

ORIGINAL ARTICLE

A Survey of Canadian Public Health Personnel Regarding Knowledge, Practice and Education of Zoonotic Diseases

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Impacts

- This study is the first to examine Canadian Public Health Inspectors' (PHIs) knowledge, perceptions, training and continuing education regarding zoonotic diseases, with a focus on non-food and non-waterborne transmission.
- Gaps exist in PHIs' knowledge about direct transmission of zoonotic pathogens from animals, particularly with regards to rabies, as well as transmission of gastrointestinal pathogens in companion animals.
- The results suggest a need for improvement in the quality and quantity of continuing education for PHIs regarding zoonotic diseases.

Keywords:

Zoonoses; public health inspector; Canada; survey; knowledge; education

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Summary

Zoonoses, diseases that can spread under natural conditions between humans and other animals, are becoming a major public health concern in many countries including Canada. In Canada, investigations of zoonotic disease incidents are often conducted by public health inspectors (PHIs). However, little is known about PHIs' knowledge of transmission of zoonotic pathogens, their perceptions of zoonotic disease importance or their education regarding zoonotic diseases. The objective of this study was therefore to assess the knowledge, perceptions and education of Canadian PHIs regarding zoonotic diseases. Data were collected from December 2008–January 2009 using an internet-based survey distributed to members of the Canadian Institute of Public Health Inspectors national listserv. Responses were received from 229 PHIs in four provinces, with a response rate of approximately 20%. The majority of respondents reported at least 10 years of experience in the public health sector, 80% (181/225) were in frontline positions, and 62% (137/222) were routinely involved in investigations of infectious diseases. Two-thirds believed that the importance of zoonotic diseases with regards to public health would increase in the next 5 years. Whilst most respondents were able to correctly identify animals capable of directly transmitting common zoonotic pathogens, there were gaps in knowledge, particularly with regard to rabies and transmission of gastrointestinal pathogens by companion animals. PHIs tended to feel that their training on zoonotic diseases prior to working as PHIs was deficient in some areas, or left some room for improvement. Their responses also suggested that there is a need for improvement in both the quantity and the quality of continuing education on zoonotic diseases. In particular, less than one-third of PHIs received ongoing continuing education regarding zoonotic diseases, and of those that did, nearly two-thirds rated the quantity and quality as only fair.

Introduction

Zoonoses, diseases that can spread under natural conditions between humans and other animals (Last, 2001), are a major public health issue. In the last decade, Canada has experienced significant outbreaks of human illness caused by established and newly emergent zoonotic pathogens as varied as influenza A viruses, *E. coli* O157, *Salmonella*, severe acute respiratory syndrome (SARS) coronavirus, West Nile virus and *Campylobacter* (O'Connor, 2002; Varia et al., 2003; Isaacs et al., 2005; Gilbert et al., 2006; Artsob et al., 2009; Cutler et al., 2009). Publicity surrounding incidents, such as the 2000 *E. coli* O157 outbreak in Walkerton, ON (Public Health Agency of Canada, 2000) and *Salmonella* contamination of various imported food items (e.g. peanut butter, tomatoes and peppers (Maki, 2009)), has raised awareness of food and waterborne transmission of such pathogens. However, only recently has more attention been focused on other sources of zoonotic diseases such as household pets, although the majority of the population has regular contact with companion animal species and that transmission of organisms such as *Salmonella*, *Campylobacter*, methicillin-resistant *Staphylococcus aureus* (MRSA), hookworms, roundworms, *Toxoplasma*, *Cryptosporidium*, dermatophytes, *Leptospira*, *Bartonella* spp. can occur between people and pets (Lefebvre et al., 2006; Weese et al., 2006; Brown and Prescott, 2008; Pickering et al., 2008; Reaser et al., 2008; Salb, 2008). The increased attention on animal-to-human transmission of zoonoses from the medical and public health communities has raised awareness of the significant burden of zoonoses on the Canadian economy (Stephen et al., 2004). Sufficient knowledge and awareness amongst those responsible for the investigation of zoonotic disease incidents is vital to reducing this burden.

