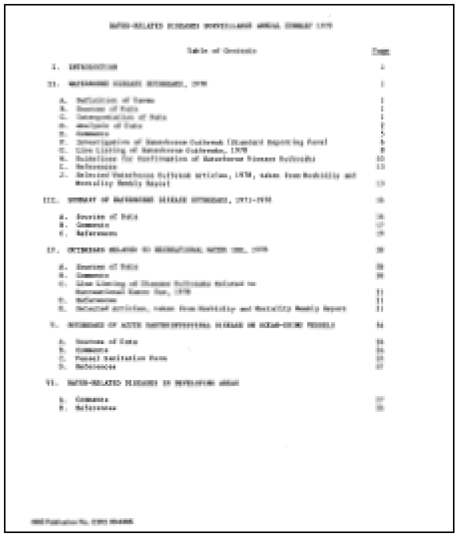

WATER-RELATED DISEASES SURVEILLANCE ANNUAL SUMMARY 1978

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HHS Publication No. (CDC) 80-8385

I. INTRODUCTION

Since 1971 the Center for Disease Control (CDC) has tabulated foodborne and waterborne disease outbreak data separately and reported these data in 1 report. In July 1978 the 2 surveillance activities were officially separated, and the Water-Related Diseases Activity was established. The Water-Related Diseases Activity has set these goals: 1) to determine the frequency of epidemics of water-related diseases, 2) to characterize the epidemiology of water-related diseases in the United States, 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 for the investigation of water-related disease outbreaks, and 5) to collaborate with local, state, other federal and international agencies in initiatives concerning prevention of water-related diseases. Also included in the responsibilities of the Water-Related Diseases Activity is the investigation of outbreaks of acute gastrointestinal disease on ocean-going vessels.

II. WATERBORNE DISEASE OUTBREAKS, 1978

In 1978, 32 outbreaks of waterborne disease involving 11,435 cases were reported to the Center for Disease Control (CDC).

A. Definition of Terms

In this report a waterborne disease outbreak is defined as an incident in which 1) 2 or more persons experienced similar illness after consumption of water, or after use of water intended for drinking, and 2) epidemiologic evidence implicated the water as the source of illness. In addition, a single case of chemical poisoning constitutes an outbreak if laboratory studies indicated that the water was contaminated by the chemical.

Only outbreaks associated with water intended or used for drinking are included in sections II and III (waterborne disease outbreaks). Section IV summarizes data from reported outbreaks related to recreational use of water.

Municipal systems (community public water systems) are defined as public or investor-owned water supplies that serve large or small communities, subdivisions or trailer parks of at least 15 service connections or 25 year-round residents. Semipublic water systems (noncommunity public water systems) are those in institutions, industries, camps, parks, hotels, or service stations that may be used by the general public. Individual systems (private water systems), generally wells and springs, are those used by single or several residences or by persons traveling outside populated areas (e.g., backpackers). These definitions correspond to those in the Safe Drinking Water Act (PL 93-523) of 1974.

B. Sources of Data

Waterborne disease outbreaks are reported to CDC by state health departments on a standard reporting form (Section F). 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; information from both sources is included in this report. Outbreak data are reviewed and summarized by representatives from CDC and EPA, who also work together in the investigation and evaluation of waterborne disease outbreaks. In addition, upon 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 for indentification of viruses, parasites, and bacterial pathogens.

C. Interpretation of Data

The limitations of the data in this report must be appreciated in order to avoid misinterpretation. The number of outbreaks of waterborne disease reported to CDC and EPA clearly represents 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 coming to the attention of health authorities varies considerably from 1 locale to another depending 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 more 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 disease outbreaks and its budgetary, investigative, and laboratory capabilities.

This report should not be the basis for firm conclusions about the true incidence of waterborne disease outbreaks, and it should not be used to draw final conclusions about the relative incidence of waterborne diseases of various etiologies. The number of reported outbreaks of different etiologies may depend upon the interest of a particular health department or individual. If an epidemiologist or microbiologist becomes interested in Giardia lamblia or Norwalk-like viruses, he is likely to confirm more outbreaks caused by these agents. Furthermore, a few outbreaks involving very large numbers of persons may vastly alter the relative proportion of cases attributed to various etiologic agents.

These data are helpful in revealing the etiologies of reported waterborne disease outbreaks, the seasonality of outbreaks, and the deficiencies in water systems that most frequently result in outbreaks. As in the past, the pathogens responsible for many outbreaks in 1978 remain unknown. It is hoped that more complete epidemiologic investigations, advances in laboratory techniques, and standardization of reporting of waterborne disease outbreaks will augment our knowledge of waterborne pathogens and the factors responsible for waterborne disease outbreaks.

D. Analysis of Data

In 1978, 32 waterborne disease outbreaks, a slight decrease from 1977 (34 outbreaks) and 11,435 cases, a 3-fold increase from 1977 (3,860 cases), were reported to CDC (Section G).

Figure 1 shows the geographic distribution of outbreaks by state. Eighteen states reported at least 1 outbreak. For the sixth consecutive year, Pennsylvania accounted for the highest percentage of total outbreaks (7/32, 21%).

Table 1 shows the number of outbreaks and cases by etiology and type of water system. Of the 32 outbreaks, 16 (50%) were of unknown etiology and were designated as "acute gastrointestinal illness" (AGI). This category includes outbreaks characterized by upper and/or lower gastrointestinal symptomatology for which no specific etiologic agent was identified. There were 16 (50%) outbreaks of confirmed etiology (Section H): Giardia lamblia (4), Shigella (4), parvovirus-like agents (3), Salmonella (2), chemical (2), and Campylobacter (1). In 3 of the 4 largest outbreaks an etiologic agent was found. A municipal water system in Colorado was implicated in an outbreak of giardiasis (5,000 cases). An estimated 3,000 people were infected with Campylobacter fetus ssp. jejuni in an outbreak in Vermont traced to a municipal water supply. A semipublic school water supply in Washington was implicated in an outbreak due to a parvovirus-like agent (467 cases). The 2 chemical outbreaks were due to toxic amounts of copper (13.8 ppm) and fluoride (375 ppm). The copper outbreak (12 cases) was attributed to leaching of copper from pipes leading to an infrequently used water fountain in a school. Thirty-four persons became ill with acute fluoride poisoning shortly after consuming water contaminated with fluoride in a public school. The source of the water supply was a small well with a fluoridator mechanically coupled through an electric relay to the pump and designed to increase the concentration of fluoride to a range of 1 to 5 ppm. On the day of the outbreak the fluoridator continued to feed fluoride solution due to a faulty relay when the pump was not operating.

In the 30 non-chemical outbreaks, results of microbiological tests of water samples were reported in 27; evidence of contamination (presence of coliforms or pathogens) was found in 22 (81%). Results of microbiologic examination were known in 3 of the 4 Giardia outbreaks, and in only 1 was the coliform count elevated. Cysts of G. lamblia were recovered from water in 2 of the outbreaks (Colorado and New York).

Fig. 1 WATERBORNE DISEASE OUTBREAKS, UNITED STATES, 1978

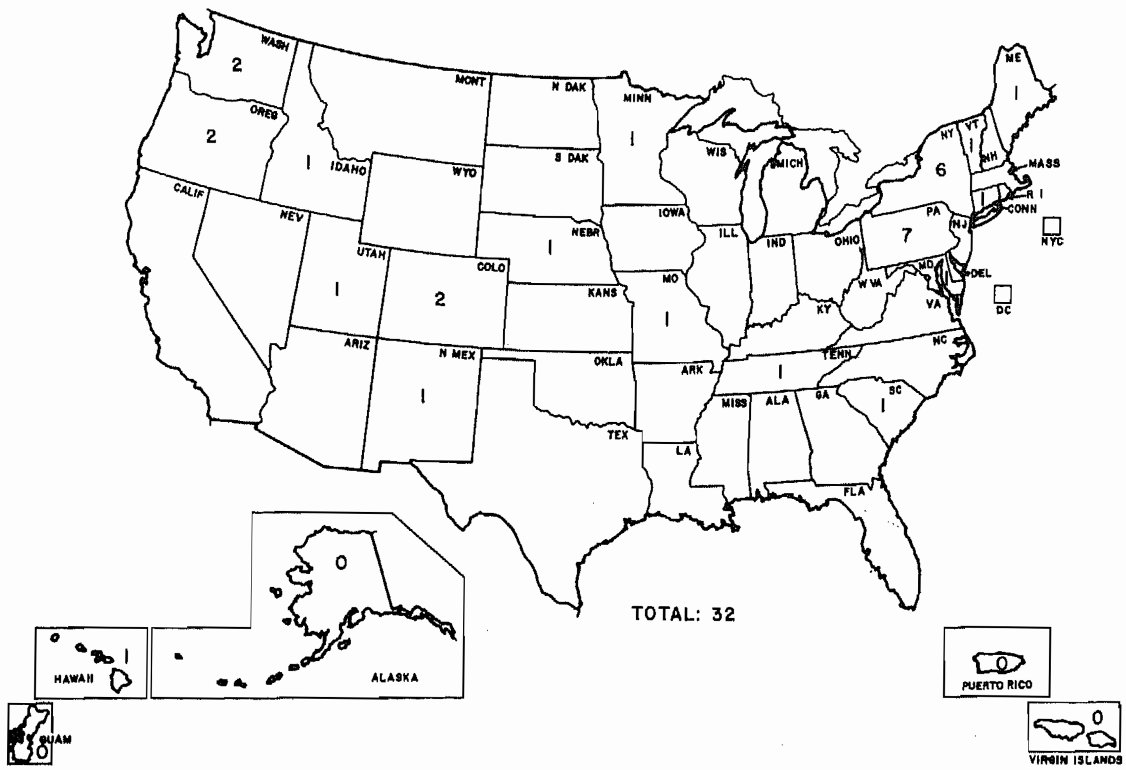


Table 1 Waterborne Disease Outbreaks by Etiology and Type of Water System, 1978

	Municipal		Semipublic		Individual		Total	
	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
Acute gastrointestinal illness	3	511	10	1490	3	13	16	2014
Giardiasis	2	5130	1	23	1	18	4	5171
Shigellosis	2	56	2	122	0	0	4	178
Parvovirus-like agent	0	0	3	937	0	0	3	937
Salmonellosis	1	78	1	11	0	0	2	89
Chemical poisoning	1	12	1	34	0	0	2	46
Campylobacter	1	3000	0	0	0	0	1	3000
TOTAL	10	8787	18	2617	4	31	32	11435

Most outbreaks involved semipublic (56%) and municipal (31%) water systems. Outbreaks attributed to water from municipal systems affected an average of 879 persons compared with 145 persons in outbreaks involving semipublic systems and 8 persons in outbreaks associated with individual water systems. Use of untreated or inadequately treated water accounted for 23 (72%) of the outbreaks (Table 2). Outbreaks occurred most frequently from May through November (Table 3). Outbreaks in recreational areas continued to be a problem in 1978 (Figure 2), accounting for 50% of all outbreaks. Of the 18 outbreaks associated with semipublic water supply systems, implicated water supplies were in camps and campgrounds (8), restaurants (4), schools (3), and a town (1), resort (1), and work area (1). The outbreak of giardiasis associated with a semipublic system occurred in a resort area in Colorado and was due to sewage contamination of the water supply.

