Everyday and exotic foodborne parasites

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MB Lee. Everyday and exotic foodborne parasites. Can J Infect Dis 2000;11(3):155-158.

Everyday foodborne parasites, which are endemic in Canada, include the protozoans *Entamoeba histolytica*, *Giardia lamblia* and *Cryptosporidium parvum.* However, these parasites are most frequently acquired through unfiltered drinking water, homosexual activity or close personal contact such as in daycare centres and occasionally via a food vehicle. It is likely that many foodborne outbreaks from these protozoa go undetected. Transmission of helminth infections, such as tapeworms, is rare in Canada because of effective sewage treatment. However, a common foodborne parasite of significance is *Toxoplasma gondii*. Although infection can be acquired from accidental ingestion of oocysts from cat feces, infection can also result from consumption of tissue cysts in undercooked meat, such as pork or lamb. Congenital transmission poses an immense financial burden, costing Canada an estimated $240 million annually. Also of concern is toxoplasmosis in AIDS patients, which may lead to toxoplasmosis encephalitis, the second most common AIDS-related opportunistic infection of the central nervous system. Exotic parasites (ie, those acquired from abroad or from imported food) are of growing concern because more Canadians are travelling and the number of Canada's trading partners is increasing. Since 1996, over 3000 cases of *Cyclospora* infection reported in the United States and Canada were epidemiologically associated with importation of Guatemalan raspberries. Unlike toxoplasmosis, where strategies for control largely rest with individual practices, control of cyclosporiasis rests with government policy, which should prohibit the importation of foods at high risk.

Key Words: Cyclospora cayetanensis*; Foodborne parasites; Parasite isolations;* Toxoplasma gondii

Parasites communs et exotiques transmis par la nourriture

RÉSUMÉ : Les parasites communs transmis par la nourriture et qui sont endémiques au Canada, comprennent les protozoaires *Entamoeba histolytica*, *Giardia lamblia* et *Cryptosporidium parvum*. Cependant, ces parasites sont le plus fréquemment transmis par de l'eau buvable non filtrée, les relations homosexuelles ou les contacts étroits entre personnes comme dans les garderies, et quelquefois par le biais de la nourriture. Il est probable que de nombreuses éclosions d'infection causées par ces protozoaires et transmises par la nourriture restent non décelées. La transmission des infections à helminthes, tels les ténias, est rare au Canada à cause d'un système efficace de traitement des eaux usées. Cependant, un parasite d'une importance significative transmis par la nourriture est *Toxoplasma gondii*. Bien que l'infection puisse se transmettre par une ingestion accidentelle d'oocystes de déjections de chat, elle peut aussi se transmettre par la consommation de kystes tissulaires dans de la viande insuffisamment cuite, comme du porc ou de l'agneau. La transmission congénitale représente un énorme fardeau financier, et coûte au Canada environ 240 millions de dollars par années. Un sujet d'inquiétude est la toxoplasmose chez les patients atteints du SIDA, qui peut entraîner une encéphalite à toxoplasma, la deuxième infection opportuniste la plus courante et liée au SIDA touchant le système nerveux central. Les parasites exotiques (c'est-à-dire provenant de l'étranger ou d'aliments importés) sont maintenant un sujet d'inquiétude grandissant du fait que plus de Canadiens voyagent et que le nombre des partenaires commerciaux du Canada augmente. Depuis 1996, plus de 3000 cas d'infection à *Cyclospora* recensés aux États-Unis et au Canada ont été épidémiologiquement associés à des importations de framboises du Guatemala. À la différence de la toxoplasmose, où les stratégies de contrôle des infections reposent grandement sur des pratiques individuelles, le contrôle des infections à *Cyclospora* repose sur des politiques gouvernementales, qui devraient interdire l'importation d'aliments à risque élevé.

Presented at the BIOP '99 Symposium, Ryerson Polytechnic University, Toronto, Ontario February 25, 1999
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This paper is a brief survey of the everyday foodborne parasites endemic in Canada and exotic foodborne parasites, which may be acquired by the travelling Canadian or be brought into Canada by an immigrant. Special attention will be paid to *Toxoplasma gondii* infection because of its severity in terms of human misery and costs, and to *Cyclospora cayetanensis* because of its recent appearance in North America.

