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Shigellosis from Swimming in a Park Pond in Michigan

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Synopsis

In July 1989 an outbreak of shigellosis occurred among visitors to a recreational park in Oakland County, MI. An epidemiologic investigation discovered an association between illness and swimming in a pond at the park, especially for those who had put their head underwater. No other factors were epidemiologically incriminated. A total of 65 cases were identified; nine were culture confirmed, all Shigella sonnei.

Several water samples evaluated for fecal coliform counts shortly after the outbreak were found satisfactory. Cultures of water samples were negative for Shigella *species. Inspection of the park's sewage disposal and toilet facilities found all equipment in proper working condition and no evidence of a sewage contamination event from these potential sources. No other commercial or residential sources of potential sewage contamination existed near the pond.*

Investigators concluded that Shigella *contamination of the pond by a swimmer or swimmers on one or more occasions was a strong possibility. Factors supporting this conclusion included elevated incidence of* S. sonnei *in the community during the 2 months prior to the outbreak, greater use of the pond, warm water and air temperatures, and inadequate water exchange in the pond.*

This report adds one of the few documented outbreaks of shigellosis implicating bather contamination to the literature on the growing number of incidents that have been associated with recreational use of water.

ON JULY 14, 1989, infection control staff members at a hospital in Pontiac, MI, reported to the Oakland County Health Division the occurrence of several cases of acute gastroenteritis among patients and workers at an adolescent psychiatric facility affiliated with the hospital. The four stricken persons were part of a small group from the facility who had taken a field trip to a county park 3 days earlier. Three were seen in the emergency room and hospitalized; one was seen by a private physician.

Field trip activities had included a nature walk, lunch, and swimming in a pond at the park. Four other persons from the field trip group were not ill. There were no reports of gastroenteritis among other patients or staff members at the facility.

During the next two days, the county health division received additional reports of illness from persons who had visited the park. Meanwhile, a bacterial culture analysis of stool specimens from the three hospitalized children showed positive growth of *Shigella sonnei*.

Table 1. Frequency distribution of symptoms among 65 cases of shigellosis, Oakland County, MI

Symptom	Number	Percent
Watery diarrhea	64	98.5
Abdominal pain, cramp	54	83.1
Fever	53	81.5
Nausea	52	80.0
Vomiting	45	69.2
Chills	45	69.2
Bloody diarrhea	13	20.0

Table 2. Age distribution of case and control groups in shigellosis outbreak, Oakland County, MI

Age group (years)	Cases	Controls
0 to 4	16	5
5 to 9	24	7
10 to 14	10	5
15 to 19	2	2
20 to 24	0	0
25 to 29	4	0
30 to 34	5	5
35 to 39	2	6
40 to 44	0	1
Unknown	2	2
Total	65	33

Table 3. Exposure factors associated with illness in shigellosis outbreak, Oakland County, MI

Factor	Odds ratio	95 percent CI	P value
Swimming (more than wading)	11.43	2.62–57.17	<0.0001
Head underwater	12.43	3.73–43.48	<0.000005
More than 1 hour in water	4.97	1.69–14.89	<0.005

CI = Confidence interval.

A review of routine communicable disease surveillance data conducted several weeks before identified elevated rates of reported shigellosis cases in the central county area since the late spring of the same year.

Materials and Methods

Data collection. In Michigan, shigellosis must be reported to local public health authorities. In Oakland County, public health followup of reported cases includes assessment of sources of potential infection and education about prevention of secondary disease transmission. To evaluate possible factors in this outbreak, a supplementary questionnaire was developed to assess park use, illness, specific recreational activities, use of the restroom facilities, and consumption of food, beverage, and drinking water at the park. The questionnaire was added to the followup evaluation of all shigellosis cases reported since July 1, 1989. In any case that included visits to the park, family members who accompanied the ill person but did not become infected were also questioned. In addition, persons who telephoned in response to news media accounts of the outbreak to report they had been at the park were questioned by public health nurses and environmental health staff members.

