Person-to-person transmission of *Giardia lamblia* in day-care nurseries

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In an outbreak of giardiasis at two day-care nurseries in metropolitan Toronto *Giardia lamblia* appeared to be transmitted person to person. No common source of infection could be found. The proportions of children infected in the two nurseries were 39% and 17%; infection was spread to 7% and 23% of their household contacts. Of the infected children and household contacts 26% and 30% respectively of those for whom detailed information could be obtained were symptomatic.

Canadian children were more likely to be infected and symptomatic than were immigrant children attending the nurseries. The most susceptible ages for infection were 1 to 3 years.

The results of this study suggest that all children in day-care nurseries who are infected with *G. lamblia* should be treated, regardless of whether they are symptomatic.

Lors d'une flambée de giardiase dans deux garderies du Toronto métropolitain le *Giardia lamblia* a semblé s'être transmis de personne à personne. Aucune des sources habituelles d'infection n'a pu être trouvée. Les pourcentages des enfants infectés dans chacune des deux garderies ont été de 39% et de 17%; l'infection s'est propagée à 7% et 23% de leurs contacts familiaux. Parmi les enfants infectés et les contacts familiaux 26% et 30% respectivement de ceux dont une information complète a pu être obtenue présentaient des symptômes.

Les enfants canadiens étaient plus susceptibles d'être infectés et symptomatiques que les enfants d'immigrants placés dans ces garderies. Les enfants de 1 à 3 ans étaient les plus susceptibles d'être infectés.

Les résultats de cette étude indiquent que tous les enfants en garderie infectés par *G. lamblia* devraient être traités, qu'ils soient symptomatiques ou non.

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With the increasing numbers of women combining employment outside the home with child-rearing, and with the increasing numbers of single-parent families, the provision of day-care centres for pre-school-aged children has expanded rapidly in North America. Facilities that bring young children in close contact have increased the risk of spread of communicable diseases within a highly susceptible population. Viral infections such as hepatitis, and bacterial infections such as shigellosis have long been recognized to spread readily within day-care nurseries because of inadequate personal hygiene and lack of toilet training.[1-3]

In the past, transmission of *Giardia lamblia* has been documented to occur only by the water-borne route.[4] Recently, however, Black and colleagues[5] have reported epidemiologic evidence suggesting person-to-person transmission of *G. lamblia* in three day-care centres. Our investigation of *G. lamblia* outbreaks at two day-care nurseries confirms their findings and provides more evidence not only for person-to-person transmission of *G. lamblia* but also for moderately severe illness associated with giardiasis in these children and infected household contacts.

Methods

In January 1977 the Etobicoke Health Department requested assistance from the tropical disease unit of Toronto General Hospital to control an outbreak of giardiasis at a day-care nursery (A) within the Borough of Etobicoke in northwest metropolitan Toronto. In March 1977 a second day-care nursery (B), near nursery A, was faced with the same problem.

The stools of all the children at both nurseries were examined. The parents and household contacts of all the infected children (those whose stools were found to contain *G. lamblia* cysts), as well as the staff members, were interviewed, when possible, to obtain clinical and epidemiologic information, and their stools were examined. For this study diarrhea was defined as loose stools occurring more frequently than usual for that person. Individuals were considered to have symptomatic giardiasis only if their symptoms were consistent with those of giardiasis (apart from diarrhea one or more of the following: nausea, vomiting, flatulence, bloating, abdominal pain and weight loss), they had no concurrent illness and they responded completely to drug therapy. Control groups of children and household contacts whose stools were free of *G. lamblia* cysts were matched by age, sex and ethnic origin with their infected counterparts, and symptoms were compared for the periods September 1976 to March 1977 at nursery A and February to April 1977 at nursery B. To be considered symptomatic the controls had to have had gastrointestinal symptoms for at least 2 weeks, the shortest duration of symptomatic giardiasis in this study.

