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Perspectives on and prevalence of ticks and tick-borne diseases in Alaskan veterinary clinics

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Abstract

OBJECTIVE—To assess knowledge, attitudes, and practices (KAP) of veterinary personnel and pet owners regarding ticks and tick-borne diseases in Alaska and to conduct a serosurvey for tick-borne disease pathogens among domestic animals visiting veterinary clinics for preventative care.

SAMPLE—Across 8 veterinary clinics, we sampled 31 veterinary personnel, 81 pet owners, 102 client-owned dogs, and 1 client-owned cat.

PROCEDURES—Information on KAP among veterinary staff and pet owners was collected via self-administered questionnaires. Tick and tick-borne disease prevalence were assessed via tick checks and benchtop ELISA antibody tests detecting *Anaplasma phagocytophilum, Anaplasma platys, Erlichia canis, Erlichia ewingii*, and *Borrelia burgdorferi*.

RESULTS—The veterinary personnel KAP survey showed a low average knowledge score (53.5%) but a moderate attitude score (71.7%). In contrast, owner average knowledge score was higher (67.5%) and attitude score was comparatively low (50.6%). Both veterinary personnel and owners had low average practice scores (64.5% and 56.3%, respectively). One dog was positive for anaplasmosis (unknown species) antibody, and 1 dog was positive for *B burgdorferi* antibody. No ticks were found during the study.

CLINICAL RELEVANCE—This study was the first of its kind in the state and indicated a low prevalence of ticks and tick-borne diseases in the domestic pet population and highlighted significant knowledge gaps that could be targeted by public health efforts. Our results suggest the value of a One Health approach and of the veterinary-client relationship to address ticks and tick-borne diseases.

Ticks are recognized as important vectors of disease for humans, domestic animals, and wild-life.[1,2] The geographic range of many tick species has expanded due to human and pet travel, movement of wildlife hosts, and the ability of ticks to find niches in new environmental conditions.[3–5] Although historical wildlife surveys have identified a number of endemic tick species in Alaska, recent research has demonstrated the importation of

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Supplementary Materials

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new, medically important ticks into the state,[6] with the occurrence and number of species increasing over the past decade.[7] Many of the nonnative ticks found in Alaska have been associated with people or pets that have a recent history of out-of-state travel; however, there have been records of *Amblyomma americanum, Dermacentor variabilis, Ixodes pacificus, Ixodes texanus*, and *Rhiphicephalus sanguineus* found on hosts that did not report recent travel.[7] In 2013, there was evidence of local establishment (defined as 2 or more life stages or more than 6 ticks found in a borough [county equivalent] within 1 year) of *R sanguineus* in 1 region of Alaska.[7]

Because of the low prevalence of ticks in Alaska, few residents have had encounters with ticks and tick-borne disease rates are very low. Thus, veterinarians infrequently see pets affected by tick bites or tick-borne disease.[8] Nonetheless, veterinary clinics can be an integral part of tick surveillance programs, particularly in areas with a low prevalence of human cases but where ticks are an emerging concern.[9] Not only do veterinarians examine large numbers of domestic animals, potentially helping to find undiscovered ticks, but their role requires them to spend just as much time with pet owners as they do with animals.[10] Much of that time is spent recommending treatments and prevention, educating clients about pet health, and discussing potential risks to both animal and human health based on lifestyle. Recent research has highlighted the importance of this veterinary-client relationship as a potential opportunity for improving many public health efforts, especially through the use of partnership communication strategies for education.[11,12] This represents a One Health approach to public health that emphasizes the zoonotic potential of many tick-borne pathogens and the need for interdisciplinary efforts to address changes in tick prevalence and disease risk for wild and domestic animals as well as humans.[9] This approach to tick surveillance could provide a model for many other public health concerns by establishing a unified front for messaging through a broad range of health professionals in the community. Understanding the current level of knowledge and engagement in protective behaviors regarding ticks among veterinary professionals as well as pet owners can help guide public health messaging to prevent these risks.[13]

The purpose of this study was to collect information to establish a baseline of the prevalence of select tick-borne disease pathogens in dogs and cats in Alaska as well as veterinary and public perceptions about tick-borne disease prior to potential emergence. Our goal was to better understand practices and beliefs regarding ticks and tick-borne disease for both pet owners and veterinary personnel. We recruited veterinary clinics across Alaska to (1) assess the knowledge, attitudes, and practices (KAP) of veterinary personnel (licensed veterinarians, technicians, and assistants) and pet owners regarding ticks, tick-borne diseases, and protective actions and (2) conduct surveillance for ticks and tick-borne disease pathogens among pets in Alaska.

