Master of Public Health

Integrative Learning Experience Report

TICK-BORNE DISEASES

By

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submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

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Abstract

The spread of tick-borne pathogens in the United States has risen significantly and, despite this spread, the public is not fully aware of the threat posed by these pathogens at the local level. To address this concern, I researched and developed portfolio products specifically for the Seventy-First Animal Hospital in Fayetteville, North Carolina. The portfolio products included five Facebook posts on the threat posed by tick-borne diseases, an intra-clinic training presentation, and a client brochure on the tick threat in Southeastern North Carolina. As a veterinary assistant at the Seventy-First Animal Hospital, I have seen firsthand how tick-borne diseases in the community impact both humans and animals in a household. Using the knowledge and valued competencies acquired from the Kansas State's Master of Public Health program, I have put into practice the key competencies by developing the portfolio products for the patrons, administrative staff, and medical staff at The Seventy-First Animal Hospital.

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Chapter 1 - Literature Review

Introduction

Worldwide, there are more than 900 species of ticks (Sonenshine et al. 2013a). Ticks are identified as arthropods because they feed on blood. Ticks belong to the Ixodida suborder of the Parasitiformes order and are classified as part of the Acari suborder. There are three families of ticks. The first family is hard ticks or the Ixodidae, which are found in the East and Midwest of North America and the southeast of Canada. The second family of ticks is soft ticks and there are two types of soft ticks. The first type of soft ticks is the Argasidae, found in arid regions of North and South America, India, and South Africa. The second type of soft ticks are the Nuttallielidae, which is only found in South Africa (Sonenshine et al. 2013a). Hard ticks are classified by their sclerotized dorsal plate compared to soft ticks, which are classified by their flexible, leathery exoskeleton. Of all tick species found worldwide, only a handful are responsible for transmitting various pathogens, including protozoans, viruses, and bacteria (Medina et al., 2021). The Ixodidae tick family is responsible for spreading most diseases. Within this family, only a handful "carry a wider array of disease-causing bacteria" found in this family of ticks (Admin, 2022).

Over the past 40 years, the number of individuals infected with tick-borne diseases has increased significantly in the United States. Lyme Disease is the most reported type of tick-borne disease. According to the Centers for Disease Control and Prevention (CDC), other common tick-borne diseases include babesiosis, ehrlichiosis, Rocky Mountain Spotted Fever, anaplasmosis, Southern Tick-Associated Rash Illness, Tick-Borne Relapsing Fever, and tularemia (CDC, 2011). Research into these tick-borne diseases has enabled the scientific community to better understand how individuals are affected by these diseases and how ticks infect people. This research is important for advancing global health. Understanding tick-borne etiology requires understanding anatomy, habitat, host interaction, and life cycle. This enables researchers to understand how pathogen transmission happens and enables scientists to develop processes to slow the spread of tick-borne diseases.

Tick Anatomy

There are three significant parts to a tick's anatomy: the capitulum (head), the body, and the legs. As indicated in Figure 1-1, the capitulum contains two paired chelicerae, two palps, and an unpaired hypostome. The main parts of the mouth include the chelicerae, which enable a tick to cut into a host's skin, gaining access to the host's blood. The palps are sensory organs of a tick that enable a tick to detect an approaching host. The barbed hypostome enables a tick to anchor itself to the host during feeding (Tick Anatomy, 2022).

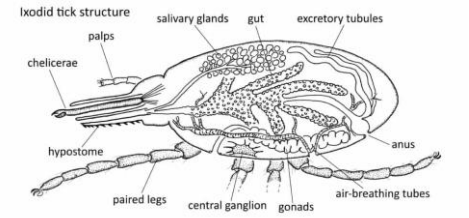

Figure 1-1 Anatomy of a Tick

Source: Ticksafety, 2022

The external body of hard and soft ticks differs, with only the hard tick possessing a sclerotized plate or scutum that covers part of the body (Tick Anatomy, 2022). A tick's body consists of various internal organs bathed in hemolymph to form an open circulatory system that provides nutrients to the different parts of the body (Sonenshine & Roe, R. M., 2013a). The body cavity includes the central nervous system fused in one structure, the synganglion, and an extensive tracheal system that reaches out and holds organs in place (Stark et al. 2018). Salivary glands in the body cavity serve as organs of osmoregulation and are the site of pathogen development. Typically, ticks will have six paired legs in the larva stage and eight paired legs in the nymph and adult phases. The paired legs are covered in tiny spiny hairs and a small little claw at the end, allowing ticks to grasp their host or items in the environment (Tick Anatomy, 2022). According to the CDC, the general size of a tick differs depending on the stage of

development. An adult tick is "approximately the size of a sesame seed, and nymphal ticks are approximately the size of a poppy seed" (CDC, 2022a).

Habitat/Host

In the United States, naturally occurring populations of ticks can be found in all states except Alaska and can be active year-round (CDC, 2011). Geographically, the highest number of reported tick-borne diseases occur in the Northeast and Midwest of the United States, and the number of reported cases is increasing. According to the CDC (2011), tick-borne diseases are increasing because of habitat change and climate change. The ideal tick habitat consists of a protected area, such as a densely shaded wooded area that is humid/moist which is essential for survival. Generally, ticks are found at the ground level and cling to tall grass and low shrubs (Ticks, 2022). Because of their anatomy, ticks are slow movers. They do not jump or run; instead, they crawl. While waiting for a host, they perform an action called questing, where they hold onto grass or leaves with their third or fourth leg, allowing them to hold out their first pair of legs to attach to or climb onto a host (CDC, 2020). A tick finds its hosts by "detecting animals′ breath and body odors or by sensing body heat, moisture, and vibrations" (CDC, 2020). For a tick to survive, it must take at least one blood meal during each of the three stages of its life. The blood meal is from various sources, including mammals, birds, and reptiles (Sonenshine et al. 2013a). Depending on the tick species and stage of life, the most common blood hosts are white-footed mice, white-tailed deer, and birds (Ticks, 2022). Typically, ticks prefer a different host at each stage of their life, thus increasing the likelihood of transmitting pathogens from one host to the next if they are infected by a pathogen (CDC, 2020).

