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Waterborne Disease Outbreaks, 1986-1988

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Summary

From 1986 to 1988, 24 states and Puerto Rico reported 50 outbreaks of illness due to water that people intended to drink, affecting 25,846 persons. The protozoal parasite Giardia lamblia *was the agent most commonly implicated in outbreaks, as it has been for the last 10 years; many of these outbreaks were associated with ingestion of chlorinated but unfiltered surface water.* Shigella sonnei *was the most commonly implicated bacterial pathogen; in outbreaks caused by this pathogen, water supplies were found to be contaminated with human waste.* Cryptosporidium *contamination of a chlorinated, filtered public water supply caused the largest outbreak during this period, affecting an estimated 13,000 persons. A large multistate outbreak caused by commercially produced ice made from contaminated well water caused illness with Norwalk-like virus among an estimated 5,000 persons. The first reported outbreak of chronic diarrhea of unknown cause associated with drinking untreated well water occurred in 1987. Twenty-six outbreaks due to recreational water use were also reported, including outbreaks of* Pseudomonas *dermatitis associated with the use of hot tubs or whirlpools, and swimming-associated shigellosis, giardiasis, and viral illness. Although the total number of reported water-related outbreaks has been declining in recent years, the few large outbreaks due to* Cryptosporidium, *Norwalk-like agent,* Shigella sonnei, *and* Giardia lamblia *caused more cases of illness in 1987 than have been reported to the Water-Related Disease Outbreak Surveillance System for any other year since CDC and the Environmental Protection Agency began tabulating these data in 1971.*

INTRODUCTION

Since 1971, CDC—in collaboration with the Environmental Protection Agency (EPA)—has tabulated data on waterborne-disease outbreaks separately from those for foodborne-disease outbreaks and has compiled these data in annual surveillance reports. The Water-Related Diseases Activity has the following goals: 1) to determine trends in the incidence of water-related diseases in the United States, 2) to characterize the epidemiology of water-related diseases, 3) to disseminate information on prevention and control of water-related diseases to appropriate public health personnel, 4) to train personnel in federal, state, and local health departments in epidemiologic techniques used in the investigation of water-related disease outbreaks, and 5) to collaborate with local, state, and other federal and international agencies in initiatives concerning the prevention of water-related diseases.

In addition to outbreaks associated with water intended for drinking, the Water-Related Disease Surveillance Report cites reports of 1) outbreaks of illness associated with exposure to recreational water and 2) epidemiologic investigation of outbreaks of gastroenteritis on ocean-going passenger vessels that call on U.S. ports.

METHODS

Definition of Terms

A waterborne disease outbreak is an incident in which 1) two or more persons experience a similar illness after consumption or use of water intended for drinking and 2) epidemiologic evidence implicates the water as the source of illness. In addition, a single case of chemical poisoning constitutes an outbreak if laboratory studies indicate that the water has been contaminated by the chemical. Only outbreaks associated with water intended for drinking are included.

Community public water systems (municipal systems) are defined as public or investor-owned water systems that serve large or small communities, subdivisions, or trailer parks with at least 15 service connections or 25 year-round residents. Noncommunity public water systems (semipublic water systems) are those of institutions, industries, camps, parks, hotels, or service stations that may be used by the general public. Individual systems (private water systems), which are generally wells and springs, are those used by one or several residences or by persons traveling outside populated areas. These definitions correspond to those in the Safe Drinking Water Act (Public Law 93-523) of 1974.

Disease outbreaks associated with water used for recreational purposes meet the same criteria used for waterborne outbreaks associated with drinking water. However, outbreaks associated with recreational water involve exposure to or unintentional ingestion of fresh or marine water, but they exclude wound infections caused by water-related organisms.