Table 2 Waterborne Disease Outbreaks by Type of System and Type of Deficiency, 1978

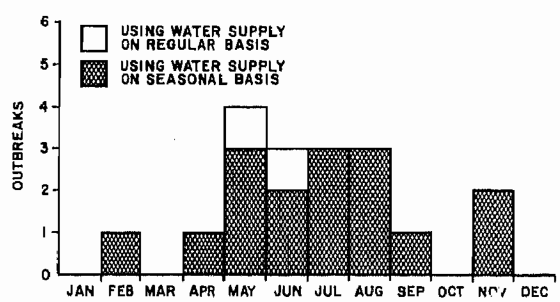
	Municipal		Semipublic		Individual		Total	
	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
Untreated surface water	0	0	1	23	2	8	3	31
Untreated ground water	1	34	8	1432	1	5	9	1471
Treatment deficiencies	6	8404	4	536	0	0	10	8940
Deficiencies in distribution system	3	349	4	603	0	0	8	952
Miscellaneous	0	0	1	23	1	18	2	41
TOTAL	10	8787	18	2617	4	31	32	11435

Table 3 Waterborne Disease Outbreaks, by Month of Occurrence, 1978

Month	Number of Outbreaks	Month	Number of Outbreaks
January	0	July	6
February	1	August	3
March	0	September	3
April	2	October	2
May	6	November	5
June	4	December	0

Total: 32

Fig. 2 WATERBORNE DISEASE OUTBREAKS INVOLVING SEMIPUBLIC WATER SUPPLIES, BY MONTH AND POPULATION AFFECTED, UNITED STATES, 1978



In 7 of the 16 outbreaks of acute gastroenteritis of unknown etiology an incubation period was reported. In each instance the median incubation period was less than 48 hours, and the mean was approximately 30 hours. Efforts to document a bacterial etiology were made in 14 of the 16 outbreaks and stool specimens were submitted for viral studies in 5 outbreaks.

E. Comments

The increase in the number of outbreaks reported in 1976-1978 is probably due to more complete reporting rather than an actual increase in waterborne disease outbreaks. Intensive surveillance can identify relatively small waterborne outbreaks that often originate in semipublic water systems. It is hoped that increased investigation and reporting will define major deficiencies commonly affecting semipublic water systems, especially in recreational areas, so that they can be better understood and corrected. However, in many instances investigations have not been initiated until long after the outbreaks have occurred, precluding timely collection of specimens for determination of etiology.

Water systems used on a seasonal basis such as those in camps, parks, and resorts have an abnormal demand placed upon them by large numbers of visitors during specific periods of the year and in some instances cannot meet such demands. For the most part these systems are semipublic. Water supply systems in such areas, especially campgrounds and parks, must be reappraised and monitored and corrections made to ensure the continued provision of safe water during periods of increased demand. The large outbreaks that occurred in 1975 in Crater Lake National Park (1) and in 1977 in Yellowstone National Park (2) underscore the actual problems related to water supplies in recreational areas that can occur.

Coliform organism identification is used as an indication of fecal contamination of water supplies and is widely employed in routine surveillance programs. Negative results have usually been interpreted as providing assurance that the water is free of enteric pathogens. This interpretation must be reevaluated in recognition of data available on waterborne outbreaks of giardiasis (3). Outbreaks of giardiasis have occurred in the absence of documented coliform contamination of the water. It is important that an attempt be made to isolate pathogens from the water system during an outbreak to help establish the etiology and to show further that the outbreak was waterborne, but it is equally important to document the presence of coliforms to demonstrate that contamination has occurred.

Two etiologic agents recently reported as causing waterborne disease outbreaks in the United States are *Campylobacter* and parvovirus-like agents. A large outbreak of gastroenteritis caused by *C. fetus* subspecies *jejuni* (formerly called *Vibrio fetus*) occurred in Vermont in May and June 1978. The primary water supply of the town is surface water which is chlorinated but not filtered. Two supplementary sources of water, neither of which is chlorinated, are used when the pressure is low in the distribution system. One of these sources had not been used since February 1978; the other activates automatically when pressure is low. Records showed that throughout the outbreak period water samples from several areas of the town had no residual chlorine. Routine coliform counts performed during and after the outbreak were negative. This is the first reported waterborne outbreak of *Campylobacter* diarrhea.

Three outbreaks, 2 in Pennsylvania and 1 in Washington, were due to a parvovirus-like agent; all were due to a Norwalk-like agent. Fecal coliform contamination of the semipublic water supply was evident in all 3 outbreaks. Viruses have long been suspected as etiologic agents in outbreaks of waterborne disease, but it was not until the newer methods such as radioimmunoassay and immunoelectron microscopy that it has been possible to identify the viruses responsible for waterborne disease outbreaks. Parvovirus-like agents (for example, Norwalk, Montgomery County, and Hawaii agents) have been suspected of causing waterborne outbreaks of gastroenteritis (4). The agents responsible for 2 outbreaks previously reported to CDC have been confirmed as parvovirus-like (2,5). The 3 outbreaks in 1978 further illustrate that parvovirus-like agents may contribute to waterborne gastrointestinal disease. Diagnosis of waterborne disease outbreaks due to parvovirus-like agents is dependent upon the timely collection of proper specimens. A large volume of stool, 10 grams or more, should be collected from 6-10 acutely ill patients during the first 48 hours of illness and frozen at -70 C until studied; acute- and convalescent-serum specimens should also be collected. Similar specimens should be collected from nonill control individuals.

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
BUREAU OF EPIDEMIOLOGY
ATLANTA, GEORGIA 30333

INVESTIGATION OF A WATERBORNE OUTBREAK

Form Approved
OMB No. 68-R0557

1. Where did the outbreak occur?

________ (1-2) City or Town ________ County ________

2. Date of outbreak: (Date of onset of 1st case)

________ (3-8)

3. Indicate actual (a) or estimated (e) numbers:

Persons exposed ________ (9-11)
Persons ill ________ (12-14)
Hospitalized ________ (15-16)
Fatal cases ________ (17)

4. History of exposed persons:

No. histories obtained ________ (18-20)
No. persons with symptoms ________ (21-23)
Nausea ________ (24-26) Diarrhea ________ (33-35)
Vomiting ________ (27-29) Fever ________ (36-38)
Cramps ________ (30-32)
Other, specify (39) ________

5. Incubation period (hours):

Shortest ________ (40-42) Longest ________ (43-4
Median ________ (46-48)

6. Duration of illness (hours):

Shortest ________ (49-51) Longest ________ (52-54)
Median ________ (55-57)

7. Epidemiologic data (e.g., attack rates [number ill/number exposed] for persons who did or did not eat or drink specific food items or water, attack rate by quantity of water consumed, anecdotal information) * (58)

ITEMS SERVED	NUMBER OF PERSONS WHO ATE OR DRANK SPECIFIED FOOD OR WATER				NUMBER WHO DID NOT EAT OR DRINK SPECIFIED FOOD OR WATER			
	ILL	NOT ILL	TOTAL	PERCENT ILL	ILL	NOT ILL	TOTAL	PERCENT ILL

8. Vehicle responsible (item incriminated by epidemiologic evidence): (59-60) ________

9. Water supply characteristics

(A) Type of water supply** (61)

- ☐ Municipal or community supply (Name ________)
- ☐ Individual household supply
- ☐ Semi-public water supply
  - ☐ Institution, school, church
  - ☐ Camp, recreational area
  - ☐ Other, ________
- ☐ Bottled water

(B) Water source *(check all applicable)*:

(C) Treatment provided *(circle treatment of each source checked in B)*:

☐ Well	a	b	c	d
☐ Spring	a	b	c	d
☐ Lake, pond	a	b	c	d
☐ River, stream	a	b	c	d

a. no treatment
b. disinfection only
c. purification plant — coagulation, settling, filtration, disinfection *(circle those applicable)*
d. other ________

10. Point where contamination occurred: (66)

☐ Raw water source ☐ Treatment plant ☐ Distribution system

*See CDC 4.245 Investigation of a Foodborne Outbreak, Item 7.
**Municipal or community water supplies are public or investor owned utilities. Individual water supplies are wells or springs used by single residences. Semipublic water systems are individual-type water supplies serving a group of residences or locations where the general public is likely to have access to drinking water. These locations include schools, camps, parks, resorts, hotels, industries, institutions, subdivisions, trailer parks, etc., that do not obtain water from a municipal water system but have developed and maintain their own water supply.

CDC 4.461
11-78

This report is authorized by law (Public Health Service Act, 42 USC 241).
While your response is voluntary, your cooperation is necessary for the understanding and control of the disease.

11. Water specimens examined: (67)
(Specify by "X" whether water examined was original (drunk at time of outbreak) or check-up (collected before or after outbreak occurred)

ITEM	ORIGINAL	CHECK UP	DATE	FINDINGS		BACTERIOLOGIC TECHNIQUE (e.g., fermentation tube, membrane filter)
				Quantitative	Qualitative	
Examples: Tap water	X		6/12/74	10 fecal coliforms per 100 ml.		
Raw water		X	6/2/74	23 total coliforms per 100 ml.		

12. Treatment records: *(Indicate method used to determine chlorine residual):*
Example: **Chlorine residual — One sample from treatment plant effluent on 6/11/74 — trace of free chlorine**

Three samples from distribution system on 6/12/74 — no residual found

13. Specimens from patients examined (stool, vomitus, etc.) (68)

SPECIMEN	NO. PERSONS	FINDINGS
Example: Stool	**11**	**8** ***Salmonella typhi***
		3 negative

14. Unusual occurrence of events:
Example: Repair of water main 6/11/74; pit contaminated with sewage, no main disinfection. Turbid water reported by consumers 6/12/74.

15. Factors contributing to outbreak *(check all applicable):*

- ☐ Overflow of sewage
- ☐ Seepage of sewage
- ☐ Flooding, heavy rains
- ☐ Use of untreated water
- ☐ Use of supplementary source
- ☐ Water inadequately treated
- ☐ Interruption of disinfection
- ☐ Inadequate disinfection
- ☐ Deficiencies in other treatment processes
- ☐ Cross-connection
- ☐ Back-siphonage
- ☐ Contamination of mains during construction or repair
- ☐ Improper construction, location of well/spring
- ☐ Use of water not intended for drinking
- ☐ Contamination of storage facility
- ☐ Contamination through creviced limestone or fissured rock
- ☐ Other (specify) ________

16. Etiology: (69-70)

Pathogen ________
Chemical ________
Other ________

(71)
Suspected 1
Confirmed . . . . 2 *(Circle one)*
Unknown 3

17. Remarks: *Briefly describe aspects of the investigation not covered above, such as unusual age or sex distribution; unusual circumstances leading to contamination of water; epidemic curve; control measures implemented; etc. (Attack additional page if necessary)*

Name of reporting agency: (72)

Investigating Official: | **Date of investigation:**

Note: Epidemic and Laboratory assistance for the investigation of a waterborne outbreak is available upon request by the State Health Department to the Center for Disease Control, Atlanta, Georgia 30333.

To improve national surveillance, please send a copy of this report to: Center for Disease Control
Attn: Enteric Diseases Branch, Bacterial Diseases Division
Bureau of Epidemiology
Atlanta, Georgia 30333

Submitted copies should include as much information as possible, but the completion of every item is not required.

