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Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water — United States, 2003–2004

and

Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2003–2004




DEPARTMENT OF HEALTH AND HUMAN SERVICES

CENTERS FOR DISEASE CONTROL AND PREVENTION

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On the cover: *Left to right*: Two children, wearing goggles, in a swimming pool. A man drinking water from a glass. Young girl on boogie board in water. Drinking fountain with water running.

Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water — United States, 2003–2004

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Abstract

Problem/Condition: Since 1971, CDC, the U.S. Environmental Protection Agency, and the Council of State and Territorial Epidemiologists have collaboratively maintained the Waterborne Disease and Outbreak Surveillance System for collecting and reporting waterborne disease and outbreak (WBDO)-related data. In 1978, WBDOs associated with recreational water (natural and treated water) were added. This system is the primary source of data regarding the scope and effects of WBDOs in the United States.

Reporting Period: Data presented summarize WBDOs associated with recreational water that occurred during January 2003–December 2004 and one previously unreported outbreak from 2002.

Description of the System: Public health departments in the states, territories, localities, and the Freely Associated States (i.e., the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau, formerly parts of the U.S.-administered Trust Territory of the Pacific Islands) have primary responsibility for detecting, investigating, and voluntarily reporting WBDOs to CDC. Although the surveillance system includes data for WBDOs associated with drinking water, recreational water, and water not intended for drinking, only cases and outbreaks associated with recreational water are summarized in this report.

Results: During 2003–2004, a total 62 WBDOs associated with recreational water were reported by 26 states and Guam. Illness occurred in 2,698 persons, resulting in 58 hospitalizations and one death. The median outbreak size was 14 persons (range: 1–617 persons). Of the 62 WBDOs, 30 (48.4%) were outbreaks of gastroenteritis that resulted from infectious agents, chemicals, or toxins; 13 (21.0%) were outbreaks of dermatitis; and seven (11.3%) were outbreaks of acute respiratory illness (ARI). The remaining 12 WBDOs resulted in primary amebic meningoencephalitis (n = one), meningitis (n = one), leptospirosis (n = one), otitis externa (n = one), and mixed illnesses (n = eight). WBDOs associated with gastroenteritis resulted in 1,945 (72.1%) of 2,698 illnesses. Forty-three (69.4%) WBDOs occurred at treated water venues, resulting in 2,446 (90.7%) cases of illness. The etiologic agent was confirmed in 44 (71.0%) of the 62 WBDOs, suspected in 15 (24.2%), and unidentified in three (4.8%). Twenty (32.3%) WBDOs had a bacterial etiology; 15 (24.2%), parasitic; six (9.7%), viral; and three (4.8%), chemical or toxin. Among the 30 gastroenteritis outbreaks, *Cryptosporidium* was confirmed as the causal agent in 11 (36.7%), and all except one of these outbreaks occurred in treated water venues where *Cryptosporidium* caused 55.6% (10/18) of the gastroenteritis outbreaks.

In this report, 142 *Vibrio* illnesses (reported to the Cholera and Other *Vibrio* Illness Surveillance System) that were associated with recreational water exposure were analyzed separately. The most commonly reported species were

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Vibrio vulnificus, V. alginolyticus, and *V. parahaemolyticus. V. vulnificus* illnesses associated with recreational water exposure had the highest *Vibrio* illness hospitalization (87.2%) and mortality (12.8%) rates.

Interpretation: The number of WBDOs summarized in this report and the trends in recreational water-associated disease and outbreaks are consistent with previous years. Outbreaks, especially the largest ones, are most likely to be associated with summer months, treated water venues, and gastrointestinal illness. Approximately 60% of illnesses reported for 2003–2004 were associated with the seven largest outbreaks (>100 cases). Deficiencies leading to WBDOs included problems with water quality, venue design, usage, and maintenance.

Public Health Actions: CDC uses WBDO surveillance data to 1) identify the etiologic agents, types of aquatic venues, water-treatment systems, and deficiencies associated with outbreaks; 2) evaluate the adequacy of efforts (i.e., regulations and public awareness activities) to provide safe recreational water; and 3) establish public health prevention priorities that might lead to improved regulations and prevention measures at the local, state, and federal levels.

Introduction

During 1920–1970, statistical data regarding waterborne disease and outbreaks (WBDOs) in the United States were collected by different researchers and federal agencies (*1*). Since 1971, CDC, the U.S. Environmental Protection Agency (EPA), and the Council of State and Territorial Epidemiologists (CSTE) have collaboratively maintained the Waterborne Disease and Outbreak Surveillance System (WBDOSS), a surveillance system that tracks the occurrences and causes of WBDOs associated with drinking water (*2–11*). In 1978, WBDOs associated with recreational water were added to the surveillance system. The types of outbreaks and diseases included in the surveillance summaries have expanded multiple times. Outbreaks of Pontiac fever (PF) were added in 1989 (*9*), outbreaks of Legionnaires' disease were added in 2001 (*2*), and single cases of *Vibrio* illness associated with recreational water but not limited to preexisting wounds have been added in this report. WBDOs associated with drinking water and water not intended for drinking are presented in a separate report (*12*).

WBDO surveillance activities are intended to 1) characterize the epidemiology of WBDOs; 2) identify changing trends in the etiologic agents and other risk factors associated with WBDOs; 3) identify major deficiencies in providing safe recreational water; 4) encourage public health personnel to detect and investigate WBDOs; and 5) foster collaboration among local, state, federal, and international agencies on initiatives to prevent waterborne disease. Data obtained through the WBDOSS are useful for identifying major deficiencies in providing safe recreational water, influencing research priorities, supporting public health recommendations, and encouraging improved water-quality policies and regulations. However, the WBDOs summarized in this report represent only a portion of the illness associated with water exposure. The surveillance information described in this report does not include endemic waterborne disease risks, although studies to measure the levels of endemic illness associated with recreational water use are needed. Reliable estimates of the number of unrecognized WBDOs are not available.

Background

Regulation of Recreational Water Quality

Recreational water use has involved a risk for disease for virtually all of human history. Evidence of schistosomiasis, a parasitic disease only contracted by having contact with contaminated water, can be found in Egyptian mummies approximately 3,000 years old (*13*). In the United States, state and local governments establish and enforce regulations for protecting recreational water from naturally occurring or human-made contaminants. For treated water venues (e.g., swimming and wading pools), no federal regulatory agency or national guidelines for standards of operation, disinfection, or filtration exist. Because these swimming pool codes are developed and enforced by state and local health departments, substantial variation is observed across the country in terms of policy, compliance, and enforcement (*14*). In 1986, EPA published bacterial water-quality criteria for untreated fresh and marine water sources (*15*) and made these criteria water-quality standards for the states and territories that did not adopt the criteria before 2004. For freshwater (e.g., lakes and rivers), EPA has recommended criteria that the monthly geometric mean water-quality indicator concentration be ≤33 CFU/100 mL for enterococci or ≤126 CFU/100 mL for *Escherichia coli*. For marine water, EPA has recommended criteria that the monthly geometric mean water-quality indicator concentration be ≤35 CFU/100 mL for enterococci. However, state and local authorities have discretionary authority to determine which interventions should be used (e.g., posting signs to alert visitors of water contamination or closing the beach for swimming) when these limits have been exceeded. Natural processes to improve the quality of untreated recreational water might take days to months to occur. In contrast, disinfection, filtration, and pool drainage are examples of techniques that are used to restore a safe swimming environment in treated water venues. Whereas pools and other treated-water venues might need to be closed for a period of time and continued monitoring might be necessary, decontamination is usually feasible in hours to days.