Methods

Study participants and recruitment

Between December 28, 2020, and May 28, 2021, veterinary clinics across Alaska were recruited to participate in the study. An email explaining the study with a link to an enrollment survey (Qualtrics) was sent to a list of 46 veterinary clinic contacts as well

as the Alaska Veterinary Medical Association's listserv. We followed up with a second email and by phone. An additional 11 veterinary clinics did not have a publicly listed email and were contacted solely by phone. Clinics had the option to participate in one or both study components of the study: (1) the veterinary personnel survey and (2) recruitment of clients for an owner survey and tick screening or tick-borne pathogen testing of their pet(s). All clinics that participated in either the personnel survey or client/pet recruitment received compensation in the form of electronic Visa gift cards for amounts proportional to the number of employees at their clinic. For ease of purchase, clinics were sorted into size classes based on the number of employees reported at enrollment and were compensated within a range of $10 to $15/employee (for 26- to 50-person clinics, $500; 11- to 25-person clinics, $250; 6- to 10-person clinics, $100; and clinics with 5 people or less, $50). Educational materials created for outreach, including the option for a live or recorded lecture, were provided to all participating clinics as well as inquiring clinics.

Enrolled clinics were asked to have their employees complete the veterinary personnel survey before receiving sampling materials. After we received the results of their staff surveys, we sent them a binder containing instructions for client recruitment and sampling, a data sheet for recording results, and prenumbered consent forms for owners with a QR code providing access to the owner survey as well as 30 benchtop ELISA antibody tests that detect common tick-borne pathogens.

Veterinary personnel survey

We developed a 34-item self-administered KAP questionnaire consisting of 4 sections for the veterinary personnel survey. Questions were designed by use of surveys from previous research,[14,15] in consultation with the Alaska State Veterinarians, and through a review of information provided to the public, such as on the Centers for Disease Control and Prevention (CDC) and Alaska Department of Environmental Conservation tick websites. The first section of the survey gathered information on respondents' demographic and professional characteristics; the second section about knowledge of the Alaska Submit-A-Tick Program (the state's tick passive surveillance program), ticks, and tick-borne diseases; and the third about attitudes regarding the risk of exposure to ticks and the use of tick preventative activities. The personal implementation of preventative activities in the veterinary clinic setting was the topic of the final section.

Owner survey, tick checks, and tick-borne pathogen testing

Enrolled clinics were asked to present owners with the opportunity to enroll in the owner/pet component of the study. Dogs and cats were recruited equally. Each participant was provided a consent form and an online self-directed survey that included questions regarding travel history, use of chemical tick prevention, personal experience with ticks, knowledge about ticks, and their perspectives on tick prevalence in Alaska. Pets enrolled in the study had a standardized tick check performed by veterinary staff during their physical examination. Procedures for the tick check were based on CDC recommendations[16] and outlined in the binders distributed to clinics prior to sampling. Patients that required venipuncture for another part of their appointment or were well behaved and that veterinarians deemed would not undergo undue stress by having blood drawn were enrolled in the serosurvey.

A benchtop ELISA antibody test was performed in-clinic on whole blood or serum and screened for *Dirofilaria immitis, Borrelia burgdorferi, Ehrlichia canis, Ehrlichia ewingii, Anaplasma phagocytophilum*, and *Anaplasma platys*.

Both surveys were informally reviewed by a variety of veterinary professionals for ease and efficacy and were administered using Qualtrics software. This study was approved by the University of Alaska IACUC (624005) and determined to be exempt by the University of Alaska Institutional Review Board (protocol No. 1635389).

