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Seroprevalence of *Toxoplasma gondii* infection among veterinary staff in Ontario, Canada (2002): Implications for teratogenic risk

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Abstract

Background: *Toxoplasma gondii* infection is embryotoxic in humans. It is mainly transmitted through raw/undercooked meat and ingestion of oocysts in cat feces. There remains controversy about the actual risk of cats transmitting the disease to humans. Our primary objective was to determine the seroprevalence of *T. gondii* antibody among veterinary staff, to ascertain whether they have an increased risk through occupational exposure. Our secondary objective was to examine their practices regarding cats, toxoplasma infection, and pregnancy.

Methods: Veterinary staff attending the 2002 Annual Ontario Veterinary Medical Association Conference were invited to discuss their toxoplasma seroprevalence. Interested attendees completed a questionnaire and a physician drew blood samples to determine *T. gondii* titres using the ELISA IgG test.

Results: We collected 161 completed questionnaires, and 141 blood samples. There were 20 (14.2%, CI95%:8.4–19.9%) reactive titres among the veterinarian staff (80% females aged 30–45). All were regularly exposed to cats, washed their hands when in contact and few wore gloves routinely.

Conclusions: These findings of low positive rates may be used to reassure veterinary staff that their exposure to cats does not appear to increase their risk of contracting toxoplasma infection and that pregnant women are not at an increased risk by owning a cat.

Background

The incidence of toxoplasmosis varies around the world, with the highest rates in Europe (up to 55% in France). [1] The parasite can be transmitted to humans in several ways, including ingestion of raw or undercooked meat,

contact with soil, eating poorly washed raw fruits and vegetables, and ingestion of oocysts in cat faeces. [2] An investigation of a recent Canadian outbreak has suggested that *Toxoplasma gondii* could also be waterborne.[3]

The most recent and reliable estimate of the seroprevalence of antibodies to *Toxoplasma gondii* in the United States was provided by the third National Health and Nutrition Examination Survey (NHANES-III), a study of a representative sample of the non-institutionalized population. [4] The antibody tests for toxoplasma were conducted during 1991–1994, with the survey design comprised of a cluster sample of US residents. Serum samples from 17,658 people were tested at the Centers for Disease Control and Prevention (CDC) for Toxoplasma-specific IgG antibodies; 23% were positive. Of 5,988 women of childbearing age (i.e., age 12–49 years), 14% were seropositive.

There is no comparable statistic for Canada, but it would be reasonable to extrapolate these results, based on the fact both countries have similar populations and lifestyles. The prevalence of congenital toxoplasma infection in Canada is unknown because it is not a reportable disease and most neonatal infections are asymptomatic. The seroprevalence of reactive (positive) titres encountered at the Provincial Health Laboratory in Toronto was 16.8% of 659 ELISA IgG tests for April 2001, and 18.6% of 488 tests performed for the month of December 2001 (Personal Communication, 2002). Thus, results are in agreement with the American statistics.

Although the overall risk of transmission of infection in Canada is estimated to be 20–50%, only 10% of infected women give birth to severely affected children.[5] The classic triad of symptoms for congenital toxoplasma infection includes chorioretinitis, intracranial calcifications and hydrocephalus.[6–9] Thus, *T. gondii* infection is embryotoxic in humans, and its consequences are severe.

The Motherisk Program in Toronto is an information service for pregnant and lactating women and their health care providers. We provide evidence based information on the safety/risk of drugs, chemicals, radiation and infectious diseases. Over the years, we have received numerous calls from pregnant women regarding toxoplasma infections and exposure to cats, inquiring if they should completely avoid exposure to their feline pets. Despite the fact that eating raw and undercooked meat is the most common way to transmit toxoplasma infection, health care providers and pregnant women appear to believe that cats are probably the most prevalent source of transmission. In fact, many women have reported to us that their physicians have told them to "get rid of" their cat when they (i.e., the women) become pregnant. This advice is far more common than being advised to cook meat thoroughly and carefully wash vegetables and fruits (personal communication).

