Master of Public Health

Integrative Learning Experience Report

The veterinary team's role in the One Health tularemia system

by

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submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

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2026

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Abstract

Tularemia is a zoonotic disease of One Health importance, with Kansas having the highest incidence of human tularemia cases reported in the United States in 2022. This project was designed with the Kansas Department of Health and Environment to determine the knowledge, attitudes, and common practices of veterinarians and veterinary technicians in Kansas regarding tularemia. Specifically, we aimed to better understand occupational risk, personal protection behaviors, patient diagnostic testing and management preferences, zoonotic risk communication, and public health reporting.

This was a cross-sectional study with an online survey from June to September 2024, recruiting veterinarians and veterinary technicians who serve dogs and cats. The survey was completed by 109 veterinarians and 19 technicians from all regions of the state. Forty-three percent of veterinarians reported diagnosing tularemia in cats, and 13% reported diagnosing tularemia in dogs. Seven percent of veterinarians reported having had tularemia at some point in their career; the majority suspected they contracted it from a hospitalized tularemia feline or canine patient. Veterinarians reported that glove use was 100% when performing high-risk procedures, but other personal protective equipment use was inconsistent. A tularemia-specific cage sign was created to help veterinary staff understand what veterinary procedures were considered high risk and appropriate personal protective equipment and other precautions that should be taken. Forty-two percent of veterinarians reported that they never submit a diagnostic test to confirm the diagnosis of tularemia, with owner finances being the primary hurdle; the most common diagnostic tests used were PCR and antibody titer. For treatment of tularemia, Kansas veterinarians most commonly prescribe either fluoroquinolones or doxycycline, but there

are no approved drugs or efficacy studies. Ninety-one percent of veterinarians reported discussing public health implications with pet owners, and 63% reported always documenting these discussions in the pet's medical record. Veterinarians and technicians have inconsistent knowledge about reporting regulations, with fewer than 20% knowing that tularemia is only reportable when diagnosed in a human patient.

In conclusion, veterinarians and technicians play an essential One Health role in the prevention and control of tularemia in Kansas. Moving forward, veterinary personnel need additional continuing education, staff training, and hospital protocols to ensure they are protecting themselves from zoonotic transmission. Ongoing efforts should be made to expand the availability and affordability of diagnostic testing. Controlled clinical trials are needed to determine the optimal antimicrobial therapy for veterinary patients with tularemia. Veterinary teams would benefit from additional educational tools for clients of tularemia patients. Designating tularemia as mandatory for reporting in Kansas when diagnosed in animals would allow improved public health surveillance and response.

Subject Keywords: tularemia, *Francisella tularensis***,** personal protective equipment, One Health, veterinary personnel

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Manuscript

This Applied Practice Experience (APE) project was performed over the summer and fall of 2024 in collaboration with the Kansas Department of Health and Environment (KDHE). A manuscript was submitted for peer review to the Journal of the American Veterinary Medical Association on November 26, 2024 and accepted for publication on January 15, 2025. It is available online in a full-text link "free access" at https://avmajournals.avma.org/view/journals/javma/263/5/javma.24.11.0725.xml, and its full reference is:

KuKanich KS, Mulcahy ER, Petro EM. Companion animal veterinary personnel have occupational risk for tularemia and One Health role for tularemia prevention in Kansas. *J Am Vet Med Assoc*. 2025 Feb 5;263(5):619-627. doi: 10.2460/javma.24.11.0725. PMID: 39908665.

Client Communication

Tularemia is truly a One Health concern, and veterinarians play a vital role in educating the public to minimize disease transmission. Disease incidence is related to the environment, with higher disease incidence occurring in geographic areas and seasons where vectors and animal reservoirs thrive. The veterinarian's role begins with teaching clients about the importance of tick protection for their pets during routine yearly examinations. Ticks are a primary vector for tularemia for both pets and people. Pets can bring ticks in closer proximity to family members, increasing their odds of infection. Markowitz reported an outbreak of tularemia in 20 children on two Native American reservations. They found that exposure to ticks was the major risk factor for developing clinical illness from tularemia, and children who had ticks in their homes had 9.2x odds of developing tularemia.[1] By prescribing and administering routine tick preventative products, veterinarians and pet owners are protecting both pets and family members from tick-borne diseases such as tularemia. Veterinarians should also discuss behavioral actions pet owners can take to minimize tick contact for pets, such as avoiding tall grass and leaf piles or brushing up against bushes. While difficult for some pets with long hair, conducting tick checks after walks and removing ticks promptly before they can transmit disease are both advised. Since tularemia and many other tick-borne diseases are zoonotic, veterinarians should also discuss behaviors to keep people safe from ticks, such as wearing white clothing with repellents, tucking in clothes, and doing tick checks on people after exposure.

Veterinarians have limited time during appointments to discuss the patient's history, exam findings, concerns, and general wellness recommendations; yet, preventative care and public health recommendations are important. From human healthcare, we know that 40-80% of what patients hear from their healthcare providers is forgotten immediately, and almost half of what they remember is incorrect.[2] Therefore, the messages we provide verbally must be clear, concise, and to the point. These messages are best followed by a written document, such as patient-specific discharge instructions or premade client handouts.

Once a pet becomes ill with tularemia, veterinarians play a crucial role in recognizing the signs, making an accurate diagnosis, prescribing treatment, and minimizing further transmission. Clinical signs of tularemia overlap with signs of many other infectious diseases, and initially, signs can be vague (inappetence, anorexia, lethargy). Especially in cats, a rapid confirmatory

diagnosis by a veterinarian and administration of antimicrobial therapy can be life-saving. At this point, veterinarians should ask clients about other pets as well; all pets showing clinical signs of illness, even if vague, should be evaluated by a veterinarian so they can be diagnosed and treated if appropriate. During hospitalization, there is an opportunity for education and training to ensure tularemia is not transmitted to veterinary staff. During this time, pet owners may visit the hospital, and client communication about the disease begins verbally. Some veterinary hospitals treat tularemia patients in isolation wards. Other veterinary hospitals treat them in intensive care units with precautions in place. In either situation, it is a good idea to minimize unnecessary contact with infected patients until they have had at least 48 hours of effective antibiotics; however, there are currently no studies documenting the extent of tularemia shedding in dogs and cats post-antibiotic treatment. If clients are visiting with their hospitalized pets, they should be required to wear gloves and discouraged from face snuggling or kissing their pets, as this has been reported to be a route of transmission to people.[3] Clients should also be required to wash hands thoroughly after each visit.

