

Master of Public Health
Integrative Learning Experience Report

***DEVELOPMENT OF INFORMATIONAL RESOURCES
PERTAINING TO ZONOTIC DISEASES FOR KANSAS
MEDICAL PROFESSIONALS***

by

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submitted in partial fulfillment of the requirements for the degree

MASTER OF PUBLIC HEALTH

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Summary/Abstract

As zoonotic diseases represent the majority of all emerging diseases, there is an increasing risk to public health. Zoonotic diseases infect both animals and humans and thus require both veterinary and human medical professional intervention. However, there may be a lack of cooperation between the two professions. Moreover, these medical professionals must be able to provide critical information about the transmission of zoonotic disease for patients and/or animal owners. Although these topics are critical for facing zoonotic disease, practitioners may not have easy-to-access resources to reference when faced with zoonoses. To address these concerns, I worked with the National Agricultural Biosecurity Center to create information handouts. By forming a multidisciplinary team, we identified which zoonoses are of highest concern to Kansas and what information for each disease was the most important. This information was then used to create two sets of handouts. The first set of zoonoses handouts were specifically for veterinarians and human medical professionals. The second set of handouts were tailored for veterinarians to provide to animal owners when faced with certain diseases. These handouts will provide medical professionals with the necessary information they need to address the disease as well as encourage collaboration and education efforts between professions. Through these projects, I was able to expand my knowledge of zoonotic disease and amplify my skills of working on multidisciplinary teams.

Subject Keywords: Zoonosis, Infectious Disease, One Health, Veterinary Medicine

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List of Abbreviations

APE	Applied Practical Experience
BRI	Biosecurity Research Center
CDC	Centers for Disease Control and Prevention
KDA	Kansas Department of Agriculture
KDHE	Kansas Department of Health and Environment
NABC	National Agricultural Biosecurity Center
RMBD	Raw Meat-Based Diet

Chapter 1 - Literature Review

Throughout history, humans have relied on animals for different necessities. Primarily, animals were used as a source of resources such as food and clothing. This was first accomplished through hunting and then through farming. As time progressed, humans found other uses for animals such as transportation, protection, physical labor, and entertainment. Through these uses, companionship eventually developed into what is now known as the human-animal bond. Animals are an essential part of human life, however, interactions between humans and animals introduce the possibility of disease.

Zoonotic diseases represent 75% of all emerging diseases across the globe (Taylor et al, 2001). Zoonotic diseases are diseases that can be transmitted between animals and humans. Some of these diseases, especially those widely known to be transmitted from pets to owners, include rabies, tularemia, salmonellosis, and toxoplasmosis (Rahman et al, 2020). One of the most recent and well-known emerging zoonotic diseases is SARS-CoV-2, also known as the COVID-19 virus. The virus has been associated with over 1.1 million deaths in the United States since disease's emergence in 2019 to September, 2023 (Centers for Disease Control and Prevention, 2023). Although now known for the global pandemic in humans, accounting for over 700 million cases worldwide (Worldometers, 2024), the virus is believed to have come from animal origins (Latif & Mukaratirwa, 2020) (Holmes et al, 2021). Due to the dependence on the animal-human interface, emerging human diseases are likely to come from animal origins (Magouras et al, 2020).

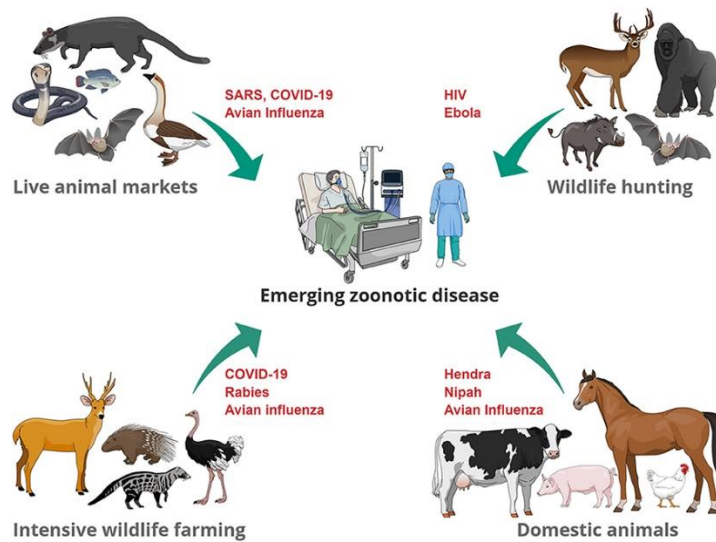


Figure 1.1 Examples of (re-) emerging zoonotic diseases (Magouras et al, 2020)

Zoonotic diseases provide additional challenges in eradication and prevention due to their multitude of host species, and thus require mitigation efforts from professionals in both the veterinary and human medical fields. Diseases of this nature not only impact human lives through illness, but can also greatly affect the economy due to losses of production animals such as cattle, swine, and poultry or through loss of labor because of human quarantine and isolation (Cascio et al, 2014). Zoonotic diseases are estimated to represent over \$20 billion in direct costs and over \$200 billion indirect costs globally between 2000 and 2010 (World Bank, 2010). One Health efforts are needed to face these issues. One Health refers to the collaboration between multiple disciplines to promote human, animal, and environmental health. Although the concept of One Health approaches is not new, recent global events such as the COVID-19 pandemic, have shined a light on the importance of embracing this approach to solving infectious and zoonotic disease issues (Sironi et al, 2022).

Although both veterinary and human medical professionals are needed to address zoonotic diseases, there is an overall lack of knowledge pertaining to these diseases. A survey of practicing human physicians in Ohio revealed that over half of these physicians were uncomfortable with their knowledge and ability to diagnose and treat zoonotic diseases. Of these same physicians, only 53% believe that collaborating with a veterinarian specialized in zoonotic infections would have any benefit (Kersting et

al, 2009). This lack of knowledge is also seen in the veterinary field as well. Only 57% of veterinarians in Arizona report that they know when to report zoonotic diseases. In this same study, it was found that multiple veterinarians had diagnosed zoonotic diseases reportable in that state in patients, but did not report them. These diseases included leptospirosis, avian chlamydiosis, brucellosis, and tularemia (Venkat et al, 2019). This lack of knowledge not only puts other humans and animals at risk of infection, but also diminishes disease traceability when they are not reported.

Another issue is the lack of communication between clinicians and human clients/patients. Only 54% of physicians agree that it is important to ask patients involved with livestock about potential zoonotic exposure risks (Kersting et al, 2009). Further, a study of veterinarians demonstrated that only 43% of veterinarians reported initiating discussions with clients about zoonotic diseases on a daily basis (Lipton et al, 2008). Client and patient education are important factors in preventing and limiting the spread of zoonotic diseases. Without these interventions, the general public may never learn what zoonotic diseases are or how they can become infected. A study of pet owners showed that only half had heard of the term “zoonotic disease” before. Of these same owners, less than 20% were moderately to very concerned about contracting zoonoses from pets (Powell et al, 2022). These data demonstrate pet owners’ lack of knowledge concerning zoonoses, but also shows where improvements can be made in the veterinary field. Veterinarians are essential in explaining not only what zoonotic diseases are but also are key figures in providing insight on how to prevent them as well. Human physicians must also increase efforts to educate the public.

Although zoonotic diseases cause illness in both animals and humans, people are more willing to contact veterinarians than physicians for information on zoonotic diseases (Powell et al, 2022). This could be caused by multiple different factors. One such explanation is that the public may trust veterinarians more and thus feel more comfortable reaching out to veterinarians with their questions. A study on the public perception of veterinarians and human physicians showed that public perception of veterinarians is more favorable compared to physicians. The most common traits used to describe veterinarians included “punctual”, “patient”, and “understanding”, whereas the most common word used to describe physicians was “overconfident” (Kedrowicz &

Royal, 2020). Another potential explanation is that veterinarians may be more likely to initiate conversations about zoonosis as they are exposed to the diseases more often (Grant & Olsen, 1999). Although it is important to understand the reason why the general public would rather reach out to veterinarians for information, both groups of professionals need to be prepared and able to have these discussions.

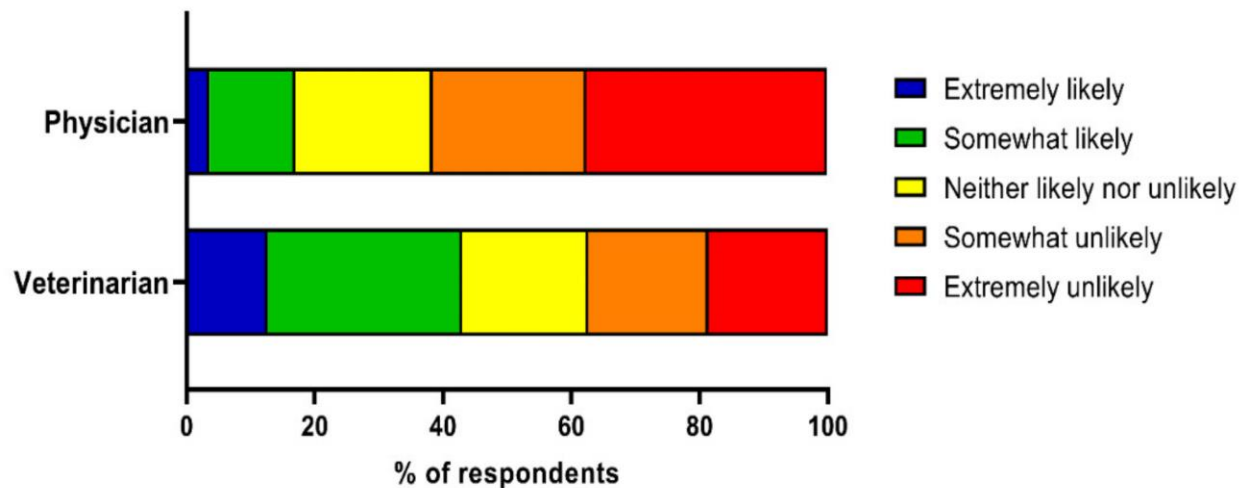


Figure 1.2 Likelihood of participants contacting their physician and veterinarian for information about zoonotic diseases (Powell et al, 2022)

To address zoonosis concerns through a One Health approach, veterinarians and human physicians must expand their knowledge of the diseases. Professionals from both fields need to collaborate to understand both the human and animal side of zoonoses (Kahn, 2006). Further, these professionals need to share their knowledge with the public through multiple formats, including face-to-face discussions and through informational handouts. However, many professionals do not have access to handouts such as these. 47% of veterinarians report that they do not have educational materials to provide clients within their practices that cover zoonotic diseases (Lipton et al, 2008).