Case definition. We defined a confirmed case as any person who visited the park between July 8 and July 16 and had a positive shigellosis stool culture within 7 days. We defined a presumptive case as any person who reported diarrhea and any abdominal pains, fever, nausea, or vomiting within 7 days of having been at the park between July 8 and July 16. Controls were defined as persons who went to the park in the same period and reported no illness.

Analysis. Confirmed and presumptive cases were compared with controls. Analysis was restricted to persons who were at the park on only one occasion during the study period. Persons who reported illness that did not meet the definition were excluded from analysis. Analysis was performed using the Epi Info software package (Version 3). Chi-square tests assessed the statistical significance of associations between illness and exposure factors.

Environmental sampling. Water samples from the swimming pond were collected daily from July 16 to July 24, inclusive, and analyzed for fecal coliforms (*1*). In addition, results of an analysis of routine water samples collected as part of a swimming beach water quality program were reviewed. Water samples were also collected for bacterial culture at two separate private laboratories.

Staff sanitarians conducted a physical site inspection of the sewage system and drinking wells serving the park facilities. The food service operation at the site was also inspected.

Results

Epidemiologic findings. During the investigation, 185 persons were interviewed, and 111 were identified as having been at the park on a single occasion between July 8 and July 14. Of the 111, 65 met the

study criteria for illness, 33 reported no illness, and 13 were excluded from analysis because of illness that did not fit the case definition. Of the 65 cases, 9 (14 percent) were culture confirmed (all *Shigella sonnei*). No other enteric pathogens were identified.

The most frequently reported dates of park attendance among the cases were July 8 and July 11 (fig. 1). Estimated attack rates based on total park attendance figures for these dates were 1.8 percent for July 8 and 2.3 percent for July 11. No other date in the study period had an attack rate of more than 0.3 percent. Onsets of illness ranged from July 8 to July 19 (fig. 2). The median incubation period was 2 days for both presumptive and confirmed cases. The duration of illness did not differ significantly between confirmed and presumptive cases. The median duration for all cases was 4 days. Frequencies of reported symptoms among the people stricken are given in table 1. Physician visits were reported in 18 cases (28 percent), and there were four hospitalizations.

The median age of those infected was 7 years (range 1 to 37), and it was significantly lower than that of people not infected (median age 12 years, $P = 0.05$). Fifty persons (77 percent) were younger than 15 (table 2). The male to female ratio of cases was 1.4:1.

Illness was significantly associated with immersion in the water beyond wading, spending more than 1 hour in the water, and putting one's head underwater (table 3). No association was demonstrated between illness and other activities at the park, including use of water fountains, foods purchased and eaten at the park concession stands, or use of park restrooms.

The analysis was unable to detect any association between illness and swimming activity in a particular area of the pond.

Figure 1. Cases of shigellosis by date of park attendance, Oakland County, MI

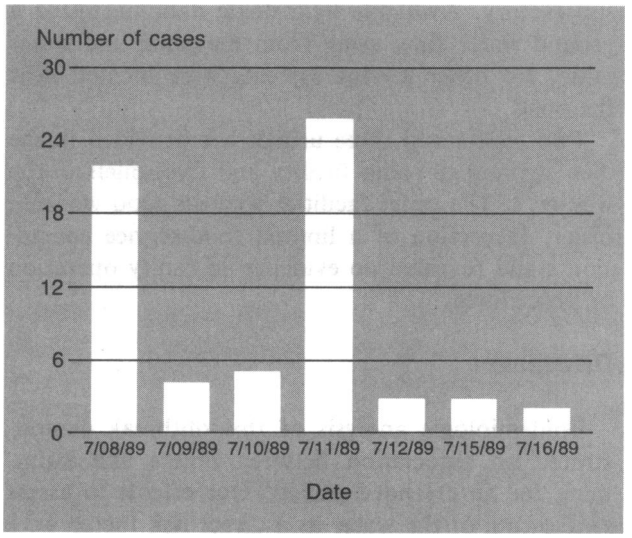
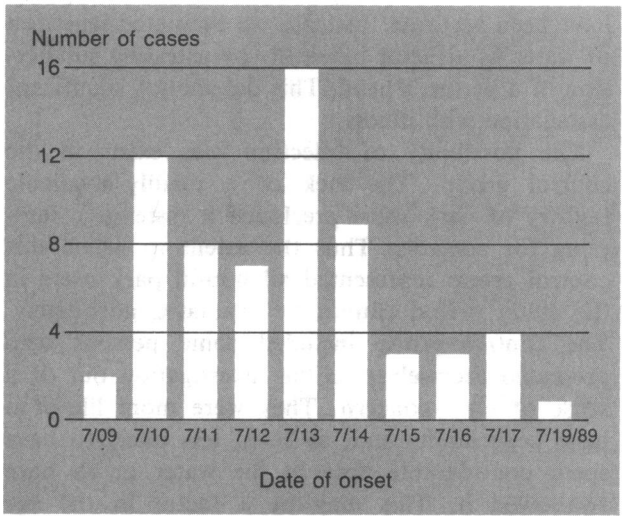


