ADDRESSING LYME DISEASE: AN EDUCATIONAL MODULE FOR HEALTHCARE PROVIDERS

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Addressing Lyme Disease:
An Educational Module for Healthcare Providers

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The supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

DOCTOR OF NURSING PRACTICE

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ABSTRACT

Since its identification over 40 years ago, Lyme disease has continually spread, and the number of cases have significantly increased in the northeastern and northcentral United States. The Center for Disease Control and prevention (CDC) estimates that approximately 30,000 individuals in the United States per year are diagnosed with Lyme disease (2016). Lyme disease is a vector-borne disease that is caused by *Borrelia burgdorferi*, a bacteria transmitted by the *Ixodes scapularis* tick. The disease presents in numerous ways, often making the diagnosis difficult.

Healthcare providers have the opportunity to reduce and prevent health complications associated with Lyme disease, but substantial knowledge gaps are present in relation to the overall care of patients with the disease (Hill, 2013). In addition, numerous healthcare providers within the United States have reported not feeling confident in their knowledge level of tick-borne disease (Brett et al., 2014). By facilitating healthcare providers learning through a continuing education module, they may improve their practices and provide more competent, safe, and high quality care for patients with Lyme disease.

With the apparent need for increased knowledge and awareness of Lyme disease among healthcare providers, a continuing education module was constructed for distribution with the American Association of Nurse Practitioners Continuing Education Center. Information on the prevention, diagnosis, and treatment of Lyme disease was incorporated into the module to educate healthcare providers.

The online module evaluated Lyme disease knowledge through a pretest, posttest, and evaluation survey. Approximately 10 weeks of data were collected with a total of 305 healthcare provider participants. As a result of the continuing education module, learning was demonstrated

by improvement on 17 of 18 pretest and posttest content-related questions. Additionally, approximately 93% (n = 283) of participants felt the continuing education module enhanced their current knowledge base. Additionally, raw survey data provided from the American Association of Nurse Practitioners is available under supplementary files. In summary, results demonstrated that the continuing education module impacted the participants positively by advancing their knowledge of Lyme disease prevention, diagnosis, and treatment.

ACKNOWLEDGEMENTS

The extraordinary journey that resulted from the completion of this Doctor of Nursing Practice clinical dissertation could not have been accomplished alone. Throughout the graduate program, many individuals have provided invaluable advice, support, and guidance that I would like to recognize. First, I would like to thank Dr. Dean Gross, my committee chair. He has not only been a great resource for a wide variety of clinical and educational questions, but instrumental in assisting in the coordination of my dissertation. In addition, I would like to express my sincere appreciation to my clinical dissertation committee members including Dr. Kelly Buettner-Schmidt, Dr. Paul Carson, and Dr. Eugene Berry. Their contributions to discussions, ideas, and feedback have been instrumental in enhancing the implementation and completion of my clinical dissertation.

I would like to also thank Stormy Causey and the American Association of Nurse Practitioners Continuing Education Center for assisting in the coordination of and hosting my continuing education module on their website, and providing data reports. Additionally, I want to recognize Stephen Beckerman, Media Technologies Consultant, for providing his expertise in regards to the recording and editing of the continuing education module.

DEDICATION

This dissertation is dedicated to my husband, Michael, who has provided constant support and encouragement. His honesty and confidence in my abilities has helped me persevere through the challenges that have presented along the way to the completion of my dissertation. I will be forever grateful for his strength, patience, and love. Also I would like to dedicate this project to my son, Miles, for always brightening my days and reminding me to be thankful for even the little joys of life.

I would like to also dedicate this project to my parents, Lynn and Roger, who have instilled values of determination, passion, hard work and resilience throughout my life. No words can express my deep appreciation for their advice, enduring support, and unconditional love through my life endeavors that have ultimately made this accomplishment possible. Additionally, I am extremely grateful for my in-laws, Sheila and Todd, for the love and support they provide to our family and my education.

Having my classmates by my side through this challenging and rewarding journey has provided me with a great support system and lifelong friendships. I am also forever grateful for all of my friends and family who have been a source of immense support and encouragement through this process. Lastly, I would like to recognize my sister, Megan, for not only being supportive and encouraging, but my inspiration for creating this project. She has suffered the ill effects from delayed recognition and treatment of Lyme disease and today still faces many struggles related to this disease.

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CHAPTER I: INTRODUCTION

Background and Significance

Lyme disease (LD), a zoonotic vector-borne disease, has caused debilitating illness in children and adults across the United States, Europe, and Asia for years. The risk of acquiring LD is on the rise and is spreading to areas today that were not affected in the past. Over 30,000 cases of LD are reported every year in the United States, but documented cases do not capture every diagnosis, estimates of actual cases being approximately 300,000 (Center for Disease Control and Prevention [CDC], 2015). LD can be a debilitating disease that causes a wide array of life threatening complications including meningitis and heart arrhythmias if not treated promptly and properly. Although often associated with geographical locations of states in Northeastern and upper Midwestern United States, LD has been reported in nearly every state (CDC, 2015).

Early detection of LD has been problematic due to wide array of possible signs and symptoms that may be present, the tendency for the disease to mimic other illnesses, and lack of accurate testing within the early stage. Currently the CDC (2016) recommends the use of two-tiered testing, which includes the enzyme-linked immunosorbent assay (ELISA) and western blot. The accuracy of these tests has been strongly correlated with the stage of disease. When used too early after a suspected infectious tick bite the tests have been shown to have a decreased sensitivity (CDC, 2015). Providing proper education on the use of these tests has been demonstrated to improve accuracy and aid in the diagnosis of LD (Aucott & Seifter, 2011). With the already increasing reported cases within the United States, the ability for individuals to travel, and the lack of patient and provider awareness, all healthcare providers need to be vigilant when assessing patients for possible LD. The need for an educational module was established

through a literature review of providers' knowledge and through observance of various views and practices among healthcare providers.

Problem Statement

Healthcare providers and patients have been found to have an insufficient information in regards to how to care for LD. Expanding provider knowledge about LD including prevention, signs and symptoms, diagnosis, testing, and treatment are essential components in decreasing the incidence and complications related to LD (Hill, 2013). Many healthcare providers' lack of knowledge can put patients at risk for not only contracting LD, but developing Post Treatment Lyme Disease Syndrome (PTLDS) or late stage LD when treatment has been delayed or inappropriate. To address the knowledge gap, an online educational module was developed for healthcare providers to increase knowledge and awareness of LD.

Project Objectives and Description

Healthcare providers are crucial in promoting awareness, enhancing education, and providing appropriate diagnostic testing and treatment in relation to LD. To develop applicable strategies in relation to LD, healthcare providers must identify obstacles and stratify patients' risks in accordance to each patient. The participating providers achieved the educational module's purpose through the following objectives: 1) state factors that increase risk of contracting LD and ways to prevent LD, 2) recognize barriers to early diagnosis and treatment of LD, 3) identify interventions to improve awareness amongst providers and systematize diagnosis and treatment of LD.

An hour-long continuing education module was made available online through the American Association of Nurse Practitioners Continuing Education Center (AANP CEC). The target population for the practice improvement project are the readers of the AANP continuing

education module. In addition, healthcare providers who deliver care to patients with or at risk for LD with a focus on prevention, early diagnosis and treatment would benefit from the information. Enhancing awareness of LD in all healthcare providers, has the potential to decrease diagnosis and treatment delays leading to improved health outcomes among the target population.

CHAPTER II: LITERATURE REVIEW

Introduction

In the United States, LD is the most common vector-borne disease (Hamer, Hickling, Sidge, Walker, & Tsao, 2011). Although endemic areas are associated with contracting LD, all individuals across the United States are susceptible (Cameron et al., 2014). The Ixodes scapularis, also known as the black-legged tick, is a deer tick that most commonly transmits the *Borrelia burgdorferi* spirochete that in turn causes the bacterial infectious disease (Marchese & Primer, 2013). A deer tick progresses through development stages including larva, nymph, and adult. Most commonly individuals are infected through the bite of a nymph, an immature tick that is less than 2 mm in size (see Figure 1). Adult deer ticks can also transmit Lyme, but due to their larger size they are often discovered before the bacteria is transmitted (CDC, 2015). LD prevention, diagnosis, and treatment all consist of multifaceted approaches in which healthcare providers can assist in reducing associated risks and complications.

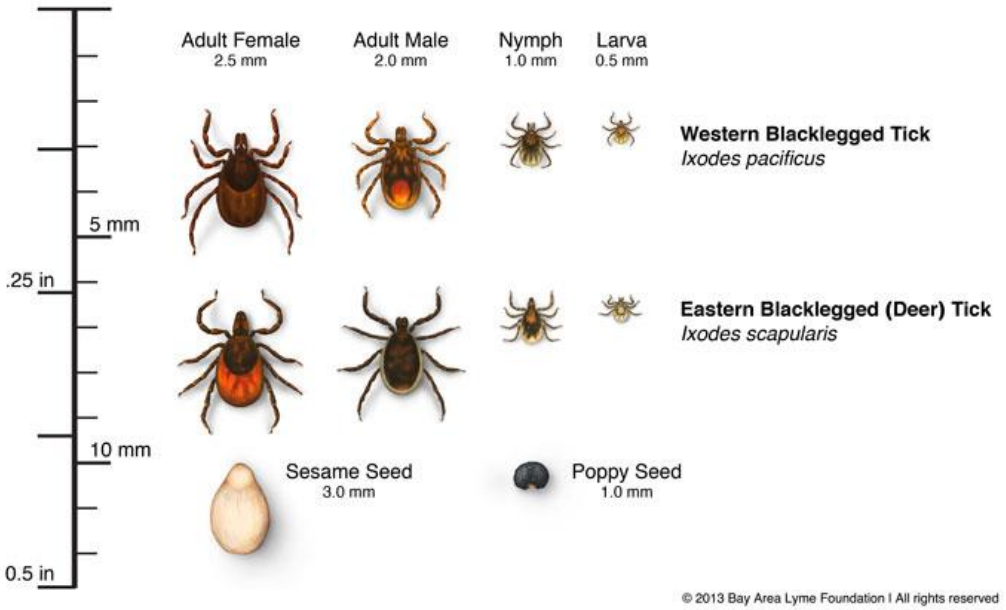


Figure 1. Relative sizes of blacklegged tick at different life stages (Eng, Tick Size Chart, 2013). Copyrighted by Bay Area Lyme Foundation.

History

The first signs of LD were noticed early in the 1900s with a red migrating rash called erythema migrans (EM). The rash was found to be caused by tick bites and later with a systemic disease. During the 1970s in Lyme, Connecticut, a group of children presented with a rash and arthritis and physicians called the illness LD (Steere et al., 1983). LD incidence has been steadily rising over the past 20 years, whether the increased incidence is due to improved diagnosis and awareness or actual increase in disease is difficult to say (CDC, 2015). Regardless, through effective evidence-based prevention strategies have emerged and should be utilized to assist in decreasing incidence and prevalence of LD.

Stages and Classifications of Lyme Disease

LD is a systemic illness that is classified into three different stages. PTLDS and unrecognized are two other ways that LD is classified. Reviewing what the stages and classifications of LD are will help providers have further understanding of the disease (Sanchez, Vannier, Wormser, & Hu, 2016).

Stage 1: Early Localized

The first stage of LD is called early localized disease, but does not occur in everyone or may not be recognized. Often presenting similar to a viral syndrome, early localized LD is characterized by EM and nonspecific symptoms such as fatigue, headache, myalgias, arthralgias, fever, anorexia, neck stiffness, and regional lymphadenopathy (Hu, Steere, & Mitty, 2016). Commonly, symptoms associated with this stage begin to appear within the first 2-14 days after tick detachment. Gastrointestinal and upper respiratory symptoms are rare in LD; if present other diagnoses should be considered (Nichols & Windemuth, 2013).

Stage 2: Early Disseminated

Occurring weeks to months after tick detachment or localized infection, approximately 50% of untreated patients will go on to develop early disseminated LD. Early disseminated LD begins when the spirochete bacteria spreads through lymphatic and hematologic pathways possibly causing multiple EM lesions (see Figure 2) to appear, along with acute neurological and cardiac symptoms (Nichols & Windemuth, 2013). Meningitis, unilateral or bilateral cranial nerve palsies, cranial neuritis, radiculopathy, peripheral neuropathy, and rarely cerebellar ataxia and encephalomyelitis are neurological manifestations of early disseminated LD (Hu et al., 2016). The facial nerve, the nerve associated with Bell's palsy, is the most common cranial nerve to be affected by LD. Cardiac manifestations may include varying degrees of atrioventricular blocks, myopericarditis, and pancarditis (Nichols & Windemuth, 2013). Lyme carditis can be life threatening, but is generally mild and only occurs in approximately 1% patients with LD (CDC, 2015). In addition, ocular manifestations such as keratits, and conjunctivitis can occur (Hu et al., 2016).

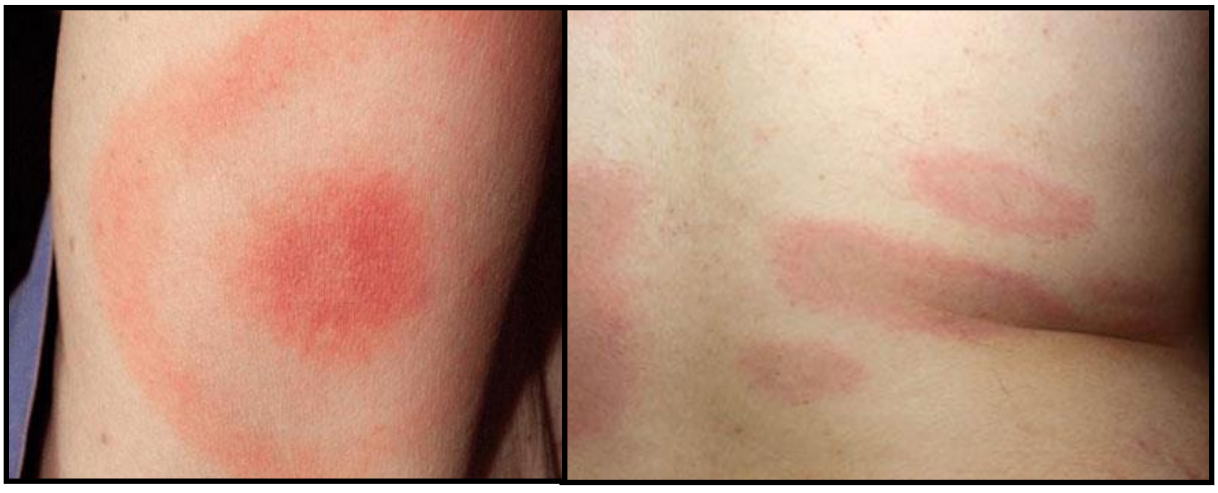


Figure 2. Left: Circular red rash with central clearing that slowly expands (classic LD rash) Right: Early disseminated LD; multiple red lesions with dusky centers (CDC, 2016).

Stage 3: Late Disseminated

Months to years after a *Borrelia burgdorferi* infection, late disseminated LD may occur and is not always preceded by early localized or early disseminated LD (Nichols & Windemuth, 2013). When LD is left untreated, 60% of patients may develop late disseminated LD (Aucott, Rebman, Crowder, & Kortte, 2013). Arthritis in one or a few joints is the most common manifestation in the United States of late LD. Other features that may be present include subtle encephalopathy and polyneuropathy such as peripheral neuropathies and spinal radicular pain (Hu et al., 2016).

Post Treatment Lyme Disease Syndrome

After the recommended antibiotic therapy for LD is completed, up to 17% of patients experience persistent symptoms such as fatigue, myalgias, arthralgias, cognitive difficulties, and headaches (Aucott et al., 2013). Persistent *Borrelia burgdoferi* infection despite standard treatment course is termed chronic LD by some practitioners and advocacy groups, but this term is not accepted by Infectious Disease Society of America (IDSA) or the CDC. The condition is properly termed PTLDS with treatment approaches that differ and are discussed later in the section PTLDS treatment (CDC, 2015). The symptoms of PTLDS can persist for months and usually improve gradually over six months to one year (Hu et al., 2016). The IDSA defines the syndrome as a patient having a "history of LD treated with an accepted regimen and resolutions or stabilization of the objective manifestations of LD. In addition, the onset of subjective symptoms (e.g. fatigue, widespread musculoskeletal pain, complaints of cognitive difficulties) must have occurred within six months of the diagnosis of LD and persist (continuously or relapsing) for at least six months after completion of antimicrobial therapy" (Wormser et al., 2006, p. 1121). Several exclusion criteria exist as well (see Table 1). Long-term or repeat

antibiotic therapy is not recommended or supported by evidence in these patients, as discussed further below.

Table 1

Proposed definition of post-Lyme disease syndrome. Reproduced by UpToDate from Wormser et al., 2006

Inclusion criteria
• An adult or child with a documented episode of early or late Lyme disease fulfilling the case definition of the Centers for Disease Control and Prevention. If based on erythema migrans, the diagnosis must be made and documented by an experienced healthcare practitioner.
• After treatment of the episode of Lyme disease with a generally accepted treatment regimen, there is resolution or stabilization of the objective manifestation(s) of Lyme disease.
• Onset of any of the following subjective symptoms within 6 months of the diagnosis of Lyme disease and persistence of continuous or relapsing symptoms for at least a 6-month period after completion of antibiotic therapy:
- Fatigue
- Widespread musculoskeletal pain
- Complaints of cognitive difficulties
• Subjective symptoms are of such severity that, when present, they result in substantial reduction in previous levels of occupational, educational, social, or personal activities.
Exclusion criteria
• An active, untreated, well-documented coinfection, such as babesiosis.
• The presence of objective abnormalities on physical examination or on neuropsychologic testing that may explain the patient's complaints. For example, a patient with antibiotic refractory Lyme arthritis would be excluded. A patient with late neuroborreliosis associated with encephalopathy, who has recurrent or refractory objective cognitive dysfunction, would be excluded.
• A diagnosis of fibromyalgia or chronic fatigue syndrome before the onset of Lyme disease.
• A prolonged history of undiagnosed or unexplained somatic complaints, such as musculoskeletal pains or fatigue, before the onset of Lyme disease.
• A diagnosis of an underlying disease or condition that might explain the patient's symptoms (eg, morbid obesity, with a body mass index [calculated as weight in kilograms divided by the square of height in meters] ≥45; sleep apnea and narcolepsy; side effects of medications; autoimmune diseases; uncontrolled cardiopulmonary or endocrine disorders; malignant conditions within 2 years, except for uncomplicated skin cancer; known current liver disease; any past or current diagnosis of a major depressive disorder with psychotic or melancholic features; bipolar affective disorders; schizophrenia of any subtype; delusional disorders of any subtype; dementias of any subtype; anorexia nervosa or bulimia nervosa; and active drug abuse or alcoholism at present or within 2 years).
• Laboratory or imaging abnormalities that might suggest an undiagnosed process distinct from post-Lyme disease syndrome, such as a highly elevated erythrocyte sedimentation rate (>50 mm/hour); abnormal thyroid function; a hematologic abnormality; abnormal levels of serum albumin, total protein, globulin, calcium, phosphorus, glucose, urea nitrogen, electrolytes, or creatinine; significant abnormalities on urine analysis; elevated liver enzyme levels; or a test result suggestive of the presence of a collagen vascular disease.
• Although testing by either culture or PCR for evidence of *Borrelia burgdorferi* infection is not required, should such testing be done by reliable methods, a positive result would be an exclusion.

