

Ottawa Science Innovation Challenge

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The Case:



An Unusual Target

“3... 2... 1... Ready or not, here I come!”

On a mild Sunday afternoon, Anna hid in the tall grass as her best friend sought to find her. The two middle school girls were playing in Carp Hills forest, a beautiful conservation in west Ottawa filled with convenient hiding spots. “I see you over there Anna, beside that bush!” her friend proclaimed. Oblivious to any hazard, Anna’s mother Nora kept watch as they giggled and crept through the underbrush until the daylight finally faded.

Dressing for school the following morning, Anna noticed a small rash below her left ankle as she attempted to slip on her socks; the diffuse circle was red and irritated. “I hate mosquitos” she mumbled, as she itched and itched. The blood-hungry pests are rampant in the early summer. Merely a few nights prior, the whole family was peppered with bites. Understandably so, she didn’t think much of this one. *It will go away eventually* she reassured, *just like dad said.*

Over the course of a few days, the troublesome rash began to expand. Anna was puzzled as it appeared far less like a simple mosquito bite. She soon acquired symptoms that referenced the flu: fever, headaches and fatigue. Her mother noticed her sluggish demeanor.



Tick “hot spot”

Public health officials report that the number of Lyme disease cases reported in the Ottawa region has tripled compared to last year’s statistics. (Duffy, 2016) The Carp Hills is one of many forests in Ottawa reporting an increase in ticks, particularly blacklegged ticks that can carry Lyme disease. (“Ticked Off in the Carp Hills | Friends of the Carp Hills”, 2016)

“Anna are you feeling well? You seem a bit tired.”

“My head kind of hurts” she whined, followed by a prominent shiver.



Nora dusted off an old thermometer and plugged it in her ear. "39.7 degrees hunny, you're running a fever! You can't go to school like this" the mother ruled. Thus, Anna stayed home, bedridden, for the remainder of the week. In the meantime, Nora gave her some acetaminophen tablets, convinced she had just contracted the flu from a peer.



Target Rash

Classic presentation of erythema migrans rash occurs in approximately 70% to 80% of infected individuals. It begins at the site of the tick bite after an average delay of about 7 days. It can result in a bull's-eye appearance and can emerge on any part of the body. However, fever and other general symptoms (e.g. fatigue, headache, body ache) may occur in the absence of the rash. ("Signs and Symptoms | Lyme Disease | CDC", 2016)

The weekend promptly arrived, and Anna was fed up with her condition. "Mommy this mosquito bite is really bugging me, it's been itching the whole week now. My head really hurts and my leg aches so bad!" Concerned, Nora lifted her pajamas to examine the bite, only to reveal a peculiar sight—a sizable target-shaped rash was spread across her ankle. Upon closer inspection, she identified a minuscule tick lodged in its epicentre, easilymistakable for a mole.

Nora did not take any chances. Recalling a news article detailing the growth of tick populations in Ontario and the dangerous pathogen they could carry, she immediately drove Anna to the emergency room at CHEO (Children's Hospital of Eastern Ontario).

The emergency physician managed to remove and preserve the tick for species identification. Dr. Samson, an Infectious Disease specialist at CHEO, was called to consult on the matter. Having considered Anna's systemic symptoms, she assessed the minuscule parasite and Anna's peculiar rash—an exemplary case of erythema migrans—and quickly reached a diagnosis. "Unfortunately, your daughter has been bit by a notorious blacklegged tick most likely carrying bacteria of the *Borrelia* family" she affirmed.



You're saying this thing infected my daughter with bacteria?

We will evaluate the tick to determine exactly what it's harboring, but there is strong evidence to suggest your daughter is a victim of Lyme disease.

Wait, what does this have to do with limes?! Will my daughter be able to recover?!

We will begin evasive treatment with antibiotics, and re-evaluate after a couple of days to resolve the next course of action.