Sources of Data

State health departments report water-related disease outbreaks to CDC on a standard reporting form. In addition, the Health Effects Research Laboratory of EPA contacts all state water-supply agencies annually to obtain information about waterborne disease outbreaks. This report includes information from both sources. Representatives from CDC and EPA review and summarize outbreak data and also work together to investigate and evaluate waterborne disease outbreaks. Also, on request by state health departments, CDC and EPA offer epidemiologic assistance, provide consultation in the engineering and environmental aspects of water treatment, and, when indicated, collect large-volume water samples to identify viruses, parasites, and bacterial pathogens.

In an effort to increase reporting, CDC sent a letter in January 1989 to all state and territorial epidemiologists and laboratory directors requesting any additional reports of outbreaks investigated during the 3-year period 1986 to 1988. States not responding or reporting any outbreak during this period were contacted again by telephone.

Vessel masters of passenger cruise ships must report all persons who visited the ship's physician because of diarrheal illness during each voyage as a part of their request for permission to enter a port. If ≥3% of passengers visit the ship's physician

with gastrointestinal illness on a 1-week voyage, a quarantine officer will board and inspect the ship, and an epidemiologic investigation may be conducted.

Interpretation of the data

Data in this report should be interpreted with caution. The number of waterborne disease outbreaks reported to CDC and EPA represents a fraction of the total number that occur. Since investigations were sometimes incomplete or conducted long after the outbreak, the quality of epidemiologic evidence implicating water varied; however, the waterborne hypothesis was the most logical explanation in these outbreaks. The likelihood of an outbreak's coming to the attention of health authorities varies considerably from one locale to another and depends largely upon consumer awareness, physician interest, and disease surveillance activities of state and local health and environmental agencies. Large interstate outbreaks and outbreaks of serious illness are most likely to come to the attention of health authorities. The quality of investigation conducted by state or local health departments varies considerably according to the department's interest in waterborne diseases and its budgetary, investigative, and laboratory resources. Additionally, a few outbreaks involving large numbers of persons may vastly alter the relative proportion of cases attributed to various etiologic agents. Therefore, this report should not be used to draw firm conclusions about the true incidence of waterborne disease outbreaks, or about the relative incidence of waterborne diseases of various etiologies.

RESULTS

For the 3-year period 1986-1988, state and local health departments reported 50 outbreaks due to water that people intended to drink, causing illness in 25,846 persons. Twenty-two outbreaks were reported in 1986, 15 in 1987, and 13 in 1988. The individual outbreaks are listed by year in Tables 1-3. Each outbreak is summarized by agent and type of water system (Table 4). Outbreaks occurred in all months except December; 26% occurred in July (Figure 1).

Each of 24 states and Puerto Rico reported at least one outbreak during this period. Thirty-four percent of outbreaks were reported from three states: Pennsylvania (7), Colorado (6), and Vermont (4).

Giardia lamblia was identified as the causative agent in nine (18%) outbreaks, eight of which were associated with deficiencies in community water systems. Six of these outbreaks were associated with unfiltered surface water systems in which the only treatment was chlorination. The largest *Giardia* outbreak reported to CDC affected >500 people; increased turbidity of the water and improper operation of the chlorinator may have contributed. *Cryptosporidium* in a chlorinated and filtered water supply caused one large parasitic disease outbreak (*1*). *Shigella sonnei* was the most common bacterial agent, implicated in four outbreaks. The largest of these was associated with contamination of a reservoir after heavy rains and loss of electricity. Thirty persons were hospitalized among the estimated 1,800 who became ill. One outbreak of gastroenteritis due to *Salmonella newport* and other species of *Salmonella* was caused by improper placement of a sewer line, possibly contaminating untreated well water. Another *Salmonella*-related outbreak was caused by ingestion of water from a storage tank that had possibly been contaminated by irrigation water; the one patient's isolate serotyped was identified as *S. dublin*. One *Campylobacter*-related outbreak occurred and was possibly caused by contamination of water mains

through a cross-connection. Norwalk-like viral agents were detected serologically or by identification of Norwalk antigen in stool in three outbreaks (*2,3*). In 24 of the 50 outbreaks, the etiology of acute gastrointestinal illness (AGI) could not be determined. Also reported was an outbreak of chronic gastrointestinal illness (CGI) of unknown etiology; the outbreak was associated with drinking untreated ground water at a rural restaurant (*4*).