As clients take patients home and resume care for their pets with tularemia, veterinarians again need to provide clear verbal and written instructions to direct them regarding their pet's needs and how to protect the family. Their communications should start by explaining the basics: that tularemia is a bacterial disease. Veterinarians should explain routes of transmission and how their pet might have been infected initially (e.g., from a tick or rabbit), and that tularemia is zoonotic, meaning it can spread from infected pets to people. Explaining exactly how to administer the antibiotics is essential. This should include when the next dose is due (i.e., 7pm tonight), how much of the medication should be given (i.e., 1 antibiotic tablet), and what route (i.e., by mouth). Without clear directions, some pet owners might start administering the medication sooner or later than desired, use an inappropriate route, or place the tablets in the food bowl where the pet can selectively eat around them. They should also clearly advise whether the tablet can be given with food or not. Since antibiotic medication is most commonly given by mouth, and tularemia can be spread via saliva or bite wounds, anyone medicating a tularemia pet by mouth should wear gloves. Pets that are difficult to medicate should remain in the hospital for therapy. To ensure the pet is available to receive antibiotics, infected pets should be kept indoors until the treatment course is complete. This also gives pets a chance to rest inside

during their recovery. If any additional medications or dietary recommendations are needed, the veterinarian should communicate those with the pet owner as well.

After explaining the best way to care for an infected pet to a pet owner, it is important to discuss protecting other pets and family members from contracting tularemia. Infected pets should stay indoors and away from other pets during therapy, using separate food and water bowls. Pet owners should also try to minimize contact with pets during therapy. Veterinarians understand this is challenging due to the human-animal bond and the desire to spend time with pets, but it is safer to minimize higher-risk behaviors such as snuggling, kissing, and rough play that could lead to transfer of saliva, scratches or bites.[3] As saliva can be spread throughout a pet's fur during grooming, it is safest to wear gloves even for petting during the acute illness stage. Once antibiotic treatment is complete and the pet is feeling back to normal, these precautions can be lifted.

While veterinarians need to be careful not to provide human medical advice, they should be familiar with the human symptoms of this zoonotic disease and be able to communicate these symptoms to their clients. Occasionally, pets and people have clinical tularemia concurrently, or pets are a sentinel for human disease. Veterinarians should recommend that any pet owner exhibiting symptoms of tularemia or feeling ill consult with their healthcare provider and relay their pet's tularemia diagnosis. Veterinarians should also provide pet owners with contact information for public health authorities (in Kansas, the state public health veterinarian at KDHE or the local health department). These public health officials can assist with questions and can decide if additional people might have been exposed or if further action is required.

Veterinarians should document these conversations with clients in the pets' medical records for legal purposes and record which handouts are sent home with the clients. There are numerous websites and information sheets available online about tularemia in general, including one from the Centers for Disease Control and Prevention,[4] one from the Minnesota Department of Health,[5] and one from the American Veterinary Medical Association.[6] While these are helpful to give an overview of the disease, pet owners benefit from patient-specific information. Providing patient-specific handwritten or typed discharge instructions or client handouts designed for owners of pets with tularemia is ideal. When using pre-made client handouts, veterinarians can add additional hand-written notes (such as medication specifics) and other patient-specific information to assist the client in providing optimal care during recovery.

APE Products

For my APE, I worked with Dr. Erin Petro, our Kansas state public health veterinarian, at the Kansas Department of Health and Environment and Dr. Ellyn Mulcahy to investigate the role of veterinary personnel and pets in the One Health system of the zoonotic disease tularemia. We recognized that the incidence of human tularemia cases has been on the rise in the U.S., with the highest rates in Kansas and the surrounding states, but we lacked a good understanding of the true veterinary occupational risk, perceptions, and behaviors of veterinary personnel regarding tularemia in Kansas.[7,8] Thus, I designed a survey for veterinary personnel in Kansas called *Knowledge, attitudes, and practices of Kansas veterinary personnel in the diagnosis, management, and One Health implications of tularemia in cats and dogs.* With this survey, I asked about veterinary personnel's general demographics (type of vet, age, geographic region in KS), if they believe tularemia is reportable, if they believe tularemia is zoonotic, and how they diagnose and treat patients. I asked general questions about how many cases of tularemia each veterinarian diagnoses on average yearly, and I asked about specific diagnostic behavior and hurdles. I was not able to acquire specific incidence information. I also asked about personal protective equipment (PPE) they use when treating tularemia patients, education for pet owners, and reporting to public health departments. Finally, I asked if they themselves had been diagnosed with tularemia or if they knew of clients who had been diagnosed with tularemia. I distributed this survey to veterinarians and veterinary technicians throughout Kansas via email and LinkedIn, analyzed the results, and submitted a manuscript to a veterinary journal to be considered for publication. This survey is included as a product in this report.

To help improve the safety of veterinary personnel, I created a cage sign with guidelines for PPE and when this PPE is recommended during the management of tularemia suspects or confirmed cases. The cage sign notifies everyone in the hospital setting that the patient has a zoonotic disease and briefly explains what the disease agent is and that it can spread to people. The sign differentiates between low-risk and high-risk exposures, giving common veterinary examples of each, and provides appropriate PPE recommendations for each. The sign then provides a suggested follow-up response for each exposure, such as to monitor for fever, consult a healthcare provider if you see clinical signs, or consult a healthcare provider to seek post-exposure prophylaxis. This cage sign is included as a product in this report.

To help improve the education of veterinary personnel regarding tularemia, I presented this study as a one-hour oral presentation called "One Health Update for Tularemia Management and Prevention in Kansas" at the Kansas State University 87th Annual Conference for Veterinarians in June 2025 in the One Health track. The primary audience for this conference was practicing veterinarians from Kansas and alumni from Kansas State University (KSU) College of Veterinary Medicine, but any veterinary personnel can register and attend. It was offered both in-person and virtually https://www.vet.k-state.edu/academics/continuing/conferences/annual-con25/. An abstract of the proceedings for this conference is included as a product in this report. Additionally, I was invited to write a book chapter for Blackwell's Five-Minute Veterinary Consult: Canine and Feline, 8th Edition, on the topic of tularemia. I have written this chapter to help practicing veterinarians recognize clinical signs of tularemia, know the most up-to-date diagnostic and treatment information, and understand the optimal safety precautions for their staff and clients. This chapter has been submitted to the editor, and the book is expected to be published in late 2026.

To help improve client education regarding the public health implications of tularemia, I was invited to write a companion Client Education Handout about tularemia for Blackwell's Five-Minute Veterinary Consult. This handout is written in lay language to help pet owners understand the basics about tularemia, how to best care for their pets, and how to prevent disease transmission to their families. This Client Education Handout has also been submitted to the editor and is expected to be published in late 2026.

To help improve the education of other public health professionals about tularemia, I also presented a 1-hour oral seminar called "Tularemia in Kansas—The Veterinarian's Role in One Health Management" at the Kansas Public Health Association Conference in 2025 https://kpha.us/wp-content/uploads/2025/09/KPHA-25-brochure.pdf. The abstract for this presentation is also included as a product in this report.

In addition to working on the tularemia project, I participated in monthly Interagency One Health Working Group meetings from summer 2024-summer 2026, with members from KDHE, Kansas Department of Agriculture, Kansas Department of Wildlife and Parks, the KSU Rabies Laboratory, United States Department of Agriculture, and the Centers for Disease Control and Prevention. At these meetings, we discussed collaborative management of various infectious diseases important in Kansas, including tularemia, as well as the avian influenza outbreak, rabies

cases, *Candida auris, Corynebacterium ulcerans*, and many others. These meetings were an effective way to bring together veterinarians and One Health professionals from across the state to discuss timely topics and brainstorm practical solutions, keeping everyone informed and able to respond efficiently.