(Wormser, et al., 2006)

Unrecognized/Untreated Lyme Disease and Reinfection

Unrecognized, untreated or recurring LD are other terms that are used to classify LD. Unrecognized LD is when the condition is not diagnosed as LD or the patient does not recognize or seek medical attention due to vague symptoms (Aucott & Seifter, 2011). Due to the difficulty of accurately diagnosing LD, a patient may not be treated or treated inappropriately for another possible condition, this is termed as untreated LD. The risks that are associated with unrecognized or untreated LD are advancement of disease with more serious symptoms and the response to treatment is often slower (Hu et al., 2016).

Lastly, recurring LD transpires when a patient has been successfully treated for LD and in the future becomes reinfected. Currently criteria for diagnosis of reinfection has not been established and is commonly diagnosed as PTLDS (Hu et al., 2016). After appropriate antibiotic therapy, patients with later stages have been relatively more resistant than earlier stages of LD to reinfection due to a broad antibody response (Hu et al., 2016).

Contributing Factors Associated with Lyme Disease

There are several risk factors that have been associated with the risk of contracting LD. A main recognized risk factor for LD is geographical location. In addition, social risk factors such as inadequate use of prevention strategies and a lack of patient, provider and community awareness/education may escalate the risk for LD (CDC, 2015).

Patient, Healthcare Provider, and Community Education

Although providing education to community members is important, educating healthcare providers creates opportunities for improved prevention, recognition, diagnosis, and treatment of LD. A 2014 survey conducted on healthcare providers in the United States reported over 30% of practitioners did not feel knowledgeable about tick-borne diseases and a large part of this

percentage were nurse practitioners and obstetricians/gynecologists (Brett et al., 2014). In 2013, a questionnaire focused on LD was conducted in Arkansas on 660 healthcare providers (Hill, 2013). The results revealed that correct responses were 59.1% for recognition of symptoms, 46.2% for related testing processes, and 78.9% for knowing that LD is a reportable disease (Hill, 2013). In addition, a study conducted on British Columbia family practitioners found that approximately 26% knew that EM is diagnostic for LD (Henry, Crabtree, Roth, Blackman, & Morshed, 2012). The data supports that additional education is needed in regards to LD in primary care.

One study assessed how knowledge and prevention of tick-borne diseases vary in urban areas compared to rural areas (Bayles, Evans, & Allan, 2012). Over 57% of individuals within the study reported not being concerned about contracting LD at all. Lower percentages correlated with more rural populations. Additionally, over 75% of the participants reported not wearing long sleeves or pants to prevent tick bites, but approximately 31% used insect repellant in suburban areas and 65% in rural areas (Bayles et al., 2012). These results infer that improvements in patient and community education are needed to help prevent LD.

Geographical Location

Individuals are at higher risk for contracting LD when living in known endemic areas. The tick-borne disease has been found in Europe, Asia, and North America, but is most commonly found in New England, mid-Atlantic and upper-north central states, and northwestern California. In 2014, 96 % of confirmed cases in the United States occurred in 14 states including Connecticut, Delaware, Maine, Maryland, Massachusetts, Minnesota, New Jersey, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and Wisconsin (CDC,

2015). Figure 3 and 4 illustrate the endemic areas and increasing number of reported cases over the past 13 years in association to LD (CDC, 2015).

Figure 3. Reported cases of LD in the United States, 2001. One dot illustrates each reported case of LD within the county of residence (CDC, 2015).

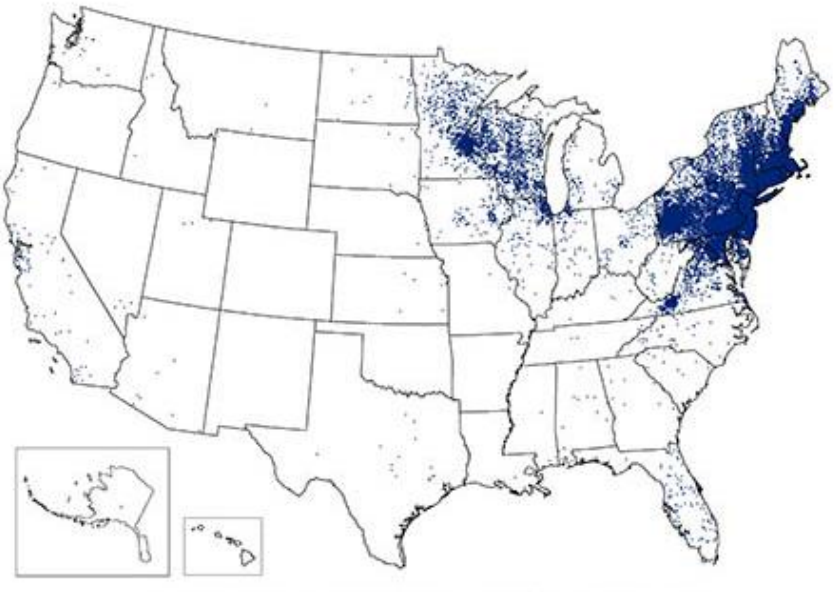


Figure 4. Reported cases of LD in the United States, 2015. One dot illustrates each reported case of LD within the county of residence (CDC, 2015).

Prevention Strategies

Prevention is an essential component of primary care and key in providing quality care to patients at risk for contracting LD. Successful education of providers about LD prevention strategies may lead to a decrease in incidence and complications related to LD. Preventative clothing, use of tick repellents, awareness of high risk areas and activities, checking for ticks promptly, and proper removal of attached ticks have all been shown effective in reducing the risk of LD (Vaughn & Meshnick, 2011). Additionally, vaccinations are an essential component of prevention in healthcare, so the past, present, and future of LD vaccinations will be explored. The approaches above will be within the continuing education module to expand healthcare providers' prevention education abilities (Gutierrez & Decker, 2012).

Proper Clothing

Coverage of skin helps provide protection from ticks by offering less skin for attachment and allowing more time for individuals to find and remove ticks before attachment. Since the most common tick attachment sites are the legs and torso, taking the extra measure to cover these areas is essential to the primary prevention of LD (Gutierrez & Decker, 2012). Examples of protective clothing include, long sleeve shirts, pants, long socks, and close toed shoes. Additionally, when in wooded areas or highly endemic areas tucking pant legs into socks can help further hinder ticks from attaching to individuals (Eisen, Piesman, Zielinski-Gutierrez, & Eisen, 2012).

Tick Repellents

DEET containing repellents are the most commonly promoted and effective repellents that deters the Ixodes scapularis tick, which are carriers of LD (Eisen et al., 2012). Although promising for LD, repellents are only regularly used by 20-40% of individuals in prevalent areas

while 40% of the United States public believing the repellents could make the user ill (Eisen et al., 2012). Even though adverse health effects have been reported with the use of DEET such as mild to moderate skin irritation in users, the amount of cases is small in relation to the number of people who use DEET (Cisak, Wojcik-Fatla, Zajac, & Dutkiewicz, 2012). DEET alternatives that are recommended by the CDC and approved by the Environmental Protection Agency are picaridin in products like Cutter Advanced, oil of lemon eucalyptus in Repel and Off!, and IR2535 found in Skin So Soft Bug Guard Plus Expedition (CDC, 2015).

Another effective option for tick repellent is permethrin, used primarily to treat or impregnate clothing and other materials (nets, tents etc.) to repel ticks. A study found that outdoor workers that wore permethrin-treated clothing had 93% fewer tick bites when compared with other coworkers (Vaughn & Meshnick, 2011). Additionally, treating just shoes and socks with permethrin was shown to reduce the likelihood of a tick bite by 73.6 times in comparison to untreated shoes and socks (Cisak et al., 2012). Generally, permethrin use is considered to be more repellent than DEET, but due to the need to re-impregnate clothing after a couple washes some individuals find permethrin cumbersome or prefer alternative repellent methods (Cisak et al., 2012).

High Risk Areas and Activities

As discussed previously, within the United States 14 states account for nearly 96% of confirmed cases (CDC, 2015). Although living in endemic areas puts residents at higher risk for contracting LD, providers should not exclude individuals from diagnosis of Lyme based solely on location. With today's ease and frequency of travel, along with unconfirmed cases of LD, many individuals are placed at risk for contracting the disease. General areas that ticks

commonly attach to hosts are wooded areas, near brush or grassy areas, wood piles, logs, and leaf litter (Gutierrez & Decker, 2012).

Identifying activities that put individuals at risk such as camping, gardening, yard work, having outdoor jobs, hunting, fishing, horse riding, and outdoor exercises (running, walking etc.), is crucial in preventing LD (Wood & Lafferty, 2013). In addition, feeding animals (bears, birds, deer etc.), mice infestations, owning cats/dogs, and having woodpiles on a property can increase the likelihood of contracting LD (Brett et al., 2014).

Proper Tick Removal

The CDC recommends that individuals should promptly check for ticks after coming indoors, preferably within two hours (2015). Conducting a full body assessment using a mirror, making sure to check for ticks under arms, in and around ears, inside belly button, behind knees, between legs, and in hair. Showering as soon as possible helps prevent tick attachment as well. Additionally, examining outdoor gear and pets for hidden ticks is important since ticks can transfer to the human and transmit the *Borrelia burgdorferi* spirochete at a later time.

Proper removal of a tick includes using a fine tipped tweezers to grasp the tick as near to the skin as possible, pulling steadily upwards with even pressure, then washing the bite area with rubbing alcohol, an iodine scrub, or soap and water. Do not jerk or twist the tick during removal because mouth parts may break off in the skin (CDC, 2015). If this happens, remove them with the tweezers if possible; if not leave them and let the skin heal. Live tick disposal should be done by placing in a sealed bag or container, flushing the tick down the toilet, wrapping the tick in tape tightly, or by placing the tick in alcohol, and never by crushing the tick with fingers (CDC, 2015).

Few tick removal methods have scientific support in literature on whether or not the technique impacts infection rates. Some methods of tick removal that are not recommended include application of heat to the tick with a match or hot nail; covering the tick with substances (petroleum jelly, perfume, paint, nail polish, alcohol, gasoline, lidocaine etc.); using a jerking or twisting motion to remove tick; crushing, squeezing or puncturing the body of the tick; or handling the tick with bare hands (Marchese & Primer, 2013). The previously mentioned removal methods can cause the tick to burrow deeper into the tissue or salivate and regurgitate into the site of attachment, possibly increasing the infection risk. The overall goal is to remove the tick as quickly as possible and not wait for the tick to detach (CDC, 2015).

Vaccination

Vaccinations are a key healthcare strategy to prevent and eradicated diseases and illnesses. Although there is not a vaccine available for LD currently, a vaccine was developed in the past. The LYMErix vaccine, developed in the early 1990s, was licensed by the United States Food and Drug Administration for the prevention of LD in 1998 (Shen, Mead, & Beard, 2011). The vaccine was indicated for people 15-70 years of age who resided, worked, or participated in recreational activities in high or moderate risk areas only (CDC, 2015). The vaccine was a three-dose series with booster doses at 1 and 12 months after the original vaccination (Shen et al., 2011).

Results of the phase III trial for the vaccine concluded an efficacy of 76% in preventing laboratory-confirmed LD and 100% efficacy in persons who completed the three-dose series in the prevention of asymptomatic infection (Shen et al., 2011). Overall, the safety of the vaccine was similar to other vaccines. Of the reports of adverse events, 7.4% were classified as serious, in comparison to an average of 15% in Vaccine Adverse Event Reporting System (VAERS)

reports for all vaccines annually (Beard, et al., 2015). A few of the main adverse effects were flu-like symptoms, fever, headache, rash, arthralgia, and myalgia. In 2002, the LYMErix vaccine was discontinued voluntarily by the producing pharmaceutical company due to poor sales and negative publicity in regards to unconfirmed adverse events, predominately arthritis (CDC, 2015).

Currently there are no vaccines offered to prevent LD in humans, but clinical trials are being conducted. LymeVax is an example of an available vaccine for the prevention of LD in canines. One double blind, randomized trial funded by Baxter showed results that a vaccine for LD was immunogenic, safe, and had predominately mild adverse events (Wressnigg et al., 2013). The vaccine consists of three doses and a booster with each dose given 28 days apart and the booster given at 9-12 months. Although the trial shows promise additional studies need to be conducted on a large scale before the release of a new vaccine for LD can be considered (Wressnigg et al., 2013).

Diagnosis

Diagnosing LD is a problematic task since available testing can be unreliable and nonspecific in early disease. In addition, the signs and symptoms of LD can be nonspecific, widely vary between patients, and mimic a multitude of other diseases. A multifaceted approach should be taken in LD diagnosis, including patient history, associated signs and symptoms, and diagnostic labs and procedures.

Patient History

Collecting an accurate and detailed history of patients with possible LD exposure can help identify the likelihood of disease contraction. Important information to obtain includes exposure to an endemic area, tick attachment and duration, and presence of rash or other

symptoms. Since LD is highly associated with certain locations, identifying recent travel, patients living in an endemic area, and exposure to wooded areas is essential (Brett et al., 2014). In a majority of cases, the deer tick has to be attached for at least 24 hours, more commonly 36-48 hours, in order for the spirochete to be transmitted (Marchese & Primer, 2013).

Associated Signs and Symptoms

A diverse collection of signs and symptoms can be present in individuals with LD, making each patient presentation unique. Skin rashes, flu-like symptoms, arthritis, cardiac complications, and neurological manifestations, just to name a few, may all appear in an individual with LD (Eisen et al., 2012). Due to the diversity of symptoms LD can often be misdiagnosed as another disease, illness, or disorder, making provider education on disease presentation essential.

Erythema migrans.

One of the most well-known signs of LD is a red rash that looks like a bull's eye target called EM, which is considered a diagnostic sign (Moore, 2015). EM may be warm to the touch, but is seldom painful or pruritic (Marchese & Primer, 2013). Often EM rashes are discovered in or by the axilla, inguinal region, the belt line, or popliteal fossa. The rash typically develops slowly over 7-14 days over the area of the original tick bite, but may appear in other places as well in as few as 3 days or as long as 1 month after tick contact (Moore, 2015). According to the CDC, the EM needs to be at least five centimeters or two inches in diameter to be associated with LD (2015). The average size of an EM rash is 15 cm, while some are as large as 30 cm.

Although EM is a hallmark sign for LD, the rash occurs in fewer than 50% of individuals with the illness (Cameron et al., 2014). The typical presentation associated with LD is the Bullseye rash (see Figure 2 and 5), but the EM rash can appear in many ways including a bluish

red lesion, a uniformly red, or with no central clearing lesion (Hu et al., 2016). Additionally, the EM rash can have a blistering look surrounded by erythema, while other individuals present with disseminated lesions that can be numerously scattered over the body and erythematous (see Figure 5).

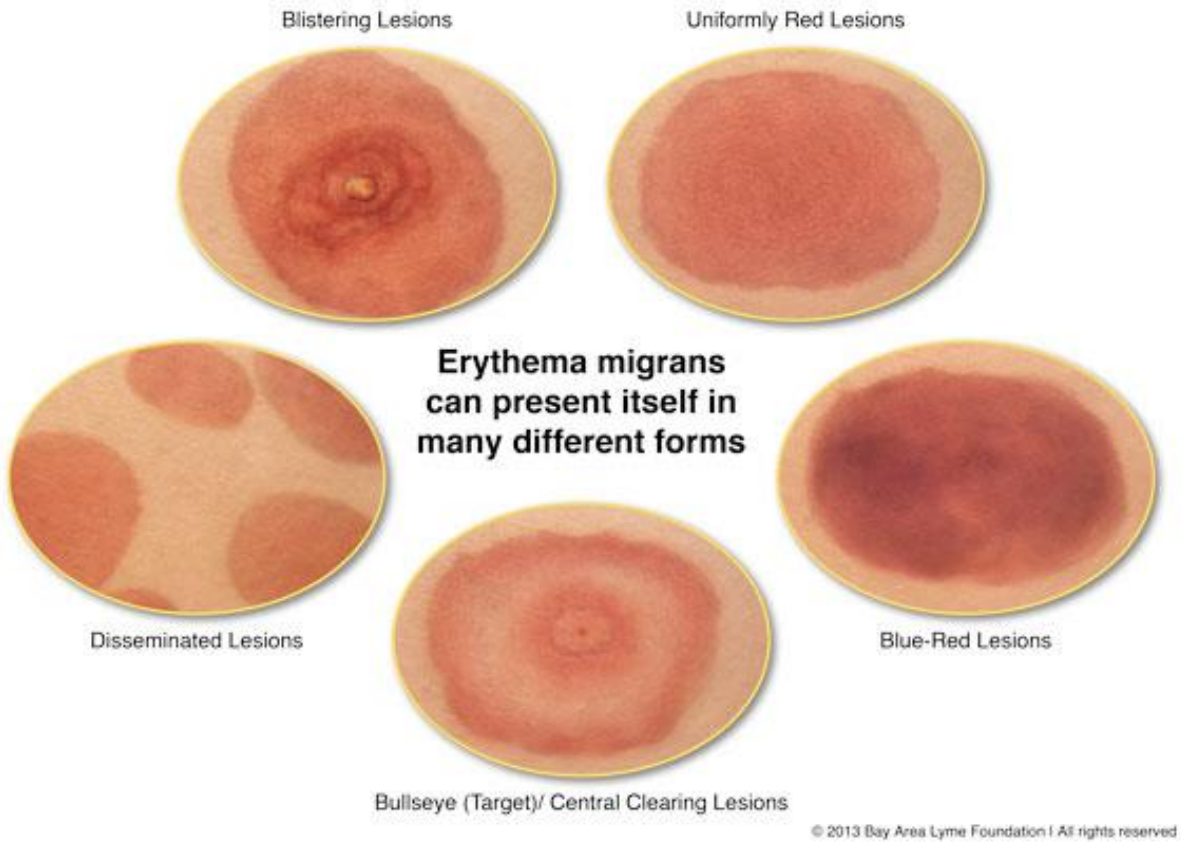


Figure 5. Erythema migrans rash types (Eng, 2013). Copyrighted by Bay Area Lyme Foundation.