CDC 4.461 (BACK)
11-78

G. Line Listing of Waterborne Disease Outbreaks, 1978

State	Month	Disease	Cases	Type of System	Location of Outbreak	System Deficiency*	Water Source
Colorado	April	*Giardia lamblia*	5,000	Municipal	Town	3†	Stream
Colorado	June	AGI	350	Semipublic	Town	2	Wells
Connecticut	November	Copper	12	Municipal	School	4	Lake
Hawaii	July	*Salmonella weltevreden*	11	Semipublic	Camp	4	Unknown
Idaho	November	AGI	27	Semipublic	Restaurant	2	Well
Maine	August	AGI	70	Semipublic	Camp	2	Well
Maryland	July	*Shigella flexneri*	22	Municipal	Trailer park	3	Well
Minnesota	October	AGI	137	Municipal	Trailer park	4	Well
Missouri	May	AGI	750	Semipublic	Restaurant/ residential	2	Wells
Nebraska	June	AGI	23	Semipublic	Work crew	5††	Unknown
New Mexico	November	Fluoride	34	Semipublic	School	4	Well
New York	May	*Shigella*	23	Semipublic	School	2	Well
New York	July	AGI	55	Semipublic	Camp	3	Lake
New York	September	AGI	11	Semipublic	Restaurant	3	Well
New York	September	AGI	3	Individual	Camp	1	Lake
New York	October	AGI	5	Individual	Camp	1	Lake
New York	November	*Giardia lamblia*	130	Municipal	Town	3	River
Oregon	May	*Shigella sonnei*	34	Municipal	Apartments	2	Well

Line Listing of Waterborne Disease Outbreaks, 1978 (continued)

State	Month	Disease	Cases	Type of System	Location of Outbreak	System Deficiency*	Water Source
Oregon	July	AGI	174	Municipal	Town	3	Stream
Pennsylvania	February	AGI	91	Semipublic	Resort	4	Well
Pennsylvania	April	AGI	50	Semipublic	Camp	2	Well
Pennsylvania	May	Parvovirus-like agent	350	Semipublic	Camp	3	Well
Pennsylvania	June	*Shigella sonnei*	99	Semipublic	Camp	2	Well
Pennsylvania	July	Parvovirus-like agent	120	Semipublic	Camp	3	Well
Pennsylvania	August	AGI	63	Semipublic	Camp	2	Well
Pennsylvania	November	AGI	200	Municipal	School	4	Surface
South Carolina	September	*Salmonella* Group B	78	Municipal	Trailer park	3	Well
Tennessee	June	AGI	5	Individual	Work crew	2	Spring
Utah	July	*Giardia lamblia*	18	Individual	Picnic	1	Irrigation water
Vermont	May	*Campylobacter fetus* ss *jejuni*	3,000	Municipal	City	3	River
Washington	May	Parvovirus-like agent	467	Semipublic	School	4	Well
Washington	August	*Giardia lamblia*	23	Semipublic	Camp	1	Pond

*(1) Untreated surface water (2) Untreated ground water (3) Treatment deficiencies (4) Distribution system deficiencies (5) Miscellaneous

†filtration inadequate for *Giardia*

††contaminated ice

Guidelines for Confirmation of Waterborne Disease Outbreaks

Etiologic Agent	Clinical Syndrome	Laboratory and/or Epidemiologic Criteria
1. *Escherichia coli*	a) Incubation period 6-36 hours b) Gastrointestinal syndrome: majority of cases with diarrhea	a) Demonstration of organisms of same serotype in epidemiologically incriminated water and stool of ill individuals and not in stool of controls -OR- b) Isolation from stool of most ill individuals, organisms of the same serotype which have been shown to be enterotoxigenic or invasive by special laboratory techniques.
2. *Salmonella*	a) Incubation period 6-48 hours b) Gastrointestinal syndrome--majority of cases with diarrhea	a) Isolation of *Salmonella* organism from epidemiologically implicated water -OR- b) Isolation of *Salmonella* organism from stools or tissues of ill individuals
3. *Shigella*	a) Incubation period 12-48 hours b) Gastrointestinal syndrome--majority of cases with diarhrea	a) Isolation of *Shigella* organism from epidemiologically implicated water -OR- b) Isolation of *Shigella* organism from stools of ill individuals
4. *Vibrio cholerae*	a) Incubation period 24-72 hours b) Gastrointestinal syndrome--majority of cases with diarrhea and without fever	a) Isolation of *V. cholerae* from epidemiologically incriminated water -OR- b) Isolation of organisms from stools or vomitus of ill individuals -OR- c) Significant rise in vibriocidal, bacterial agglutinating, or antitoxin antibodies in acute and early convalescent sera, or significant fall in vibriocidal antibodies in early and late convalescent sera in persons not recently immunized
5. *Campylobacter fetus* ssp. *jejuni*	a) Incubation period not known b) Gastrointestinal syndrome--majority of cases with diarrhea	a) Isolation of *Campylobacter* organisms from epidemiologically implicated water -OR- b) Isolation of *Campylobacter* organisms from stools of ill individuals

6. Yersinia enterocolitica	a) Incubation period 3-7 days b) Gastrointestinal syndrome--majority of cases with diarrhea	a) Isolation of Yersinia organisms from epidemiologically implicated water b) Isolation of Yersinia organisms from stools of ill individuals c) Significant rise in bacterial agglutinating antibodies in acute and early convalescent sera
7. Leptospira	a) Incubation period 4-19 days b) Protean group of diseases--headache, conjunctivitis, rash, meningitis, etc.	a) Isolation of leptospires from epidemiologically implicated water b) Isolation of leptospires from blood of ill individuals c) Significant rise in bacterial agglutinating or complement fixing antibodies in acute and early convalescent sera
8. Others	Clinical data appraised in individual circumstances	Laboratory data appraised in individual circumstances
CHEMICAL		
1. Heavy metals Antimony Cadmium Copper Iron Tin Zinc, etc.	a) Incubation period 5 min. to 8 hours (usually less than 1 hour) b) Clinical syndrome compatible with heavy metal poisoning--usually gastrointestinal syndrome and often metallic taste	Demonstration of high concentration of metallic ion in epidemiologically incriminated water
2. Fluoride	a) Incubation period usually less than 1 hour b) Gastrointestinal illness--usually nausea, vomiting, and abdominal pain	Demonstration of high concentration of fluoride ion in epidemiologically incriminated water
3. Other chemicals	Clinical data appraised in individual circumstances	Laboratory data appraised in individual circumstances
PARASITIC		
1. Giardia lamblia	a) Incubation period: Variable; 1-4 weeks b) Gastrointestinal syndrome--chronic diarrhea, cramps, fatigue and weight loss	a) Demonstration of Giardia trophs in epidemiologically incriminated water -OR- b) Demonstration of Giardia trophs in stools or duodenal aspirates of ill individuals
2. Amebiasis	a) Incubation period: Variable; usually 2-4 weeks b) Variable gastrointestinal syndrome from acute fulminating dysentery with fever, chills, and bloody stools to mild abdominal discomfort with diarrhea	a) Demonstration of Entamoeba histolytica in epidemiologically implicated water - OR- b) Demonstration of Entamoeba histolytica in stools of affected individuals

3. Others	Clinical and laboratory data appraised in individual circumstances	

VIRAL

1. Hepatitis A	a) Incubation period 15-28 days b) Clinical syndrome compatible with hepatitis--usually including jaundice, GI symptoms, dark urine	Liver function tests compatible with hepatitis in affected persons who consumed the epidemiologically incriminated food
2. Parvovirus-like Agents (Norwalk, Hawaii, Miami)	a) Incubation period 16-72 hours b) Gastrointestinal syndrome--vomiting, watery diarrhea, abdominal cramps	a) Demonstration of virus particles in stool of ill individuals by immune electron microscopy -OR- b) Significant rise in antiviral antibody in acute and convalescent sera
3. Rotavirus	a) Inducation period 24-72 hours b) Gastrointestinal syndrome--vomiting, watery diarrhea, abdominal cramps	a) Demonstration of the virus in the stool of ill individuals
4. Enterovirus	a) Incubation period: Variable b) Syndrome: Variable; poliomyelitis, aseptic meningitis, herpangina, etc.	a) Isolation of virus from epidemiologically implicated water -OR- b) Isolation of virus from ill individuals
5. Others	Clinical evidence appraised in individual circumstances	Laboratory evidence appraised in individual circumstances

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1. Rosenberg ML, Koplan JP, Wachsmuth IK, et al. Epidemic diarrhea at Crater Lake from enterotoxigenic *Escherichia coli*. Ann Intern Med 1977;86:714-18.

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4. Zweighaft RM, Morens DM, Bryan JA. Viral Gastroenteritis. Practice of Medicine IV. (Chapter 12). Harper & Row, 1978:1-10.

5. Morens DM, Zweighaft RM, Vernon TM, et al. A waterborne outbreak of gastroenteritis with secondary person-to-person spread: Association with a viral agent. Lancet 1979;1:964-966.

J. Selected Waterborne Outbreak Articles, 1978, taken from Morbidity and Mortality Weekly Report

Giardiasis--Vail, Colorado

A multi-state outbreak of giardiasis in travelers to and residents of Vail, Colorado, occurred from March 14 to April 20, 1978. At least 49 confirmed cases were reported.

On April 13 a gastroenterologist in Petoskey, Michigan, reported the occurrence of giardiasis in 6 members of a family who had vacationed in Vail from March 23-25. All had epigastric pain, nausea, and weight loss. *Giardia lamblia* was confirmed in the stool specimen of 1 of the 6 patients. Additional information obtained from the Colorado State Health Department revealed that 13 cases of confirmed giardiasis had been reported from Colorado (7 from Colorado Springs, 6 from Denver), and 12 more confirmed cases from the state of New York--all in individuals who had visited Vail during the last week in March.

An epidemiologic investigation was begun by the Colorado Department of Health and CDC. Information was obtained on 777 long-term Vail residents by means of a questionnaire and stool survey. Of those surveyed, 465 (60%) gave a history of diarrheal illness within the past 3 months. A rise in the number of acute diarrheal illnesses began March 14-16 and reached a peak April 1-12 (Figure 3).

There were no differences in attack rate by age or sex. Long-term (≥7 days) and short-term (<7 days) diarrheal illness peaked at similar periods of time. The local hospital's routine examinations of stools for bacterial pathogens were negative.

Because contaminated water is a frequent cause of outbreaks of giardiasis, the Environmental Protection Agency and CDC reviewed the city's recent records of weekly sewage output. During the week of March 28-April 3, the number of gallons of sewage produced had dropped approximately 50%. This coincided with a sewer-line obstruction and leak into the creek supplying water to the city that had been discovered on March 31 and corrected. Meter readings of gallons of sewage had returned to normal by the next week. Cases continued to occur, however, up to the day of the survey, but at a much reduced level. Water from the creek and the storage tanks was filtered for *Giardia* cysts and viral pathogens by the EPA. *Giardia* cysts were found in treated water in 1 water district in Vail.

