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Contents

Water-Related Disease Outbreaks, 1985

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INTRODUCTION

Since 1971 CDC has tabulated data on waterborne disease outbreaks separately from those for foodborne disease outbreaks and compiled these data in annual 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 federal, state, and local health department personnel in epidemiologic techniques used to investigate water-related disease outbreaks, and 5) to collaborate with local, state, and other federal and international agencies in initiatives concerning prevention of water-related diseases.

In addition to waterborne disease 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 gastroenteritis outbreaks on ocean-going passenger vessels that call at U.S. ports.

METHODS

Definition of Terms

A waterborne disease outbreak occurs when two or more persons experience a similar illness after consumption or use of water intended for drinking and epidemiologic evidence implicates the water as the source of illness. Also, 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 include illnesses due to exposure to or unintentional ingestion of fresh or marine water, but 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 the

Environmental Protection Agency (EPA) contacts all state water-supply agencies annually to obtain information about waterborne disease outbreaks. This present 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.

As a part of their request for permission to enter a port, vessel masters of passenger cruise ships must report all persons who visited the ship's physician because of diarrheal illness during each voyage. In the event the ship's physician reports that 3% or more of passengers sought consultation for 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

The data in this report have limitations, which one must recognize to avoid misinterpretation. The number of waterborne disease outbreaks reported to CDC and EPA clearly represents only a fraction of the total number that occur. Since investigations were sometimes incomplete or conducted long after the outbreak, the waterborne hypothesis could not be proved in all instances; however, it 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, the number of reported outbreaks due to different agents may depend on the interest of a particular health department or individual. For example, if epidemiologists or microbiologists become interested in *Giardia lamblia* or Norwalk-like viruses, they are likely to confirm more outbreaks caused by these agents. Furthermore, a few outbreaks involving many persons may vastly alter the relative proportion of cases attributed to various etiologic agents. Therefore, the reader should be aware that the numbers in this report do not represent either the true incidence of waterborne disease outbreaks or the relative incidence of waterborne diseases of various etiologies.

RESULTS

In 1985, 13 states reported 16 outbreaks of waterborne illness with 1,561 cases to CDC (Table 1). Bacterial agents were identified in four outbreaks. *Campylobacter jejuni* caused two outbreaks—one communitywide outbreak associated with the repair of a municipal water main and the other associated with consumption of untreated spring water at a recreational area near livestock pastures. An outbreak of *Shigella sonnei* infections was associated with drinking untreated well water at a summer camp. An outbreak of typhoid fever (*Salmonella typhi* infections) followed possible cross-contamination between parallel sewer and water lines during maintenance procedures. Three outbreaks were attributed to *G. lamblia*; all were associated

with drinking chlorinated but unfiltered water. In eight other reported outbreaks of acute gastrointestinal illness no agent was convincingly demonstrated. No waterborne outbreaks of documented viral diseases were reported in 1985.

In the one reported outbreak related to a chemical agent in the drinking water supply, 31 cases of dermatitis occurred. All patients had been exposed to levels of residual (free) chlorine as high as 27 mg/L in the municipal water supply (normal, < 1 mg/L). Symptoms included apparent contact dermatitis, urticarial rashes, skin burning or "flaking," and change in hair color to green for one person who also had chemical dermatitis. These symptoms were the result of excessive amounts of calcium hypochlorite, which had been added to the water to disinfect the lines immediately after repair.

In addition to disease outbreaks related to water intended for drinking, five outbreaks related to recreational water exposure were reported in 1985 (Table 2). Two outbreaks of giardiasis were associated with swimming in pools. Three outbreaks of *Pseudomonas* dermatitis were associated with the use of whirlpool baths or hot tubs.