In Canada, PHIs are involved with reducing the burden of zoonoses through investigations of infectious disease outbreaks and providing infection control advice. There are approximately 2600 certified PHIs in Canada, most of them work for public health agencies (Canadian Institute of Public Health Inspectors, 2010). To be eligible for certification as a PHI by the Canadian Institute of Public Health Inspectors (CIPHI), persons must complete a specialized four-year bachelor's degree, or if they already have a bachelor's degree, a two-year accelerated programme, at one of five Canadian educational institutions. Prior to the certification examination, candidates are required to undertake a 12-week practicum (Canadian Institute of Public Health Inspectors, 2010).

Public health inspectors serve in a wide range of positions, from front-line field investigators to administrators. The specific responsibilities of front-line inspectors vary by employer and province and include restaurant inspection, water testing, investigations of infectious diseases in health-

care settings, pool inspections, animal bite investigations, tobacco control programmes, injury prevention programmes and air quality assessment. As a result, whilst all PHIs receive initial training about infectious diseases, not all encounter infectious diseases, particularly zoonoses, as part of their day-to-day responsibilities, or play a direct role in investigation of cases. However, those PHIs who do investigate infectious diseases play a pivotal role in their control.

There is little information regarding the experiences, knowledge and perceptions of PHIs with respect to zoonotic diseases. The aims of this survey-based study were to estimate how often Canadian PHIs are involved with investigations of potential zoonoses and to assess the general knowledge of PHIs regarding zoonotic diseases so potential knowledge gaps could be identified. In addition, the study described current opinions on the provision and quality of continuing education (CE) on zoonotic diseases, as well as the demand for such education, amongst PHIs.

Methods and Materials

An online survey was used to investigate the knowledge, education and experience of PHIs in Canada regarding zoonotic diseases. Questions were drafted by two researchers (MA and JSW) in consultation with members of a working group consisting of representatives from academia, federal government agencies and local public health agencies. Questions were mainly close-ended; however, open-ended, or semi open-ended questions were used to collect additional information (e.g. when an 'other' option was selected). Likert or other scales were used in several questions to assess frequency or opinions. The survey was administered via a web-based survey platform (www.surveymonkey.com).

Participants were recruited via the CIPHI national listserv; a link to the survey was included as part of a message sent to the listserv. The first e-mail, which included an introductory letter, was sent on 5 December 2008, and a follow-up e-mail was sent on 16 December 2008. The survey remained available through January 2009. Participants were informed of the voluntary nature of the study and that all identifying information would be kept confidential. The study was approved by the Research Ethics Board of the University of Guelph.

Data were exported into Microsoft Excel format for cleaning and analysis. All variables were examined to identify potentially implausible values. Each variable linked to a specific question was described, with frequencies and percentages calculated for nominal data using Microsoft Excel and R (R Development Core Team, 2009). In some instances, respondents were asked to estimate or provide details on the number or type of pathogens/species involved in their investigations.

Results

Demographics

The survey was distributed to approximately 1245 members of CIPHI in nine of the 10 Canadian provinces and one of the three Canadian territories; the listserv did not include any PHIs from the Northwest Territories, Nunavut or Prince Edward Island. A total of 229 respondents answered at least one question and were thus included in the study. A total of 220 PHIs provided information on the province in which they worked, with the highest representation from Ontario (140, 63.6%), followed by British Columbia (37, 16.8%), Alberta (35, 15.9%) and New Brunswick (8, 3.6%). The highest rates of response were from Ontario (~26%) and Alberta (~20%).

The majority of respondents (80.4%, 181/225) described their position as front line, with 14.2% in administrative roles and 4.9% selecting "other". The most common work location reported was mixed rural and suburban (40.6%, 91/224), followed by urban (25.5%), rural (16.1%), mixed urban and suburban (15.6%) and suburban (2.2%) locations. Over half of the PHIs (56.4%, 127/225) had at least 10 years of experience in the public health sector; only two respondents had less than a year of experience.

Perceptions of zoonoses

On average, respondents indicated that diseases transmitted from a variety of species had some or moderate impact on

public health (Table 1). Respondents ($n = 219$) were most likely to be of the opinion that the importance of zoonotic diseases in the next 5 years would increase slightly (53.9%), not change significantly (31.1%) or would increase dramatically (12.8%). Less than 3% of the PHIs believed the importance would decrease, either slightly or dramatically.