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Appendix

Appendix A - Synthesis and Integration of Competencies

Table 1. Synthesis and Integration of Competencies

Competency	Description of Synthesis and Integration
MPH4. Interpret results of data analysis for public health research, policy or practice	To analyze my survey results, I used descriptive and analytic statistics, and I interpreted these results to make recommendations for improved personal protective equipment and One Health communications.
IDZ4. Disease surveillance. Analyze disease risk factors and select appropriate surveillance.	The concept of risk analysis was paramount in this project. Our population of veterinary workers was selected because they are high-risk for tularemia. We asked survey questions about their recognition and response to risk. We prepared educational tools to enhance risk awareness and protection from transmission. We recommended improved surveillance and response via mandatory reporting.
MPH19. Communicate audience-appropriate public health content, both in writing and through oral presentation	Throughout this study, I tailored my communications (survey, cage sign, presentations, book chapter, client handout) to appropriate audiences to help them understand tularemia and prevention.

MPH Competency 4

Interpret results of data analysis for public health research, policy or practice

This study involved both qualitative and quantitative data collection and analysis. In the design phase, it was challenging to determine the best ways to ask the right questions in the survey. Initially, we wanted to determine the prevalence and incidence of tularemia in pets; however, we could not reasonably gather that dataset because many veterinarians do not submit diagnostic tests, and there is no central agency that collects these data, as this is not a reportable disease in animals. We also do not know the total number of pets in Kansas for an accurate denominator. The data we gathered regarding the number of cases diagnosed and cared for by Kansas veterinarians and technicians had limitations of recall bias and thus were not very robust.

In the data analysis phase of the project, our interpretation provided valuable information about which PPE is donned, risk of tularemia in veterinarians, diagnostic behaviors, which antibiotic treatments are prescribed most often, and reporting behaviors. Our data analysis also led to suggestions and recommendations for the future. If Kansas policy were changed to make tularemia reportable when diagnosed in animals, we would recommend integrating a One Health approach, collecting data on potential human exposures as well. Our data interpretation also led to conclusions that we need more research into the ideal treatment protocols for pets, and we need increased awareness of guidelines for PPE in veterinary personnel to protect against exposure to tularemia.

IDZ Competency 4

Disease surveillance. Analyze disease risk factors and select appropriate surveillance

For this study, we selected a population that is known to be at high-risk for tularemia—veterinary workers—and enrolled them in a survey study to learn more about their behaviors that could increase or decrease risk. We asked about whether they know tularemia is zoonotic, if they have diagnosed or treated canine and feline cases of tularemia, and their personal protective equipment use with such patients. We also asked specifically if these veterinary workers had ever developed tularemia themselves, and if so, if they believed they contracted the disease from a patient or other source. Additionally, survey participants were asked if they knew veterinary peers and/or clients who developed tularemia and the etiology of their disease. While this study was not designed to determine additional risk factors, it did help to synthesize current knowledge

and perceptions with Kansas-specific data to recognize areas where additional education is needed in the veterinary field to improve safety and decrease the chance of transmission of *F. tularensis*. Specifically, based on responses, veterinary staff seemed unclear about what PPE was indicated, which became a target for education. Similarly, veterinary staff seemed unclear about whether they should report cases to the public health authorities. We recommend that tularemia become mandatory for reporting when diagnosed in animals in Kansas, to allow improved surveillance and determination of incidence, as well as a quicker public health response when there is human and animal exposure.

MPH Competency 19

Communicate audience-appropriate public health content, both in writing and through oral presentation

Throughout the project, I had the opportunity to work with numerous people from various backgrounds and to communicate my tularemia messages in audience-appropriate ways. Initially, I worked with the KDHE team to create and develop the survey. With the survey, I designed specific questions for Kansas veterinarian vs technician populations with different language and content for these two groups. Based on how participants answered the initial demographic questions of the survey, they would either be taken down the veterinarian path of questions or the technician path of questions. We had several practicing veterinarians and technicians pilot the survey for clarity of content and understanding prior to launching the study. I also explained our study in writing in our Institutional Review Board protocol, which was approved. Once the survey was launched, I also conducted several phone interviews with veterinarians and clients who contacted me to share information about and discuss tularemia patients. These were additional opportunities to integrate audience-appropriate information about public health recommendations to veterinarians and pet owners in a verbal format.

In response to the inconsistent PPE usage by veterinary staff identified in our study, I created a cage-side sign. This was designed for any veterinary personnel in the veterinary hospital setting, which could include veterinarians, technicians, assistants, kennel workers, and volunteers. It is written using lay language to highlight that the dog or cat in the cage has a zoonotic disease, and it explains the precautions needed when handling that patient. Since tularemia is not a common disease, this sign does not assume baseline knowledge of the disease

by any reader, and instead it provides the basics that tularemia is a bacterial infection, routes of exposure, precautions needed, and what to do if exposed. This was designed to be very practical yet integrate key information into a veterinary clinic setting.

I also created an oral tularemia presentation for general practitioners to review the basic epidemiology, explain diagnosis and treatment of tularemia, expand on public health implications of tularemia, report our study outcomes, and highlight ways we can work together as a veterinary community to reduce risk of tularemia exposure in our patients, our peers, and our clients. My goal through this oral presentation was to provide Kansas-specific data that might help veterinarians and their staff to recognize occupational risk and be willing to make behavioral changes to improve safety in their daily practice. There was time at the end for discussion and questions, allowing sharing of additional perspectives on the topic and additional areas for learning. Additionally, I have written a book chapter—Tularemia—for veterinarians and a client handout in Blackwell's Five-Minute Veterinary Consult, which provide practical written information for veterinarians and clients, respectively. Finally, I have presented to a wider public health audience to share with them a veterinarian's view of tularemia, including how veterinarians play an essential One Health role with the environmental aspect (especially tick control), animal management (pets, livestock, and wildlife), and human infection (pet owners, farmers, veterinary staff). In all, these products have synthesized the value of the APE for tularemia research in that they represented targeted tularemia data collection from an at-risk population (survey) and then, through analysis and interpretation of those data, led to the creation of focused and impactful teaching tools (cage sign) and continuing education (presentations) to improve One Health safety of veterinary personnel and pet owners managing pets with tularemia.