In 1985, CDC personnel investigated four outbreaks of diarrheal illness on cruise ships calling at U.S. ports. In May, on a 1-week Caribbean cruise ending in Miami, at least 403 of 1,751 passengers developed gastroenteritis that was clinically compatible with a 27-nm Norwalk-like virus, but no disease agent was found by laboratory tests. Shrimp cocktail was implicated as the vehicle of illness. In July, on a 1-week Caribbean cruise out of St. Petersburg, at least 238 passengers suffered diarrhea and vomiting of generally short duration, but neither a disease agent nor a vehicle was

TABLE 1. Reported waterborne disease outbreaks, United States, 1985*

State	Month	Etiologic agent†	No. cases	Type of system§	Deficiency¶	Location of outbreak	Source
Ark.	Apr.	*Campylobacter*	19	NC	1	Resort	Spring
Ill.	July	AGI	18	NC	1	Recreation area	Well
Mass.	Nov.	*Giardia*	703	Com	1	Community	Reservoir
N.Y.	Feb.	*Giardia*	6	NC	3	Industrial plant	Cross-connection
N.Y.	Aug.	AGI	19	NC	2	Recreation area	Well
Okla.	Sept.	AGI	59	NC	1	Camp	Well
Pa.	Aug.	*Shigella*	27	NC	1	Camp	Well
P.R.	Aug.	AGI	274	Com	2	Community	Well
Va.	Apr.	*Giardia*	32	NC	1	Resort	Spring
V.I.	June	*Salmonella typhi*	60	Com	3	Community	Maintenance error
Vt.	Aug.	AGI	21	Com	2	Trailer park	Well
Vt.	Nov.	AGI	105	NC	1	School	Spring
Vt.	Nov.	AGI	19	NC	1	School	Spring
Wash.	July	AGI	18	Ind	1	Residence	Well
Wis.	Sept.	*Campylobacter*	150	Com	3	Community	Defective main
Wyo.	Apr.	Chlorine**	31	Com	3	Community	Broken main

*Please 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 ground water, 2 = treatment deficiencies, 3 = distribution system deficiencies.
**Illness was chemical dermatitis.

identified. In August and September, at least 387 of 945 passengers had a diarrheal illness on a cruise ship voyage along the Pacific coast of Mexico and California; however, because the cruise line failed to notify quarantine authorities in a timely manner, only a limited investigation could be conducted. In December, at least 70 of 540 passengers on a transatlantic cruise docking in Miami reported gastrointestinal illness associated with a seafood cocktail, but no agent was identified as the cause of illness.

DISCUSSION

The reported number of waterborne disease outbreaks and the number of associated cases in 1985 were the lowest since CDC began waterborne disease surveillance in 1971 (Table 3, Figures 1 and 2). Some evidence suggests that an actual decrease in water-related diseases is occurring. Active surveillance in some states reveals defects in water delivery systems, and as these are corrected, the potential for water-related disease outbreaks may be diminished. For example, Colorado received

TABLE 2. Reported disease outbreaks related to recreational water use, 1985

State	Month	Illness	No. cases	Etiologic agent	Location	Source
Ill.	July	Gastroenteritis	15	*Giardia*	Municipal area	Swimming pool
Minn.	Nov.	Dermatitis	4	*Pseudomonas*	Private party	Hot tub
N.J.	Sept.	Gastroenteritis	9	*Giardia*	Municipal area	Swimming pool
Vt.	Aug.	Folliculitis	14	*Pseudomonas*	Condominium	Whirlpool
Vt.	Dec.	Dermatitis	3	*Pseudomonas*	Motel	Whirlpool

TABLE 3. Reported waterborne disease outbreaks, by year and type of water supply systems, United States, 1971-1985*

	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	7	44	9,769
1980	26	20	7	53	20,045
1981	14	18	4	36	4,537
1982	26	15	3	44	3,588
1983	30	8	4	42	20,923
1984	12	5	8	25	1,742
1985	6	9	1	16	1,561
TOTAL (%)	**211 (44)**	**216 (45)**	**58 (12)**	**485**	**110,359**

*Please see methods section for description of reporting variables.