Single stool samples from each child and each staff member at the nurseries, as well as from household contacts of the infected children, were placed in sodium acetate–formalin preservative in special containers and forwarded by mail to the Ontario Ministry of Health laboratories in Toronto, where they were examined by the formalin–ether concentration technique.

Etobicoke public health inspectors sought water supply–sewage cross-connections and plumbing deficiencies by testing for fecal contamination, and tested the water supply and selected areas within the day-care nurseries for parasitic pathogens.

Children harbouring *G. lamblia*, whether symptomatic or not, were segregated from uninfected children until treatment was given and two follow-up examinations showed that the stools were free of the parasite. All the infections cleared with a single course of either metronidazole (Flagyl), 5 mg/kg *tid* for 10 days, or mepacrine (quinacrine) hydrochloride (Atabrine), 2 mg/kg *tid* for 7 days.

Statistical analyses were carried out by binomial two-sample ratio testing.

Results

The nursery populations consisted of children 6 weeks to 5 years of age from lower-middle-income families; 55% of the children were from immigrant families, most of whom had recently emigrated from the West Indies, India, Africa or southeast Asia. Most of the immigrant children had been born abroad. Nursery A, with 30 employees, had 152 children separated by age into eight rooms. Nursery B, with 40 employees, had 175 children separated in the same manner.

A substantial proportion of children in both nurseries were infected with *G. lamblia* (Table I). The large difference in the proportions of infected persons associated with each nursery was probably due to the longer duration of the outbreak at nursery A. The index of suspicion was higher at nursery B because the staff were aware of the outbreak that had occurred earlier at nursery A. As well, at the first sign of diarrhea in nursery B children, stools were examined for parasite cysts. None of the infected employees were kitchen staff. Four children and nine household contacts were found to be infected with other parasites; included were one case each of pinworm and strongyloidiasis, two cases each of amebiasis, schistosomiasis and ascariasis, three cases of ancylostomiasis and six cases of trichuriasis.

Between 20% and 39% of the infected children and their household contacts had symptomatic giardiasis; only 2 (2.9%) of the 68 uninfected controls associated with nursery A and none of those associated with nursery B were symptomatic (Table II). Diarrhea and abdominal pain were the most common complaints among the children, whereas fatigue and flatulence were more common among the household contacts. The mean duration of symptoms was 5 weeks (range 2 to 12 weeks) for the infected children and 7 weeks (range 3 to 8 weeks) for the household contacts.

Analysis of more detailed information from nursery A revealed a significant association ($P < 0.01$) of giardiasis with children of Canadian origin; 71% of the infected children were Canadian (Table III).

The age-specific attack rate of giardiasis at nursery A was 96% in children between 1 and 2 years old, 26% in children between 2 and 3 years old and 80% in children 3 years old (Fig. 1). The children in certain rooms had a high rate of infection, whereas those in other rooms were virtually untouched. Those in rooms 3 and 5 used potties, two children sharing one potty, while those in room 4 were in diapers. The children in rooms 1, 2 and 8 shared one toilet; those in rooms 6, 7 and 10 shared the other. No evidence could be found for sewage contamination of the water supply, and all areas tested were free of *G. lamblia*.

The epidemic curve for the outbreak of giardiasis at nursery A was virtually flat and extended over 7 months (Fig. 2). The index case was that of a 2-year-old girl who began attending the nursery in July 1976.

Table I—Frequency of *Giardia lamblia* infection among children in two day-care nurseries, and among staff and household contacts of infected children, as determined from stool testing

Group	Nursery A		Nursery B	
	No. tested	No. (and %) infected	No. tested	No. (and %) infected
Children	152	59 (39)	175	30 (17)
Staff	30	2 (7)	40	3 (8)
Household contacts of infected children	124/128	9 (7)	57/60	13 (23)

Table II—Numbers of symptomatic persons among the infected and the uninfected*

Group	No. (and %) of symptomatic persons†					
	Nursery A			Nursery B		
	Infected	Uninfected	P value	Infected‡	Uninfected	P value
Children	12 (20)	2 (2)	< 0.01	10 (39)	0 (0)	< 0.01
Staff	0 (0)	0 (0)	NA	1 (50)	0 (0)	NA
Household contacts of infected children	3 (33)	0 (0)	NA	3 (27)	0 (0)	NA
Total	15 (21)	2 (1)	< 0.01	14 (36)	0 (0)	< 0.01

*According to results of stool testing.
†NA = not applicable because samples were too small for statistical analysis.
‡Percentages based on total numbers of 26, 2 and 11 (and a sum of 39), which are lower than those cited in Table I because detailed information could not be obtained for every infected person.

