NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Does Jazmyne Need a New Chair?

Exploring Factors Influencing Management of Feline Hyperthyroidism

by

Melissa S. Kosinski-Collins[1] and Ariana L. Hinckley-Boltax[2]

[1]Department of Biology, Brandeis University, Waltham, MA

[2]Department of Comparative Pathobiology, Cummings School of Veterinary Medicine at Tufts University, North Grafton, MA

Part I – Meet Jazmyne

You are a veterinary assistant at Dr. Hernandez's small animal veterinary clinic. Your next patient is a new appointment for a cat named Jazmyne. You collect the following basic information from Jazmyne's owners.

Jazmyne is an approximately 11-year-old female spayed domestic shorthair cat. Her owners adopted her from a friend five years ago, and her previous owner took her in as a stray about five years prior, but her exact age is unknown. Jazmyne is here today because over the last few months or so, her owners have noticed some changes to Jazmyne's behavior.

Jazmyne has been more active and vocal than usual. She's an excellent eater, voracious, even. She used to take little interest in human food, but now the family keeps food locked away in cabinets because she's been more prone to "counter surfing" to find anything edible. Despite this excellent appetite, Jazmyne's owners feel like she has lost some weight. She otherwise seems to be doing okay; she loves snuggling on her favorite armchair and playing with toy mice.

You perform Jazmyne's intake exam in preparation for Dr. Hernandez's arrival. The results are listed below:

- *Heart rate:* 220 beats per minute (normal: 180–200 bpm).
- *Respiratory rate:* 45 breaths per minute with normal effort (normal: 10–40 bpm).
- *Temperature (rectal):* 101 °F (Normal: 100.5–102.5 °F).
- *Weight:* 3.9 kg (based on Jazmyne's size, normal: 5.0 kg).
- *Blood pressure:* 140 mm Hg systolic, via doppler (normal: less than 150 mm Hg).
- *Attitude/appearance:* Jazmyne is a friendly cat who eagerly takes the treats you offer her. She is bright, alert, and responsive. She has a body condition score of 3 out of 9 (normal: 4–5 out of 9), and her coat is full, but unkempt.

When Dr. Hernandez enters the room, she confirms your initial history and collects some additional information. Jazmyne lives indoors only and is not on any medications. She does not live with any other animals, and she is up-to-date on core vaccines.

You scribe the results of Dr. Hernandez's physical exam. In addition to the findings listed above, Jazmyne has some mild muscle wasting and an enlarged thyroid gland. The remainder of her physical exam is normal.

"Based on what you've just told me and my physical exam, I think I know what's going on with Jazmyne," Dr. Hernandez says.

To make a diagnosis for Jazmyne, Dr. Hernandez engages in a process called clinical reasoning, which is a dynamic and complex process in which she acquires and interprets clinical information in an intentional and organized fashion to make clinical decisions. To help you think like Dr. Hernandez, answer the following questions.

Questions

1. Complete the following chart by listing the abnormal observations that you know about Jazmyne. For each observation, indicate whether that abnormality is specific (just a few possible explanations for that abnormality) or non-specific (many possible explanations for that abnormality). For each observation, list some possible causes for that abnormality. An example is provided.

Abnormal Observation	*Specific or Non-specific*	*Possible Cause(s)*
Active and vocal	Specific (relatively)	Behavioral, neurologic, hyperthyroidism.

2. When doctors are presented with a series of clinical problems, they often try to distinguish whether all of those problems can be explained by one single diagnosis or whether there are multiple diagnoses present. Given the observations that you classified above, explain whether you believe there is a single diagnosis for Jazmyne or multiple diagnoses. Explain your answer.

3. How could you obtain additional information to help you confirm or deny your suspicion? For example, what additional history questions might you ask? What additional aspects of the physical exam might you perform? What dignostic tests might you run? Justify your reasoning.

Part II – Making the Diagnosis

"In isolation, clinical signs such as weight loss, increased heart rate, and an unkempt coat are vague, but taken together with more specific signs such as her enlarged thyroid gland, I suspect that Jazmyne has hyperthyroidism, which means that her thyroid gland is overactive," Dr. Hernandez says confidently.

The thyroid gland is a symmetrical, metabolic organ that is located on either side of the upper trachea. Intimately associated with the thyroid gland is another metabolic organ, the parathyroid gland, and some important nerves and blood vessels such as the vagus nerve, jugular vein, and carotid artery.