Flu-like symptoms.

A common complaint among those with LD in the early stages are "flu-like symptoms". Many of these symptoms include fever, chills, fatigue, generalized body aches, malaise, anorexia, and head and neck pain (Aucott & Seifter, 2011). One way to help distinguish whether an individual has the flu or LD, is when the flu-like symptoms appear during off season times

and last longer than normal. The peak of LD cases occurs in May through September with the highest incidence during June and July, making LD the more likely culprit of the symptoms than the flu (Marchese & Primer, 2013).

Diagnostic Procedures

Two-tiered testing for LD is recommended by the CDC and IDSA (see Figure 5). The first step of the testing includes the enzyme immunoassay (EIA) or rarely, the indirect immunofluorescence assay (IFA). Two examples of EIA tests include enzyme-linked immunosorbent assay (ELISA) and enzyme-linked fluorescent immunoassay (ELFA). An alternative diagnosis should be considered if negative EIA/IFA testing occurs, unless the patient has been having symptoms less than 30 days. In this case, appropriate treatment should be given and followed up with first tiered testing. If the first test yields positive or equivocal results, two options are available: 1) if the patient has had symptoms for less than or equal to 30 days, an IgM Western Blot is performed; or 2) if the patient has had symptoms for more than 30 days, the IgG Western Blot is performed. To explain further the IgM antibodies are made sooner, so testing for them is only meaningful during the first 4 weeks of illness. The downside of testing for IgM antibodies is that they are more likely to give false positive results. Tests for IgG antibodies are more reliable, but may take 4-6 weeks for the body to produce in large enough quantities for the test to detect them. If the patient has been ill for longer than 4-6 weeks and the IgG immunoblot test is negative, a diagnosis of LD is unlikely, even if the IgM immunoblot is positive (CDC, 2015).

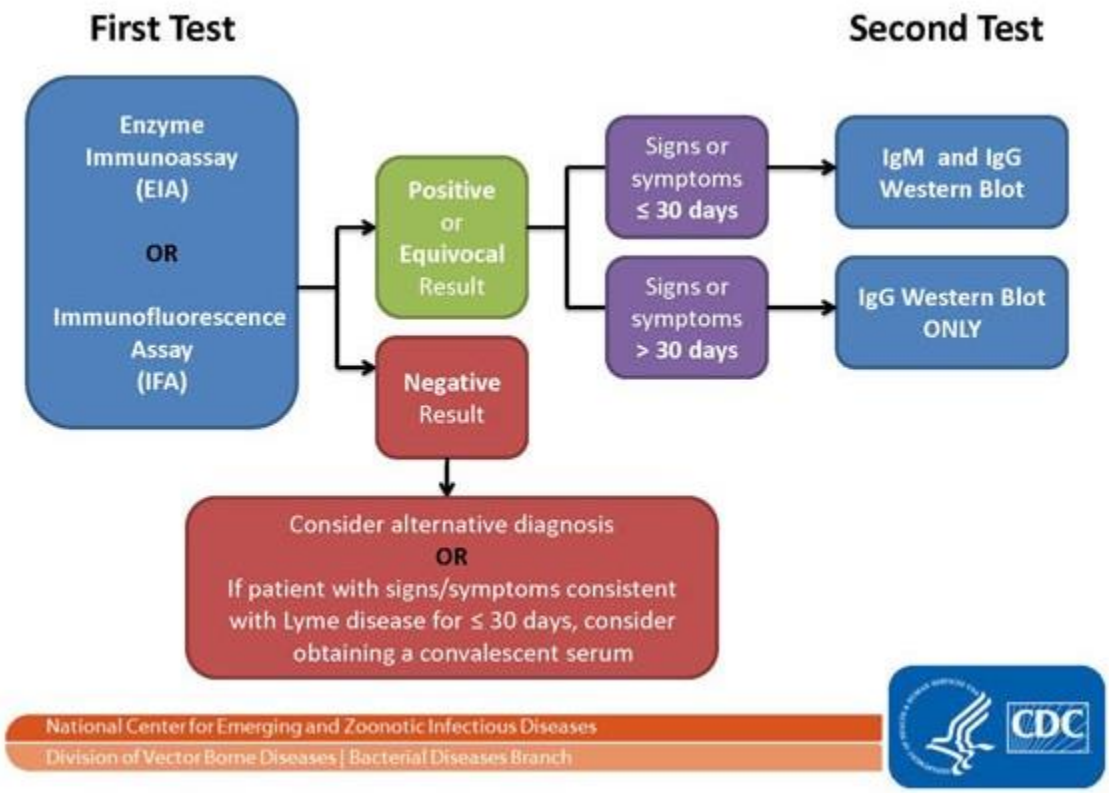


Figure 6. Two-tiered testing for Lyme disease (CDC, 2016).

The accuracy of these tests is strongly correlated with the stage of disease. When used too early after a suspected infectious tick bite the EIA have been shown to have a sensitivity of 65% or less (CDC, 2015). Approximate specificity for the ELISA and western blot is 99% (Wormser et al., 2013). When using the two-tier testing approach within the first few weeks of the expected infection, the test often renders negative results. The CDC reports the sensitivity of the testing to increase significantly several weeks after infection (2015). Often antibodies are not produced for up to eight weeks, which will ultimately lead to a false negative result. Many other testing approaches have been introduced and studied, but are not widely accepted to diagnose LD (Moore, 2015). A few examples of tests that are not validated include lymphocyte transformation tests, quantitative CD57 lymphocyte assay and culture with immunofluorescence staining (CDC, 2015).

Treatment of Lyme Disease

Lyme is a unique systemic disease that presents with a multitude of symptoms and a large portion of treatment is based on the symptoms that present on a case to case basis. In general, oral antibiotics and/or intravenous antibiotics are started if the individual renders a positive test, and/or clinical signs or symptoms are present. In early localized or disseminated LD, the IDSA recommends 100 mg doxycycline twice daily for 10-21 days. Alternative treatment includes a 14-21-day course with 500 mg amoxicillin three times daily or 500 mg cefuroxime axetil twice daily for treatment of LD (Wormser et al., 2006).

Prophylactic Treatment

Although the best available method for prevention of LD is avoiding exposure to vector ticks, the ISDA does offer a prophylactic treatment when certain criteria is met. The following criteria must be met for prophylaxis: "(a) the attached tick can be reliably identified as an adult or nymphal I. scapularis tick that is estimated to have been attached for >36 hours on the basis of the degree of engorgement of the tick with blood or of certainty about the time of exposure to the tick; (b) prophylaxis can be started within 72 hours of the time that the tick was removed; (c) ecologic information indicates that the local rate of infection of these ticks with B.burgdorferi is >20%; and (d) doxycycline treatment is not contraindicated" (Wormser et al., 2006, p. 1090). Areas that generally have >20% ticks infected with *Borrelia burgdoferi* occurs in parts of Minnesota, Wisconsin, and the mid-Atlantic states (Wormser et al., 2006). The 72-hour time limit is recommended because data on the efficacy of chemoprophylaxis for tick bites following tick removal is absent after longer time intervals (Wormser et al., 2006).

A single 200 mg dose of doxycycline is given for prophylactic treatment of LD once the above criteria have been met (Wormser et al., 2006). Relative contraindications for doxycycline

include pregnant women due to possible fetal harm and children <8 years of age because of tooth discoloration (Epocrates, 2016). All patients that have removed attached ticks including those treated with prophylaxis should be observed for signs and symptoms of tick-borne illness for 30 days (Wormser et al., 2006).

Post Treatment Lyme Disease Syndrome Treatment

Depending on the healthcare provider, management can vary greatly due to the controversies involved with certain LD treatments. A randomized trial conducted by Berende et al. (2016) revealed that the use of long-term antibiotics does not result in additional quality of life benefits to patients in comparison to short-term treatment. Several other studies have been conducted to address the use of long-term antibiotics, and the studies all revealed similar results; there were no added benefit in long-term antibiotics in comparison to placebos (Fallon et al., 2008; Kaplan et al., 2003; Klempner et al., 2001; Krupp et al., 2003). Additionally, long-term antibiotics can lead to serious complications such as infection, thrombus, and death (Patel et al., 2000). Not only could prolonged antibiotic therpay impact antimicrobial resistance within communities, but one case report revealed a life-threatening hemolytic anemia and an acute kideny injury in a woman treated for so-called chronic LD (De Wilde, Speeckaert, Callens, & Van Biesen, 2016). Pronlonged antibiotic therapy is not reccommended, and it is unknown what treatments may be truly beneficial in PTLDS (CDC, 2016). The mainstream infectious disease recommendations for PTLDS is to complete thorough assessment for alternative diagnoses such as pain (fibromyalgia) or sleep (chronic fatigue) disorders and treat accordingly (Melia & Auwaerter, 2016).

Theoretical Framework

Throughout the development, implementation, and evaluation processes, the practice improvement project was guided by the Adult Learning Theory and the Model for Evidenced Based Practice Change. The models were chosen in relation to their applicability and ease of use in relation to the entirety of the project.

Adult Learning Theory

Malcolm Knowles' theoretical framework of adult learning was utilized in the development and application of the LD educational module. The model was introduced in 1973 and is also known as andragogy "the art and science of helping adult learners" (Keesee, 2011, p. 1). Additionally, Knowles acknowledges the significant differences that are present between an adult and child learner (McGrath, 2009). Due to the target population of the educational module being adult healthcare providers, the adult learning theory was applicable and was utilized to meet the unique needs of this population.

The theory of androgogy consists of five assumptions that was applied to the educational LD module to provide a beneficial learning experience for the participating providers. The first assumption is that in comparison to children who are dependent learners, adults are autonomous and independent learners (Cerone, 2008). Because adults are self-sufficient, they should be actively involved in the learning process and be able to guide the direction of their learning. The assumption was utilized by allowing participants to learn independently about LD on the AANP CEC at a convenient time, pace, and place. Once a participant registered for the course they could complete the module all at once or in several sittings. The module was made available 24/7 and could be accessed through logging in as a guest or with an AANP member account and then completed on any supported electronic devices.

Knowles' second assumption is that adults come with prior life experiences and knowledge that can be used as a learning resource (Keesee, 2011). Instruction of the educational module tied into the learners past experiences to help tailor to the adult learners needs (Cercone, 2008). One way the participants' experiences were incorporated was by the use of problem-based learning where participants could use and build upon the knowledge they already possess to increase their knowledge base further of LD.

Learning readiness, which is associated with social roles (jobs, personal lives), is the third assumption (Keesee, 2011). The module was developed with relevant and useful information to benefit the participants in having a successful learning experience. Adult learners have to recognize a purpose for learning new information, as well as connecting the information with their daily lives (Cercone, 2008). One way the assumption was incorporated into the educational module for LD was by displaying objectives at the beginning and providing content that was useful in their current practice as a healthcare provider.

The fourth assumption of the theory of andragogy is that adults are problem-centered and need to use the new information immediately (Keesee, 2011). With maturation, a change in time perspective occurs, from learning information for the future to immediate use of information. The educational module used this assumption by making the information on LD applicable and relevant to healthcare providers in their daily work activities. The information provided within the module included prevention strategies, diagnostics approaches, and treatment options.

The last assumption is that as people mature they become motivated by internal rather than external factors (Keesee, 2011). Internal motivation examples may include increased self-esteem, job satisfaction, accomplishment, and enhanced quality of life. The learning environment should be safe and comfortable to enhance adult learning (Cercone, 2008). The online availability provided

the participants not only with the flexibility to complete the module as they wished, but also includes the option to learn in an environment that best fits the individual learner.

The Model for Evidenced Based Practice Change

The Model for Evidence-Based Practice Change is a revision of the model by Mary Rosswurm and June Larrabee (Melnyk & Fineout-Overholt, 2011). The evidence based practice model contains six steps that was utilized in the development and application of the online educational modules for LD.

Step one was to assess the need for change in practice, which included identifying the problem and collecting data on current practice (Melnyk & Fineout-Overholt, 2011). Through an extensive review of literature that continued through the development of the project, assessment of the need for practice change in relation to LD was completed. A majority of the literature reviewed consisted of scholarly articles, research articles, and guidelines to help guide in the prevention, diagnosis, and treatment of LD. Additionally, a number of credible resources supported the need of further education in primary care for the prevention and management of LD. As described earlier, less than 70% of U.S. healthcare providers felt comfortable with the management of tick-borne disease (Brett et al., 2014). According to Eisen et al. (2012), individuals in endemic areas use protective measures more often than those in non-endemic areas, but even in endemic areas the majority of people use no measures.

The second and third steps go together; they are locating the best evidence and critically analyzing the evidence (Melnyk & Fineout-Overholt, 2011). To develop a successful online educational module, multiple research articles, guidelines, and other sources were reviewed and critically appraised for reliability. Several articles were reviewed to provide the highest quality evidence possible within the educational module. A variety of scholarly articles have all supported

the use of preventive measures such as tick repellants, protective clothing, and timely tick removal as being effective in reducing the risk of contracting LD (Gutierrez & Decker, 2012). Use of information on prevention was incorporated throughout the educational module through displays in charts, videos, and informational slides. Images, informational slides, and case studies were also utilized to assist providers in gaining further knowledge on LD diagnosis. Additionally, treatment recommendations from the IDSA were presented with a chart and application of treatment was completed through case studies within the module and pre/posttests (Wormser, et al., 2006).

The fourth step in the Model for Evidence-Based Practice Change is designing the practice change (Melnyk & Fineout-Overholt, 2011). The design of the online module was to educate healthcare providers to promote change in their practice when providing care to individuals with or at risk for LD. Additionally, the fourth step includes designing an evaluation procedure. Demographic information including type of provider, specialty, geographic location, practice length, gender, and race were collected from participants prior to the module being started (see APPENDIX H). Healthcare providers who participate in the module were also evaluated through a pre and posttest with 2-3 questions corresponding to each project objective (see APPENDIX I). Additionally, an evaluation survey was available for healthcare providers to make suggestions and leave comments in regards to the online module after their completion.

Implementing and evaluating practice changes are included in the fifth step. As discussed above the evaluation was done through pretests and posttests (Melnyk & Fineout-Overholt, 2011). The tests were made available before and after the completion of the module by the AANP CEC. The final step was integrating and maintaining change in practice. The module was made available for 1.0 contact hours of continuing education credits in the initial implementation by the AANP CEC. In addition, the module has been made available for the learning benefit of future healthcare

providers until December 31, 2018. If continued after this date, the educational module would have to be updated to supply practitioners with the most current information.

CHAPTER III: PROJECT DESCRIPTION

Project Implementation

Through an extensive review of literature, the LD educational module was created. From the data of many research studies, the necessity to develop educational interventions on the prevention, diagnosis, and treatment of LD to reduce long term complications became apparent (Marchese & Primer, 2013). While healthcare providers play a key role in the prevention and care of patients with LD, a significant amount of healthcare providers have not been properly equipped or comfortable to diagnose and treat early LD effectively (Brett et al., 2014).

Project Description

The target audience of the continuing education module were healthcare providers who deliver care to individuals at risk for LD. The educational module was approximately 1 hour and provided participants with 1.0 contact hours of continuing education credits through AANP CEC (see APPENDIX J). The modules design consisted of a power point presentation with pictures, case studies, graphs, videos, and written text that support the advancement of provider's knowledge on LD. The educational module incorporates information on the prevention, diagnostic strategies, and treatment options for early LD. Not only were contributing factors discussed such as endemic areas, behavioral risks, and varying symptom presentations, but common barriers to proper treatment of LD as well.

A recorded voice-over lecture was included in the continuing education module to explain certain aspects of the content further. One video clip was incorporated into the module to demonstrate how to properly remove a tick to decrease risk of infection. Additionally, several figures were used to demonstrate tick engorgement sizes in relation to length of attachment, EM rashes, two-tiered testing, and endemic areas of LD. Knowles' theory of andragogy guided the

development of the online continuing education module through incorporating multiple teaching strategies to address the various learning styles of the adult participants. Also utilized in the creation was the Model for Evidenced Based Practice Change, which assisted from the process of development to implementation of the continuing education module on AANP CEC.

Project Development

The first step of developing the online continuing education module was an extensive literature review to provide the most up to date and evidenced based information to participants on LD. Subsequently, permission from several entities was obtained for use of figures, a video, and informational charts (see APPENDICIES C, D, and E). Once the PowerPoint and script were finalized the educational module was recorded with assistance from the North Dakota State University's (NDSU) Information Technology Services. Prior to recording, discussions were held regarding available recording appointment times, equipment, and PowerPoint/video file options. At this time coordination with AANP CEC on preferred formatting was completed as well. Next the demographic survey, pretest, posttest and evaluation survey were created to complement the continuing education module on LD in accordance to the project's learning objectives. A handout with the PowerPoint slides and a comprehensive reference list was made to promote participating healthcare providers in independent research and reading in accordance to their interests and learning needs, which is an assumption of Knowles' theory of andragogy.