Infectious disease investigations

Nearly, two-thirds of PHIs (61.7%, 137/222) reported that they routinely participated in or performed investigations of infectious diseases. These PHIs were involved with a median of 24 infectious disease investigations per year (range 2 – 1100, $n = 123$), and most reported that <20% (44.9%) or >90% (14.7%) of the investigations in the last year involved potentially zoonotic diseases. However, 53.5% inquired about animal contact in >90% of their infectious disease investigations in the last year, and 71.6% inquired in >70% of investigations. In these infectious disease investigations, PHIs were most likely to report always obtaining data on dietary history and contact with household pets (both 62.8%), and least likely to always ask about contact with wildlife (36.9%; Table 2).

Most respondents were, over the last decade, involved less than once per month with investigations where a human illness was determined or strongly suspected to have been transmitted from a household pet (89.8%), farm animals (excluding foodborne or waterborne illness)(95.0%) or wildlife including feral animals (98.4%).

Table 1. Canadian public health inspectors' perceptions of the impact of zoonotic diseases transmitted from animals on public health (percentage)

	No impact	Some impact	Moderate impact	Large impact	Very large impact	Number of responses
Dogs	8 (3.6%)	78 (35.3%)	87 (39.4%)	37 (16.7%)	11 (5.0%)	221
Cats	7 (3.2%)	90 (41.1%)	89 (40.6%)	26 (11.9%)	7 (3.2%)	219
Smaller pet mammals	26 (12.0%)	120 (55.3%)	55 (25.3%)	12 (5.5%)	4 (1.8%)	217
Pet reptiles, birds and fish	9 (4.1%)	64 (29.2%)	95 (43.4%)	39 (17.8%)	12 (5.5%)	219
Horses	37 (17.3%)	128 (59.8%)	38 (17.8%)	9 (4.2%)	2 (0.9%)	214
Farm animals excluding horses	13 (5.9%)	77 (35.2%)	63 (28.8%)	45 (20.5%)	21 (9.6%)	219
All wildlife	3 (1.4%)	85 (38.8%)	75 (34.2%)	40 (18.3%)	16 (7.3%)	219

Table 2. Frequency of data collected by Canadian public health inspectors in infectious disease investigations

	Never	Rarely	Sometimes	Often	Always	Number of responses
Dietary history	9 (7.0%)	5 (3.9%)	9 (7.0%)	25 (19.4%)	81 (62.8%)	129
Consumption of raw milk or cheese	7 (5.5%)	10 (7.9%)	15 (11.8%)	26 (20.5%)	69 (54.3%)	127
Contact with household pets	2 (1.6%)	3 (2.3%)	11 (8.5%)	32 (24.8%)	81 (62.8%)	129
Contact with farm animals/livestock	3 (2.3%)	14 (10.8%)	14 (10.8%)	28 (21.5%)	71 (54.6%)	130
Contact with wildlife	5 (3.8%)	10 (7.7%)	37 (28.5%)	30 (23.1%)	48 (36.9%)	130
Contact with animals in petting zoos, animal shows or similar events	4 (3.1%)	13 (10.0%)	26 (20.0%)	27 (20.8%)	60 (46.1%)	130

The most common zoonotic disease pathogens investigated by PHIs were *Salmonella*, *Campylobacter*, eEnterohemorrhagic *E. coli* (EHEC), rabies and *Giardia*. For *Salmonella*, respondents reported being involved with investigations where disease was associated with turtles (57% of respondents had been involved with one or more investigations associated with turtles over the last 10 years), other reptiles (58%), or poultry (59%). PHIs most commonly reported involvement with EHEC investigations associated with cattle (56%) and *Campylobacter* investigations with dogs (58%) or poultry (54%). In addition, many reported investigations of potential rabies exposures associated with dogs (86%), cats (70%) or wildlife (62%), in addition to horses (25%), cattle (19%) or pocket pets (15%) (e.g. gerbils, hamsters, guinea pigs, rats, mice, chinchillas, sugar gliders and ferrets). Most respondents reported giardiasis investigations involved an association with wildlife (51%), dogs (28%) or non-animal sources (42%).

Approximately, 60% of PHIs had made contact with a veterinarian in the last year regarding a zoonotic disease issues ($n = 137$), but only about 40% had been contacted by a veterinarian for the same reason during the same time period.