Data analysis

For both the veterinary personnel and owner surveys, frequency distributions were used to summarize participant responses. For knowledge questions, scores were calculated by starting with the maximum number of points an individual could receive and subtracting a point for each incorrect or "don't know" response.

Responses to most questions in both the attitude and practice sections of both surveys were on a 5- or 3-point Likert scale. In the attitude section, a score of 1 was given when respondents indicated no concern (eg, strongly disagree that most dogs and cats traveling out of Alaska would benefit from tick prevention). A score of 2 was given when respondents indicated a low concern (eg, slightly disagree). A score of 3 was given to "neutral/undecided" answers, and a score of 4 or 5 was given to attitudes in line with feelings of concern about ticks and tick-borne disease. For questions with fewer options, point values were assigned similarly from 1 to 3 with higher scores based on common recommendations in tick-borne disease prevention, as well as local guidelines from the Alaska State Veterinarian.[14] In the practices section, when participants recorded that they "never" adhere to a practice, they received a score of 1, while responses of "rarely," "occasionally," "frequently," and "very frequently" doing a practice were assigned point values of 2, 3, 4, and 5, respectively.

After scoring, we assigned each participant a KAP score by summing the point values within each section and converting to a percent of possible score. Bloom's cutoff points, 80.0% to 100.0%, 60.0% to 79.0%, and ≤ 59.0% were used to classify scores into 3 levels.[17]

We built univariate linear regression models to assess the association between KAP scores. Assumptions were met before proceeding with modeling. To see if a clustering variable was needed, we ran the ICC using the provided Clinic ID as the single grouping structure for the random effect. We found that the clustering variable was not needed and left it out. Results are presented as parameter estimates and the associated *P* value. *P* values < .05 were considered statistically significant. Data analysis was conducted by use of the Statistical Package for SPSS Statistics (version 28.0; IBM) and Excel (Microsoft Corp).

Results

Eight veterinary clinics were recruited for this study. One clinic enrolled from each of the Northern, Matanuska-Susitna, and Southwest regions. Two clinics enrolled from the Gulf Coast region, and 3 clinics enrolled from the Interior region. One clinic completed

the personnel survey but did not complete owner/pet recruitment, and 1 did not complete the personnel survey component but recruited owners/pets. Across all veterinary clinics, 34 veterinary personnel responded to the personnel survey. Three surveys were incomplete or not sufficient for analysis and consequently excluded, leaving 31 veterinary personnel surveys for analysis. Across all clinics, 81 owner surveys were completed and 102 dogs and 1 cat were checked for ticks and tested for tick-borne pathogens. Some clinics were unable to complete owner surveys due to internet connectivity issues or the nature of their clinics (eg, mobile or rural). One clinic printed paper surveys that were completed and mailed to the researchers to be added to the data set manually. Descriptive results of veterinary and owner surveys are presented, and complete tables of survey questions and responses are available in the supplementary material.

Veterinary personnel survey

Demographic characteristics—Of the 31 respondents to the veterinary personnel survey, most (27/31 [87.1%]) reported working in a small animal practice (Table 1).

Respondents worked in a variety of positions within the clinic, with veterinary technicians (12/31 [38.7%]) and veterinarians (11/31 [35.5%]) being the most frequent. Over a third of respondents (12/31 [38.7%]) had more than 10 years of experience working in veterinary medicine; fewer (8/31 [25.8%]) had more than 10 years of experience working in veterinary medicine in Alaska specifically. Demographic information was not impactful to analysis.

Knowledge—The mean knowledge score among veterinary personnel was 21.4 (SD, 9.7; possible range, 0 to 40) or 53.5%. Out of the 31 participants in the veterinary survey, most (16/31 [51.6%]) fell in the low knowledge category. Others had scores indicating moderate (11/31 [35.4%]) or high (4/31 [12.9%]) knowledge about ticks and tick-borne diseases.

