

A STUDY ON LYME DISEASE IN MICHIGAN

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ABSTRACT

There have been increasing incidents of Lyme Disease reported in Upper Peninsula of Michigan over the past few decades. The objective of this research is to identify flaws in the current system regarding treatment and prevention of Lyme Disease and recommending a model-based risk assessment to prevent Lyme Disease in future. In addition to ticks, more means of communication have been discovered.

1. Introduction

1.1 History

A mysterious clustering of arthritis cases occurred among children in Lyme, Connecticut and its neighborhood in early 1970s. During 1975, a large number of children were diagnosed with rheumatoid arthritis. Researchers started finding causes of illness and realized most of the infected children lived in wooded areas and reported a skin rash before developing arthritis. Few believed and reported bitten by a tick mostly 12 days before symptom onset. Eventually medical experts named this new illness as Lyme Disease.

1.2 Lyme Disease

Lyme Disease is an illness caused by a spirochete bacterium called “*Borrelia Burgdorferi*”. It is

usually transmitted by a type of tick called “*Ixodes Scapularis*”, a blacklegged tick. These ticks feed themselves by inserting their mouth into the skin of host (animal or human) and suck blood slowly and painlessly.

1.3 Disease Expansion to Michigan

In Michigan, Lyme Disease was reported in Menominee County of Upper Peninsula of Michigan in 1985. However, infected tick population had been found in western lower Michigan too. Data collected from the Michigan Department of Health and Human Services shows that 1057 cases of Lyme Disease were reported and diagnosed between 2000 and 2014.



Image 1.1 Female Black-Legged Tick from Southwest Michigan

1.4 Lyme Disease Cases in Houghton

A total of 17 cases were confirmed in Houghton County between 2000 to 2015 with an increasing trend. A nearby county

called Menominee County confirmed 271 cases during the same period of time.

1.5 Symptoms of Lyme Disease

EM which is Erythema Migrans is the first symptom of this disease. A bull's eye looking rash is reported to appear on skin usually after a week of tick bite. Other commonly appear symptoms can include infections such as:

- Headache
- Fever, Sweats
- Body Aches
- Fatigue
- Swollen Lymph Nodes
- Sore Throat

Although, these symptoms are commonly known as viral infections, however, in the case of Lyme Disease they tend to continue longer.

1.6 Diagnosis

Early diagnosis and treatment are essential in the case of this disease because if it's not done on time it might affect the nervous system and heart. Information available on CDC's website suggests taking a two-step lab test using EIA (Enzyme Immunoassay) or IFA (Immunofluorescence assay) followed by a blot test to confirm presence of the Igm and Ige antibodies.

1.7 Treatment

It is advised to avoid tick habitats but in case you are going to the

area that may be tick infested, below are the precautions that can be taken: -

- ✓ Spray insect repellent with 20 - 30 percent DEET on exposed skin.
- ✓ Spray clothing with permethrin. It kills ticks on contact.
- ✓ Cover your body by wearing long pants and long sleeves and socks.
- ✓ Take preventive antibiotics such as doxycycline, amoxicillin, or cefuroxime axetil if bitten by tick.

2. Problem Statement

Data from "[cdc.gov](https://www.cdc.gov)" stated that every year around 300,000 new people get infected with Lyme Disease in United States. Majority of the people misunderstand symptoms with common viral infection and hence does not sense the disease on time. Using Machine Learning and Predictive Analytics, an algorithm will be developed which will identify chances of the disease ahead of time by providing initial screening to the prospects.

3. Literature Review

3.1 Previous Study

Recent study on Lyme Disease was performed by Michigan State University. Dr. Jean Tsao of MSU and her research team followed movements of ticks based on cases found and proposed destroying their eggs before they grow up.

3.2 Use Cases

"Pets can be carriers of infected ticks" says Dr. Guy Hembroff of Michigan Technological University. In an interview with Dr. Hembroff, he mentioned spotting a tick on his puppy's ear last summer and he took it in a zip lock packet to the clinic to identify the tick.