EPA's Action Plan for Beaches and Recreational Waters (i.e., Beach Watch) was developed as part of the Clean Water Action Plan (available at http://www.cleanwater.gov). The intent of Beach Watch is to assist state, tribal, and local authorities in strengthening and extending existing programs to protect users of fresh and marine recreational waters. As part of the Beaches Act of 2000, the U.S. Congress directed EPA to create a new set of guidelines for recreational water based on novel water-quality indicators. As a result, EPA has been collaborating with CDC since 2002 on a series of epidemiologic studies at fresh and marine water recreational beaches in the United States. Information on the National Epidemiologic and Environmental Assessment of Recreational (NEEAR) Water Study is available at http://www.epa.gov/nerlcwww/neearnerl.htm. This study is being conducted to test rapid new water-quality methods that are able to produce results in <2 hours and to correlate these indicators with health effects among beachgoers. Preliminary results from two Great Lakes beaches have demonstrated an association between an increasing signal detected by a quantitative polymerase chain reaction–based test method for enterococci and human health effects (*16*).

Methods

Data Sources

Public health departments in individual states, territories, localities, and the Freely Associated States (FAS)* have the primary responsibility for detection and investigation of WBDOs. The outbreaks are voluntarily reported to CDC through a standard form (i.e., CDC form 52.12) available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf. The form solicits data on the WBDO, including characteristics of person, place, time, and results of epidemiologic studies, disease symptoms, microbiology, and water sampling. Information regarding the setting of the outbreak also is gathered, including water-supply descriptions, any sanitary measures in place, and possible factors contributing to the contamination of the water. Public health professionals in each state or locality are designated as WBDO surveillance coordinators, and CDC annually requests reports from each coordinator and conducts as much follow-up correspondence as needed to resolve unaddressed questions. Contact is made with all states or localities, including those without WBDO reports. Information is sometimes solicited from other CDC surveillance systems and confirmed with the state or locality for inclusion as a WBDO. Outbreaks or cases, where applicable, are assigned to a state, based on location of exposure rather than state of residence of ill persons. Numeric and text data from the CDC form and any supporting documentation are entered into a database for analysis. Although all WBDOs are collected through the same CDC reporting system, the recreational water-associated outbreaks are analyzed and published in this report separately from drinking water-associated outbreaks and other WBDOs (*12*). SAS programming is used for all statistical analyses.

Definitions†

The unit of analysis for the WBDOSS is typically an outbreak, not an individual case of a waterborne disease. To be defined as a WBDO associated with recreational water, an event must meet two criteria. First, two or more persons must be epidemiologically linked by location of exposure to water, time, and illness. This criterion is waived for 1) single cases of laboratory-confirmed primary amebic meningoencephalitis (PAM) associated with recreational water, 2) wound infections or other *Vibrio* infections associated with recreational water, and 3) single cases of chemical/toxin poisoning if water or air-quality data indicate contamination by the chemical/toxin. Second, the epidemiologic evidence must implicate water as the probable source of the illness. WBDOs associated with cruise ships are not summarized in this report. Recreational water settings include swimming pools, wading pools, spas, waterslides, interactive fountains, wet decks, and fresh and marine bodies of water. For this analysis, the WBDOs are separated by

* Composed of the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau; formerly parts of the U.S.-administered Trust Territory of the Pacific Islands.

† Additional terms have been defined (Appendix A, Glossary of Definitions).

venue as untreated (i.e., fresh and marine surface water) or treated (i.e., disinfected [e.g., chlorinated]) water.

Strength of Evidence Classification for Waterborne Disease and Outbreaks

WBDOs reported to the WBDOSS are classified according to the strength of evidence that implicates water as the vehicle of transmission (Table 1). The classification scheme (i.e., Classes I–IV) is based on the epidemiologic and water-quality data provided on the WBDO report form. Although in certain instances WBDOs without water-quality data were included in this report, outbreaks that lacked epidemiologic data linking the outbreak to water were excluded.

Class I indicates that adequate epidemiologic and water-quality data were reported (Table 1). However, the classification does not necessarily imply that an investigation was optimally conducted nor does a classification of II, III, or IV imply that an investigation was inadequate or incomplete. Outbreaks and the resulting investigations occur under different circumstances, and not all outbreaks can or should be rigorously investigated. In addition, outbreaks that affect fewer persons are more likely to receive classifications of III or IV because of the limited sample size available for analysis.

Changes in the 2003–2004 *Surveillance Summary*

Names, definitions, classifications, and other parameters in this *Surveillance Summary* have been modified and expanded to better reflect the changing epidemiology of WBDOs and to capture the wide scope of water-related disease. This section highlights these changes.

Title

The title of this *Surveillance Summary* has been changed. Previously titled *Surveillance for Waterborne-Disease Outbreaks Associated with Recreational Water*, the title of the report has been changed to *Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water*. This subtle difference ("Disease *and* Outbreaks") emphasizes the public health importance of certain waterborne contaminants (e.g., *Naegleria*, *Vibrio*, or chemicals) that frequently cause single cases of illness, can be strongly linked to recreational water exposure, and are reported to the WBDOSS, despite not being associated with multiple cases in a traditional "outbreak" setting.