The education of veterinarians, human medical professionals, and animal owners is an important step in preventing the spread of zoonoses. My project focuses on this topic of educating these three groups of people. This was accomplished by creating educational handouts for specific zoonotic diseases or situations found in the

midwestern United States that may lead to the spread of zoonotic diseases, such as backyard poultry operations. My project was completed at the National Agricultural Biosecurity Center (NABC) in Manhattan, Kansas. The center works with local, state, and federal agencies, as well as with experts from around the world on topics such as homeland security and One Health. The center's objectives include reviewing agricultural policy, procedures, and training, as well as educating the public about agroterrorism (Kansas State University, 2023). My preceptor, Adrian Self, is an operations research analyst for the NABC. Adrian employs his skills in economics research, risk analysis, and communications to aid in reaching the center's goals. He earned his bachelor's degree from the University of Kansas. My project aligned with the NABC's objectives to provide training and education for the public to promote One Health and ensure the biosecurity of the United States. By bringing together experts in veterinary medicine, human medicine, and public health, we were able to identify specific diseases of greatest concern to Kansas as well as certain scenarios that may cause increased risk of disease transmission. The most recent published data on infectious diseases that are reportable in Kansas and used in the handouts are listed in Table 1.1.

Table 1.1 Kansas Reportable Infectious Disease Cases in 2016 (KDHE, 2016)

Disease	Kansas Case Count			Reportability
	Confirmed	Probable	Total	
Cryptosporidiosis	100	33	133	KDHE
Giardiasis	100	4	104	KDHE
Q Fever	1	3	4	KDHE, KDA (sheep and goats)
Rabies, animal	54	0	54	KDHE, KDA (all mammals)
Rabies, human	0	0	0	
Tularemia	15	10	25	KDHE

Zoonotic diseases pose a great risk for both animals and humans. This risk is increasing over time as zoonotic pathogens are twice as likely to be associated with emerging diseases compared to non-zoonotic diseases (Taylor et al, 2001). To address

the issue, veterinary and human medical professionals must collaborate and expand their knowledge to prevent the spread of zoonoses. Further, they must educate their clients and/or patients about these diseases. One Health plays a vital role in prevention and treatment strategies. Veterinarians and human physicians need to learn to embrace a One Health mindset to successfully face the zoonotic disease threats of today and the future.

Chapter 2 - Learning Objectives and Project Description

My Applied Practical Experience (APE) began in December of 2022 and went until January of 2024 with Adrian Self, an operations research analyst, at the National Agricultural Biosecurity Center (NABC). The NABC is housed in the Biosecurity Research Institute (BRI) in Manhattan, Kansas. I began by first learning about the center and then started discussing how to address the needs in both the veterinary and human medical professions. Initial discussions were held through team meetings including Adrian Self, my preceptor, Dr. Anna Pees, DVM, MPH, Savannah Greiner, an emergency management specialist, and myself. The project primarily focused on the overall lack of resources pertaining to zoonotic diseases specifically designed for veterinarians and human physicians. The team decided to create a webpage where medical professionals can find informational resources about zoonoses. My specific duty was to create some of the resources to be housed on the webpage.

2.1 Learning Objectives:

1. Gain a better understanding of what information is important for different audiences to know about zoonoses
2. Learn more about different zoonotic diseases that are commonly transmitted from animals to humans in Kansas
3. Become proficient in working on interdisciplinary teams to reach set goals
4. Gain knowledge in designing informational tools and writing in appropriate styles based on various audiences

2.2 Experience Activities and Responsibilities:

1. Attended meetings with various groups

Throughout my time working with the NABC, I met with various groups to develop my project and make connections. My initial meetings were limited to employees of the NABC team to brainstorm project ideas and how to reach the center's goals. I then attended a meeting with various groups to discuss current issues surrounding rabies in

Kansas. Groups in attendance included the Kansas Department of Health and Environment (KDHE), Kansas State Veterinary Diagnostic Laboratory (KSVDL) Rabies Laboratory, and health professionals from Fort Riley, a local army installment. My later meetings were based specifically on developing informational handouts and were with a multidisciplinary team that I formed.

2. Formed and lead a multidisciplinary team

Through attending the meeting pertaining to current rabies issues in Kansas, I was able to build connections with professionals from multiple different fields who shared a passion for zoonotic diseases. I later reached out to the different professionals including a physician, veterinarians, and an epidemiologist to see if they would be willing to participate in a team to develop the zoonosis handouts. The team was able to meet remotely through Zoom calls to discuss what diseases and information pertaining to each disease should be covered in the handouts.

3. Researched information pertaining to different zoonotic diseases and situations

In preparation to create the handouts, I had to research the different zoonotic diseases to understand different aspects of each disease. I utilized resources such as the Centers for Disease Control and Prevention, the American Veterinary Medical Association, and the Kansas State Veterinary Diagnostic Laboratory to find information. Topics researched included general disease information, pathology, common clinical signs and symptoms, and diagnostic tests.

4. Developed informational handouts for both veterinary and human medical professionals

After meeting with the multidisciplinary team and conducting literature searches on the different zoonoses, I was able to use that information to create seven different handouts. The handouts covered six different zoonotic diseases as well as a handout covering disease risks associated with backyard poultry operations. The handouts were developed so that they can be used by both veterinarians and human physicians.

5. Developed informational handouts for veterinarians to provide animal owners

After I finished creating the handouts for medical professionals, I created handouts for veterinarians to give to animal owners if their pet is diagnosed with or suspected to

have certain zoonotic diseases. I created nine handouts covering different diseases and another handout discussing risks associated with feeding pets raw meat-based diets.

Chapter 3 - Results

3.1 General Observations

When I first began my experience with the NABC, we held initial meetings to discuss what area my project should focus on pertaining to zoonotic diseases. Discussions with both the NABC team and veterinarians at Kansas State University's College of Veterinary Medicine revealed two overarching themes. The first being that veterinarians felt as though there was no singular website where they could find all the information, they needed pertaining to specific zoonotic diseases such as common symptoms, if they needed to be reported and to whom, precautionary measures to take to prevent transmission, as well as how to approach these discussions with clients. Veterinarians expressed concerns that since there was no single source for this information, they would have to spend too much time looking up this information. Another theme found was that collaboration efforts between veterinarians and human physicians may be lacking, which is an important part of stopping the spread of zoonotic diseases.

These observations led to the conclusion that the NABC could provide a resource to address these needs. We decided to create a webpage where people can find comprehensive resources pertaining to zoonotic diseases. The webpage would be hosted on the NABC's website. My assignment for this webpage was to create handouts pertaining to zoonotic diseases that would address the themes brought up in our initial conversations.

3.2 Multidisciplinary Team

To determine what diseases and what information was most important to be in the handouts, a multidisciplinary team was formed. The team was made up of Adrian Self, NABC operations research analyst, Dr. Anna Pees, veterinarian and NABC program manager, Dr. Erin Petro, Kansas State Public Health Veterinarian at the KDHE, Stephanie Lindemann, KDHE vector-borne disease epidemiologist, and Dr. Kellie Wark, an infectious disease physician. The team reviewed multiple different zoonotic diseases found in Kansas. The team decided to focus on the disease that they

see most commonly in the state of Kansas. However, to ensure that we could cover some of the most important zoonotic diseases in a limited time, the team decided to omit certain vector-borne diseases that could also be present in Kansas such as West Nile Virus. Diseases determined to be included were based on a mix of information including what diseases the team had either seen in practice or had been reported to their agencies, what diseases could have the largest impact if an outbreak were to occur, and which diseases already had similar resources. The team determined that these handouts should be brief but still provide a comprehensive amount of information. After the initial creation of the handouts, the members of the team would meet to review the information and to make any edits or recommendations that they deemed necessary.

3.3 One Health Briefs for Practitioners

Seven handouts were created using Canva, an online graphic design tool (Appendix 1-7). Six covered different zoonotic diseases and one covered the topic of backyard poultry operations. These handouts were created so that both veterinarians and human medical professionals could use them. At the top of each disease handout were two sections explaining what the disease is and what the modes of transmission are. The backyard poultry handout, however, begins with an explanation of what backyard poultry operations are and what disease risks are associated with them. The rest of the handouts were divided into two sections, one for veterinarians and one for human practitioners. Both sections contained information such as common signs and symptoms, appropriate diagnostic tests, and tips for patient/owner communication. The veterinary section also contained a subsection on appropriate personal protection equipment to use if they suspect a patient may have the disease.