The 1987 listing includes one multistate outbreak of Norwalk-like viral gastroenteritis due to contaminated ice (*2*). At least four clusters of illness were traced to ice produced by a manufacturer in Pennsylvania, including illness following a university football game in Pennsylvania, a museum fund-raising event in Delaware, and at least two catered events. Water used to make the ice originated in wells that had been flooded by a creek during heavy rains in early September; high concentrations of fecal coliforms were found in both the ice and well water. The ice (60-300 tons), produced the week after the flood and distributed to Pennsylvania, Delaware, and New Jersey, may have caused illness in >5,000 people; this estimate is based on distribution records and on the attack rates found in the Pennsylvania investigations. Residents with private wells flooded by the same creek were also thought to have been affected. The manufacturer recalled the remaining ice.

Five outbreaks were attributed to chemical intoxications. One was caused by back-siphoning of sodium hydroxide into a public water supply. Patients seen in emergency rooms had mouth ulcers, dermatitis, and first-degree skin burns. At several homes, the tap water had a pH of 12. Another outbreak due to an alkaline community water supply (pH 8.5-11) caused malaise, headaches, and dry, cracking, pruritic skin. Large amounts of soda ash and lime had been used to soften the water, without subsequent adjustment of the pH. Hyperfluoridation of a water supply resulted in illness characterized by nausea, vomiting, diarrhea, abdominal cramps, and pruritus. The pH of the water was 3.1, and copper levels were elevated because of the effects of acidity on the copper pipes. Ethylene-glycol contamination of a public water supply due to a cross-connection with a heating system also caused an outbreak (*5*). Symptoms included excessive fatigue, sleepiness, unsteadiness when walking, and dizziness. Water from the spigot had an ethylene-glycol concentration of 9%. One fatal case of methemoglobinemia was reported, involving an infant who was fed powdered formula; the formula had been prepared with well water contaminated with nitrates (*6*).

Pathogens reportedly were isolated from water samples during the investigation of five outbreaks: *Giardia* cysts in three, *Cryptosporidium* oocysts in one, and *Salmonella* in one. Coliform organisms were detected during the investigation of water systems in 32 outbreaks; in four outbreaks, coliforms were not detected. In the remaining investigations of outbreaks, no information was reported concerning testing of water for coliforms.

Most reported outbreaks were associated with community and noncommunity public water systems, as has been the case for most years since 1971 (Table 5). Deficiencies in water treatment were identified in 23 (46%) outbreaks, and untreated ground water was implicated in 16 (32%) (Table 6). Well water was the most common source of outbreaks, accounting for 28 (56%) over the 3-year period.

Data on 26 outbreaks associated with recreational water use for the period 1986-1988 are shown in Table 7. The most common illness was *Pseudomonas* dermatitis; all 10 of these outbreaks were associated with use of whirlpools or hot

tubs. The two outbreaks of giardiasis were associated with swimming in pools; three outbreaks of shigellosis affected persons swimming in lakes; and one outbreak in which a Norwalk-like agent was confirmed also affected persons swimming in a lake. Four other swimming-related outbreaks of AGI were of unknown etiology. One outbreak of aseptic meningitis involved four persons who swam in a family pool filled with unchlorinated water from a nearby creek. An outbreak of a febrile enterovirus-like illness was associated with swimming in an inadequately chlorinated wading pool (*7*). Pontiac fever affected 14 persons who had used a hotel whirlpool; symptoms were fever, shortness of breath, chest pain, myalgia, and joint pain. Six of eight patients tested had elevated antibodies to *Legionella pneumophila* serogroup 6. An outbreak of leptospirosis among persons swimming in a stream was reported from Hawaii.