Table III—Characteristics of infected individuals in nursery A and their infected household contacts

Group	Age (yr)		No. of individuals			
			Sex*		Origin†	
	Mean	Range	Male	Female	Canadian	Immigrant
Children, n = 59	2	0.75-4	31	28	42	17
Household contacts of infected children, n = 9	30	27-43	4	5	8	1
Total, n = 68	–	–	35	33	50	18

*Numbers in the two categories were not significantly different.
†Numbers in the two categories were significantly different ($P < 0.01$).

Discussion

Infection with *G. lamblia* has largely been associated with waterborne epidemics in North America where drinking water has been contaminated, and in groups of travellers exposed to similar conditions abroad.[6-8] Persons in institutions have long been noted to have a higher frequency of infection with this organism.[9-11] Children are more frequently infected and more likely to have symptoms than adults.[12] A de-

crease in gastric acidity facilitates infection with *G. lamblia*,[13] and immunoglobulin deficiency syndromes, especially isolated IgA deficiency, are frequently associated with symptomatic giardiasis.[14]

The pathogenesis of diarrhea and malabsorption in giardiasis is unknown. The more common proposed explanations include a mechanical barrier to absorption caused by massive parasite coverage of the small bowel mucosa,[15] mucosal dysfunction secondary to mucosal invasion,[16] and mechanical irritation of microvilli by the trophozoite's sucking disc.[17]

As in our subjects, the clinical findings in giardiasis are quite variable. Most infected individuals are asymptomatic. Symptom complexes may include chronic mild intermittent diarrhea associated with nausea, fatigue and abdominal bloating, severe malabsorption, or acute diarrhea occasionally associated with chills and low-grade fever.[18,19]

Although the diagnosis of giardiasis is usually made by means of stool examination, the absence of cysts in the stool may necessitate duodenal intubation or small bowel biopsy to detect the trophozoite. Since in up to 40% of cases giardiasis cannot be diagnosed from examination of a single stool specimen it is likely that the frequency of giardiasis would have been much higher in our subjects had more than one stool specimen from each been examined.[20-22]

The epidemic curve for nursery A strongly suggested person-to-person transmission of *G. lamblia*. We could not, however, rule out the possibility of a low-grade continuing common source of infection or spread by fecally contaminated fomites. The highest frequency of giardiasis in this nursery was in the children between 1 and 2 years old; children of this age have begun to be mobile but are not yet toilet-trained and hence are at highest risk for person-to-person transmission. The frequency of infection gradually decreased with age as toilet training was established and personal hygiene improved. The low frequency in children less than 1 year old might be explained by the fact that they were in diapers and spent more time in cribs, thus being less often in direct contact with other children. The lack of infection among the 2½- to 3-year-olds in room 7 was thought to be the result of their teachers' desire to keep the

