



Article

Adaptation of the One Health Zoonotic Disease Prioritization Tool for Government and Privately Owned Companion Animal Zoonotic Disease Surveillance

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Simple Summary: Zoonotic diseases are diseases that can be transmitted between humans and animals. There is currently no system in place to monitor the spread of zoonotic disease among U.S. military Service Members, their family members, and their pets. The aim of this project was to use a systematic methodology to prioritize zoonotic diseases to include in a Department of Defense Companion Animal (pets) Disease Surveillance System.

Abstract: The U.S. Army Veterinary Services (AVS) provides public health guidance, consultation, and clinical support regarding zoonoses for the Department of Defense (DoD). AVS One Health Division was tasked with developing a surveillance tool for zoonoses of companion animals presenting to DoD veterinary facilities. Such a tool could help monitor the spread of zoonoses between U.S. military Service Members, their family members, and their pets. The primary objective was to prioritize zoonoses of interest for companion animal disease surveillance in the DoD. AVS implemented a semi-quantitative One Health approach to prioritize zoonoses of interest. The prioritization process followed five steps: (1) generate list of zoonoses to be ranked that are applicable to a DoD companion animal disease surveillance system, (2) develop criteria to identify the importance of a zoonoses, (3) develop criteria definition questions, (4) rank criteria, and (5) rank zoonoses. The prioritization process resulted in a ranked list of 14 zoonoses of interest which was presented to AVS leadership with three potential courses of action. Twelve zoonoses were selected for inclusion in DoD Companion Animal Disease Surveillance. The prioritized list of diseases was the first step in developing a DoD companion animal disease surveillance effort. Mirroring such an approach in civilian companion animal populations could fill a critical public health gap.

Keywords: zoonotic disease surveillance; companion animal; One Health; disease prioritization



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1. Introduction

According to the 2021–2022 American Pet Products Association Pet Owners Survey, 70% of U.S. households own a pet, an estimated 90.5 million homes [1]. There are 69 million households with dogs and 45.3 households with cats [1]. Fifty-six percent of dog owners reported allowing their dogs to sleep in their beds, and 62% of cat owners allow their cats to sleep in their beds [1]. Overall, this leads to an increase in close interactions between companion animals and humans and increases the risk of zoonotic disease transmission. Now more than ever, surveillance for companion animal zoonotic disease is of critical importance.

A zoonosis is any disease that can be naturally transmitted from animals to humans [2]. An estimated 58–61% of all communicable diseases among humans are attributed to zoonoses [2,3]. Due to the tremendous impact of zoonoses on human health, the global efforts on zoonotic disease surveillance and prevention have increased in recent years.

However, there is a knowledge gap in companion animal zoonotic disease surveillance data and methods, specifically for canines and felines. There is an absence of standard companion animal disease terminology when reporting and categorizing different zoonotic diseases, no existing universal clinical data storage for companion animal disease diagnoses, and minimal reporting [4]. Various systematic methods have been employed for disease prioritization in both human and animal populations [5–7]. However, published methods are primarily limited to disease prioritization for national surveillance systems outside the United States [5–7]. These methods are not specific to companion animal zoonotic disease surveillance. Recommendations for the development of a companion animal surveillance system include the involvement of multiple experts across a variety of disciplines such as public health, veterinary medicine, and agriculture [8]. The published literature supports a systematic approach for disease prioritization for surveillance and disease control activities [9].

There exists a range of published methodologies for the selection and prioritization of diseases [10]. The methods are varied and include qualitative, quantitative, and semi-quantitative approaches. Qualitative disease prioritization methods rely strictly on expert opinions on whether the disease poses a serious threat to the human community and animals [11]. Quantitative disease prioritization methods consist of assigning points to different factors that increase the threat the disease poses [12]. The diseases are scored then ranked from most threatening to least threatening. Semi-quantitative methods combine both quantitative and qualitative methods. Though the approaches are different, all strategies have the same goal of providing an objective means for prioritizing diseases of interest. A One Health approach to zoonotic disease prioritization has been adopted by the Centers for Disease Control and is a collaborative effort by the human, animal, and environmental health sectors in a country, region, or other area [13].

