Article

Occupational health hazards in veterinary medicine: Zoonoses and other biological hazards

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Abstract — This study describes biological hazards reported by veterinarians working in western Canada obtained through a self-administered mailed questionnaire. The potential occupational hazards included as biological hazards were zoonotic disease events, exposure to rabies, injuries due to bites and scratches, and allergies. Only 16.7% (136/812) of responding veterinarians reported the occurrence of a zoonosis or exposure to rabies in the past 5 years; the most commonly reported event was ringworm. Most bites and scratches (86%) described by 586 veterinarians involved encounters with cats; 81% of the resulting 163 infections were due to cat bites or scratches. Approximately 38% of participants reported developing an allergy during their career, with 41% of the affected individuals altering the way they practiced in response to their allergy.

Résumé — Risques pour la santé des travailleurs en médecine vétérinaire : zoonoses et autres risques biologiques. Cette étude décrit les dangers biologiques signalés par les vétérinaires travaillant dans l'Ouest canadien dans le cadre d'un questionnaire à remplir soi-même acheminé par la poste. Les risques potentiels pour les travailleurs incluent des dangers biologiques comme des cas de zoonoses, l'exposition à la rage, des blessures causées par des morsures ou des égratignures et des allergies. Seulement 16,7 % (136/812) des vétérinaires répondants ont signalé l'occurrence d'une zoonose ou l'exposition à la rage au cours des 5 dernières années; l'incident le plus communément signalé était la teigne. La plupart des morsures et des égratignures (86 %) décrites par les 586 vétérinaires impliquaient des chats; 81 % des 163 infections résultantes étaient attribuables à des morsures et à des égratignures de chats. Environ 38 % des participants ont signalé avoir développé une allergie durant leur carrière et 41 % des personnes touchées ont modifié la façon dont elles exercent la médecine en réaction à leur allergie.

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Introduction

Few previous studies have examined the exposure of veterinarians to zoonotic diseases. In a 1978 study from Illinois, more than 40% of participants reported experiencing a zoonotic disease at some point in their career (1). The study ranked the occurrence of illness or treatment for 6 zoonoses as follows: brucellosis, rabies exposure, animal bites, psittacosis, *Erysipelothrix* infection, and leptospirosis. A serological survey of Australian veterinarians from 1975 to 1982 determined that the most common zoonotic infections were brucellosis, toxoplasmosis, and Q-fever (2). A German study (1998–2002) reported that zoonotic infections accounted for 14% of all reports of occupational diseases filed with the mandatory accident insurance service (3).

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Many of the diseases indicated as important risks to veterinarians in these early studies are not endemic, have been locally eradicated, or occur at low prevalence in animals in western Canada. Although veterinarians are at increased risk of zoonotic infections, the occurrence of specific zoonoses in humans is dependent on the frequency of infection in local animal populations, likelihood of disease transmission, availability and use of personal protective equipment, and even quality of veterinary education (4). Importantly, the risk of contracting zoonoses has not been examined for veterinarians in western Canada.

Australian researchers have identified animal-related injuries, particularly dog and cat bites, as important hazards in the veterinary profession (5). Because pathogens are carried in the mouths of many species, animal bites can result in cellulitis, abscesses, and more severe sequelae such as sepsis, arthritis, endocarditis, and central nervous system (CNS) infections (6). In addition to exposure to zoonotic disease and infection resulting from bites and scratches, veterinarians may develop occupational allergies. Commonly reported triggers include contact with vaginal secretions, amniotic fluids, or latex gloves, and exposure to blood proteins, parasites, or dander (5,7). Occupational asthma has also been reported; a survey of veterinarians in the Netherlands showed that after accounting for smoking status, the odds of chronic cough and phlegm production were higher