Life Cycle of Ticks/ Reproduction

As depicted in Figure 1-2, a tick goes through four life stages: an egg, a larva, a nymph, and an adult. Beginning in the larva stage to the adult stage, a tick must have a blood meal to survive. Depending on the species, the lifecycle of a tick is two to three years, but many do not complete their life cycle (and die) because they are not able to find a blood meal (CDC, 2020). During the first stage, eggs are usually laid in the spring and hatch at the end of spring into summer. During this life cycle, a tick is considered a larva. For the hard tick, the larva only needs one blood meal to molt from a larva into a nymph and from a nymph into an adult tick. Some species of soft ticks require several blood meals between each life stage. Once an adult, male ticks mate with one to two females and then die shortly after mating. Typically, the female

tick lays thousands of eggs in the spring and then dies shortly after. With the eggs laid, the life cycle of a tick is repeated.

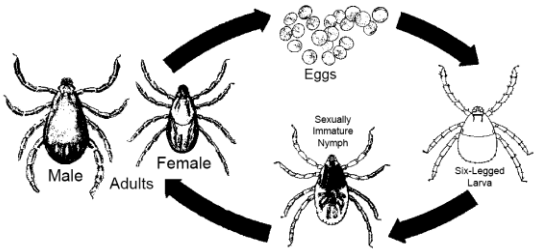

Figure 1-2 Life Cycle of Ticks

Source: Gibb, 2016

Tick reproduction is unique and, depending on the species, a tick can be sexual or asexual. Reproduction usually occurs in the winter when a male and a female tick reproduce sexually. Some species of ticks will reproduce before or after engorgement, and this blood meal is used for the nourishment of the eggs (New York Department of Health, 2011). The female tick will then lay her eggs on the ground, in a safe spot, usually near a trail, where the larva can find a host (Tick Research Lab of Pennsylvania, 2020).

The Transmission of Tick-borne Pathogens

The transmission of tick-borne pathogens starts at the larva stage when a tick is infected with a pathogen after feeding from an infected host. The transmission process occurs once the tick cuts into the host's skin inserts its feeding tube, and typically secretes a cement-type substance to keep it attached to the host during feeding (CDC, 2020). Once attached, the tick undergoes a process called engorgement, where the body grows substantially from the blood meal. When it first attaches, the tick secretes small amounts of saliva that contain an anesthetic property that numbs the area, so the host does not feel the attached tick (CDC, 2020). Depending on the tick species, it can take several minutes to several hours to complete feeding. It is during

this first feed that a tick can become infected with a pathogen if the host's blood contains a pathogen. As the tick becomes engorged, the pathogen is metabolized throughout the body of the tick due to its open circulatory system. As indicated in Figure 1-3, the pathogen stays in the salivary glands. As the tick continues to go through its life stages, the pathogen is replicating in the tick, and there is a likelihood that the pathogen is passed to the new host through small amounts of saliva that enter the skin as the tick feeds (Sonenshine et al. 2013a).

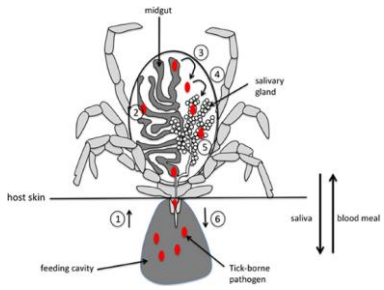

Figure 1-3 Transmission of Pathogens

Source: Simo et al., 2017

When a tick feeds again if the host is infected with a different pathogen, the tick acquires a second pathogen through engorgement; thus, ticks are able to carry and transmit multiple pathogens over their lifetime. If a tick is infected with a pathogen at the larva stage, as the tick develops through engorgement, there are at least two more opportunities to transmit or obtain a new pathogen from a host. During the final stage of a tick's life, if a female tick is infected with pathogens, it rarely transmits the pathogen to the thousand-something eggs the female lays. Because of the unique life cycle of ticks, the transmission of tick-borne diseases can occur over a 2- to 3-year period. In the United States, the transmission of tick-borne diseases occurs year-round. For example, humans are most at risk in late spring and early summer because ticks are in the nymph stage and are so small that they go unnoticed by the host when bitten (New York Department of Health, 2011). Animals, such as dogs, are most at risk in the winter of acquiring a

tick-borne disease from an adult tick because they will lay close to the ground which is an area where ticks are located.

Importance of Data Collection on Tick-Borne Diseases

Data collection is an important component of global health initiatives. This information can be used as a multi-purpose tool. Ongoing data collection in public health enables scientists to advance global health. For example, data on infectious and non-infectious diseases expand society's understanding of these diseases and enable public health officials to develop tools for decision-making, observation, and management. The collection of data is dependent on the field of study. In the United States, data on tick-borne diseases are gathered by tick researchers, U.S. public health departments, U.S. government agencies, and animal health experts such as veterinarians on a continued basis.

For the various types of tick-borne diseases, a search of Google's database indexes offers a wealth of information, especially data on Lyme disease that is readily available to the public. This data is located on the websites of state and local public health departments, the CDC, and non-profits focused on public health. The continued collection of data enables public health officials to observe, monitor, and better understand the threat of tick-borne diseases. The information gathered also enables researchers to develop and implement new measures that advance global health. Currently, the CDC's tick-borne disease surveillance program provides data focused on awareness and is used as an educational source. In the field of animal health care, veterinarians provide data that is available through the Companion Animal Parasite Council (CAPC) founded in 2002. However, the availability of data on human health and tick-borne diseases exceeds the amount of data generated from the animal healthcare sector. To understand both the strengths and weaknesses of the data, it is essential to discuss how tick-borne disease data is collected and defined. This enables researchers to identify where improvements in knowledge can be made and in turn enables researchers to work to advance tools against tick-borne diseases.

Data Reporting in Human Healthcare

Data collection in human healthcare starts in a healthcare setting and includes a doctor's office, urgent care facility, or hospital where a patient seeks medical care pertaining to a tick bite or underlying issues that correlate with a tick-borne disease. The medical provider may run a tick-borne panel to identify the suspected tick-borne diseases. If that patient is confirmed positive

and meets case guidelines as being reportable, then the healthcare provider reports the case to state and local health departments. Data collected consists of both confirmed cases or suspected cases of a tick-borne disease. This data is sent by state and local health departments to the CDC, which aggregates the data into tabular data and interactive maps showing trends of tick-borne disease over time, such as the information listed in Figure 1-4. The three maps in Figure 1-4 illustrate reported cases of Lyme Disease from 2001 to 2020 in the US. This information is available publicly through the CDC's website and is broken down by counties of a state. This data is an essential tool for tracking trends and developing new strategies for tick-borne disease management.