Julie Allison, women from west Michigan had a tick bite as a child and it took many years to get diagnosed. In her interview with a website she stated *"The symptoms are extremely debilitating. There's fatigue. It's crushing, There's neurological disturbances."* Sometimes I have to use a cane.". By sharing her story, she is hopping others will take precautions.

A student at Michigan Tech called Ray had Lyme Disease in the past and he believes that ticks are not the only way disease is expanding. It can be spread by mosquito bite, spiders and sexual transmission. To strengthen his belief, I looked upon and found a study performed in 2014 by a researcher called Marianne Middelveen in California. Study suggests that Lyme Disease may be sexually transmitted. In study, researchers tested semen samples and vaginal secretions of patients who were tested positive for Lyme Disease and turned out couples engaging in unprotected sex tested positive with the disease.

3.3 Michigan Tick ID Card

A pocket size ID card provided by Michigan Government to identify common ticks in Michigan area. It also has all the important information regarding tick bite and prevention methods.



Image 1.2 MITick ID Card picture taken by Michigan.gov website

4. Methods

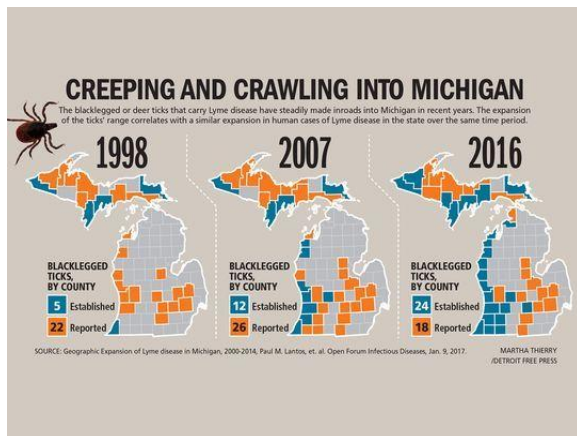
4.1 Data Analysis

This study is more specific to Michigan however, the numerical data is collected from various sources and for both Michigan and United States to compare trends and variations in the disease over the time. R studio was used to organize the data based on requirement of research question. Data visualization was performed in both R Studio and Python Jupyter Notebook.

Other statistical analysis such as Chi-square analysis was used for the study to determine correlations between spread of Lyme Disease in different regions of United States.

4.2 Disease in Michigan

A student at Michigan State University found six adult blacklegged ticks (Three male and Three Female) as a report of freep.com. Those ticks were collected by his dog recently in Lansing, MI. Here is the analysis provided by Martha Thierry from Detroit free press which shows tick population distribution in different counties of Michigan from 1998 to 2016.



Source: www.freep.com

In, 1998, ticks were established in five counties which later increased to twenty-four counties in 2016. Later part of the report I will try to figure out increase in tick population over the time using algorithms and Machine Learning techniques.

4.3 Modelling Climate Factor with Machine Learning

Different Machine Learning models are being used such as Logistic Regression, Naïve Bayes and Linear SVC to predict Lyme Disease in future.

4.4 Means of communication

Till now it is widely accepted that Lyme is only communicated through ticks, but cases show that it is being transported via birds and white legged mice. Deers and Birds are only a medium of transportation while these mice are actually getting infected and spreading the disease by contact.

Linda mentioned in one of the interview that few counties in lower peninsula of Michigan are collecting those mice in a place and then using road rollers to kill them.

5. Case Study

5.1 Case Study 1 – Linda Lobes, President, Lyme Association of Michigan: In a conversation with Linda she spoke about her journey combating Lyme. In 1989, she got infected from a spider bite. She took ELISA test 7 times and each one of them was positive. However, her doctor denied reports and declared them false positives. In 1992, she had a heart related medical problem and she went to the hospital. The doctor suspected Lyme and she had another

test which diagnosed her with Lyme. She left Michigan soon after diagnosis as Medical Personnel in Michigan were less educated and aware at the time and went to Long Island, New York for her treatment. After few years she recovered and came back to Michigan and joined Lyme Disease Association as vice president. She believes that if Michigan had better test facilities then conditions would have been better today.