Table 1. Descriptive analysis: Demographics of survey participants

Variable	N	Mean (range)	Variable	Category	N
Age	814	44.5 y (24 to 77)	Gender	Male	368
				Female	451
Hours per week for veterinarians in practice[a]	621	42.0 h (2 to 84)	Primary species contact	Companion	369
				Food	103
				Equine	42
Hours per week for veterinarians not in practice[b]	190	43.3 h (1 to 80)		Mixed	238
				Other	30
				No animals	41
Years at location	810	12.1 y (few mo to 45 y)	Location	Urban	532
				Rural	276
				Both	11
Graduation year	819	1990 (1960 to 2009)	Work environment	Practice[a]	625
				Academia	91
				Industry	43
				Government	64

N — number of responses.
[a] Individuals surveyed could work full- or part-time in clinical practice only.
[b] Individuals surveyed could work full- or part-time in work conditions such as academia or other.

in veterinarians working more than versus less than 20 h per week in a swine facility (8).

The objective of this study was to determine the occurrence of occupational biological hazards including zoonotic diseases, animal bites and scratches, and work-related allergies in western Canadian veterinarians.

Materials and methods

In June 2009, a questionnaire was mailed to all veterinarians in Western Canada (N = 2187; Alberta, Saskatchewan, and Manitoba) who were listed in 2008 as members of the Canadian Veterinary Medical Association (CVMA). All veterinarians in the 3 prairies provinces are members of the CVMA. Veterinarians from British Columbia were excluded as a similar survey had recently been completed by their provincial association.

Ethics approval for the study was obtained from the University of Saskatchewan Behavioral Ethics Board. The envelope mailed to each participant contained a cover letter describing the study and its purpose, a questionnaire, and a stamped and addressed return envelope. Veterinarians were instructed to complete the questionnaire and return it by mail in the envelope provided. In July 2009, an e-mail reminder was sent to all clinics with listed email addresses (approximately 60% of veterinarians). Completed questionnaires were accepted up to October 30, 2009.

Data were collected from questionnaires on demographics, and physical, psychological, chemical, and biological hazards. Recall for each response was limited to occurrences in the preceding 5 y of the study start date. Individual responses were categorized by the type of veterinary work indicated by the participant: private practice, industry, government, or academia. Those who had retired, relocated, or experienced disability in the past 5 y were asked to describe their previous type of work in an open-ended question. Only questionnaires from individuals who had veterinary work experience in the past 5 y were included in the analysis.

Most questions were closed, whereby the participant was asked to rank or select from a list of options; 4 open-ended questions were included at the end of the questionnaire to capture other issues of importance.

Information on occupational species exposure was summarized into a single category for each veterinarian. Those who indicated working with food animals, equine, and companion animals (primarily food and companion, with or without equine) were classified as "mixed"; those who indicated zoo, laboratory, wildlife, or marine animals were classified as "other." "Food" and "companion" animal classifications included relevant exotic species, "equine" was > 90% of time with equine only, and "no animals" referred to little to no animal contact on the job (> 90% of time).

Individuals were classified as experiencing a zoonotic disease if they indicated diagnosis or treatment for any of the diseases listed in the survey tool; this included post-exposure rabies prophylaxis. Individuals were classified as having been bitten or scratched if they answered yes to either or both on the question and indicated by what species. Only bite or scratch events that had occurred in the past 5 y were recorded, not the number of bites or scratches. Individuals were classified as having an allergy if they indicated they had developed an allergy since starting work as a veterinarian.

Data were entered into a computerized database and checked for errors. Data were then summarized using frequency tabulations for categorical variables and means and standard errors for continuous variables (SPSS v.17, SPSS, Chicago, Illinois, USA). Differences between groups (work environment, gender, and others) were assessed with univariate logistic regression and reported as a *P*-value. For veterinarians in private practice, multiple logistic regression was then used to estimate the association between each of 3 specific outcome measures (occurrence of personal zoonoses, occurrence of animal bites, development of allergies), and potential risk factors of interest. The strengths of associations were reported as odds ratios (OR) with 95%

Table 2. Summary of zoonotic events reported by all participating veterinarians with animal contact in their employment including personal experiences and animal diagnoses