Since the previous surveillance summary was published (1988) (*8*), we have obtained 10 additional reports from previous years: one from 1983, two from 1984, and seven from 1985. One of the 10 was associated with recreational water use. These outbreaks are included in Table 8, and those associated with water used for drinking are included in Table 5.

From 1986 to 1988, CDC personnel investigated 10 outbreaks of diarrheal illness on cruise ships calling on U.S. ports. Three were investigated in 1986, two in 1987, and five in 1988. The mean size of the outbreak was 323 passengers (range 112-477). One ship had outbreaks on two consecutive 1-week cruises (*9*). Norwalk-like agents were identified as the cause of two outbreaks. No specific pathogens were identified in the eight others, but many had features consistent with Norwalk-like viral illness. Two outbreaks were possibly associated with meals served on board; in one, a "marinated calamari and vegetable julienne" dish was suspect. The ship's water was the probable vehicle in one outbreak. Illness on two cruises was possibly caused by food or water consumed offshore.

DISCUSSION

The number of reported outbreaks associated with water intended for drinking was the same in 1986 as in the previous year, although the number was smaller in 1987 and 1988. The number of outbreaks reported in 1988 was the smallest ever reported to the Waterborne Outbreak Surveillance System. Additional outbreaks for these years may be reported to CDC after this summary is published.

The decrease in reported outbreaks may be due to an actual decrease in number of occurrences or to a decrease in the recognition or reporting of outbreaks. At the Workshop on Methods for Investigation of Waterborne Disease Outbreaks in Denver in October 1988, representatives from many state health departments, departments of natural and environmental resources, CDC, and EPA addressed this issue. The participants made recommendations to improve reporting; these recommendations include designating Waterborne Outbreak Surveillance Coordinators in each state, at CDC, and at EPA to assist with the gathering and reporting of data on waterborne outbreaks (*10-12*).

Despite the smaller number of outbreaks reported in recent years, some individual outbreaks were large. As a result, more cases of water-related illness were reported in 1987 than in any other year since CDC and EPA began tabulating these data in 1971. The number of cases reported in 1988 was also larger than in 3 of the 4 previous

years. Several large outbreaks due to *Cryptosporidium*, Norwalk-like viruses, *Shigella sonnei*, and *Giardia lamblia* are responsible for this reported increase in the total number of ill persons.

The cryptosporidiosis outbreak that occurred in Georgia in 1987 was the largest outbreak ever reported to the Waterborne Outbreak Surveillance system. An estimated 13,000 people became ill with gastroenteritis after consuming water from a filtered, chlorinated public water supply (*1*). *Cryptosporidium* oocysts were isolated from patients' stool specimens and from samples of treated public water. Unlike a previously reported cryptosporidiosis outbreak associated with intermittent contamination of a water supply (*13*), this water system met current state and federal drinking water standards. These standards may not be sufficient to prevent outbreaks due to this pathogen; the investigation showed that although treated water met turbidity standards, filters allowed passage of particulate matter likely accompanied by oocysts. Recommended improvements in chemical flocculation and filtration practices resulted in clearance of oocysts from the water.

The outbreak of Norwalk-like viral gastroenteritis associated with commercially manufactured ice in 1987 (*2*) demonstrates the potential for large outbreaks when a commercial product becomes contaminated; this potential applies to water and ice as well as to food. Production of commercial ice, like bottled water, is not consistently monitored by state or federal agencies.

Shigella sonnei was the bacterial agent most commonly associated with waterborne outbreaks for the period 1986-1988, causing four outbreaks with 2,733 persons ill. Each of the drinking water outbreaks was associated with deficiencies in water supplies, leading to contamination with human waste. Large outbreaks of shigellosis can lead to secondary transmission in day-care centers, temporary encampments, and other settings.