Etiologic Agents

Etiologic agents are identified through clinical specimens or occasionally by water testing. In previous summaries, the term "acute gastrointestinal illness (AGI)" was used to indicate WBDOs of unidentified etiology associated with gastrointestinal symptoms. Because AGI refers to a type of illness and not to an etiologic agent, the term "unidentified" is now used to describe WBDOs with unknown etiology. A classification of "unidentified" might occur for various reasons, including a lack of clinical specimens, lack of appropriate testing, or inadequate laboratory capacity. If more than one agent is implicated, only those that appear in ≥5% of positive clinical specimens are included in the tables and calculations as etiologic agents. When each agent is of the same agent type (e.g., bacteria, chemicals/toxins, parasites, and viruses), the outbreak is analyzed within that agent type (e.g., an outbreak with both *Cryptosporidium* and *Giardia* would be analyzed as a parasitic outbreak). When agents represent more than one agent type, the outbreak is analyzed as a mixed agent outbreak. All outbreaks

TABLE 1. Classification of investigations of waterborne-disease outbreaks — United States

Class	Epidemiologic data	Water-Quality data
I	Adequate Data provided concerning exposed and unexposed persons, with relative risk or odds ratio ≥2 or p≤0.05	Provided and adequate Laboratory data or historical information (e.g., the history that a chlorinator or pH acid feed pump malfunctioned, resulting in no detectable free-chlorine residual, or a breakdown in a recirculation system)
II	Adequate	Not provided or inadequate (e.g., laboratory testing of water not conducted and no historical information)
III	Provided but limited Epidemiologic data provided that did not meet the criteria for Class I, or claim made that ill persons had no exposures in common, besides water, but no data provided	Provided and adequate
IV	Provided but limited	Not provided or inadequate

in which the etiologic agent is not known or confirmed are listed as unidentified, and they constitute a separate analysis category from those outbreaks with identified etiologic agents, even when other data (e.g., clinical findings) are suggestive of a particular pathogen or chemical/toxin.

In previous *Surveillance Summaries,* outbreaks in which patients sought medical care for dermatologic symptoms consistent with *Pseudomonas aeruginosa* infection but in which *Pseudomonas* was not isolated from clinical specimens or water samples were still classified as *Pseudomonas* outbreaks. However, in this report, only those outbreaks in which clinical specimens or water samples test positive for *Pseudomonas* are classified as *Pseudomonas* outbreaks.

Predominant Illness, Case Counts, and Deaths

Whereas the illness associated with a WBDO generally includes only one category of symptoms (e.g., gastroenteritis), WBDOs do occur where the symptoms cluster into more than one category (e.g., gastroenteritis and dermatitis). Therefore, in this report, if any one illness category is reported by ≥50% of ill respondents, then multiple illnesses will be listed for that WBDO. These mixed-illness WBDOs constitute a separate analysis category from WBDOs involving a single illness. In addition, the number of deaths associated with each WBDO is now presented in this report. This change provides increased information on the severity of illness associated with each WBDO.

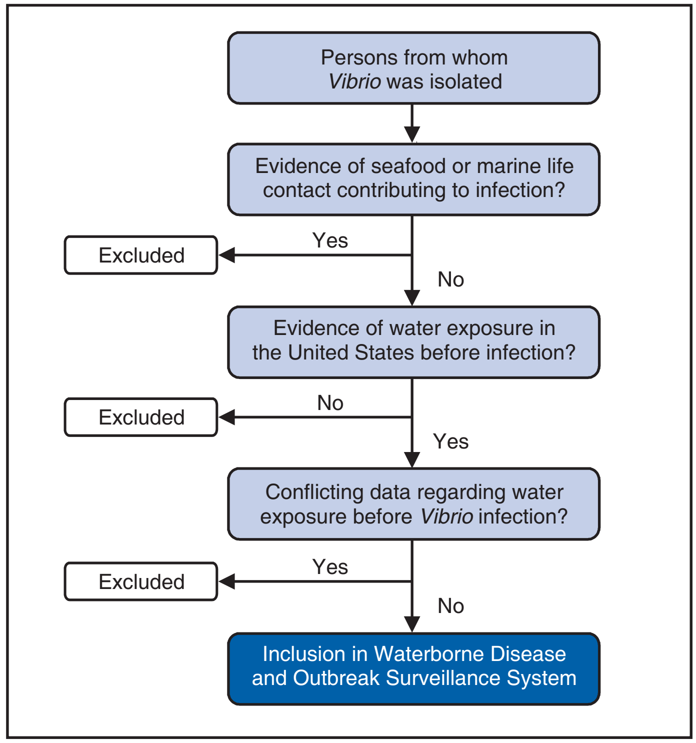
Strength of Evidence Classification for Waterborne Disease and Outbreaks

For the first time, the strength of evidence classification for WBDOs (Table 1) is used for nongastroenteritis outbreaks (e.g., dermatitis, PAM, and chemical/toxin poisonings). Classification of these WBDOs should provide a better understanding of the strength of each outbreak investigation.

Vibrio Cases

For the first time, single cases of recreational water-associated *Vibrio* illness were selected for inclusion in this *Surveillance Summary* by using an algorithm (Figure 1). The algorithm selected *Vibrio* cases for inclusion based on previous water exposure in the United States and the absence of seafood consumption or contact. All selected cases were verified by the state or local health departments. These infections frequently were associated with preexisting wounds but also were associated with other water-related exposure routes (e.g., wounds incurred while swimming or walking on the beach or unintentional inhalation of recreational water, resulting in a sinus infection). These cases

FIGURE 1. Algorithm for selection of illnesses associated with *Vibrio* isolation and recreational water — United States, 2003–2004*



* **Note:** *Vibrio*-related data are only presented in Figures 6–8 and in Tables 8 and 9.

are reported to the Cholera and Other *Vibrio* Illness Surveillance System on CDC form 52.79 (available at http://www.cdc.gov/foodborneoutbreaks/documents/cholera_vibrio_report.pdf). Staff operating the Cholera and Other *Vibrio* Illness Surveillance System collaborated with staff from the WBDOSS to gather all reported recreational water-associated *Vibrio* cases for inclusion in this report. These cases were analyzed separately from other recreational water illnesses to avoid substantially altering total WBDO numbers when compared with previous reports. Similarly, *Vibrio* cases are also discussed separately in this report.

Results

Excluding *Vibrio* cases, which are analyzed and discussed separately, a total of 62 outbreaks (28 in 2003 and 34 in 2004) associated with recreational water were reported to CDC (Tables 2–5). Of the 50 states and 10 territories, localities, and FAS participating in the WBDOSS, 27 (26 states and the territory of Guam) reported WBDOs (Figure 2). Descriptions of selected WBDOs have been presented (Appendix B, Selected Descriptions of Waterborne

TABLE 2. Waterborne-disease outbreaks (n = 18) associated with treated recreational water, by state — United States, 2003