Multiple diseases were discussed as candidates for topics on the handouts. The topics selected were focused on diseases based on two main factors, the amount of information readily available for practitioners and the likelihood that practitioners will encounter the diseases. The topics of the seven handouts were:

- Tularemia

- Toxoplasmosis
- Rabies
- Q Fever
- Ringworm
- Zoonotic Influenza
- Backyard Poultry

3.4 Owners' Guides to Zoonotic Diseases

Ten handouts were created using Canva for veterinarians to provide animal owners (Appendix 8-17). Nine handouts focus on specific diseases and can be given to owners if the veterinarian diagnoses an animal with that disease. The remaining handout covers the topic of raw meat-based diets (RMBDs). Veterinarians can provide these to clients if they feed or are considering feeding their pets raw animal tissues. This specific handout discusses some of the infectious disease risks associated with RMBDs.

Although some of the diseases align with topics covered in the One Health Briefs for Practitioners, not all do. This is because there may already be resources available for practitioners on some of the diseases covered in the Owners' Guides. Topics included in the handouts for animal owners were:

- Tularemia
- Toxoplasmosis
- Rabies
- Q Fever
- Ringworm
- Zoonotic Influenza
- Helminthiasis
- Cryptosporidium
- Giardiasis
- Raw Meat-Based Diets

Chapter 4 - Discussion and Next Steps

The development of quality resources for medical practitioners, both veterinary and human, is an important aspect of preventing the spread of zoonotic diseases. Throughout my time researching information for the One Health Briefs for Practitioners, it became apparent that there truly are some shortcomings in current resources which supported my early findings in discussions with veterinarians and professionals at the NABC. Although much of the general information can be found through webpages such as the CDC website, specific information is missing. This is especially apparent when looking for information pertaining to reportability, client/patient communication, and opportunities for One Health, or veterinary and human physician, collaborations.

My project addresses these shortcomings by providing the information in a brief and easy-to-read method. The handouts provide the most important information in short summaries but also provide links to where people can find more in-depth information. By having sections for both veterinary and human practitioners on the same document, the practitioners may be more likely to understand and seek out opportunities to collaborate between the two fields of medicine.

An area that needs to be reviewed further is the reportability of zoonotic diseases. Certain infectious diseases, both for animals and humans, are considered reportable at different levels. Different agencies provide lists of diseases that are required to be reported in specific species, however, these lists may vary based on state or species, thus causing confusion. A specific example of this in Kansas is tularemia. In the state of Kansas, tularemia is considered reportable to KDHE if found in a human patient, but not in an animal to state animal health agencies such as the Kansas Department of Agriculture (KDA). This species discrimination can cause confusion for medical and public health professionals. Also, as zoonotic diseases can be transmitted between humans and animals, by only having a disease reportable in humans, there is a gap in traceability. One “next step” in this project of educating practitioners should be to encourage practitioners to involve local public health departments in more zoonotic disease cases, and not just those that are considered reportable at the state or federal level.

Another future step for this project is to ensure that these handouts are shared and readily available. Although the main home for these handouts will be the NABC webpage, another location where these will be shared is through the KDHE on the State Public Health Veterinarian's webpage. These handouts should also be promoted through other outlets as well to ensure they are properly dispersed. Other options may include the One Health Newsletter hosted by Kansas State University or professional organizations such as the American Association of Food Safety and Public Health Veterinarians or the American Association of Public Health Physicians.

Although there are other resources available for diseases not covered in the current list of handouts, a future goal should be to cover more diseases. Covering more diseases in the handouts available from the NABC webpage will further prevent medical professionals from spending long periods of time searching through other sources for similar handouts. Further, as new zoonotic diseases emerge, such as COVID-19, more handouts will need to be created. Future diseases addressed could include COVID-19, West Nile Virus, brucellosis, avian chlamydiosis, or *Yersinia pestis* (plague). Handouts will also need to be updated as new technologies develop and diagnostic approaches change.

As zoonotic diseases are becoming a greater issue in society, medical professionals need to adapt to face this change. By using the One Health Briefs for Practitioners, medical professionals can quickly review important information pertaining to common zoonotic diseases and can make informed decisions. The briefs as well as the Owners' Guides to Zoonotic Diseases encourage medical professionals to provide better education to clients or patients on zoonotic diseases. Zoonotic disease education for all people involved is imperative to the control of zoonoses.

Chapter 5 - Competencies

Student Attainment of MPH Foundational Competencies

Competency #13: Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes

At the beginning of my Applied Practical Experience, I needed to identify important stakeholders that could best assist me in creating informational handouts about zoonotic diseases. After attending an informational session on current efforts in Kansas to prevent the spread of rabies, I reached out to some of the professionals in attendance. These health professionals included the state public health veterinarian, Dr. Erin Petro, DVM, MPH, a vector-borne disease epidemiologist, Stephanie Lindemann, MPH, and an infectious disease physician, Dr. Kellie Wark, MD, MPH. Discussions were held with these health professionals, along with members of the National Agricultural Biosecurity Center to determine what diseases and information are most important for veterinary and human medical professionals to know.

Competency #18: Select communication strategies for different audiences and sectors

An important task for this project was to find ways to effectively communicate with veterinary and human medical professionals as well as with animal owners. We discussed multiple different methods for our target audiences to find information about zoonotic diseases. We decided to create brief informational handouts to cover the important information for both practitioners and pet owners. These handouts needed to be brief summaries of the important topics that people should understand when faced with zoonotic diseases. By keeping the handouts short, but also providing links or QR codes to more information, practitioners and owners can quickly pick out the information they need immediately, but also have resources to learn more about the topic if they choose.

Competency #19: Communicate audience-appropriate public health content, both in writing and through oral presentation

To build the multidisciplinary team to create the handouts, I had to present my project idea to the selected group of individuals. This required me to engage people from multiple professions to explain why these handouts are important. Further, to create the handouts, I had to think specifically about who would be utilizing each handout and what information would be valuable and understandable. For the One Health Briefs for Practitioners, the general information about the diseases needed to be understood by both veterinary and human medical professionals. The later sections needed to be more focused on either veterinarians or human practitioners. When creating the Owners' Guides, I needed to ensure the handouts were written using lay terms that the general public could understand. Through changing writing and oral presentation styles based on the intended audience, I was able to effectively share information on zoonotic diseases.

Competency #21: Perform effectively on an interprofessional team

A large part of this experience was building and working with an interprofessional team consisting of public health professionals, veterinarians, epidemiologists, and an infectious disease physician. Team interactions took place through multiple platforms including Zoom meetings, emails, and in person discussions. The team's main goal was to identify zoonotic diseases of highest concern to Kansas, what information should be provided in the handouts, and what platforms the handouts should be shared through. I also worked with members of the team to reference information and review the handouts.

Competency #22: Apply systems thinking tools to a public health issue

Systems thinking is important when discussing public health issues. One specific example of how a systems thinking tool was used in this project was for the “Owners’ Guide to Raw Meat-Based Diets” handout. As raw pet diets are becoming more popular in the United States, there is an increasing risk of zoonotic and/or foodborne diseases to be spread. A causal loop diagram was used to best identify causes of disease transmission from raw meat-based diets to pets and pet owners (Appendix 18). I used the information gained from the diagram to determine what information was most critical to include in the handout.

Table 5.1 Summary of MPH Foundational Competencies

Number and Competency		Description
13	Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes	I proposed and built a team of stakeholders that have direct impacts on zoonotic disease spread in Kansas.
18	Select communication strategies for different audiences and sectors	I created brief informational handouts for veterinarians, human practitioners, and pet owners to reference when faced with different zoonotic diseases.
19	Communicate audience-appropriate public health content, both in writing and through oral presentation	I presented information about the importance of accessibility to zoonotic disease information for health professionals. I then created different informational handouts for various audiences about the common zoonotic disease.
21	Perform effectively on interprofessional teams	I worked with an interprofessional team including public health professionals, veterinarians, and physicians to identify zoonotic diseases of concern in Kansas.

22	Apply systems thinking tools to a public health issue	I used a causal loop diagram to determine what information is important for owners to know about disease transmission from feeding pets raw meat-based diets.
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Table 5.2 MPH Foundational Competencies and Course Taught In

22 Public Health Foundational Competencies Course Mapping	MP H 701	MPH 720	MP H 754	MP H 802	MP H 818
Evidence-based Approaches to Public Health					
1. Apply epidemiological methods to the breadth of settings and situations in public health practice	x		x		
2. Select quantitative and qualitative data collection methods appropriate for a given public health context	x	x	x		
3. Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate	x	x	x		
4. Interpret results of data analysis for public health research, policy or practice	x		x		
Public Health and Health Care Systems					
5. Compare the organization, structure and function of health care, public health and regulatory systems across national and international settings		x			
6. Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to achieving health equity at organizational, community and societal levels					x
Planning and Management to Promote Health					
7. Assess population needs, assets and capacities that affect communities' health		x		x	
8. Apply awareness of cultural values and practices to the design or implementation of public health policies or programs					x
9. Design a population-based policy, program, project or intervention			x		
10. Explain basic principles and tools of budget and resource management		x	x		
11. Select methods to evaluate public health programs	x	x	x		
Policy in Public Health					
12. Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence		x	x	x	
13. Propose strategies to identify stakeholders and build coalitions and partnerships for influencing public health outcomes		x		x	
14. Advocate for political, social or economic policies and programs that will improve health in diverse populations		x			x
15. Evaluate policies for their impact on public health and health equity		x		x	
Leadership					

22 Public Health Foundational Competencies Course Mapping	MP H 701	MPH 720	MP H 754	MP H 802	MP H 818
16. Apply principles of leadership, governance and management, which include creating a vision, empowering others, fostering collaboration and guiding decision making		x			x
17. Apply negotiation and mediation skills to address organizational or community challenges		x			
Communication					
18. Select communication strategies for different audiences and sectors	DMP 815, FNDH 880 or KIN 796				
19. Communicate audience-appropriate public health content, both in writing and through oral presentation	DMP 815, FNDH 880 or KIN 796				
20. Describe the importance of cultural competence in communicating public health content		x			x
Interprofessional Practice					
21. Perform effectively on interprofessional teams		x			x
Systems Thinking					
22. Apply systems thinking tools to a public health issue			x	x	

Student Attainment of MPH Emphasis Area Competencies

The five emphasis area competencies for Infectious Disease and Zoonoses were obtained through coursework, including both core and elective courses, as well as through the APE project. The competencies are listed below in Table 5.3.