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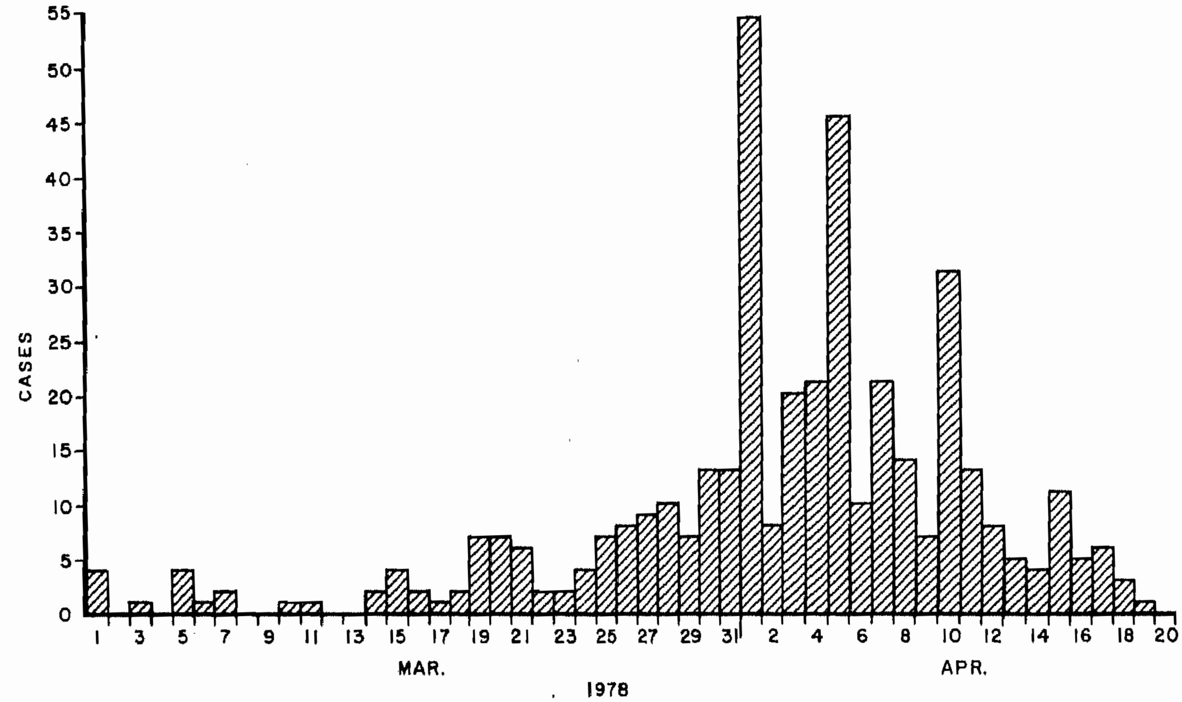
Editorial Note: The fact that many cases occurred after discovery of the sewer-line obstruction is probably a reflection of the long giardiasis incubation period (variable, but approximately 7 days) and the continued use of water from contaminated storage tanks. As dilution with fresh water occurred, illness disappeared.

Fig. 3 CASES OF DIARRHEAL ILLNESS IN HOUSEHOLDS, BY DATE OF ONSET, VAIL, COLORADO, MARCH 1 – APRIL 20, 1978



Physicians examining patients who have recently traveled to Vail should be alert to symptoms compatible with giardiasis--diarrhea, abdominal cramps, gas, anorexia, and weight loss. Because the Giardia organism is intermittently excreted, 3 stool specimens obtained on different days may be needed to confirm the diagnosis.

Gastroenteritis Associated with a Sewage Leak--Missouri, Arkansas

In the period May 7-26, 1978, at least 750 cases of gastroenteritis associated with a sewage leak occurred in southern Missouri and adjacent portions of Arkansas.

On May 9 the sanitarian of the West Plains Branch of the Missouri Department of Social Services, Division of Health, notified state health officials of several outbreaks of gastroenteritis in high school teams that had visited West Plains on May 6 for a regional intramural sports day. All of the patients had eaten at a local restaurant approximately 33 hours before onset of the illness, which was characterized by nausea, vomiting, diarrhea, and chills and lasted approximately 24-48 hours. Illness was specifically associated with drinking water and ice-containing beverages.

Subsequent investigation revealed that the municipal sewage lagoon--an open sewage-oxidation pond, 36 acres in size--had leaked approximately 18 million gallons of contents into the ground on May 5-6. Additional leaks developed later. The surrounding rural terrain is hilly and composed of porous limestone with numerous subterranean streams, permitting rapid movement of ground water. The direction of flow of the ground water is in a southeasterly direction towards Mammoth Spring, Arkansas.

The area has a large number of private wells which serve as individual water sources. When examined, the well supplying the restaurant involved in the common-source outbreak was found to be contaminated. Contamination in other areas was ascertained by sampling wells throughout Howell and Oregon counties, Missouri. This revealed contamination rates of 60% in wells south-southwest of West Plains, 48% in those east of West Plains, 34% in those southeast of West Plains, 33% in those due south of West Plains, and 33% in the wells north-northwest of West Plains.

Intensive surveillance systems to ascertain the extent of gastroenteritis were established by the Missouri and Arkansas departments of health. Physicians, hospitals, and medical personnel in the affected areas were contacted. In addition, an alert to boil water was issued for portions of Howell and Oregon counties, and for the 6 counties in northern Arkansas that were potentially involved. All municipal water supplies in the 2 affected counties in Missouri had emergency chlorination increased to a level of 2 parts per million.

Cultures of more than 200 stool specimens from acute cases were negative for bacterial enteric pathogens. As of May 25 the surveillance systems had accumulated information on approximately 750 cases of gastroenteritis in Howell and Oregon counties. Preliminary analysis of symptoms in 579 ill individuals revealed the following: diarrhea (69.8%), nausea (64.4%), vomiting (54.9%), cramps (50.8%), fever (28.8%), chills (16.2%), prostration (11.7%), and headache (8.3%).

Intensive epidemiologic investigations by the Arkansas Department of Health revealed no increases in gastrointestinal illness associated with the sewage leak. Several cases were uncovered in Mammoth Spring, but all had a history of travel to West Plains before onset of illness. Although underground streams empty into Mammoth Spring, repeated water samples from that city and others in the potentially affected areas of Arkansas have not shown any increase in coliform or nitrate levels.

Reported by PE Phillips, DVM, B Poor, RN, J Wooldridge, BS, West Plains Br, HD Donnell, Jr, MD, State Epidemiologist, W Raithel, DVM, Missouri State Dept of Social Services, Div of Health; T Skinner, PC White, Jr, MD, State Epidemiologist, Arkansas State Dept of Health; Field Services Div, Viral Diseases Div, Bur of Epidemiology, CDC.

Editorial Note: This outbreak illustrates a major multiple-county outbreak of acute gastroenteritis associated with a sewage-lagoon leak. The terrain of the area involved combined with the numerous unchlorinated private wells appears to be responsible for the magnitude of the outbreak. The sewage lagoon involved has had a history of leakage on 3 previous occasions in the past 15 years, but this is the first time that related illness has been recognized. The fact that the stool cultures were negative when tested for bacterial enteric pathogens suggests a possible viral etiology.

Waterborne Campylobacter Gastroenteritis--Vermont

A large outbreak of acute gastroenteritis occurred in Bennington, Vermont, during the 2-week period beginning May 28, 1978. An estimate from a household survey indicated that as many as 2,000 of the town's 10,000 residents may have been affected by the illness. The number of cases peaked on June 4. Epidemiologic investigation showed a strong association between illness and the consumption of water from the town supply ($p < .005$).

The illness was characterized by abdominal pain or cramps (88%), diarrhea (83%), malaise (76%), headache (54%), and fever (52%). Symptoms generally lasted 1-4 days. All age groups and both sexes were affected equally. All areas of the town, including those along the main supply line, had similar attack rates, ranging from 14% to 23%. There was no evidence of secondary spread in households.

Initial laboratory studies in a Bennington hospital for all common bacterial and parasitic pathogens did not identify the organism. Subsequently, rectal swab specimens from 5 of 9 cases cultured at CDC were positive for *C. fetus* ssp. *jejuni*. None of 20 rectal swab specimens from nonill controls from the Bennington area were positive.

Bennington has a new water treatment plant under construction, but its present main water supply comes from surface water east of town. This water is chlorinated but not filtered. There are 2 supplementary sources of water that are used when there is low pressure in the main system; neither is chlorinated. One of these sources had not been used since February; the other turns on automatically when pressure is low. Records show that throughout the period of the outbreak, water specimens from several areas of the town had no residual chlorine.

Attempts to isolate *Campylobacter* organisms from town water and from wild and domestic animals within the watershed area of the town water supply were unsuccessful.

Reported by W Tiehan, MD, Putnam Memorial Hospital, Bennington; RL Vogt, MD, Acting State Epidemiologist, Vermont State Dept of Health; Environmental Protection Agency; Enteric Diseases Br, Bacterial Diseases Div, Bur of Epidemiology, CDC.

Editorial Note: This is the first outbreak of Campylobacter diarrhea described in the United States, although isolates of what is now called C. fetus ssp. jejuni have been made occasionally from blood specimens obtained from individuals in the United States with diarrhea (1,2). Formerly called Vibrio fetus, this organism has been found previously in domestic livestock and fowl.

In 1973 isolation of these organisms from stools was described in Belgium (3). A study in England in 1977 described a routine procedure for isolation of C. fetus ssp. jejuni requiring a microaerophilic culture technique, incubation at 43 C (110 F), and a culture medium including vancomycin, polymyxin B, and trimethoprim (4). This method was used in studying material in the Vermont outbreak.

Campylobacter gastroenteritis has recently been described in persons with diarrhea in Rwanda and in Canada (5,6). As the techniques for isolation of Campylobacter organisms become routine a clearer idea of the frequency with which C. fetus ssp. jejuni occurs with diarrhea in the United States should emerge.

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III. SUMMARY OF WATERBORNE OUTBREAKS, 1971-1978

A. Sources of Data

The surveillance system described in Section II has been in effect since 1971. Sources of data and definitions of outbreaks before 1971 varied. In the period 1920-1936, the American Public Health Association collected statistics on waterborne disease outbreaks from state health departments (1,2,3). A waterborne outbreak was included in the report only if 5 or more persons were ill and a public or semipublic water supply was implicated. Outbreaks related to individual systems were not included. Information concerning waterborne outbreaks in 1937 could not be located. Data collected by the U.S. Public Health Service from state health departments for the period 1938-1945 were presented to Congress in 1947 (4) and summarized by Eliassen and Cummings (5). Outbreaks attributed to public, semipublic, and individual water supplies were included, and an outbreak was included if 2 or more persons became ill and there was epidemiologic or laboratory evidence of water contamination. Outbreaks for the period 1946-1960 were reported by Wiebel et al (6). To be considered an outbreak during this period, a death or at least 2 cases of a specific disease had to be identified and reported to the Public Health Service. Additional outbreaks were found by review of medical and engineering literature, and through inquiries to state and local health departments. For the decade 1961-1970, summaries of waterborne disease outbreaks appeared (7,8) based on data compiled by the U.S. Public Health Service and EPA. With the exception of chemical poisoning, an outbreak was defined as 2 or more persons with illness attributed to contaminated drinking water. The primary source of information about outbreaks of waterborne disease for 1961-1970 was the state health departments. Additional reports were obtained from newspapers, sanitarians, engineers, and reviews of the medical and engineering literature. Reviews of waterborne disease outbreaks in the 1970s were numerous (9-15).

B. Comments

In the period since the present surveillance system for waterborne disease outbreaks was established in 1971, 224 documented waterborne outbreaks have been reported to CDC (Table 4). The average number of outbreaks reported for the years 1976, 1977, and 1978 (33.7) represents a 40% increase over the 5-year average for 1971-1975. Increased reporting by certain states probably accounts for the increased number of reported outbreaks in the period 1976-1978. The number of outbreaks reported by state is shown in Figure 4. All but 8 states have reported at least 1 outbreak due to waterborne transmission. Figure 5 depicts the trend in reported waterborne disease outbreaks in the period 1938-1978; as noted above, sources and definitions for these data are not uniform. Fifty-five percent of these outbreaks were of unknown etiology, 11% were caused by Giardia, 10% by chemicals, 9% by Shigella, 6% by hepatitis virus (presumably type A), 3% by Salmonella, 2% by Salmonella typhi, and 2% by viruses; 1 outbreak was due to enterotoxigenic Escherichia coli and 1 to Campylobacter (Table 5). The number of reported waterborne outbreaks due to hepatitis A has declined dramatically since 1971, and no waterborne outbreaks of typhoid fever have been identified since 1974. The majority of the outbreaks for 1971-1978 occurred in the summer months (Figure 6), probably reflecting the abnormal demands placed on semipublic water supplies by the seasonal influx of visitors and tourists.