Reported zoonotic diseases	Veterinarians reporting that they had been diagnosed with specific zoonosis N = 775	Prevalence of personal zoonoses[a]	Province(s) from which personal zoonoses were reported[b]	Veterinarians reporting a diagnosis of specific zoonosis in animals N = 776	Prevalence of diagnosing an animal zoonoses[a]	Province(s) from which animal zoonoses were reported[b]
Anthrax	7	0.9%	AB, SK, MB	63	8.1%	AB, SK, MB
Bartonella	6	0.8%	AB, MB	52	6.7%	AB, SK, MB
Blastomycosis	1	0.1%	SK	9	1.1%	SK, MB
Brucellosis (canine)	1	0.1%	AB	9	1.1%	AB, SK
Campylobacteriosis	14	2.0%	AB, SK	221	28.4%	AB, SK, MB
Cryptosporidiosis	6	0.8%	AB, SK, MB	221	28.4%	AB, SK, MB
Giardia	7	0.9%	AB, SK, MB	430	55.4%	AB, SK, MB
Leptospirosis	0	0%		53	6.8%	AB, SK, MB
MRSA[c]	6	0.8%	AB, SK	56	7.2%	AB, SK, MB
Q-fever	0	0%		11	1.4%	AB, SK, MB
Rabies[d]	21	2.7%	AB, SK, MB	99	12.8%	AB, SK, MB
Ringworm	59	7.6%	AB, SK, MB	591	76.1%	AB, SK, MB
West Nile Virus	2	0.3%	SK, MB	178	22.9%	AB, SK, MB

N — number of responses.
[a] Prevalence was calculated as the number of individuals reporting a particular zoonosis at least once during the 5-year study period as a percentage of the total number of study participants who answered the question on the survey.
[b] AB — Alberta, SK — Saskatchewan, MB — Manitoba.
[c] MRSA — methicillin-resistant *Staphylococcus aureus*.
[d] Rabies reported in humans refers to administration of post-exposure treatment not clinical diagnosis.

confidence intervals (95% CI). In the case of correlated or co-linear variables, only 1 variable, based on significance values, was selected for inclusion in the final multivariable model. Factors were identified as confounders and retained in the models if their addition or deletion changed the effect estimate for factors of interest by more than 10%. Biologically reasonable two-way interactions were assessed between significant risk factors ($P < 0.05$) and included only if statistically significant.

Due to the anonymity of the survey, characterization of non-respondents to assess a potential bias due to a moderate response rate could not be achieved. Instead, individual responses were categorized as to the date they were received; early respondents were received in the first month and all others were later respondents. Comparisons of individual characteristics and specific outcomes of interest were made for early and later respondents to assess the potential for bias in this study design.

Results

Demographics

In June 2009, surveys were mailed to 2187 western Canadian veterinarians; 116 envelopes were returned due to death, long-standing retirement, or no forwarding address. The overall response rate for surveys was 41% (849/2071). Of this, individual surveys were excluded from analysis if the veterinarian had been retired for more than 5 y (n = 19), answered questions relating to a period of time more than 5 y ago (n = 1), or was currently not working in the veterinary profession due to disability, change of occupation, or leave for more than 5 y (n = 6).

A total of 823 surveys was included in the analysis (Table 1), including 131 from Manitoba, 210 from Saskatchewan, and 482 from Alberta (with response rates of 38%, 41%, and 39%, respectively). For those in clinical practice (76%, 625/823), 54% (n = 338) worked with companion animals (including small exotics), 8% (n = 47) worked with food animals, 4% (n = 28) worked with equine, and 34% (n = 212) worked with a mixed array of animals. Of the 198 veterinarians in work environments other than clinical practice, 41 (21%) reported little to no direct animal contact in their daily work, 4 (2%) worked in zoos, and 64 (32%) reported some contact with common domestic species during their daily work.

A comparison of early and late respondents revealed that there was no statistical difference for all individual characteristics and these specific outcomes of interest: zoonotic disease occurrence, bites and development of allergies. The denominator reported for each percentage indicates the number of respondents who answered the corresponding questionnaire question.