Giardia was the agent most commonly implicated in outbreaks, as it has been for the last 10 years. Filtration is necessary to remove *Giardia* from water; chlorination alone is insufficient without high concentrations and long contact times (*14,15*). To prevent waterborne transmission of *Giardia* and other infectious agents, EPA has prepared criteria for filtration and disinfection of all public water systems using surface-water sources (*16,17*).

The first reported outbreak of chronic diarrhea associated with drinking untreated well water occurred in 1987 (*4*). This outbreak was listed as CGI. Patients with CGI during this outbreak had diarrhea of unknown cause lasting ≥4 weeks. Examination of stools did not detect pathogenic viruses, bacteria, or parasites. Patients had clinical and pathologic characteristics similar to those of patients in an outbreak associated with drinking raw milk that occurred in Brainerd, Minnesota, in 1984 and 1985 (*18*); the term "Brainerd diarrhea" has been used to describe this illness. Because the disease can be debilitating and the cause is unknown, rapid identification, investigation, and control of outbreaks of chronic diarrhea are particularly important.

Outbreaks of AGI of unknown etiology accounted for 48% of all outbreaks reported. Incubation period, duration of illness, and symptoms for many of the outbreaks suggest that they were caused by 27-nanometer Norwalk-like viruses. In four outbreaks in which patients were culture-negative for common bacterial pathogens, fewer than 50% of the patients vomited, and the mean or median duration of illness was ≥4 days; these outbreaks may have been due to *Escherichia coli*. Increased

availability of testing for viral serology, detection of viral antigen in stool, and identification of *E. coli* toxins would aid in determining the causes of these outbreaks.

Swimming-associated outbreaks due to *Shigella, Giardia,* Norwalk-like viruses, and other enteroviruses continue to occur; outbreaks due to unintentional ingestion of these pathogens during swimming have now been well documented (*7,19-26*). Provision of temporary toilet facilities to adequately serve summer crowds is the single measure most likely to prevent such outbreaks. EPA has published guidelines for evaluating the quality of recreational waters (*27,28*).

Outbreaks of *Pseudomonas* dermatitis associated with use of hot tubs, whirlpool baths, and swimming pools are preventable if the water is maintained at a pH of 7.2-7.8 with free residual chlorine levels of at least 1.0 mg/L (*29*). Pontiac fever due to aerosolized antigens of *Legionella pneumophila* is another risk of whirlpool use (*30,31*). CDC health and safety guidelines for public spas and hot tubs are available (*32*).

Large outbreaks aboard passenger cruise ships continue to occur, although less often than in the past, demonstrating the importance of diarrheal disease surveillance and the Vessel Sanitation Program (*33,34*).

Illnesses reported by the Waterborne Outbreak Surveillance System probably represent only a small proportion of all illness associated with waterborne-disease agents, not only because of underreporting, but also because many sporadic cases occur. An association of sporadic cases of giardiasis with use of unfiltered municipal or nonmunicipal water has been demonstrated (*35*), as has an association of sporadic cryptosporidiosis with ingestion of untreated surface water (*36*). Illnesses occurring after years of chronic exposure to low-level toxins are not detectable by this system, nor are outbreaks or sporadic illnesses due to opportunistic pathogens that may be widespread in chlorinated water systems but may cause illness with insidious onset and long incubation periods in persons who are immunocompromised (*37,38*).

Despite these limitations, the data summarize reported waterborne disease outbreaks, identifying disease agents, types of water systems involved, and associated deficiencies. Monitoring these patterns is important because new diseases, such as cryptosporidiosis and Brainerd chronic diarrhea, can emerge, possibly requiring new means of control. Maintaining the capabilities of local and state health departments to investigate outbreaks and to identify their causes remains important in controlling and preventing outbreaks of waterborne disease.