Table 5.3 Summary of MPH Emphasis Area Competencies

MPH Emphasis Area: Infectious Disease and Zoonosis		
Number and Competency		Description
1	Pathogens/pathogenic mechanisms	Evaluate modes of disease causation of infectious agents.
2	Host response to pathogens/immunology	Investigate the host immune response to infection.
3	Environmental/ecological influences	Examine the influence of environmental and ecological forces on infectious diseases.
4	Disease surveillance	Analyze disease risk factors and select appropriate surveillance.

5	Disease vectors	Investigate the role of vectors, toxic plants and other toxins in infectious diseases.
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Competency #1: Pathogens/pathogenic mechanism

Knowledge of this competency was primarily attained through DMP 814 (Veterinary Bacteriology and Mycology), DMP 834 (Veterinary Parasitology), and VDMP 891 (International Animal and Zoonotic Disease). Through these courses, I learned about various viral, bacterial, fungal, and parasitic pathogens that affect animals. The zoonotic potential of specific diseases was also discussed as well. Topics taught on each pathogen included virulence factors, pathogenic mechanisms, transmission, and more. I applied this knowledge of pathogens directly to my APE project. My expertise in these areas allowed me to discuss different diseases that could be addressed in the handouts with the multidisciplinary team. Further, the knowledge was then shared in the first two sections of the One Health Briefs for Practitioners which covered basic information about the diseases including the pathogen involved, species affected, and routes of transmission.

Competency #2: Host response to pathogens/immunology

This competency was attained through DMP 817 (Veterinary Immunology). Through this course, I learned what the immune system is and how the body utilizes immunological reactions to address different threats such as pathogens. My knowledge of immunology was most useful in my APE project when either discussing or writing about clinical signs associated with different diseases. My understanding of a host's response to pathogens better allowed me to determine what information was most valuable for practitioners to know. Further, this competency was useful when in meetings discussing current efforts to address rabies. A foundational knowledge of immunology better allowed me to participate in discussions focusing on vaccination and prophylaxis protocols.

Competency #3: Environmental/ecological influences

Information gained to achieve this competency was primarily attained through MPH 802 (Environmental Health). Through this class, I learned about topics such as environmental policy, toxins, and the effect of the environment on public health. This information was useful when discussing routes of transmission for diseases that I focused on in my handouts for my APE project. Further, I utilized my knowledge gained from MPH 802 when developing a research project for DMP 880 (Problems in Pathology) looking into using wild-caught house flies as feed supplements in agricultural animals. By understanding environmental ecological influences, I was able to determine where to collect the most amounts of flies as well as understand the relationship between those environments and the potential pathogens they may carry. This project was used to develop the poster found in Appendix 19.

Competency #4: Disease surveillance

The principles of disease surveillance were taught in classes such as MPH 754 (Introduction to Epidemiology) and VDMP 891. Through these classes, I learned what disease surveillance is and why it is important, especially for biosecurity. Specifically, for VDMP 891, I learned of current disease surveillance programs for different high-consequence infectious and zoonotic diseases in the U.S. and around the world. I applied my knowledge of surveillance for both my APE project and my project for DMP 880. For my APE project, I used my knowledge to discuss the importance of reporting specific diseases to the appropriate entities. A specific example of this was in the rabies handout for practitioners where I discussed where to submit samples for laboratory diagnosis. Disease surveillance was also applied in my DMP 880 project by collecting flies from different locations over time to show what pathogens are present and to monitor for antimicrobial resistant bacteria.

Competency #5: Disease vectors

I attained this competency through two main courses, DMP 814 and DMP 834. These courses discussed arthropods' roles in the transmission of diseases such as bacteria, viruses, and protozoa. I also learned different mitigation techniques for managing arthropod populations to prevent disease spread. This knowledge was

applied to my APE project to create both the handouts for practitioners and animal owners. Some specific examples of vectors that I discussed were ticks and deer flies known for transmitting *Francisella tularensis*, the bacteria known for causing tularemia. My knowledge of vectors also played a role in my DMP 880 project. As house flies are mechanical vectors for many different diseases, I needed to apply this knowledge to ensure that flies fed to animals were treated to prevent the spread of disease.

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Appendix

Appendix 1: One Health Briefs for Practitioners: Tularemia

One Health Briefs For Practitioners: Tularemia

What is Tularemia?

Tularemia, also called Rabbit Fever or Deer Fly Fever, is a disease caused by the gram-negative coccobacillus, *Francisella tularensis*.

Tularemia has over 100 host species with the most common being rodents, rabbits, cats, humans, dogs, sheep, and birds.

How is Tularemia spread?



Tularemia is primarily spread through arthropod vectors. Tick species in the U.S. that can transmit the bacteria are the American Dog Tick (*Dermacentor variabilis*), Wood Tick (*Dermacentor andersoni*), and the Lone Star Tick (*Amblyomma americanum*). Deer flies (*Chrysops spp.*) can transmit the bacteria as well.

Other methods of transmission include contact with or consumption of infected animal tissues or contaminated water, cat bites, and inhalation.

Veterinary Medical Professionals

Common signs and symptoms: Symptoms vary based on route of entry with ulceroglandular tularemia being the most common type. Signs in cats and rabbits can include lymphadenopathy, lingual or oral ulcers, abscesses, fever, splenomegaly, and hepatomegaly.

Diagnostics: Veterinarians with patients suspected to be infected with *Francisella tularensis* should contact the Kansas Veterinary Diagnostic Laboratory to submit samples. Necropsies should only be performed by a qualified pathologist under a biosecurity hood.

PPE: Veterinary staff should use gloves, eye and face shields, and gowns when working with suspected infected animals. All surfaces and instruments that contact the animal should be cleaned with an appropriate disinfectant.

Owner Communication: Owners should be informed of the zoonotic potential and that animals treated with antibiotics are no longer infectious after 72 hours. Clients are encouraged to discuss health concerns with their local health department or medical provider.



Human Medical Professionals

Common signs and symptoms: Symptoms vary based on route of entry with ulceroglandular tularemia being the most common type. Most signs are non-specific and can include fever, chills, headache, malaise, and chest pain.

Diagnostics: The most common diagnostics used for Tularemia in human patients include culture and serology. Wounds believed to have caused the infection should be cultured. Suspected cases without wounds or ulcers should utilize serology.

Patient Communication: Patients should be asked if they have any exposure to animals such as cats or rabbits, whether domestic or wild, as well as raw or under cooked meat. They should also be asked if they have been to an area infested by ticks or deer flies, or if they have recently mowed. Patients should be informed that there is no evidence that Tularemia can spread from person to person.

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Appendix 2: One Health Briefs for Practitioners: Toxoplasmosis

One Health Briefs For Practitioners: Toxoplasmosis

What is Toxoplasmosis?

Toxoplasmosis is a zoonotic disease caused by the intracellular protozoal parasite, *Toxoplasma gondii*.

T. gondii can infect nearly all warm-blooded animals, however, cats are the only definitive host.

How is Toxoplasma spread?

Toxoplasmosis is the leading cause of death due to foodborne disease. Consumption of contaminated water, produce, and raw or under-cooked animal tissues, such as meat, are the most common routes of infection.

Other methods of transmission include fecal-oral from improper hygiene techniques when cleaning cat feces or gardening, and transplacentally from mother to fetus.



Veterinary Medical Professionals

Common signs and symptoms: Most patients are typically asymptomatic. However, some patients may present with diarrhea, fever, emesis, abortion, and/or respiratory, ocular, or neurological disease. Species of most concern include cats, goats, and sheep. This disease can be fatal in some cats.



Diagnostics: A centrifugal fecal exam can be performed to determine if cats are shedding the protozoan in their feces due to intestinal infections. Serologic testing can be performed to detect systemic infections in cats as well as other species.

PPE: Veterinary staff should use gloves when working with patients or fecal material. Hands should be washed after removing gloves and following exams or diagnostics tests on suspect animals.

Owner Communication: Owners, especially those who may be pregnant, should be informed of the zoonotic potential and encouraged to talk to their medical provider about diagnostic testing if concerned. Veterinarians should discuss safe methods of cleaning pet feces and that cat feces is typically only infectious for two weeks, and stress the importance of keeping cats indoors.

Human Medical Professionals

Common signs and symptoms: Although most patients infected will be asymptomatic, fever, muscle pains, and other flu-like symptoms can develop. Pregnant women infected are at the highest risk of complications, including spontaneous abortion. Fetuses with congenital infections can develop serious conditions such as ocular disease, mental disability, or seizures.

Diagnostics: The most common test used for the diagnosis of Toxoplasmosis is serology. Immunofluorescence (IFA) stains can be used to detect the protozoal organisms from tissue biopsies and cerebral spinal fluid.

