

Giardia Transmission in a Swimming Pool

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Abstract: In the fall of 1985, an outbreak of giardiasis occurred among several swimming groups at an indoor pool in northeast New Jersey. Nine clinical cases were identified, eight of whom had *Giardia* positive stool specimens. All were female; seven were adults (>18 years) and two were children. The attack rate was highest (39 per cent, 5/13) for the ladies lap group who had exposure on one day. These cases had no direct contact with children or other risk factors for acquiring *Giardia*. Infection most likely occurred following the ingestion of swimming pool water contaminated with *Giardia* cysts. The source of *Giardia* contamination was a handicapped child who had a fecal accident in the pool. He was a member of a group that

swam at the same time as the ladies lap group. A stool survey of the handicapped group showed that of the 20 persons tested, nine were positive for *Giardia*, including the specimen from this child. Examination of the pool records showed that no chlorine levels had been taken on the day of the fecal accident and that on the following day the chlorine level was zero. This is the second report of *Giardia* transmission among swimming pool attendees. It emphasizes the need to maintain appropriate chlorine levels in swimming pools and to institute measures to clear pools after a fecal accident. (*Am J Public Health* 1988; 78:659-662.)

Introduction

Transmission of *Giardia lamblia* occurs by ingestion of cysts in fecally contaminated water, and less often from fecally contaminated food.¹ The parasite can also be transmitted from person to person via an infected individual; this often occurs in institutions and day care centers.²

The majority of reported outbreaks of *Giardia* have been from contaminated water supplies.^{3,4} At the present time there has been only one report of foodborne *Giardia*; the source of the outbreak was found to be contaminated home prepared salmon.⁵ Transmission of *Giardia* by ingestion of contaminated swimming pool water has been reported once previously, from Washington State, where members of an infant toddler class contracted the illness.⁶ The data presented suggested that *Giardia* infection had been transmitted in the swimming pool.

We describe herein an outbreak of giardiasis among members of several swimming groups, who very likely acquired their infection from ingesting fecally contaminated pool water. The water was contaminated following a fecal accident by a handicapped infected child.

Background

On October 15, 1985, a local New Jersey Health Department was notified of a giardiasis outbreak at the local swimming pool. A woman telephoned the department to say that she and three friends had *Giardia* infections and she thought that they had contracted the infections at the swimming pool. The only occasion on which the women had met during the previous four months was at the pool on the morning of September 17, 1985. Six days following this event, one of the women developed diarrhea. Subsequently, all four women developed diarrhea and four were found to be positive for *Giardia* on stool microscopy.

The pool was in a recreation center that had a membership of between 400 and 500 people, with approximately 150 people using the swimming facilities each day. Water for the 75 feet by 35 feet, 165,000 gallon, pool was supplied by the

local water company which used 80 per cent surface water and 20 per cent well water. The water was filtered by the company before it reached the pool. Once in the pool, it was recirculated and filtered by three 72-inch rapid sand filters within a six-hour period. Liquid chlorine was used for disinfection and levels were maintained by a sensing electrode device in the filtration system. The electrode detected low levels of chlorine which triggered an infusion of liquid chlorine into the water from a large storage container. There was no alarm system to indicate that the container was empty. Chlorine levels were normally kept above 0.3 mg/l and were tested using the diethyl-p-phenylene-diamine (DPD) test. The water temperature was maintained at 25°C with a pH level between 7.4 and 7.7.

A swim schedule was available which showed that on week days extensive use of the facility was made by different swimming groups between 8:00 am and 5:00 pm. During these hours, several groups used the pool at the same time. This was made possible by dividing the pool into separate lap areas.

Methods

Groups of swimmers using the pool on the day of the first identified case (September 17) and the two subsequent days (September 18 and 19) were identified. The following information was collected on each of the swimmers: age, sex, symptoms of illness and type of swimming (i.e., whether they put their head under the water and whether they dived), and whether they had had contact with day care centers, children under five years of age, or institutions for the handicapped. A questionnaire was also administered to pool employees.