Over half of respondents (20/31 [64.5%]) knew about endemic tick species in Alaska and (19/31 [61.3%]) knew of Alaska's passive tick surveillance program (Supplementary Table S1). More than a quarter (9/31 [29.0%]) correctly likened the size of a nymphal tick to that of a poppy seed, and most respondents identified wooded areas and forest edges (28/31 [90.3%]) and/or tall grass (26/31 [83.9%]) as a place a person or pet are most likely to encounter ticks. However, many veterinary personnel did not know that ticks can be found in leaf litter (18/31 [58.1%]) and incorrectly identified manicured lawns as a habitat where ticks can often be found (8/31 [25.8%]).

For questions regarding the region where most cases of the most common tick-borne diseases (eg, anaplasmosis, ehrlichiosis, or Lyme disease) occur in the US, responses were mixed. Participants were asked to select among regions on a map that corresponded to the CDC's reference manual, *Tickborne Diseases of the United States*.[18] Partially correct responses were more common than entirely correct responses (Supplementary Table S1). Only 1 (3.2%) veterinary personnel incorrectly responded that most cases of anaplasmosis, ehrlichiosis, or Lyme disease occur in Alaska, but there seemed to be general confusion about where most tick-borne diseases occur in the continental US. Slightly over half of respondents correctly identified the Northeast (18/31 [58.1%]) as an area of a high Lyme disease transmission compared to only 22.6% (7/31) and 32.3% (10/31) correctly identifying

important regions of transmission for anaplasmosis and ehrlichiosis. For these diseases, 48.4% (15/31) and 45.2% (14/31) of veterinary personnel, respectively, responded that they did not know which regions were high transmission areas.

While 93.5% (29/31) of respondents correctly identified at least 1 symptom of Lyme disease in a dog and 67.7% (21/31) correctly identified all symptoms, less than a quarter (7/30 [23.3%]) of respondents correctly answered that a tick must be attached for at least 24 hours for the bacteria that causes Lyme disease to be transmitted. Just over a third of respondents (11/31 [35.5%]) indicated they knew how tularemia is transmitted, but among these respondents, many (8/11 [72.7%]) knew it can be transmitted through a tick bite.

Attitudes—The mean attitude score for veterinary personnel was 86.2 (SD, 6.2; possible range, 28 to 120) or 71.7%. Only 2 (2/31 [6.5%]) participants' total attitude scores fell within the high concern attitude score range. Most (29/31 [93.5%]) participants scored within the neutral range.

Few participants (5/31 [16.1%]) indicated that they were confident that their knowledge about ticks and tick-borne disease was current (Supplementary Table S2). More than half of respondents (21/31 [67.8%]) believed ticks are a concern for dogs and cats living in Alaska, while a quarter were undecided (8/31 [25.8%]) and 6.5% (2/31) thought that ticks were not a problem. While most felt it was important to screen dogs and cats for ticks during routine vet visits (24/31 [77.4%]), some (7/31 [22.6%]) were undecided. Just under half (15/31 [48.4%]) of respondents felt most dogs and cats living in Alaska would benefit from tick prevention for some or all of the year, and almost all (30/31 [98.7%]) thought tick prevention could benefit dogs and cats traveling out of Alaska.

All participants (31/31 [100%]) felt veterinary clinics are an important source of information for pet owners about ticks and tick-borne disease. Most (20/31 [64.6%]) believed they play an important role in tick prevention and education at work, but nearly a fourth (8/31 [25.8%]) were neutral/undecided.

Practices—The mean practice score for veterinary personnel was 24.2 (SD, 4.8; possible range, 9 to 45) or 52.4%, and no participants scored in the good practice category. Although most scores fell under the poor practice category (20/31 [64.5%]), just over a third (11/31 [35.5%]) of scores were identified as fair.