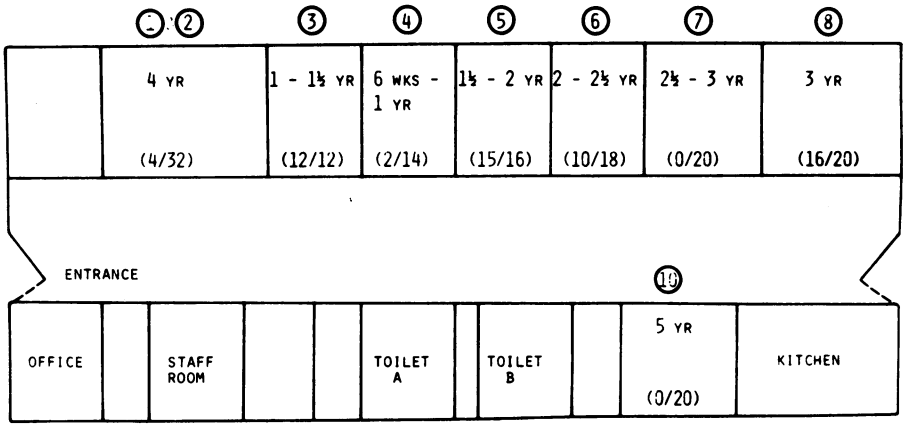

FIG. 1—Layout of day-care nursery A, with ages of children in each room. Proportions of children with giardiasis are in parenthesis.

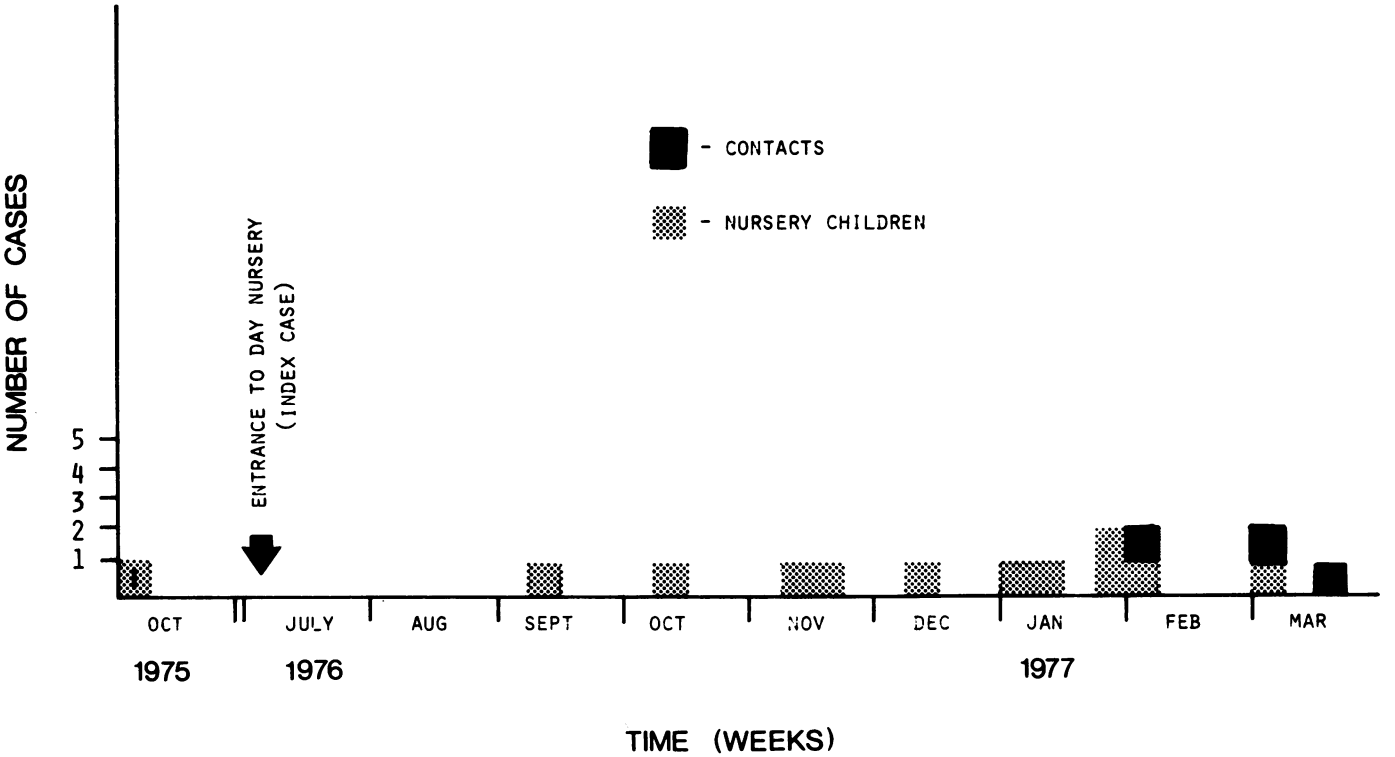

FIG. 2—Number of symptomatic cases of giardiasis in day-care nursery A.

children's hands clean.