Table 4 Waterborne Disease Outbreaks, 1971-1978

	1971	1972	1973	1974	1975	1976	1977	1978	Total
Outbreaks	19	30	24	26	24	35	34	32	224
Cases	5182	1650	1784	8363	10879	5068	3860	11435	48246

Table 5 Waterborne Disease Outbreaks by Etiology and Year, 1971-1978

	1971	1972	1973	1974	1975	1976	1977	1978	Total (%)
Acute gastrointestinal illness	9	13	13	11	17	25	19	16	123(55)
Giardiasis	0	4	3	5	1	3	4	4	24(11)
Chemical	1	3	0	5	3	3	6	2	23(10)
Shigellosis	3	3	4	3	1	2	1	4	21(9)
Hepatitis A	6	5	2	0	1	0	1	0	15(6)
Salmonellosis	0	1	0	1	0	1	2	2	7(3)
Viral gastroenteritis	0	0	0	0	0	1	1	3	5(2)
Typhoid fever	0	1	2	1	0	0	0	0	4(2)
Enterotoxigenic E. coli	0	0	0	0	1	0	0	0	1(1)
Campylobacter fetus ssp jejuni	0	0	0	0	0	0	0	1	1(1)
TOTAL	19	30	24	26	24	35	34	32	224(100)

Fig. 4 WATERBORNE DISEASE OUTBREAKS, UNITED STATES, 1971-1978

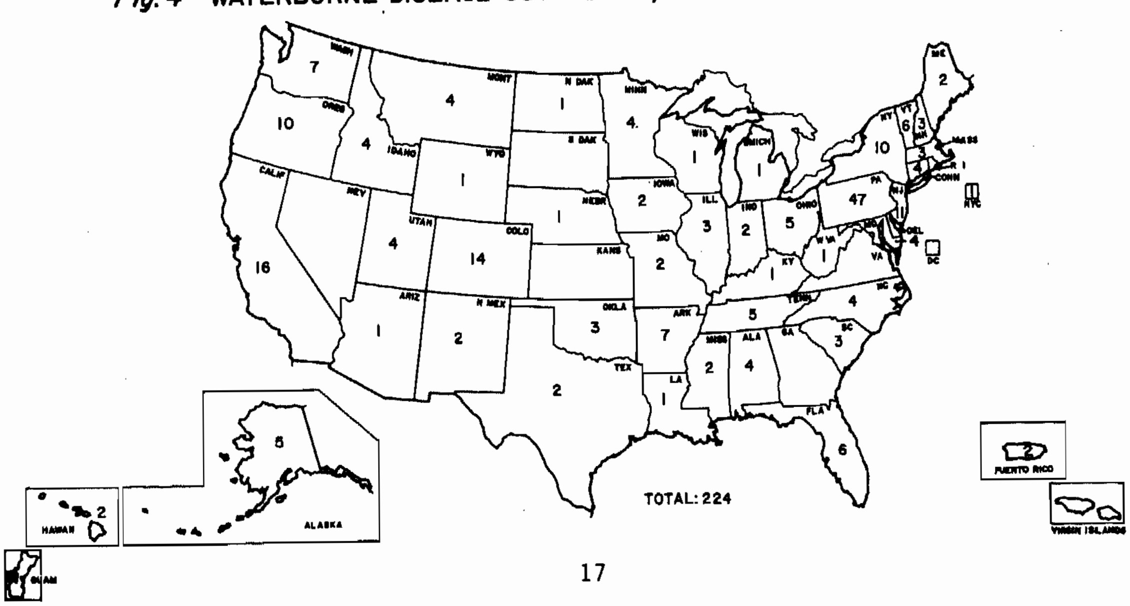
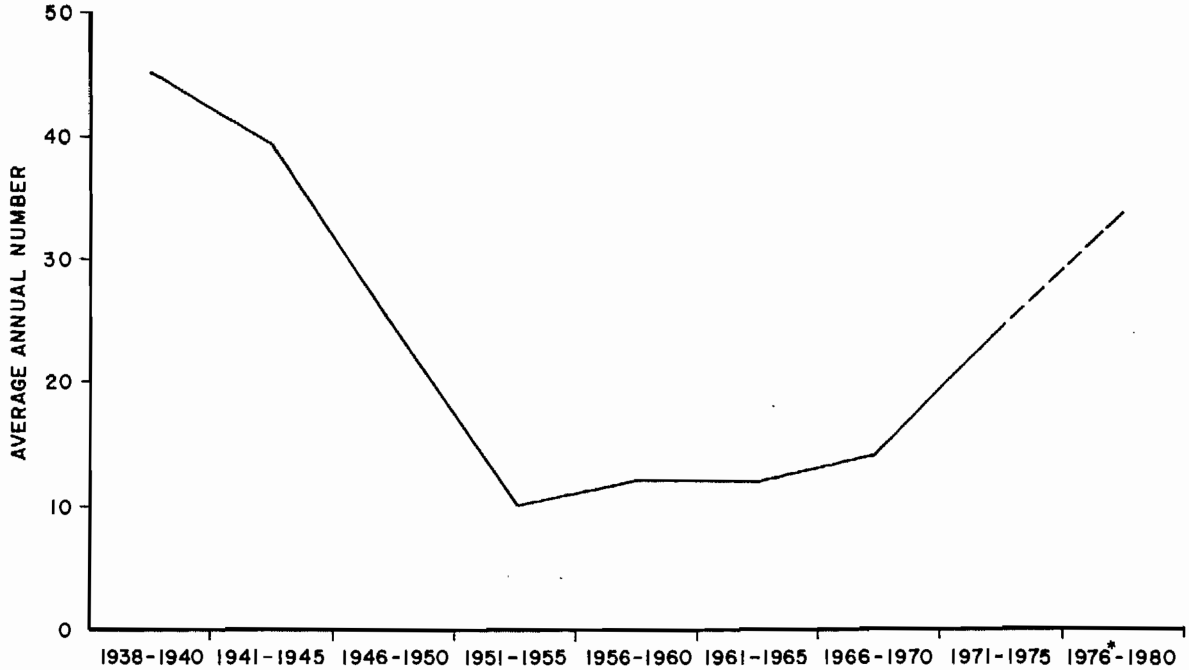
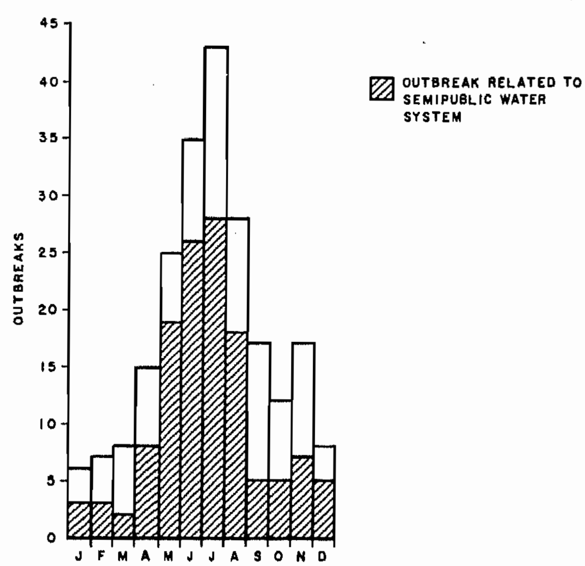


Fig. 5 AVERAGE ANNUAL NUMBER OF WATERBORNE DISEASE OUTBREAKS, 1938 - 1978



*NUMBER OUTBREAKS 1976-1978

Fig. 6 OUTBREAKS OF WATERBORNE DISEASES, BY MONTH, UNITED STATES, 1971-1978



In tabulating these data, several outbreaks were assigned to the year they began rather than the year in which they were originally reported. In addition, the etiology of 2 outbreaks has been reclassified. Both were previously listed as acute gastrointestinal illness and are now recognized as due to parvovirus-like agents. One occurred in December 1976 in Colorado and affected 110 people while the other occurred in 1977 in Wyoming and affected approximately 400 people.

The largest group of reported outbreaks were associated with use of semipublic water supplies (Table 6) and were due to treatment deficiencies and the use of untreated ground water (Table 7). Most deficiencies in municipal systems were defects in the distribution system, such as cross-connections. Treatment deficiencies such as failure of a chlorinator were the second most common cause of outbreaks associated with municipal systems (Table 7).

Table 6 Waterborne Disease Outbreaks, by Year and Type of System, 1971-1978

	1971	1972	1973	1974	1975	1976	1977	1978	Total(%)
Municipal	5	10	5	11	6	9	12	10	68 (30)
Semipublic	10	18	16	10	16	23	19	18	130 (58)
Individual	4	2	3	5	2	3	3	4	26 (12)
TOTAL	19	30	24	26	24	35	34	32	224(100)

Table 7 Waterborne Disease Outbreaks, by Type of System and System Deficiency, 1971-1978

	Municipal	Semipublic	Individual	Total	(%)
Untreated surface water	8	8	10	26	(12)
Untreated ground water	7	54	11	72	(32)
Treatment deficiency	22	51	0	73	(33)
Deficiency in distribution system	26	7	1	34	(15)
Miscellaneous	5	10	4	19	(5)
TOTAL	68 (30%)	130 (58%)	26 (12%)	22	(100)

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IV. DISEASE OUTBREAKS RELATED TO RECREATIONAL WATER USE, 1978

A. Sources of Data

As with disease outbreaks associated with drinking water, the sources of data for these outbreaks are the state epidemiologists and their staffs. However, the reporting of disease outbreaks related to recreational water use is not systematic; therefore, the outbreaks reported here certainly represent a small fraction of the total number that occur. The likelihood of an outbreak coming to the attention of health authorities varies considerably from 1 locale to another depending largely upon consumer awareness and physician interest. We include in this section infections or intoxications related to recreational water, but have specifically excluded wound infections caused by water- related organisms. Before 1978 outbreaks or cases of disease related to recreational use of water were not tabulated so comparisons with previous years cannot be made.

B. Comments

In 1978, 8 outbreaks or single cases of illness related to recreational use of water were reported to CDC (Section C).

In 1978, 3 of the outbreaks, each consisting of only 1 case, were due to infections with the free-living ameba, *Naegleria fowleri*. Two of the 3 cases were fatal. The only survivor was a 9-year-old California girl who became ill in May 1978.

Primary amebic meningoencephalitis (PAM) is an infection of the central nervous system caused by free-living amoeba of the genera *Naegleria* and *Acanthamoeba*. Most cases caused by *Naegleria* occur in the summer within 5-8 days after swimming in warm, fresh or brackish water. The portal of entry is probably the nasal mucosa overlying the cribiform plate (1,2). Since PAM was first described in 1965, over 80 cases have been reported, including about 35 in the United States.

The risk of infection from swimming in water containing *Naegleria* is unknown but probably small. In Florida, millions of people swim in lakes known to contain these organisms yet only 7 cases of PAM have been recognized there in 14 years (3).

An outbreak of schistosome dermatitis (swimmer's itch) occurred in August 1978 on a private beach of a freshwater lake in Vermont. Visiting the beach and swimming in the water were factors significantly associated with the disease. Furthermore, attack rates doubled for those swimming more than 1 hour (attack rate 95%) compared with those swimming less than 1 hour (attack rate 44%). These epidemiologic data were supported by the recovery of schistosomes from snails at the beach.