The majority of respondents indicated that they very frequently or frequently interact with clients (29/31 [93.5%]; Supplementary Table S3). Very frequently (3/31 [9.7%]) or frequently (1/31 [3.2%]) recommending tick prevention for dogs and cats spending time outdoors was less common among participants than was recommending tick prevention for out-of-state travel (very frequently, 23/31 [74.2%]; frequently, 5/31 [16.1%]). Few respondents (3/31 [9.7%]) reported frequently answering clients' questions about ticks and tick-borne disease; providing clients with brochures, handouts, and other materials about ticks or tick-borne disease (1/31 [3.2%]); or using outreach materials from the Alaska Submit-A-Tick Program (1/31 [3.2%]). Most respondents had occasionally (9/31 [29.0%]), rarely (11/31 [35.5%]), or never (8/31 [25.8%]) sought out information about ticks or

tick-borne disease in the past year. Popular sources of information about the topic were from veterinary textbooks (16/28 [57.1%]); colleagues, coworkers, or peers (10/28 [35.7%]); and the Alaska Department of Fish and Game (11/28 [39.3%]). Less popular sources of information were conventions and other events (3/28 [10.7%]), awareness campaigns (3/28 [10.7%]), and veterinary pharmaceutical sales representatives (3/28 [10.7%]). No respondents selected friends and family members (0/28 [0.0%]) or social media (0/28 [0.0%]).

Association between veterinary KAP regarding ticks and tick-borne diseases—We found that the overall attitude score among veterinary personnel was a positive predictor of practice score (β = 0.38; $P = .006$), indicating that those with attitude scores indicating higher concern had a higher frequency of practices related to tick and tick-borne disease prevention. Knowledge was a marginally significant predictor of attitude score (β = 0.23; $P = .05$) but not of practice score (β = 0.09; $P = .34$).

Owner survey

The majority (68/81 [84.0%]) of owners reported that their pets that participated in this study live primarily indoors, while some (12/81 [14.8%]) reported that their pets spend about half their time indoors and half their time outdoors and only 1 (1.2%) reported that their pet lives primarily outdoors (Table 2). Owners also reported how much time their pets spend in or near wooded areas or fields outside the yard in the summer. About a third (24/81 [29.6%]) answered rarely or never, and other owners answered as follows: 1 to 2 d/wk (24/81 [29.6%]), 3 to 5 d/wk (10/81 [12.4%]), or 6 or more d/wk (23/81 [28.4%]). When asked about personal experience with ticks, the majority of owners (60/81 [74.1%]) responded they had never seen ticks in Alaska or “we don’t have ticks in Alaska,” almost a quarter of owners (19/81 [23.5%]) had at least 1 confirmed sighting of a tick, and very few (2/81 [2.5%]) reported occasionally seeing ticks (more than once/y). No owners reported frequently (ie, on most trips outdoors) finding ticks.

Knowledge—The mean knowledge score among owners was 5.4 (SD, 1.8; possible range, 1 to 8), or 67.5%. Owners’ knowledge scores were divided, with nearly a third (22/81 [27.2%]) in the high category, slightly over a third (32/81 [39.5%]) in the moderate category, and another third (27/81 [33.3%]) in the low category.

When asked if there were ticks native to Alaska, approximately a quarter of owners (19/81 [23.5%]) correctly answered yes, while nearly half of owners (39/81 [48%]) were unsure (Supplementary Table S4). Similarly, when asked if ticks are capable of overwintering in Alaska, very few owners (7/81 [8.6%]) responded that ticks are “very capable” of overwintering in the state. Some thought they are capable of overwintering (34/81 [42.0%]), and almost half (40/81 [49.4%]) thought they are not capable.

Attitudes—The mean attitude score from the owner survey was 9.1 (SD, 2.9; possible range, 4 to 18), or 50.6%, with no owners falling in the category of high concern. Most owners (51/81 [63.0%]) fell in the category of low concern, while the rest (30/81 [37.0%]) fell in the fair category.

When asked how often they worry about fleas, ticks, and other parasites in Alaska, over a third (29/81 [35.8%]) of owners responded that they never worry and about a quarter responded that they rarely (23/81 [28.4%]) or sometimes (18/81 [22.2%]) worry (Supplementary Table S4). Few (10/81 [12.4%]) owners often worry about parasites, and only 1 (1.2%) owner reported regularly worrying. Similarly, when asked how likely they think their pet is to pick up a tick on a walk or a hike, the majority of owners reported that they think this is not likely (26/81 [32.1%]) or very unlikely (34/81 [42.0%]). A small number (20/81 [24.7%]) of owners reported that they think picking up a tick is possible, and only 1 (1.2%) owner reported thinking this is likely. Despite a low level of worry about parasites, many pet owners reported that ticks are somewhat (20/81 [24.7%]) or very (6/81 [7.4%]) concerning in Alaska, though more owners reported that ticks are somewhat unconcerning (18/81 [22.2%]) or not concerning at all (21/81 [25.9%]). The majority (43/81 [53.1%]) of owners answered that they will become more concerned about ticks in Alaska in the next 5 years while fewer (35/81 [43.2%]) reported that their concern would not change and only 3 (3.7%) owners reported that they would become less concerned.