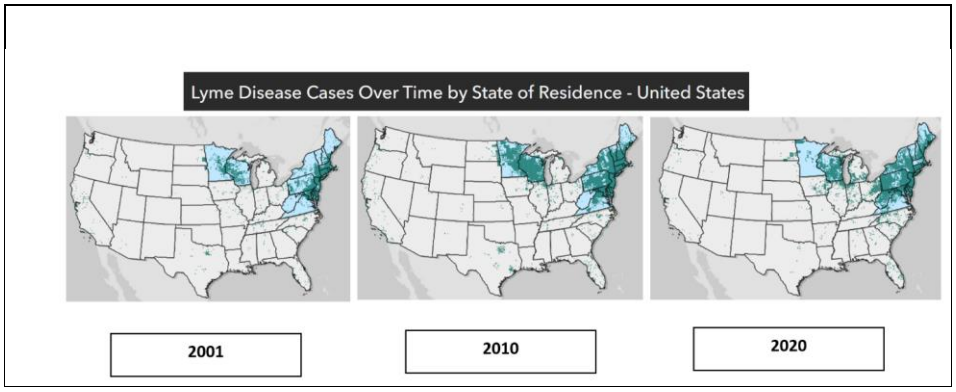

Figure 1-4 Lyme Disease in the United States
Source: Centers for Disease Control and Prevention, 2022

There are limitations to the reporting process of human infection discussed because it is dependent on individuals seeking medical treatment for a suspected tick bite and the ability of medical staff to diagnose illness as related to a tick bite. Individuals may have signs of a tick-borne disease but relate them to another ailment when seeking medical assistance. When a patient seeks medical attention, the tick-borne disease may not be diagnosed since many individuals can be unaware that a tick has bitten them. Depending on the doctor's assessment, if the doctor feels a patient is suspected of having tick-borne disease symptoms, the doctor may treat the underlying symptoms rather than wait for diagnostic testing to address the patient's

concerns. A second limitation relates to the costs associated with treating tick-borne disease. Health insurance plays a significant role in tick-borne disease data collection because, depending on an individual's insurance, diagnostic testing to confirm a tick-borne disease can be very pricey and may not be available in a patient's locale, and thus the insurance company may refuse to cover the testing. A third limitation relates to the doctor's record keeping. Even if a doctor identifies a confirmed or suspected case, the doctor's office may not have protocols in place to forward the information to the local or state health department. Lastly, some individuals infected by a tick-borne disease may be asymptomatic and thus unaware they have contracted a disease. Thus, given these limitations, it is assumed that the confirmed or suspected cases of tick-borne diseases are underreported, and the data does not indicate the true magnitude of tick-borne diseases yearly.

Data Surveillance in Animal Healthcare

Most data collected on animal health is considered surveillance because it is part of an animal's wellness routine. When an animal goes to a veterinary clinic for a wellness check, an essential part of the animal's check-up includes a blood sample. This blood sample allows several tests depending on the owner's agreement. The typical yearly panel runs for animals look at white and red blood cells, liver, kidney, and electrolyte values. Usually added to these panels are a test for heartworm and three tick-borne diseases. If an owner does not want a full panel run on a patient, they can have the option to test for heartworms alone or to include the three tick-borne diseases, which is more typical. If a patient tests positive for heartworms or the three tick-borne diseases, the doctor will plan accordingly and conduct additional tests to ascertain if there is an active infection. However, when it is determined there is an infection, veterinarians will note the infection in the patient's record. Unfortunately, until recently, there were no protocols to report the confirmed infection. Since 2002, an effort has been made to gather data on tick-borne disease in animals spearheaded by the testing laboratories, IDEXX Laboratories and ANTECH Diagnostics, which test blood samples submitted by veterinary clinics across the United States. This data is now sent to the Companion Animal Parasite Council, which aggregates the information for public dissemination.

Figure 1-5 is a graphical representation of this aggregated data for the Year 2019 and indexes the prevalence of Lyme Disease in companion animals throughout the United States.

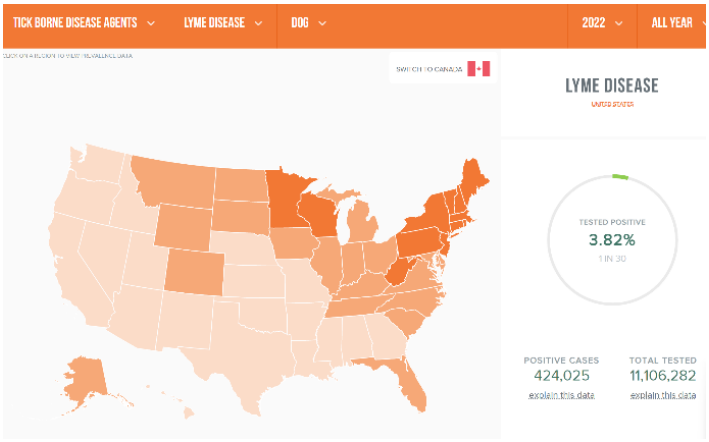

Figure 1-5 Lyme Disease in Companion Animals

Source: CAPC 2019

Data on the CAPC website provides information on positive cases for three major tick-borne diseases: Anaplasmosis, Ehrlichiosis, and Lyme Disease. The CAPC estimates the information in its database "represents less than 30% of the activity in the geographic regions" (CAPC, 2023); therefore, tick-borne diseases in companion animals are underreported.