An intriguing finding in our investigation was that 71% of the infected children were Canadian, whereas the nursery population was only 45% Canadian. A similar association of giardiasis with the indigenous rather than the immigrant population was found in a recent survey of parasitic infection in Glasgow.[23] This unexpected finding might be explained by the recent observation in animals that prior infection with *G. lamblia* confirmed partial immunity to rechallenge.[24] It is conceivable, therefore, that previous exposure to *G. lamblia* in the children of immigrant families might have provided a degree of protection not present in the susceptible Canadians.

Still controversial among many groups of physicians, including parasitologists, is the need to treat the asymptomatic individual who passes *G. lamblia* cysts. Our findings confirm that a substantial proportion (up to one third) of persons with locally acquired *G. lamblia* infection have symptoms, and that the illness is lengthy, the average duration ranging from 5 to 7 weeks. In view of this degree of morbidity and the apparent ease of person-to-person transmission of *G. lamblia* in day-care nurseries, asymptomatic children in these centres who are infected with *G. lamblia* should be treated.

In addition, we recommend the following to help reduce the transmission of *G. lamblia* in day-care nurseries: (a) new entrants to day-care nurseries should be screened for giardiasis; (b) staff education should emphasize the importance of personal and environmental hygiene, particularly handwashing in children; and (c) giardiasis should be considered in the differential diagnosis of diarrhea in day-care nursery populations.

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References

1. WEISSMAN JB, GANGAROSA EJ, SCHMERLER A, et al: Shigellosis in day-care centres. *Lancet* 1: 88, 1975
2. WILLIAMS SV, HUFF JC, BRYAN JA: Hepatitis A and facilities for preschool children. *J Infect Dis* 131: 491, 1975
3. THOMAS MEM, TILLETT HE: Sonne dysentery in day schools and nurseries: an eighteen-year study in Edmonton. *J Hyg* 71: 593, 1973
4. SCHULTZ MG: Giardiasis. *JAMA* 233: 1383, 1975
5. BLACK RE, DYKES AC, SINCLAIR SP, et al: Giardiasis in day-care centers — evidence of person-to-person transmission. *Pediatrics* 60: 486, 1977
6. MOORE GT, CROSS WM, MCGUIRE D, et al: Epidemic giardiasis at a ski resort. *N Engl J Med* 281: 402, 1969
7. BARBOUR AG, NICHOLS CR, FUKUSHIMA T: An outbreak of giardiasis in a group of campers. *Am J Trop Med Hyg* 25: 384, 1976
8. WALZER PD, WOLFE MS, SCHULTZ MG: Giardiasis in travelers. *J Infect Dis* 124: 235, 1971
9. YOELI M, MOST H, HAMMOND J, et al: Parasitic infections in a closed community: results of a ten-year survey in Willbrook stage schools. *Trans R Soc Trop Med Hyg* 66: 764, 1972
10. BROWN EH: Giardia lamblia: the incidence and results of infestation of children in residential nurseries. *Arch Dis Child* 23: 119, 1948
11. ORMISTON G, TAYLOR J, WILSON GS: Enteritis in a nursery home associated with Giardia lamblia. *Br Med J* 2: 151, 1942
12. YARDLEY JH, BAYLESS TM: Giardiasis. *Gastroenterology* 52: 301, 1967
13. GIANNELLA RA, BROITMAN SA, ZAMCHECK N: Influence of gastric acidity on bacterial and parasitic enteric infections. A perspective. *Ann Intern Med* 78: 271, 1973
14. AMENT ME, RUBIN CE: Relation of giardiasis to abnormal intestinal structure and function in gastrointestinal immunodeficiency syndromes. *Gastroenterology* 62: 216, 1972
15. VEGHELYI P: Celiac disease imitated by giardiasis. *Am J Dis Child* 57: 894, 1939
16. BRANDBORG LL, TANKERSLEY CB, GOTTLIEB S, et al: Histological demonstration of mucosal invasion by *Giardia lamblia* in man. *Gastroenterology* 52: 143, 1967
17. MUELLER JC, JONES AL, BRANDBORG LL: Scanning electron microscope observation in human giardiasis, in *Proceedings of the Workshop on Scanning Electron Microscopy in Pathology*, IIT Research Institute, Chicago, 1973, pp 557-64
18. WOLFE MS: Current concepts in parasitology. Giardiasis. *N Engl J Med* 298: 319, 1978
19. MAHMOUD AAF, WARREN KS: Algorithms in the diagnosis and management of exotic diseases. II. Giardiasis. *J Infect Dis* 131: 621, 1975
20. KAMATH KR, MURUGASU R: A comparative study of four methods for detecting *Giardia lamblia* in children with diarrheal disease and malabsorption. *Gastroenterology* 66: 16, 1974
21. AMENT ME: Diagnosis and treatment of giardiasis. *J Pediatr* 80: 633, 1972
22. HOSKINS LC, WINAWERS SJ, BROITMAN SA, et al: Clinical giardiasis and intestinal malabsorption. *Gastroenterology* 53: 265, 1967
23. GOEL KM, SHANKS RA, MCALLISTER TA, et al: Prevalence of intestinal parasitic infestation, salmonellosis, brucellosis, tuberculosis and hepatitis B among immigrant children in Glasgow. *Br Med J* 1: 676, 1977
24. ROBERTS-THOMSON IC, STEVENS DP, MAHMOUD AAF, et al: Acquired resistance to infection in an animal model of giardiasis. *J Immunol* 117: 2036, 1976