Figure 2. Epidemic curve—number of cases of shigellosis by date of onset, Oakland County, MI



Laboratory Findings

Fecal coliform tests. Between July 12 and July 24, a total of 30 pond water samples were obtained for coliform analysis. Three samples taken on July 12 were part of a routine program for monitoring the swimming beach, and all were less than 10 fecal coliforms per 100 milliliters (ml). All other samples were special, nonroutine samples taken between July 16 and July 24 in connection with the investigation. Samples were taken from a variety of locations in the pond, including the inlet and outlet areas. All samples registered less than 200 fecal coliforms per 100 ml, the Environmental Protection Agency standard. Drinking water samples from all park drinking fountains analyzed for fecal coliforms were satisfactory.

Microbiologic culture. Pond water samples taken by health division staff members on July 18 were sent to the county laboratory for bacterial culture. In addition, the park administration contracted with a private laboratory for analysis of 10 water samples taken on July 20 from a variety of pond locations and depths for presence of *Shigella* species. All water culture tests by both laboratories were negative.

Environmental investigation findings. An inspection of the onsite sewage disposal system revealed

no evidence or signs of failure. The system's distance from the pond and from drinking wells was satisfactory. Available hydrologic data suggested a ground water flow away from the pond and water table. No other sewage systems were located near the pond.

Two toilets and three urinals are provided in the men's changing room facility and five toilets in the women's. The toilet facilities were in good working order. Inspection of a limited food-service concession stand revealed no evidence of faulty operation or procedures.

Discussion

Epidemiologic analysis of this outbreak demonstrated an association between illness and swimming for an extended period. Our efforts to assess swallowing of the water as a direct risk factor were unsuccessful, because many of those in the study were young children who were unable to respond to such a question, and parents' responses may not have been accurate. Instead, we evaluated ingestion of water as a factor indirectly by assessing submersion of a person's head. This did show a significant association with illness.

The possibility of selection bias exists in the control group. The lack of a readily available registry of park users precluded a systematic sampling for controls. Thus the extent to which this control group represented all non-ill park users in the study period cannot be evaluated adequately. The control group included some persons who presented themselves to the investigation out of a sense of civic concern. They were more likely to have been adults and, as such, less likely to have spent considerable time in the water or to have swallowed it. This may be a factor in the age disparity between infected persons and members of the control group.

However, relatively few control group members were obtained in this manner. The majority were family members of stricken persons who attended the park with those infected but did not become infected themselves. Moreover, a further analysis of the association between a person's head being placed underwater and illness stratified by age (dichotomized to younger than 12 and older than 12) did not support age as a confounding variable (summary Mantel Haenzel weighted odds ratio = 9.94, 95 percent confidence interval = 3.13-39.03, $P = 0.00002$).

The negative fecal coliform and culture tests for pond water samples cannot be taken as definitive evidence of a lack of contamination. Although commonly used as a standard monitoring index of water quality, the validity of such fecal coliform guidelines has not been supported by epidemiologic data in examining the risk of gastrointestinal illness, and more sensitive indicator systems have been proposed (*2*). In addition, the water samples evaluated do not necessarily judge the water quality at the time of exposure, as is commonly the case in such investigations. Only three of the samples obtained were taken during the period of the outbreak.