Chapter 2 - The Applied Practice Experience

Introduction

For my Applied Practice Experience (APE), the field study focused on Fayetteville, North Carolina, which is located in the southeastern region of the United States and is home to many tick species that carry zoonotic tick-borne pathogens and various types of ticks harboring disease including the Deer Tick, American Dog Tick, Brown Dog Tick, and Lone Star Tick. The most common tick-borne diseases found in North Carolina include Lyme Disease, Ehrlichiosis, Anaplasmosis, and Rocky Mountain Fever. Over thirty years, the burden of tick-borne disease has continually increased in North Carolina and poses a significant health risk for humans and animals. Due to its climate and geography, the Fayetteville region is a perfect habitat for ticks because of its humid subtropical environment and mild winters. Year-round tick-borne diseases are a concern for humans and animals. My APE was conducted at the Seventy-First Animal Hospital located in Fayetteville, North Carolina. Lab testing associated with wellness checks reveals that, throughout the year, companion animals test positive for one or more tick-borne diseases. According to the CAPC, a total of 1,279 tick-borne diseases have been reported in the Fayetteville metropolitan area including Cumberland, Harnett, and Hoke Counties (CAPC 2023). The Seventy-First Animal Hospital services all three countries and thus is an excellent location for the APE.

APE Learning Objectives

For the APE, I pursued the following learning objectives:

1. To better understand the environmental health relationship between animals and humans.
2. Educate the Fayetteville community on the importance of preventing and treating tick-borne diseases.
3. Utilize the skill sets acquired through the Master of Public Health and put these into practice in the Fayetteville community.
4. Become an effective educator in my community.
5. Improve written communication proficiency.

Portfolio Products of the APE

As a veterinary assistant, who has worked at several veterinary hospitals in Southeastern North Carolina, I observed the importance of One Health in public health and animal health care. This realization influenced my decision to focus the APE on zoonotic tick-borne diseases at my current place of employment, The Seventy-First Animal Hospital in Fayetteville, North Carolina where I work as a veterinary assistant. In September 2022, I held a meeting with Julie Papp, the office manager at the Seventy-First Animal Hospital, to discuss conducting an APE at the Seventy-First Animal Hospital and have her serve as my preceptor for the project. I highlighted the threat of tick-borne diseases in North Carolina, and how I wanted to create educational materials for the staff and clients at the Seventy-First Animal Hospital. During a joint meeting with Mrs. Papp and my major professor Dr. Kastner, Mrs. Papp agreed to serve as the preceptor. It was agreed at the meeting that I would complete portfolio products on tick-borne diseases in companion animals, including multiple Facebook posts, an intra-clinic presentation for colleagues, and an educational brochure.

To complete the APE, I undertook the following steps or phases. First, I reviewed the current educational material on tick-borne diseases provided by the Seventy-First Animal Hospital to the staff of the hospital and the clients. This review indicated the educational materials only vaguely discussed tick-borne diseases and are not specific to the threat of tick-borne diseases present in North Carolina. Given the number of cases of tick-borne disease identified each year, both the staff and clients must be made aware of this threat. As a veterinary assistant at the hospital, I discovered during conversations with clients that many are unaware of the threat of tick-borne diseases to both them and their animals.

Once I identified how the APE would best serve the Fayetteville community, the second step of the APE was to gather information specific to the region based on data available through the three county health departments, the CDC, and the CAPC. The data indicated what types of ticks are active in the region, the type of tick-borne diseases found in companion animals, and tick prevention recommendations specific to North Carolina. This research focused on tick-borne pathogens, the complete transmission process, and how tick-borne diseases affect both humans and animals. During this research phase, I reached out to one of my committee members, Dr. Reif, who specializes in vector-borne disease, to get a better understanding of tick-borne

pathogens and how data is collected and processed. During a Zoom meeting, Dr. Reif explained the transmission process and suggested additional sources of information for tick-borne diseases found in companion animals in my local area.

During the third step of the APE, I developed my portfolio products for the APE, and I met multiple times with Mrs. Papp and other staff members at the Seventy-First Animal Hospital to ensure the materials apply to the clients. Listed in Table 2-1 are the portfolio products developed over several months and represent over 300 hours of meetings and research-and writing work.

Table 2-1 A Summary of Portfolio Products

Portfolio Product		**Description**
A.	Social media posts	Five posts about tick-borne diseases were posted on Seventy-First Animal Hospital's Facebook page. These blogs were used as an educational tool to make clients at Seventy-First Animal Hospital aware of zoonotic tick-borne disease and how to effectively protect themselves and their animals.
B.	Intra-clinic presentation for colleagues	A presentation was prepared and presented to train the staff of Seventy-First Animal Hospital. The training educated the team on how zoonotic tick-borne diseases are a public health concern and can be prevented through good client care and communication.
C.	Educational brochure	An educational brochure was created on tick-borne diseases endemic to North Carolina. The brochure was given to pet owners as a resource to protect themselves and their animals.

Social Media Educational Posts

The first portfolio product developed for the APE is social media educational posts submitted to the Seventy-First Animal Hospital Facebook page used to communicate with clients. From December 2022 to February 2023, I posted a total of five Facebook posts designed to educate clients on the threat posed by tick-borne pathogens. See Appendix A for a listing of the educational social media posts. The first educational post, titled "Let's Talk about Ticks," is an introduction designed to educate clients on the threat of tick-borne disease in North Carolina

and how pets are often accidental carriers that can bring ticks into the home. The second educational post informed clients that tick-borne disease is a year-round problem and that their companion animals need to stay on tick preventatives during the winter months even when temperatures may be below freezing. The post highlighted in-house tick preventions available through the Seventy-First Animal Hospital, including Bravecto, Simparica trio, and Revolution. The post includes a link to the hospital's online store. The third post sought to educate clients on the proper method for removing a tick, as discussed by the CDC, including an illustration of the method. The post also provided a CDC website link for clients interested in additional information on tick-borne diseases. The fourth post stressed the importance of yearly testing for tick-borne disease as an essential part of their animal wellness check-up. The post included a link to the CAPC's prevalence map highlighting first-hand the number of positive cases in the Fayetteville metropolitan area. Lastly, the fifth post sought to educate pet owners on the importance of performing routine body checks for ticks on companion animals that frequent areas known for tick infestations. The post includes illustrations from the CDC on where to check for ticks on their animal and themself. Also, the post included a link for owners interested in accessing additional preventive strategies against ticks. All five posts are easily accessible on Seventy-First Animal Hospital's Facebook page and can be accessed by future clients interested in tick prevention.

Intra-clinic Training for Hospital Staff

A second component of my APE is an intra-clinic presentation developed for the staff of the Seventy-First Animal Hospital. This presentation is designed as an essential training tool that educates the staff on the threat posed by tick-borne pathogens in North Carolina, the staff's role in public health, and how to effectively communicate and inform owners about tick-borne pathogens. The training was delivered through a PowerPoint presentation and activities designed to get the staff to interact through games leading to questions and prizes for correct answers. See Appendix B for the PowerPoint Presentation.