Pseudomonas aeruginosa, particularly serogroup 0-11, has been implicated in a number of outbreaks of skin infection over the last several years (4-8). In 1978, 2 outbreaks were reported to CDC. A whirlpool-associated outbreak involved 27 members of a racquet-ball club in Maine. There was a significant association between presence at the club on Sunday, December 10, and illness 2 days later. No secondary cases occurred. *P. aeruginosa* was cultured from 1 skin lesion and 1 of 2 whirlpools. The second outbreak of *Pseudomonas* follicular dermatitis represents the first outbreak associated with a swimming pool. Fourteen cases of pustular dermatitis occurred in members of a snowmobile club who swam in a motel pool in Montana. *P. aeruginosa* serotype O-11 was isolated from a pustule in 1 person and from the carpet that surrounded the pool. In these latter 2 outbreaks chlorination of the pools was sporadic and was not monitored.

In addition, 2 other similar outbreaks, 1 of folliculitis and 1 of otitis externa, occurred in persons who swam in public swimming pools. In 1, approximately 200 people who used a public swimming pool in California developed a pustular skin rash similar to that seen with *Pseudomonas*. No cultures were taken. Chlorine residuals in the pool had been 1.0 to 1.5 ppm, and cyanuric acid had been used as a stabilizer. In the other outbreak, 8 of 10 members of 2 families traveling together developed external ear infections after swimming in a Minnesota hotel swimming pool. Cultures were not done.

C. Line Listing of Disease Outbreaks Related to Recreational Water Use, 1978

State	Month	Disease	Cases	Nature of Water
California	May	Primary amebic meningoencephalitis	1	Fresh water hot spring
Florida	July	Primary amebic meningoencephalitis	1	Fresh water lake
South Carolina	September	Primary amebic meningoencephalitis	1	Fresh water lake
Vermont	August	Schistosome dermatitis	30	Fresh water lake
California	July	Folliculitis	200	Public swimming pool
Maine	December	*Pseudomonas* folliculitis	27	Whirlpool
Minnesota	October	Otitis externa	8	Hotel swimming pool
Montana	February	*Pseudomonas* folliculitis	21	Hotel swimming pool

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E. Selected Articles, 1978, taken from Morbidity and Mortality Weekly Report

Primary Amebic Meningoencephalitis--California, Florida, New York

Seven cases of primary amebic meningoencephalitis (PAM), a rare disease that affects the central nervous system, have recently been reported to CDC. Details of 3 of these cases follow. One, acquired in California, is the first nonfatal case described in the United States.

California: A previously healthy 9-year-old girl was hospitalized May 27, 1978, after a 3-day history of headache, nausea, vomiting, lethargy, and stupor. Examination of cerebrospinal fluid (CSF) revealed ameboid organisms. She developed papilledema, seizures, and left focal neurologic signs and became comatose. She was treated with intravenous and intrathecal amphotericin B, miconazole--an investigational drug effective *in vitro* against *Naegleria*, the most common cause of PAM--and oral rifampin. Her condition improved after 48 hours, and within a month she had recovered completely with no significant neurologic sequellae. Culture of her initial CSF specimens yielded *N. fowleri*.

One week before onset she had bathed in a hot spring near San Bernardino. This same hot spring was implicated as the source of infection in a fatal case of PAM in 1971 (1).

Florida: On July 2, a 14-year-old boy began to complain of a progressive, severe, frontal and bitemporal headache. He had been swimming and diving in a fresh water lake for the past 3 weeks. He developed a low grade fever and malaise, and on July 4 was admitted to the hospital with mild nuchal rigidity, lethargy, and fever of 40 C. Examination of the CSF revealed a cell count of $3900/mm^3$, a glucose of 13 mg/dl, and a protein of 490 mg/dl. Motile amebae (N. fowleri) were seen on the initial wet mounts. The patient deteriorated rapidly, becoming disoriented, agitated, and then comatose. Despite therapy with amphotericin B, neurogenic pulmonary edema ensued. Just before receiving miconazole the patient developed cerebral edema and herniation. He died 3 days later.

New York: An 11-year-old girl who had not recently traveled or gone swimming was admitted to a hospital May 27 with a 2-day history of headache, vomiting, fever, and nuchal rigidity. Spinal fluid realed many neutrophils, and routine cultures were negative. Her condition deteriorated, and she died 8 days after onset. Autopsy revealed a vasculitis and meningoencephalitis. Amebae identified as Acanthamoeba species were found on fixed sections.

Reported by JS Powers, MD, Victor Valley Community Hospital; R Abbott, MD, L Boyle, M Lee, MD, R Rudas, MD, San Bernardino County Hospital; K Mackey, MPH, L Mahoney, MD, DrPH, San Bernardino County Health Dept; A Cohen, MD, J Edwards, MD, P Harmatz, MD, J Seidel, MD, PhD, J Turner, MD, Harbor General Hospital, Los Angeles; J Chin, MD, State Epidemiologist, C Powers, C Taclindo, MPH, California Dept of Health; CG Culbertson, Eli Lilly Company, Indianapolis, Indiana; S Lee, MD, RM Prudente, MD, New York City; E Galaid, MPH, C Wang, MD, MPH, New York City; JS Marr, MD, City Epidemiologist, Bur of Preventable Diseases; M Cichon, MD, Tampa, Florida; RM Yeller, MD, Acting State Epidemiologist, Florida State Dept of Health and Rehabilitative Services; Field Services Div, Parasitic Diseases Div, Bur of Epidemiology, CDC.

Prompt diagnosis, early treatment with miconazole, amphotericin B, and rifampin, and careful fluid management were probably responsible for the survival of the California patient. Intrathecal therapy appears critical since amphotericin and miconazole otherwise do not reach therapeutic levels in the CSF. The CDC Parasitic Disease Drug Service does not distribute miconazole but can help physicians obtain the drug for patients.

The risk of infection from water containing Naegleria organisms is unknown but probably small, since thousands of people swim in lakes known to contain these organisms, yet cases of PAM are rare. In the United States no cases have been associated with man-made swimming pools.

Acanthamoeba, another free-living ameba, generally causes subacute or chronic infections, rather than the fulminant meningoencephalitis reported here. Its mode of transmission is unknown.

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Rash Associated with Use of Whirlpools--Maine

Twenty-seven members of a new racquetball club in South Paris, Maine, developed a rash illness in the period December 9, 1978-January 6, 1979. In a follow-up investigation, the club's 2 whirlpools were found to be statistically associated with illness.

The generalized and nonpruritic rash began as a single crop of discrete, maculopapular lesions, a few millimeters in diameter, which soon developed either a vesicle or a pustule on the apex. The lesions crusted over in a few days, and by the seventh day they were disappearing without treatment. Most of the lesions were on the trunk or proximal extremities. They were not found on the palms, soles, head, or neck. No lesions were noted on mucosal surfaces. The lesions were predominant around the axillae and pelvis.

Although the majority of patients--who included 16 men and 11 women--had no symptoms, 8 had painful axillary adenopathy, 7 reported headache, and 5 noted myalgia.

Three patients had chills and low grade fever. Five of the patients, 3 men and 2 women, had painful breasts.

The cause of the rash was not initially apparent, but a survey of physicians and school nurses in the area indicated that only members of the racquetball club were affected. Results of a questionnaire, administered on December 15 to 20 patients and 18 control members from the club, demonstrated a significant association between using the club on December 10, a day of unusually heavy use, and becoming ill during the next 2 days ($p<0.002$). A significant association was found between using the men's or women's whirlpool on December 10 and developing rash ($p<0.03$) within the next 2 days. No association was found between rash and the use of any other facility at the club.

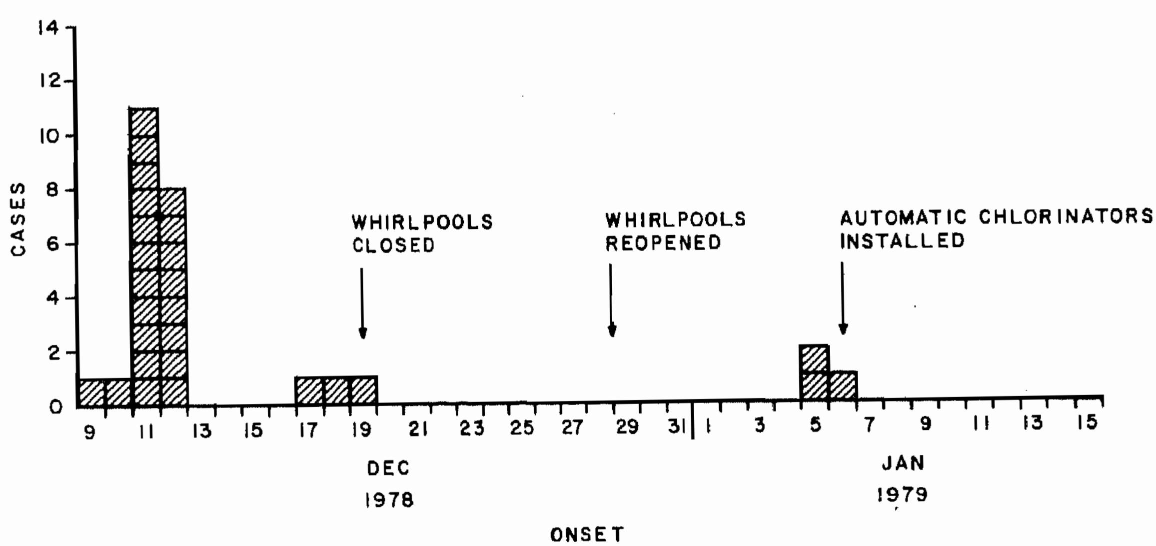
P. aeruginosa was isolated from the skin lesions of 2 of the patients on December 12 and December 19, respectively. One of these isolates was sent to CDC for serotyping and found to be serotype 0-11. A culture of water from the men's whirlpool, taken on December 19, grew P. aeruginosa serotype 0-11. Stool, pharyngeal, and vesicle swabs from 6 of the patients did not grow any viruses in tissue culture.

Investigation revealed that the 2 implicated whirlpools had been chlorinated by hand each morning. Peak levels of free residual chlorine, measured on the morning of December 19 by the N,N diethylparaphenylinediamine (DPD) method, were 0.7 parts per million (ppm) in the men's whirlpool and 1.2 ppm in the women's whirlpool.

Once the statistical association between illness and use of the whirlpools had been demonstrated, the whirlpools were closed from December 19 to December 29. During this period the filters were changed, and the whirlpools were drained and acid-washed.

No more cases occurred until after January 1, when the whirlpools were reopened. Three women who had used the women's whirlpool on January 3 developed a rash January 5-6. Automatic chlorinators that maintain a free residual chlorine level of 1 ppm were installed on January 6. No subsequent cases have been reported (Figure 7).

Fig. 7 **RASH ILLNESS AMONG MEMBERS OF RACQUET BALL CLUB, BY DATE OF ONSET, MAINE, DECEMBER 9, 1978 – JANUARY 15, 1979**



A recent survey of 5 other whirlpools in similar commercial health clubs in Maine found that the water from 3 of them had confluent growth of P. aeruginosa. One of the 3 isolates was serotype 0-11. No rash illness was observed at any of these clubs.