Zoonoses

Of the 812 veterinarians who completed the survey question about zoonoses, 136 (16.7%) reported that they had personally been diagnosed or treated for a zoonotic disease in the past 5 y; 9 of these individuals reported receiving post-exposure rabies prophylaxis only. Of the 775 veterinarians with animal contact who completed this question, 129 (16.6%) reported a zoonotic disease event. Ringworm was the most commonly reported zoonotic disease for all respondents with animal contact (Table 2); 47% (28/59) of those reporting ringworm worked with companion animals, 39% (23/59) worked with both large and small animals, and the remainder worked with food, equine, or other animals. The most common zoonoses encountered in clinical practice were ringworm, rabies, and methicillin-resistant *Staphylococcus aureus* (MRSA) for companion animal veterinarians; *Campylobacter,* ringworm, and rabies for food animal veterinarians; West Nile virus (WNV) for equine veterinarians; and ringworm, rabies, and *Campylobacter* for mixed animal veterinarians.

When broken down by work environment, 118 (N = 699, 16.9%) of those in practice or academia (those with animal contact only) and 11 (N = 76, 14.5%) in other work environments (with animal contact) reported experiencing a zoonotic

Table 3. Final multivariable regression models describing the occupational risk factors associated with the risk of personal zoonoses, animal bites, and infections (for practicing veterinarians only)

Outcome	Variable	N	OR	95% CI	*P*-value
Personal Zoonoses		618			
	Years worked full-time				
	≤ 5 y		**2.2**	**1.4, 3.4**	**0.001**
	> 5 y		ref[a]		
	Primary species contact				
	Companion		Ref		
	Food		1.7	0.7, 3.9	0.23
	Equine		0.3	0.04, 2.3	0.25
	Mixed		**2.6**	**1.6, 4.1**	**< 0.001**
Bites		619			
	Years worked full-time				
	≤ 5 y		**1.6**	**1.0, 2.6**	**0.047**
	> 5 y		Ref		
	Primary species contact				
	Companion		**18.4**	**8.4, 40.2**	**< 0.001**
	Food		Ref		
	Equine		**4.2**	**1.4, 12.0**	**0.007**
	Mixed		**12.9**	**5.8, 28.6**	**< 0.001**
Infections		618			
	Hours per work week				
	≤ 40 h		Ref		
	> 40 h		**1.8**	**1.2, 2.6**	**0.005**
	Primary species contact				
	Companion		**6.5**	**1.9, 21.7**	**0.002**
	Food		Ref		
	Equine		1.7	0.3, 9.2	0.52
	Mixed		**5.4**	**1.6, 18.2**	**0.006**

[a] ref — reference.

disease event ($P = 0.9$). Seven of the veterinarians who had little or no animal contact in their daily work (18.9%) reported a personal disease event involving ringworm, *Campylobacter,* West Nile virus, *Streptococcus suis,* or tuberculosis. The data did not indicate if the reports of tuberculosis were with regard to clinical disease, a positive skin test, or active disease, or if this referred to bovine tuberculosis or not. None of the study respondents reported experiencing an episode of avian influenza infection, equine encephalitis, leptospirosis, listeriosis, orf, psittacosis, Q-fever, tularemia, or yersiniosis in the previous 5 y.

Risk factors unconditionally associated ($P < 0.05$) with developing a personal zoonosis for those in practice included years of full-time experience, location of practice, number of hours worked per week, and the category of primary species contact. Only years worked full-time and primary species contact were retained in the final model (Table 3). Mixed animal veterinarians had 8.6 times the odds of developing a personal zoonosis than did equine veterinarians [95% confidence interval (95% CI): 1.1, 65.1], but the data for food animal veterinarians were not statistically different from those for equine veterinarians ($P = 0.12$), accounting for years in full-time work.

A larger number and greater variety of zoonotic diseases were reportedly diagnosed in their animal patients than were personally experienced by study participants (Table 2). Ringworm was the most commonly diagnosed condition in animals. Of the 603 veterinarians who had diagnosed ringworm in animals in the past 5 y, 61 (10%) reported a clinical diagnosis for themselves: 28 veterinarians who worked with companion animals, 23 who worked with mixed animals, 7 with either food or equine, 1 with zoo species, and 2 with minor contact with animals in their daily work. Veterinarians who diagnosed an animal zoonosis (excluding rabies) were approximately twice as likely to have reported a personal zoonotic infection; however, this was not statistically significant (OR = 2.4, 95% CI; 0.9, 6.0).