To find additional cases who did not swim in specified groups, a letter was sent to all pool members asking them to report any gastroenteritis symptoms that had occurred during September or October. Local hospitals were surveyed to determine if there was a community-wide outbreak of giardiasis.

A case of giardiasis was defined as a person with diarrhea of ≥ 3 stools per day for ≥ 5 days, or intermittent diarrhea for ≥ 5 days duration with at least two of the following; flatulence, nausea, malaise, and abdominal cramps. To be an outbreak-associated case, a person had to have swum at the pool on September 17-19 and symptoms had to have appeared within 25 days of exposure.

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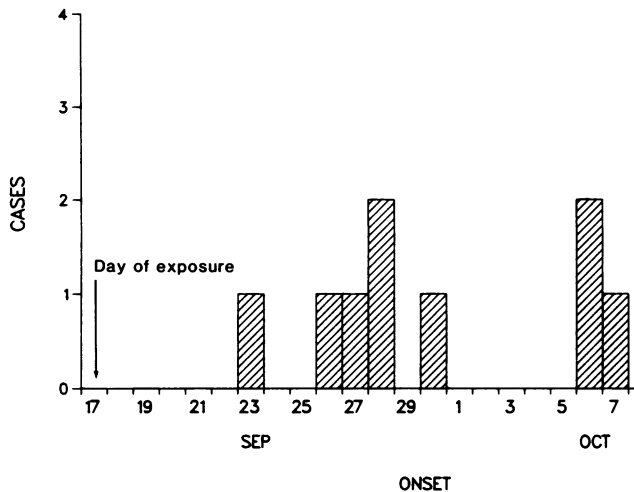


FIGURE 1—Giardiasis Cases, by Day of Onset, Swimming Pool Outbreak, New Jersey, 1985

Stool specimens were collected from all members of the swimming groups and from pool employees. They were examined for *Giardia* microscopically; enteric bacterial cultures were performed for *Salmonella*, *Shigella* and *Campylobacter* on all persons with clinical symptoms.

An environmental investigation of the pool chlorine and filtration system was carried out. Water specimens were collected from different sections of the pool for coliform and total bacterial counts.

Results

Nine cases of outbreak-associated giardiasis (as defined) were identified from a total of approximately 450 persons who used the pool during the three-day period. Seven were in adults (>18 years) and two were in children; all were female. Seven of the cases were in pool users and the remaining two were swimming instructors at the pool. Cases by day of onset are shown in Figure 1.

No additional cases were found among other swimmers. The four local hospitals that were contacted reported only one case of giardiasis during the previous two months; the case was one of the outbreak-associated cases.

The groups of swimmers who swam during the period September 17 to 19 are shown in Table 1. The attack rate was highest, 39 per cent (5/13), for the ladies lap group; none of the cases in this group had other risk factors for *Giardia* infection. A handicapped class that swam at the same time as

the ladies group had an attack rate of 10 per cent (2/20). The 11:00 am parent/toddler group which swam one-and-a-half hours after the ladies and handicapped groups, had an attack rate of 6 per cent (1/16) and three subsequent groups (N = 25) had no cases. The one case of giardiasis in the 9:00 am parent/toddler session was the swimming instructor who swam with her child in this class and then remained in the pool until 11:00 am.

In the ladies lap group, all the swimmers put their heads under the water. However, among those who dived, 100 per cent (4/4) became ill compared to 11 per cent (1/9) of those who did not dive (RR = 9.0, 95% CI 1.49, 54.54).

The source of *Giardia* in the pool was most likely from a child in the handicapped class who had defecated in the pool, sometime between the hours of 9:30 am and 10:15 am (Figure 2). The accident was identified when the child, who had had no symptoms of giardiasis, had removed his swimming attire after vacating the pool. Information about whether the stool was loose or formed was unavailable, but swimmers were not asked to vacate the pool although the managers of the facility were aware of the incident.

Laboratory

Eight of the nine cases had *Giardia* positive stool specimens. The single case with a negative result had been treated with metronidazole prior to collection of a stool specimen. All specimens were negative for other pathogens.

