:

Infection
Machine error
Patient variability
Some types of cancer
Stress



*"The truth must be quite plain, if one could just clear away the litter."
— Agatha Christie*

Use your clues to "clear away the litter" and reach a diagnosis!

Here's one more clue to help you out...

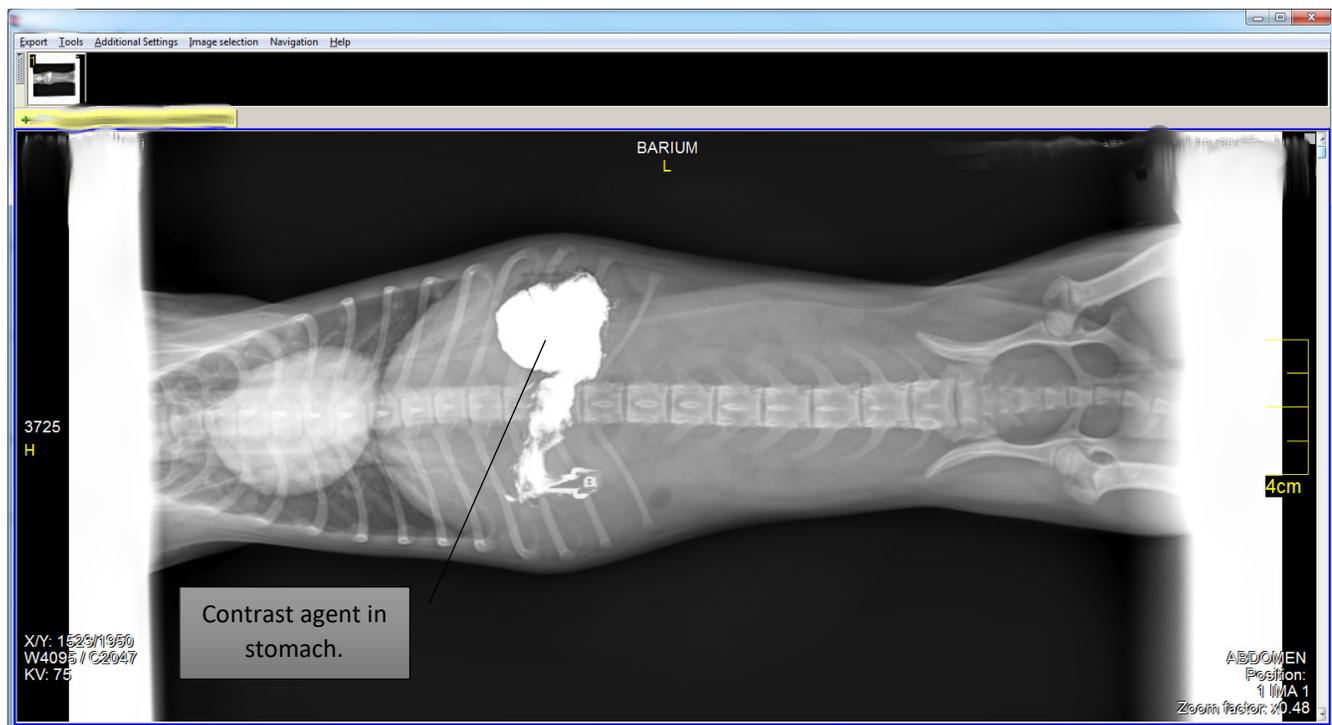


Figure 3: VD view of Furrbeus 4 hours after being fed barium. Barium is a contrast agent, a liquid which shows up brightly on an X-ray. By feeding contrast and then taking X-rays at certain intervals, you can see liquid moving down his GI tract. At 30 minutes post contrast you should see contrast emptying from the stomach. At 4 hours post contrast feeding in a normal cat, you should see contrast well into the small intestines.

And your Diagnosis is?



Don't turn the page until you've made a diagnosis...

The correct diagnosis is GI foreign body.

There is a GI foreign body causing an obstruction in Furrbeus' intestines. It's probably the "light pale object" on the radiograph. A segment of bowel is distended with gas on the other side of the foreign body.

But wait, there's more...

Furrbeus has white blood cell elevation too! Elevated white cell counts are usually a clue to an infection. Fitting this into the whole picture of our diagnosis of GI foreign body, this should make us concerned about a perforation (a puncture) in the intestines from that foreign body, which caused oozing of bacteria and intestinal goo into the abdomen, and then peritonitis (an infection in the abdomen).

So the really, really correct diagnosis is GI foreign body and peritonitis.

At vet school you will hear about Occam's Razor, which is a dictum in philosophy attributed to a 14th century monk. William Occam said "*pluralitas non est ponenda sine necessitate.*" Translated and simplified into normal speak, that means, "the simplest explanation is the best one." If you find a disease process that explains all the clues (versus finding multiple disease to explain each clue) it's likely what's going on. In medical diagnosis, as in detection, we use the clues to "tell a story" about what went wrong.



Poor Furrbeus McPurr! Somebody should help him.

Oh wait... That's you! You should help him.

How do you fix this problem?

Treatment Plan?

(choose a few, then turn the page)

- a) Change his diet
- b) Deworm him
- c) Give him antibiotics
- d) Give him steroids
- e) Hospitalized him on IV fluids
- f) Sprinkle healing herbs topically
- g) Surgery

Here is where we come up with some possible solutions (treatments) to the problems (diagnosis) we have discovered in the animal. I'll give you several choices and you pick which ones you think would work best to treat the animal. Usually there are several things we should/could do. For example, it's obvious Furrbeus needs surgery. However, we wouldn't just do surgery—there are a couple other things we need to do. See if you can find them! Remember which letters you pick and see if you are right on the next page.

STOP!!!!!!

Don't turn the page until you've picked some treatments...



If you answered c, e, and g give yourself a pat on the head!

The best plan would be to hospitalize Furrbeus, start some antibiotics, and do surgery to take out that foreign body stuck in his intestines! And while you're in there, you should flush his abdomen a whole bunch to remove the infection and intestinal juices that have leaked in there.

You take him to surgery and cut open his abdomen and remove this thing (though it doesn't look as pretty as the photo in real life when it comes out)...



Why on earth would Furrbeus McPurr eat that?!?! Are you a cannibal kitty? Crazy cat!

He's going to have to stay in the hospital for several days on antibiotics and fluids, but for now he recovers well from anesthesia, seems grateful to be missing the doodad which made his tummy hurt, and licks your face when you check on him a few hours later.

"Ohhhhh yeah..." Barry B. Barlow says on the phone when you tell him about your surgical findings. "I'm pretty sure that toy had some catnip on it." He's out of town for some work to do with computers and IT, but he'll pick up Furrbeus as soon as he can.

Good job using your veterinary detective skills!

Don't take too long doing your victory dance though, because (after giving a few vaccines and other dull but very important things like that) your tech tells you there's a really sick (and really mean) dog in Room 2. Off you go!



Thanks for your interest in *Fuzzy Logic*!

Want to read more? An autographed discounted copy is available for purchase at our store (www.posttenebrasluxbooks.com) or can be found on Amazon.

Sign up for my email list (www.nmgrubens.com) or like my Facebook page (www.facebook.com/authoraarongruben) to keep up with various writing projects.