Parasites have been with us since the beginning of humankind, despite the media's new found attention to them. The protozoan parasites, *Cryptosporidium parvum, Giardia lamblia* and *Entamoeba histolytica* are commonly acquired through water, homosexual activity or by close personal contact, such as in daycare centres (1), rather than by food. However, in countries where raw human excrement is used as fertilizer, foodborne transmission is undoubtedly higher. Occasionally, reports of protozoan foodborne outbreaks make their way into the literature, but this is uncommon (2). In 1997, in Spokane, Washington, 54 people who had eaten at a banquet became ill with diarrhea, fever, chills and headache (3). *C parvum* was the culprit, epidemiologically associated with green onions that were not consistently washed during preparation, and were used in the *au gratin* potatoes, romaine salad and pasta. Because protozoan parasites are sparsely distributed in food, recovery and identification are not routinely possible, so foodborne outbreaks go largely undetected.

The most common of the protozoan parasites in Ontario is *G lamblia* (Table 1). Many infected individuals are asymptomatic, while others may have gas, abdominal cramping, fatigue and diarrhea. Often physicians will choose to treat symptomatic patients while not treating asymptomatic ones.

Entamoeba dispar is not a pathogen but is morphologically indistinguishable from its close relative *E histolytica*. It is thought that many laboratory identifications in Canada for *E histolytica* are really *E dispar*. However, without knowing, physicians usually choose to treat patients when the report says *E histolytica*. A rapid test that can distinguish between these two pathogens is awaited.

Endemic helminth infections are rare in Canada. However, *Trichinella spiralis* in underprocessed wild boar meat caused illness in 24 people in southern Ontario in 1993 (4). The wild boar may have acquired the organism by eating undercooked pig slaughterhouse scraps or foraging for rats. One may question what is meant by the term 'wild' boar if they were feeding on garbage scraps, rather than roaming free to seek their food. Outbreaks of trichinosis have also been reported from the consumption of raw, fresh horsemeat, which is popular in Europe. Because horses are herbivorous, it is a mystery how they become infected. Carnivores may have been ground up in their hay. Outbreaks in France and Italy from 1975 to 1993 resulted in over 2600 human cases of trichinosis (5). Imported carcasses, some from the United States and Canada, that were refrigerated, but not frozen, were linked to these outbreaks. Freezing is a reliable method for inactivating trichinae when done at the appropriate temperatures for the required time.

The adult tapeworms *Taenia solium* and *Taenia saginata* are acquired by eating undercooked pork or beef, respectively. *T solium* is the nastier of the two. A person harbouring an adult *T solium* worm will release worm eggs in their stool. If the person's handwashing habits after toileting are poor, they may unwittingly transmit eggs to others via food that it handled. This may occur within a family, where the eggs, after being ingested, may develop into cystic lesions in the brain. In one case in Boston in 1990, a 16-month-old girl had a seizure. A computed tomography (CT) scan revealed several ring-enhancing lesions. Stool specimens from her father contained *Taenia* species eggs (6). He had undoubtedly eaten undercooked pork sometime previously, likely in the Cape Verde Islands where he had lived before his daughter's birth. Fortunately, pork tapeworm is rare in Canada. *T saginata* is more common, due to the more common habit of eating undercooked beef than pork. Laboratories cannot distinguish the egg of *T saginata* from that of *T solium,* so only the genus is reported. A detailed food history may point to a particular species.

Raw fish may also be a source of parasites. Anisakid worms are occasionally found in raw sea fish and, when consumed, may burrow into the stomach or intestine, causing acute pain. With the increasing popularity of sushi in Canada (seaweed wrapped rice topped with raw seafood), one might think that anisakids would be an increasing concern. However, documented cases of anisakiasis in Canada are few (7), unlike Japan where hundreds of cases are reported annually (8). In Spain, allergic reactions to the dead anisakids have been reported which may be a more significant consequence than having the live parasite (9). One fish parasite that is reported, albeit infrequently, in Ontario is *Diphyllobothrium latum*, which is acquired by eating undercooked freshwater fish, such as pike. Twenty isolations were made by private and public health laboratories in Ontario in 1997 (Table 1).