Of the 20 stool specimens collected from the handicapped group, nine were positive for *Giardia*, including the specimen from the child who had had the fecal accident, giving an infection rate of 45 per cent (Table 1). A total of four people in the 11:00 am parent/toddler class were found to have *Giardia* positive stool specimens, although only one was symptomatic.

Environmental

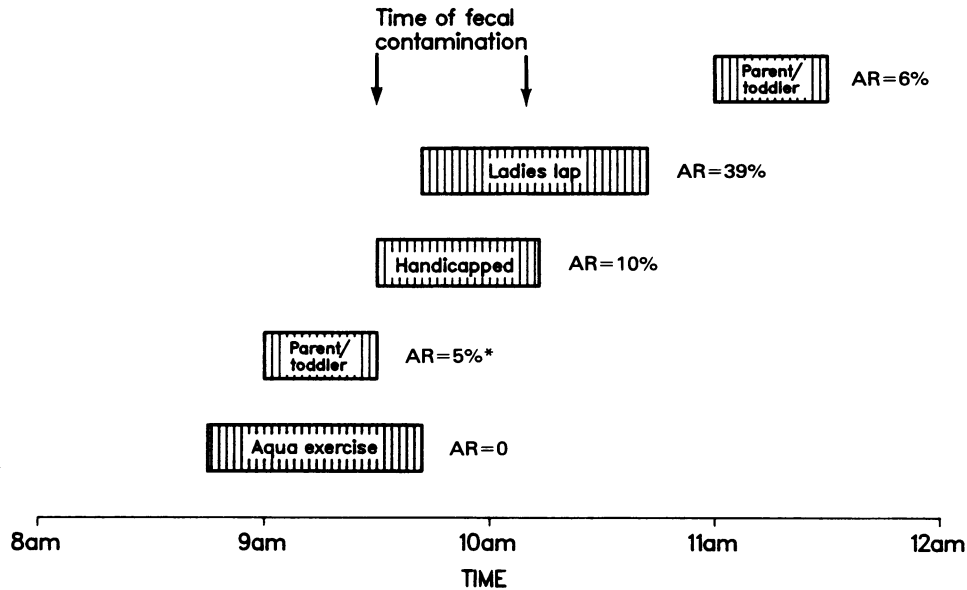
Inspection of the pool records from September 15–18 indicated a chlorine level of 0.4 mg/l on the 15th and 16th, no readings were taken on the 17th, and there was a zero reading on the 18th (Table 2). The pool management indicated that, upon finding a zero chlorine level, a search of the chlorination system revealed an empty chlorine storage container.

An inspection of the pool on November 11 found the filtration system to be functioning normally. Serial samples of the water from different areas of the pool showed zero coliform counts with standard bacterial plate counts of 1–2 per ml. These levels are considered within normal limits.

TABLE 1—Swimming Groups by Giardiasis Attack Rate, Swimming Pool Attendees, New Jersey 1985

Swim Groups	Date	Time	No. in Group	Cases/No. Interviewed	Attack Rate %	Stool pos/No. tested	Infection Rate %
Aqua Exercise	9/17	8:45–9:45	23	0/15	0	0/15	0
Parent/Toddler	9/17	9:00–9:30	24	1*/20	5	1/16	6
Handicapped	9/17	9:30–10:15	20	2**/20	10	9/20	45
Ladies Lap	9/17	9:45–10:45	16	5***/13	39	4/12	33
Parent/Toddler	9/17	11:00–11:30	24	1/16	6	4/16	25
Guppies	9/17	3:45–4:45	23	0/18	0	0/9	0
Mighty Mites	9/18	9:50–10:00	7	0/7	0	0/9	0
Seahorses	9/19	9:15–9:45	12	0/10	0	0/0	0

*Case was a swimming instructor who remained in the pool until 11:00 am.
 **One case was a swimming instructor.
 ***One case was treated prior to stool testing.



*Infected person stayed in pool until 11am.