State	Month	Class*	Etiologic agent	Predominant illness†	No. of cases (n = 1,141)	Type	Setting
Arkansas	Aug	IV	*Cryptosporidium*	AGI†	4	Pool	Large facility
Connecticut	Jul	I	Echovirus 9	Neuro†	36	Pool	RV§ campground
Connecticut	Aug	I	MRSA¶	Skin†	10	Spa	Athletic center
Georgia	Apr	IV	Unidentified	Skin	5	Spa	Hotel
Illinois	Jan	I	*Pseudomonas aeruginosa*	Skin	52	Spa	Hotel
Illinois	Dec	I	Unidentified**	AGI	12	Pool	Hotel
Iowa	Jun	IV	*Cryptosporidium* and *Giardia intestinalis*††	AGI	63	Wading pool	Day care center
Kansas	Jul	I	*C. hominis*§§	AGI	617	Pools, Wading pools	Community
Massachusetts	Jun	II	*G. intestinalis*	AGI	149	Pool	Membership club
Michigan	Feb	II	Unidentified¶¶	Skin	25	Spa	Hotel
New Mexico	Jun	III	*Legionella pneumophila* serogroup 1	ARI†	4	Spa	Hotel
New York	Mar	III	Muriatic (hydrochloric) acid	ARI	3	Pool	Membership club
New York	Nov	IV	Unidentified¶¶	Skin	7	Pool	Membership club
Ohio	Jan	I	*P. aeruginosa*	Skin	17	Pool, spa	Hotel
Oregon	Jul	I	*Shigella sonnei*	AGI	56	Interactive fountain	Community
South Carolina	Nov	II	Unidentified	Skin	64	Spa, pool	Hotel
Wisconsin	Feb	I	*L. pneumophila* serogroup 1	ARI	3	Spa	Hotel
Wisconsin	Jul	II	*Cryptosporidium*	AGI	14	Wading pool	Community

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12 (available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf).
† AGI: acute gastrointestinal illness; Neuro: neurologic condition or symptoms (e.g., meningoencephalitis or meningitis); Skin: illness, condition, or symptom related to skin; and ARI: acute respiratory illness.
§ RV: recreational vehicle.
¶ MRSA: Methicillin-resistant *Staphylococcus aureus*.
** Etiology unidentified; chemical contamination from pool disinfection by-products (e.g., chloramines) suspected.
†† Each pathogen was identified in ≥5% of positive clinical specimens; therefore, both are listed as etiologic agents.
§§ Species determined by using molecular technology and current taxonomic guidelines (**Source:** Xiao L, Fayer R, Ryan U, Upton SJ. *Cryptosporidium* taxonomy: recent advances and implications for public health. Clin Microbiol Rev 2004;17:72–97).
¶¶ Etiology unidentified: *P. aeruginosa* suspected on the basis of clinical syndrome and setting.

Disease and Outbreaks [WBDOs] Associated with Recreational Water). These 62 outbreaks resulted in 2,698 ill persons, including one death (attributable to PAM; Table 4). The median outbreak size was 14 persons (range: 1–617 persons). The seven largest outbreaks each had more than 100 ill persons and accounted for 60.3% (n = 1,628) of the total cases. Illinois reported the highest number of WBDOs (10), Ohio reported six WBDOs, and Georgia and Wisconsin both reported five WBDOs.

During 2003–2004, treated water venues were associated with 43 (69.4%) of the recreational water outbreaks and 2,446 (90.7%) of the cases (Tables 2 and 3; Figure 3). Untreated venues were responsible for 19 (30.6%) of the WBDOs but only 252 (9.3%) of the cases (Tables 4 and 5). Similar proportions were identified by venue treatment type when gastroenteritis outbreaks were analyzed separately (Table 6).

Of the 62 WBDOs, 30 (48.4%) were outbreaks of gastroenteritis, 13 (21.0%) were outbreaks of dermatitis, and seven (11.3%) were outbreaks of acute respiratory illness (ARI). The remaining WBDOs resulted in PAM (n = one), meningitis (n = one), leptospirosis (n = one), otitis externa (n = one), and mixed illnesses (n = eight) (Table 6, Figure 3). Gastroenteritis accounted for 1,945 (72.1%) of the cases of illness. The route of entry implicated for each WBDO was ingestion for 30 WBDOs (48.4%), contact for 15 (24.2%), inhalation for seven (11.3%), combined routes for eight (12.9%), other for one (1.6% [*Naegleria*]), and unknown for one outbreak (1.6%) (Figure 3).

WBDOs occurred in every calendar month except October, but the summer months (June through August) accounted for 35 (56.5%) WBDOs and 1,888 (70.0%) cases (Figure 4). Gastroenteritis was particularly clustered during these months, in which 22 (73.3%) of 30 outbreaks and 1,631 (83.9%) of 1,945 cases (Figure 4) were reported. Treated venues were associated with WBDOs throughout the year, whereas untreated venue-associated WBDOs occurred almost exclusively from May through August (Tables 2–5). Increased reporting of WBDOs occurred during the summer, with a relative risk (RR) of 3.9 (95% confidence interval [CI] = 2.4–6.4). This risk increased for certain outbreak categories. Gastroenteritis outbreaks compared with other illnesses (RR = 8.2; 95% CI = 3.7–18.5) were especially frequent during the summer (Figure 4).

TABLE 3. Waterborne-disease outbreaks (n = 25) associated with treated recreational water, by state — United States, 2004

State	Month	Class*	Etiologic agent	Predominant illness†	No. of cases (n = 1,305)	Type	Setting
California	Aug	I	*Cryptosporidium*	AGI†	336	Pool	Water park
Colorado	Aug	III	*Cryptosporidium*	AGI	6	Pool	Hotel
Florida	May	III	Norovirus	AGI	42	Waterslide	School
Georgia	Jan	IV	Unidentified§	Skin†	17	Pool	Hotel
Georgia	Jun	IV	*Cryptosporidium*	AGI	14	Pool	Community
Idaho	Mar	II	Norovirus	AGI	140	Pool	Community
Illinois	Jan	I	Unidentified¶	Eye†, ARI†	45	Pool	Hotel
Illinois	Jan	I	Unidentified¶	Eye, ARI	22	Pool, spa	Hotel
Illinois	Feb	III	*Pseudomonas aeruginosa*	Skin, ARI	16	Pool, spa	Hotel
Illinois	Feb	I	*P. aeruginosa*	Skin	5	Spa	Hotel
Illinois	Mar	I	Unidentified¶	Eye, ARI	57	Pool, spa	Hotel
Illinois	Jul	IV	Unidentified**	AGI	9	Pool	Community
Illinois	Jul	I	*Cryptosporidium*	AGI	37	Pool, wading pool, interactive fountain	Community
Illinois	Sep	I	*Cryptosporidium*	AGI	8	Pool	Hotel
New Mexico	Aug	IV	Unidentified¶	ARI	16	Pool	Membership club
New York	Dec	IV	Unidentified¶	ARI	5	Pool	Military facility
North Carolina	Mar	II	*P. aeruginosa*	Skin	41	Spa	Hotel
Ohio	Jul	I	*C. hominis*††	AGI	160	Pool, wading pool	Community
Ohio	Jul	I	*P. aeruginosa*	Ear†, skin	119	Pool, spa	Resort
Ohio	Aug	I	*Legionella pneumophila* serogroup 1	ARI	3	Spa	Household
Oklahoma	Mar	I	*L. pneumophila* serogroup 1	ARI	107	Spa	Hotel
Oregon	Mar	III	*P. aeruginosa*	Skin	2	Spa	Motel
Vermont	Feb	I	Norovirus	AGI	70	Pool	Membership club
Wisconsin	Jun	I	*P. aeruginosa*	Skin, AGI	22	Pool, spa	Hotel
Wisconsin	Aug	IV	*Cryptosporidium*	AGI	6	Pool	Community