Appendix B - Demonstration of Competency Attainment

Table 2. Attainment of Competencies

Practice-based products that demonstrate competency attainment	
Specific products	**Competency**
Presentations, Cage Sign	1. IDZ Competency 1. Evaluate modes of disease causation of infectious agents.
Survey, Cage Sign	2. IDZ Competency 4. Disease surveillance. Analyze disease risk factors and select appropriate surveillance.
Survey	3. MPH Competency 7. Assess population needs, assets and capacities that affect communities' health
Survey, Cage Sign, Presentations	4. MPH Competency 19: Communicate audience-appropriate public health content, both in writing and through oral presentation
Cage Sign	5. MPH Competency 22. Apply systems thinking tools to a public health issue

IDZ Competency 1

Evaluate modes of disease causation of infectious agents

For tularemia disease to develop, it requires a combination of agent, environmental, and host factors to intersect. I have demonstrated this competency in my presentations by explicitly teaching about *Francisella tularensis*, geographic predilection, seasonality, vectors and other routes of transmission, virulence, risk factors, zoonotic nature, as well as clinical signs and manifestations of disease. Throughout these presentations, I have integrated current and past research as well as intertwined case reports of tularemia to remind the audience that this disease has real consequences. The ability to teach others is a true sign of deeper understanding and competency of the material. I also applied this competency while creating the tularemia cage

sign, as it was critical to understand disease causation and transmission in order to recommend safety precautions.

Tularemia is a rare but important zoonotic disease caused by *Francisella tularensis*, a gram-negative aerobic intracellular non-spore-forming bacillus. It is a small bacterium, measuring 0.2-1 µm x 1-3µm with two main subspecies, type A (*Francisella tularensis* subsp *tularensis*) and type B (*Francisella tularensis* subsp *holarctica*).[9] The majority of *F. tularensis* isolates in North America are Type A, and they are more virulent, causing clinical illness in animals and people with as few as 10 organisms.[10] On the contrary, Type B strains are found in the temperate regions of the Northern Hemisphere, are associated with more aquatic epidemiology and cause less clinical illness.[9,10]

Tularemia affects mammals, birds, reptiles, and amphibians. Rabbits are most commonly infected, followed by other wildlife, including rodents and prairie dogs, domestic cats, sheep, dogs, and humans. In the United States, the life cycle of tularemia involves transmission from several main sources: the cottontail rabbit (*Sylvilagus* spp), wild hares, and rodents, and 4 species of ticks, including the *Dermacentor variabilis* (American dog tick) and *Amblyomma americanum* (lone star tick) in the central USA*, Dermacentor andersoni (Rocky Mountain wood tick),* and *Dermacentor occidentalis (Pacific coast tick*). Ticks can be reservoirs and biological vectors for tularemia, pass the infection transstadially and transovarially, and be persistently infected for life.[10] When a tick feeds, *F. tularensis* can spread from the tick's salivary gland to the new host, with adult ticks posing the greatest risk for tularemia transmission. Deer flies (*Chrysops discalis*) are an important vector for tularemia in the Western USA.[11] Additionally, other blood-feeding insects (such as mosquitoes and biting flies) can mechanically disseminate the disease. In Sweden and Finland, mosquitoes are the primary vector for tularemia, but the exact mechanism and reason for this vector predominance in Scandinavia is still unclear.[12] Dogs and cats can become infected through hunting, contact and ingestion of infected prey (most often rabbits or rodents), bites or scratches from infected animals during fights, other direct contact with infected tissue, blood, or bodily fluids, inhalation of infected aerosols, ingestion of contaminated food or water, or via vectors. Rabbits and rodents become lethargic when infected, making them easy prey and promoting transmission of disease.[13] Outdoor pets and younger cats and dogs may be at increased risk.[13]

Most human cases are caused by tick-borne infection or contact with infected animals. Specifically, humans can be infected by a scratch or bite from an infected animal, by hunting and handling infected rabbits, or by shearing infected sheep. Lawn mowing is also a risk factor if rabbit tissue is aerosolized.[13] The incidence of tularemia is highest in people who are young or elderly (1-14 yrs or >65 yrs), male, white, non-Hispanic, and Native Americans.[7,13] Certain occupations are also associated with increased risk, such as veterinarians, laboratory workers, farmers, sheep workers, hunters and trappers, cooks and meat handlers, and landscapers.[13] Veterinary staff practicing in endemic states, such as Kansas, have higher risk due to serving animals who may be ill from tularemia.

The national incidence of tularemia in people has been on the rise, from 0.04 cases per 100,000 person-years from 2001-2010, up to 0.07 per 100,000 person-years from 2011-2019.[7] The states reporting the most cases during 2011-2019 were Arkansas (374 cases, 20.4% of all cases), Missouri (13.1%), Oklahoma (11.9%) and Kansas (11.2%).[7] Cases can occur year-round. Most cases have been reported from spring-midsummer, reflecting tick activity and outdoor human activity, but historically, cases have peaked in winter as well due to people hunting rabbits.[7,13]

After infection, *F. tularensis* lives intracellularly in macrophages, multiplies, and disseminates via the lymphatics and bloodstream. Localization, severity, and course of disease depend on route of infection. There is local inflammation at the site of inoculation (such as a tick bite or cat scratch). Bacteremia can lead to abscessation in various organs, including regional lymph nodes, liver, spleen, lungs, skin, and bone marrow. Microabscesses can progress to granulomatous lesions as the immune system attempts to wall off the infection. Without prompt and proper treatment, thromboembolic disease, multiple organ failure, and death can follow. Onset of clinical signs occurs 24-48 hours after ingestion of infected prey or inoculation. Cell-mediated immunity develops within 1-2 weeks and is the major defense against these intracellular bacteria. Humoral immunity develops within 2-3 weeks, but antibodies are not sufficiently protective against virulent infection. Inhalation of *F. tularensis* often leads to a more quickly progressive illness with coughing, fever, hilar lymphadenopathy, pneumonia and a higher rate of mortality than other forms.

Clinical signs in cats can range from subclinical disease to severe overwhelming infection, sepsis, and death. Most cats present with acute febrile illness, lymphadenomegaly,

anorexia, lethargy, and oral ulcers.[14] Peripheral lymph nodes can abscess. Dissemination, similar to the typhoid form in people, can cause multiorgan disease resulting in icterus and hepatosplenomegaly in cats. The pneumonic form is less common in cats than in people.

It was previously believed that dogs were relatively resistant to natural infection with tularemia compared with cats and humans, with few dogs showing clinical signs.[10,13] However, clinical tularemia can appear similar in dogs as in other species. One case report from Oklahoma documented a 4-year-old female spayed Irish Setter who had eaten an adult rabbit 36 hours prior to presenting to her veterinarian with signs including fever (104.9F), depression, slightly enlarged mandibular lymph nodes, bilateral ocular discharge, and conjunctival hyperemia.[15] A lymph node aspirate was cultured, indirect fluorescent antibody test for tularemia was submitted (but was nondiagnostic due to high background fluorescence), and the dog was treated with doxycycline. The dog improved and was clinically normal by day 6 when the culture confirmed *F. tularensis*. PCR further characterized the isolate as *F. tularensis* subsp *tularensis*. She had a negative acute *F. tularensis* antibody titer by microagglutination, but a positive titer (1:320) 4 weeks later. A larger study summarized tularemia in 88 dogs from New Mexico from 2014-2016, using a case definition of 4-fold rise in anti-*F. tularensis* titer or isolation of *F. tularensis* from a clinical or necropsy specimen.[16] All dogs were diagnosed with paired titer, and 95% of cases had negative acute titer taken on a median of 1 day after onset of illness (range 0-4 days). Most dogs were reported to be exposed via contact with rabbits (43 cases) or wild rodents (9 cases). The most common clinical signs included lethargy (92%), pyrexia (91%), anorexia (76%), and lymphadenopathy (20%). The most common antimicrobials prescribed included doxycycline (55%), enrofloxacin (36%), other tetracyclines, other fluoroquinolones, and gentamicin; some dogs only received antimicrobials not traditionally thought to be effective against tularemia (such as amoxicillin). Infected dogs were described to have moderate to severe illness with 36% requiring hospitalization. Yet all dogs were discharged from the hospital by day 3, and all dogs survived. The median convalescent titer (16 days, range 10-72 days after first sample) was 1:512 (range 1:128-1:4,096). Interestingly, 6 pairs of dogs from 6 households were naturally infected in this study, emphasizing the risk of shared exposure to wildlife. One dog had two separate confirmed infections 10 months apart.