Knowledge of directly transmitted zoonoses

When PHIs were asked to indicate which species/animal groups were capable of directly transmitting specific diseases to humans, some important gaps in knowledge were identified (Table 3). Seventeen respondents indicated that rabies could be directly transmitted from non-mammalian species such as pet birds, turtles, other reptiles and/or poul-

try, and not all respondents indicated that the disease could be transmitted from dogs or cats. Additionally, fewer than half of respondents indicated that rabies could be transmitted from pocket pets or pigs and less than two-thirds from cattle or horses.

Almost all respondents correctly identified turtles and poultry as being linked with transmission of *Salmonella*, but fewer associated the pathogen correctly with other reptiles and with other species categories. Many respondents did not identify cattle (46%), swine (48%) and poultry (19%) as species associated with direct transmission of *Campylobacter*, and only 54% indicated that dogs could directly transmit leptospirosis. Nearly, 80% identified MRSA as a pathogen that could be spread by dogs.

Up to 85% of respondents incorrectly identified at least one species or species grouping as being associated with direct transmission of tickborne pathogens (*Anaplasma phagocytophilum*, *Borrelia burgdorferi*, *Neorickettsia risticii*), including one (*N. risticii*) that does not affect humans. Fourteen (7%) did not identify cats as being able to transmit toxoplasmosis, but 66 to 83% identified dogs and cats correctly as being associated with direct transmission of ringworm, roundworms and hookworms. Fewer than 50 respondents answered the questions about *Anaplasma phagocytophilum*, *Neorickettsia risticii*, *Capnocytophaga* and *C. difficile*.

Education and continuing education

Approximately, half the respondents (47.3%, $n = 167$) had more than four years of post-secondary education prior to

Table 3. Percentage of respondents indicating that they believed the species is capable of directly transmitting the disease or pathogen

	Dogs	Cats	Pet birds	Turtles	Other reptiles	Pocket Pets	Cattle	Horses	Swine	Poultry	Wildlife	Number of responses
Salmonellosis	63	56	48	97	87	49	54	33	51	92	45	156
EHEC	44	38	9	10	9	17	96	34	46	26	43	149
Campylobacteriosis	71	65	32	11	14	27	64	27	52	81	38	149
Leptospirosis	54	30	12	8	19	38	37	15	41	12	71	107
MRSA	77	65	11	10	8	24	40	37	37	27	26	62
<i>Clostridium difficile</i>	63	50	6	8	10	21	44	35	40	23	31	48
<i>Capnocytophaga spp.</i>	60	36	0	12	12	8	16	8	8	0	40	25
<i>Anaplasma phagocytophilum</i>	37	11	0	4	11	19	22	15	7	0	70	27
<i>Borrelia burgdorferi</i>	19	14	3	0	0	5	19	9	5	3	85	74
<i>Neorickettsia risticii</i>	22	9	4	2	7	9	11	22	9	74	30	46
Toxoplasmosis	10	93	9	0	0	5	8	4	9	6	17	138
Cryptosporidiosis	56	52	12	10	11	13	65	35	35	16	62	126
Giardiasis	53	43	9	9	9	11	37	26	27	13	84	139
Roundworms	78	66	2	3	3	14	25	23	42	7	45	103
Hookworms	78	69	2	3	2	7	19	18	35	9	35	94
Dermaphytosis (ringworm)	83	77	7	4	2	15	46	29	26	10	38	82
Rabies	95	90	2	1	1	28	59	61	44	7	86	148
Influenza (any)	11	12	37	1	2	6	10	12	63	76	35	104

becoming a PHI. Few PHIs felt that the training in zoonotic diseases they received prior to becoming an inspector was excellent and had prepared them very well for their PHI duties (7.1%, $n = 170$), whilst most felt that there was room for improvement (40.0%) or that their training had been deficient in some areas (39.4%).