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12 (available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf).
† AGI: acute gastrointestinal illness; Skin: illness, condition, or symptom related to skin; Eye: illness, condition, or symptom related to eyes; ARI: acute respiratory illness; and Ear: illness, condition, or symptom related to ears.
§ Etiology unidentified; psychogenic factors and chemical contamination suspected.
¶ Etiology unidentified; chemical contamination from pool disinfection by-products (e.g., chloramines) suspected.
** Etiology unidentified; chemical contamination with pool algaecide suspected.
†† Although both *Cryptosporidium* oocysts and *Giardia* cysts were identified in the pool water, only *Cryptosporidium* oocysts were isolated from clinical specimens.

Etiologic Agents

Of the 62 WBDOs associated with recreational water, the etiologic agent was confirmed in 44 (71.0%), suspected in 15 (24.2%) and unidentified in three (4.8%) (Table 7). Twenty (32.3%) outbreaks were confirmed as bacterial; 15 (24.2%), as parasitic; six (9.7%) as viral; and three (4.8%) as chemical- or toxin-mediated (Figure 3).

Of the 43 outbreaks associated with treated water venues that had an identified etiologic agent, 14 (32.6%) involved bacteria; 12 (27.9%), parasites; four (9.3%), viruses; and one (2.3%), involved chemicals (Table 7). However, parasites were responsible for more than three times more cases than bacterial causes (1,414 versus 457). Of the 19 WBDOs associated with untreated water venues, six (31.6%) involved bacteria; three (15.8%) parasites; two (10.5%) viruses; and two (10.5%) toxins. Unlike treated water venues, bacteria were responsible for more than six times more cases in untreated water venues than parasites (96 versus 14).

Parasites

Of the 30 outbreaks of gastroenteritis, 14 (46.7%) were parasitic in origin, including 11 (78.6%) caused by *Cryptosporidium*, two (14.3%) caused by *Giardia intestinalis*, and one (7.1%) caused by both *Cryptosporidium* and *Giardia* (Tables 2–6; Figure 5). Of the 12 gastroenteritis outbreaks associated with untreated water venues, only two (16.6%) were caused by parasites. A single *Cryptosporidium* outbreak and a single *Giardia* outbreak each occurred in untreated lake water, causing four and nine cases of illness, respectively. In contrast, parasites were the most common causes of gastroenteritis outbreaks associated with treated water venues; *Cryptosporidium* was the most common parasitic agent, causing 10 (55.6%) of the 18 outbreaks. A total of 12 parasitic gastroenteritis outbreaks occurred in treated water venues that caused illness in 1,414 persons. Four of these outbreaks each caused over 100 (range: 149–617 persons) cases of illness. In June 2003, an

TABLE 4. Waterborne-disease outbreaks (n = 10) associated with untreated recreational water, by state — United States, 2003

State	Month	Class*	Etiologic agent	Predominant illness†	No. of cases (deaths) (n = 133)	Type	Setting
California	Jun	IV	Unidentified§	Skin†	9	Lake	Lake
Florida	Jul	II	Unidentified¶	AGI†	10	Lake	Lake
Florida	May	II	Unidentified¶	AGI	20	Lake	Camp
Georgia	May	I	*Shigella sonnei*	AGI	13	Lake	Park
Idaho	Jul	IV	*Cryptosporidium*	AGI	4	Lake	Lake
Maryland	Jul	III	*S. sonnei* & *Plesiomonas shigelloides***	AGI	65	Lake	Park
North Carolina	Jul	IV	*Naegleria fowleri*	Neuro†	1 (1)	Lake	Lake
Ohio	Jul	IV	*P. shigelloides*	AGI	3	Lake	Bathing beach
Ohio	Jun	IV	Unidentified§	Skin	6	Lake	Private beach
Wyoming	Jul	IV	*P. shigelloides*	AGI	2	Reservoir	Reservoir

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12 (available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf).
† Skin: illness, condition, or symptom related to skin; AGI: acute gastrointestinal illness; and Neuro: neurologic condition or symptoms (e.g., meningoencephalitis, meningitis).
§ Etiology unidentified; clinical diagnosis of cercarial dermatitis (caused by avian schistosomes).
¶ Etiology unidentified; illness was most consistent with norovirus infection.
** Each pathogen was identified in ≥5% of positive clinical specimens; therefore, both are listed as etiologic agents.

TABLE 5. Waterborne-disease outbreaks (n = nine) associated with untreated recreational water, by state/territory — United States, 2004

State/Territory	Month	Class*	Etiologic agent	Predominant illness†	No. of cases (n = 119)	Type	Setting
Arkansas	Jun	IV	*Shigella flexneri*	AGI†	10	Lake	Swimming beach
Georgia	Aug	IV	Unidentified	Ear†	9	Lake	Lake
Guam	Apr	IV	*Leptospira* species	Leptospirosis	3	River	Waterfalls
Minnesota	Jun	IV	Norovirus	AGI	9	Lake	Swimming beach
Missouri	Mar	IV	*Giardia intestinalis*	AGI	9	Lake	Lake
Nebraska	Jul	III	Microcystin toxin (blue-green algae)	AGI, Skin†	20	Lake	Lake
Nebraska	Jul	III	Microcystin toxin (blue-green algae)	AGI, Skin	2	Lake	Lake
Oregon	Jul	IV	Norovirus	AGI	39	Lake	Swimming beach
Wisconsin	Jul	IV	Unidentified§	AGI	18	Lake	State park

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12 (available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf).
† AGI: acute gastrointestinal illness; Ear: illness, condition, or symptom related to ears; and Skin: illness, condition, or symptom related to skin.
§ Etiology unidentified; Illness was most consistent with norovirus infection.