FIGURE 2—Swimming Groups, by Time in Pool, Swimming Pool Giardiasis Outbreak, New Jersey, September 17, 1985

Discussion

The results of this study strongly suggest that *G. lamblia* infection was transmitted to swimmers exposed to swimming pool water that was contaminated after a fecal accident by a *Giardia* positive handicapped child. Our finding that adults in the ladies lap group, who had no other risk factors for *Giardia* infection, became ill after swimming, supports our contention that swimming pool water was the vehicle of infection. In addition, we showed that the adults (ladies lap group) increased their risk of illness if they dived into the water. We did not have data on whether these persons swallowed water, but it seems likely that persons diving would get water into their mouths more often than would less active swimmers.

A previous report of a swimming pool giardiasis outbreak in Washington State⁶ demonstrated occurrence among an infant/toddler class and their parents. There are similarities between the two outbreaks; both involved children and both reported evidence of low chlorine as possibly contributing to transmission. Although fecal accidents were reported in the Washington outbreak, a single accident was not epidemiologically linked to infection of swimmers, as in our investigation.

Giardia is known to be prevalent in institutions for the mentally retarded,² and a 45 per cent *Giardia* infection rate

among a handicapped class is not necessarily unusual. It is not possible to say how these children became infected, but it seems likely that the child who had the fecal accident on September 17 was already positive for *Giardia* when he entered the pool on that day. A high stool positivity rate for *Giardia* among the various child swim groups may reflect endemic infection in these groups and illustrates the increased hazard these children pose if they both swim and defecate in a community pool.

The environmental investigation of the pool showed that the chlorine level was not tested on the day of the fecal accident. By the following day, the chlorine level was zero and the storage container was empty indicating that the level of chlorine may well have been low on the day of the accident, thus contributing to transmission of *Giardia*. Filters do trap *Giardia* cysts and indeed this is how these cysts are prevented from entering municipal water systems. Rapid sand filters, as were found in this pool, are effective in the removal of *Giardia* cysts and trophozoites.⁷ An effective filter pore size of 5 µm or less will remove the *Giardia* in all life stages. However, the rate of filtration in the pool was such that it took six hours for a complete turnover of pool water. An adequate chlorine level was therefore important in ensuring a more rapid destruction of the cysts.

Giardia cysts are not killed immediately by chlorine,

TABLE 2—Pool Chlorine and pH Levels Swimming Pool Outbreak, New Jersey, 1985

Date September	9:00 am		12:00 noon		5:00 pm		9:00 pm	
	Chlorine mg/l	pH	Chlorine mg/l	pH	Chlorine mg/l	pH	Chlorine mg/l	pH
15	*NT	NT	NT	NT	0.4	7.7	NT	NT
16	NT	NT	NT	NT	NT	NT	0.4	7.4
17	NT	NT	NT	NT	NT	NT	NT	NT
18	NT	NT	0	7.5	0	7.7	0.8	7.4

*Not Tested

and, as previous waterborne outbreaks of *Giardia* have shown, they can be very resistant to chlorine.⁸ Chlorine efficacy against *Giardia* has been studied by researchers at the University of Oregon.⁸ The relation between the chlorine concentration (CONC) and contact time (TIME) required to kill *Giardia* cysts at 25C can be expressed by the formula: CONC (mg/l) multiplied by TIME (mins) = 15 (a constant). Therefore, at 25C with a chlorine content of 0.3 mg/l, 50 minutes (15/0.3) is required to destroy *Giardia* cysts. This method can be used by pool management to determine the minimum length of time a pool should be cleared following a fecal accident.

In the pool where the outbreak occurred, the temperature was kept at approximately 25C and minimal chlorine content was normally 0.3 mg/l; therefore, the pool should have been cleared for a minimum of 50 minutes following the fecal accident. However, the chlorine container was empty and the chlorine concentration was zero within 24 hours of the fecal accident. Thus an analysis of chlorine content of the pool should be made at the time of a fecal accident to assure that the time of pool evacuation calculated is adequate to protect swimmers from infection. To prevent this type of outbreak, regular testing of the pool chlorine level and proper maintenance of the filtration system are recommended.

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