Nora was frightened and bewildered by this diagnosis. Dr. Samson tried to calm Nora as best she could, but the prognosis was unclear.

In fact, bacteria of the *Borrelia* family are extremely resistant to antibiotics. Since Anna was already expressing late symptoms of Lyme, notably muscle and joint pain, Dr. Samson recommended a combination of doxycycline and intravenous ceftriaxone.

After a couple of days of treatment, the rash softened and Anna regained some vitality. Nonetheless, a painful ache persisted in her left knee and thigh, inducing a prominent limp. Nora became worried the treatment wasn't entirely effective. During Anna's reassessment, Dr. Samson concluded that the consistent pain in Anna's left leg was indeed forthcoming of PTLDS, or post treatment Lyme Disease Syndrome.



Patients with PTLDs suffer from chronic symptoms such as muscle and joint pain, and occasionally neurological problems, all of which can persist for many years following the onset of Lyme disease. Unfortunately, there is no cure.

"How can I have missed this? This is all my fault!" Nora lamented. Dr. Samson's expression grew stern.

"Don't blame yourself Nora, Lyme is very hard to detect and to treat. While a permanent solution may not be available, we will do everything we can to help Anna cope with PTLDs for the years to come."



PTLDs – An ongoing battle

The Center for Disease Control and Prevention states that 10% to 20% of individuals diagnosed with Lyme disease develop ongoing symptoms lasting more than 6 months; including fatigue, joint and muscle pain, and thinking problems. Theories surrounding the cause of PTLDs include damage to tissues and changes in the immune system. More research is underway, but no matter the cause, the symptoms are real and get better over time. (Wait, 2014)

After laying out the options to minimize Anna's chronic symptoms, Dr. Samson exited the room and caught the mother coddling her daughter with a smile, attempting to hide her disarray. "Cases like these are terribly sad," the doctor admitted to a nearby nurse. "That little girl's life will be forever scarred. Perhaps with further awareness and research on Lyme disease, not to mention action against the spread of these deer tick populations, we will succeed in preventing such an outcome, or at least soothe the lingering burden".



The Challenge

The case is used to identify possible avenues to explore related to this year's topic: Lyme Disease. In fact, your proposal should not focus on any of the characters or the story illustrated in the case. You should use the case as an eye opener to the different problems related to Lyme disease, and from there conduct a literature search to better understand this problem. Only then will you be able to connect ideas together and form a new research proposal.

Below are examples of problems and possibilities for the proposals. You are not limited to these problems or solutions, these are simply for inspiration:

Problems highlighted	Possibilities to explore
Black-legged tick population is growing	Find ways to control the population, a novel insecticide, or preventing the spread of bacteria from one tick to the next
The tick bite	Repel the tick from the skin (prevent the tick from biting)
Tick was not identified nor removed in time	Educate better on tick bites, find tools to better visualize the tick, locate ticks, and safe ways to remove them
Early detection	Find easier ways to diagnose Lyme from an early standpoint, before later symptoms kick in (molecular markers, at home tests, etc)
Borrelia bacteria treatment	Explore the molecular biology of the disease, find ways to better fight the bacteria (Borrelia is very resistant and persist post-treatment for many years, linking to PTLDS)
PTLDS persistence for many years	Find better treatments for PTLDS, ways to cope with PTLDS



Additional Information

Discovering Lyme Disease

In the early 1970s, several cases of rheumatoid arthritis emerged among children living in Lyme, Connecticut and surrounding towns. Researchers first thought that aquatic or airborne microbes were the cause of these puzzling cases. However, they began to consider deer ticks as a more plausible cause once realizing that the majority of the children with arthritis resided in wooded areas.

Several other signs indicated that ticks were most likely responsible for these cases. These signs include the first manifestation of symptoms in children – during the summer, the peak of tick season – as well as being bitten by a tick and developing a skin rash at the site of the bite before the onset of arthritis. By the mid-1970s, the term Lyme disease was used by physicians to diagnose patients showing these signs and symptoms. ("History of Lyme Disease | Bay Area Lyme Foundation", n.d.)