Practices—The mean score for owner practices was 4.5 (SD, 1.3; possible range, 3 to 8), or 56.3%. Very few owners (5/81 [6.5%]) scored in the good practices category. Over half the owners (42/81 [54.5%]) fell in the poor practices category, while about a third (30/81 [39.0%]) were categorized as fair.

When asked about tick prevention, the vast majority of owners (67/81 [82.7%]) responded that their pets were not on prevention while very few (11/81 [13.6%]) responded that yes, their pets were on prevention (Supplementary Table S4). Three (3.7%) owners were unsure if their pets were on tick prevention. However, over half (50/81 [61.7%]) of owners responded that they know how to check their pet for ticks. Despite this, nearly half (37/77 [45.7%]) of owners responded that they never check their pet for ticks. A third (27/77 [33.3%]) of owners responded that they rarely (a few times per year) check their pet for ticks, few (11/77 [13.6%]) owners reported weekly or monthly tick checks, and very few (2/77 [2.5%]) owners reported daily checks.

Association between owner KAP regarding ticks and tick-borne diseases

We found that knowledge and attitude were both positive predictors for practices ($\beta = 0.33$; $P < .001$; and $\beta = 0.178$; $P < .001$) demonstrating that owners with greater knowledge or attitude scores were more likely to perform more protective practices. Knowledge was not a predictor of attitude scores ($\beta = -0.012$; $P = .95$).

Tick checks and tick-borne pathogen testing

No ticks were found on animals during sampling. Of the 102 animals enrolled for tick checks and serosurvey, 1 tested positive for Lyme disease and 1 tested positive for anaplasmosis (unknown species). The Lyme disease–positive animal was reported to have recent travel history to New York in the notes section of the clinic data sheet. The owner reported that their pets were on prevention when traveling outside of Alaska on the owner survey. No travel history was known for the animal that tested positive for anaplasmosis. Both animals underwent treatment with their veterinarian.

Discussion

This study was conducted to evaluate perceptions of ticks and tick-borne disease among Alaskan veterinary personnel and pet owners and to gain a better understanding of the prevalence of tick-borne diseases in the domestic animal population. Using a knowledge-attitude-practice approach, we highlighted key differences between pet owners and veterinary personnel and identified areas for potential improvement in communication. The serosurvey of tick-borne pathogens in animals visiting veterinary clinics for preventative care visits allowed us to collect samples from communities across Alaska. Participating veterinary clinics were spread out across 5 of the 6 Alaska public health regions, and most were reported as small animal practices. On the basis of our findings, the risk of tick-borne disease in Alaska is low.

While the surveys distributed to pet owners and veterinary personnel featured different questions, scores were analyzed in the same way to provide a means for comparison. On average, veterinary personnel scored lower than pet owners on knowledge questions (53.5% vs 67.5%), though veterinary personnel were asked far more technical questions than owners. Veterinary personnel scored much higher (71.6%) in terms of their ascribed attitude compared to pet owners (50.6%), demonstrating a much higher level of concern about ticks. Both veterinary personnel and owners fell into the poor practice category (64.5% and 56.3%, respectively). The practice scores may be reflective of the low tick-borne disease risk in Alaska.