These findings, viewed in the absence of physical or epidemiologic implications of food or drinking water, suggest the possibility of fecal contamination of the pond water. Further, the absence of any findings of a sewage disposal system failure or other sources of external fecal pollution suggests that the source of such contamination may have been a swimmer or swimmers. The fact that illness occurred following separate exposures on different dates implies either ongoing or multiple contaminations or persistence of viable organisms in the water. Not surprisingly, our investigation did not identify an occurrence of fecal contamination of the pond during the outbreak period by anyone known to be infected with shigellosis. Several factors suggest an increased potential for such an occurrence around the time of the outbreak, however.

In the late spring, about 8 weeks before this outbreak, an elevated rate of shigellosis (relative to endemic reported levels in comparable periods of previous years) was noted in the course of routine disease surveillance. Figure 3 compares reported shigellosis incidence for the first 6 months of 1989 with comparable periods of previous years. The vast majority of these cases in the first half of 1989 occurred in persons who lived within a 10-mile radius of the park. A point source was not found in connection with those shigellosis cases. Epidemiologic investigation suggested secondary transmission, largely centered among young children in diapers and their families, extended families, and day care settings.

The park and swimming pond are popular among area residents, and it is likely that persons from the area where the elevated shigellosis rates were reported used the facility. In addition, the park and swimming pond also were used by a number of youngsters attending day camps and organized activity groups on a regular daily basis during the summer months. Hotter weather during the second week of July resulted in higher attendance in the park and at the pond.

If indeed the pond was contaminated fecally by a swimmer, characteristics of the pond and its usage patterns may have facilitated infection of others. The rate of freshwater infusion and exchange in the pond was less than optimal. The pond has a single inlet and a single outlet. At the time of the outbreak, the water entering through the inlet depended solely on a gravity feed system from a larger nearby lake. Thus a primary factor in the infusion rate was the water level of the larger lake. The pond covers approximately 3 acres. Under normal climatic conditions the gravity feed system is estimated to have a flow rate of 15–20 gallons per minute. This correlates to an exchange of from 21,600 to 28,800 gallons per day, or less than 1 percent of the pond volume.

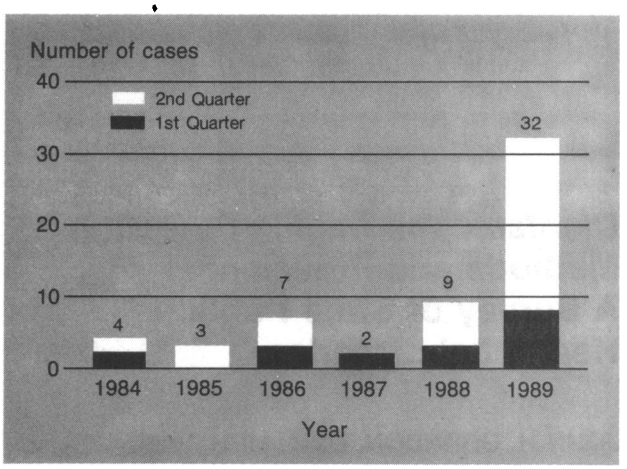
During the week of the outbreak, the hotter air temperatures may have resulted in lower lake levels, which in turn would reduce the water exchange in the swimming pond. Between July 4 and July 16 the median afternoon water temperature was 83 degrees Fahrenheit, ranging from 76 degrees on July 16 to 86 degrees on July 8.

Studies have demonstrated that low doses of *Shigella* bacteria can result in infection, indicating ingestion of as few as 10 organisms may cause illness (*3*). Other studies have shown *Shigella* organisms may remain viable in water at room temperature for up to 6 months (*4*).