Project Dissemination

The submission of the educational module was done through the AANP CEC on November 3, 2016 and the content was approved on November 8, 2016 (see APPENDIX A). Revisions were requested to be made in regards to the addition of copyright information for images and the video. After the copyright revisions were made, no other revisions were required.

On December 21, 2016, the continuing educational module went live, and was available to all AANP members. Non-members could also gain access as a guest to the continuing education module at no cost, after an account was created with AANP and contact information was provided. The continuing education module was made available for healthcare providers learning benefit until December 31, 2018.

In addition, to share the information more widely and spread LD awareness, email invitations were sent to healthcare providers in the region as well as nurse practitioner students enrolled in North Dakota schools about the availability and purpose of the continuing education module (see APPENDIX G). Furthermore, a poster abstract was presented at NDSU's College of Health Professions annual poster presentations on March 7th. The presentation allowed for free learning that was convenient, independent, and applicable to practice for healthcare providers helps meet the needs of the target population of adult learners (Cercone, 2008).

Institutional Review Board Approval

The LD practice improvement project was submitted for approval by the NDSU Institutional Review Board. The educational module did not involve direct patient contact, posing minimal risk to the participants throughout the entirety of the project. The correlating evaluation data from the pretest, posttest, and demographics, as described further below, was kept anonymous and confidential (see APPENDIX B).

Data Collection

Data from the pretest, posttest, and demographic information were collected. Prior to the start of the educational module, providers completed a demographic survey (see APPENDIX H). Healthcare providers who participated in the continuing educational module also completed pretest questions prior to beginning the module. Healthcare providers took part in the posttest

after successful completion of the module (see APPENDIX I). Participants' knowledge was tested through the use of an 18 question multiple choice test on content including risk factors, prevention, diagnosis, and treatment of LD. Additionally, an evaluation section for feedback and opinions on the effectiveness of the continuing education module was available to assist in future improvement of related teaching (see APPENDIX K).

Not only did the AANP CEC host the continuing education module, but they were also accountable for the data collection as well. Data were compiled into a report by the AANP CEC and shared with the co-investigator at approximately 2 weeks and 10 weeks. The initial evaluation summary report was received on January 3, 2017 contained data from December 21, 2016 to December 31, 2016. On March 1, 2017, the second report was provided including evaluation data from January 1, 2017 to February 28, 2017.

CHAPTER IV: EVALUATION

Evaluation Methods

The evaluation process of the continuing education module was measured through pretest and posttest questions that assisted in identifying the participants' level of knowledge and awareness in regards to LD prevention, diagnosis, and treatment. Eighteen questions were developed in accordance with the learning objectives in the pretest and posttest to compare the level of understanding before the educational intervention and after the intervention (see APPENDIX I). On December 21, 2016, the educational module was made available online at the AANP CEC where participants also completed the pretest and posttest evaluations. The questions within the pretest and posttest were created in accordance to the learning objectives of the continuing education module.

Within the time constraints of the project the short-term outcome of healthcare providers and students gaining knowledge about LD prevention, diagnosis, and treatment was achieved. The design of the project does not allow for the evaluation of the medium and long term outcomes, but healthcare providers incorporating gained knowledge into practice to reduce LD incidence and complications is the intended goal (see Figure 7). The co-investigator fully intends on addressing the medium and long term goals after the closure of the module in December of 2018 by continuing evaluation of pretest and posttest scores and evaluation surveys. At the closure of the continuing education module the co-investigator may provide any updated information that was collected on LD and reframe evaluation questions to measure medium and long term outcomes more thoroughly.

INPUTS	OUTPUTS		OUTCOMES		
	Activities	Participation	Short Term	Medium Term	Long Term
People: -Doctor of Nursing Practice students -Committee chair -Committee members -AANP contact Resource materials Planning process (meetings, research)	Online Educational Module: -Case studies -Videos -Graphs -Images Poster presentation at the pharmacology conference	Healthcare Providers: -Medical Doctors -Nurse Practitioners -Physician Assistants Nurse Practitioner students	Healthcare providers and students will gain awareness and knowledge about LD prevention, diagnosis, and treatment.	Incorporate gained knowledge into practice to benefit patients at risk or diagnosed with LD including: -prevention strategies -diagnostic labs and procedures -clinical diagnosis -treatment for early LD	Continuance of application of gained knowledge into practice. Decrease disease incidence and long term complications of LD in patients.

Situation	**Priorities**
• Problem: ○ Most common vector-borne disease in the United States (estimates of 300,000 cases per year). ○ Lack of provider knowledge in prevention, diagnosis, and treatment strategies can lead to long term complications. ○ Recommended two-tier testing (ELISA/Western Blot) has a 99% specificity and 65% sensitivity when used to early. • Target Population ○ Healthcare providers ○ Nurse practitioners, physician assistants, and medical students Location: American Association of Nurse Practitioners (AANP) Continuing Education Center	• Provide Education on: ○ Prevention strategies ○ Diagnostic testing and clinical diagnosis ○ Treatment for early LD

Figure 7. Lyme Disease educational module logic model.

CHAPTER V: RESULTS

Presentation of Findings

The AANP CEC compiled data from the continuing education module into reports and shared with the co-investigator at approximately 2 weeks and 10 weeks. The initial evaluation summary report was received on January 3, 2017 that contained data from December 21, 2016 to December 31, 2016. On March 1, 2017, the second report was provided including evaluation data from January 1, 2017 to February 28, 2017. The data received were then combined by the co-investigator to provide comprehensive results from December 21, 2016 through February 28, 2017. The raw data were provided by the AANP CEC and interpreted by the co-investigator.

Approximately 10 days of data were included within the first data report with a total of 42 participants who completed the pretest, continuing education module, posttest, and evaluation questions. The second data report was comprised of 263 participants who completed the entirety of the module, with slightly over 8 weeks of data collection. A total of 305 participants completed the entire program to receive the continuing education certificate.

The program's completion rate was approximately 74.2%, as 411 individuals initiated the continuing education module, and 305 participants finished the module and received the 1.0 hour continuing education credit. Nearly 10 weeks of data were collected from 305 participants from across the United States. Most participants (87.2%; n = 266) have practiced as a healthcare provider for less than 10 years. Roughly 6.2% (n = 19) of the providers had obtained their Doctoral degree, while 93.8% (n = 286) had their Master's degree. There was a wide variety of ages and number of patients seen per week, with the majority of participants being females (see Table 2)

Table 2

Participant Demographics

Demographic	(%)	(n)
Years of Practice		
< 5 years of practice	68.8	210
5-10 years of practice	18.4	56
>10 years of practice	12.8	39
Gender		
Female	91.1	278
Male	8.9	27
Age		
30 and under	15.7	48
31-50 years	65.6	200
51-70 years	18.4	56
>71 years	0.3	1
Highest Level of Education		
Master's degree	93.8	286
Doctoral degree	6.2	19
Professional degree (MD, JD etc.)	0.0	0
Number of Patients seen per week		
50 patients or less	57.4	175
50-100 patients	35.4	108
>100 patients	7.2	22

Among the participants, there was a high acceptance level regarding the continuing education module. Over 90% of participants felt that the continuing education module met all three objectives "completely" or "quite a bit" (see Table 3). Additionally, 283 (92.8%) of the 305 participants felt that the continuing education module enhanced their current knowledge base completely or quite a bit. Several participants commented on what was helpful throughout the continuing education module including treatment protocols, diagnostic recommendations, differentiating the stages of LD, images, and the tick removal video.

Table 3

Participant Objective Responses

How well did the CE activity help you achieve this objective?	Completely (%; n)	Quite a bit (%; n)	Neutral (%; n)	Somewhat (%; n)	Not at all (%; n)
1. State factors that increase risk of contracting LD and ways to prevent LD	40.3; 123	50.5; 154	5.2; 16	3.0; 9	1.0; 3
2. Recognize barriers to early diagnosis and treatment of LD	43.9; 134	49.5; 151	3.9; 12	2.0; 6	0.7; 2
3. Identified interventions to improve awareness amongst providers and systematize diagnosis and treatment of LD	42.65; 130	49.85; 152	5.2; 16	1.6; 5	0.7; 2

Objective One

The first objective was to state factors that increase the risk of contracting LD and ways to prevent LD (see Table 4). Several questions addressed the first objective including questions 1, 2, 9, and 13 (APPENDIX I). Prior to completion of the continuing education module, approximately 47.6% (n = 145) of participants correctly identified question 1, "in the United States, high endemic area of LD are:" with the answer "Northeastern & upper Midwestern United States, Northwestern California." During the posttest questionnaire, the number of participants who could correctly identify endemic areas of LD grew to approximately 70.8% (n = 216) as a result of the continuing education module.

Another question that showed enhancement of knowledge for objective one was "what is the minimum length of time a tick needs to be attached to transmit LD?" The correct response was "24 hours", which was answered correctly by participants in the pretest 37.7% (n = 115) and

77.9% (n = 238) in the posttest. “Prevention strategies for LD include:” with a correct response of “a, b, d, & f” assessed objective one as well, and had improved scores from the pretest (86.7%; n = 264) to the posttest (90.5%; n = 276). The answers a, b, d, & f included “wearing long sleeve shirts, pants, tucking pants into socks,” “using insect repellent,” “proper removal of ticks with tweezers,” and “eliminating or minimizing wood pills, brush, and tall grassy areas in yards.”

The first objective was also measured by the question: “prophylactic treatment for LD is which of the following?” The correct answer was “200 mg doxycycline once.” Again, the comparison of participants who correctly identified the pretest question (26.0%; n = 79) improved after the completion of the module to 75.9% (n = 231) within the posttest, showing an improvement of 49.9%. As a result of the continuing education module, an increased number of participants became knowledgeable of risk factors and prevention strategies in regards to LD.

Table 4

Objective 1 Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change (%)
Question 1	47.6, 145	70.8, 216	23.2
Question 2	37.7, 115	77.9, 238	40.2
Questions 9	86.7, 264	90.5, 276	3.8
Question 13	26.0, 79	75.9, 231	49.9

Objective Two

The second objective was recognizing barriers to early diagnosis and treatment of LD (see Table 5). The following question was used to evaluate the second objective: “What is the causative agent of LD” with the answer being “*Borrelia burgdorferi*.” Only 66.5% (n = 202) of

participant identified the correct causative agent of LD during the pretest, while after the completion of the module the posttest results revealed a 29.9% improvement to 96.4% (n = 294) of participants with correct responses. An improvement of participants' scores were also evident in the following question: "Erythema migrans is sufficient for diagnosis of LD." The answer was "true" with 34.1% (n = 104) correct in the pretest and 75.6% (n = 230) correct responses in the post test.

An additional question that evaluated the second objective included: "What are manifestations of LD?" A total of 154 out of 305 (50.8%) participants answered correctly in the pretest, while 245 (80.5%) participants within the posttest responded with the correct answer of "Erythema migrans, AV blocks, arthritis, and fever." "What testing is appropriate for confirming LD as a diagnosis?" with the right answer of "two-tiered testing (ELISA and Western Blot)," also showed score improvement of pretest (78.9%; n = 241) to posttest scores (85.3%; n = 260). The last questions used for the evaluation of objective 2 was: "Treatment of LD with doxycycline is contraindicated for children <8 years old." with a correct answer of "true." Pretest scores were enhanced from 82.0% (n = 250) to 90.8% (n = 277) during the posttest.

Table 5

Objective 2 Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change (%)
Question 3	66.5, 202	96.4, 294	29.9
Question 4	34.1, 104	75.6, 230	41.5
Questions 5	50.8, 154	80.5, 245	29.7
Question 7	78.9, 241	85.3, 260	6.4
Question 8	82.0, 250	90.8, 277	8.8

Objective Three

The third objective was to identify interventions to improve awareness amongst providers and systematize diagnosis and treatment of LD (see Table 6). The first question to evaluate the third objective was "What stage of LD begins when the spirochete bacteria spreads through lymphatic and hematologic pathways causing multiple EM lesions, acute neurological and/or cardiac symptoms?" Prior to the continuing education module, 26.6% (n = 81) answered the question correctly by choosing the response: "Early disseminated." The posttest results demonstrated an increase of correct responses to 58.5% (n = 178). Another question that evaluated objective three was "Characteristics of late disseminated LD include:" with the correct response of "Symptoms present months to years after infection with common manifestations of arthritis, subtle encephalopathy, peripheral neuropathies, and spinal radicular pain." Again, there was an improvement of pretest (32.0%; n = 98) and posttest (41.6%; n = 127) scores. An additional two questions about the stages and classifications showed improvement of posttest scores that included: "What stage of LD is characterized by EM and nonspecific symptoms such as fatigue, headache, myalgias, arthralgias, fever, anorexia, neck stiffness, and regional lymphadenopathy?" and "What categorization of LD occurs after appropriate antibiotic therapy

has been completed with symptoms that may include fatigue, myalgias, arthralgias, cognitive difficulties, and headaches?" Consecutively, the pretest scores were 16.5% (n = 50) and 60.9% (n = 186), while posttest scores improved to 48.4% (n = 148) and 74.9% (n = 229).

The final question that was asked to evaluate the third objective was "What is appropriate treatment for early localized LD?" The correct response was "All of the above." The responses included 100 mg doxycycline twice daily for 10-21 days, 500 mg amoxicillin three times daily for 14-21 days, and 500 mg cefuroxime axetil twice daily for 14-21 days. In the pretest, 27.3% (n = 68) of participants responded with the correct answer of "all of the above." After the completion of the continuing education module, 42.3% (n = 129) of participants responded correctly in the posttest. Through the comparison of pretest and posttest scores, there was a comprehensive improvement of posttest scores in 17/18 questions.

Table 6

Objective 3 Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change
Question 6	26.6, 81	58.5, 178	31.9
Question 10	32, 98	41.6, 127	9.6
Questions 11	16.5, 50	48.4, 148	31.9
Question 12	60.9, 186	74.9, 229	14.0
Questions 14	27.3, 68	42.3,129	15.0

Additional Objective Data

Towards the end of the pretest and posttest four case study questions evaluated all three objectives to assist participants in application of potential enhancement of knowledge (see Table 7). Prior to starting the continuing education module participants were asked, "A patient presents

with EM, no laboratory testing has been performed to date, and the patient cannot recall a tick bite. How would you treat this patient?" Participants responded correctly 54.1% (n = 163) with the answer "Treat with antibiotic therapy for LD." After the module, 68.2% (n = 208) of the participants answered the same questions correctly. The second case study question was "A patient presents with a known deer tick bite, no symptoms, no laboratory testing, and normal findings on examination," with the correct response of "No antibiotic, reassure and educate patient, follow up as needed." Pretest scores indicated 34.9% (n = 106) of participants correctly identified the answer, and the posttest scores were 33.6% (n = 103). Although a decrease in participant scores occurred, the answers revealed that 68.7% (n = 209) of participants correctly identified that an antibiotic was not indicated in the scenario.

Another case study question was: "A patient who recently went on vacation in Connecticut presents with fever, myalgias, arthralgias and fatigue; no erythema migrans is seen on examination. Patient reports finding a tick attached upon arrival home 2 days ago. ELISA results come back negative." The pretest had a correct response rate of 51.4% (n = 157) with the answer "treat with antibiotic therapy for LD." The posttest scores revealed improvement to 59.0% (n = 180) of participants with right answers. The fourth case study question consisted of: "A patient presents with a 6-month history of joint pain, migraines, and with symptomatic complete heart block. Patient has no history of erythema migrans. It is unknown if the patient has ever been bitten by a deer tick, but the patient spends a lot of time outdoors and lives in Minnesota. Patient has not received antibiotics. No cause for symptoms on initial work-up." During the pretest, 50% (n = 153) identified the correct response of "admit patient to hospital, refer patient to specialists," and after the continuing education module 58.9% (n = 180) answered correctly.

Table 7

All Objectives: Case Study Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change
Question 15	54.1, 163	68.2, 208	14.1
Question 16	34.9, 106	33.6,103	-1.3
Questions 17	51.4, 157	59, 180	7.6
Question 18	50.0, 153	58.9, 180	8.9

Qualitative Data

Additional information was provided through the evaluation survey of the continuing education module, which include Likert scale and open ended questions. Information that was gathered included participants' opinions on how well the continuing education module helped achieve the objectives, enhance current knowledge base of LD, and what the participants found most helpful and least helpful. Out of 305 participants, 66 (21.6%) provided additional feedback through written response and 305 participants completed the Likert scales questions. More than 98% of participants felt that the continuing education module achieved the objectives. Out of 305 participants, 303 (99.3%) responded positively when asked if the activity enhanced their current knowledge base.

Comments were left by 19 of the participants stating the continuing education module was helpful, great, thorough, easy to follow, current, good, informative, and enjoyable. Several participants found that the illustrations, tick removal video, diagnostic testing algorithm, treatment plans, and staging of LD was very helpful to their learning throughout the continuing education module. A few examples of comments that were left in response to what participant found most helpful included: "The overall presentation. Offered a great review on assessment

and intervention;" "The information was simple, thoughtful, and questions were discussed during the presentation with rational;" and "I have done a lot of CE and this is the first one to actually acknowledge post Lyme issues."

When participants were asked about what was least helpful 32 replied in similar fashions such as "it was all good" or "nothing." There were a few suggestions for improvement in regards to the presenter's tone and presenting style. Six individuals commented on a question that had two similar correct answers, as a response the developer adjusted the question to reflect only one correct answer. Several individuals gave suggestions to make a PowerPoint handout and reference list available for review. Because of the feedback, the presenter provided the AANP CEC with a reference and PowerPoint handout to be made available to future participants. A few suggestions for improvement that individuals left were more "case scenarios," "information on the use of prophylaxis treatment," "information on clinical management," and "discuss alternative and complimentary therapies."

CHAPTER VI: DISCUSSION AND RECOMMENDATIONS

Interpretation of Results

Not only was there a high level of satisfaction with the content, but also on how the continuing education module was presented as well. As discussed previously in the fifth chapter, the participants felt that the continuing education module met the first (90%; n = 277), second (93.4%; n = 285), and third (95.1%; n = 290) objectives "completely" or "quite a bit." Most participants (92.8%; n = 283) felt that the continuing education module enhanced their current knowledge base completely or quite a bit with only two participants (0.66%) that felt their knowledge was not improved at all.