The U.S. Army Veterinary Services provides veterinary public health guidance, consultation, and clinical support regarding zoonotic diseases for the Department of Defense (DoD) [14]. This role encompasses the responsibility to implement public health initiatives that support Service Members, Families, and Veteran health across the Joint Force. The U.S. Army Medical Command, Veterinary Services Directorate (VSD), One Health Division was tasked with developing a companion animal zoonotic disease surveillance system to monitor zoonotic disease diagnoses of government- and privately owned animals (GOAs and POAs) presenting to DoD veterinary treatment facilities (VTFs). Government-owned animals, particularly military working dogs, are a critical asset to the DoD. Working dogs and their handlers are in close proximity and can be exposed to the same zoonotic pathogens, and zoonoses may spread between the pair. The health and readiness of the canine and human Warfighter is of utmost importance to the DoD.

Historically, the Army Veterinary Services provides local, installation-level zoonotic disease surveillance programs. Though important, these programs are not consistent across installations with respect to the zoonotic diseases of interest, how diseases are defined, and how disease occurrence is captured. The Army Veterinary Service is uniquely poised to conduct companion animal zoonotic disease surveillance with 135 veterinary clinics distributed globally, and access to a centralized veterinary electronic health record (EHR) system for reporting diagnoses of zoonotic diseases. The goal of the One Health Division was to develop a companion animal disease surveillance system to capture a defined list of zoonotic diseases with clear case definitions, using data that can be compared not only across VTFs, but also with civilian veterinary practice data. Here, we present a modified approach to the Centers for Disease Control (CDC) One Health Zoonotic Disease Prioritization (OHZDP) Tool. Modifications were made to account for the population of interest (feline and canine POAs and GOAs), data constraints, and military priorities.

2. Materials and Methods

A semi-quantitative One Health approach to prioritize zoonotic diseases of interest was used. Based on the OHZDP Tool, our disease prioritization process followed five steps:

(1) generate the list of zoonotic diseases to be ranked, (2) develop the criteria, (3) develop the criteria definition questions, (4) rank the criteria, and (5) rank the zoonotic diseases [13].

Step 1 involved compiling a list of zoonotic diseases using Iowa State Center for Food Security and Public Health (CFSPH) online listing of animal zoonotic diseases [15]. In the field of veterinary medicine, CFSPH is a leading partner known to produce trusted information. The list of zoonoses and associated materials maintained by CFSPH is not known to be maintained by any other organization. Canine influenza and select multi-drug resistant bacteria were added to this initial list based on subject matter expertise input. Canine influenza viruses belong to the species, *Influenza A virus*, which is known for high variability and adaptability [15]. Canines have the potential to serve as mixing vessels for cross-species influenza A virus, which leads to the potential for human health concern [15,16]. Select multi-drug resistant bacteria were included based on the known importance of antimicrobial resistance in public health surveillance [17]. Three exclusion criteria were applied to the list of diseases based on our population of interest. First, because our animal population of interest was specific to canine and feline companion animals, diseases that do not occur in these populations were removed. Second, diseases with known limited zoonotic potential to humans from these species were removed. Third, because the only method of capturing the diagnosis of a zoonotic disease among animals presented to DoD VTFs is through the testing and diagnosis of the disease, we excluded zoonotic diseases that would not be diagnosed clinically. Animals with such diseases, showing no clinical signs, would not present to a DoD VTF for diagnosis.