More than two-thirds of respondents (69.8%, total $n = 169$) did not receive any ongoing continuing education (CE) on zoonotic diseases, with those who received formal CE regarding zoonotic diseases most often obtaining it in the form of seminars (60.8%, total $n = 51$), conferences (70.6%) and e-mail bulletins (52.9%). Almost all rated this CE as less than excellent; most found it satisfactory (32.7%) or fair (32.7%), and 88.5% wanted more CE on zoonoses. The areas in which respondents felt additional zoonotic disease CE/training was most needed were household infection control practices (81.7%) and zoonotic diseases in pocket pets, dogs, cats, pet birds and reptiles (all >71%). At least 50% of respondents expressed a desire for more training regarding all species. The most preferred formats for this training were seminars, e-mail bulletins, websites and conferences.

Discussion

This study suggests that there are significant gaps in the awareness of PHIs regarding direct transmission of zoonotic diseases, particularly rabies, as well as a need for great awareness of pathogens directly transmitted from small pet mammals, livestock and wildlife. Also, there appears to be a need for improved continuing education about zoonotic pathogens.

More than two-thirds of PHIs ranked diseases transmitted from smaller pet mammals and horses as having no more than some impact. One aspect that is hard to evaluate is true burden of zoonotic diseases, especially non-food-borne and non-reportable diseases, because there is limited surveillance and reporting. The lack of incidence and outcome information hampers understanding of the true impact of many zoonotic diseases. Whilst it is well established that horses can carry both MRSA and *Salmonella*, the risk of opportunistic transmission of zoonotic illnesses from horses to humans is thought to be low (Bender and Tsukayama, 2004), and PHIs who work outside of rural areas may not encounter horses in their investigations. However, persons who live in suburban or urban areas may have contact with horses at riding stables or petting zoos, and thus, the potential for animal contact should be investigated even in urban situations. Small pet mammals also can transmit a number of zoonoses (Reaser et al., 2008), but many of these zoonoses are not reportable (in humans) in Canada (Public Health Agency of Canada, 2010) and as such, often receive limited attention.

Given that approximately two-thirds of respondents were regularly involved with infectious disease investigations, it is important for PHIs to be knowledgeable about zoonotic diseases and to ask about potential animal contact in investigations. However, it appears that investigators may not always recognize the zoonotic potential of the diseases in question, and many do not ask about animal contact in relevant investigations. Fewer than two-thirds of respondents often or always asked about contact with animals in petting zoos/shows where relevant. Eleven respondents indicated that poultry could transmit rabies and 10% of respondents did not associate rabies with cats. As feline hunting and male roaming behaviours increase the risk of cats having contact with rabies vectors, including raccoons and bats, and cats are less likely to be vaccinated for rabies than dogs (Moore et al., 2000), it is important to consider cats a source of rabies. In fact, 70% of respondents who were involved in rabies exposure investigations reported involvement of cats in those incidents. Though many respondents may not investigate rabies exposures as part of their position, this apparent lack of knowledge about rabies, a disease with a near 100% fatality rate, raises concern.

In addition, whilst the high level of knowledge regarding *Salmonella* and reptiles is encouraging, only 63% of respondents made the association of *Salmonella* with dogs. Knowledge of these associations is important due to the current popularity of raw food diets and raw animal based treats (e.g. pig ears) which may be contaminated with *Salmonella* (Lenz et al., 2009) and the number of dogs used as assistance animals and/or in hospital visitation programmes (Lefebvre et al., 2006) where they encounter persons at increased risk of disease. Also, 3–13% of respondents did not associate *Salmonella* with turtles, other reptiles or poultry. Although it is encouraging that the majority of respondents did associate *Salmonella* with these species, the proportion that did not is still a concern given the potentially significant impact on public health caused *Salmonella* in these species. Other points of concern were the lack of knowledge regarding toxoplasmosis in cats and *Campylobacter* in dogs. Many PHIs incorrectly identified tickborne pathogens as being directly transmitted from animals. These results suggest that PHIs need to be better educated about distinctions between direct and indirect methods of transmission. For instance, with a tickborne zoonosis, whilst an animal is not the source of the disease, it is infected in the same manner as humans, so animals may act as sentinel for human exposure.

In general, the data suggest that PHIs are less knowledgeable about direct transmission of zoonoses from livestock and wildlife; many PHIs may not encounter wildlife or livestock in their positions or investigate zoonotic disease incidents where such animals play a direct role. Thus, their

awareness of zoonotic disease transmission is limited to household pets, and well-known disease-species links (e.g. cattle and EHEC, poultry and *Campylobacter*). However, as many respondents did not answer all of the questions detailed in Table 3, the reasons for the low response rate is not known, but it could suggest that they were not sure of the answer. Thus, our results may have under-reported the number of PHIs who were not well informed about zoonotic pathogen transmission.