Patient Communication: Patients should be asked about their diet and food handling techniques, including if raw or under-cooked animal tissues or raw goat milk are included in their diet. Patients should also be asked if they have had any exposure to animals, especially cats that are allowed to hunt or eat raw meat based diets, if they have come into contact with sand boxes that may be used by cats, and about hobbies, such as gardening, which may expose people unknowingly to cat feces.

References

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Appendix 3: One Health Briefs for Practitioners: Rabies

One Health Briefs For Practitioners: Rabies

What is Rabies?

Rabies is a deadly zoonotic disease caused by the negative-sense RNA Lyssavirus, Rabies virus.

Rabies can infect all mammals and is considered to have a 100% fatality rate after the onset of symptoms.

How is Rabies spread?

Rabies is primarily spread through direct contact with the saliva of infected animals. Mostly commonly, this occurs through a bite. However, contact of saliva with open wounds or mucus membranes should also be considered.

Other less potential methods include scratches and contact with nervous or brain tissue.



Veterinary Medical Professionals

Common signs and symptoms: Symptoms of rabies in animals can vary based on the stage of disease and species. Some of the most common symptoms can include ataxia, paralysis, seizures, aggression, and excessive salivation.



Diagnostics: The most common diagnostic test is a postmortem direct fluorescent antibody test (dFA) of brain tissue. Rabies in animals is reportable in the state of Kansas and samples should be submitted to the Kansas State Veterinary Diagnostic Laboratory (KSVDL).

PPE: Veterinary staff should use extreme caution when working with suspected rabid animals. Heavy rubber gloves, masks, eye protection, and protective gowns should be worn when decapitating suspected animals. Staff should be vaccinated against the virus.

Owner Communication: Owners and those who have come into contact with the animal should be informed of the zoonotic potential. They should be encouraged to talk to the local health department and/or their medical provider, especially if they have come into contact with saliva.

Human Medical Professionals

Common signs and symptoms: Symptoms of rabies in humans typically begin as non-specific flu like symptoms that progress to cerebral disease, agitation, hydrophobia, and hallucinations. Patients suspected to be infected with rabies should immediately be reported to the state health department.

Post-Exposure Prophylaxis (PEP): Not all animal bites require PEP. State and local guidelines should be used to determine when PEP should be administered with bite and non-bite exposures. Bats found in rooms with children as well as adults who are asleep or impaired are considered exposed.

Diagnostics: Multiple ante-mortem tests including RT-PCR and virus isolation can only be performed to diagnose rabies in the terminal stage of disease. Collected samples should include CSF, skin biopsies, saliva, and serum.

Patient Communication: Bites and scratches from wildlife, bats, and stray animals present the greatest risk for rabies exposure. Patients should be educated to avoid handling or petting these animals and to seek medical care if they are bitten or scratched or consult public health if they find a bat in their home.

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Appendix 4: One Health Briefs for Practitioners: Q Fever

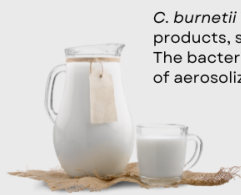
One Health Briefs For Practitioners: Q Fever

What is Q Fever?

Q Fever is a disease caused by the gram-negative, obligate intracellular bacteria, *Coxiella burnetii*.

C. burnetii can infect many animals, but, is most commonly associated with infections in cattle, sheep, goats, and occasionally humans.

How is Q Fever spread?



C. burnetii is shed from the milk, urine, feces and birth products, such as the placenta, of infected animals. The bacteria is primarily spread through the inhalation of aerosolized dust particles that contain the bacteria.

Another route of infection is through the consumption of undercooked animal tissues or unpasteurized milk products. Some species of ticks may also play a role in transmission, however, this is considered controversial and not proven.

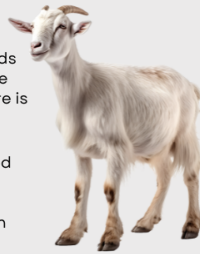
Veterinary Medical Professionals

Common signs and symptoms: The most common signs of Q Fever infection in animals such as cattle, goats, or sheep are abortions or stillbirths. Other symptoms are typically non-specific and can include fever, anorexia, and lethargy.

Diagnostics: As many animals may be asymptomatic, diagnosis may be difficult. Serological testing can be used to screen herds for *C. burnetii*. Other diagnostic tools available include PCR or immunohistochemistry. Culture is typically not used due to the bacteria being highly pathogenic.

PPE: Gloves should be worn and hands washed when handling tissues or excretions from animals that may be infected. Masks are also recommended when assisting with parturition of a suspect animal.

Owner Communication: Owners of animals infected with *C. burnetii* should be informed of the zoonotic potential of the bacteria. They should be encouraged to use proper PPE and hand hygiene when working with potentially infected animals.



Human Medical Professionals

Common signs and symptoms: Many people infected with *C. burnetii* are asymptomatic. Symptomatic individuals may develop non-specific symptoms such as fever, headache, and muscle pain. More serious infections may lead to miscarriage, pneumonia, or chronic Q fever.

Diagnostics: For definitive diagnosis of Q Fever PCR and/or serological testing on acute and convalescent samples is used. Treatment should not be withheld pending laboratory results and should be initiated based on clinical signs and patient history. Culture is not typically useful in the diagnosis of Q fever.

Patient Communication: Patients suspected of having Q Fever should be asked if they have come into contact with agricultural animals, particularly sheep, goats, or cattle or if they consume raw milk or dairy products. Patients should be informed of the zoonotic potential of the disease and should be advised on proper safety precautions to minimize the risk of future infections.

References

World Organization for Animal Health. (2023). Q Fever. <https://www.woah.org/en/disease/q-fever/>
Centers for Disease Control and Prevention. (2019). Q Fever. <https://www.cdc.gov/qfever/index.html>

Appendix 5: One Health Briefs for Practitioners: Ringworm

One Health Briefs For Practitioners: Ringworm

What is Ringworm?

Ringworm, also known as tinea or dermatophytosis, is an infectious disease caused by fungus. There are multiples species that cause ringworm.

Ringworm can affect many species, especially mammals such as humans, dogs, cats, sheep, and cattle. Many species of fungus that cause dermatophytosis are species specific, however, some are zoonotic .

How is Ringworm spread?



Ringworm is primarily spread through direct contact with three primary sources. These include direct contact with infected people, infected animals, or contagious spores in the environment.

Since the fungus prefers dark, moist environments, places such as locker rooms and communal showers often harbor ringworm.

Veterinary Medical Professionals

Common signs and symptoms: Animals that contract ringworm will likely present with round, hairless areas on their skin. Some of the most common species infected include dogs, cats, sheep, and cattle.

Diagnostics: There are multiple different diagnostic tools and tests that can be used to diagnose ringworm. Some tests include the Wood's Lamp Examination, direct microscopic examination, and culture.

PPE: Since ringworm is a highly contagious disease, veterinary professionals should not allow bare skin to come into contact with infected patients. Gloves and gowns should be worn to prevent the spread of disease. Hands should also be washed thoroughly afterwards.



Owner Communication: Owners should be informed of the zoonotic potential of the fungus. They should be encouraged to not allow their animals to come into contact with other animals and hands should be washed after handling infected animals or items that may act as fomites such as halters, collars, or leads.

Human Medical Professionals

Common signs and symptoms: Ringworm in humans typically presents with circular areas of red, scaly, and often itchy skin.

Diagnostics: There are multiple options for ringworm diagnostics. Potassium hydroxide preparation of skin scrapings, fungal culture, PCR, and the Wood's Lamp Examination are all accepted methods to diagnose ringworm.

Patient Communication: Patients should be asked if they have any exposure to animals such as dogs, cats, or cattle, whether domestic or wild. They should also be asked if they regularly use public showers or locker rooms. If the fungus is determined to be a zoonotic species, patients should be informed of its potential to spread to pets in addition to the typical transmission to other humans.

References

Centers for Disease Control and Prevention. (2014). Ringworm.
<https://www.cdc.gov/healthypets/diseases/ringworm.html>
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Appendix 6: One Health Briefs for Practitioners: Zoonotic Influenza

One Health Briefs For Practitioners: Zoonotic Influenza

What is Zoonotic Influenza?

Influenza, commonly called the flu, can infect multiple different species. However, most influenza viruses are species specific and not zoonotic.

Although uncommon, influenza A is known to occasionally be spread from animals to humans. The most common animals implicated in the spread of the disease to humans include poultry and swine.

How is Influenza spread?

Influenza virus is primarily spread through aerosolized respiratory droplets. Outbreaks are most likely to occur when large quantities of sick animals are kept in close quarters with limited ventilation or airflow.



Veterinary Medical Professionals

Common signs and symptoms: Swine typically present with respiratory disease with signs including coughing, conjunctivitis, and pyrexia. Poultry infected with influenza often present with both respiratory and digestive symptoms and very high mortality rates.



Diagnostics: Common diagnostic tests used to identify influenza virus in poultry and swine include RT-PCR, virus isolation, and ELISA.

PPE: Veterinary professionals who come into contact with poultry, swine, or other animals potentially infected with influenza should use caution. Gloves should be worn while handling animals and hands should be washed afterward. N-95 masks are also recommended to be worn.

Owner Communication: Owners of animals infected with influenza should be informed of the risk of zoonotic infection. They should be encouraged to avoid face-to-face contact with their animals, wash hands immediately after handling or feeding sick animals, and consult their healthcare provider if they develop fever, cough, or other upper respiratory symptoms. Depending on the species, public health monitoring may occur after an individual has been exposed to zoonotic influenza.

Human Medical Professionals

Common signs and symptoms: Zoonotic influenza presents with the same symptoms as typical influenza found in humans including fever, sore throat, cough, conjunctivitis, and fatigue. Although typically uncomplicated, some patients, especially those who are immunocompromised, may have more severe symptoms including encephalitis, sepsis, or even death.