T gondii is the most significant foodborne parasite because it is common, its acquisition can be devastating and it places an immense financial burden on society. The most likely route of exposure is through consumption of undercooked meat; pork or lamb are more likely to be infected than beef (Table 2) (10). Cattle appear to develop a more effective immune response to toxoplasma than sheep. Additionally, *T gondii* may be acquired from accidental ingestion of oocysts in cat excrement, by transplant or transplacentally, a potentially devastating consequence. Tizard et al (14) tested 7060 human serum specimens from a cross section of Ontario residents for antibody to *T gondii* and found 38% testing positive. As the population ages, the incidence rises due to increased opportunity for exposure. Rates of seropositivity are known to climb from 2.7% in infants, who have had little opportunity to be exposed to *T gondii*, to 50% in individuals aged 25 years or older, who have had increased opportunities for exposure.

The congenital form of toxoplasmosis may result in children being developmentally delayed, blind or deaf. Economic losses primarily result from institutionalization or special education needs of victims. In 1992, Roberts et al (15) estimated that 4179 cases of congenital toxoplasmosis occur annually in the United States at a cost to society of US$2.4 billion. One could interpolate the American data, using a 1 to 10 ratio, to predict about 400 cases of congenital toxoplasmosis in Canada annually. This is a reasonable estimate because

TABLE 1
Parasite isolations from human fecal sample submissions for 1997 in Ontario

Parasites	Food of concern	Public and private labs*	LCDC†
Everyday (endemic in Canada)			
Entamoeba histolytica or *Entamoeba dispar*	Nonspecific	1426	1806
Giardia lamblia	Nonspecific	4157	5877
Cryptosporidium parvum	Nonspecific	386	
Taenia saginata/Taenia solium	Beef/pork	111	
Trichinella spiralis	Pork		21
Anisakis/pseudoterranova	Marine fish		
Diphyllobothrium latum	Freshwater fish	20	
Toxoplasma gondii	Meats		
Exotic parasites (imported)			
Cyclospora cayetanensis	Nonspecific	81	
Echinostoma species	Snails		
Heterophyes/metagonimus species	Freshwater fish		
Clonorchis/opistorchis species	Freshwater fish	69	
Fasciola hepatica	Watercress		
Paragonimus westermanni	Crab/crayfish		
Ascaris lumbricoides	Nonspecific	281	
Trichuris trichiura	Nonspecific	517	

**Compiled from Ontario Public Health Laboratories data (courtesy of Dr Ted Scholten, Chief [Ret] Parasitology), the three largest private laboratories in Ontario, and one smaller laboratory. Isolations may represent multiple submissions from patients and collectively represent about 65% of all laboratories in Ontario; †Laboratory Centre for Disease Control, Ottawa, Ontario*

TABLE 2
Prevalence of serum antibodies to *Toxoplasma gondii*

Animal species	% positive by antibody titre			
	Tizard et al (10) (Ontario)	Patton et al (11) (southern United States)	Dubey et al (12) (Illinois)	Gajadhar et al (13) (Canada)
Cats	20		68	
House mice	11		2	
Deer mice	5		5	
Finishing pigs	45		2	3.5-13
Goats	63	65		
Sheep	65			
Cattle	17			
Rats	3		5	

in 1986, Carter and Frank (16) estimated 140 to 1400 cases annually of congenital toxoplasmosis in Canada. Likewise, using 10% of the American cost estimates would place the cost to Canadian society at $240 million annually, no small amount.

Toxoplasmosis in AIDS patients is another concern because the organism may go to the brain, causing toxoplasmic encephalitis (TE). TE is the second most common AIDS-related opportunistic infection of the central nervous system, and occurs in 10% to 50% of patients with AIDS who are positive by antibody serology to toxoplasma and have a low CD4+ T lymphocyte count (17). American costs for infected patients' care are estimated at over US$17,000/patient annually (18). Toxoplasmosis in the AIDS patient is likely a reactivation of latent tissue cysts and not a recent infection because immunoglobulin G antibodies in patients indicate prior infection.

Food control of *T gondii* includes cooking meats to at least 66°C (19) (better yet cook to 71°C because that will destroy salmonellae too) or freezing to –12°C (20). Gamma irradiation of meat has been shown to be effective at 0.5 kGy in inactivating tissue cysts of toxoplasma. If consumers are willing to accept irradiated food, this would appear to be the best strategy because public health efforts are maximized when control is centralized rather than relying on individual behaviour.