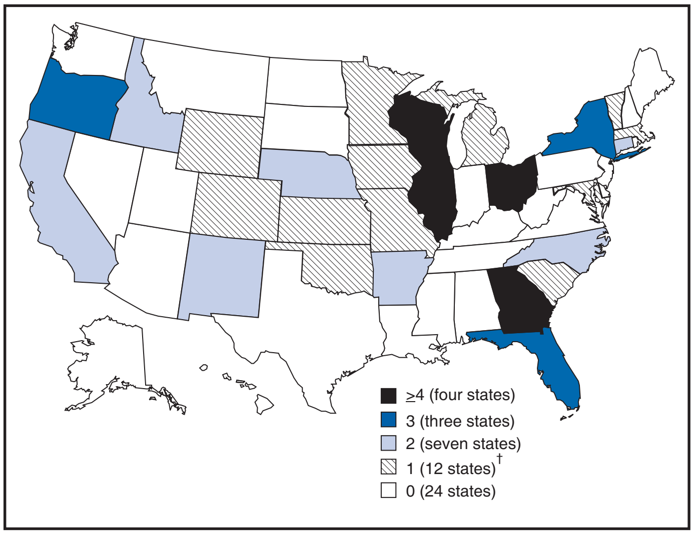
outbreak of *G. intestinalis* started at a Massachusetts membership club pool and resulted in 149 cases, including cases of secondary person-to-person transmission. In July 2003, a *C. hominis* outbreak spread in multiple Kansas pools and day care centers and resulted in 617 cases; this outbreak was the largest recreational water outbreak during 2003–2004. In July 2004, an outbreak of *Cryptosporidium* in a community pool in Ohio caused gastroenteritis in 160 persons from three counties. In August 2004, employees ill with gastroenteritis at a California water park continued working and swimming in the pools, resulting in a *Cryptosporidium* outbreak involving 336 persons.

Of the 15 WBDOs of all illness types confirmed to be of parasitic origin, only one (6.7%) did not involve gastroenteritis; a single fatal case of PAM caused by *Naegleria fowleri* occurred in July 2003 at a lake in North Carolina. This case was the only death reported among the 62 WBDOs during this reporting cycle (excluding *Vibrio* cases).

Bacteria

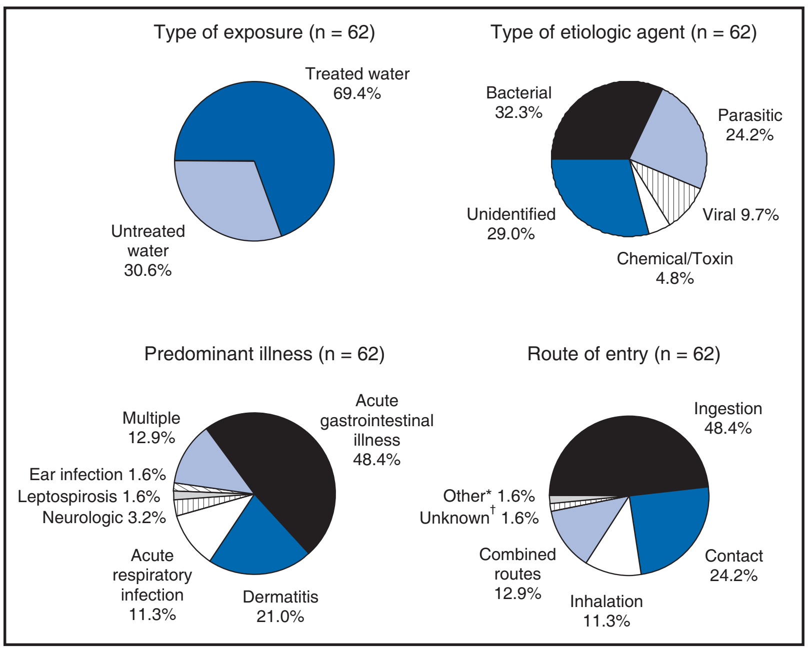
Six reported gastroenteritis outbreaks of confirmed bacterial origin were reported (Figure 5), one of which was at a treated water venue. This outbreak of *Shigella sonnei* occurred in an interactive fountain in Oregon in July 2003, resulting in 56 cases. Inadequate disinfection, poor monitoring of water chemistry, and heavy use of the fountain by young diaper-aged children were all cited as factors contributing to the outbreak. The other five bacterial outbreaks of gastroenteritis were associated with untreated bodies of water, including two additional outbreaks of *Shigella,* two outbreaks of *Plesiomonas shigelloides,* and one outbreak that involved both *Shigella* and *Plesiomonas* associated with the use of a lake in Maryland, resulting in illness in 65 persons. Fecal accidents and sewage contamination were implicated in this outbreak. The other four outbreaks were substantially smaller; illness occurred in 13 or fewer persons in each outbreak.

FIGURE 2. Number of recreational water-associated outbreaks (n = 62) — United States, 2003–2004*



* **Note:** These numbers are largely dependent on reporting and surveillance activities in individual states and do not necessarily indicate the true incidence in a given state.
† Guam also reported one recreational water-associated outbreak in 2004.

FIGURE 3. Recreational water-associated outbreaks, by type of exposure, type of etiologic agent, predominant illness, and route of entry — United States, 2003–2004



* Infection with *Naegleria* was categorized as other because of the nasal, noninhalational route of infection.
† Route of transmission for leptospirosis was unclear after investigation.

Nine of the bacterial outbreaks resulted in cases of dermatitis; for eight of these outbreaks, *Pseudomonas aeruginosa* was the confirmed etiologic agent. Three of the eight *Pseudomonas* outbreaks were associated with mixed illnesses. All eight *Pseudomonas* outbreaks occurred at treated water venues that involved heated spa water (some of these outbreaks also involved pools), and illness occurred in 274 persons. One outbreak in Ohio in July 2004 involving a spa and pool accounted for 119 of these cases, which is the largest bacterial outbreak summarized in this report. Potential exposure also occurred in this outbreak when the hotel spa water flowed directly into the swimming pool. The one bacterial dermatitis outbreak that did not involve *Pseudomonas* occurred in August 2003. Multiple members of a Connecticut college football team were diagnosed with methicillin-resistant *Staphylococcus aureus* (MRSA) skin infections. A spa at the team's athletic facility, which was disinfected with an unapproved disinfectant (i.e., povidone), was implicated in the outbreak.

Four outbreaks caused by *Legionella pneumophila* were associated with treated recreational water venues (i.e., spas) during 2003–2004. Three of these outbreaks each had fewer than five cases of Legionnaires' disease. The fourth outbreak, which occurred at a hotel in Oklahoma during a weeklong basketball tournament in March 2004, included six cases of Legionnaires' disease and 101 cases of PF. The bather load (i.e., maximum occupancy) of the hotel spa was exceeded, and the bromine concentrations in the spa were not adequately monitored.

An April 2004 outbreak of leptospirosis in Guam involved three U.S. military personnel who swam in a remote set of waterfalls. This was the only outbreak of leptospirosis reported and the only outbreak reported from outside the 50 states.