Reported by MA Lacombe, MD, HS Sodhi, MD, Norway, Maine; J Datsis, S Zineski, MD, Acting State Epidemiologist, Maine State Dept of Human Services; Special Pathogens Br, Bacterial Diseases Div, Field Services Div, Bur of Epidemiology, CDC.

Editorial Note: Several outbreaks of rash caused by P. aeruginosa serotype 0-11 and associated with the use of whirlpool baths have been reported (1-4). The rash has been described as intensely pruritic, progressing from a maculopapular to vesiculopustular eruption within hours to several days after exposure. Other systemic manifestations have been uncommon. In this outbreak the rash was nonpruritic, and nearly one-third of the infected individuals had no other systemic manifestations including painful lymphadenopathy.

Pseudomonads are well adapted to survival in water, and whirlpools appear especially prone to contamination because of the difficulty in maintaining adequate chlorination in the presence of high temperatures, turbulent flow, and a large amount of organic debris. Automatic chlorinators may help to maintain adequate levels of free chlorine--1.0 ppm free residual chlorine continually (5)--in these systems.

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V. OUTBREAKS OF ACUTE GASTROINTESTINAL DISEASE ON OCEAN-GOING VESSELS

A. Sources of Data

After shipboard outbreaks of typhoid fever (1), viral gastroenteritis, and shigellosis (2) in 1971-1973, a review of ships' medical logs revealed an incidence of gastrointestinal illness on passenger cruise ships of 1% or less on 92% of cruises and 5% or greater on 2% of cruises (3). Shortly thereafter, the CDC's Bacterial Diseases Division and Quarantine Division established a surveillance system for shipboard gastrointestinal illness which required vessel masters to report all cases of diarrheal illness seen by the ship's physician as a part of his request for radio pratique (permission to enter a port). These reports are made by radio 4 to 24 hours before arrival in port and are logged by quarantine officers for forwarding to CDC monthly. In the event that 3% or more passengers on any 1 cruise visit the ship's physician with gastrointestinal disease, a quarantine officer will board and inspect the ship and then telephone a report to the Center for Disease Control. Based on his report, the Enteric Diseases Branch may perform an in-depth investigation of the outbreak.

The Quarantine Division performs a vessel sanitation inspection on each cruise ship semiannually (Section C) or more frequently if indicated by poor sanitary ratings. Since the sanitation rating represents the results of an inspection carried out at dockside on a given day, this rating may not reflect the sanitary conditions at sea. In 1978, however, results of the ships' reports of diarrheal illness since 1975 were compared with the vessel sanitation inspection reports for the same period. The number of outbreaks of diarrheal illness was significantly less on vessels with sanitation scores that met the Public Health Service standards than on vessels which did not (4).

B. Comments

In 1978 CDC personnel investigated 3 outbreaks of diarrheal illness on cruise ships that sailed between U.S. ports and Caribbean or Mexican ports. In only 1 instance was an etiologic agent identified; in that instance 267 people had shigellosis. Also in only 1 instance was a vehicle identified; in that outbreak, 245 people had an illness of unknown etiology epidemiologically linked to contaminated drinking water.

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
BUREAU OF EPIDEMIOLOGY
QUARANTINE DIVISION

VESSEL SANITATION INSPECTION REPORT

I. IDENTIFICATION AND SCORE

NAME OF VESSEL	NATIONALITY	NO. PAX	NO. CREW	TOTAL SCORE	RESULTS EXPLAINED TO

INSPECTION DATE (mo/day/yr)	U.S. QUARANTINE STATION	TYPE OF EVALUATION
PORT	OWNER OR GENERAL AGENT	☐ Semi-annual ☐ Follow up ☐ Other
Local Agent's Name	Signature of each Quarantine Inspector conducting inspection	

Rating
(By Center for Disease Control Standards)
☐ 85-100 = Meets Std.
☐ 0- 84 = Does Not Meet Std.

II. RESULTS OF EVALUATION

√ = acceptable X = Defective — = not applicable or not observed

Item No.	Item Wt.	√ X —	ITEM	Item No.	Item Wt.	√ X —	ITEM
	20		**A. WATER**		20		**D. POTENTIAL CONTAMINATION OF FOOD**
1			FW tanks chlorinated to 2 ppm(mg/l)	23			Handwashing facilities, soap and single service towels within 25 ft. (8 meters) of any food service, preparation, or storage area
2			PW distribution system treated by approved chlorination or UV system	24			No food handlers with diarrhea or infected skin lesions including boils
3			Acceptable evidence of potability	25			Minimum handling in preparing and serving cooked or raw food
4			≥0.2 ppm free chlorine residual (not applicable to UV systems)	26			Same equipment and containers not used for processing or storing cooked and raw foods without thorough intermediate cleaning and sanitizing; adequate shelving
5			No cross connections between potable & non-potable water supply				
6			Only PW supplied to galley, other food service areas and hospital	27			All dishes, equipment, and utensils washed and sanitized properly
7			Swimming pools not used in port unless recirculating and system chlorinated	28			Cutting boards and other equipment in good repair — no open seams or corrosion
8			PW filling hose and storage acceptable				
9			PW bunkering acceptable	29			Food not subjected to sewage drippage, overflow, backflow, blocked drains, or other potential contamination
10			No possibility of backflow				
11			Sample cocks on FW and PW Tanks	30			Ice storage and handling acceptable
	20		**B. REFRIGERATION**	31			Pesticides and other toxic substances properly labeled and not stored in the same room with food
12			Foods leftover or cooked in advance refrigerated within 30 min. or held at ≥140°F (60°C)	32			Sewage and waste disposal satisfactory
13			Foods leftover or cooked in advance stored to a depth of not more than 4 inches (10cm)				**E. PERSONAL CLEANLINESS OF FOOD HANDLERS**
14			All refrigeration ≤40°F (4°C)	33	2		Food handlers apparently healthy. No fever, colds, jaundice, sore throat, etc.
15			All meat, poultry and fish thawed so that no part of the product reaches a temperature of 45°F (7°C) during the thawing process	34	2		Hands washed after using toilet
16			Cooked foods and raw foods stored in separated sections of refrigerators, and adequate shelving	35	2		No evidence of other poor personal hygiene practices while on duty such as smoking, coughing, sneezing, touching sores, working in dirty clothes
17			Displayed cold food including cream filled pastries on buffet or other tables ≤45°F (7°C)	36	2		Hands thoroughly washed after touching raw foods of animal origin
18			Accurate thermometers provided in all refrigerators	37	2		Handwashing signs in appropriate languages
	20		**C. FOOD PREPARATION**				**F. GENERAL CLEANLINESS AND REPAIR**
19			Food held in warming devices ≥140°F (60°C)	38	2		Decks, bulkheads, deckheads clean and in good repair
20			Stuffed poultry, turkey and meat cooked to internal temperature ≥165°F (74°C)	39	2		Storage racks and shelves clean and in good repair
21			Pork cooked to internal temperature of ≥150°F (66°C)	40	2		Refrigerators and freezers clean and in good repair
22			Leftover cooked food reheated to an internal temperature of ≥165°F (74°C)	41	2		Dry storage area clean, in good repair, and adequate shelving
				42	2		Pest control programs effective

III LOG REVIEWS AND LABORATORY INFORMATION

MEDICAL LOG REVIEW

Dates From	Dates To	Cruise Length (days)	Diarrheal Illness Pax	Diarrheal Illness Crew

Refrigerator Log Review	☐ Accept.	☐ Not Accept.
Chlorine Recorder Chart Review	☐ Accept.	☐ Not Accept.
Membrane Filter Review	☐ Accept.	☐ Not Accept.

LABORATORY ANALYSIS

	Water Tanks	PW Dist. System
No. Water Samples Collected		
No. Coliform Positive		

DO NOT WRITE IN THIS SPACE

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RADIO CALL SIGN	DATE OF INSPECTION

V. RESULTS, REFERENCES, AND RECOMMENDATIONS

THE FOLLOWING INFORMATION IS PROVIDED REGARDING ITEMS WHICH WERE DEFECTIVE. ADDITIONAL INFORMATION CORRESPONDING TO EACH REFERENCE NUMBER IS AVAILABLE IN THE **GUIDE TO SHIP SANITATION**, WORLD HEALTH ORGANIZATION, 1967, AND THE **CENTER FOR DISEASE CONTROL RECOMMENDATIONS ON SANITATION**, OCT. 17. 1974.

ITEM NO.	REFERENCE NO.	RESULTS AND RECOMMENDATIONS

CDC 4.467-2
1-76

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VI. WATER-RELATED DISEASES IN DEVELOPING AREAS

A. Comments

Safe drinking water and its corollary, proper sanitation, are usually taken for granted in the more affluent countries of the world but are at a premium in the developing countries. This concern expressed itself in several recent large international conferences convened by the United Nations. Water supply and sanitation as essential health measures particularly in respect to rural and urban fringe populations were stressed by the recommendations of HABITAT (the United Nations Conference on Human Settlements in Vancouver, June 1976) and the United Nations Water Conference (Mar del Plata, March 1977). The HABITAT conference stated as a goal: "Fresh water for all by 1990." Later, the U.N. water conference made this more specific and designated the period 1981-1990 as the "International Water Supply and Sanitation Decade." The International Conference on Primary Health Care (Alma Ata, USSR, September 1978) recognized that water supply and sanitation are an integral part of primary health care.

The World Health Organization program includes a commitment to develop better information systems since no rational plan is possible without an adequate information base. A global survey conducted in 1962 covered 75 developing countries and dealt with urban water supply conditions. A second global survey conducted in 1970 was more extensive, covering community water supply and excreta disposal conditions in both urban and rural areas. Then, in late 1975 a mid-decade global survey of developing countries was conducted by WHO. The results of these last 2 surveys (Table 8) show that the majority of the world's population currently has inadequate water supply and excreta disposal facilities (1). Furthermore a large disparity exists between the availability of services in urban and rural areas. Between 1970 and 1975, the amounts invested in water throughout the world were an average of $67 per person in urban areas and $17 per person in rural areas, perhaps accounting for the disparity between services in urban and rural areas. The World Bank and the World Health Organization reported to the Mar del Plata conference that 140 billion dollars would be needed to reach the target of clean water for all by 1990 (2). For this to be achieved, investment in water supplies would have to be increased at least 1 1/2 times in urban areas and 4 times in rural areas.

A number of diseases may result from the absence of an adequate supply of water of good quality. A useful classification of water-related diseases originally proposed by Bradley (3) and more recently modified by Feacham and his colleagues (4) divides water-related diseases into 4 categories, depending on their mode of transmission: waterborne, water-washed, water-based, or water-related insect vector (Table 9). The classification suggests different preventive measures to interrupt disease transmission. It is not clear, however, to what extent the occurrence of these diseases would be reduced by the provision of clean water and proper sanitation. Clearly, there is an urgent need for precise data on the impact of water and sanitation projects so that reasonable priorities may be set in developing countries.

Studies of the relationship of water supplies and excreta disposal to health and particularly to diarrheal disease incidence or prevalence have reached inconsistent conclusions. Several indicators have been used to measure the impact of diarrheal diseases on individuals and communities, and additional indicators have been proposed for use in studies designed to measure the impact of water supplies and excreta disposal on diarrheal diseases. The most commonly used indicators have been incidence or prevalence of diarrhea, enteric bacterial pathogens, and intestinal parasites. Results of selected published studies of the impact of water supply and/or sanitation projects on these 3 indicators of waterborne and water-washed gastrointestinal diseases are summarized in Tables 10-12. In the majority of these studies in which no impact was demonstrated, the acceptance, utilization, and maintenance of the new facilities were not evaluated. In addition, most of these studies lacked a health education component.