Diagnostics: Multiple different tests are available to diagnose influenza, the most common being the "rapid influenza diagnostic tests" (RIDT). Other tests available include rapid molecular assays, RT-PCR, viral culture, or immunofluorescence assays.

Patient Communication: Patients presenting with symptoms of influenza should be asked if they regularly work with or come into contact with animals such as poultry or swine. Although zoonotic influenza infections are rare, rapid identification is necessary. If you suspect your patient has zoonotic influenza, contact the state or local health department for confirmatory testing. Patients who work with ill swine or poultry animals should be encouraged to use PPE, including fit-tested N-95 masks.

References

World Health Organization. (n.d.). Zoonotic influenza. <https://www.who.int/news-room/spotlight/influenza-are-we-ready/zoonotic-influenza>

Centers for Disease Control and Prevention. (2022). Influenza (flu). <https://www.cdc.gov/flu/other/animal-flu.html>

Appendix 7: One Health Briefs for Practitioners: Backyard Poultry

One Health Briefs For Practitioners: Backyard Poultry

What is Backyard Poultry?

Keeping backyard poultry has become a popular hobby with increasing prevalence over the years. Poultry animals can include many different species with some of the most popular birds being chickens, ducks, turkeys, and geese.

Although many poultry animals are raised for egg and meat purposes, some may be raised as pets or for educational purposes.

How are diseases spread?

Poultry can be carriers of multiple infectious and zoonotic diseases. Some of these diseases can include *Salmonella*, *E. coli*, *Campylobacter*, and avian influenza.

Most zoonotic diseases spread by poultry are spread through fecal-oral routes, however, some may be aerosolized. Owners should wash their hands after handling their birds. Eggs should also be brushed off before storage in a refrigerator.



Veterinary Medical Professionals

Common signs and symptoms: Zoonotic diseases found in backyard poultry can have varying symptoms. Veterinarians should look for diarrhea, sudden death, decreased appetite and respiratory signs.

Diagnostics: Necropsy is often an integral part of poultry disease diagnosis, however, PCR and culture and sensitivity can also be used to more specifically identify pathogens.

PPE: Veterinary professionals should take the proper precautions when working with sick poultry animals including wearing gloves and washing their hands and equipment used.

Owner Communication: Clients that own backyard poultry should be informed of common zoonotic diseases such as *Salmonella*, and encouraged to take proper precautions to minimize disease transmission. Birds should only be purchased from reliable sellers and should be quarantined for 4 weeks before introducing them to the rest of the flock. Birds should also receive their recommended vaccinations.



Human Medical Professionals

Common signs and symptoms: Patients that have backyard poultry animals may become infected with various diseases. The clinical signs will vary based on the disease. Most commonly, these diseases will be enteric diseases such as Salmonellosis, resulting in diarrhea, abdominal pain, and fever.

Patient Communication: Patients should be asked if they keep poultry animals or eat farm-fresh eggs. Patients that may have contracted a disease from their poultry animals should be informed of zoonotic potential and educated on best practices to prevent themselves from becoming infected in the future by methods such as wearing gloves, washing hands, and cleaning bedding. Patients that consume farm-fresh eggs should also be encouraged to brush off eggs before storage or consumption.

References

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Appendix 8: Owners' Guide to Tularemia



What is Tularemia?

Tularemia, also called Rabbit Fever, is a zoonotic disease caused by the bacteria *Francisella tularensis*. The disease can cause varying symptoms depending on the species infected and method of infection.

How did my pet become infected?

Tularemia can be transmitted through multiple pathways. Most commonly, infection happens from the bite of an infected tick or consuming animal tissues or milk from infected animals.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted between animals and humans. Animals do not have to show signs of illness to transmit some diseases.

How do I prevent myself or others from becoming infected?

Pets infected with tularemia are no longer considered infectious after 72 hours of antibiotic treatment and clinical improvement. Pet owners should use flea and tick preventatives to avoid future infections. They should also work to reduce fly populations and use tick repellents in infested areas. People should avoid animal bites/scratches and seek medical care if they feel unwell.

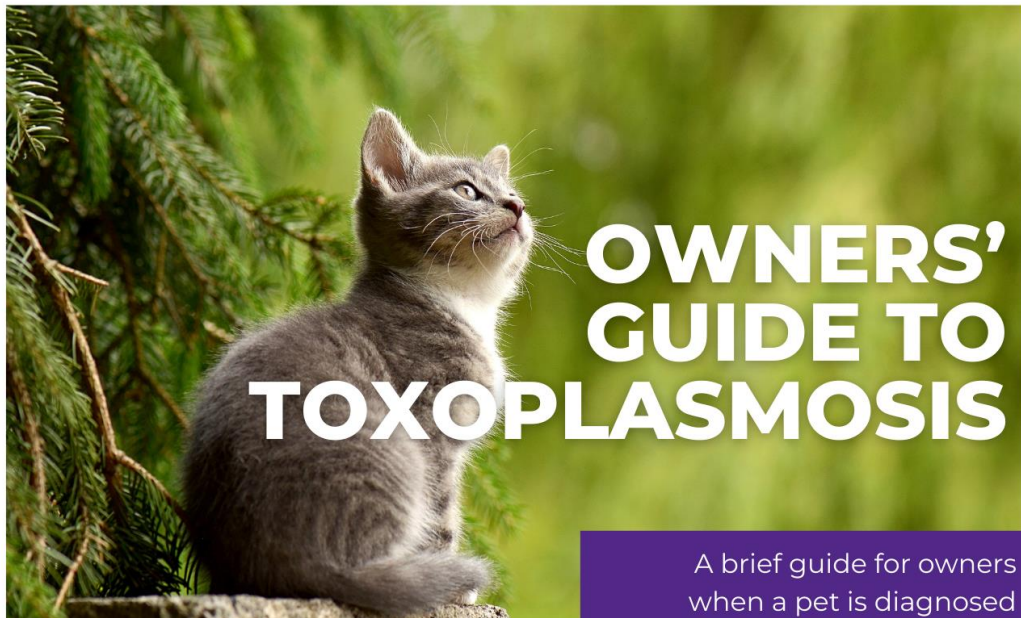
Should I seek medical treatment?

People who are exposed to Tularemia positive animals should contact their medical provider to determine the next steps.



Scan to learn more about tularemia from the Centers for Disease Control and Prevention (CDC).

Appendix 9: Owners' Guide to Toxoplasmosis



What is Toxoplasmosis?

Toxoplasmosis is a zoonotic disease caused by a protozoal parasite called *Toxoplasma gondii* which can infect many different species. The most commonly affected species includes cats, goats, sheep, and humans. Although most do not have any clinical signs, some pets may present with diarrhea, fever, or other symptoms such as respiratory disease.

How did my pet become infected?

Cats commonly are infected with *T. gondii* by eating infected mice or birds. It can also be spread through other routes including fecal contamination of water and vegetation, consuming raw animal products such as meat or raw goat milk.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted from animals to humans. Animals do not have to show signs of illness to transmit some diseases.

How do I prevent myself or others from becoming infected?

Owners of pets infected with *Toxoplasma gondii* should take appropriate actions to prevent transmission to humans. Gloves should be worn when cleaning up pet feces, and hands washed thoroughly afterwards. Owners should not feed pets raw animal products such as raw or undercooked meat or unpasteurized milk, and cats should be kept indoors.

Should I seek medical treatment?

Most people do not need to seek medical treatment if a pet has toxoplasmosis. However, pregnant or immunocompromised individuals should consult with their primary medical provider due to risk of severe health complications in the fetus.



Scan to learn more about toxoplasmosis from the Centers for Disease Control and Prevention (CDC).

Appendix 10: Owners' Guide to Rabies



What is rabies?

Rabies is a zoonotic disease caused by the rabies virus. Rabies is fatal and considered to be incurable after the onset of symptoms in all species. Early symptoms typically begin with fever, weakness, or discomfort but then progress to symptoms such as agitation or aggression, hallucinations, hydrophobia (fear of water), salivation and eventually, death.

How do pets become infected?

The virus is transmitted through the saliva of infected animals. Animals typically become infected by being bitten by an infected wild animal, such as a skunk. Less commonly, scratches can also transmit the virus.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted between animals and humans. Animals do not have to show signs of illness to transmit some diseases.

What will happen to my pet?

If your pet has been bitten by another animal, you should immediately contact your local veterinarian. Your veterinarian may recommend that your pet receives additional vaccinations. Quarantine or observation may also be required depending on your pet's rabies vaccination status.

Should I seek medical treatment?

People who come into contact or own animals suspected to be infected with rabies should contact their health providers to discuss potential treatment.

How can I prevent myself or others from becoming infected?

To avoid contracting rabies virus, people should avoid coming into contact with wild or stray animals and animals expressing aggressive behaviors.



Scan to learn more about rabies from the Centers for Disease Control and Prevention (CDC).

Appendix 11: Owners' Guide to Q Fever



What is Q Fever?

Q Fever is a disease caused by infection with the bacteria, *Coxiella burnetii*. In animals, the bacteria most commonly causes abortions or stillbirths in cattle, sheep, and goats. In humans, the bacteria often does not cause illness. Those who do become sick may have symptoms such as headaches and fevers. Some cases can be more severe and lead to miscarriages, heart valve infections, or chronic symptoms.

How did my animal become infected?

The most common route of infection is through the inhalation of the bacteria from excretions or tissues such as milk, urine, feces, or reproductive tissues, such as placentas, from infected animals.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted between animals and humans. Animals do not have to show signs of illness to transmit some diseases.