Steps 2 and 3, consisted of developing a set of criteria used to identify the importance of a zoonotic disease in a DoD companion animal zoonotic disease surveillance system along with categorical criteria questions. Table 1 displays the list of criteria and the criteria definitions we developed. Steps 2 and 3 were performed qualitatively within the VSD Directorate based upon subject matter expertise of the population of interest and other published methods for disease prioritization [5,9,13]. The criteria questions served two purposes: they were used as definitions to clarify the criteria for subject matter expert input in step 4 and their binomial answers (yes/no) were used in a decision tree analysis in step 5. Step 4 used a semi-quantitative method to rank the criteria. We elicited cross-disciplinary expert opinions by distributing a web-based survey collection tool to a variety of 15 army human healthcare providers (preventive medicine physician, general practice physician, public health nurse, nurse practitioner, physician's assistant, etc.) and 15 army veterinarians from varying specialties (general practice, internal medicine, preventive medicine, emergency, and critical care). The survey was left open for two weeks with two reminder emails sent to the respondents. The survey asked respondents to compare the importance of the defined criteria in a pairwise fashion. Respondents were given two criteria at a time along with the criteria definitions, then asked to assess which was more important regarding its contribution to a DoD companion animal disease surveillance system. Response options included choices of each of the criterion being compared, as well as an "equally important" choice. Responses were collected and used to calculate weights for each criterion following the analytic hierarchy process where the assumption is that if the respondent thinks criterion A is more important than criterion B, and criterion B is more important than criterion C, then accordingly, criterion A is also more important than criterion C [18,19]. We used a ≤ 0.2 consistency ratio cut off to exclude inconsistent results [20–22]. After the weights of each criterion was established, step 5 was to rank the zoonotic diseases of interest using the quantitative method of decision tree analysis. The criteria questions were answered for each zoonoses of interest and a score for each disease was generated based on the answers to the categorical criteria questions and weight of each criterion. A subset of diseases was eliminated from the ranked list due to current lack of data availability for surveillance. The final ranked list was presented to VSD leadership along with three potential courses of action (COA) to determine the initial listing of diseases for inclusion in the DOD Companion Animal Surveillance effort. Specific factors associated

with the population of interest were considered, and a final list of twelve zoonoses were identified for inclusion in the first phase of DoD companion animal disease surveillance.

Table 1. List of criteria and criteria definitions used for companion animal zoonotic disease prioritization. Weights calculated during the analytical hierarchy process included for each criterion.

Criteria	Definition	Weight
Epidemic/pandemic potential in humans	Is the zoonotic disease capable of sustained human-to-human transmission?	6
Data availability	Can data for the zoonotic disease be accurately and consistently captured in the current system of record, (i.e., electronic animal health record)?	5
Bioterrorism potential	Is the zoonotic-disease-causing pathogen listed as a select agent?	4
Severity of Illness in humans	Is the case fatality in humans greater than 10% or does the pathogen cause long-term disability?	3
Ability to prevent/control	Is there an effective vaccine for the zoonotic disease in the companion animal reservoir?	2
Severity of illness in animal	Is the case fatality in animals greater than 10% or does the pathogen cause long-term disability?	1

3. Results

An initial list of 67 diseases to be considered for prioritization was compiled. This included 62 diseases from CFSPH zoonotic disease listing, plus four multidrug-resistant diseases, and canine influenza. After applying the three exclusion criteria, the list of diseases to move forward for prioritization included 24 companion animal zoonoses.

Completed responses were received from 22 of 30 subject matter experts from the web-based survey collection tool, yielding a response rate of 73.3%. Twelve of the respondents were army veterinarians and 10 respondents were army human healthcare providers. Of the army veterinarian respondents, general practice veterinarians were over-represented, so two of these respondents were excluded using a random number generator to assign a number to each and excluding the two highest numbers. After calculating the consistency ratio of responses for each respondent, five respondents were eliminated for not meeting the ≤ 0.2 consistency ratio cutoff. Responses from a total of 15 respondents were used to calculate the weights for each criterion (Table 1). Following the decision tree analysis, the scores for each of the 24 zoonoses of interest were normalized and ranked so that they could be compared in relation to one another (Table 2). Ten diseases of interest were excluded due to a lack of data availability in the data export currently available from the veterinary EHR system used in DOD VTFs (Figure 1). The ranked list of 14 remaining zoonoses of interest was presented to the VSD leadership along with three potential COAs. COA 1 followed a natural break in normalized scores and excluded all zoonotic diseases with a score less than 0.529, keeping a potential total of seven diseases to include for surveillance. The benefits of this approach are that it captures significant diseases from an army personnel readiness standpoint and exclusively follows the systematic disease prioritization process. However, it leaves out some diseases that are often diagnosed on routine screening exams such as tickborne diseases captured on SNAP[®] tests (anaplasmosis, Ehrlichiosis) and gastrointestinal parasites (hookworm infection, toxocariasis) captured on annual fecal exams. COA 2 excluded all zoonoses with a score less than 0.412, keeping a total of eight diseases. The benefits of this approach were the same as COA 1, with the added advantage of including Lyme disease, a tickborne disease which is typically screened for annually and the most commonly reported vector-borne disease in the United

States [23]. However, this approach does not include the two other tickborne disease captured on SNAP[®] tests or two of the routinely screened for gastrointestinal parasites. COA 3 was the same as COA 2 but included the addition of anaplasmosis, Ehrlichiosis, hookworm infection, and toxocariasis (all diseases commonly diagnosed via screening exams). The disadvantage of COA 3 is this the method did not respect the natural cut-off of the disease prioritization process. Ultimately, Veterinary Services leadership selected COA 3 as the initial list of diseases for inclusion in DoD Companion Animal Disease Surveillance (Table 3). COA 3 respects the scored results of the systematic process but also takes into consideration diseases that are routinely screened for in DoD VTFs.