Clinical presentation in people depends on the location and route of inoculation. There are 6 main forms of illness caused by tularemia in people: ulceroglandular, glandular,

oropharyngeal, oculoglandular, typhoidal, and pneumonic. The ulceroglandular and glandular are the most common, typically caused by a bite from a vector or animal causing a skin lesion and draining enlarged lymph node, most commonly axillary or inguinal. With the glandular form, the entry site and skin lesion are not evident, but the lymph node is enlarged. The oropharyngeal route occurs when *F. tularensis* is ingested via undercooked meat, contaminated water, or other oral exposures. This results in tonsillitis and cervical adenitis with possible oral ulcerations and abscesses. Clinically, this resembles other causes of sore throat and can be misdiagnosed.[9] Oculoglandular tularemia is the least common form and can occur from rubbing the eye with contaminated fingers, aerosolized *F. tularensis*, or splashing with infected fluid. Signs can include yellow nodules on the conjunctivae, eyelid edema, corneal ulcers, and enlarged regional lymph nodes. The typhoidal form may present as a fever of unknown origin, with flu-like signs including headache, malaise, sore throat, and gastrointestinal signs. The typhoidal form may include septicemia, multiple organ failure, and central nervous system signs, and in some patients, the typhoidal form can progress to death. Finally, the pneumonic form can occur from inhalation or hematogenous spread of the organism and causes a severe pneumonia that can mimic COVID, fungal disease, or cancer. This form can also be severe and result in death.

IDZ Competency 4

Disease surveillance. Analyze disease risk factors and select appropriate surveillance

In the survey, we enrolled participants who were at high risk for tularemia because they are in the veterinary profession serving canine and feline patients in an endemic state, Kansas. We assessed their risk by asking how many patients they have diagnosed and treated, and asked about their behaviors with PPE when handling these patients. We assessed their understanding of this risk by asking if they knew this was a zoonotic disease. We also asked if they had ever had this disease, known a colleague who had this disease, or known a client (pet owner) who had this disease; if yes, did they know the source? This survey provided improved surveillance information about the risk for veterinary professionals in Kansas. The survey also helped to identify areas where additional education is needed in the veterinary field to improve safety and decrease the chance of transmission of *F. tularensis*. Specifically, based on responses, veterinary staff seemed unclear about what PPE was indicated, which became a target for education with

our cage sign and presentations. Similarly, veterinary staff seemed unclear about if they should report cases to the public health authorities.

The cage sign is also designed to identify specific risk and provide guidance for action based on that specific risk. For example, a veterinary worker performing a basic physical exam on a dog suspected to have tularemia is at low risk of transmission, and the recommended PPE is to wear gloves and protective outerwear such as a lab coat. On the contrary, a veterinary worker performing a fine-needle aspirate or lancing an abscess on a feline patient suspected to have tularemia is considered to be at high-risk and should wear a lab coat, gloves, a facemask, and eye protection. For either of these veterinary workers in contact with a tularemia patient, it is recommended to monitor themselves for 14 days for a fever and contact their healthcare provider if they become febrile or show signs of illness. Post-exposure prophylaxis is warranted for those veterinary workers who experience a bite, scratch, or needle-stick from a tularemia patient, or if they perform a high-risk procedure without proper PPE. We recommend that tularemia become mandatory for reporting when diagnosed in animals in Kansas, to allow improved surveillance and determination of incidence, as well as a quicker public health response when there is human and animal exposure.

MPH Competency 7

Assess population needs, assets and capacities that affect communities' health

Recent national data have shown a 56% increase in human tularemia cases from 2011-2022, as compared to 2001-2010, and Kansas, along with Oklahoma, Missouri and Arkansas accounted for 50% of all reported cases of tularemia.[17,18] However, there are little data available about risk to the veterinary personnel specifically or prevalence in our pets. Our survey allowed us to assess the beliefs and practices of Kansas veterinarians and technicians regarding tularemia. Although the survey did not allow us to determine prevalence or incidence of tularemia in our veterinary population, it did confirm that tularemia is being diagnosed and treated by Kansas veterinarians and technicians. The survey helped to confirm our suspicion that many veterinarians do not submit testing for suspected cases of tularemia, and explained that the main limitation is financial, but also gave other reasons, such as timing and understanding the testing options. Lack of formal diagnosis is important, both for treating the patient appropriately and for

ensuring optimal public health precautions. Further, without submitting diagnostic testing to confirm suspected cases of tularemia, surveillance to determine incidence will be challenging.

The survey also delved into PPE usage for veterinary personnel, which is of major importance to protect against exposure and transmission of tularemia for veterinary staff. Our survey asked specifically about zoonotic exposure and if a participant had developed tularemia themselves or if a colleague or client had developed tularemia. Knowing that 7% of veterinarians have had tularemia reinforces the importance of PPE. The study suggested a need for staff education, which can be filled in part with the cage sign designed in this project.

This survey was also used to confirm that an asset of this population is their knowledge about the zoonotic potential of this disease and their habit of sharing human health implications with their clients. A population need is to remind veterinarians to record these conversations in the patient's medical record.

MPH Competency 19

Communicate audience-appropriate public health content, both in writing and through oral presentation

For the survey, I designed specific questions for Kansas veterinarian versus technician populations with different language and content. Based on how participants answered the initial demographic questions of the survey, they would either be taken down the veterinarian path of questions or the technician path of questions.

I also created a cage-side sign. This was designed for any veterinary personnel in the veterinary hospital setting, which could include veterinarians, technicians, assistants, kennel workers, and volunteers. Each of these populations has a different level of training and education, from doctorate to perhaps high school. The cage sign is written using lay language to highlight that the dog or cat in the cage has a zoonotic disease and precautions needed when handling that patient. Since tularemia is not a common disease, this sign does not assume baseline knowledge of the disease by any reader. Instead, it provides the basics that tularemia is a bacterial infection, routes of exposure, precautions needed, and what to do if exposed. This cage sign was designed to be very practical and helpful in a veterinary clinic setting.

I also created an oral tularemia presentation for general veterinary practitioners, an oral presentation for public health practitioners, a book chapter for veterinarians, and a client handout

for pet owners. These were all designed for very specific audiences to convey information about the disease, epidemiology, and public health aspects of tularemia.