Recently, we completed a study, in collaboration with the Ontario Veterinary Medical College (OVMA), of pregnant veterinarians and veterinary technicians practicing in the province of Ontario, Canada. During the course of this study, the subject of toxoplasma infection through exposure to cats arose, as one of the questions we asked these people was if they knew their *T. gondii* titres. We were surprised to discover that, of those who knew their titres, only 13% were seropositive.[10]

Given that veterinarians and veterinary technicians are continuously exposed to cats through their daily occupation, we felt that they would serve as the ideal group in which to investigate the potential risk of this route of exposure. Subsequently, The Motherisk Program decided, in collaboration with the OVMA, to determine the seroprevalence of *T. gondii* antibodies among veterinary staff attending the Annual 2002 OVMA conference. It was our opinion that, if cats are in fact a serious vector for disease transmission, then the occupational exposure to cats on a daily basis should be associated with elevated rates of seropositivity. The secondary objective was to examine their practices (e.g., exposure to cats, wearing gloves, washing hands) surrounding cats, pregnancy and toxoplasma infections.

Methods

During the conference, all veterinary staff were informed of the research and their participation solicited. Those who indicated that they were interested in participating were asked complete a questionnaire. Several large posters were placed around the conference area offering a blood test to anyone who was interested. The booth where the blood test was taken was strategically placed in the trade area where most conference attendees would visit. Respondents were asked to complete the questionnaire and subsequently, if they agreed, a physician drew approximately 5 ml of blood for the test. We indicated to participants that they would be informed later of their results via mail. The sera were labeled and placed in 2 ml microtubes, which were stored at -80 °C for one week. The sera were shipped to the Provincial Health Laboratory in Toronto, where they were tested for *T. gondii* antibodies using the Enzyme-Linked Immunoabsorbent Assay (ELISA IgG test).

Data describing occupational exposures were analyzed using descriptive statistics. We calculated proportions for such variables as gender, age category, type of practice, task performed, frequency of use of precautions, cat ownership, and whether those unaware of their status believed themselves to be serum positive for toxoplasma antibodies. Chi square was used to compare the proportion of participants who believed they would test positive with

Table 1: Numbers of responses (%) to questions about occupational exposure to *T. gondii*.

Activity	Details	Veterinarians n = 126	Veterinary technicians n = 35	All participants N = 161
Exposure to cats	Doing fecals	81/125 (64.8)	35/35 (100)	116/160 (72.5)
	Cleaning litter	112/125 (89.6)	34/35 (97.1)	146/160 (91.3)
	Accidental	124/124 (99.2)	33/35 (94.3)	157/160 (98.1)
	Owned outdoor cat	58/126 (46.0)	11/29 (37.9)	69/155 (44.5)
Precautions taken when performing tasks	Gloves always used	9/72 (12.5)	7/34 (20.6)	16/106 (15.1)
	Hands always washed	70/81 (86.4)	34/35 (97.1)	104/116 (89.7)
Cleaning litter	Gloves always used	5/92 (5.4)	2/33 (6.1)	7/125 (5.6)
	Hands always washed	81/111 (73.0)	30/34 (88.2)	111/145 (76.6)
Accidental	Gloves always used	6/106 (5.7)	4/31 (12.9)	10/137 (7.3)
	Hands always washed	109/122 (89.3)	31/33 (93.9)	140/155 (90.3)

the actual observed rate. We considered p values ≤ 0.05 significant.

Results

Participants consisted of 126 veterinarians and 35 veterinary technicians. There were 898 veterinarians and 101 auxiliary staff (some of whom were technicians; exact number was not recorded). We collected 161 completed questionnaires and 141 blood samples during the conference. All participants were currently healthy. Blood samples were not drawn from those people who already knew their titres. Most of the veterinarians ($n = 94$, 74.6%) and all of the veterinary technicians ($n = 35$, 100%) were females and the age range of all the participants was between 30–45 years old (97%). A large number of them worked in small-animal practices (88.9%).

The rate of positive IgG titre was 14.2% (20 out of 141). Interestingly, when the participants who were not aware of their immune status were asked if they thought they were immune or not, a significantly higher ($P < 0.001$) proportion (i.e., 57% of veterinarians and 50% of technicians) expected to have a positive titre than what was actually found.

Details of occupational exposure to *T. gondii* and relevant behaviours are shown in Table 1. The numbers of participants who owned outdoor cats among the veterinarians ($n = 58$, 46%) and veterinary technicians ($n = 11$, 38%) was similar (chi square = 0.34, $p = 0.56$).