Table 2. Normalized score and rank for each companion animal zoonotic disease. Diseases marked with an asterisk were excluded from the final decision brief due to lack of data availability for surveillance.

Disease	Normalized Score	Rank
Leptospirosis	1.000	1
Plague *	0.824	2
Anthrax *	0.765	3
Acariasis, Zoonotic	0.647	4
Campylobacteriosis	0.647	4
Dermatophytosis	0.647	4
Giardiasis	0.647	4
Rabies	0.647	4
Leishmaniasis	0.529	5
MRSA *	0.529	5
Tularemia *	0.471	6
Lyme Disease	0.412	7
MDR Campylobacter *	0.353	8
MDR <i>E. coli</i> *	0.353	8
MDR Salmonella *	0.353	8
RMSF	0.353	8
Salmonellosis *	0.353	8
Anaplasmosis	0.294	9
Brucellosis (<i>B. canis</i> only)	0.294	9
Ehrlichiosis	0.294	9
Hookworm Infection	0.294	9
Toxocariasis	0.294	9
Chagas *	0.235	10
Baylisascariasis *	0.176	11

Table 3. Final zoonotic disease list for inclusion in surveillance.

Final Zoonotic Disease List
Rabies
Leishmaniasis
Leptospirosis
Giardiasis
Campylobacteriosis
Acariasis, Zoonotic
Dermatophytosis
Lyme Disease
Anaplasmosis
Ehrlichiosis
Hookworm Infection
Toxocariasis