Potential solutions for controlling toxoplasmosis in livestock include a live vaccine for sheep, available in New Zealand and the United Kingdom (21). The vaccine is intended to prevent abortion in sheep. A live vaccine is being developed in the United States for cats to reduce oocyst shedding.

In this discussion, 'exotic parasites' refers to parasites entering in imported foods or brought back by Canadians travelling abroad. *C cayetanensis* has been in the North American news since 1996, when it was associated with an outbreak arising from importation of Guatemalan raspberries (22-24). Washing raspberries will not remove all the parasites which may be hiding in nooks and crannies. From 1996 to 1998, there were over 3000 cases of cyclosporiasis in North America. Raspberries are not the only food vehicle linked to illness; a Florida outbreak involved mesculun lettuce (23) and another outbreak in the Maryland area involved basil in a basil-pesto salad (25). One of the Maryland victims did not even eat the salad but used the serving spoon to serve himself leftovers. This suggests a small infective dose, as does the fact that this is a coccidian parasite (*T gondii* and *C parvum* are others), which are infective in small numbers. Although a team of federal investigators travelled from Canada and the United States to Guatemala in the spring of 1998 to investigate, the source of the *C cayetanensis* was not found. Human sewage from pits near fields or from workers with poor personal hygiene were suspect. Other documented outbreaks in Nepal and Papua, New Guinea have occurred from contaminated water (26). Although coccidia are not destroyed by chlorination, because of their resistant oocyst wall, filtration in municipal treatment plants can capture the 10 m oocyst of *Cyclospora* species.

Potential solutions on farms include the use of potable water for spraying crops, workers thoroughly hand washing after using the toilet and toilet facilities that keep sewage from contaminating the environment. It would also be useful to be able to trace berries back to a particular farm if an outbreak were to occur. Canadians must rely on federal government policy to restrict the sale of imported produce if the produce is 'high risk', eg, produced under unhygienic conditions. Irradiation may be a future alternative if it will not compromise the texture of the berry.

Other exotic parasites include the flatworm species *Echinostoma*, *Hetrophyes, Metagonimus, Clonorchis*, and *Opisthorchis*, which live in intestines or bile ducts. They are usually

acquired from eating raw or improperly processed fish, snails or crab in Asian countries (Table 1). Some species of *Opisthorchis* in Thailand infect over 90% of the inhabitants in some villages (27).

Nematodes, roundworms of the intestinal tract, that are transmitted in food include *Ascaris lumbricoides* and *Trichuris trichiura*. They are not associated with any specific food but are acquired when human sewage contaminates produce that is not cooked. These parasites may pose a medical problem to the infected but not to the public's health because they are not directly infective, needing to mature in soil for one to several weeks. Because of good sewage control in developed countries, through municipal treatment plants and septic tank systems, the eggs are not disseminated to fertilize produce where they would start the cycle again.

CONCLUSIONS

We are fortunate to live in Canada, where we generally have good public health practices such as cooking foods well, municipal water filtration and sewage disposal, that aid in reducing our exposure to infectious agents. Additionally, we rely on government policy to prohibit importation of foods that may be high risk. Occasionally, however, these systems can fail as this discussion has indicated. We still have room for reducing risk and improving our health.