Eighty-seven veterinarians (11%) reported seeking medical attention for a zoonosis in the past 5 y; over 80% of those were one-time events, but 6 individuals had to make 3 visits in the past 5 y. Thirty veterinarians (4%) reported missing ≥ 1 days of work due to a zoonosis in the past 5 y; 23 of those had sought medical attention for a zoonosis in that same time period.

While almost all study participants (806/812, 99%) had been vaccinated for rabies at some time in their career, 26% (209/809) had not had their titer checked in the past 5 y. One-hundred and twenty-one individuals were vaccinated or revaccinated for rabies more than 10 y after graduation; the motive for these vaccinations is not known. However, 7 of these individuals reported post-exposure treatment, 27 reported exposure to a rabid animal, and 93 reported having had their vaccine titer checked in the last 5 y.

Animal bites

Of all study participants, 63% (507/809) reported at least 1 bite, 64% (516/809) reported at least 1 scratch, and 20% (163/809) reported at least 1 post-bite or scratch infection. In total, 586 individuals reported being bitten, scratched, or both due to work-related contact with animals. The most common animals involved in individuals reporting at least 1 event were cats (501/586, 85%), dogs (399/586, 68%), and horses

Table 4. Summary of common allergens reported by veterinarians with work-related allergies who were exposed to different types of species

Allergen group	Substances	Number of individuals with allergies	Primary contact species with highest representation
Body fluids	Blood or urine proteins, amniotic, vaginal or placental fluids, animal saliva	114/313 (36%)	Other, mixed
Dust	Dust, mold	87/313 (28%)	Food, equine
Hair	Hair, dander, fur, exposure to specific animal species	151/313 (48%)	Companion, other
Hay	Hay, pollen, grasses	79/313 (25%)	Equine, food
Latex	Latex gloves	46/313 (15%)	Equine, mixed, companion
Parasites	Ecto- and endo-parasites	14/313 (4%)	Equine, food
Other	Soaps, perfumes, pine shavings, glove powder, antibiotics, NSAIDs[a], gluten, formalin, etc.	46/313 (15%)	Mixed, companion

[a] Non-steroidal anti-inflammatory drugs.

(33/586, 6%). Other animals reported included cattle, poultry, swine, elk, sheep, alpaca, small rodents, wildlife, reptiles, and birds. Infections from a bite or a scratch were most commonly associated with cats (132/163, 81%), but only 23% (132/586) of bitten or scratched study participants reported a cat-related infection. For those in practice, years worked full-time and the primary species contacted were associated with the risk of animal bites and infection from animal bites or scratches (Table 3). Accounting for years worked full-time, companion animal veterinarians had 4.4 times greater odds of being bitten than did equine veterinarians (95% CI: 2.0, 9.6); mixed animal veterinarians had 3.1 times greater odds of being bitten than did equine veterinarians (95% CI: 1.4, 6.9). Accounting for hours worked per week, companion animal veterinarians had 3.8 times greater odds of developing an infection post-bite or scratch than did equine veterinarians (95% CI: 1.1, 12.9, $P = 0.04$), and mixed animal veterinarians had 3.2 times greater odds than did equine veterinarians (95% CI: 0.9, 10.8, $P = 0.07$).

The number of individuals who sought medical attention or were off work for 1 or more days due to animal bites was not indicated. Fifty-nine percent (446/760) of veterinarians stated that they never used antibiotics for work-related infections; the remaining 41% described using antibiotics for work-related infections anywhere from 1 to 20 times in the past 5 y. Sixty percent of the participants with post-bite or scratch infections (98/163) reported self-medicating with antibiotics.