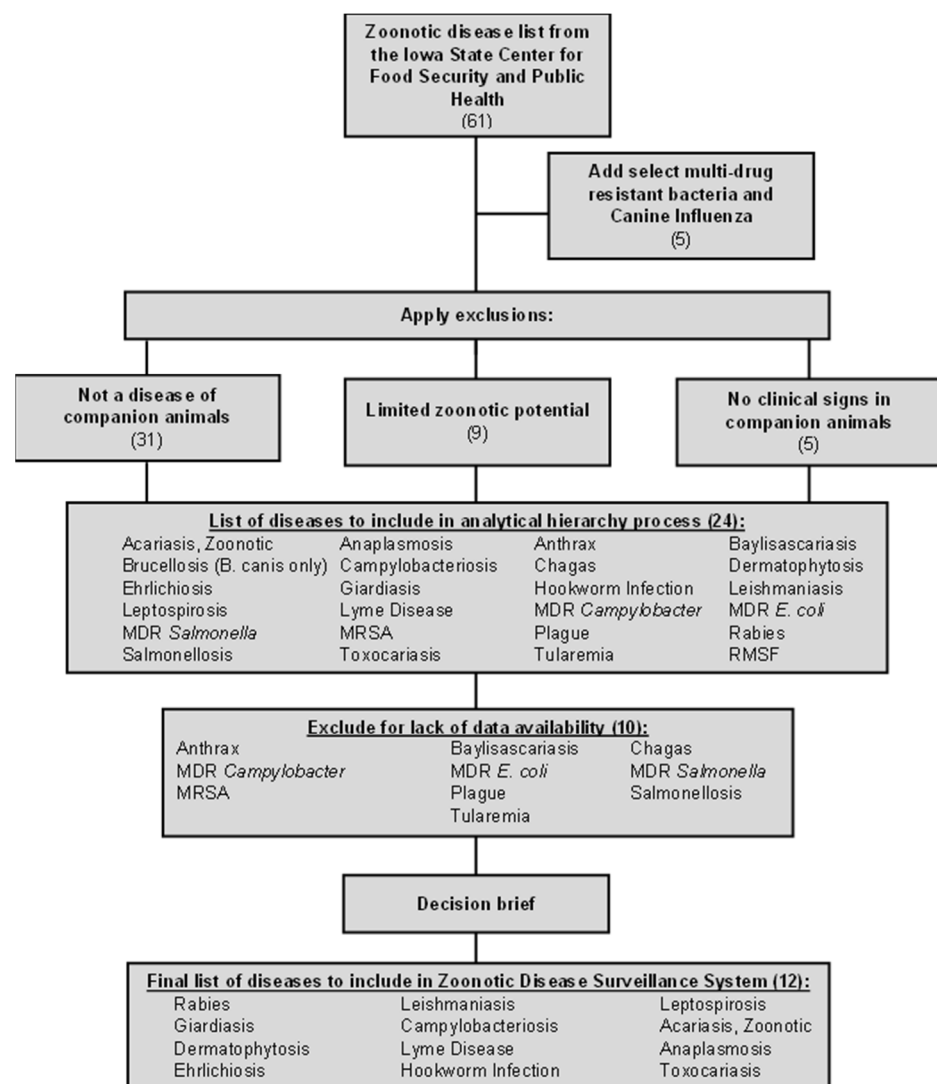


Figure 1. Steps of the modified One Health Zoonotic Disease Prioritization Process for the DoD companion animal zoonotic disease surveillance effort.

4. Discussion

The semi-quantitative One Health approach used by the VSD One Health Division, adapted the CDC OHZDP Tool to prioritize companion animal diseases diagnosed in DoD VTFs for disease surveillance (Figure 1). While the overall steps of the process mirrored those outlined in the OHZDP tool, we approached the first three qualitative steps, internally using VSD One Health Division personnel. While this was in part due to personnel resources available and could be seen as a limitation of the study, our population of interest is very specifically defined as companion animals, canines and felines, seen in DoD VTFs, and the effort was on zoonoses. This limits the availability of possible diseases to include in step 1. Additionally, when considering criteria questions, there are several published examples of criteria used we were able to reference [5,13]. Due to the need to be able to answer each criteria question with a categorical answer, however, we were ultimately limited on the available criteria questions we could use due to limited data available on companion animal zoonoses specifically (steps 2 and 3). For example, criteria based on incidence could not be used. Furthermore, it was important to have expert familiarity with factors influencing the population of DoD companion animals as opposed to the civilian companion animal population. A cross-disciplinary One Health approach was used to solicit SME input in step 4 to rank the criteria. This was important as companion animal populations in the military work closely with their human counter parts,

and diseases of interest have the potential to impact both the animal and human Warfighter. Input on the criteria important to DoD companion animal disease surveillance was solicited from 30 SMEs via a web-based survey collection tool. Using a web-based collection tool to collect the SME input eliminated the need for SMEs to meet in person and allowed for a greater reach to SMEs able to participate. After the disease ranking was generated in step 5, a final decision was made internally by VSD leadership on the preferred COA. This decision was based on the need for expert understanding of factors such as the military companion animal population, VTF operations, and the veterinary EHR system used. This included the need to remove the 10 diseases for which surveillance data is currently not available. As this is only the first step to actualize companion animal disease surveillance in the DoD, and we are currently constrained to reports available in the current veterinary EHR system, it is important to have a ranked list of all identified zoonoses of interest to reference when we are able to expand to additional data sources in the future. Our disease prioritization generated a relative ranking based on the identified criteria that are important to DoD companion animal disease surveillance. The final decision respected the semi-quantitative adapted OHZDP Tool results but was adjusted to meet the need of the target population, a similar adjusted approach can be seen with other uses of the OHZDP tool [13,24]. Our prioritized list of diseases was the first step in developing a DoD companion animal disease surveillance tool that monitors disease trends for 12 zoonotic diseases.

5. Conclusions

To our knowledge, this is the first attempt to prioritize companion animal zoonoses, using a One Health approach, for surveillance within the DoD. Furthermore, there is, to our knowledge, no current companion animal disease surveillance effort in the United States (U.S.) that has used a disease prioritization process. Companion animal disease surveillance efforts and data are limited primarily to efforts outside the U.S. or companion animal parasitic disease (Companion Animal Parasite Council) in North America [6]. Such efforts are not specific to companion animal zoonoses. Using a systematic zoonotic disease prioritization process for companion animal disease surveillance can be applied to civilian companion animal disease surveillance. Mirroring such an approach in civilian companion animal populations could fill a critical public health gap.

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