BOOKS

This list is an acknowledgement of books received. It does not preclude review at a later date.

THE CHRONIC MENTAL PATIENT IN THE COMMUNITY. Vol 10, publ no 102, May 1978. Formulated by the Committee on Psychiatry and the Community. Group for the Advancement of Psychiatry. 99 pp. Group for the Advancement of Psychiatry, New York, 1978. $3.50, paperbound. ISBN 0-87318-139-5

A CONSUMER'S DICTIONARY OF FOOD ADDITIVES. Ruth Winter. 252 pp. Crown Publishers, Inc., New York; General Publishing Co. Limited, Don Mills, 1978. $5.95, paperbound. ISBN 0-517-35161-5

LA CORRECTION INSTRUMENTALE DES SCOLIOSES PAR VOIE ANTERIEURE. M. Onimus, José Adrey, Elio Ascani et l'autres. 88 pp. Illust. Expansion Scientifique Française, Paris, 1978. $24.24, broché. ISBN 2-7046-0970-5

HANDBOOK OF ULTRASONIC B-SCANNING IN MEDICINE. R.M. Lunt. 172 pp. Illust. Cambridge University Press, Cambridge; Cambridge University Press, New York, 1978. Price not stated, paperbound. ISBN 0-521-21753-9, hardbound; ISBN 0-521-29264-6, paperbound

RECENT ADVANCES IN CLINICAL IMMUNOLOGY. No. 1. Edited by R.A. Thompson. 299 pp. Illust. Churchill Livingstone, Edinburgh; Longman Canada Limited, Don Mills, 1977. $28. ISBN 0-443-01388-8

RENIN. Vol. 2, 1977. Suzanne Oparil and Richard Katholi. 332 pp. Eden Press Inc., Montreal, 1977. $24. ISBN 0-88831-014-5

ROBERTS' HANDBOOK OF NORMAL CLINICAL VALUES. 62 pp. Science Editors, Inc., Louisville, 1977. $6.95, paperbound

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