The presentation contains four parts. The first part of the presentation focuses on educating the staff on tick-borne pathogens and how these pathogens transmit from one host to another. The second section focuses on the ways pet owners can protect themselves and their companion animals, with an emphasis on the importance of client education, tick preventatives, and companion animal testing.

The third part of the presentation focuses on educating the staff on their role in public health and how the hospital's continued efforts to keep companion animals healthy contribute to global health. The fourth part of the presentation was an assessment of the training using a fun game I developed called "Who has a tick-borne disease?" The game assessed if the staff understood the importance of educating clients on tick-borne pathogens and the staff's role in public health. During the game, I received positive feedback from many staff members who stated they were unaware of how harmful tick-borne diseases were in North Carolina and now they felt more confident after the training to talk with owners about tick-borne diseases and the tick preventatives available through the Seventy-First Animal Hospital.

Educational Brochure

The third product of the APE is an educational brochure on tick threats and prevention in North Carolina. Research of brochures materials currently available at the Seventy-First Animal Hospital revealed only one brochure that addressed ticks and it was only for Lyme Disease in canines. To address this void in materials, I developed a brochure aimed at clients and the threat posed by tick-borne diseases. I titled the brochure, "Welcome to Tick-Borne North Carolina," to alert clients to the threat. See Appendix C for the educational Brochure.

Figure 2-1 Seventy-First Animal Hospital New Patient Packet

The initial distribution of the brochure coincided with the intra-clinic training presentation since it would serve as an essential educational tool used by the Seventy-First Animal Hospital to educate pet owners on tick-borne diseases. In addition to displaying the

brochure, each new client is given the brochure as part of the hospital's new patient packet of information. See Figure 2-1 on page 13. The brochure consists of nine related sections designed to educate owners on the nature of ticks, how ticks transmit diseases, ticks common to North Carolina that transmit diseases, and common health effects. The brochure also included a discussion on intervention strategies, preventative strategies for avoiding tick-infested areas, and how to correctly remove a tick. The portfolio products created for this APE have been adopted by Seventy-First Animal Hospital and will be utilized by the staff and clients for years to come.

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Chapter 3 - Summary of APE

Over the past two years, working part-time as a veterinary assistant at the Seventy-First Animal Hospital and enrolled as a full-time MPH student, I was continuously able to relate the significance of my public health courses to my work as a veterinary assistant. The APE allowed me to put into practice the knowledge acquired in the coursework and enabled me to impact my community. While tick-borne diseases are not a new public health issue, the continued spread of tick-borne diseases has led society to recognize this as a major issue for public health officials. Through the APE I created educational material specific to the Fayetteville, North Carolina metropolitan area designed to educate the community on the threat posed by tick-borne disease. Considering risk factors that contribute to the increase in tick-borne diseases, I was able to identify areas where client education is lacking. The most important finding is the realization that the staff and clients at the Seventy-First Animal Hospital are not fully aware of the threat posed by tick-borne diseases in Southeastern North Carolina. Research into this threat revealed the ability of ticks to transmit pathogens from one host to another is zoonotic in nature but the complexity of the issue can be confusing to the general public. Through research and an assessment of my hospital, I was able to develop educational materials to inform the public that the tick pathogen process can be seen as a simple process and that prevention can be a straightforward matter. As a result of the APE, the Seventy-First Animal Hospital staff now has the appropriate material needed to help protect owners and patients from tick-borne diseases. Clients are continuously encouraged to keep patients on a flea and tick preventative, check themselves and their pets for ticks, and increase their situational awareness of tick-borne disease as discussed in the materials and information provided by the staff at the Seventy-First Animal Hospital. From the portfolio products, the staff at the Seventy-First Animal Hospital are now empowered to do their part in global health and continue providing tick-borne disease education. In May 2023, I will attend the Ross School of Veterinary Medicine, but the educational materials developed for the APE will still be accessible to staff and clients.

Tick-borne diseases are not likely to go away overnight in Fayetteville, North Carolina but with continued efforts to make the public aware of the threat of tick pathogens in the community, there is continued hope the spread of tick-borne disease will decline over time. The Seventy-First Animal Hospital is just the start to slowing the spread of tick-borne diseases and

more will need to be done in the future. Through the APE, I hope I have inspired others to start making a change in their community because small things can lead to big changes in the future. It just takes one person to want to make a difference to empower others around them.

Chapter 4 - Competencies addressed in the Applied Practical Experience

My portfolio products developed for the APE emphasized specific competencies that are valued by K-State's MPH program. Of the twenty-two MPH competencies, five (7, 9, 16, 18, 19) were practiced as I completed the APE. Table 4-1 summarizes these competencies followed by a discussion of each competency.

Table 4-1 Summary of Completed MPH Foundational Competencies

Portfolio Product		**Number and Competency Addressed**	
A	Social media posts	18	Use of a social media platform to educate Seventy-First Animal Hospital clients on tick-borne diseases to reach simultaneously a large and diverse audience
B.	Intra-clinic presentation for colleagues	19	PowerPoint Presentation created that educates the Seventy-First Animal Hospital team on tick-borne diseases. Training provided the team with skill sets for effectively communicating with clients about how zoonotic diseases are a public health concern.
B.	Intra-clinic presentation for colleagues	16	Client education was promoted by training the Seventy-First Animal Hospital team on effectively communicating with clients on how to protect themselves and their animals against tick-borne diseases.
C.	Educational brochure	7	The development of an education program focusing on a sizable military population of new transfers to Fayetteville, North Carolina that accounts for most new pet owners in the Fayetteville, North Carolina area. The brochure is given to new clients to educate them on tick-borne diseases endemic to North Carolina.

Table 4-1 Continued

D.	Educational brochure	9	Through the educational brochure, Seventy-First Animal Hospital clients are provided with intervention strategies for tick-borne diseases.