5.2 Case Study 2 – Female from Wayne County, Detroit (Does not want to declare her name) – This female was diagnosed with Lyme soon after she got pregnant. She took ELISA test twice and her test results were negative. She later gave birth to a son and unfortunately, he caught her disease. Scenario would have been different if we had better testing facility.

5.3 Case Study 3 – Female from Oakland County (Does not want to declare her name) This female was diagnosed with Lyme Disease when she was 5 months pregnant. She then took proper treatment and later she had 4 children, and all are healthy, none of them caught her disease.

5.4 Case Study 4 – Ray Mullins – Male from Flint, Michigan started noticing symptoms 11 years from now. He was working for General Motors and suddenly started feeling depressed. Feeling of depression,

fatigue and stress lasted for 3 years and that lead him to resign his job. After few years when he started feeling better, he started another career as a nurse in a hospital. One day he was walking through the corridor and suddenly passed out. He said, *“I was walking and suddenly everything went black, It took me a while to get out of that zone and that was second time when I noticed symptoms”*. Ray started consulting doctors and started taking therapies. In the beginning doctors assumed that this is happening because of the change in career and muscle weakness which overwhelmed his immune system. He said, *“I found myself sleeping for 16-20 hours a day and used to feel some tingling sensations in my legs”*. He was diagnosed with the disease 4 years back and since then he is taking proper treatment. Long term undiagnosed disease made changes in Ray’s body. He had a testosterone of 30 (300-400 normal). He said, *“I had no testosterone at a moment and my doctor said, how are you even alive?”*. Ray believes it was miracle that saved his life. Currently he is taking shots for C4A test which checks whether treatment is working for Lyme and fortunately he is in a stable state.

6. Recommendations

6.1 Education to doctors

Frequent seminars and awareness campaigns to educate

doctors regarding the trend in the region and how the disease trend is changing will help them understand and consider other mediums of disease spread. Since it is evident from these case studies that Lyme can showcase different symptoms and can be transmitted through different means with new means discovered every now and then, that doctors should entertain the possibility of this disease and keep it on their radar while diagnosing patients with similar symptoms.

6.2 Patient care

There is a need of Care management teams to help patients during the treatment process. They can monitor their conditions and can report to doctor time by time. This is more important with Lyme as it has such a wide variety of symptoms and so much is yet to be discovered about it. Also, once the treatment is completed, they can manage monthly visits to check on patients. This would help patients to get their trust back on the system and the government.

6.3 Better Testing Facility

Testimonies suggest a need for better testing facilities. ELISA test is only 35-40 percent accurate and this is the main reason doctors often get confused with the results and confuse them with false positives.

6.4 Insurance for everyone

Nation-wide insurance programs should be available for

people to tackle such diseases which rock the foundation of human life. This can be put in the same category of HIV, Cancer, Hepatitis C etc. This would widely help low income households which do not actively enroll in medical insurance.

6.5 Support System

It is evident from this study that an online forum is required and will be developed with the help of Michigan Lyme disease association to provide people with a platform where they can ask for help, they can have someone to talk to and to support their battle against Lyme. Taking this as an initiative to support “Limies” mentally.

Conclusion

Many people cannot find out Lyme until they go chronic. People like Linda, who are working towards helping Lyme patients strongly suggest changing current guidelines. Ray mentioned during the interview that his insurance does cover the Lyme Treatment but does not cover Lyme diagnosis test fee. Also, for taking Lyme diagnosis test, they ask patients to pay in cash and these might be one of the reasons why people ignore taking test in the first place.

People with Lyme die due to suicides more and less due to the disease itself. Long term undiagnosed Lyme creates variety of issues including cardiac issues, unbalanced

Hormones in the body and depression. Currently available tests are either ineffective or way too expensive. Treatment can be cheaper if treated the right way.

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