MPH Competency 22

Apply systems thinking tools to a public health issue

Process mapping is a good tool for helping inform veterinary professionals of the risks involved with tularemia exposure, how to minimize those risks, and how to respond post-exposure. I created a process mapping flow chart in the format of a sign to go on the cage of a dog or cat who is suspected or confirmed to have tularemia. The flow includes exposure activities, PPE, and response and post-exposure prophylaxis that can help them visualize the risk and learn how to apply this information to their clinical situation. The advantages of this process mapping tool are that it is visual and easy to follow and apply. It also has a lot of information on one page that can be a quick reference. Disadvantages are that it cannot include all possible scenarios, so veterinary professionals might still be left with questions such as (well, what about "x" procedure or what if he only sort of scratched me but didn't break the skin?). The risk labels and recommendations mentioned on the sign might also change over time, so this sign might need to be updated regularly. Still, I think this sign is a very helpful way to bring attention to a feline or canine patient in the hospital setting with potential or confirmed tularemia, and that it can greatly enhance the awareness and safety precautions taken by the staff caring for that patient. It is cost-effective, easy to implement, and can be added to any practice immediately.

Appendix C - Survey for Veterinarians and Veterinary Technicians

Figure 1. Survey. A copy of the digital survey that was distributed to veterinarians and technicians in Kansas to learn about their knowledge, attitudes, and practices regarding the diagnosis, management, and One Health implications of tularemia in cats and dogs.[19]

We are conducting a One Health survey about the knowledge, attitudes, and practices of veterinary practitioners in Kansas regarding tularemia.

This survey is for any practicing veterinarian or veterinary nurse/technician in Kansas who cares for cats and dogs (mixed animal is great too, you don't have to be small animal exclusive). There is no anticipated risk from the survey, nor any direct reward for participating. Survey participation is voluntary, and participants may refuse to answer any questions or stop at any time. Survey answers will be anonymous, and no individually identifiable data will be reported. Information collected for the study, even with identifiable information removed, will not be used or distributed for future research studies.

Questions about this survey can be addressed to:
Dr. Kate KuKanich, DVM, PhD, at KSU, kstenske@ksu.edu
Dr. Ellyn Mulcahy, PhD, MPH, at KSU, emulcahy@vet.k-state.edu
Dr. Erin Petro, DVM, MPH, State Public Health Vet at KDHE, erin.petro@ks.gov
KSU University Research Compliance Office, comply@ksu.edu 785-532-3224

If you consent to participate in the survey, please continue by clicking the arrow below

Are you a veterinarian servicing cats and/or dogs in Kansas?

- Yes
- No

Are you a veterinary nurse/technician working at a veterinary clinic/hospital servicing cats and/or dogs in Kansas?

- Yes
- No

What best describes your position?

- I am a registered veterinary technician/nurse (RVT)
- I am a veterinary assistant
- Other

What type of practitioner do you consider yourself (not your practice)?

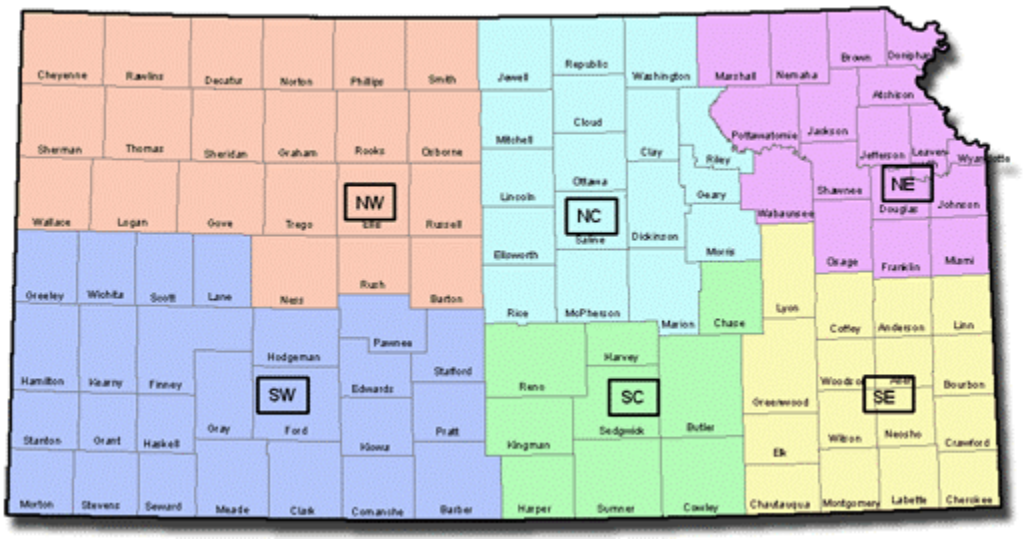
- Companion animal exclusive (sum of canine, feline, non-poultry avian, exotics are at least 90% of job)
- Companion animal predominant (sum of canine, feline, non-poultry avian, exotics are at least 50% of job)
- Mixed animal with at least 25% from companion animal and 25% from either food animal or equine
- Food animal predominant (sum of bovine, porcine, ovine/caprine, camelid, cervid, and poultry are at least 50% of job)
- Food animal exclusive (sum of bovine, porcine, ovine/caprine, camelid, cervid, and poultry are at least 90% of job)
- Equine: at least 50% contact with equines

How many years have you been a veterinary medicine professional?

- 1-5 years
- 5-10 years
- 10-15 years
- 15-20 years
- >20 years

In which district in Kansas do you practice?

- Northwest (NW)
- Southwest (SW)
- North Central (NC)
- South Central (SC)
- Northeast (NE)
- Southeast (SE)



Have you ever diagnosed a cat or dog with tularemia in Kansas, whether suspected or confirmed with laboratory testing?

- Yes, a cat
- Yes, a dog
- Yes, both a cat and a dog
- No, neither a cat nor a dog
- I don't recall

Have you ever helped care for a cat or dog who has been diagnosed with tularemia in Kansas (whether suspected or confirmed)?

- Yes, a cat
- Yes, a dog
- Yes, both a cat and a dog
- No, neither a cat nor a dog
- I don't recall

Can tularemia be transmitted from animals to people?

- Yes
- No
- I don't know

Is tularemia reportable in Kansas?

- Yes, for animal patients only
- Yes, for human patients only
- Yes, for both animal and human patients
- No, not for animals or humans
- Unsure

On average, how many cats with tularemia (suspected or confirmed) have you cared for per year in Kansas over the past 5 years?

- None in the past 5 years
- 0-1 cats per year
- 2-3 cats per year
- 4-5 cats per year
- 6-10 cats per year
- > 10 cats per year
- I don't remember

On average, how many cats with tularemia (suspected or confirmed) have you diagnosed per year in Kansas over the past 5 years?

- None in past 5 years
- 0-1 cats per year
- 2-3 cats per year
- 4-5 cats per year
- 6-10 cats per year
- >10 cats per year
- I don't remember

On average, how many dogs with tularemia (suspected or confirmed) have you cared for per year in Kansas over the past 5 years?