Lyme Facts

Canadians often associate Lyme disease to an uncommon “hiker illness” caused by ticks buried deep in the woods. The infected individual would develop a bull’s-eye rash that would be treated with antibiotics for a few weeks... end of story. However, this picture fails to educate the population about the real threat of Lyme disease, such as its chronic form that can cause debilitating joint pain and neurological problem. In the past two decades, disease-carrying ticks have increased tenfold in Canada due to migratory birds and warming climate. (Barton, 2014) Originally only found in Ontario, Lyme-carrying ticks now live in almost all Canadian provinces. In 2014, Canada reported 500 cases of Lyme disease, but predicts that by 2020, 10 000 Canadians will be infected annually. (Mangione, 2015)

Beginner's Guide to Lyme Disease

Lyme disease is an inflammatory infection caused by a spirochete – a corkscrew-shaped bacterium named *Borrelia burgdorferi* – and transmitted by *Ixodes* ticks, known as deer ticks or black-legged ticks. ("Lyme Disease: Introduction to Symptoms, Diagnosis and Treatment", 2015) In fact, it is one of the most common vector-borne diseases reported worldwide. (Vasudevan & Chatterjee, 2013) Ticks, typically found in wooded and grassy areas, acquire the bacteria by biting infected animals like birds, small rodents, and deers. These ticks are then able to infect other organisms, including human hosts. Moreover, Lyme disease diagnosed in humans can be caused by many genospecies of borrelia bacteria varying in virulence. ("Lyme Basics | CanLyme – Canadian Lyme Disease Foundation", n.d.)



The Great Imitator

Lyme disease is often called the “The Great Imitator” since its accompanying symptoms mimic several other diseases. Consequently, patients infected with Lyme disease are frequently misdiagnosed with multiple sclerosis, fibromyalgia, chronic fatigue syndrome, and depression. With a misdiagnosis, correct diagnosis is delayed and the infection progresses untreated. ("Lyme Disease: Introduction to Symptoms, Diagnosis and Treatment", 2015)

Lyme Disease can affect any organ of the body, such as skin, joints, nervous system and heart. Generally, the first symptom presents itself as a rash, known as erythema migrans, which starts at the site of the tick bite and enlarges, sometimes appearing like a bull's eye. Rashes may materialize at different parts of the body as the infection spreads. Other symptoms are similar to those of viral infections (e.g. fatigue, headache, stiff neck, body aches, and fever), but tend to persist or fluctuate over time in cases of Lyme disease. In chronic cases, patients may develop arthritis, neurological problems, eye inflammation, severe fatigue, hepatitis, and seldom, heart problems. (Vasudevan & Chatterjee, 2013)

At war with Lyme

Treatment of Lyme differs according to the stage of infection. In the early stages of Lyme disease, patients can be rapidly and completely treated with the appropriate antibiotics. Common oral antibiotics are doxycycline, amoxicillin, and cefuroxime. Certain patients suffer of neurological or cardiac problems and require intravenous treatment with drugs like penicillin and ceftriaxone. ("Treatment | Lyme Disease | CDC", 2015)

Symptoms can last for more than 6 months, but only in a small percentage of cases. These cases fall under the category of “chronic Lyme disease”, also known as “Post-treatment Lyme Disease Syndrome” (PTLDS). ("Treatment | Lyme Disease | CDC", 2015) The cause of PTLDS has yet to be discerned, therefore effective therapy has not been developed. Possible causes include autoimmune reaction to the infecting organism and prolonged post-infection fatigue. (Brody, 2013) Therefore, physicians attempt to help these patients cope with their symptoms by treating them similarly to patients who have fibromyalgia or chronic fatigue syndrome and with prolonged antibiotic treatment. ("Post-Treatment Lyme Disease Syndrome | Lyme Disease | CDC", 2015)



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