federal funds in 1980-1983 to improve surveillance of water-related disease outbreaks; for these years, the state reported an average of 4.5 outbreaks per year, in contrast to its previous average of only 2.0 outbreaks per year for the period 1971-1979 (*1*). For 1984 and 1985 together, however, only three outbreaks were discovered in that state, despite both active and passive surveillance of water-related

FIGURE 1. Reported outbreaks of waterborne disease, by year, United States, 1971-1985

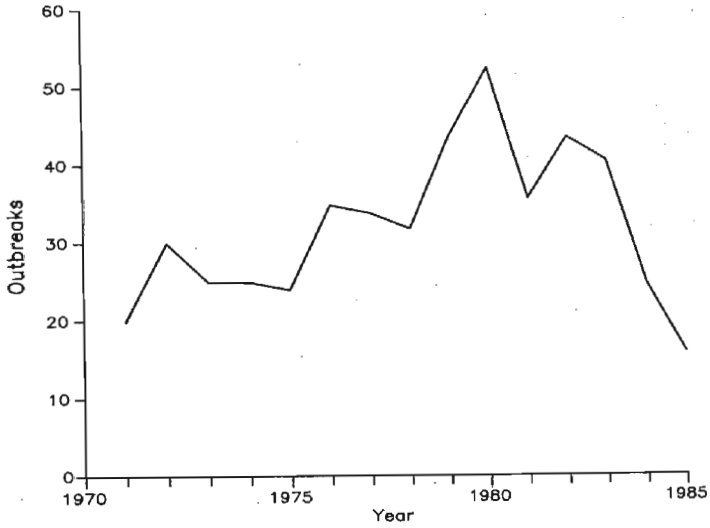
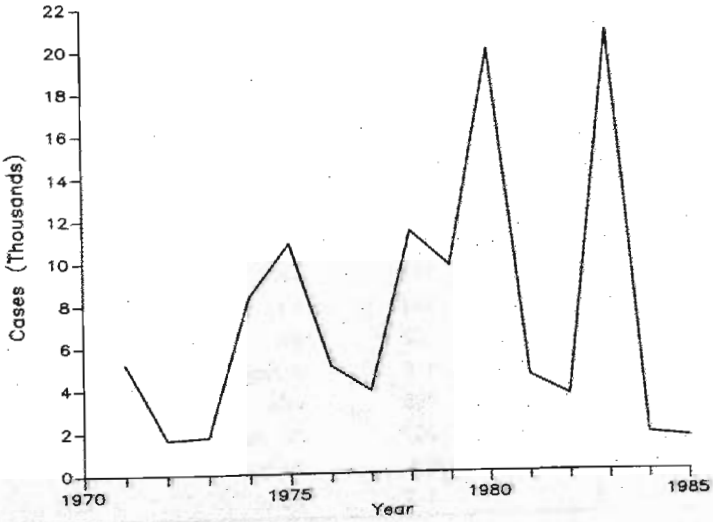


FIGURE 2. Reported cases of illness associated with outbreaks of waterborne disease, by year, United States, 1971-1985



diseases. As other states begin to look for problems, they may also experience sudden increases in reported water-related diseases, followed by a decline in cases as identified problems are corrected.

The smaller number of outbreaks reported in 1985 may be due, however, to less complete reporting rather than to an actual decrease in outbreaks. The waterborne disease surveillance system is largely passive. Evidence suggests that this system contains only a small and variable fraction of the outbreaks and cases that occur yearly in the United States. Five states (Colorado, Oregon, Pennsylvania, Vermont, and Washington), with only 9.7% of the U.S. population, reported 42% of all waterborne outbreaks between 1971 and 1985 (Table 4). In 1982, three of these states, Colorado, Vermont, and Washington, received federal funds for surveillance through contracts with EPA (*2*), and Pennsylvania and Oregon have well-developed surveillance systems. Continued surveillance and, perhaps, special studies will be necessary to determine if the apparent decrease in reported outbreaks of water-related disease in recent years is a true trend.