Viruses

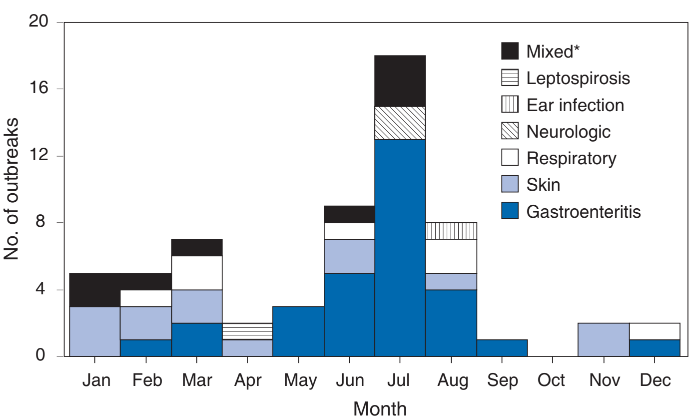
Six outbreaks of confirmed viral origin occurred, five of which caused gastroenteritis. In all five of these gastroenteritis outbreaks, norovirus was identified as the etiologic agent; two occurred at lake swimming beaches, and three occurred in treated water settings. These five norovirus outbreaks resulted in 300 cases of gastroenteritis. Three other outbreaks were suspected to have been caused by norovirus contamination. One outbreak (Idaho, March 2004) occurred during a swimming competition at a community pool and resulted in 140 cases. One outbreak (Florida,

TABLE 6. Number of waterborne-disease outbreaks (n = 62) associated with recreational water, by predominant illness and type of water — United States, 2003–2004

	Type of water					
	Treated		Untreated		Total	
Predominant illness*	No. of outbreaks	No. of cases	No. of outbreaks	No. of cases	No. of outbreaks (%)	No. of cases (%)
AGI	18	1,743	12	202	**30 (48.4)**	**1,945 (72.1)**
ARI	7	141	0	0	**7 (11.3)**	**141 (5.2)**
Ear	0	0	1	9	**1 (1.6)**	**9 (0.3)**
Ear and Skin	1	119	0	0	**1 (1.6)**	**119 (4.4)**
Eye and ARI	3	124	0	0	**3 (4.8)**	**124 (4.6)**
Leptospirosis	0	0	1	3	**1 (1.6)**	**3 (0.1)**
Neurologic	1	36	1	1	**2 (3.2)**	**37 (1.4)**
Skin	11	245	2	15	**13 (21.0)**	**260 (9.6)**
Skin and AGI	1	22	2	22	**3 (4.8)**	**44 (1.6)**
Skin and ARI	1	16	0	0	**1 (1.6)**	**16 (0.6)**
Total (%)	**43 (69.4)**	**2,446 (90.7)**	**19 (30.6)**	**252 (9.3)**	**62 (100.0)**	**2,698 (100.0)**

* AGI: acute gastrointestinal illness; ARI: acute respiratory illness; Ear: illness, condition, or symptom related to ears; Skin: illness, condition, or symptom related to skin; Eye: illness, condition, or symptom related to eyes; and Neuro: neurologic condition or symptoms (e.g., meningoencephalitis, meningitis).

FIGURE 4. Number of recreational water-associated outbreaks (n = 62), by predominant illness and month — United States, 2003–2004



* A combination of illnesses.

May 2004, norovirus etiology) involved an elementary school that used an outdoor hose to supply waterslides during outdoor play time. Children were infected after one ill child with diarrhea used one of the slides; secondary transmission to household contacts also occurred, resulting in 42 cases.

In July 2003, a viral outbreak of meningitis occurred in a pool at a Connecticut campground. Echovirus 9, an enterovirus, was isolated from patient cerebrospinal fluid samples. Although aseptic meningitis occurred in 12 of 36 persons, a wide range of other symptoms were reported by the other 24 ill persons, including headache and rash.

Chemicals/Toxins

During 2003–2004, three outbreaks involving chemicals or toxins resulted in 25 ill persons. One outbreak occurred in a treated water venue. In March 2003, muriatic (i.e., hydrochloric) acid, used for pH control in recreational water, spilled on the floor at an indoor pool in New York and resulted in exposure to toxic fumes, which led to respiratory distress in three persons who sought emergency department medical care.

During 2004, two toxin-associated outbreaks occurred in untreated water venues in Nebraska. These outbreaks were attributed to elevated levels of microcystin toxin (*17*) from blue-green algae (i.e., cyanobacteria) in lakes, causing 22 cases of illness. The predominant illnesses in both outbreaks involved dermatitis and gastroenteritis. Patients who sought medical care had a combination of rashes, diarrhea, cramps, nausea, vomiting, and fevers.

Unidentified Etiologic Agents

Eighteen outbreaks occurred in which no etiologic agent was confirmed; however, in 15 of these outbreaks, investigation reports described a suspected agent, based on symptoms, setting, and circumstances (Table 7). Of these 18 outbreaks, seven reported skin infections, five reported gastroenteritis, three reported mixed-eye and ARI, two reported ARI, and one reported ear infections. Eight of these 15 outbreaks were suspected to be related to chemical exposure. For one of these outbreaks (Georgia, January 2004), psychogenic factors also were suspected to play a role in the 17 cases of dermatitis because certain rashes resolved before first responders arrived to investigate. Another outbreak of gastroenteritis was suspected to be a result of the application of a pool algaecide before swimmers entered the pool. The six remaining outbreaks all were suspected to involve exposure to excess chloramines (i.e., disinfection by-products of chlorination) (*18–20*) in the indoor pools and surrounding areas (i.e., indoor pool air), which resulted

TABLE 7. Number of waterborne-disease outbreaks (n = 62) associated with recreational water, by etiologic agent(s) and type of water — United States, 2003–2004

	Type				Total	
	Treated		Untreated			
Etiologic agent	No. of outbreaks	No. of cases	No. of outbreaks	No. of cases	No. of outbreaks (%)	No. of cases (%)
Bacteria	**14**	**457**	**6**	**96**	**20 (32.3)**	**553 (20.5)**
Legionella pneumophila	4	117	0	0	**4**	**117**
Leptospira species	0	0	1	3	**1**	**3**
MRSA*	1	10	0	0	**1**	**10**
Plesiomonas shigelloides	0	0	2	5	**2**	**5**
Pseudomonas species	8	274	0	0	**8**	**274**
Shigella species	1	56	2	23	**3**	**79**
Shigella and *Plesiomonas* species	0	0	1	65	**1**	**65**
Parasites	**12**	**1,414**	**3**	**14**	**15 (24.2)**	**1,428 (52.9)**
Cryptosporidium species	10	1,202	1	4	**11**	**1,206**
Giardia species	1	149	1	9	**2**	**158**
Naegleria fowleri	0	0	1	1	**1**	**1**
Cryptosporidium and *Giardia* species	1	63	0	0	**1**	**63**
Viruses	**4**	**288**	**2**	**48**	**6 (9.7)**	**336 (12.5)**
Echovirus 9	1	36	0	0	**1**	**36**
Norovirus	3	252	2	48	**5**	**300**
Chemicals/toxins	**1**	**3**	**2**	**22**	**3 (4.8)**	**25 (0.9)**
Microcystin toxin (blue-green algae)	0	0	2	22	**2**	**22**
Muriatic acid	1	3	0	0	**1**	**3**
Unidentified agent	**12**	**284**	**6**	**72**	**18 (29.0)**	**356 (13.2)**
Suspected chemicals†	1	17	0	0	**1**	**17**
Suspected chloramines	6	157	0	0	**6**	**157**
Suspected algaecide	1	9	0	0	**1**	**9**
Suspected norovirus	0	0	3	48	**3**	**48**
Suspected *Pseudomonas* species	2	32	0	0	**2**	**32**
Suspected schistosomes	0	0	2	15	**2**	**15**
Other unidentified	2	69	1	9	**3**	**78**
Total (%)	**43 (69.4)**	**2,446 (90.7)**	**19 (30.6)**	**252 (9.3)**	**62 (100.0)**	**2,698 (100.0)**