How do I prevent myself or others from becoming infected?

Owners of animals infected with Q Fever should take appropriate precautions to prevent themselves from becoming infected. Gloves should always be worn and hands washed after handling potentially infected animals. This should also be done when handling reproductive tissues or when assisting an animal with delivery. Masks should be worn when working near or with infected animals.

Should I seek medical treatment?

Most people do not need to seek medical treatment if an animal is diagnosed with Q Fever. However, owners can inform their medical provider of the specific infection and ask what symptoms to watch for in all people in the household.



Scan to learn more about Q Fever from the Centers for Disease Control and Prevention (CDC).

Appendix 12: Owners' Guide to Ringworm



What is ringworm?

Ringworm, also called, dermatophytosis, is a zoonotic disease caused by fungus. The most common species in dogs and cats is *Microsporum canis*. In dogs and cats, ringworm typically appears as dry, patchy, bald spots on their skin. Treatment of ringworm in pets is a long process that typically takes weeks to months.

How did my pet become infected?

Ringworm is highly contagious through direct contact. Pets become infected by coming into contact with contagious fungal spores. These could be from their environment, however, direct contact with other infected animals is the more common transmission route.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted between animals and humans. Animals do not have to show signs of illness to transmit some diseases.

How do I prevent myself or others from becoming infected?

Infected animals should be kept away from other animals to reduce the spread. It is ideal to wear gloves when applying topical medication, otherwise, thoroughly wash hands with soap and hot water after petting or handling pets. Owners should also avoid face-to-face contact or nuzzling their pets. Infected pets should not be allowed to sleep with owners while they are being treated. All blankets, bedding, or places where pets lay should be cleaned.

Should I seek medical treatment?

Owners of pets diagnosed with ringworm should contact their health care provider to determine what symptoms to watch for.



Scan to learn more about ringworm from the Centers for Disease Control and Prevention (CDC).

Appendix 13: Owners' Guide to Zoonotic Influenza



What is zoonotic influenza?

Zoonotic influenza is caused by a similar virus that causes the flu in humans. Most types of influenza viruses can not spread to different species, however, a few such as Avian and Swine Influenza occasionally can spread to humans. Influenza viruses mainly cause respiratory illness with symptoms including cough, nasal and ocular discharge, fever, and fatigue. Those who are immunocompromised may be at risk for more severe symptoms.

How did my animal become infected?

Influenza viruses are spread through respiratory droplets. Animals become infected through contact with other sick animals or contaminated objects.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted between animals and humans. Animals do not have to show signs of illness to transmit some diseases.

How do I prevent myself or others from becoming infected?

People most at risk of being infected are those who work with swine and poultry, especially in enclosed spaces with minimal ventilation. To reduce the risk of contracting the flu, people who work with infected animals should wear gloves and wash their hands afterwards, wear N-95 face masks to prevent the inhalation of respiratory droplets and avoid face-to-face contact with their animals. Annual flu vaccination is also recommended.

Should I seek medical treatment?

Most people do not need to seek medical treatment if an animal is diagnosed with influenza. However, owners should inform their medical provider of the specific infection if they develop symptoms of influenza or upper respiratory illness.



Scan to learn more about influenza from the Centers for Disease Control and Prevention (CDC).

Appendix 14: Owners' Guide to Helminthiasis



What is Helminthiasis?

Helminthiasis is an infection with a group of parasites called helminths. In small animals, these are commonly roundworms, tapeworms, and whipworms. Adult worms migrate to the digestive tract and live in the intestines. Sometimes the immature stages can migrate to other organs such as the eyes or brain and cause more severe symptoms like blindness.

How did my pet become infected?

Most pets become infected by ingesting feces or infected animal tissues. However, some of the parasites can penetrate the skin or be transmitted during lactation or pregnancy.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted from animals to humans. Animals do not have to show signs of illness to transmit some diseases. Not all helminths can be transmitted to humans, but, some specific species can.

How do I prevent myself or others from becoming infected?

Owners of pets infected with helminths should take precautions while pets are shedding the parasite eggs in their feces. Feces should be picked up and disposed of daily using good sanitation and hand washing techniques. Ensure pets do not eat their own or other animal's feces. Owners should not walk barefoot in any area where pets may defecate and should avoid allowing pets to lick their face or mouths.

Should I seek medical treatment?

Most people do not need to seek medical treatment if a pet is diagnosed with a helminth infection. However, owners can inform their medical provider of the specific infection and ask what symptoms to watch for in all people in the household. Children are especially susceptible to infection.



Scan to learn more about helminthiasis from the Centers for Disease Control and Prevention (CDC).

Appendix 15: Owners' Guide to Cryptosporidium



What is Cryptosporidium?

Cryptosporidium or "Crypto" is a protozoal parasite that can cause disease in animals and humans. There are many different species of *Cryptosporidium*, however, the species found in cattle is known to infect humans as well. The parasite most commonly causes severe, watery diarrhea. Most cases of disease in humans are caused by contaminated water and not contact with animals.

How did my animal become infected?

The parasite is spread through the feces of infected animals. When animals such as cattle consume food or water that has been contaminated with the feces of infected animals, they too can become infected with *Cryptosporidium*.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted between animals and humans. Animals do not have to show signs of illness to transmit some diseases.

How do I prevent myself or others from becoming infected?

As most outbreaks of *Cryptosporidium* in humans are caused by contaminated water, the best way to prevent infection is to avoid consuming water from places such as pools or standing water. People who work with cattle should take proper precautions as well. Hands should always be thoroughly washed after handling cattle. Gloves should also be worn when handling calves with diarrhea and hands washed promptly after removing gloves.

Should I seek medical treatment?

Most people do not need to seek medical treatment if a pet is diagnosed with cryptosporidium. However, owners can inform their medical provider of the specific infection and ask what symptoms to watch for in all people in the household.



Scan to learn more about cryptosporidium from the Centers for Disease Control and Prevention (CDC).

Appendix 16: Owners' Guide to Giardia



What is Giardiasis?

Giardia is a protozoal parasite that can infect both animals and humans. Most types or “assemblages” of *Giardia* are not zoonotic; however, *Giardia* Assemblage A is. Most commonly, the parasite causes symptoms such as diarrhea and abdominal pain. Some patients infected, both human and animal, may be asymptomatic and have no signs of disease.

How did my pet become infected?

Giardia is spread through the feces of infected animals and humans. When animals consume either water or food that has been contaminated with feces from other infected animals, they too can become infected.

What is a zoonotic disease?

Zoonotic diseases are diseases that can be transmitted from animals to humans. Animals do not have to show signs of illness to transmit some diseases. Not all *Giardia* types can be transmitted to humans, however, some can.

How do I prevent myself or others from becoming infected?

Giardia is most often spread to humans through contaminated water or improper hand hygiene. People should avoid drinking from unsafe sources such as pools, lakes, or ponds. Owners of infected animals should take precautions by wearing gloves when cleaning up feces and washing hands thoroughly after handling feces or petting unknown animals. Infected pets should be bathed to remove any feces.

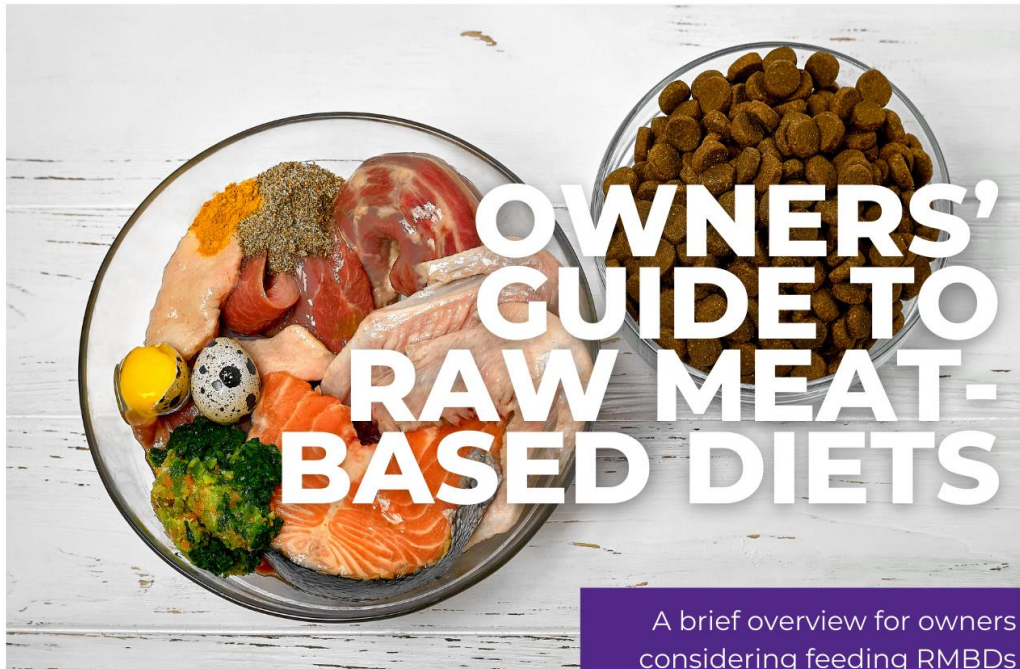
Should I seek medical treatment?

Most people do not need to seek medical treatment if a pet is diagnosed with a *Giardia* infection. However, owners can inform their medical provider of the specific infection and ask what symptoms to watch for in all people in the household.



Scan to learn more about giardiasis from the Centers for Disease Control and Prevention (CDC).

Appendix 17: Owners' Guide to Raw Meat-Based Diets



What is a RMBD?