While the surveys distributed to pet owners and veterinary personnel were different, questions that were similar in nature on the 2 surveys provided opportunities to draw additional comparisons between the groups. Veterinary personnel were more than twice as likely to be knowledgeable about endemic tick species in Alaska compared to pet owners. Veterinary personnel were also more likely than pet owners to view ticks as a concern to dogs and cats living in Alaska. The majority of pet owners reported that their pets spend some time in or near wooded areas or fields outside the yard during the summer, but nearly half of owners reported that they never check their pets for ticks despite 60% of owners reporting that they know how to perform a tick check. Checking animals for ticks is considered to be an effective method to reduce the chances that a tick bite will cause tick-borne disease.[19] This finding could be related to the low level of concern for ticks reported by most pet owners. While the majority of veterinary personnel agreed or were undecided as to whether dogs and cats living in Alaska would benefit from tick prevention for some or all of the year, most owners reported that their pets were not on prevention. Similarly, despite all veterinarians reporting that they recommend flea and tick prevention for pets traveling out of state, only half of owners reported that their pets leaving the state in the past year were on a chemical preventative. Travel to and from endemic areas is likely one of the primary means of tick and tickborne disease transport to Alaska. It should be noted that the single *B burgdorferi* positive dog found in this study had recently traveled to a Lyme-endemic state. However, this topic is not straightforward as owner compliance with flea, tick, and heartworm preventative has been linked to many factors including seasonality and financial ability.[20,21] This follows a national trend in low client adherence to veterinarians' recommended flea and tick prevention protocols.[22]

Our findings suggest that the vast majority of Alaskan veterinary personnel surveyed rarely or never teach clients how to check for ticks or answer questions or provide clients with educational materials about ticks or tick-borne disease. Less than half of respondents recommend tick prevention for pets living in Alaska. In comparison, in a recent study Nichol et al[23] found that the majority of Canadian veterinarians reported discussing ticks and tickborne disease during routine exams and half recommend tick prevention for all or part of the year. This difference in behavior may be tied to the *I scapularis* and *I pacificus* range expansion in Canada over the past decade.[23] Although the current low prevalence of tick bites and tick-borne disease for both humans and pets in Alaska is likely contributing to these low rates of preventative behaviors, the population of ticks and thus the risk for tick-borne disease in Alaska is changing and will continue to do so with a warming climate.[6,7,24] It is important that veterinary personnel and pet owners are aware of these changing risks and steps they can take to prevent importation of nonnative ticks to the state and decrease the risk of tick-borne diseases to themselves and their pets when traveling.

Although only 2 animals tested positive for tickborne pathogens during our study, there is a need for future screening, including the continuation of passive tick surveillance programs, such as the Alaska Submit-A-Tick program, because early detection of medically important ticks in a low endemic area can facilitate preventative action. Risk-based screening may also be an effective means of both combating the increase of tick and tick-borne disease prevalence in the state as well as providing a more accurate means of detecting tick-borne disease in Alaska. Many researchers have suggested that *Ixodes angustus*, a tick species historically present in Alaska and the tick species reported most often on humans and domestic dogs in the state,[7,25] has a potential role as a bridge vector and may have the potential to transmit *B burgdorferi* if it were introduced to the state. Another tick that has been present in Alaska for decades, *Haemaphysalis leporispalustris*,[7] is thought to be an important vector for *Francisella tularensis*.[26] While these 2 tick species prefer wild mammals or birds as hosts, they do occasionally feed on humans and are more likely to do so as their activity increases in warmer temperatures.[24] Veterinarians' role in addressing this issue is vital, as they are seen as credible sources of knowledge about disease threats for their communities.[27] Because we found that most Alaskan veterinary personnel believe that veterinary clinics are an important source of information for pet owners about ticks and tick-borne disease, it is possible that, with more time and outreach that highlights current tick information and addresses knowledge gaps, conversations between veterinary personnel and pet owners pertaining to ticks and tick-borne disease could become routine. By engaging in dialogue, veterinary personnel can help spur active, bidirectional engagement with the public.