The Water-Related Diseases Activity is currently working to implement similar studies both in the United States and abroad. An ideal indicator for studies of this type, one which is valid, objective, and sensitive, and specific for changes in water supplies or excreta disposal alone, has not been identified. Indicators must be selected after careful consideration of the degree to which they approach these criteria. Additional important considerations include the cost of developing the information and the level of training required for personnel to provide specific indicator data.

Table 8 Estimated Population Provided with Community Water Supply and Excreta Disposal Services in the Developing Countries, Excluding China (based on mid-decade survey in 1975)

		1970		1975	
		Population served adequately (house connections or reasonable access)			
		Populations in Millions	Percent of Population Served	Populations in Millions	Percent of Population Served
Water Supply	Urban	316	67	450	77
	Rural	182	14	313	22
	Total	498	29	763	38
		Population served adequately (public sewers or household systems)			
		1970		1975	
		Populations in Millions	Percent of Population Served	Populations in Millions	Percent of Population Served
Excreta Disposal	Urban	337	71	437	75
	Rural	134	11	209	15
	Total	471	27	646	33

Table 9 Classification of Water-Related Diseases (3, 4)

Category	Examples	Prevention Strategy
1. Fecal-oral		
a. Waterborne	Cholera	Improve water quality
b. Water-washed	Shigellosis	Increase water availability and utilization
2. Water-washed		
a. Skin	Scabies	Increase water availability and utilization
b. Eye	Trachoma	
3. Water-based		
a. Skin penetration	Schistosomiasis	Control snails or eliminate contact with water
b. Ingestion	Guinea worm	Protect water sources
4. Water-related insect vectors		
a. Biting near water	Sleeping sickness	Eliminate need to visit area or vector
b. Breeding in water	Malaria	Eliminate breeding sites or vector

Table 10 Design and Conclusion of Studies Assessing the Association of Incidence or Prevalence of Diarrhoeal Disease or Related Conditions with Water Supply and/or Excreta Disposal

Location of Study	Variables Assessed	Specific Indicator	Age Group	Type of Study	Site of Collection of Indicator Data	Time Frame	Study Result
USA							
California (5)	Water availability	Diarrhoea incidence	All	Cross-sectional/ longitudinal	Home visits once or every 4-6 weeks (6 week recall)	6 months	Data not presented by type of water supply
Kentucky (6)	Water availability, excreta disposal	Diarrhoea incidence	All	Longitudinal	Home visits monthly (1 month recall)	29 months	Incidence 135/1000/yr with, 349/1000/yr without indoor plumbing
Arizona (7)	Water availability, excreta disposal	Diarrhoea incidence	≤1 year	Record review	Clinic and hospital	6½ years	Incidence 2.0/person/yr before, 0.9/person/yr after indoor plumbing
Colorado (8)	Water quality	Gastrointestinal illness* incidence	All	Cross-sectional	Single home visit (3 month recall)	3 months	Incidence 8.8% in communities with good, 13.9% in communities with poor water quality
Five states** (9)	Water availability, excreta disposal	Diarrhoea incidence	All	Record review	Clinic	6 years	Incidence 159/1000/yr before, 136/1000/yr after indoor plumbing
Central America							
Guatemala (10)	Water quality and availability, excreta disposal	Diarrhoea incidence	All	Longitudinal	Home visits biweekly (2 week recall)	4 years	Incidence 168/1000/yr with, 224/1000/yr without privies; incidence 3 x higher with limited availability
Venezuela (11)	Water availability, excreta disposal	Diarrhoea* incidence	All	Longitudinal	Home visits monthly (1 month recall)	1 year	In children <8y.o., incidence 11.8%, 12.0%, 12.5%, 17.9% in 4 communities with; 24.2%, 27.4% in 2 communities without unlimited water availability
Guatemala** (12)	Water quality and availability	Diarrhoea incidence	All	Longitudinal	Home visits monthly (2 week recall) and clinic record review	3 years	Incidence 39.7/1000/yr initially, 39.5/1000/yr 3 years later
Costa Rica (13)	Water quality and availability, excreta disposal	Diarrhoea* incidence	All	Longitudinal	Home visits weekly (1 week recall)	1 year	Incidence 240/1000/yr ≥3, 490/1000/yr with ≤1 household connection; 270/1000/yr with septic tank, 400/1000/yr with privy, 210/1000/yr with no facility

*Definition specified
**Specific intervention evaluated

Table 10 (continued)

Location of Study	Variables Assessed	Specific Indicator	Age Group	Type of Study	Site of Collection of Indicator Data	Time Frame	Study Result
Africa							
Zambia** (14)	Water quality and availability	Diarrhoea incidence	All	Record review	Clinic and hospital	4 years	Incidence 338/1000/yr before, 212/1000/yr 2 years after piped water
Lesotho (15)	Water quality and availability	Diarrhoea incidence	All	Record review	Clinic and hospital	39 months	No difference in diarrhoea incidence in villages with and without improved supplies
Kenya (16)	Water quality and availability	Diarrhoea prevalence	All	Cross-sectional	Single home visit (1 week recall)	1 week	Illness in 3.1% of households with, 19.0% of households without piped water
Kenya (17)	Water quality and availability	Diarrhoea prevalence	All	Cross-sectional	Single home visit (? recall period)	Short	Prevalence 7%; no differences
Ethiopia (18)	Water availability, excreta disposal	Gastroenteritis* incidence	≤4 years	Longitudinal	Home visits biweekly (1 day recall)	1 year	When water available, lower incidence with private than non-private latrines
Kenya** (19,20)	Water quality and availability	Gastrointestinal illness incidence	All	Longitudinal	Home visits biweekly (2 week recall)	9 months	Gastrointestinal illness as percentage of total illness decreased from 23% to 20% in infants and from 31% to 18% in children 1-2 years of age
Asia							
Bangladesh (21)	Water quality	Diarrhoea incidence	All	Record review	Clinic and hospital	11 years	Incidence 7.5/1000/yr in tube well users, 3.2/1000/yr in non-users
Seven Countries (22)	Water availability, excreta disposal	Diarrhoea incidence	≤9 years	Cross-sectional	Single home visit (1 month recall)	~1 month	Incidence 2.0-39% where water available, 2.0-48.7% where less available

*Definition specified
**Specific intervention evaluated

Table 11 Design and Conclusion of Studies Assessing the Association of Stool Culture Results with Water Supply and/or Excreta Disposal

Location of Study	Variables Assessed	Specific Indicators	Age Group	Type of Study	Site and Method of Collection	Time Frame	Study Result
USA							
California (5)	Water availability	Shigella, Salmonella prevalence	≤10 years	Cross-sectional/ longitudinal	Home and clinic; rectal swabs	6 months	Shigella prevalence 2.1% in homes with water, 6.6% in homes without water
California (23)	Water availability	Shigella, Salmonella prevalence	≤10 years	Longitudinal	Home; rectal swabs	7 months	Shigella prevalence 0.7% in homes with water, 7.2% in homes without water
Georgia (24)	Water quality and availability	Shigella prevalence	?	Longitudinal	Home; rectal swabs	3 years	Shigella infection in 4.1% of families with nearby, 5.8% of families without nearby water
Georgia* (25)	Excreta Disposal	Shigella prevalence	≤10 years	Longitudinal	Home; rectal swabs	31 months	Shigella prevalence 4.7% before, 2.8% after privies improved
Kentucky (6)	Water availability, excreta disposal	Shigella, Salmonella, EPEC** prevalence	≤5 years	Longitudinal	Home; rectal swabs	29 months	Shigella prevalence 0.7% with and 6.4% without indoor plumbing
Five states (9)	Water availability, excreta disposal	Shigella, Salmonella incidence	All	Record review	Hospitals; stools	6 years	Low incidence; data not presented
Central America							
Panama (26)	Water quality and availability, excreta disposal	Shigella, Salmonella, EPEC** incidence	Infants	Cross-sectional	Clinic; ?	?	Shigella incidence 0% with, 0.9-2.5% without indoor plumbing
Guatemala (27)	Water availability, excreta disposal	Shigella, Salmonella prevalence	≤10 years	Cross-sectional	Clinics; rectal swabs	6 months	Shigella prevalence 6.3% in communities with private wells or municipal supply to ≥50% of houses, 9.4% in those with <50%; 4.8% in communities with privies or flush toilets in ≥50% of houses, 11.2% in those with <50%
Costa Rica (13)	Water quality and availability, excreta disposal	Shigella, Salmonella, EPEC** prevalence	All	Longitudinal	Home and clinics; rectal swabs or stools	1 year	Shigella prevalence 1% with ≥3, 7% with <1 household connection; 0% with septic tank, 4% with privy or no facility

*Specified intervention evaluated
**Enteropathogenic Escherichia coli

Table 11(continued)

Location of Study	Variables Assessed	Specific Indicators	Age Group	Type of Study	Site and Method of Collection	Time Frame	Study Result
Asia							
Bangladesh (27)	Water quality	Cholera incidence	≤11 years	Longitudinal	Home and hospital; rectal swabs	2 years	Classical cholera: 3.7% incidence in those living close to, 25.3% incidence in those living further from tube wells
Bangladesh (18)	Water quality	Cholera incidence	All	Record Review	Clinic & hospital; rectal swabs or stools	11 years	Incidence 14.2/1000/yr in tube well users, 8.4/1000/yr in non-users
Philippines* (28)	Water quality, excreta disposal	Cholera incidence	All	Longitudinal	Home; rectal swabs	4½ years	El Tor cholera incidence 10.8/1000/yr in community with improved water and excreta disposal, 12.5/1000/yr with improved water, 14.7/1000/yr with improved excreta disposal, and 46.0/1000/yr with no improvements
Seven Countries (19)	Water availability, excreta disposal	Shigella, Salmonella, EPEC** prevalence	≤10 years	Cross-sectional	Home; rectal swabs	~1 month	Shigella prevalence 2.0-6.4% where water available, 4-14% where less available

*Specific intervention evaluated
**Enteropathogenic Escherichia coli

Table 12 Design and Conclusion of Studies Assessing the Association of Incidence or Prevalence of Intestinal Parasites with Water Supply and/or Excreta Disposal

Location of Study	Variables Assessed	Specific Indicators	Age Group	Type of Study	Site of Collection	Time Frame	Study Result
USA							
Kentucky (6)	Water availability, excreta disposal	Prevalence of intestinal parasites	All	Longitudinal	Home	29 months	Prevalence 21.4% with, 61.6% without indoor plumbing
Five states (9)	Water availability, excreta disposal	Incidence of *Entamoeba histolytica*	All	Record review	Hospitals	6 years	Low incidence; data not presented
Central America							
Costa Rica (13)	Water quality and availability, excreta disposal	Prevalence of intestinal parasites	All	Longitudinal	Home and clinics	1 year	*Ascaris* prevalence 24% with ≥ 3, 49% with ≤ 1 household connection; 25% with septic tank, 37% with privy, 69% with no facility
Africa							
Kenya (16)	Water quality and availability	Prevalence of intestinal parasites	≤ 4 years	Cross-sectional	Home	Short	Prevalence 20-33%; no differences
Kenya (19,20)	Water quality and availability	Prevalence of intestinal parasites	All	Longitudinal	Home	9 months	*Ascaris* prevalence 15% initially, 8.8% 4 years later
Four Countries (22)	Water availability, excreta disposal	Prevalence of intestinal parasites	≤ 6 years	Cross-sectional	Home	~1 month	Data not presented by type of water supply or excreta disposal

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