Allergies

Of the study participants with no allergies prior to graduating as a veterinarian, 39% (313/807) reported developing an allergy during their time working as a veterinarian. The reported occurrence of developing allergies for those in practice was not different from those in industry, government, or academia ($P = 0.88$). The reported development of allergies among all veterinarians was not related to exposure to different species ($P = 0.52$). Female veterinarians in practice were more likely to develop allergies than were male veterinarians in practice (OR = 1.4, 95% CI: 1.1, 1.9). The most commonly reported allergy triggers were hair, fur, dander, and exposure to specific animal species (Table 4).

Forty-one percent (126/309) of veterinarians in practice who developed allergies during their career made modifications to how they practiced; 4 individuals did not report whether or not any modifications were made. In addition, 14 individuals reported that they modified how they practiced but did not indicate ever developing an allergy themselves or why they adopted the modifications. Modifications included avoiding the allergen [45/(126 + 14), 32%], discontinuing work with certain animal species, and using protective measures to minimize exposure to the allergen (86/126 + 14, 61%), such as wearing gloves or masks; 6% [9/(126 + 14)] did not report the type of modification.

Sixty-five individuals (8% of all veterinarians) reported seeking medical attention for an allergy in the past 5 y. About 58% (38/65) of those were one-time events. However, 16 veterinarians reported 3 or more visits in the past 5 y and the maximum number of visits reported by 1 study participant in the past 5 y was 16. Nine veterinarians (1% overall) reported missing work for 1 or more days due to allergies and 2 individuals reported missing work up to a total of 10 times over the 5 y. Of those who visited a physician because of allergies, 12% (8/65) reported missing work due to allergies in the past 5 y.

Discussion

The most frequent biological hazard for western Canadian veterinarians was animal bites, with or without accompanying infections. Bites and scratches were injuries that contributed to work days lost by staff in an Australian study (7). Injury rates are often higher for those working with large animals; however, interaction with small animals can result in minor injuries that may or may not require treatment or time off work (3). Our results indicate that working more than a 40-hour week puts

individuals at higher risk for post-bite infection but the reasons for this are not known. Other studies indicate that safety precautions, such as muzzling, are used infrequently in practice (9).

In this study and others, the most commonly reported allergens were hair, fur or dander, and specific animal exposures (3,7). Despite being the second most frequent biological hazard to veterinarians, most individuals in our study reporting allergies did not miss any work as a result. Individuals altered the way in which they worked as veterinarians by adopting avoidance strategies or using personal protective measures. None of our surveyed veterinarians reported quitting private practice work because of allergies; Nienhaus et al (3) reported at least 40 individuals whose allergic asthma or skin disorders resulted in their having to give up their jobs.

There have been recent publications on zoonoses that Canadian veterinarians might encounter in practice and case reports of interesting zoonotic events, but there are no data on the occurrence of these diseases in the broader population of Canadian veterinarians (10,11). In this study, the prevalence estimate for those experiencing a zoonotic disease was significantly lower than those from studies conducted in the 1970's, but consistent with studies from other countries done in the past 2 decades (1,3,5,7). The most prominent zoonotic diseases have changed from studies conducted more than a decade ago; brucellosis has diminished while new diseases such as infection with MRSA and WNV have emerged (1).

For some zoonoses, increased exposure to domestic animals is not a key element in the transmission cycle; however, veterinarians may still be at risk due to location or the outdoor environment in which they work. West Nile virus has become endemic in the prairies, with Saskatchewan as the "hot-spot" among the 3 prairie provinces. In a 2004 report, 1 particular geographic area of Saskatchewan reported a rate of clinical illness of 0.4%; the highest in western Canada (12). The prevalence of illness detected in this survey for all of the prairie provinces over a 5-year period (0.3%) is comparable to this value, and suggests veterinarians were either not at higher risk compared to the general population or they were more likely to adopt personal protection measures. West Nile virus can still pose a risk to veterinarians who are involved in dead bird surveillance and was recently reported in a veterinary student who performed a necropsy on a horse (suspect WNV positive); precautions need to be taken in these circumstances (13).