Raw meat-based diets (RMBD) are diets made for pets containing raw meat or other raw animal tissues.

Why do owners choose these diets?

Pet owners may choose to feed RMBDs to their pets because of multiple reasons. Some reasoning is that these diets are perceived as “healthier” or more “natural” compared to traditional kibble.

Do RMBD have health benefits?

Currently, there is no research-based evidence to prove that RMBDs have any health benefits compared to traditional kibble. However, RMBDs have been linked to pet illnesses due to improperly balanced diets and numerous bacterial and parasitic infections.

Can RMBD transmit diseases to pets?

Although all foods can potentially transmit diseases, raw meat or other raw animal tissues have a higher chance of transmitting serious pathogens such as *Salmonella*, *E. coli*, *Clostridium*, *Trichinella*, and *Toxoplasma gondii*.

Are there risks to humans?

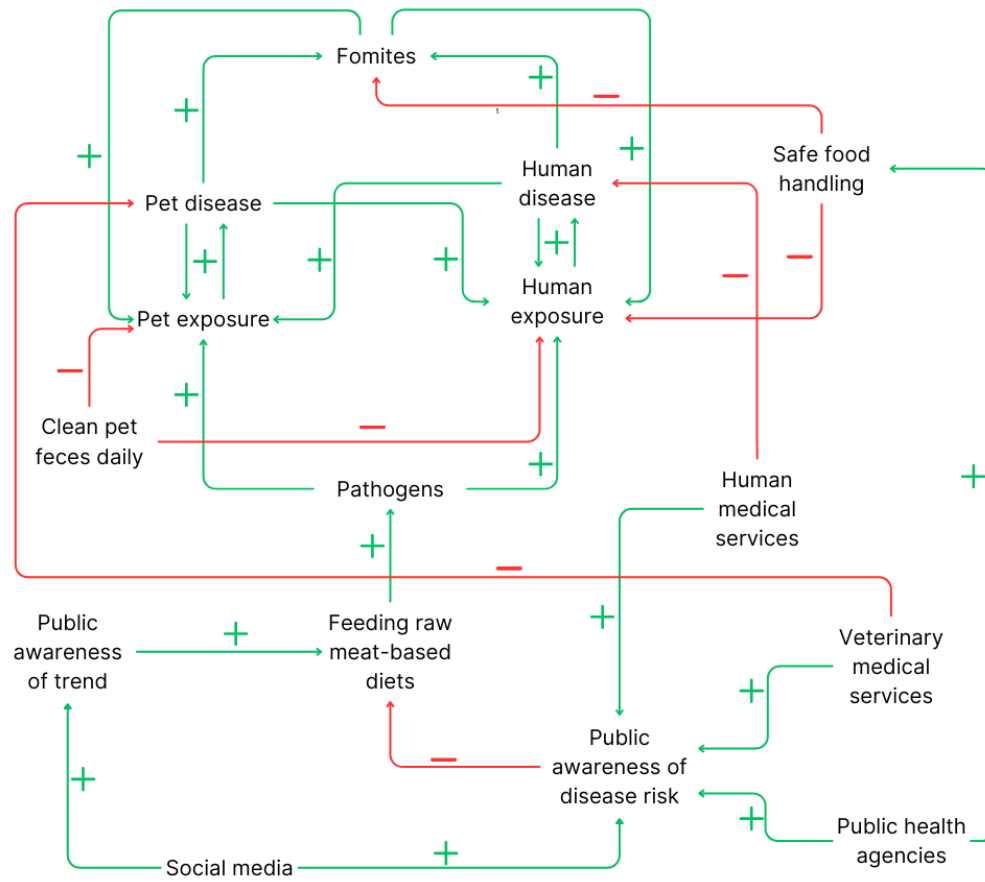
Numerous disease outbreaks in humans have been linked to RMBDs, including *Salmonella* and *Listeria*. Immunocompromised persons and children are especially at risk for infection and severe outcomes.



Scan to learn more about pet food safety from the Centers for Disease Control and Prevention (CDC).

Appendix 18: Causal Loop Diagram

Disease from RMBDs Causal Loop Diagram



Appendix 19: Problems in Pathology Poster



Safety of wild-caught *Musca domestica* for use as protein supplement in chicken feed

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Introduction

- Protein additives, such as soybean meal, can be an expensive addition to chicken feeds.
- Animal-based proteins are generally more digestible and absorbed quicker than plant-based proteins.
- Agricultural operations such as dairy and chicken farms attract a surplus of houseflies, *Musca domestica*. Previous studies indicate flies raised in captivity can be utilized as animal-based protein supplements for poultry.
- Wild houseflies are mechanical vectors for various pathogens which infect both animals and humans.
- Some harmful pathogens may be unique to certain farm types, thus harvesting flies from one livestock operation and using them as feed for a different livestock may reduce risk of infections.
- Disinfection treatments are needed to safely utilize houseflies as protein supplements in animal feed to prevent the spread of pathogens.
- Certain disinfection treatments may damage nutritional content such as crude protein.

Objectives

- Determine microbiome of houseflies found on different animal agricultural operations.
- Develop simple methods for producers to disinfect pathogens carried by flies to be utilized in animal feed.
- Quantify crude protein content of houseflies after disinfection treatments.

Methods

Sample Collection

Flies were collected using nets from two local animal agriculture operations: a dairy and a chicken farm. Both sets of samples were frozen for 24 hours to ensure all flies were euthanized.

Treatments

Samples from each location were sorted into three separate treatment groups: whole (control), dried meal, and heated meal. Flies for the "whole" treatment were left unaltered. The "dried meal" treatment consisted of flies heated in an oven at 75°C for one hour then pulverized in a food processor. The "heated meal" treatment was dried at 75°C for one hour, pulverized in a food processor, and then heated to 200°C for two minutes.

Pathogen Detection

0.01 grams of each sample were suspended in three milliliters of sterile saline solution. 0.2 milliliters of each solution were evenly spread onto an unaltered lysogeny broth agar and a lysogeny broth agar with ampicillin for incubation at two different temperatures, 41°C and 28°C. Plates were incubated for 24 hours. Area of growth was recorded and DNA from individual colonies were extracted for genus identification using Sanger DNA sequencing.

Nutritional Analysis

Subsets of each treatment group from both agricultural locations were sent to a nutritional analysis company for testing.

Results

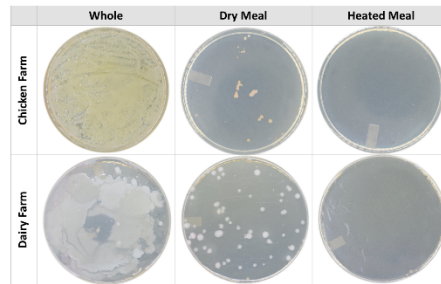


Figure 1. Differences between both the total area of bacterial growth and individual colony characteristics were noted between treatments as well as among the two collection locations.

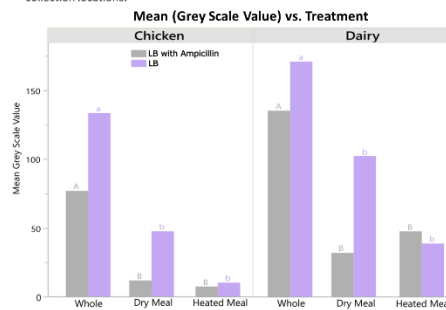


Figure 2. Disinfecting the samples reduced the area of bacterial growth in both ampicillin treated and unaltered lysogeny broth agars, independent of collection location. Total growth for dried meal and heated meal samples was significantly lower than the control for ampicillin (chicken, $P = 0.0036$; dairy, $P < 0.001$) and unaltered plates (chicken, $P < 0.001$; dairy, $P = 0.0036$).

Chicken Farm	Dairy Farm
<i>Klebsiella</i> sp.	<i>Klebsiella</i> sp.
<i>Pseudomonas</i> sp.	<i>Myroides</i> sp.
<i>Proteus</i> sp.	<i>Enterobacter</i> sp.
<i>Bacillus</i> sp.	<i>Bacillus</i> sp.
	<i>Escherichia</i> sp.

Figure 3. Bacterial genera sequenced from individual colonies varied between types of agricultural animal operations.

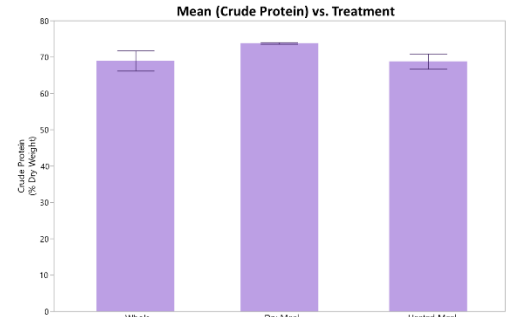


Figure 4. Nutritional analysis of the three treatments demonstrated no significant changes in percent of crude protein on a dry matter basis ($P = 0.2171$).

Discussion

Outcomes

- Bacterial genera extracted from flies collected on both the chicken and dairy operations could cause potential health issues in animals and humans.
- Both the drying and heating treatments can be utilized to disinfect flies used as feedstuffs. The heat treatment reduced the amount of bacteria by the greatest factor, thus making it the safest alternative tested.
- Overall, protein damage due to treatments, either dried or heated, was minimal if present at all. Treatments did not affect the nutritional value of the flies in terms of crude protein.

Future

- This study is limited by only testing for bacterial pathogens that can grow on agars. More detection methods are currently underway to incorporate other pathogens such as RNA viruses, fungi, or protists.

Scan the QR code to the microscopic environment of a plated sample.



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