- None in past 5 years
- 0-1 dogs per year
- 2-3 dogs per year
- 4-5 dogs per year
- 6-10 dogs per year
- >10 dogs per year
- I don't remember

On average, how many dogs with tularemia (suspected or confirmed) have you diagnosed per year in Kansas over the past 5 years?

- None in past 5 years
- 0-1 dogs per year
- 2-3 dogs per year
- 4-5 dogs per year
- 6-10 dogs per year
- >10 dogs per year
- I don't remember

If you have suspected tularemia in a cat or dog in the past 5 years, how often were you able to submit a laboratory test to help confirm the diagnosis?

- Never
- Sometimes
- About half the time
- Most of the time
- Always
- Not applicable because I have not suspected tularemia

If you have suspected tularemia but have NOT been able to submit a laboratory test to help confirm the diagnosis, what are the hurdles preventing this submission? Please check all that apply.

- ☐ Owner finances
- ☐ Unsure what sample/specimen to submit
- ☐ Unable to collect a proper sample/specimen
- ☐ Unsure what laboratory test to order
- ☐ Unsure what laboratory to submit to
- ☐ others
- ☐ Not applicable

If you have suspected tularemia in a cat or dog in Kansas and submitted laboratory testing, which test have you most frequently submitted first? (check more than one if you submit multiple concurrently)

- ☐ Antibody titer (serology)
- ☐ PCR
- ☐ Fluorescent antibody of tissue sample
- ☐ Culture from a clinical specimen (often an aspirate)
- ☐ Other
- ☐ Not applicable

If you submit an antibody titer when the patient presents initially, do you routinely submit a convalescent (paired) titer?

- [ ] Yes, regardless of the initial result (if it is negative or positive)
- [ ] Yes, if the initial result is negative
- [ ] Yes, if the initial results is positive
- [ ] No
- [ ] Comments
- [ ] Not applicable

If you diagnose a cat with tularemia (whether suspected or confirmed), what is your treatment of choice?

- ○ Chloramphenicol
- ○ Doxycycline
- ○ Enrofloxacin
- ○ Gentamicin
- ○ Pradofloxacin
- ○ Other
- ○ I don't know and would look up prior to treatment

If you diagnose a dog with tularemia (whether suspected or confirmed), what is your treatment of choice?

- Chloramphenicol
- Ciprofloxacin
- Doxycycline
- Enrofloxacin
- Gentamicin
- Marbofloxacin
- Other
- I don't know and would look up prior to treatment

If you have diagnosed tularemia in cats or dogs in Kansas, have you reported the case/s to the state or local health department?

- Yes
- No
- Not applicable

If lancing an abscess from a dog or cat, what PPE (personal protective equipment) do you routinely use? Check all that apply.

- ☐ Gloves
- ☐ Lab coat or scrub top
- ☐ Gown
- ☐ Eye protection
- ☐ Plastic face shield
- ☐ Surgical face mask
- ☐ N95 respirator mask
- ☐ Other
- ☐ None
- ☐ Not applicable

If you participate in necropsies for dogs or cats, what PPE (personal protective equipment) do you routinely use? Check all that apply.

- ☐ Gloves
- ☐ Lab coat or scrub top
- ☐ Gown
- ☐ Eye protection
- ☐ Plastic face shield
- ☐ Surgical face mask
- ☐ N95 respirator mask
- ☐ Other
- ☐ None
- ☐ Not applicable

If you suspect tularemia in a dog or cat, what PPE (personal protective equipment) would you use for routine exam and basic care? Check all that apply.

- ☐ Gloves
- ☐ Lab coat or scrub top
- ☐ Gown
- ☐ Eye protection
- ☐ Plastic face shield
- ☐ Surgical face mask
- ☐ N95 respirator mask
- ☐ Other
- ☐ None

If you suspect tularemia in a dog or cat, what PPE (personal protective equipment) would you use for lancing an abscess or performing a necropsy? Check all that apply.

- ☐ Gloves
- ☐ Lab coat or scrub top
- ☐ Gown
- ☐ Eye protection
- ☐ Plastic face shield
- ☐ Surgical face mask
- ☐ N95 respirator mask
- ☐ Other
- ☐ None

Have you ever been diagnosed with or suspected to have tularemia yourself?

- [ ] Yes
- [ ] No
- [ ] Prefer not to answer

What do you believe the source of your tularemia was?

- ○ Vectors (ticks, flies)
- ○ Contact with wildlife (rabbits, rodents, etc)
- ○ Contact with domestic animals (other than patients, such as your personal pets)
- ○ Contact with a patient in your veterinary hospital diagnosed or suspected to have tularemia
- ○ Contaminated water
- ○ Contaminated food
- ○ Aerosol/inhalation of bacteria
- ○ other

Have you worked with a veterinary professional (DVM, RVT, assistant, kennel worker, etc.) other than yourself who has been diagnosed with or suspected to have tularemia?

- ◉ Yes
- ○ No
- ○ Prefer not to answer

Do you know what the source of their tularemia was?

- Vectors (ticks, flies)
- Contact with wildlife (rabbits, rodents, etc)
- Contact with domestic animals (other than patients, such as your personal pets)
- Contact with a patient in your veterinary hospital diagnosed or suspected to have tularemia
- Contaminated water
- Contaminated food
- Aerosol/inhalation of bacteria
- other

If you have suspected or diagnosed tularemia in a dog or cat, have you discussed human health implications with their owners?

- Yes
- No
- Not applicable

When you have suspected or diagnosed tularemia in a cat or dog, how often have you documented in the patient's medical record that you discussed public health implications with the pet's owners?

- Never
- Sometimes
- About half the time
- Most of the time
- Always

If you have seen cats or dogs with tularemia, are you aware of their owners ever developing clinical signs they believed to be from tularemia, whether diagnosed or not?

- Yes
- No
- Prefer not to answer
- Not applicable

We are collecting data from cats and dogs in Kansas diagnosed with tularemia from 2020-2024. If you are willing to share any cases you have diagnosed with tularemia (suspected or confirmed cases), we would appreciate it! This information will only be used for epidemiological surveying, and patient anonymity will be preserved. Case information can be emailed to Dr. Kate KuKanich at kstenske@ksu.edu, or if you prefer to leave your contact information below, we can follow-up with you.

Thank you!!!