There are several hormones involved in the regulation and function of the feline thyroid. Thyrotropin (TRH) is a hormone produced by the hypothalamus that stimulates the production of thyroid stimulating hormone (TSH) from the pituitary gland. TSH then stimulates the production of a small amount of triiodothyronine (T3) and a large amount of thyroxine (T4) in the thyroid gland. T3 and T4 are then secreted into the bloodstream and transported to various tissues, such as the brain, heart, and skeletal muscles. Most of the T3 and T4 is bound to proteins when transported through the bloodstream, but a small amount is freely floating in the blood. Within the cells of the target tissues, much of the T4 is converted into T3. Together, the T3 and the remaining T4 increase metabolic rate, neuromuscular function, and, in young animals, encourage growth and development. These hormones are involved in a negative feedback loop. When T3 and T4 levels are low, the production of TSH is increased to stimulate their production. When T3 and T4 levels are high, they travel through the blood back to the hypothalamus and pituitary to exert negative feedback on the production of TRH and TSH, respectively.

Dr. Hernandez suggests that Jazmyne have a blood test to confirm the diagnosis. She explains that the blood test will measure total T4, which includes both protein-bound T4 and free T4. It is the most common test to start with. A high total T4 suggests the diagnosis of hyperthyroidism. The cost of this test is $40.

Although hyperthyroidism is the most likely diagnosis, it is also important to assess Jazmyne's systemic health with three additional tests: a complete blood count and chemistry profile that broadly assesses a variety of body systems, and an analysis of Jazmyne's urine. These can help further confirm the diagnosis, determine the impact of the disease on Jazmyne's other body systems, and make us aware of a diagnosis that may have been missed.

Jazmyne's owners immediately ask how much these additional tests will cost. "The additional tests will be about $250. With the test for total T4 ($40) and the examination fee ($60), the total cost will be $350," Dr. Hernandez says.

Questions

1. What is hyperthyroidism? What causes this disease?

2. How is the feline thyroid gland different from that of humans? How is it similar?

3. Using only the information given above, diagram the relationship that exists between TRH, TSH, T4, and T3 in the feline body.

Part III – Treatment for Jazmyne

Jazmyne's owners wince at the additional costs. "We can make that work, but $500 is about all we have extra each month after rent and groceries and such. We don't have a ton of savings right now."

Dr. Hernandez thanks Jazmyne's owners for sharing their financial situation, as this helps them work together to make the best plan moving forward for both Jazmyne and her family.

You assist Dr. Hernandez withdrawing Jazmyne's blood and obtaining urine, and you send the samples off for analysis. The tests take one to two days to complete. After the test results are returned, Dr. Hernandez calls Jazmyne's owners to discuss the findings.

"Jazmyne's total T4 was high, which confirms the diagnosis of hyperthyroidism. The other systemic health testing indicated some mild changes to her kidney values. Hyperthyroidism has a habit of masking underlying kidney disease, so as we treat the hyperthyroidism, we can monitor those values to see if Jazmyne truly has kidney disease as well."

Jazmyne's condition will not likely improve on its own. Dr. Hernandez suggests several possible treatment options for Jazmyne with various possible outcomes. The clients could:

- not take any action to treat Jazmyne.
- provide Jazmyne with a medication called methimazole. (Information regarding this drug can be found on the FDA website in the article "Hyperthyroidism in Cats: There's an FDA-Approved Drug to Treat It," https://www.fda.gov/animal-veterinary/animal-health-literacy/hyperthyroidism-cats-theres-fda-approved-drug-treat-it.)
- have radioactive iodine therapy performed on Jazmyne.
- opt for surgical removal of the thyroid.
- restrict the amount of iodine in Jazmyne's diet as a mechanism of dietary therapy.

A generalized example of the appearance of a hyperthyroid cat, how it is diagnosed, and how it can be treated is provided in the following short informational video:

- Hyperthyroidism in cats. Produced by Vet's Klinic, 2013. Running time: 2:44 min. <https://youtu.be/71cEVpqaT_A>

There are a variety of factors that affect the decision of which treatment option to pursue. Each option has financial implications, side effects, and prognostic effects. You decide to research each of these treatments to better understand how Dr. Hernandez can help Jazmyne's owners make a decision that is best for their family by consulting the following resource:

- Cornell Feline Health Center. (2017). Hyperthyroidism in cats. [Webpage]. Cornell University College of Veterinary Medicine. <https://www.vet.cornell.edu/departments-centers-and-institutes/cornell-feline-health-center/health-information/feline-health-topics/hyperthyroidism-cats>

Questions

1. Describe how elevated T4 levels lead to the non-specific clinical signs of weight loss, muscle wasting, increased hunger, and increased respiratory rate observed above.

2. Using the resource cited above from the Cornell Feline Health Center, complete the following table for each of the types of treatments.