Waterborne outbreaks of shigellosis historically have occurred more often as a result of contaminated drinking water sources than through recreational water use (*5–8*). However, some outbreaks due to recreational use of water have been documented. A recent outbreak in Los Angeles affected 68 persons and was associated with swimming in a manmade lake. Investigation suggested direct contamination by swimmers (*9*). A shigellosis outbreak in Oklahoma associated with swimming at a lake reservoir also may have been the result of defecation by a swimmer or swimmers (*10*), while an outbreak among swimmers in the Mississippi River in Dubuque, IA, was probably a result of a sewage treatment plant effluent discharged upstream (*11*).

Several control measures were instituted in the course of investigating this outbreak. On the advice of public health investigators, the park administrators closed the beach for 3 days. A larger pump with a capacity of 500 gallons per minute was installed to improve water exchange. When the pond was reopened for swimming, advisories were posted with specific guidelines for swimmers to follow to help in preventing fecal contamination of the pond. These advisories were also posted at other public swimming areas throughout the county. Press releases were sent to the local news media to inform area residents of the investigation, findings, and recommendations.

Figure 3. Comparison of reported shigellosis incidence in first 6 months of 1989 with previous years, Oakland County, MI



The outbreak described in this report adds to a small but growing body of documentation in the literature of *Shigella* infections contracted through recreational use of water. In addition, it echoes and supports previous calls for attention to the need for recreational water quality monitoring systems that better correlate to the true risk of illness. Further, it emphasizes the need for identifying practical ways to minimize the possibility of swimmer contamination in small freshwater areas.

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Dientamoeba fragilis Detection Methods and Prevalence: A Survey of State Public Health Laboratories

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Synopsis

Dientamoeba fragilis *is a pathogenic protozoan parasite that has no cyst stage. Because of the lack of a cyst stage, the laboratory detection of* D. fragilis *in stool specimens is dependent on the stool processing and examination methods employed. Failure to use recommended stool fixation and permanent staining techniques almost precludes identification of* D. fragilis, *which is associated with gastrointestinal illness in humans.*

In this survey, questionnaires were mailed to all State and territorial public health laboratories requesting information on the number of ova and parasite examinations, methods of processing and examining stools, and the number of D. fragilis *positive stools for 1985. Forty-three of 54 (80 percent) laboratories responded. Results showed that those laboratories which reported* D. fragilis *detection examined more stools using recommended stool fixation methods and were more likely to stain permanently all stools examined. Permanent staining of all stools, as compared to loose and watery stools only, resulted in a fivefold greater detection of* D. fragilis.

More State and territorial public health laboratories reported finding D. fragilis *infections in 1985 than in a 1978 survey performed by the Centers for Disease Control. However, in 1985 only six laboratories reported 82 percent of all* D. fragilis *detections. To increase the probability of detecting* D. fragilis *in stool specimens, the findings suggest that all stools should be submitted fixed in polyvinyl alcohol fixative, sodium acetate-acetic acid-formalin fixative, or Schaudinn's fixative. Further, all specimens, regardless of consistency, should be permanently stained prior to microscopic examination.*

THE DIAGNOSIS of most intestinal protozoan infections by stool examination requires the detection and identification of cysts or trophozoites. Cysts may survive days to weeks outside of the host, whereas trophozoites degenerate rapidly preventing accurate identification (*1-3*). Certain stool fixation methods, when combined with permanent staining, greatly enhance protozoan detection, especially trophozoites (*3-8*).

Dientamoeba fragilis, a flagellate protozoan with no cyst stage, exists only as trophozoites (*9,10*). Optimal conditions for *D. fragilis* identification require permanently stained preparations of fixed or freshly passed unpreserved stool specimens. Stool fixatives differ in their ability to maintain *D. fragilis* morphology prior to permanent staining and microscopic examination. Stools fixed in polyvinyl alcohol (PVA) fixative, sodium acetate-acetic acid-formalin (SAF) fixative, or Schaudinn's fixative, and fresh stools can be permanently stained, while formalin-fixed stools cannot (*11*). Therefore, PVA, SAF, and Schaudinn's are the preferred fixatives when combined with permanent staining for detection of *D. fragilis*.