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TABLE 1. Waterborne disease outbreaks, United States, 1986*

State	Month	Etiologic agent†	No. cases	Type of system§	Deficiency¶	Location of outbreak	Source
AL	Jul.	*Shigella sonnei*	25	Com	2	Trailer Park	
AL	Oct.	Sodium hydroxide	11	Com	4		
CA	Apr.	*Giardia*	127	Com	4	Corrections facility	
CO	Jun.	AGI	90	NC	2	Camp	Well
CO	Aug.	*Giardia*	23	NC	3	Resort	Well
CT	Mar.	Flouride-copper	52	Com	3	Community	
ME	Nov.	*Giardia*	12	Com	3	Community	River
MS	Aug.	*Salmonella*, mixed	9	Com	2	Community	Well
NM	Jun.	AGI	36	NC	3	Resort	River
NM	Jun.	AGI	233	NC	3	Camp	Spring
NY	Nov.	*Giardia*	44	Com	3	Community	Lake
OK	May	*Campylobacter*	250	Com	4	Community	Lake
PA	Sep.	AGI	213	NC	3	Restaurant	Well
SD	Jun.	Nitrate	1	Ind	2	Farm	Well**
SD	Aug.	Norwalk	135	NC	3	Camp	Well
TX	Jul.	*Shigella sonnei*	8	Ind	2	Private home	Well
UT	Jun.	*Salmonella*	61	Com	4	Community	Well
VA	Jul.	AGI	110	NC	3	Camp	Well
VT	Jan.	*Giardia*	68	Com	3	Trailer Park	River
VT	Feb.	AGI	37	NC	3	Motel	Well
VT	Mar.	AGI	8	NC	3	Motel††	Well
WY	Jul.	AGI	16	NC	3	Camp	Infiltration gallery

*See Methods section for description of reporting variables.
†AGI = acute gastrointestinal illness of unknown etiology.
§Com = community (municipal); NC = noncommunity (semipublic); Ind = individual.
¶2 = untreated ground water, 3 = treatment deficiencies, 4 = distribution system deficiencies.
**Resulted in death.
††Same motel as above.

TABLE 2. Waterborne disease outbreaks, United States, 1987*

State	Month	Etiologic agent†	No. cases	Type of system§	Deficiency¶	Location of outbreak	Source
CT	Jul.	*Giardia*	120	Com	4	Community	Well
GA	Jan.	*Cryptosporidium*	13,000	Com	3	Community	River
IL	Jul.	CGI	72	NC	2	Restaurant	Well
ME	Sep.	AGI	9	NC	2	Resort	Well
ND	Apr.	Ethylene glycol	29	Com	4	Firehall	
NH	Jul.	AGI	71	NC	1	Camp	Lake
PA	Apr.	*Giardia*	513	Com	3	Community	River
PA	Jul.	AGI	53	NC	5	Resort	Well
PA	Aug	AGI	22	NC	2	Camp	Well
PA	Sep.	AGI	?	Ind	2	Individual homes	Wells
PR	Jul.	AGI	1,400	Com	3	Community	Lake
PR	Oct.	*Shigella sonnei*	1,800	Com	3	Community	Lake
VT	Jul.	AGI	21	Com	2	Trailer park	Well
WI	Mar.	AGI	39	Com	5	Restaurant	
**	Sep.	Norwalk-like	5,000	NC	3	Multiple	Well††

*See Methods section for description of reporting variables.
†AGI = acute gastrointestinal illness of unknown etiology; CGI = chronic gastrointestinal illness of unknown etiology.
§Com = community (municipal); NC = noncommunity (semipublic); Ind = individual.
¶1 = untreated surface water, 2 = untreated ground water, 3 = treatment deficiencies, 4 = distribution system deficiencies, 5 = miscellaneous.
**Multiple states: Pennsylvania, Delaware, New Jersey.
††Ice from contaminated well water.