Our findings in this study were subject to several limitations. With challenges arising from the COVID-19 pandemic, our original study design was amended to ensure safety and compliance with local mandates. As with many industries, veterinary clinics suffered short staffing as well as additional stress from health mandates and changes in operating procedure. Though we designed the study with veterinary input to make it as easy as possible for clinics, the stress on the profession this year may have limited clinic enrollment. We were not able to include a clinic from Anchorage, the largest population center in the state, and instead focused on smaller, more rural clinics. Because convenience sampling

was used, we do not consider this sample to be representative of veterinary practices across the state. It is possible that pets and pet owners in Anchorage travel out of the state more frequently than the owners who participated in our study and therefore may have a higher risk of acquiring a tick-borne disease. The study was open equally to cats and dogs and they were recruited equally, though only 1 cat was enrolled. This might be due to the fact that dogs are more regularly tested for heartworm, and this was one of the primary means of recruitment. Additionally, due to delays because of COVID-19 restrictions, we limited our study to December to May. While previous studies have shown that many ticks are imported into Alaska over the winter after travel to tick-endemic regions,[7] veterinary personnel may have identified more ticks on animals during the summer months. The original study design accounted for full completion of all parts of sampling (tick check, serosurvey, and owner survey) during a preventative care appointment. Due to the move to “curbside care” and less traditional appointment structure, sampling became disconnected, accounting for lost surveys or incorrect participant IDs. Moreover, the sample may be overrepresentative of respondents with higher concern about ticks and tick-borne disease. Therefore, if possible, future studies should try to reduce the number of nonrespondents, potentially by providing additional incentives for owner participation.

This study provides insights into the KAP toward ticks and tick-borne disease among veterinary personnel and pet owners in a region where ticks are an emerging concern for human, animal, and wildlife health. Additionally, our results provide an indicator of the low prevalence of tick-borne disease currently present in the Alaskan pet population. One of the most exciting aspects of this study was the positive response from veterinary clinics regarding the opportunity to have a presentation by the study staff on ticks and tick-borne diseases. Our analyses suggest that attitudes scores predict practices, providing a potential strategy for future outreach to this population. An increase in education may change attitudes and therefore practices regarding ticks and tick-borne diseases as a public health issue in Alaska. As climate change continues to alter the potential risk of ticks and tick-borne diseases through expanding tick habitat, it is important that human and animal health professionals maintain current knowledge on the topic so that they can provide timely and accurate information to the public. Particularly in areas where ticks are an emerging concern, collaboration between veterinary, public health, and wildlife organizations will likely continue to be the most effective means of tracking ticks and improving tick and tick-borne disease literacy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics of veterinary personnel participating in the veterinary survey (n = 31).

Description	n (%)
Type of practice	
Small animal	27 (87.1)
Large animal	0 (0)
Mixed	4 (12.9)
Position at veterinary clinic	
Veterinarian	11 (35.5)
Veterinary technician	12 (38.7)
Veterinary assistant	8 (25.8)
Years working in veterinary medicine	
< 1	3 (9.7)
1–5	9 (29.0)
5–10	7 (22.6)
> 10	12 (38.7)
Years working in veterinary medicine in Alaska	
< 1	5 (16.1)
1–5	11 (35.5)
5–10	7 (22.6)
> 10	8 (25.8)

Table 2

Reported demographics enrolled in serosurvey and owner survey (n = 81).

Description	n (%)
Type of animal	
Dog	80 (98.8)
Cat	1 (1.2)
How often have you seen ticks in Alaska?	
Never/we don't have ticks here	60 (74.1)
Rarely (at least 1 confirmed sighting)	19 (24.5)
Occasionally (more than once/y)	2 (2.5)
Frequently (on most trips outdoors)	0 (0)
Have you ever found a tick on your pet before?	
Yes	14 (17.3)
No	64 (79.0)
Not sure/unable to identify	3 (3.7)
Does your pet live primarily indoors or outdoors (where do they spend the majority of time, not necessarily where they sleep)?	
Indoors	68 (84.0)
Outdoors	1 (1.2)
Spends about half their time indoors and half their time outdoors	12 (14.8)
How often does your pet spend time in or near	
wooded areas or fields outside the yard in the summer (hiking, walking, camping, etc)?	
Rarely or never	24 (29.6)
1–2 d/wk	24 (29.6)
3–5 d/wk	10 (12.3)
6 or more d/wk	23 (28.4)
Has your pet ever been vaccinated against Lyme disease?	
Yes	6 (7.40)
No	50 (61.7)
Unsure	25 (30.9)