Previous literature exposed significant knowledge gaps that were present among healthcare providers in relation to the prevention, diagnosis, and treatment of LD (Brett et al., 2014). Consequently, the majority of participants pretest scores were not surprising when they resulted relatively low, ranging from 16% to 60% on 13 of the content-related questions and 60% and above on the remaining 5 questions. Within the pretest, participants scored the lowest on a question related to staging early localized LD. Although only 16.5% (n = 50) of participants correctly identified early localized LD during the pretest, the posttest scores nearly tripled increasing to 48.4% (n = 148) of participants that identified the right answer. With 17 of the 18 content-related questions, the percentages of correct answers increased from the pretest to the posttest scores. The approximate increase in posttest scores ranged from 3% to 50%, demonstrating that learning occurred in direct relation to the continuing education module.

The findings from the disquisition project correlate to findings from research and studies about knowledge of healthcare providers in relation to LD. Brett et al. (2014) found that almost 1/3 of US healthcare providers did not feel confident in their knowledge of tick-borne illnesses.

Similar to the results of the continuing education module pretest score of 34.1% (n = 104), Henry et al. (2012) found that only 26% of providers knew that EM was diagnostic for LD. Additionally, another study found that 56% of providers knew that EM was a diagnostic sign for LD (Singh, Parker, Mark-Carew, White, & Fisher, 2016). Upon completion of the continuing education module, most providers not only reported enhance knowledge on the topic of LD, but had significant improvement with the majority of posttest questions. In summary, participants reported positive feedback and valuable suggestions for improvement of the continuing education module, and the results demonstrate knowledge enhancement of participants.

Singh et al. (2016) research was discovered after the initial literature review, and was in regards to clinicians' knowledge of LD that showed 53% to 79% (depending on type of provider) would treat for LD with EM alone. The results were similar to pretest (54.1%; n = 165) and posttest (68.2%; n = 208) scores for question 15 (see APPENDIX I) of the continuing education module. The data shows that additional education needs to be delivered to healthcare providers to provide safe, high-quality, and effective care to individual presenting with EM.

Theoretical Framework Discussion

As discussed previously in the second chapter, Knowles theory of androgogy guided the development, implementation, and evaluation of the practice improvement project. The framework focused on helping adult learners maximize educational opportunities. By implementing a free online educational module, the adult learners were able to independently choose where, what time, and the place they completed the module, which utilized one of five assumptions within the theory. The independence of the adult learner was also fostered by the evaluation survey that allowed for feedback. Although the participants came with different life experiences and knowledge, the second assumption, several aspects of LD care were presented in

a variety of ways (case studies, videos, graphs, images) to assist all participants in their quest for knowledge enhancement. Through both the pretest and posttest participants were evaluated on their knowledge prior to the continuing education module and after completion. Learning readiness, being problem-centered, and motivation through internal factors are the remaining assumptions. By compiling useful and relevant information within the continuing education module participants could apply the learning to their current daily practices while learning in a safe and comfortable environment. Additionally, the pretest, posttest and evaluation survey challenged the participated to utilized the newly learned information, but could be completed in a safe area of the participants' choice.

Additionally, the six steps of the Model for Evidence-Based Practice Change were utilized to enhance and guide the practice improvement project. The first three steps were used to gain a foundational base of evidence to develop and implement the continuing education module, through an extensive literature review and critically analyzing the relevant literature. The literature review and analysis was an ongoing process throughout the entire practice improvement project and the model was a great tool for guidance. Designing the practice change of a continuing educational module and the associated evaluations were done through coordination and combined efforts of the co-investigator and the AANP CEC. The AANP CEC then hosted the continuing education module along with the pretest, posttest, and evaluation survey to participants. The 305 participants of the continuing education module could gain quality information about LD, which can be utilized in their current practices. Also, the module will be available until December of 2018, assisting in maintaining the practice change through continued delivery of education on LD. In response to participants' feedback, PowerPoint and

reference handouts were provided to allow participants to review information as needed and foster independent learning while promoting integration of learned information.

Overall, the theoretical framework of androgogy coincided well with the adult learning opportunity presented within the online continuing education module, making the theory practical to recommend for similar uses in the future. The Model for Evidence-Based Practice Change enhanced not only the development and implementation process of the continuing education module, but also the evaluation process as well. Due to the flexibility of an educational module several theoretical frameworks may have been beneficial, but the theory of androgogy and Model of Evidence-Based Practice Change were straightforward and easy to apply to the entire practice improvement project and would be recommended for use in a similar practice improvement project.

Limitations

The practice improvement project has several associated limitations. One limitation was not identifying demographic location of participants to determine if there was an association between participants and endemic areas. Because there is a higher incidence of LD in Northeastern and upper Midwestern states, along with northwestern California, having a breakdown of participants by state would have been beneficial when interpreting results and making future recommendations.

Although AANP CEC was an effective platform to educated providers on LD, the continuing education module was limited through the formatting restrictions on the pretest, posttest, and evaluation questions. The formatting of questions only allowed for multiple choice or true/false questions, which led to an increased amount of questions to obtain the needed information.

A third limitation of the continuing education module was data provided by the AANP CEC were released in a cumulative form for confidentiality purposes. The data still provided a generous amount of information for a comprehensive analysis of the results. Individual participant data would have allowed for additional opportunities to analyze and summarize results. In addition, knowledge gaps related to demographic information such as gender, years of clinical practice, and age, could have been gathered to provide further recommendations.

Another limitation was that one participant reported technical difficulties with the video within the continuing education module. The technological problems may have been due to the large size of the file, internet speed, computer variations, user error, or browser selection. Out of 305 participants only one reported technical problems in relation to the continuing education module, making the technical errors a small limitation that is outweighed by the benefits of educating providers throughout the United States on LD.

The IDSA guidelines were used to develop the continuing education module, but this presents as a limitation since they were published in 2006. Currently, the IDSA is in the processes of developing new guidelines for LD with the projected publication date to be in the summer of 2018. Additional content that will be addressed in the new IDSA guideline includes the possibility of LD being acquired by means other than a tick bite, new diagnostic tests, and treatment protocols (2016). Although the guideline is in the process of being updated, many of the other current research articles supported the findings and recommendations within the IDSA. Due to the supporting research, the continuing education module is beneficial to healthcare providers and has shown enhancement of knowledge through the pretest and posttest comparisons. When new guidelines are available the continuing education module should be

updated or a new one should be developed to continue to provide healthcare clinicians with the most up to date and evidenced based research.

Recommendations

Due to the positive results of the continuing education module that were made evident by the improvement of posttest scores and constructive evaluation responses, the module is practical to recommend to all healthcare providers to partake in to close the knowledge gaps that exist in LD. Although the continuing education module targets nurse practitioners and nurse practitioner students, other healthcare providers also can complete the education on the AANP CEC as well. However, the number of providers who are not nurse practitioners using AANP CEC is likely low due to the respective continuing education opportunities within their professional organizations. Therefore, an additional recommendation is to promote and market the continuing education module further in other health professional such as physicians and physician assistants. Promotion of the LD module could be done through email correspondence and contacting related professional organizations such as Association of American Physicians and American Academy of Physician Assistants about presenting the continuing education module within their continuing education centers.

Two years after the module start date, the co-investigator intends to analyze data once the continuing education module is complete in December, 2018. Since the continuing education module is free of charge to both AANP members and non-members, recommending that the module be incorporated into the curricula of family nurse practitioners is practical. Foundational competencies must be met within graduate schools, and the continuing education module could be required to be completed to meet competencies such as evaluating healthcare delivery systems to meet the needs of specific populations, scientific foundations, and promoting quality

healthcare. The module has the potential to be incorporated into the coursework of a health promotion or practicum course to provide beneficial education on the prevention, diagnosis, and treatment of LD.

The overall feedback received from the continuing education module were positive with several participant comments that were related to how "helpful" the module was and what they learned. One participant commented "The overall presentation offered a great review on assessment and intervention." Based on the topic interest demonstrated by having 305 participants complete the module in a short 10-week timeframe and with the positive feedback, it is practical to recommend the AANP CEC accept future continuing education modules on LD or collaborate with AANP members to create additional continuing education related to LD.

Addressing PTLDS treatment options may be a beneficial addition to the module to further enhance participants' knowledge of treatment options regarding the different classifications of LD. Discussion with AANP CEC representative will be done to discuss and recommend additional PTLDS information with related pretest/posttest questions be added to the current module. The co-investigator can then analyze the evaluation data when the module expires in December, 2018 to determine effectiveness of the added educational material.

Additionally, several comments were left in the evaluation survey indicating that PowerPoint handouts (see APPENDIX C) of the slides and a separate document for references would be beneficial to the participants learning. Taking the feedback, the co-investigator recommended that the AANP CEC add the handout and reference list for the remainder of the continuing education module. The AANP CEC accepted the recommendation and after the handout and reference page was provided, they were made available to enhance participants learning experience.

Implications for Practice

The practice improvement project influenced a substantial amount of current and future healthcare providers with a total of 305 participants. Dissemination was completed through the AANP CEC hosting the continuing education module, email invitations to healthcare providers and Doctor of Nursing Practice students at NDSU, and by participating at NDSU annual health professions poster presentation. The practice improvement project adds to the current literature available authenticating healthcare provider knowledge gaps that exist related to the prevention, diagnosis, and treatment of LD. Healthcare provider education on LD has the potential to decrease the gaps in patient care that can lead to undesirable health outcomes and enhance the awareness of not only healthcare providers, but the community and patients as well.

Healthcare providers in the primary care setting will likely encounter individuals with LD, especially if working in an endemic area. To meet the needs of the population, healthcare providers must possess and continue to obtain the knowledge, skills, and awareness to provide high-quality care to all individuals within a community. Through completing educational activities specific to LD healthcare providers may be enabled to deliver competent, patient-centered healthcare to the population. Enhanced awareness and knowledge of risk factors, prevention strategies, diagnostic testing, clinical diagnosis, and treatment protocols has the potential to improve appropriate treatment and health outcomes of individuals at risk or diagnosed with LD.

Implication for Future Research

The need for further research and educational activities to promote healthcare providers' knowledge related to LD is confirmed by past and current research and the continuing education module's survey findings. Developing another continuing education module could assist in

examining barriers to individual and community prevention of LD, along with diagnostic and treatment barriers among healthcare providers. Further research is also needed in the development of more accurate testing methodologies in early LD and appropriate treatment for individuals suffering from PTLDS.

Vaccinations are a key healthcare strategy to prevent and eradicated diseases and illnesses. As discussed in the second chapter, there is not a vaccine that is currently available for use today since the LYMErix vaccine was voluntarily discontinued in 2002. Another vaccine for LD is in development through Baxter pharmaceuticals and further research is needed to examine the safety and efficacy of the vaccine on a larger scale. Additional research could also F on barriers to reintroducing a LD vaccine.

REFERENCES

Aucott, J. N., & Seifter, A. (2011). Misdiagnosis of early Lyme as the summer flu. *Orthopedic Reviews, 3*(2), 65-68.

Aucott, J. N., Rebman, A. W., Crowder, L. A., & Kortte, K. B. (2013). Post-treatment Lyme disease syndrome symptomatology and the impact on life functioning: Is there something here? *Quality of Life Research, 22*(1), 75-84. doi:10.1007/s11136-012-0126-6

Bayles, B. R., Evans, G., & Allan, B. F. (2012). Knowledge and prevention of tick-borne disease vary across an urban-to-rural human land-use gradient. *Ticks and Tick-borne Diseases, 4*, 352-358. doi:10.1016j.ttbdis.2013.01.001

Beard, B., Plotkin, S., Marconi, R., Aronowitz, R., Wressnigg, N., & Madoff, L. (2015). Vaccines for Lyme disease-Past, present, and future. Center for Disease Control and Prevention. Retrieved from http://www.cdc.gov/lyme/stats/index.html

Berende, A., Hofstede, H. J., Vos, F., Middendorp, H. V., Bogelaar, M. L., Tromp, M., . . . Kullberg, B. J. (2016). Randomized trial of longer-term therapy for symptoms attributed to Lyme disease. *The New England Journal of Medicine, 374*(13), 1209-1220.

Brett, M. E., Hinkley, A. F., Zielinski-Gutierrez, E. C., & Mead, P. S. (2014). U.S. healthcare providers' experience with Lyme and other tick-borne diseases. *Ticks and Tick-borne Diseases, 5*(5), 404-408.

Cameron, D. J., Johnson, L. B., & Maloney, E. L. (2014). Evidence assessment and guideline recommendations in Lyme disease: The clinical management of known tick bites,

erythema migrans rashes and persistent disease. *Expert Review of Anti-infective Therapy, 12*(9), 1103-1135.

Centers for Disease Control and Prevention. (2015). *Lyme disease: Data and statistics.* Retrieved from Lyme disease: Data and statistics: http://www.cdc.gov/lyme/stats/index.html

Centers for Disease Control and Prevention. (2016, March). *Post-treatment Lyme disease sydrome.* Retrieved from Centers for Disease Control and Prevention: http://www.cdc.gov/lyme/postLDS/index.html

Cerone, k. (2008). Characteristics of adult learners with implications for online learning design. *Association for the Advancement of Computing Education Journal, 16*(2), 137-159.

Cisak, E., Wojcik-Fatla, A., & Dutkiewicz, J. (2012). Repellents and acaricides as personal protection measures in the prevetion of tick-borne diseases. *Annals of Agricultural and Environmental Medicine, 19*(4), 625-30.

De Wilde, M., Speeckaert, M., Callens, R., & Van Biesen, W. (2016). Ceftriaxone-induced immune hemolytic anemia as a life-threating complication of antibiotic treatment of 'chronic Lyme disease'. *International Journal of Clinical and Laboratory Medicine,* 1-5.

Eisen, R. J., Piesman, J., Zielinski-Gutierrez, E., & Eisen, L. (2012). What do we need to know about disease ecology to prevent Lyme disease in the northeastern United States? *Journal of Medical Entomolgy, 49*(1), 11-22.

Eng, E. M. (2013). *Erythema migrans rash types.* Bay Area Lyme Foundation.

Eng, E. M. (2013). *Tick Size Chart.* Bay Area Lyme Foundation.

Epocrates. (2016). *Doxycycline.* Retrieved from Epocrates: https://online.epocrates.com/drugs/203/doxycycline

Fallon, B. A., Keilp, J. G., Corbera, K. M., Petkova, E., Britton, C. B., Dwyer, E., . . . Sackeim, H. A. (2008). A randomized, placebo-controlled trial of repeated IV antibiotic therapy for Lyme encephalopathy. *Neurology, 70*(13), 992-1003. doi:10.1212/01.WNL.0000284604.61160.2d

Gutierrez, R. L., & Decker, C. F. (2012). Prevention of tick-borne illness. *Disease-a-Month, 58*(6), 377-387.

Hamer, S. A., Hickling, G. J., Sidge, J. L., Walker, E. D., & Tsao, J. I. (2011). Synchronous phenology of juvenile Ixodes scapularis vertebrate host relationships and associated patterns of Borrelia burgdorferia ribotypes in the Midwester United States. *Ticks and Tick-bornes Diseases, 3*(2), 65-74.

Henry, B., Crabtree, A., Roth, D., Blackman, D., & Morshed, M. (2012). Lyme disease: Knowledge, beliefs and practices of physicians in low-endemic area. *Canadian Family Physcian, 58*(5), 289-295.

Hill, D. G. (2013). Provider knowledge, attitudes, and practices regarding Lyme disease in Arkansas. *Journal of Community Health, 40*(2), 339-346.

Hu, L., Steere, A. C., & Mitty, J. (2016). *Clinical manifestations of Lyme disease in adults.* Retrieved from UpToDate: https://www.uptodate.com/contents/clinical-manifestations-of-lyme-disease-in-adults?source=preview&search=lyme+disease+stages&language=en-US&anchor=H2&selectedTitle=2~150#H4

Infectious Disease Society of America. (2016). *IDSA/AAN/ACR Panel Response to Public Comments on the IDSA/AAN/ACR Lyme disease Guideline Development Project Plan.* Infectious Disease Society of America.

Kaplan, R. F., Trevino, R. P., Johnson, G. M., Levy, L., Dornbush, R., Hu , L. T., . . . Klempner, M. S. (2003). Cognitive function in post-treatment Lyme disease: Do additional antibiotics help? *Neurology*, *60*(12), 1916-1922.

Keesee, G. S. (2011). *Adult learning theory*. Retrieved from http://teachinglearningresources.pbworks.com/w/page/30310516/Andragogy--Adult%20Learning%20Theory

Klempner, M. S., Hu, L. T., Evans, J., Schmid, C. H., Johnson, G. M., Trevino, R. P., . . . Weinstein, A. (2001). Two controlled trials of antibiotic treatment in patients with persistent symptoms and history of Lyme disease. *New England Journal of Medicine, 345*(2), 85-92. doi:10.1056/NEJM200107123450202

Krupp, L. B., Hyman, L. G., Grimson, R., Coyle, P. K., Melville, P., Ahnn, S., . . . Chandler, B. (2003). Study and treatment of post Lyme disease (STOP-LD): A randomied double masked clinical trial. *Neurology*, *60*(12), 1923-1930.

Mankoff, J., Kuksenok, K., Rode, J. A., Kiesler, S., & Waldman, K. (2011). Competing online viewpoints and models of chronic illness. *Online Communitities & Social Interation, 3*, 589-598.

Marchese, N. M., & Primer, S. R. (2013). Targeting Lyme disease. *Nursing*, *43*(5), 28-33.

McGrath, V. (2009). Reviewing the evidence on how adult student learn: An examination of Knowles' model of androgogy. *The Irish Journal of Adult and Community Education,* 99-110.

Melia, M. T., & Auwaerter, P. G. (2016). Time for a different approach to Lyme disease and long-term symptoms. *The New England Journal of Medicine, 374*(13), 1277-1278.

Melnyk, B. M., & Fineout-Overholt, E. (2011). *Evidence-Based Practice in Nursing & Healthcare* (2nd ed.). Philadelphia: Lippincott Willams & Wilkins.