TABLE 4. Reported outbreaks and cases of waterborne disease, by state, United States, 1971-1985

State	Outbreaks	Cases	State	Outbreaks	Cases
Alaska	10	950	N. Dak.	1	25
Ala.	6	183	Nebr.	1	23
Ark.	8	965	N.H.	7	943
Ariz.	8	2,416	N.J.	10	1,052
Calif.	26	6,271	N. Mex.	6	171
Colo.	52	9,868	Nev.	1	342
Conn.	6	1,269	N.Y.	17	7,040
Fla.	10	2,649	Ohio	9	1,003
Ga.	5	2,101	Okla.	6	625
Hawaii	2	72	Oreg.	21	3,875
Iowa	5	620	Pa.	93	28,760
Idaho	7	266	P.R.	4	3,474
Ill.	6	374	R.I.	1	20
Ind.	4	1,806	S.C.	5	342
Kans.	1	100	S. Dak.	2	17
Ky.	3	276	Tenn.	7	95
La.	1	26	Tex.	9	14,415
Mass.	6	1,248	Utah	8	1,549
Md.	7	431	Va.	8	110
Maine	7	343	V.I.	1	60
Mich.	4	82	Vt.	18	5,145
Minn.	10	418	Wash.	20	3,171
Mo.	5	865	Wis.	7	309
Miss.	2	207	W. Va.	4	1,109
Mont.	6	1,806	Wyo.	3	454
N.C.	9	618	**Total**	**485**	**110,359**

In 1985, *G. lamblia* was the most frequently identified pathogen for the seventh consecutive year, causing three (20%) of 15 waterborne outbreaks in addition to two outbreaks that resulted from unintentional ingestion of water in swimming pools. *Giardia* has been the cause of nearly all reported outbreaks of waterborne parasitic diseases in recent years, during which time this class of agents has increased as a proportional cause of all waterborne outbreaks (Table 5). In each of the outbreaks, as in well-characterized waterborne outbreaks of giardiasis in the past (*3,4*), water chlorination had been maintained at adequate levels to make outbreaks of bacterial diseases unlikely, but the lack of an intact filtering system capable of filtering *Giardia* cysts, distribution system problems, and mechanical deficiencies allowed drinking water to become a vehicle of giardiasis. Efforts are continuing to develop practical and efficient ways to detect *Giardia* cysts in water (*5-7*).

Campylobacter, the agent in two of four bacterial disease outbreaks, caused 10 (55%) of 18 waterborne bacterial disease outbreaks between 1980 and 1984. *Campylobacter* organisms have been detected in the flora of many domestic and wild animal species, and contamination of water sources by animals was suspected in many of the outbreaks. *Campylobacter* survives for months in surface water at 4°C (*7*) and in the past has been implicated in sporadic cases and outbreaks when the organism was isolated from both patients and animals (*8*).

The outbreak of waterborne typhoid fever is the first to be reported in the United States or its territories since 1974. Consistent with the fact that humans are the exclusive reservoir of *S. typhi*, contamination of the water system with human sewage rather than animal waste was suspected.

TABLE 5. Reported waterborne disease outbreaks, by type of agent, United States, 1971-1985

	Outbreaks					
Year	**Bacterial**	**Parasitic**	**Viral**	**Chemical**	**AGI***	**Total**
1971	3	0	6	2	9	20
1972	5	4	5	3	13	30
1973	6	4	2	0	13	25
1974	5	4	0	5	11	25
1975	2	1	1	3	17	24
1976	3	3	0	3	26	35
1977	3	4	1	6	20	34
1978	7	4	3	2	16	32
1979	3	7	3	7	24	44
1980	3	8	6	7	29	53
1981	4	11	1	5	15	36
1982	3	12	7	3	19	44
1983	4	18	3	1	15	41
1984	4	7	2	3	9	25
1985	4	3	0	1	8	16
Total (%)	**59 (12)**	**90 (19)**	**40 (8)**	**51 (11)**	**244 (50)**	**484**