TABLE 3. Waterborne disease outbreaks, United States, 1988*

State	Month	Etiologic agent†	No. cases	Type of system§	Deficiency¶	Location of outbreak	Source
CO	Feb.	*Giardia*	90	Com	3	Resort	River
CO	Apr.	Alkaline water	10	Com	3	Community	Lake
CO	Jul.	AGI	80	NC	3	Resort	Well
CO	Nov.	AGI	7	Com	1	Community	Stream
ID	Jun.	Norwalk-like	339	NC	2	Camp	Well
ME	Nov.	AGI	7	NC	2	Restaurant	Well
MO	Mar.	AGI	85	Ind	2	Private home	Well
MO	Aug.	AGI	30	NC	2	Golf course	Well
PA	Jul.	*Giardia*	172	Com	3	Community	Lake
PA	Sep.	AGI	26	NC	2	Camp	Well
SD	Jul.	AGI	42	NC	3	Hotel	Well
TX	May	*Shigella sonnei*	900	NC	3	Restaurant	Well
WI	May	AGI	340	NC	2	Restaurant	Well

*See Methods section for description of reporting variables.
†AGI = acute gastrointestinal illness of unknown etiology.
§Com = community (municipal); NC = noncommunity (semipublic); Ind = individual.
¶1 = untreated surface water, 2 = untreated ground water, 3 = treatment deficiencies.

TABLE 4. Waterborne disease outbreaks, by etiologic agent and type of water system, United States, 1986-1988

	Type of water system							
	Public				Individual		Total	
	Community		Noncommunity					
Agent	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
AGI*	4	1,467	18	1,423	2	85	24	2,975
Giardia	8	1,146	1	123	0	0	9	1,169
Chemical	4	102	0	0	1	1	5	103
Shigella	2	1,825	1	900	1	8	4	2,733
Norwalk	0	0	3	5,474	0	0	3	5,474
Salmonella	2	70	0	0	0	0	2	70
Campylobacter	1	250	0	0	0	0	1	250
Cryptosporidium	1	13,000	0	0	0	0	1	13,000
CGI	0	0	1	72	0	0	1	72
TOTAL	22	17,860	24	7,892	4	94	50	25,846

*AGI = acute gastrointestinal illness of unknown etiology; CGI = chronic gastrointestinal illness of unknown etiology.

TABLE 5. Waterborne disease outbreaks, by year and type of water supply system, United States, 1971-1988*

Year	Community	Noncommunity	Individual	Total	Total cases
1971	8	8	4	20	5,184
1972	9	19	2	30	1,650
1973	6	16	3	25	1,762
1974	11	9	5	25	8,356
1975	6	16	2	24	10,879
1976	9	23	3	35	5,068
1977	14	18	2	34	3,860
1978	10	19	3	32	11,435
1979	24	13	8	45	9,841
1980	26	20	7	53	20,045
1981	14	18	4	36	4,537
1982	26	15	3	44	3,588
1983	30	9	4	43	21,036
1984	12	5	10	27	1,800
1985	7	14	1	22	1,946
1986	10	10	2	22	1,569
1987	8	6	1	15	22,149
1988	4	8	1	13	2,128
TOTAL (%)	234 (43)	246 (45)	65 (12)	545	136,833

*See Methods section for description of reporting variables.

TABLE 6. Deficiencies leading to waterborne disease outbreaks, by type of water system involved and by type of deficiency, United States, 1986-1988

Type of deficiency	Type of water system: Public: Community Outbreaks	Type of water system: Public: Noncommunity Outbreaks	Type of water system: Individual: Outbreaks	Total
Untreated surface water	1	1	0	2
Untreated ground water	3	9	4	16
Treatment	11	12	0	23
Distribution system	6	0	0	6
Miscellaneous	1	2	0	3

TABLE 7. Disease outbreaks associated with recreational water use, United States, 1986-1988