Competency 18

Competency 18 stresses communication as an essential tool used in the public health field. This competency was covered by several MPH core courses. Throughout the courses, I learned how to recognize and select different communication strategies that would allow me to engage diverse audiences and sectors. In one of the required courses, MPH 818 Social and Behavioral Sciences, I was taught to recognize and better understand the relationship between different environmental and social factors contributing to community health problems. The course allowed me to realize that the Seventy-First Animal Hospital has a diverse clientele due to being near the largest military base Fort Liberty in the United States. Thus, a large number of new clients are recently transferred military personnel and families coming from different states and are unaware of the threat of vector-borne diseases in Fayetteville, North Carolina. To tackle this problem, I had to strategize to communicate with a diverse audience simultaneously. Today, society communicates and gathers information differently than in the past. Many individuals use social media platforms as an essential communication tool to meet this new demand, Seventy-First Animal Hospital maintains a Facebook page accessible to current, potential, and previous clients. On its Facebook page, posts regularly provide updates about the hospital, general client education, and cute pictures of clients' companion animals. Clients can interact with posts by liking, sharing, or commenting on the post and thus spreading the information to other individuals. Since the Facebook page already had general client education, I decided it would be a great way to educate a diverse group on the threat of tick-borne disease in Fayetteville, North Carolina. The posts can now be seen by any individual that accesses the Seventy-First Animal Hospital Facebook page, and will continue to educate owners in the future.

Competency 19

Competency 19 stresses that communicating public health content through writing and oral presentations is essential. This was conducted routinely by professors at Kansas State University. As an MPH student, I constantly read articles, listened to lectures, and watched content on crucial public health issues. In the course, DMP 710 Intro/One Health, my professor communicated the importance of One Health. My professor gave examples of the interrelationships of animals, humans, and the environment, with zoonotic tick-borne diseases as examples. The information gathered from the course made me realize that I wanted to powerfully communicate the importance of One Health in public health to the staff at the Seventy-First Animal Hospital. I achieved this goal with the intra-clinic presentation. I was able to educate the staff as to why professionals in the animal care field should care about tick-borne diseases through an oral presentation that accompanied the PowerPoint slides. The presentation emphasized the One Health concept and explored the interrelationships of tick-borne diseases by discussing the zoonotic nature of tick-borne pathogens.

Competency 16

Competency 16 stresses that public health officials play an essential role in empowering others through decision-making and being a leader to others. Multiple courses have emphasized the importance of leadership, especially in the DMP 844 Global Health course. In this course, the professor stressed the importance of collaboration with others and how to be a leader to others. For the final paper for the class, I wrote how I would put into practice what I learned through the course if given a chance to be a chief executor for a global foundation. I discussed what I learned and the importance of empowering staff and clients of animal healthcare facilities with knowledge of tick-borne diseases. Through Facebook posts, I empowered clients with knowledge and tools to protect themselves and their animals from tick-borne diseases. For the staff at the Seventy-First Animal Hospital, I held an intra-clinic presentation as a training tool, which focuses on how to effectively communicate with an owner about tick-borne diseases. During the presentation, I discussed the importance of each staff member's role in public health and stressed the importance of becoming empowered through education which would make them more knowledgeable educators to the community. At the end of the presentation, I also assessed the training with a question game and advice on effectively communicating tick-borne disease information with clients.

Competency 7 and 9

Competencies 7 and 9 stress the importance of knowing the population's needs allowing for the development of population-based intervention strategies. Writing is an essential intervention strategy and helps promote better public health. Knowing how to communicate effectively through writing is something I learned in the DMP 815 Multidisc Thought/Pres course. My major professor, Dr. Kastner, who taught the course, pushed me hard to improve my writing skills and how to write effectively to different audiences. Taking this course enabled me to create an educational brochure on tick-borne diseases specific to the needs of North Carolina. As discussed earlier, North Carolina is home to the military base Fort Liberty. With that in mind, I created a brochure to educate clients about ticks in the area and provide appropriate intervention strategies to protect themselves and their animals. The brochure is an easy intervention strategy given to clients as they wait in a treatment room and is included in the take-home packet, which enables them to read it later.

Attainment of MPH Emphasis Area Competencies

Even though my APE is based on tick-borne diseases and not food safety issues, the knowledge of the five Food Safety and Biosecurity area competencies aided me as I developed the portfolio products for the APE. These fundamental concepts were an important part of my education and allowed me to see the broad spectrum of public health work. Table 4.2 summarizes the five competencies of food safety and biosecurity emphasized in the MPH program.

Table 4-2 Summary of FBS Five Emphasis Area Competencies

FSB Emphasis Area Competency		*Description of Competency*
1	***Food safety and biosecurity***	Evaluate solutions appropriate for different food safety, biosecurity, and defense issues in the food production continuum.
2	***Threats to the food system***	Examine specific threats to the food system and scientifically investigate how each can be prevented, controlled, and/or mitigated in the food production system.
3	***Food safety laws and regulations***	Differentiate key U.S. food safety regulatory bodies and their unique legislative authorities, missions, and jurisdictions.
4	***Food safety policy and the global food system***	Analyze and distinguish how food safety and governmental biosecurity policies, globalization, and international trade cooperation influence public health.
5	***Multidisciplinary leadership***	Contrast the food safety and biosecurity technical needs of different stakeholders and make judgments as to the appropriate methods of collaboration.

Throughout all courses, all instructors stressed that public health work ranges significantly but what the student learns about in one field can be used in another. Competency 1 was addressed in the course FDSCI 730 Multidisciplinary Overview of Food Safety and Security. This course taught fundamental information on how public health officials use tools such as crisis communication, epidemiology, and risk analysis. These tools are not only used in the practice of food safety and security but used when addressing other public health issues like tick-borne diseases. Using the tools I learned in this course; I could look at and study the threat of tick-borne disease in North Carolina and why the state is experiencing increased cases of tick-borne diseases. In the course, FDSCI 731Food Protection and Defense, the instructor stressed Competency 2. In this course, I acquired knowledge about food protection strategies and how to respond to threats to food and the agricultural systems, which I was able to also use to research and develop products raising awareness on tick-borne diseases. Using threat concepts related to threats to the food system, I was able to identify strategies for raising awareness at the Seventy-First Animal Hospital and the Fayetteville, N.C., metropolitan area. In addition to awareness, the course stressed that the education of the public is key when responding to public health threats.