Moore, K. S. (2015). Lyme disease: Diagnosis, treatment guidelines, and controversy. *The Journal for Nurse Practitioners, 11*(1), 64-69. doi:10.1016/j.nurpra.2014.09.021

Nichols, C., & Windemuth, B. (2013). Lyme disease: From early localized disease to post-Lyme disease syndrome. *The Journal for Nurse Practitioners, 9*(6), 362-367.

Patel, R., Grogg, K. L., Edwards, W. D., Wright, A. J., & Schwenk, N. M. (2000). Death from inappropriate therapy for Lyme disease. *Clinical Infectious Diseases, 31*(4), 1107-1109.

Sanchez, E., Vannier, E., Wormser, G. P., & Hu, L. T. (2016). Diagnosis, treatment, and prevention of Lyme Disease, human granulocytic anaplasmosis, and babesiosis: A review. *The Journal of the American Medical Association, 315*(16), 1767-1777. doi:10.1001/jama.2016.2884

Shen, A. K., Mead, P. S., & Beard, C. B. (2011). The Lyme disease vaccine: A public health perspective. *Clinical Infectious Diseases, 52*(3), 247-252. doi:10.1093/cid/ciq115

Singh, S., Parker, D., Mark-Carew, M., White, R., & Fisher, M. (2016). Lyme disease in West Virginia: An assessment of distribution and clinicians' knowledge of disease and surveillance. *West Virginia Medical Journal, 112*(4), 48-54.

Steere, A. C., Kornblatt, A. N., Craft, J. E., Barbour, A. G., Burgdorger, W., Schmid, G. P., . . . Malawista, S. E. (1983). The spirochetal etiology of Lyme disease. *New England Journal of Medicine*, 733-740.

Vaughn, M. G., & Meshnick, S. R. (2011). Pilot study assessing the effectiveness of long-lasting permethrin-impregnated clothing for the prevetio of tick bites. *Vector Borne and Zonotic Diseases*, 1-7. doi:10.1089/vbz.2010.0158

Wood, C. L., & Lafferty, K. D. (2013). Biodiversity and disease: A synthesis of ecological perspectives on Lyme disease transmission. *Trends in Ecology and Evolution, 28*(4), 239-247.

Wormser, G. P., Dattwyler, R. J., Shapiro, E. D., Halperin, J. J., Steere, A. C., Klempner, M. S., . . . Nadelman, R. B. (2006). The clinical assessment, treatment, and prevention of Lyme disease, humangranlocytic anaplasmosis, and babesiosis: Clinical practice guideline by the Infectious Diseases Society of America. *IDSA Guidelines, 43*, 1089-1941.

Wormser, G. P., Schriefer, M., Aguero-Rosenfeld, M. E., Levin, A., Steere, A. C., Nadelman, R. B., . . . Dumler, J. S. (2013). Single-tier testing with the C6 pepide ELISA kit compared to two-tier testing for Lyme disease. *Diagnostic Microbiology and Infectious Disease, 75*(1), 9-15.

Wressnigg, N., Pollabauer, E., Alchinger, G., Portsmouth, D., Low-Baselli, A., Fritsch, S., . . . Barrett, P. N. (2013). Safety and immunogenicity of a novel multivalentOspA vaccine

against Lyme borreliosis in health adults: A double-blind, randomized, dose-escalation phase 1/2 trial. *The Lancet Infectious Disease, 13*(8), 680-689. doi:10.1016/S1473-3099(13)70110-5

APPENDIX A. AANP APPROVAL LETTER

AANP | American Association of NURSE PRACTITIONERS™

The Voice of the Nurse Practitioner®

November 8, 2016

Shelia Greseth
DNP Student

Dear Shelia,

The continuing education activity *Addressing Lyme Disease: An Educational Module for Healthcare Providers* is approved for continuing education by the American Association of Nurse Practitioners. All session contact hours are approved as submitted.

Use the following statement in your literature to indicate the maximum *credit one person can obtain* upon completion of this activity.

"This activity is approved for 1.0 contact hour(s) of continuing education by the American Association of Nurse Practitioners. Activity ID 16112414. This activity was planned in accordance with AANP CE Standards and Policies and AANP Commercial Support Standards."

This approval is for the continuing education activity listed in the original application. With this approval, ALL changes to this activity must be reported to the AANP for review as soon as they are identified. This includes but is not limited to:

- session drops/additions,
- speaker changes,
- objective changes,
- date and /or venue changes.

Any changes to content or speakers that is not reviewed by the AANP are not approved for credit.

ID number 16112414 has been assigned to this application. Refer to this number with *all communication* pertaining to this application. This activity has been approved for 2 years (through November 8, 2018), provided no changes are made.

Thank you,

Leigh Schmidt
Leigh Schmidt
CE Accreditation Manager

Administration: PO Box 12846 • Austin, TX 78711 • 512-442-4262 • Email: admin@aanp.org • Website: www.aanp.org
Office of Health Policy: 223 Reinekers Lane, Suite 323 • Alexandria, VA 22314 • 703-740-2329 • Email: federalpolicy@aanp.org

APPENDIX B. INSITUTIONAL REVIEW BOARD APPROVAL LETTER

NDSU NORTH DAKOTA STATE UNIVERSITY

October 3, 2016

Dr. Dean Gross
Nursing

Re: IRB Certification of Exempt Human Subjects Research:
Protocol #PH17059, "Addressing Lyme Disease: An Educational Module for Healthcare Providers"

Co-investigator(s) and research team: Sheila Greseth

Certification Date: 10/3/2016 Expiration Date: 10/2/2019
Study site(s): online
Sponsor: n/a

The above referenced human subjects research project has been certified as exempt (category # 1) in accordance with federal regulations (Code of Federal Regulations, Title 45, Part 46, Protection of Human Subjects). This determination is based on the original protocol materials with pre-/post-assessments (received 9/29/2016).

Please also note the following:
• If you wish to continue the research after the expiration, submit a request for recertification several weeks prior to the expiration.
• The study must be conducted as described in the approved protocol. Changes to this protocol must be approved prior to initiating, unless the changes are necessary to eliminate an immediate hazard to subjects.
• Notify the IRB promptly of any adverse events, complaints, or unanticipated problems involving risks to subjects or others related to this project.
• Report any significant new findings that may affect the risks and benefits to the participants and the IRB.

Research records may be subject to a random or directed audit at any time to verify compliance with IRB standard operating procedures.

Thank you for your cooperation with NDSU IRB procedures. Best wishes for a successful study.
Sincerely,

Kristy Shirley

Digitally signed by Kristy Shirley
DN: cn=Kristy Shirley, o=NDSU, ou=Institutional Review Board, email=kristy.shirley@ndsu.edu, c=US
Date: 2016.10.03 14:55:03 -05'00'

Kristy Shirley, CIP, Research Compliance Administrator

For more information regarding IRB Office submissions and guidelines, please consult http://www.ndsu.edu/research/integrity_compliance/irb/. This Institution has an approved FederalWide Assurance with the Department of Health and Human Services: FWA00002439.

APPENDIX C. CONTINUING EDUCATION MODULE HANDOUT

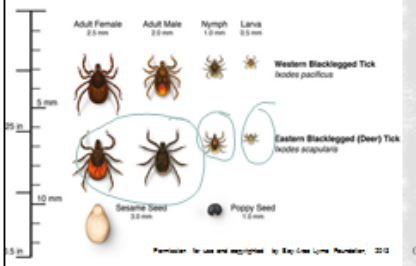
Addressing Lyme Disease: An Educational Module for Healthcare Providers

Sheila Criswell, DNP-S, RN
Dean Gross (Chair) PhD, RN, FNP-BC, Eugene Berry, PhD, Kelly Buettner-Schmidt PhD, RN
Paul Carson MD, FACP
North Dakota State University

Objectives

- State factors that increase risk of contracting and ways to prevent Lyme disease
- Recognize barriers to early diagnosis and treatment of Lyme disease
- Identify interventions to improve awareness amongst providers and systematize diagnosis and treatment of Lyme disease

Relative Sizes of Blacklegged Tick at Different Life Stages



Background of Lyme Disease

First signs noticed in early 1900s

Common carrier: Ixodes Scapularis (black-legged tick)

Cause: Borrelia burgdorferi spirochete

(Cameron et al., 2014; CDC, 2012)

Incidence

- Most common vector-borne disease
  - >30,000 reported cases every year in the United States
  - Approximately 300,000 actual cases
- Most common in the Northeastern and upper Midwestern United States

(CDC, 2012)

Contributing Factors Associated with Lyme Disease

Patient and Healthcare Provider Education Needs

Patients – Use of Preventative Strategies Survey

- 75% not wearing long sleeves or pants
- 52% perform regular tick checks
- <21% were "very concerned" about contracting Lyme disease
- 61% used tweezers for tick removal

Healthcare Providers

- Over 30% of providers did not feel knowledgeable about tick-born diseases
- Correct responses
  - 59.1% symptom recognition
  - 46.2% testing processes
  - 78.9% reportable disease
- Only 26% knew eythema migrans is diagnostic

(Bayles, Evans & Dillon, 2012; Bret et al., 2014; Hill, 2013; Khanna et al., 2012)

- 96% of confirmed cases in the United States occurred in 14 states.

Geographical Location

- Connecticut
- Delaware
- Maine
- Maryland
- Massachusetts
- Minnesota
- New Jersey
- New Hampshire
- New York
- Pennsylvania
- Rhode Island
- Vermont
- Virginia
- Wisconsin

(CDC, 2012)

Prevention Strategies

Proper Clothing

- Long sleeve shirts
- Pants
- Long socks
- Close toed shoes

(Gutierrez & Decker, 2012; Eisen, Piesman, Zielinski-Gutierrez, & Eisen, 2012)

Tick Repellents

Repellents	Examples
DEET	Repel (Sportsman), Backwoods Cutter
Picaridin	Cutter Advanced
Oil of lemon eucalyptus	Repel, Off!
IR2535	Skin So Soft Bug Guard Plus Expedition
Permethrin	Impregnating clothing and other materials

(CDC, 2012; Eisen et al., 2012)

High Risk Areas and Activities

Areas

- Wooded areas
- Grassy areas
- Near brush
- Wood piles
- Logs
- Leaf Litter

Activities

- Camping
- Gardening
- Yard work
- Outdoor jobs
- Hunting
- Fishing
- Horse riding
- Outdoor exercise (running, walking)
- Feeding animals (bears, deer, birds)
- Owning cats and dogs

(CDC, 2012; Breitschwerdt et al., 2011; Gutierrez & Decker, 2012)

Preventing Tick Attachment

- Check for ticks after coming indoors
  - Within 2 hours
- Conducting full body assessment
  - Use mirror
  - Check under arms, in/and around ears, inside belly buttons, behind knees, between legs, and in hair
- Shower as soon as possible
- Examine pets and outdoor gear

(CDC, 2012)

Proper Tick Removal

1. Grasp the tick with a fine tipped tweezers as near to the skin as possible
2. Pull upwards steadily with even pressure
3. Wash the bite area
   - Rubbing alcohol
   - Iodine scrub
   - Soap and water
4. Dispose tick
   - Sealed bag/container
   - Flushing down toilet
   - Wrapping in tape tightly
   - Placing in alcohol

DO NOT:

- Use a hot match or nail
- Cover the tick with substances
  - Petroleum jelly, perfume, paint, nail polish, alcohol, gasoline, lidocaine
- Jerk or twist when removing
- Crush, squeeze or puncture the tick body
- Handle tick with bare hands

(CDC, 2012; Marchaisa & Primer, 2012)

TICK REMOVAL VIDEO

Vaccination

- No vaccination is available for use today
- Current clinical trial:
  - Three dose series with booster
  - Results: Immunogenic, safe, predominately mild adverse events
- Past vaccine: LYMErix
  - Developed in early 1990
  - 76%-100% efficacy
  - Safety similar to other vaccines

(CDC, 2012; Shen et al, 2011; Wressnigg et al, 2012)

Case Study

A 22 year old male presents to the clinic with complaints of fever, myalgias, fatigue, headache, and decreased appetite. No rashes or lesions. He reports going camping one week ago in Wisconsin with friends. 3 days ago he removed an attached tick from behind his left knee. **What would you do next?**

a) Order an ELISA test and wait for results to treat.
b) Treat patient for Lyme disease and obtain an ELISA.
c) Refer patient to infectious disease.
d) Treat patient for Lyme disease and do not obtain any related laboratory testing at this time.

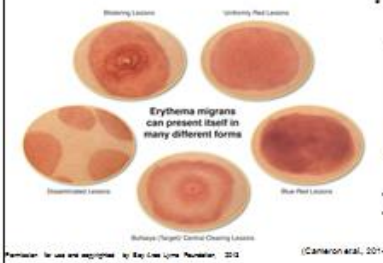
Diagnosis

Patient History

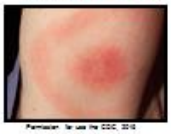
- Exposure to endemic area
- Tick attachment duration
  - At least 24 hours
- Associated signs and symptoms

(Bratt et al., 2014; Marchaisa & Primer, 2012)

Erythema Migrans



- Diagnostic
- Needs to be at least 5 cm
  - Average size: 15 cm



- Appears in 3-30 days
- Seldom painful or pruritic

(Cameron et al., 2014; CDC, 2012; Hu et al., 2012; Moore, 2012)

Stages and Classification of Lyme Disease

- Stage 1: Early Localized
- Stage 2: Early Disseminated
- Stage 3: Late Disseminated
- Post Treatment Lyme Disease Syndrome
- Unrecognized/Untreated Lyme Disease
- Reinfection

Stage 1: Early Localized

- Symptoms typically appear within 2-14 days of tick detachment
- Presents similar to a viral syndrome

Common Signs and Symptoms	
• Erythema Migrans	• Fever
• Fatigue	• Anorexia
• Headache	• Neck stiffness
• Myalgias	• Regional lymphadenopathy
• Arthralgias	

Peak Incidence of Lyme disease:
- May-September
- Highest in July

(Hu et al., 2012; Marchese & Primer, 2012; Nichols & Windemuth, 2012)

Stage 2: Early Disseminated

- Occurs weeks to months after tick detachment or localized infection
- Spirochete bacteria spreads through lymphatic and hematologic pathways
- Not always preceded by early localized
- Characterized by multiple erythema migrans lesions, cardiac and neurological manifestations

(Nichols & Windemuth, 2012)

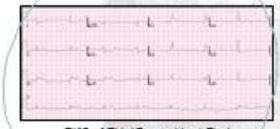
Neurological Manifestations

- Menigitis
- Unilateral or bilateral cranial nerve palsies
  - Bell's palsy
- Cranial neuritis
- Radiculopathy
- Peripheral neuropathy
- Cerebellar ataxia (rare)
- Encephalomyelitis (rare)

(Hu et al., 2012)

Cardiac Manifestations

- Atrioventricular blocks
  - First degree
  - Second degree, type 1 & 2
  - Third degree (complete heart block)
- Myopericarditis
- Pancarditis



EKG of Third Degree Heart Block

(CDC, 2012; Hu et al., 2012; Nichols & Windemuth, 2012)

Stage 3: Late Disseminated

- Occurs months to years after tick detachment
- Not always preceded by early localized or disseminated Lyme disease
- *Manifestations:*
  - Arthritis (most common)
    - In one or a few joints
  - Subtle encephalopathy
  - Polyneuropathy
    - Peripheral neuropathies
    - Radicular pain

(Jucoter al., 2013;Hu er al., 2016;Nichols &Windemuh,2012)

Post Treatment Lyme Disease Syndrome (PTLDS)

- Occurs after the recommended antibiotic therapy for Lyme disease is completed
- Up to 17% experience persistent symptoms
- Symptoms can persist for months
- Usually improve gradually over 6 months to 1 year
- Although the term Chronic Lyme Disease is used the proper term is PTLDS

Associated Signs and Symptoms
• Fatigue
• Myalgias
• Arthralgias
• Cognitive difficulties
• Headaches

***Long-term or repeat antibiotic therapy is not recommended or supported by evidence

(Jucoter al., 2013;CDC,2012;Hu eral, 2016;Wormser eral., 2006)

Exclusion Criteria for PTLDS

- An active, untreated, well-documented coinfection, such as babesiosis.
- The presence of objective abnormalities on physical examination or on neuropsychologic testing that may explain the patient's complaints. For example, a patient with antibiotic refractory Lyme arthritis would be excluded. A patient with late neuroborreliosis associated with encephalopathy, who has recurrent or refractory objective cognitive dysfunction, would be excluded.
- A diagnosis of fibromyalgia or chronic fatigue syndrome before the onset of Lyme disease.
- A prolonged history of undiagnosed or unexplained somatic complaints, such as musculoskeletal pains or fatigue, before the onset of Lyme disease.
- A diagnosis of an underlying disease or condition that might explain the patient's symptoms (eg, morbid obesity, with a body mass index [calculated as weight in kilograms divided by the square of height in meters] ≥45; sleep apnea and narcolepsy; side effects of medications; autoimmune diseases; uncontrolled cardiopulmonary or endocrine disorders; malignant conditions within 3 years, except for uncomplicated skin cancer; known current liver disease; any past or current diagnosis of a major depressive disorder with psychotic or melancholic features; bipolar affective disorders; schizophrenia of any subtype; delusional disorders of any subtype; dementias of any subtype; anorexia nervosa or bulimia nervosa; and active drug abuse or alcoholism in present or within 3 years).
- Laboratory or imaging abnormalities that might suggest an undiagnosed process distinct from post-Lyme disease syndrome, such as a highly elevated erythrocyte sedimentation rate (>50 mm/hour); abnormal thyroid function; a hematologic abnormality; abnormal levels of serum albumin, total protein, globulin, calcium, phosphorus, glucose, urea nitrogen, electrolytes, or creatinine; significant abnormalities on urine analysis; elevated liver enzyme levels; or a test result suggestive of the presence of a collagen vascular disease.
- Although testing by either culture or PCR for evidence of Borrelia burgdorferi infection is not required, should such testing be done by reliable methods, a positive result would be an exclusion.

(Wormser et al., 2006)

Unrecognized/ Untreated

- When the condition is not diagnosed as LD or the patient does not recognize or seek medical attention due to vague symptoms.

Reinfection

- Occurs when a patient is successfully treated for Lyme disease and in the future the infection reoccurs due to another tick attachment.