Year	State	Month	Illness	No. Cases	Etiologic agent*	Location	Source
1986	AK	Aug.	Dermatitis	11	*Pseudomonas*	Spa	Hot tub, pool
1986	CA	May	Gastroenteritis	16	AGI	Municipal area	Pool
1986	CA	Aug.	Gastroenteritis	41	Norwalk-like	Recreation area	Lake
1986	MN	Mar.	Dermatitis	13	*Pseudomonas*	Municipal area	Whirlpool
1986	WI	Dec.	Dermatitis	9		Motel	Whirlpool
1986	WY	May	Dermatitis	36	*Pseudomonas*	Motel	Hot tub, pool
1987	CO	Jun.	Enterovirus-like	26		Recreation area	Pool
1987	HI	Jul.	Leptospirosis	8	*Leptospira*	Recreation area	Stream
1987	MD	Jun.	Gastroenteritis	266	*Giardia*	Municipal area	Pool
1987	MD	Jul.	Aseptic meningitis	4		Recreation area	Creek
1987	ME	Jan.	Dermatitis	41	*Pseudomonas*	Motel	Hot tub
1987	PA	Nov.	Dermatitis	22	*Pseudomonas*	Motel	Hot tub
1987	SC	Jun.	Gastroenteritis	130	*Shigella sonnei*	Recreation area	Lake
1987	VT	Mar.	Dermatitis	12	*Pseudomonas*	Resort	Whirlpool
1987	WA	Sep.	Dermatitis	4	*Pseudomonas*	Apt. complex	Hot tub
1987	WI	May	Dermatitis	10	*Pseudomonas*	Private home	Hot tub
1987	WI	Aug.	Gastroenteritis	160	AGI	Camp	Pond
1988	GA	Jun.	Gastroenteritis	22	*Shigella sonnei*	Recreation area	Lake
1988	MD	Jun.	Gastroenteritis	34	*Giardia*	Recreation area	Pool
1988	ME	Dec.	Dermatitis	6		Spa	Hot tub
1988	PA	Jul.	Gastroenteritis	138	*Shigella sonnei*	Recreation area	Lake
1988	VT	Jul.	Gastroenteritis	300	AGI	Recreation area	Lake
1988	VT	Jul.	Gastroenteritis	36	AGI	Swimming area	Lake
1988	WA	Mar.	Dermatitis	2	*Pseudomonas*	Private home	Hot tub
1988	WA	Jun.	Dermatitis	2	*Pseudomonas*	Private home	Hot tub
1988	WI	Jun.	Pontiac fever	14	*Legionella*	Motel	Whirlpool

*AGI = acute gastrointestinal illness of unknown etiology.

TABLE 8. Waterborne disease outbreaks not included in previous summaries, United States, 1983-1985*

Year	State	Month	Etiologic agent†	No. cases	Type of system§	Deficiency¶	Location of outbreak	Source
1983	NM	Jun.	AGI	113	NC	2	Camp	Spring
1984	NY	Jan.	AGI	24	Ind	5	Restaurant	Ice
1984	NY	Sep.	AGI	34	Ind	5	Private party	Ice
1985	AR	Mar.	*Campylo-bacter jejuni*	24	NC	2	Camp	Spring
1985	CA	Sep.	*Shigella sonnei & boydii*	68	Rec	5	Recreation area	Lake
1985	NY	Mar.	Ethylene glycol	1	Com	4	Hospital	Hemo-dialysis**
1985	NY	Jun.	AGI	4	NC	2	Restaurant	Well
1985	PA	May	AGI	70	NC	3	Restaurant	Well
1985	PA	Sep.	AGI	275	NC	2	School	Well
1985	PA	Nov.	AGI	11	NC	3	Restaurant	Well

*See Methods section for description of reporting variables.
†AGI = acute gastrointestinal illness of unknown etiology.
§Com = community (municipal); NC = noncommunity (semipublic); Ind = individual; Rec = recreational.
¶2 = untreated ground water, 3 = treatment deficiencies, 4 = distribution system deficiencies, 5 = miscellaneous.
**Resulted in death.

FIGURE 1. Waterborne disease outbreaks, by month, United States, 1986-1988