Treatment	*How does it work?*	*Is it curative (yes/no)?*	*Side effects and follow-up*	*Cost*
1. No action				No immediate cost.
2. Methimazole				$1–2 per day for the duration of the cat's life, plus periodic blood screening of about $200 per year.
3. Radioactive iodine therapy				$2500–3000 for treatment and work-up.
4. Surgical thyroid removal				$3000–3500 for work-up and surgery.
5. Dietary therapy				$2–3 per day for the duration of the cat's life, plus periodic blood screening of about $200 per year.

3. What factors do you think go into making a treatment recommendation for Dr. Hernandez? For Jazmyne's owners?

4. If you had to suggest the best treatment strategy for Jazmyne's owners, what would it be and why? Consider what you know about the family, about Jazmyne, and about the treatments to make your decision.

Part IV – Exposure Concerns for Hyperthyroid

Jazmyne's owners opt for dietary therapy. Their decision is impacted by a few factors, which Dr. Hernandez helps them weigh. They don't have the savings at this time to consider radioactive iodine therapy or surgery, and they know that Jazmyne would not enjoy being pilled twice daily with the methimazole. Since she doesn't live with other cats and doesn't hunt outside, they're fairly confident they can ensure that she will exclusively eat the iodine-restricted diet. With this treatment, Jazyme's behavior and health is likely to improve after two months. Since Jazmyne still likely has many years ahead of her, they aim to start saving up for the radioactive iodine therapy.

Before wrapping up the appointment, Dr. Hernandez asks whether Jazmyne's owners have any additional questions. "Is there anything we did to cause this?" they ask.

"No, you've taken excellent care of Jazmyne. There have been some reports of environmental factors that have been associated with hyperthyroidism, but they're all just correlations and not causations."

Jazmyne's owners are relieved. They thank you both, and take Jazmyne home, with a sample of wet and dry versions of the iodine restricted diet to try out.

After Jazmyne's owners leave, you ask Dr. Hernandez, "How do you know that those environmental factors didn't cause Jazmyne's hyperthyroidism?"

"I didn't," Dr. Hernandez replies with a sigh, "but I think that's what they needed to hear at that moment."

You're not sure how to feel about what Dr. Hernandez said, so you go home and do some research to learn more about these potential environmental influences.

After some searching in the literature, you find that certain chemicals called endocrine disruptors found in a cat's home have been associated with cases of hyperthyroidism. Flame retardants used in furniture, carpets, and other household upholstery have been shown to be endocrine disruptors. You find one particular study that developed a test which elucidated this correlation.

- Poutasse, C.M., *et al.* (2019). Silicone pettags associate tris(1,3-dichloro-2-isopropyl) phosphate exposures with feline hyperthyroidism. *Environmental Science and Technology* 53(15): 9203–13. <https://doi.org/10.1021/acs.est.9b02226>

Use the reference above to answer the following questions.

Questions

1. How common is hyperthyroidism in cats?

2. How has this trend changed over time? Why do you think this trend is occurring?

3. How did the authors come to the conclusion that TDCIPP exposure was associated with risk of hyperthyroidism? Describe the experiment, the control, the mechanism of data collection, and the overall trend observed.

4. Do you agree with the authors' conclusions? Why or why not?

5. Why might it be challenging to conduct studies linking environmental toxins to pet diseases?

6. What is the difference between correlation and causation? Is TDCIPP exposure correlated with or a causation for hyperthyroidism? Justify your answer.

7. Could exposure to a flame retardant be a possible cause of Jazmyne's hyperthyroidism? Justify your answer.

Part V – Environmental Hazards and Feline Disease

After considering Jazmyne's case and the possible impact of flame retardants on feline thyroid disease, you become very curious about other possible connections. You find the following additional connections between feline hyperthyroidism and exposure to, or ingestion of, chemicals or toxins.

- Polybrominated diphenyl ether (PBDE)
- Polychlorinated biphenyl (PCB)
- Bisphenol A

Questions

Select one of the environmental connections above. Use PubMed to find a peer-reviewed study that demonstrates either a correlation or a causation between the hazard and hyperthyroidism. This should *not* be a review article. Provide the reference. Read the article and answer the following questions in a single-spaced, no more than two-page, essay format.

1. How does a cat get exposed to this environmental hazard?
2. What question were the authors trying to answer in this study?
3. How did the authors set up the experiment? How many cats were enrolled? What clinical indications did these animals have? What methods did the authors use to collect data?
4. What results did the authors find? What conclusions did they draw from this data?
5. Do you believe the author's conclusions? Why or why not. Consider what limitations were inherent in the study or data analysis process.
6. Dr. Hernandez mentioned telling owners only "what they needed to hear at the moment." Considering your answer to Question 5, do you think veterinarians should make pet or owner lifestyle recommendations based on studies that show "correlation" between environmental exposures and disease? When is it okay, and when is it not okay? Justify your answer and consider the ethical concerns inherent in these types of recommendations.