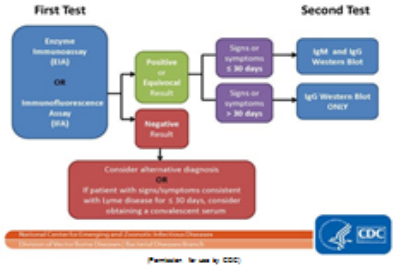
(Jucoté &Seltar; Hu eral., 2016)

Diagnostic Procedures

- Recommended:
  - Two-tiered testing
    - ELISA
    - Western Blot
- Unvalidated:
  - Lymphocyte transformation tests
  - Quantitative CD57
  - Lymphocyte assay
  - Culture with immunofluorescence staining

(CDC,2012;Wormser eral., 2012)

Two-tiered Testing



(CDC,2012)

Treatment

Antibiotic Treatment for Lyme Disease

	Drug	Adult dosage	Pediatric dosage
Erythema migrans (early disease)	Doxycycline	100 mg PO bid x 10-21 days	>8 years: 2 mg/kg PO bid (max 100 mg/dose) x 10-21 d
	or Amoxicillin	500 mg PO bid x 14-21 days	50 mg/kg/day divided tid PO (max 500 mg/dose) x 14-21 d
	or Cefuroxime axetil	500 mg PO bid x 14-21 days	30 mg/kg/day divided bid PO (max 500 mg/dose) x 14-21 d
Neurologic disease Isolated facial nerve palsy (early dissem.)	Doxycycline	100 mg PO bid x 14-28 days	>8 years: 2 mg/kg PO bid (max 100 mg/dose) x 14-28 d
Carditis Mild (1st degree AV block- PR interval <300ms)	Doxycycline	100 mg PO bid x 14-21 days	>8 years: 2 mg/kg PO bid (max 100 mg/dose) x 14-21 d
	or Amoxicillin	500 mg PO bid x 14-21 days	50 mg/kg/day divided tid PO (max 500 mg/dose) x 14-21 d
	or	500 mg PO bid x 14-21	30 mg/kg/day divided bid PO

(Wormser et al., 2006)

Prophylactic Treatment Criteria

All of the following criteria must be met:

1. Identified attached Ixodes scapularis tick (adult or nymph) for >36 hours
2. Prophylaxis can be started within 72 after tick removal
3. Local infection rate of ticks with Borrelia burdorferi is >20%
4. Doxycycline is not contraindicated

Adult Female Ixodes Scapularis Engorgement Stages

(Wormser et al., 2006)

Prophylactic Treatment

- **Single 200 mg dose of doxycycline**
- Relative contraindications:
  - Pregnant women
  - Children <8 years of age
- Monitor for signs and symptoms of tick-borne illness for 30 days

(Epocrates, 2016; Wormser et al., 2006)

Consultation

Infectious disease should be consulted if:

- Serious neurologic disease
  - Meningitis, radiculopathy, encephalitis (in early or late disseminated disease)
- Serious cardiac manifestations
  - Symptomatic 2nd or 3rd degree atrioventricular block or 1st degree with PR interval >300 ms
- Recurrent arthritis
- Late disseminated disease
- Post treatment Lyme Disease Syndrome

Key Points

- **Endemic areas:** Northeastern and upper Midwestern United States
- **Erythema migrans:** Diagnostic for Lyme disease
- **Causative agent:** *Borrelia burgdoferi*
- **Approved testing method:** Two-tiered testing (ELISA & Western Blot)
- **Prophylactic dose:** 200 mg doxycycline PO once
- **Treatment dose (adults):** 100 mg doxycycline PO bid x 10-21 days
- **Minimum attachment duration for transmission:** 24 hours
- **ELISA testing:** Do not obtain if tick exposure <2 weeks
- No current vaccination available

References

- Jill, J., Vatsiano, L., Lee, R., Weiss, T., & Colson, E. R. (2014, May). Experiences of patients identifying with chronic Lyme disease in the healthcare system: A qualitative study. *BMC Family Practice, 15*(79), 1-9.
- Jiuccot, J. N., & Seltzer, J. (2011). Misdiagnosis of early Lyme as the summer flu. *Orthopedic Reviews, 3*(2), 93-99.
- Jiuccot, J. N., Rebman, A. W., Crowder, L. D., & Horta, K. S. (2012, February). Post-treatment Lyme disease syndrome symptomatology and the impact on life functioning: Is there something here? *Quality of Life Research, 22*(1), 75-84. doi:10.1007/s11136-012-0129-6
- Bayles, B. R., Evans, G., & Allan, B. F. (2012, December). Knowledge and prevention of tick-borne disease vary across an urban-to-rural human land-use gradient. *Ticks and Tick-borne Diseases, 4*, 502-509. doi:10.1016/j.ttbdis.2013.01.001
- Beard, B., Rokin, A., Marconi, R., Dronovitz, R., Wressnigg,N., & Madoff, L. (2015, July 30). Vaccines for Lyme disease:Past, present and future. *Center for Disease Control and Prevention*. Retrieved from http://www.cdc.gov/lyme/stats/index.html
- Berende, A., Hofstede, H. J., Vos, F., Middendorp, H. V., Bogaetaar, M. L., Tromp, M., . . . Kullberg, B. J. (2016, March). Randomized trial of longer-term therapy for symptoms attributed to Lyme disease. *The New England Journal of Medicine, 374*(12), 1209-1220.
- Brei, M. E., Hinkley, J. R., Zielnski-Gutierrez, E. C., & Mead, P. S. (2014, January). U.S. healthcare providers' experience with Lyme and other tick-borne diseases. *Ticks and Tick-borne Diseases, 5*(3), 404-409.

References

- Cameron, D. J., Johnson, L. B., & Maloney, E. L. (2014, September). Evidence assessments and guideline recommendations in Lyme disease: The clinical management of known tick bites, erythema migrans rashes and persistent disease. *Expert Review of Anti-Infective Therapy, 12*(9), 1103-1122.
- Center for Disease Control and Prevention. (2012). *Lyme disease:Data and statistics*. Retrieved from Lyme disease: Data and statistics: http://www.cdc.gov/lyme/stats/index.html
- Center for Disease Control and Prevention. (2012, March). *Post-treatment Lyme disease syndrome*. Retrieved from Center for Disease Control and Prevention: http://www.cdc.gov/lyme/post_tx/index.html
- Cerone, k. (2008). Characteristics of adult learners with implications for online learning design. *Association for the Advancement of Computing Education Journal, 1*(2), 137-159.
- Cisak, E., Wojcik-Fatla, J., & Dutkiewicz, J. (2012). Repellents and acaricides as personal protection measures in the prevention of tick-borne diseases. *Annals of Agricultural and Environmental Medicine, 19*(4), 825-30.
- Eisen, R. J., Pleman, J., Zielinski-Gutierrez, E., & Eisen, L. (2012). What do we need to know about disease ecology to prevent Lyme disease in the northeastern United States? *Journal of Medical Entomology, 49*(1), 11-22.
- Eng, E. M. (2012). *Erythema migrans rash types*. Bay Area Lyme Foundation.
- Eng, E. M. (2012). *Tick Bite Chart*. Bay Area Lyme Foundation.
- Epocrates. (2016). *Doxycycline*. Retrieved from Epocrates: https://online.epocrates.com/drugs/209/doxycycline

References

- Fallon, B. A., Kelly, J. G., Corbera, K. M., Petkova, E., Britton, C. B., Dwyer, E., . . . Sackeim, H. A. (2008, March). A randomized, placebo-controlled trial of repeated IV antibiotic therapy for Lyme encephalopathy. *Neurology, 70*(13), 992-1003. doi:10.1212/01.WNL.0000296904.91160.2d
- Gutierrez, R. L., & Decker, C. F. (2012, June). Prevention of tick-borne illness. *Disease-a-Month, 58*(6), 377-387.
- Hamer, S. A., Hickling, G. J., Sidge, J. L., Walker, E. D., & Tsao, J. I. (2011, November). Synchronous phenology of juvenile Ixodes scapularis vertebrate host relationships and associated patterns of Borrelia burgdorferi ribotypes in the Midwestern United States. *Ticks and Tick-borne Diseases, 2*(2), 62-71.
- Henry, B., Crabtree, J., Roth, D., Blackman, D., & Morshed, M. (2012, May). Lyme disease: Knowledge, beliefs and practices of physicians in low-endemic area. *Canadian Family Physician, 58*(5), 568-592.
- Hill, D. G. (2013, November). Provider knowledge, attitudes, and practices regarding Lyme disease in Arkansas. *Journal of Community Health, 40*(2), 339-349.
- Hu, L., Steere, A. C., & Nby, J. (2016, August 17). *Clinical manifestations of Lyme disease in adults*. Retrieved from UpToDate: https://www.uptodate.com/contents/clinical-manifestations-of-lyme-disease-in-adults?source=preview&search=lyme+disease+stages&language=en-US&anchor=H3&selectedTitle=2~150#H4
- Johnson, L., Aylward, A., & Stricker, R. B. (2011). Healthcare access and burden of care for patients with Lyme disease: A large United States survey. *Health Policy, 102*, 64-71.

References

- Kaplan, R. F., Trevino, R. P., Johnson, G. M., Levy, L., Dornbush, R., Hy, L. T., . . . Wormser, G. P. (2000, June). Cognitive function in post-treatment Lyme disease: Do additional antibiotics help? *Neurology, 54*(11), 1473-1480.
- Kessler, G. S. (2011). *Adult learning theory*. Retrieved from http://teachinglearningresources.pbworks.com/w/page/36910216/andragogy--adult%20Learning%20Theory
- Klempner, M. S., Hu, L. T., Evans, J., Schmid, C. H., Johnson, G. M., Trevino, R. P., . . . Weinstein, A. (2001, July). Two controlled trials of antibiotic treatment in patients with persistent symptoms and history of Lyme disease. *New England Journal of Medicine, 345*(2), 85-92. doi:10.1056/NEJM200107123450202
- Krupp, L. B., Hyman, L. G., Grimson, R., Coyle, P. K., Melville, P., Ahnn, S., . . . Chandler, B. (2003, June). Study and treatment of post Lyme disease (STOP-LD): A randomized double masked clinical trial. *Neurology, 60*(12), 1923-1930.
- Mankoff, J., Kuksenok, K., Rode, J. A., Hester, S., & Waldman, K. J. (2011, May). Competing online viewpoints and models of chronic illness. *Online Communities & Social Computing, 2*, 259-268.
- Marchese, N. M., & Primer, S. R. (2013, May). Targeting Lyme disease. *Nursing, 43*(5), 29-33.
- McGrath, V. (2009). Reviewing the evidence on how adult students learn: An examination of Knowles' model of andragogy. *The Irish Journal of Adult and Community Education*, 99-110.
- Melnyk, B. M., & Fineout-Overholt, E. (2011). *Evidence-Based Practice in Nursing & Healthcare (2nd ed.)*. Philadelphia: Lippincott Williams & Wilkins.
- Moore, K. S. (2015, January). Lyme disease Diagnosis, treatment guidelines, and controversy. *The Journal for Nurse Practitioners, 11*(1), 94-98. doi:10.1016/j.nurpra.2014.08.021

References

- Nichols, C., & Windemuth, S. (2013, June). Lyme disease: From early localized disease to post-Lyme disease syndrome. *The Journal for Nurse Practitioners, 9*(6), 362-367.
- Sanchez, E., Vannier, E., Wormser, G. P., & Hu, L. T. (2016, April). Diagnosis, treatment, and prevention of Lyme Disease, human granulocytic anaplasmosis, and babesiosis: A review. *The Journal of the American Medical Association, 315*(2145), 1767-1777. doi:10.1001/jama.2016.2884
- Shen, J. K., Mead, P. S., & Beard, C. B. (2011). The Lyme disease vaccine: A public health perspective. *Clinical Infectious Diseases, 52*(3), 347-352. doi:10.1093/cid/ciq115
- Vaughn, M. G., & Meshnick, S. R. (2011). Pilot study assessing the effectiveness of long-lasting permethrin-impregnated clothing for the prevention of tick bites. *Vector Borne and Zoonotic Diseases, 11*-7. doi:10.1089/vbz.2010.0139
- Wood, C. L., & Lafferty, K. D. (2013, April). Biodiversity and disease: A synthesis of ecological perspectives on Lyme disease transmission. *Trends in Ecology and Evolution, 28*(4), 239-247.
- Wormser, G. P., Dattwyler, R. J., Shapiro, E. D., Halperin, J. J., Steere, A. C., Klempner, M. S., . . . Nadelman, R. B. (2006, November). The clinical assessment, treatment, and prevention of Lyme disease, human granulocytic anaplasmosis, and babesiosis: Clinical practice guidelines by the Infectious Diseases Society of America. *IDSA Guidelines, 43*, 1089-1941.
- Wormser, G. P., Schriefer, M., Iguero-Rosenfeld, M. E., Levin, J., Steere, A. C., Nadelman, R. B., . . . Dumler, J. S. (2013, June). Single-tier testing with the C6 peptide ELISA as compared to two-tier testing for Lyme disease. *Diagnostic Microbiology and Infectious Disease, 74*(1), 8-13.
- Wressnigg N, Pollabauer E, Jochinger G, Poremouth, D., Lovo-Gasalli J., Fritsch, S., . . . Sennet, P. N. (2013, August). Safety and immunogenicity of a novel multi-stem OspA vaccine against Lyme borreliosis in health adults: A double-blind, randomized, dose-escalation phase I/II trial. *The Lancet Infectious Disease, 13*(8), 690-699. doi:10.1016/S1473-3099(13)70110-5

INCORRECT

A. Order an ELISA test and wait for results to treat.

ELISA sensitivity within the first several weeks is less than 65%. ELISA should not be obtained before 2 weeks of illness. Antibodies can take up to 8 weeks or longer to be produced. This patient should be diagnosed clinically.

INCORRECT

B. Treat patient for Lyme disease and obtain an ELISA.

The patient should be treated for Lyme disease at this time. The diagnosis of Lyme disease can be clinical. The ELISA should not be obtained before 2 weeks of illness. Antibodies can take up to 8 weeks or longer to be produced. ELISA sensitivity within the first several weeks is less than 65%.

INCORRECT

C. Refer patient to infectious disease.

If the patient is out of your scope of practice this would be appropriate. Typically this patient can be managed in primary care. Referral should be considered if the patient presents with serious neurologic or cardiac manifestations, recurrent arthritis, late disseminated disease, or PTLDS.

CORRECT

D. Treat patient for Lyme disease, do not obtain any related laboratory testing at this time.

The patient should be diagnosed clinically with the presenting signs, symptoms (fever, myalgias, headaches, fatigue) and history (endemic area, tick attachment). No laboratory testing for Lyme disease should be obtained at this time, since it is to early in the disease course. The ELISA should not be obtained before 2 weeks of illness. Antibodies can take up to 8 weeks or longer to be produced. ELISA sensitivity within the first several weeks is less than 65%.

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APPENDIX E. BAY AREA LYME FOUNDATION PERMISSION FOR IMAGE USE

To whom it may concern,

I am Nurse Practitioner student at North Dakota State University. I am doing a dissertation project on Lyme disease to promote awareness in healthcare providers through an educational module and would love to use a few of your illustrations by Emily Eng if possible. The following are the two I would like to include within the educational module:

1. Erythema migrans rash types

2. Tick size chart

Sincerely,

Sheila Greseth

Hi Sheila,

Please credit Bay Area Lyme Foundation for the use of these images in your paper. Thanks.

Dianne

APPENDIX F. TERC PERMISSION FOR IMAGE/VIDEO USE

To whom it may concern,

I am a DNP student at North Dakota State University who is developing a module on the prevention, diagnosis, and prevention of Lyme disease to help educate healthcare providers. I would love to use your video on "How to Remove a Tick" and the Tick Engorgement Stages image within the module. Please don't hesitate to contact me with any questions. Thank you for considering.

Sheila

Greetings Sheila,

Thank you for requesting permission to use the video and image.

You may use it for non-commercial, educational presentations. If at any point you or North Dakota State University are charging attendees for a prevention program or other, we would require a small license fee.

Thank you again!

TERC

APPENDIX G. INVITATION FOR AANP COURSE PARTICIPATION

NDSU NORTH DAKOTA STATE UNIVERSITY

Dear Healthcare Provider:

My name is Sheila Greseth. I am in the Doctor of Nursing Practice program at North Dakota State University, and I am conducting a practice improvement project to improve provider knowledge about Lyme disease through an online educational module. The course is titled "Addressing Lyme Disease: An Educational Module for Healthcare Providers." By participating you may benefit by gaining awareness and knowledge in relation to the prevention, associated testing, diagnosis, and treatment of Lyme disease. In addition, after the completion of the 42-minute educational module, 1.0 contact hours of continuing education will be awarded through the American Association of Nurse Practitioners (AANP).

The course website is: https://aanp.inreachce.com/Details?groupId=0b96af6f-8ffc-4d6f-8828-50f329e5f1f9

Click on the address above to go directly to the AANP website for the module. Next click on the "Register Now" button in the upper right of the screen. If the link does not work, copy and paste the above URL into the address bar of your internet browser or go to https://cecenter.aanp.org/ and type in "Lyme disease" in the search bar. The module will be the first option.

If you choose to participate in this practice improvement project, you will be asked to complete a pretest and participate in an educational module on Lyme disease. Following the completion of the module you will complete a posttest and a short survey including questions on demographics,

healthcare experience and evaluation of the educational module. The time estimated for your participation in the course is approximately 60 minutes.

Your participation in this project is strictly voluntary and we will keep private all records that identify you. We may publish the results; however, we will keep your name and other identifying information private.

If you have any questions, please contact me at sheila.noska@ndsu.edu or contact my advisor at (701) 231-8355 or dean.gross@ndsu.edu.

Thank you for your taking part in this practice improvement project.