*AGI = Acute gastrointestinal illness

No waterborne outbreaks of viral diseases were reported in 1985. Identifying the agents of viral diseases is more difficult than identifying agents for parasitic or bacterial diseases. Hepatitis A has a much longer incubation period (15-50 days) than either bacterial or parasitic diseases, which complicates both outbreak identification and implication of the vehicle of transmission. Identification of outbreaks due to Norwalk virus, the Snow Mountain agent, and other 27-nm viruses depends on sophisticated laboratory techniques (*9,10*) and on the procurement of paired serum samples from patients for diagnosis. Reviews of common-source outbreaks of acute, nonbacterial gastroenteritis have suggested that many are due to Norwalk virus and related agents (*11*). The same may be true for some of the eight (50%) waterborne outbreaks of unknown etiology reported in 1985, particularly since Norwalk virus is more resistant to chlorine than many other viruses and may remain infectious at routine chlorination levels (5-6 mg/L free chlorine) (*12*).

In 1985, nine (60%) waterborne outbreaks were associated with noncommunity water systems. In the period 1971-1985, the number of outbreaks related to noncommunity systems was 45% of all reported outbreaks (Table 3). EPA estimates, however, that there are 20 million noncommunity, 180 million community, and 30 million individual water system users in the United States, so the rate of reported illness was far greater among noncommunity system users than among community system users. In 1985, six (37%) outbreaks were associated with water systems used on a seasonal basis. For the most part these are noncommunity systems, such as those in camps, parks, and resorts, which have a large demand placed upon them by visitors during specific periods of the year. In some instances, the systems cannot meet such demands. These water supply systems, especially those at campgrounds and parks, must be periodically reevaluated and monitored, and corrections must be made to ensure the continued provision of safe water during periods of increased demand. The large outbreaks that occurred during 1975 in Crater Lake and Yellowstone national parks (*13,14*) underscore the problems related to water supplies that can occur in recreational areas. Substantial differences exist in the types of deficiencies that lead to waterborne outbreaks associated with various water supply systems (Table 6).

The first outbreak of *Pseudomonas* folliculitis associated with the use of recreational water was reported in 1975 (*15*). Since then, the majority of outbreaks have been related to whirlpool baths, although outbreaks related to swimming pools have been reported (*16*). Outbreaks have not been reported at facilities in which pool water

TABLE 6. Deficiencies leading to waterborne disease outbreaks, by type of water system involved, United States, 1971-1985

	Type of deficiency*										
	Number (%)										
System	1		2		3		4		5		Total
Community	5	(2)	24	(11)	109	(52)	60	(29)	11	(5)	209
Noncommunity	13	(6)	96	(44)	79	(36)	17	(8)	12	(6)	217
Individual	15	(26)	33	(57)	0	(0)	4	(7)	6	(10)	58
Total	**33**	**(7)**	**153**	**(32)**	**188**	**(39)**	**81**	**(17)**	**29**	**(6)**	**484**

*1 = untreated surface water, 2 = untreated ground water, 3 = treatment deficiencies, 4 = distribution system deficiencies, 5 = miscellaneous

has been continually maintained at pH 7.2-7.8 with free residual chlorine levels of at least 1.0 mg/L (*17*). CDC recently published suggested health and safety guidelines for public spas and hot tubs (*18*). Also, EPA has published new guidelines for the microbiologic safety of fresh and marine water for swimming and other recreational uses (*19,20*).

Despite the underreporting of outbreaks and questions about the stability of the surveillance system for waterborne disease outbreaks, these data show the causes of reported waterborne disease outbreaks, the seasonality of outbreaks, and the deficiencies in water systems that most frequently result in recognized outbreaks. As in the past, the pathogens responsible for many outbreaks in 1985 were not determined. More complete epidemiologic investigations, advances in laboratory techniques, and standardized reporting of waterborne disease outbreaks should augment our knowledge of waterborne pathogens and the factors responsible for waterborne disease outbreaks.

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