Competency 3, which addressed safety and regulations, was emphasized in DMP 888 Globalization, Cooperation, and the Food Trade and stressed the importance of cooperation across fields when tackling public health issues. The same is true when public health authorities are addressing tick-borne diseases and recently, it has been recognized that the veterinary field plays an important role in slowing the spread of tick-borne diseases. Conducting the APE at Seventy-First Animal Hospital enabled me to use the knowledge I have acquired from the course to create educational material not only for staff at the hospital but for clients as well. This was emphasized in the intra-clinic presentation on tick-borne diseases, which stressed the importance of individuals working in this field to promote education and cooperation within the veterinary field.

For Competency 4, I acquired a greater understanding of food safety policy and the global food system in the course DMP 816 Trade & Agricultural Health. In the course, the instructor's discussions and readings stressed the importance of interrelationships between different fields and how these relationships are interconnected through systems. Through my research on tick-borne diseases, the literature discussed multiple times the zoonotic nature of the pathogens is interrelated, and production animals are affected by these pathogens and thus

impact the food industry. Over the last few centuries, tick pathogens have created health and economic burdens for humans and animals, especially livestock. From the late 1800s and 1900s, tick-borne diseases have accounted for a significant economic loss in the cattle industry (Garcia et al., 2022) illustrating how these public health concerns are interrelated. Being able to correlate the course materials with the literature for the APE was both fascinating and emphasized the importance of my topic.

Competency 5, which addresses multidisciplinary leadership, was emphasized in DMP 815 Multidisciplinary Thought & Presentation course. The course made me aware of how the other competencies are multi-disciplinary and apply to the portfolio products developed for Seventy-First Animal Hospital. This class was essential to understanding "critical thinking, writing, and speaking for the food, veterinary, plant, health, and related sciences" (Kansas State University MPH Program, 2023). From this class, I was able to improve my writing skills and learn how to write appropriately to different audiences such as the Seventy-First Animal Hospital. Thus, even though my APE topic was not specifically related to food safety specific, through the course work in the program, I was to complete the APE and tackle the important public health issue of tick-borne diseases in Southeastern North Carolina through the concepts covered in the course work of the MPH.

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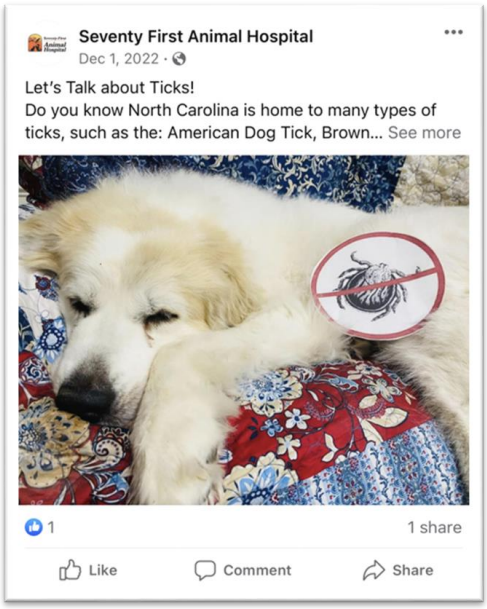
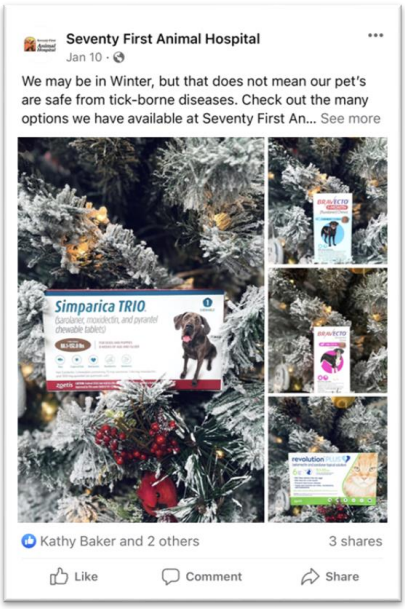
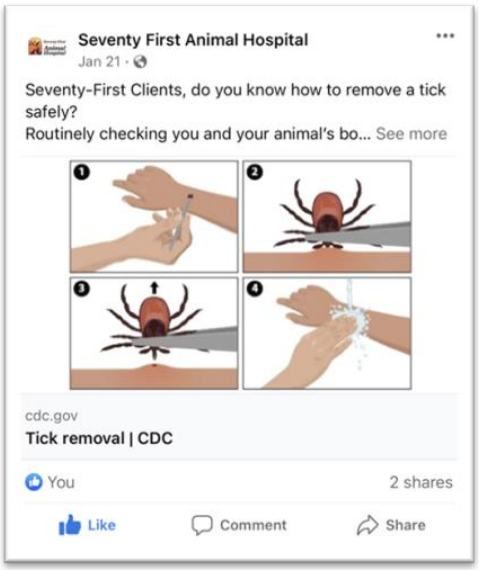
Appendix A Social Media Educational Posts That Were Posted







Appendix A Social Media Educational Posts That Were Posted Continued

Seventy First Animal Hospital

Posts About Videos More

Does your canine companion get a yearly heartworm test?

Heartworm tests are an essential part of your canine's wellness check. Checking for heartworms and the three common tick-borne diseases (Lyme disease, Ehrlichia, and Anaplasma) helps veterinarians keep your canine companion safe from vector-borne diseases. It only takes one bite from these vectors to infect your pet. Ticks that transmit tick-borne diseases and mosquitoes that transmit heartworm disease are a year-round problem in Fayetteville, North Carolina.

As an owner, you can explore parasite prevalence maps for the area you and your animal live in. Check out the Companion Animal Parasite Council website listed below.

https://capcvet.org/maps/#/2023/all-year/heartworm-canine/dog/united-states

Don't forget to ask one of our staff members on your pets' next visit to discuss heartworm testing and prevention.

CAPC
Companion Animal Parasite Council

Seventy First Animal Hospital

Posts About Videos More

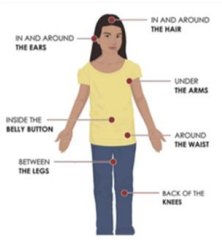
With the weather warming up, it's time to go outside and enjoy the fresh air!

To keep you and your pet safe against tick-borne diseases, it is important to know how to conduct body checks for ticks. Body checks are an essential prevention strategy to avoid a tick bite and only take a few minutes.