REFERENCES

1. Keystone JS, Yang, J, Grisdale D, Harrington M, Pillon L, Andreychuk R. Intestinal parasites in metropolitan Toronto day-care centres. Can Med Assoc J 1984;131:733-5.
2. Smith JL. *Cryptosporidium* and *Giardia* as agents of foodborne disease. J Food Prot 1993;56:451-61.
3. Quinn K, Baldwin G, Stepak P, et al. Foodborne outbreak of cryptosporidiosis – Spokane, Washington, 1997. MMWR Mort Morbid Wkly Rep 1998;47:565-7.
4. Greenbloom SL, Martin-Smith P, Isaacs S, et al. Outbreak of trichinosis in Ontario secondary to the ingestion of wild boar meat. Can J Pub Health 1997;88:52-6.
5. Dupouy-Camet J, Soule C, Ancelle T. Recent news on trichinellosis: another outbreak due to horsemeat consumption in France in 1993. Parasite 1994;1:99-103.
6. Locally acquired neurocysticercosis – North Carolina, Massachusetts and South Carolina, 1989-1999. MMWR Mort Morbid Wkly Rep 1992;41:1-4.
7. Kowalewska-Grochowska K, Quinn J, Perry I, Sherbaniuk R. A case of anisakiasis – Alberta. Can Dis Wkly Rep 1989;15:221-3.
8. Adams AM, Murrell KD, Cross JH. Parasites of fish and risks to public health. Rev Sci Tech 1997;16:652-60.
9. Moreno-Ancillo A, Caballero MT, Cabanas R, et al. Allergic reactions to *Anisakis simplex* parasitizing seafood. Ann Allergy Asthma Immunol 1997;79:246-50.
10. Tizard IR, Harmeson J, Lai CH. The prevalence of serum antibodies to *Toxoplasma gondii* in Ontario mammals. Can J Comp Med 1978;42:177-83.
11. Patton S, Johnson SS, Puckett K. Prevalence of *Toxoplasma gondii* antibodies in nine popultions of dairy goats. J Parasit 1990;76:74-7.
12. Dubey JP, Weigel RM, Siegel AM, et al. Sources and reservoirs of *Toxoplasma gondii* infection on 47 swine farms in Illinois. J Parasit 1995;81:723-9.
13. Gajadhar AA, Aramini JJ, Tiffin G, Bisaillon JR. Prevalence of *Toxoplasma gondii* in Canadian market-age pigs. J Parasit 1998;84:759-63.
14. Tizard IR, Chauhan SS, Lai CH. The prevalence and epidemiology of toxoplasmosis in Ontario. J Hyg (Lond) 1977;78:275-82.
15. Roberts T, Murrell KD, Marks S. Economic losses caused by foodborne parasitic diseases. Parasitol Today 1994;10:419-23.
16. Carter AO, Frank JW. Congenital toxoplasmosis: epidemiologic features and control . CMAJ 1986;135:618-23.
17. Richards FO, Kovacs JA, Luft BJ. Preventing toxoplasmic encephalitis in persons infected with human immunodeficiency virus. Clin Infect Dis 1995;21(Suppl 1):S49-56.
18. Gable CB, Tierce JC, Simison D, Ward D, Motte K. Costs of HIV+/AIDS at CD4+ counts diseases stages based on treatment protocols. J Acquir Immune Def Syndr Hum Retrovir 1996;12:413-20.
19. Dubey JP, Kotula AW, Sharar A, Andrews CD, Lindsay DS. Effect of high temperature on infectivity of *Toxoplasma gondii* tissue cysts in pork. J Parasit 1990;76:201-4.
20. Dubey JP. Strategies to reduce transmission of *Toxoplasma* to animals and humans. Vet Parasitol 1996;64:65-70.
21. Buxton D. Protozoan infections (*Toxoplasma gondii*, *Neospora caninum* and *Sarcosystis* spp.) in sheep and goats: recent advances. Vet Res 1998;29:289-310.
22. Herwaldt BL, Ackers ML, Cyclospora Working Group. An outbreak in 1996 of cyclosporiasis asociated with imported raspberries. N Engl J Med 1997;336:1548-56.
23. DeGraw E, Heber S, Rowan A. Update: Outbreaks of cyclosporiasis – United States and Canada, 1997. MMWR Mort Morbid Wkly Rep 1997;46:521-3.
24. Toronto Public Health Unit, Haliburton-Kawartha-Pine Ridge District Health Unit, Simcoe County District Health Unit et al. Outbreak of cyclosporiasis – Ontario, Canada, May 1998. MMWR Mort Morbid Wkly Rep 1998;47:806-9.
25. Pritchett R, Gossman C, Radke V, et al. Outbreak of cyclosporiasis – Northern Virgina-Washington, D.C.-Baltimore, Maryland, Metropolitan area, 1997. MMWR Mort Morbid Wkly Rep 1997;46:689-91.
26. Brennan MK, MacPherson DW, Palmer J, Keystone JS. Cyclosporiasis: a new cause of diarrhea. CMAJ 1996;255:1293-6.
27. Harinasuta T, Pungpak S, Keystone JS. Trematode infections. Opisthorchiasis, clonorchiasis, fascioliasis, and paragonimiasis. Infect Dis Clin North Am 1993;7:699-716.