- Optional name and email for tularemia case follow-up

Appendix D - Tularemia Cage Sign

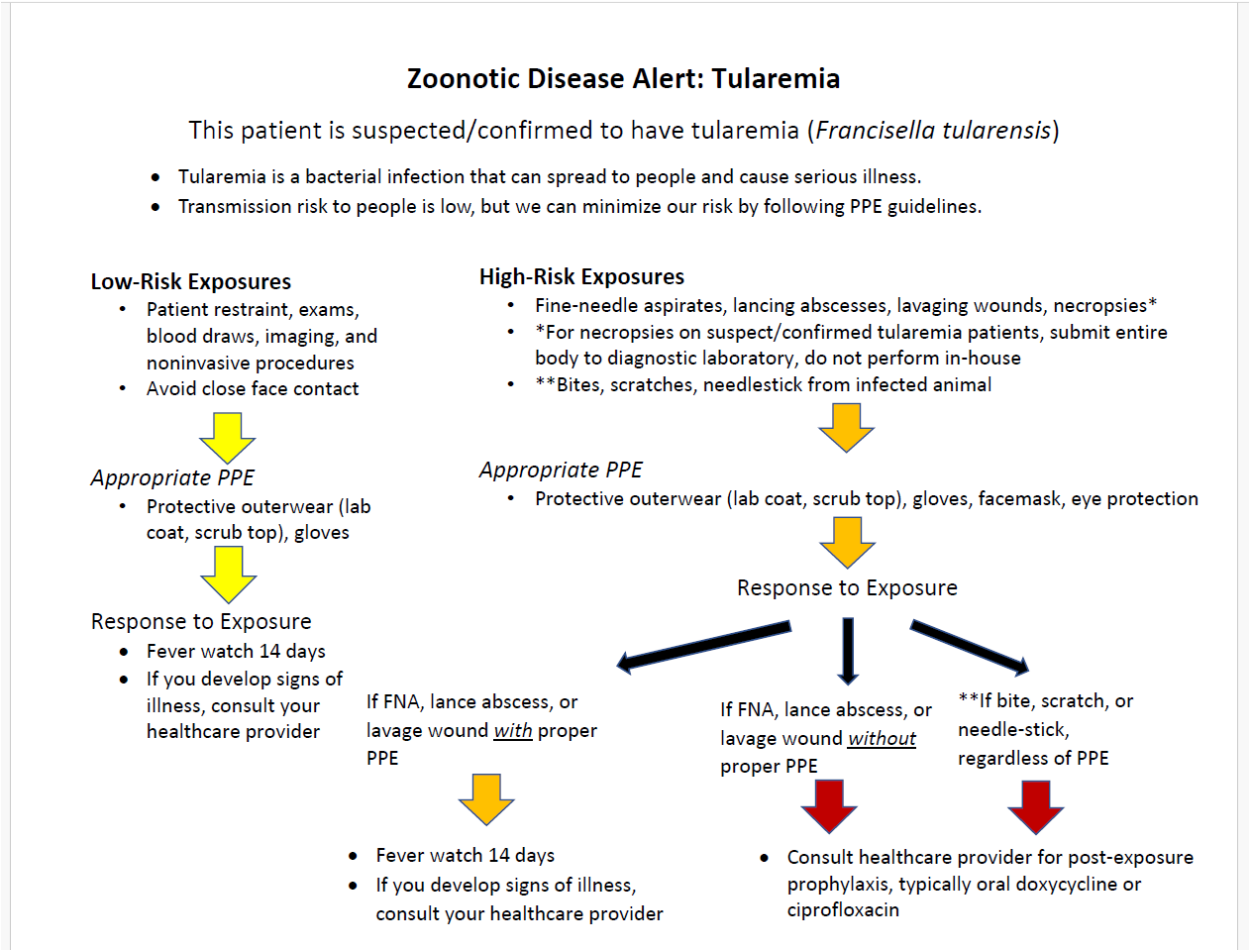


Figure 2. Tularemia Cage Sign. Informational cage sign that can be posted in veterinary hospitals to notify veterinary personnel of patients with suspected or confirmed tularemia and educate about the zoonotic risk, types of exposures, personal protective equipment recommended, and appropriate responses post-exposure.[19]

Appendix E - Conference Proceedings

Kansas State University 87th Annual Conference for Veterinarians, 2025

KuKanich K. One Health Update for Tularemia Management and Prevention in Kansas. Kansas State University Annual Conference for Veterinarians. 1-hour presentation. Manhattan, KS, June 2025.

Tularemia, caused by *Francisella tularensis*, is an important zoonotic pathogen in Kansas and surrounding states. It can infect domestic and wildlife species and be transmitted to people, with veterinary personnel at increased risk. A 2024 survey of Kansas veterinarians (N= 109) and technicians (N=19), found that 43% of responding veterinarians have diagnosed tularemia in Kansas cats and 13% in Kansas dogs. Clinical signs of tularemia in pets are: fever, lethargy, anorexia, lymphadenopathy, and oral ulcers (especially in cats). Both serology and PCR are useful diagnostic tests. Culture and necropsy should be performed only in laboratories capable of additional biosafety precautions; Dr. Francis himself developed tularemia after conducting a necropsy, and 5 of his assistants subsequently developed tularemia from working with tularemia in the laboratory. Doxycycline or fluoroquinolones are current treatments of choice. Personal protective equipment such as gloves, eye protection, and face protection, are important to keep veterinary personnel safe, especially for high-risk procedures such as aspirating nodes, lancing abscesses, or lavaging wounds. A zoonotic disease cage sign can help educate veterinary personnel of appropriate PPE for tularemia suspects and confirmed cases. Seven percent of KS veterinarians responding to the 2024 survey reported having had tularemia themselves, emphasizing the importance of PPE and caution regarding this disease. Educating pet owners is also a public health responsibility and should be noted in patients' medical records. Though tularemia is NOT a reportable disease when diagnosed from animals in Kansas, reporting cases to KDA or KDHE allows them to assist with public health follow-up.

Kansas Public Health Association Conference of Kansas, 2025

KuKanich K. *Tularemia in Kansas—The Veterinarian's Role in One Health Management.* Kansas Public Health Association Public Health Conference of Kansas. 1-hour presentation. Wichita, KS. September 2025.

Tularemia, caused by *Francisella tularensis*, is an important zoonotic pathogen in Kansas and surrounding states, with Kansas having the highest human incidence (0.9 per 100,000 residents) of all U.S. states in 2022. A 2024 survey of Kansas veterinarians (N=109) and technicians (N=19), found that 43% of responding veterinarians have diagnosed tularemia in Kansas cats and 13% in Kansas dogs. Most human and veterinary cases result from tick bites or exposure to infected rabbits or rodents. Outdoor cats and pets who hunt are at an increased risk. Clinical signs of tularemia in pets mimic those in people and include: fever, lethargy, anorexia, enlarged lymph nodes, and oral ulcers (especially in cats), with more severe disease including icterus, hepatosplenomegaly, and pneumonia. Early recognition, diagnostic confirmation and treatment are essential for a good outcome and prevention of further spread. Pet owners and veterinary personnel can acquire tularemia from infected pets. Seven percent (8/109) of Kansas veterinarians report having had tularemia themselves; thus, personal protective equipment, including gloves, mask, eye and face protection, is important within the veterinary hospital setting to minimize transmission. Veterinarians also must educate pet owners about zoonotic potential, as tularemia can be transmitted via scratch, bite, or even face-snuggling with an infected pet. Keeping cats indoors and using tick preventatives for both dogs and cats will also decrease the risk of infection for pets and exposure for people. Reporting is required when tularemia is diagnosed in people, but not animals; however, voluntary reporting allows a coordinated One Health response.