Sincerely,

Sheila Greseth RN, BSN, DNP-Student

Department of Nursing

North Dakota State University, Fargo, ND

APPENDIX H. HEALTHCARE PROVIDER DEMOGRAPHIC SURVEY

1. What is your age?
    - ☐ 30 and under
    - ☐ 31-50
    - ☐ 51-70
    - ☐ 71 or older
2. What is your gender?
    - ☐ Male
    - ☐ Female
3. What is your ethnicity/race?
    - ☐ White/Caucasian
    - ☐ Hispanic/Latino
    - ☐ African American/Black
    - ☐ Asian/Pacific Islander
    - ☐ Other _____
4. What is the highest level of education you have completed?
    - ☐ Master's degree
    - ☐ Doctoral degree
    - ☐ Professional degree (MD, JD etc.)
5. Which of the following best describes the type of practitioner you are?
    - ☐ Family/general practice
    - ☐ Internist
    - ☐ Nurse practitioner
    - ☐ Other_____
6. How many years have you been practicing?
    - ☐ 5 years or less
    - ☐ 5-10 years
    - ☐ Greater than 10 years

7. How many patients per week do you see?
    - ☐ 50 patients or less
    - ☐ 50-100 patients
    - ☐ Greater than 100 patients

APPENDIX I. PRETEST AND POSTTEST QUESTIONS

1. In the United States, high endemic areas of Lyme disease are:

    a. Minnesota, Connecticut, Colorado, New Mexico

    b. Southwestern United States, Washington, Montana

    c. Northeastern & upper Midwestern United States, Northwestern California

    d. North Dakota, West Virginia, Northeastern United States

2. What is the minimum length of time a tick needs to be attached to transmit Lyme disease?

    a. 12 hours

    b. 24 hours

    c. 48 hours

    d. 72 hours

3. What is the causative agent of Lyme disease?

    a. Rickettsia rickettsii

    b. Borrelia burgdorferi

    c. Kingella kingae

    d. Shigella sonnei

4. Erythema migrans is sufficient for diagnosis of Lyme disease.

    a. True

    b. False

5. What are manifestations of Lyme disease?

    a. Fever, erythema migrans, arthritis, goiter

    b. Diarrhea, myalgias, meningitis, arthritis

    c. Goiter, fever, diarrhea, atrioventricular (AV) blocks, myalgias

    d. Erythema migrans, AV blocks, arthritis, meningitis, fever

6. What stage of Lyme disease begins when the spirochete bacteria spreads through lymphatic and hematologic pathways causing multiple EM lesions, acute neurological and/or cardiac symptoms?

    a. Early disseminated

    b. Late disseminated

    c. Post treatment Lyme disease syndrome

    d. Early localized

7. What testing is appropriate for confirming Lyme disease as a diagnosis? (Please select all that apply).

    a. Two-tiered testing (ELISA & Western Blot)

    b. Western Blot alone

    c. Quantitative CD57 lymphocyte assays

    d. Culture with immunofluorescence staining

8. Treatment of Lyme disease with doxycycline is contraindicated for children <8 years old.

    a. True

    b. False

9. Prevention strategies for Lyme disease include:

    a. Wearing long sleeve shirts, pants, tucking pants into socks

    b. Using insect repellent

    c. Owning cats and dogs

d. Proper removal of ticks with tweezers

e. Feeding animals such as deer, bears, and birds

f. Eliminating or minimizing wood piles, brush, and tall grassy areas in yards

g. a, b, d, & f

h. All of the above

10. Characteristics of late disseminated Lyme disease include:

a. Symptoms present months to years after infection with common manifestations of arthritis, subtle encephalopathy, peripheral neuropathies, and spinal radicular pain

b. Occurs after appropriate antibiotic therapy with symptoms of fatigue, myalgias, arthralgias, cognitive difficulties, and headaches

c. Multiple EM lesions, acute neurological and/or cardiac symptoms that occur when the spirochete bacteria spreads through the lymphatic and hematologic pathways.

d. Erythema migrans and nonspecific symptoms such as fatigue, headache, myalgias, arthralgias, fever, anorexia, neck stiffness, and regional lymphadenopathy

11. What is appropriate treatment for early localized Lyme disease?

a. 100 mg Doxycycline twice daily for 10-21 days

b. 500 mg amoxicillin three times daily for 14-21 days

c. 500 mg cefuroxime axetil twice daily for 14-21 days

d. a & c

e. All of the above

12. What stage of Lyme disease is characterized by erythema migrans and nonspecific symptoms such as fatigue, headache, myalgias, arthralgias, fever, anorexia, neck stiffness, and regional lymphadenopathy?

    a. Early disseminated

    b. Late disseminated

    c. Post treatment Lyme disease syndrome

    d. Early localized

13. Prophylaxis treatment for Lyme disease is which of the following?

    a. 100 mg doxycycline BID x 1 day

    b. 200 mg doxycycline once

    c. 100 mg doxycycline twice daily for 7 days

    d. 300 mg doxycycline once

14. What categorization of Lyme disease occurs after appropriate antibiotic therapy has been completed with symptoms that may include fatigue, myalgias, arthralgias, cognitive difficulties, and headaches?

    a. Early localized

    b. Early disseminated

    c. Late disseminated

    d. Post treatment Lyme disease syndrome

15. A patient presents with erythema migrans, no laboratory testing has been performed to date, and the patient cannot recall a tick bite. How would you treat this patient?

    a. Treat with antibiotic therapy for Lyme disease

    b. No antibiotic, reassure patient, no follow-up

    c. No antibiotic or Lyme disease testing, but see patient again for follow-up

    d. No antibiotic, test patient for Lyme disease

    e. No antibiotic, refer patient to a specialist

16. A patient presents with a known deer tick bite, no symptoms, no laboratory testing, and normal findings on examination.

    a. Treat with an antibiotic for Lyme disease

    b. No antibiotic, reassure and educate patient, follow up as needed

    c. No antibiotic, test patient for Lyme disease

    d. No antibiotic, refer patient to a specialist

17. A patient who recently went on vacation in Connecticut presents with fever, myalgias, arthralgias and fatigue; no erythema migrans is seen on examination. Patient reports finding a tick attached upon arrival home 2 days ago. ELISA results come back negative.

    a. Treat with antibiotic therapy for Lyme disease

    b. No antibiotic, reassure patient, see patient for follow-up

    c. No antibiotic, test patient for Lyme disease in 2 weeks

    d. No antibiotic, refer patient to a specialist

18. A patient presents with a 6 month history of joint pain, migraines, and with symptomatic complete heart block. Patient has no history of erythema migrans. It is unknown if the patient has ever been bitten by a deer tick, but the patient spends a lot of time outdoors and lives in Minnesota. Patient has not received antibiotics. No cause for symptoms on initial work-up.

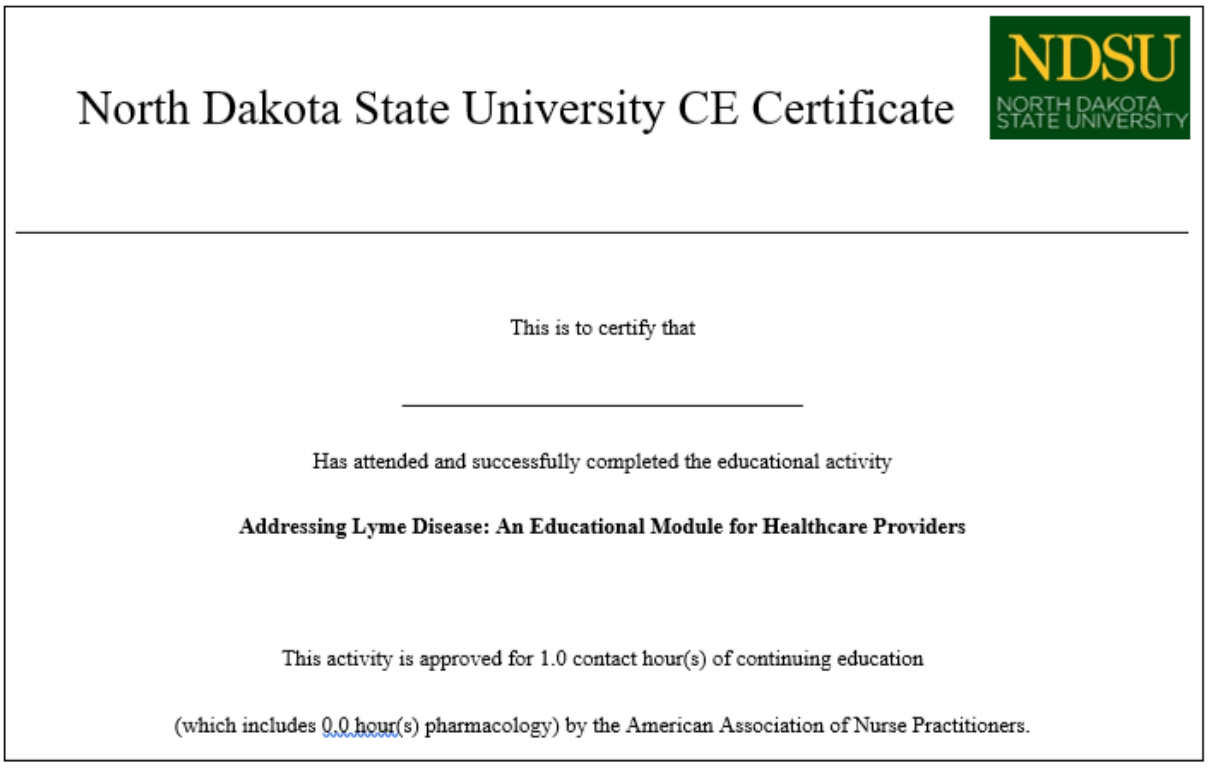
    a. Treat with antibiotic therapy for Lyme disease and follow up as needed

    b. Admit patient to hospital, refer patient to specialists

    c. No antibiotic, test patient for Lyme disease

    d. No antibiotic, refer patient to a specialist

APPENDIX J. AANP CONTINUING EDUCATION CERTIFICATE



North Dakota State University CE Certificate

NDSU NORTH DAKOTA STATE UNIVERSITY

This is to certify that

_____

Has attended and successfully completed the educational activity

Addressing Lyme Disease: An Educational Module for Healthcare Providers

This activity is approved for 1.0 contact hour(s) of continuing education

(which includes 0.0 hour(s) pharmacology) by the American Association of Nurse Practitioners.

APPENDIX K. AANP CE PROGRAM EVALUATION QUESTIONS

Program Title: Addressing Lyme Disease Program ID #_____

Date: _____ Location: AANP Online Continuing Education Center

Rating Scale: 1=poor 2=fair 3=average 4=good 5=excellent

Objectives:

1. How well did the CE activity help you achieve stated objectives?

a. State factors that increase risk of contracting Lyme and ways to prevent LD.	1	2	3	4	5
b. Recognize barriers to early diagnosis and treatment of LD.	1	2	3	4	5
c. Identified interventions to improve awareness amongst providers and systematize diagnosis and treatment of LD.	1	2	3	4	5
2. I would recommend this program to my colleagues.	1	2	3	4	5
3. This activity enhanced my current knowledge base.	1	2	3	4	5

4. What did you find most helpful?

5. What did you find least helpful?

6. Please provide suggestions for improvement below:

APPENDIX L. EXECUTIVE SUMMARY

Introduction

Lyme disease (LD), a zoonotic vector-borne disease, has caused debilitating illness in children and adults across the United States, Europe, and Asia for years. The risk of acquiring LD is on the rise and is spreading to areas today that were not affected in the past. Over 30,000 cases of LD are reported every year in the United States, but documented cases do not capture every diagnosis, estimates of actual cases being approximately 300,000 (Center for Disease Control and Prevention [CDC], 2015). LD can be a debilitating disease that causes a wide array of life threatening complications including meningitis and heart arrhythmias if not treated promptly and properly.

Although often associated with geographical locations of states in Northeastern and upper Midwestern United States, LD has been reported in nearly every state (CDC, 2015). With the already increasing reported cases within the United States, the ability for individuals to travel, and the lack of patient and provider awareness, all healthcare providers need to be vigilant when assessing patients for possible LD. One survey conducted on United States healthcare providers found that over 30% of the providers did not feel knowledgeable about tick-borne disease (Brett et al., 2014). The need for an educational module was established through a literature review of providers' knowledge and through observance of various views and practices among healthcare providers.

Project Purpose

Expanding provider knowledge about LD including prevention, signs and symptoms, diagnosis, testing, and treatment are essential components in decreasing the incidence and complications related to LD (Hill, 2013). Many healthcare providers' lack of knowledge can put

patients at risk for not only contracting LD, but developing PTLDS or late stage LD when treatment has been delayed or inappropriate. To address the knowledge gap, an online educational module was developed for healthcare providers to increase knowledge and awareness of LD.

Project Description

The target audience of the continuing education module were healthcare providers who deliver care to individuals at risk for LD. The educational module was approximately 1 hour and provided participants with 1.0 contact hours of continuing education credits through AANP CEC. The modules design consisted of a power point presentation with pictures, case studies, graphs, videos, and written text that support the advancement of provider's knowledge on LD. The educational module incorporates information on the prevention, diagnostic strategies, and treatment options for early LD. Not only were contributing factors discussed such as endemic areas, behavioral risks, and varying symptom presentations, but common barriers to proper treatment of LD as well.

Results

The program's completion rate was approximately 74.2%, as 411 individuals initiated the continuing education module, and 305 participants finished the module and received the 1.0 hour continuing education credit. Nearly 10 weeks of data were collected from 305 participants from across the United States. Over 90% of participants felt that the continuing education module met all three objectives "completely" or "quite a bit" (see Table 1). Additionally, 283 (92.8%) of the 305 participants felt that the continuing education module enhanced their current knowledge base completely or quite a bit. Several participants commented on what was helpful throughout the

continuing education module including treatment protocols, diagnostic recommendations, differentiating the stages of LD, images, and the tick removal video.

Table L1

Participant Objective Responses

How well did the CE activity help you achieve this objective?	Completely (%; n)	Quite a bit (%; n)	Neutral (%; n)	Somewhat (%; n)	Not at all (%; n)
4. State factors that increase risk of contracting LD and ways to prevent LD	40.3; 123	50.5; 154	5.2; 16	3.0; 9	1.0; 3
5. Recognize barriers to early diagnosis and treatment of LD	43.9; 134	49.5; 151	3.9; 12	2.0; 6	0.7; 2
6. Identified interventions to improve awareness amongst providers and systematize diagnosis and treatment of LD	42.65; 130	49.85; 152	5.2; 16	1.6; 5	0.7; 2

With 17 of the 18 content-related questions, the percentages of correct answers increased from the pretest to the posttest scores. The approximate increase in posttest scores ranged from 3% to 50%, demonstrating that learning occurred in direct relation to the continuing education module. The pretest and posttest contained 4-5 direct questions for each of the 3 objectives, with improvement of comparison score in all (see Table 2, 3, & 4). An additional 4 case study questions were present to allow for application of comprehensive knowledge, 3 of 4 questions had improvement of scores (see Table 5).

Table L2

Objective 1 Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change (%)
Question 1	47.6, 145	70.8, 216	23.2
Question 2	37.7, 115	77.9, 238	40.2
Questions 9	86.7, 264	90.5, 276	3.8
Question 13	26.0, 79	75.9, 231	49.9

Table L3

Objective 2 Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change (%)
Question 3	66.5, 202	96.4, 294	29.9
Question 4	34.1, 104	75.6, 230	41.5
Questions 5	50.8, 154	80.5, 245	29.7
Question 7	78.9, 241	85.3, 260	6.4
Question 8	82.0, 250	90.8, 277	8.8

Table L4

Objective 3 Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change
Question 6	26.6, 81	58.5, 178	31.9
Question 10	32, 98	41.6, 127	9.6
Questions 11	16.5, 50	48.4, 148	31.9
Question 12	60.9, 186	74.9, 229	14.0
Questions 14	27.3, 68	42.3,129	15.0

Table L5

All Objectives: Case Study Score Comparisons

Correct Response Comparisons (n=305)	Pre (%, n)	Post (%, n)	Change
Question 15	54.1, 163	68.2, 208	14.1
Question 16	34.9, 106	33.6,103	-1.3
Questions 17	51.4, 157	59, 180	7.6
Question 18	50.0, 153	58.9, 180	8.9

Recommendations

Due to the positive results of the continuing education module that were made evident by the improvement of posttest scores and constructive evaluation responses, the module is practical to recommend to all healthcare providers to partake in to close the knowledge gaps that exist in LD. Being that AANP CEC targets nurse practitioners, further encouragement of other health professionals such as physicians and physician assistants to complete the module is recommended. Additionally, recommending the continuing education module be incorporated into the curricula of family nurse practitioners is realistic to help meet core competencies.

Implications for Practice

The practice improvement project adds to the current literature available authenticating healthcare provider knowledge gaps that exist related to the prevention, diagnosis, and treatment of LD. Healthcare provider education on LD has the potential to decrease the gaps in patient care that can lead to undesirable health outcomes and enhance the awareness of not only healthcare providers, but the community and patients as well.

Through completing educational activities specific to LD healthcare providers may be enabled to deliver competent, patient-centered healthcare to the population. Enhanced awareness

and knowledge of risk factors, prevention strategies, diagnostic testing, clinical diagnosis, and treatment protocols has the potential to improve appropriate treatment and health outcomes of individuals at risk or diagnosed with LD.

Implications for Further Research

The need for further research and educational activities to promote healthcare providers' knowledge related to LD is confirmed by past and current research and the continuing education module's survey findings. Developing another continuing education module could assist in examining barriers to individual and community prevention of LD, along with diagnostic and treatment barriers among healthcare providers. Additional research is also needed in the development of more accurate testing methodologies in early LD and appropriate treatment for individuals suffering from PTLDS. There is not a vaccine that is currently available for use today, but current vaccine development is in process through Baxter pharmaceuticals with further research needed to examine the safety and efficacy of the vaccine on a larger scale. Additional research could also focus on barriers to reintroducing a LD vaccine.

Conclusions

Based on the pretest and posttest comparison improvements, and the participants' positive responses in regards to the module meeting objectives and enhancing knowledge, the continuing education module was an effective intervention to enhance participants' knowledge and awareness of LD. The continuing education module on LD should continue to be offered until the end date of December 2018. Also, developing or updating the module after the program closes would assist in continuing to close the knowledge gap present in healthcare providers in relation to LD prevention, diagnosis, and treatment.