Transmission of other zoonoses is increased by close contact with sick or carrier animals, thus placing veterinarians at increased risk for exposure. Ringworm was the most commonly reported zoonosis in both this survey and a recent German study (3). Ringworm transmission involves direct contact with animals that carry the fungal agent (9). Simple precautionary measures, such as wearing gloves to examine patients or frequent hand washing, could prevent zoonotic transmission of ringworm and other contact-related infections. In a recent study on infection practices, it was noted that most respondents did not take precautions considered appropriate for protection against zoonotic disease transmission (14). In this study, all practicing veterinarians were at risk of experiencing ringworm, regardless of whether they worked with small or large species. Comparable data are not available for the general population, farmers, or other specific occupational groups.

The risk of occupational exposure to each zoonosis is associated with the occurrence of the disease in animals in each veterinarian's practice. For example, *Brucella abortus* has been eradicated from the Canadian cattle herd and the only brucellosis event reported in this study was related to the canine *Brucella* organism. Brucellosis, however, is a common zoonotic infection encountered by veterinarians in Australia (2); while Australian cattle herds are free of bovine brucellosis, *Brucella* in feral pigs in some areas may still pose a risk to humans. In Canada, nonbovine *Brucella* serovars may pose a risk to humans; of specific concern (not particular to veterinarians) is *Brucella suis,* which is present in caribou and other northern game animals.

Numerous examples of zoonoses diagnosed in client animals, including Q-fever and leptospirosis, were not reported by any veterinarians in the survey. This indicates these zoonoses may not be easily transmitted to humans through professional contact, the transmission cycle for these zoonoses is effectively broken by protective measures used by veterinarians, or that individuals were exposed but never developed clinical disease. As this survey relied on veterinarians reporting clinical signs of zoonotic diseases and did not evaluate exposure or infection status using serological evidence or other laboratory data, the occurrence of some of the zoonoses, such as WNV or the many gastro-intestinal bacterial agents, are probably underreported but also may not be strictly associated with occupational exposure.

Only a small percentage of veterinarians visited physicians for zoonoses or allergies, with an even smaller percentage missing work due to either condition. This is consistent with an Australian study in which staff missed over 400 d due to influenza but only 7 d due to all zoonoses combined (7). Some comments by veterinarians in this study suggest they did not feel they could afford to be absent from their practice. Consistent with other studies, a significant percentage of western Canadian veterinarians reported self-administering antibiotics (Australian, 68%; present study, 60% of those reporting animal bites); self-reported treatments by veterinarians in other studies have included suturing lacerations, and reducing fractures and dislocations (7). As a result, monitoring physician visits may not be a good indicator of the risks of infection of veterinarians following bites or scratches.

Veterinarians with more years of experience in private practice were less likely to report zoonoses or injuries resulting from bites or scratches. This could indicate that more animal handling experience for veterinary students during their training could potentially decrease the risk of animal-related injuries in the first years of practice. Many zoonotic disease manifestations may be one-time events due to the development of immunity (ringworm). As such, the longer an individual is in practice, the fewer zoonotic disease events may develop due to either more cautious use of protective measures or immunity to the agent.

We employed the most comprehensive study design deemed feasible and methodologies similar to previous relevant studies (1,5). Neinhaus et al (3) were able to use a database of accident insurance, as this was a mandatory service for all veterinary

practices in Germany. In western Canada, workers compensation is not mandatory nor is there a central database; indeed, only 2/3 of the survey participants indicated coverage. The addition of serological testing, as done in 1 Australian survey (2), would have improved the estimation of the risks of zoonotic exposure; however, inclusion of all the veterinarians in western Canada would have been financially unfeasible.

Safe animal handling practices may reduce the risk from all biological hazards, but specifically could reduce the number of animal bites. As the risk of experiencing zoonotic diseases decreases among veterinarians, individuals may become lax with precautionary measures. The Compendium of Veterinary Standard Precautions was developed in response to an outbreak of monkeypox in the United States in which 21% of those affected were veterinary personnel (18,19). These standard guidelines can be adapted to each location and work environment. Each veterinarian should be aware of the risks associated with their work environment and attempt to decrease the risks of biological hazards by employing effective strategies. CVJ

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