In the pictures below are recommendations from the Centers for Disease Control on how to check yourself and your pet for ticks. Body checks should be done every time after being outdoors. Additional information on body checks and further tick prevention strategies can be found on the link listed below, provided by the CDC.

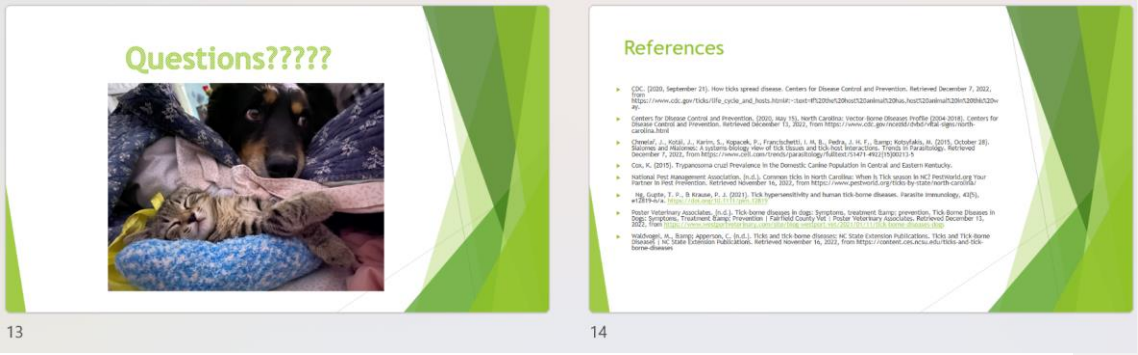
Body Checks for humans- https://www.cdc.gov/ticks/avoid/on_people.html

Body Checks for animals- https://www.cdc.gov/healthypets/publications/check-pet-for-ticks.html



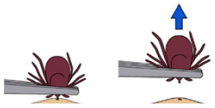
Appendix B Intra-Clinic Training Presentation

Appendix B Intra-Clinic Training Presentation Continued



Appendix C Educational Brochure

Properly Removing a Tick



The Centers for Disease Control recommends the following steps to become a master tick remover.

1. Use clean, fine-tipped tweezers to grasp the tick as close to the skin's surface as possible.

2. Pull upward with steady, even pressure. Don't twist or jerk the tick; this can cause the mouth parts to break off and remain in the skin. If this happens, remove the mouth parts with tweezers. If you cannot remove the mouth easily with tweezers, leave it alone and let the skin heal.

3. After removing the tick, thoroughly clean the bite area and your hands with rubbing alcohol or soap and water.

4. Never crush a tick with your fingers. Dispose of a live tick by

- Putting it in alcohol,
- Placing it in a sealed bag/container,
- Wrapping it tightly in tape, or
- Flushing it down the toilet.

Preventative Measure That Can Be Taken Against Ticks.

Preventive strategies to avoid a tick bite include the following.

1. Awareness – Be aware of your surroundings, and if going into an area that ticks habitat, take protective measures.
2. Protection- Wear protective clothing or tick repellents in high-tick areas. Make sure your pet is on tick prevention
3. Body Checks- Routinely check your and your animal's body for ticks. It only takes a few minutes!
4. Know how to remove a tick- Being able to remove a tick properly can help prevent a tick from transmitting dangerous pathogens.
5. Report- If bitten by a tick, notify your doctor and monitor the tick bite location. If a tick is found on the animal, notify your local veterinarian.

Note: Make sure to consult your local veterinarian about the correct flea and tick prevention for your pet at their next visit.

Resources:
Centers for Disease Control, 2022, https://www.cdc.gov/ticks /index.html
Lethargic Dog Image, https://www.dutch.com/blogs/dogs/dog-lethargy
NC Tick ID Card, https://epi.dph.ncdhhs.gov/cd/diseases/ticks.html
Rash Image, https://physicianoneurgentcare.com/blog/lyme-disease-bulls-eye-rash-what-is-it-and-when-does-it-appear/
Tick Images, https://content.ces.ncsu.edu/ticks-and-tick-borne-diseases
Life Cycle: https://ticksafety.com/lyme-disease-tick-testing/

Welcome to Tick-Borne North Carolina

Tick Threat in North Carolina

North Carolina is home to numerous ticks that carry zoonotic tick-borne diseases. In recent years, the burden of tick-borne diseases in North Carolina has increased significantly. Tick-borne diseases pose significant health risks for humans and animals. Awareness is critical; thus, you can take preventative steps to protect yourself and your pet from the dangers of ticks.

Understanding the Nature of Ticks

Ticks are primarily found in warm, moist environments, which makes all parts of North Carolina a perfect breeding ground for ticks. While ticks are found everywhere, the preferred habitat is wooded areas, tall grass, and bushes. Increased time outdoors, especially in the areas listed above, increases a human or animal's chance of encountering a tick.

How Ticks Spread Diseases

Ticks spread diseases by biting a host for a blood meal. There are four life stages of a tick: egg, larva, nymph, and adult. Once a tick hatches, it must get a blood meal to survive through each life stage, thus it will seek many different hosts over a three-year lifespan. A host may not realize it has been bitten by a tick because the saliva contains an anesthetic property and thus the host does not feel the bite. Therefore, even though it can take several hours for a tick to transmit a pathogen, many humans and animals that are bitten may not remove the tick in time to prevent an infection.

What are Common Tick-Borne diseases in North Carolina?

- Lyme Disease
- Ehrlichiosis
- Anaplasmosis
- Rocky Mountain Fever

Note: Humans and animals can be potentially affected by one of these diseases from just one tick bit.

Common Ticks in North Carolina


Deer (Blacklegged) Tick


American Dog Tick


Brown Dog Tick


Lone Star Tick

Life Cycle of Ticks

Symptoms of Tick-Borne Diseases.

Common human symptoms include Fever, rash, headache, fatigue, muscle aches, and joint pain.


Lyme Disease Bullseye Rash

Common animal symptoms include Fever, swelling around joints, lameness, lethargy, and vomiting.


Lethargic Dog

Diagnosing Tick-Borne Disease

If you believe you or your pet may have contracted a tick-borne disease, immediately contact your doctor or pet's veterinarian. A doctor or veterinarian can test for tick disease and recommend the right treatment.