Discussion

To our knowledge, this is the first report to investigate the seroprevalence of *T. gondii* antibodies among veterinarians and veterinary technicians in Canada. The response rate of 16.1% does not appear to be very high, however, the testing was done within a very restricted time frame and a significant number of individuals would have al-

ready known their *T. gondii* titres, so would not have offered to be tested. Moreover, there were many more individuals who offered to be tested and even lined up, but there was insufficient time during the meeting to accommodate all of the potential enrollees. Furthermore, we do feel that the number who did respond gives us a large enough sample size to make some definitive conclusions.

Our findings indicate a 14.2% rate (95% confidence limits: 8.4% to 19.9%) of seropositivity among veterinary staff, which is lower than the 23% rate reported in the general population by a recent US survey. [4] In the Midwest, the area immediately adjacent to Toronto, the age-adjusted seroprevalence was 20.5%. However, our rate is quite consistent with that study's finding of 14% reported in the 5,988 women of childbearing age. [1] In Stockholm, Sweden, which has a climate and standard of living comparable to that of Toronto, the seroprevalence was exactly the same, at 14.0%. [11] Rates in hotter climates such as India, [12] and Venezuela [13] are known to be higher than those in more temperate places.

These results corroborate other reports that cat ownership or contact with cats is not a risk factor for toxoplasma infection. [15–18] Again, it is interesting to note that 57% of veterinarians and 50% of technicians who provided a blood sample expected a positive titre. These results emphasize the fact that veterinary staff themselves may also be misinformed and erroneously overestimate their risk of contracting toxoplasma infection through their occupational exposure. At the same time, the finding of a rate that is comparable to those from other studies rules out one form of selection bias. It might be thought that women who suspected that they were positive would have been more eager to have themselves tested than would those believing themselves to be negative. If that were the case,

Table 2: Seroprevalence (%) of *Toxoplasma gondii* antibodies among participants, as determined by ELISA IgG test versus participants' expectations of being positive.

Outcome	Veterinarians n = 110	Veterinary technicians n = 31	All participants N = 141
Reactive IgG titre	18 (16.4)	2 (6.5)	20 (14.2)
Non-reactive IgG titre	92 (83.6)	29 (93.5)	121 (85.5)
Expectation of positive titre	63 (57.3)	15 (50)	78 (55.7)

then one would expect a much higher rate than the 14.2% that was actually found.

Despite the fact that the majority of the participants worked in small-animal practices, performed all the tasks that could potentially expose them to *T. gondii* and owned cats, 86% were seronegative. The relatively low seropositive titres among veterinary staff could be explained by the lifecycle of *T. gondii* in the cat. Upon infection cats excrete oocysts for only two weeks of their life. Oocysts then require 1 to 5 days to sporulate and thus become infectious [3] Common practice in veterinary clinics is to clean cat litter within 24 hours. This, in turn, means that veterinary staff would not be exposed to the infectious form of the parasite. In addition, our data indicate that most participants practiced good hygiene such as hand washing after doing fecals, cleaning cat litter, or accidental exposures. The 17–18% seropositivity rate encountered by the Provincial Health Laboratory suggests that the true overall Canadian prevalence of toxoplasma is even lower, as these cases are referred to the laboratory specifically because of a physician's strong suspicion of infection.

The main limitation of our study is that data on culinary practices of participants and exposure to soil (*e.g.*, gardening) were not collected. This is important information because many previous studies have shown that ingestion of raw or undercooked meat is the primary source of infection, followed by exposure to soil [11–14]. In Canada, eating raw meat is not common, so one would expect the prevalence of infection to be lower than, for example, in France, where eating raw and undercooked meat is popular.

Conclusion

Our findings may be used to reassure veterinary staff that their exposure to cats would not increase the risk of infection with toxoplasma, which in turn is reassuring information for women of childbearing age who own cats. Contrary to popular belief, they can keep and care for their cats during pregnancy, providing they use good hand washing techniques and wear gloves when changing the litter box.

Competing interests

none declared

Authors contributions

Samar Shuhaiber: conceived the study, carried it out and wrote the manuscript

Gideon Koren: participated in designing study, and writing of manuscript.

Rada Boskovic: participated in carrying out the study and analysing results

Thomas R Einarson: analysed and performed statistics

Offie Parat-Soldin: provided expertise and statistics in background of toxoplasmosis

Adrienne Einarson: participated in the conception of study and writing up the manuscript

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