As coordination and collaboration between the human and veterinary communities, as per the "One Health" concept, is a vital component of controlling zoonotic infections (Osburn et al., 2009), it is encouraging that almost two-thirds of respondent had contacted a veterinarian about a zoonotic disease issue in the last year, though far fewer were contacted by a veterinarian. This suggests that connections between the human and animal health professions still need to be strengthened, and individuals in both groups should be made aware of sources of information regarding zoonotic illnesses and encouraged to seek further information when appropriate.

There was a tendency for respondents to rate their education on zoonoses as being deficient in at least some areas; few felt well prepared for their job requirements and the majority did not receive any ongoing CE on zoonotic diseases. Considering the significant impact emerging zoonotic diseases have had on the Canadian public health sector and the economy (e.g. SARS, H1N1 influenza, *E. coli* O157), it is important that training of PHIs on zoonotic illnesses does not end when they complete their formal education. The responses suggest improvements are needed in both the quality and quantity offered. One possible improvement in current CE suggested by this study is in the format. Conferences, then seminars and e-mail bulletins were the most common form of current CE, but respondents preferred seminars, followed by e-mail bulletins and websites. The overwhelming preference for seminars suggests that PHIs prefer forms of CE that involve in-person (or videoconference) talks, but smaller blocks of time commitment. Websites and e-mail bulletins allow for prompt communication of new information and allow PHIs to engage in CE according to their own schedules.

There were several limitations of this study, most importantly the limited survey population and relatively low response rate. A low response rate may result in the sampled population not being representative of the target population, and the results should be interpreted in this context. Responses were received from PHIs in only four of the ten provinces and territories represented on the survey mailing list. The reason(s) for the disparity in response rates is not known; one possibility is that the survey was not forwarded to listserv members in all provinces and ter-

ritories on the list. In addition, the national CIPHI listserv only includes PHIs who are current members of CIPHI, and not all PHIs maintain CIPHI membership. Also, the respondent pool was heavily weighted towards those with more than 10 years of experience. Thus, caution should be taken in extrapolating the results to the whole of Canada or to all PHIs in Canada. However, respondents were most likely to work in mixed suburban/rural or urban areas, a statistic that reflects the distribution of populations in most provinces, and only 14% considered themselves to be in administrative roles. Thus, the data and results still provide a description of PHI knowledge, experience and education regarding zoonotic diseases.

The low response rate also resulted in a small sample size. Use of the CIPHI mailing list was the only feasible way of contacting large numbers of PHIs, as CIPHI is the only organization that has a nationwide database of contact information for PHIs. Given the small sample size, no formal statistical analyses were carried out, and the data were described to provide a general picture of knowledge and opinions on investigations, education and CE, rather than to make specific conclusions. Additionally, the CIPHI listserv is not strictly limited to PHIs, and as the survey questions did not explicitly exclude non-PHIs, it is possible that some respondents worked in other positions or were not actively practicing as PHIs. Finally, some of the survey questions referred to infectious diseases rather than specifically to zoonotic pathogens, so some responses may include non-zoonotic diseases. However, as the survey referred repeatedly to zoonotic and directly transmitted pathogens and the majority of infectious diseases are zoonotic, the inclusion of non-zoonotic pathogens is likely to be minimal.

Conclusion

Our survey provides insight into the roles, knowledge and education of Canadian PHIs regarding zoonotic diseases. A majority of PHIs regularly investigate infectious diseases, including zoonoses. In addition, whilst most PHIs correctly identified the animals able to transmit common or well-publicized zoonotic pathogens, there appeared to be some gaps in their knowledge, particularly with regard to rabies, tickborne illnesses and gastrointestinal pathogens in household pets. Further study would be of use in assessing whether PHIs are making sufficient inquiries about animal contact in their investigations. The survey responses also suggest a need for improvement in the quality and quantity of both initial and continuing education on zoonotic diseases in a wide variety of species. In particular, PHIs expressed interest in methods of continuing education that required less time commitment and allowed for more flexibility such as seminars and e-mail bulletins.

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