* Methicillin-resistant *Staphylococcus aureus*.
† Suspected psychogenic factors and chemical exposure.

in ARI, eye irritation, and gastroenteritis. *P. aeruginosa* was the suspected pathogen in two dermatitis outbreaks in treated water venues. Norovirus was the suspected pathogen in three gastroenteritis outbreaks at lakes, based on epidemiologic and clinical evidence. Two outbreaks were suspected to be the result of contact with avian schistosomes, causing cercarial dermatitis.

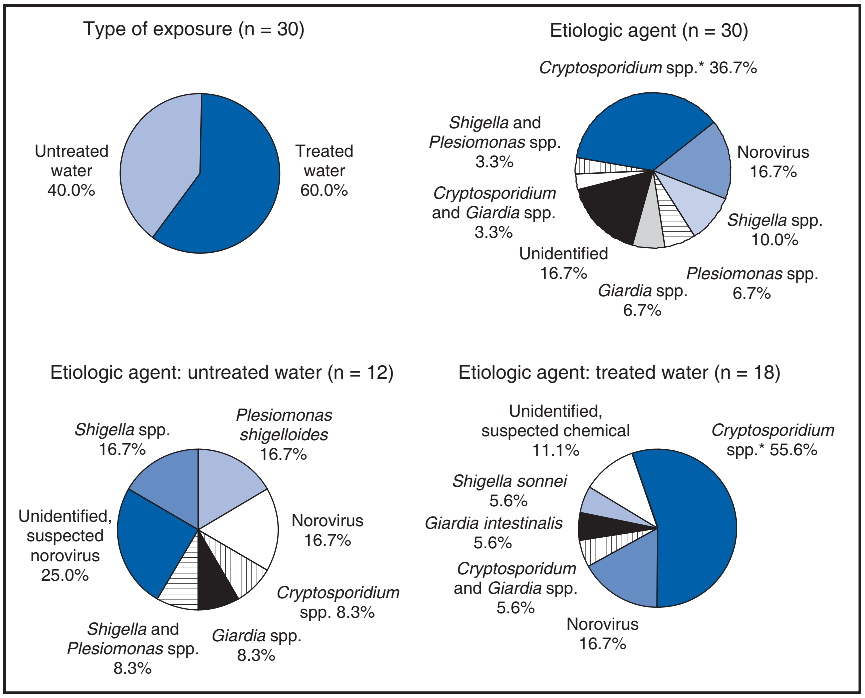
Information regarding the remaining three outbreaks of unidentified etiology was not sufficient to suggest an etiologic agent. Skin infections were reported as the predominant illness in two of these outbreaks, and ear infections were reported for the third one. Two outbreaks of skin infections were associated with spas. One resulted in 64 ill persons, but water sampling could not be conducted because the spa had been drained for routine maintenance before the investigation (South Carolina, November 2003). The third outbreak resulted in ear infections in nine children (Georgia, August 2004) who had been swimming and submerging their heads in a lake.

Vibrio Cases Associated with Recreational Water

During 2003–2004, a total of 142 *Vibrio* cases associated with recreational water were reported from 16 states. Recreational water-associated *Vibrio* cases were defined as those with recreational water exposure in the United States before infection and with no evidence that contact with seafood or marine life might have caused infection (Figure 1). Among patients for whom information was available, 70 (49.3%) of 142 were hospitalized, and nine (6.3%) of 142 died (Table 8).

The most frequently isolated *Vibrio* species was *V. vulnificus*, which was isolated from 47 (33.1%) persons; 41 (87.2%) were hospitalized, and six (12.8%) died. *V. alginolyticus* was isolated from 43 (30.2%) persons; eight (18.6%) were hospitalized, and one (2.3%) died. *V. parahaemolyticus* was isolated from 34 (23.9%) persons; 15 (44.1%) were hospitalized, and none died. Other *Vibrio* species (including noncholerigenic *V. cholerae*, *V. damsela*,

FIGURE 5. Recreational water-associated outbreaks of gastroenteritis, by type of exposure and etiologic agent — United States, 2003–2004



* For one of these outbreaks, cysts of *Giardia* species and oocysts of *Cryptosporidium* species were identified in pool water, but only *Cryptosporidium* was identified in the tested clinical samples.

V. fluvialis, nonspeciated *Vibrio*, and mixed *Vibrio* species) were identified in 18 (12.7%) persons; six (33.3%) were hospitalized, and two (11.1%) died. Six patients were reported to have had an amputation; five were infected with *V. vulnificus*; and one with *V. parahaemolyticus.*

Other bacterial species also were identified with *Vibrio*; 25 (25.3%) of 99 *Vibrio* isolates for which information was available yielded other bacterial species. These other species included *E. coli, Pseudomonas* species, *Staphylococcus marcescens*, *S. aureus,* and *Streptococcus*. Of the 149 *Vibrio* isolates taken from 142 patients, 85 (57%) were from wounds, 31 (20.8%) from blood, 27 (18.1 %) from ears, and six (4%) from other sites (i.e., chest abscess, eye, incision, sinus, sputum, stool, and urine).

Geographic location. Nearly all *Vibrio* patients reported that they were exposed to recreational water in a coastal state (Figure 6). The most frequently reported location was the Gulf Coast (62.7%); Pacific Coast states (19.7%); Atlantic Coast states, excluding Florida (16.9%); and inland states (0.7%) (Table 9). Florida, Hawaii, and Texas reported the highest number of cases, 51, 23, and 28 cases, respectively (Figure 6; Table 9).

Seasonality. In the temporal distribution of illness in patients from whom *Vibrio* species were isolated, a clear seasonal peak occurred during the summer (Figure 7). The greatest frequency of *Vibrio* cases occurred during July and August for all species.

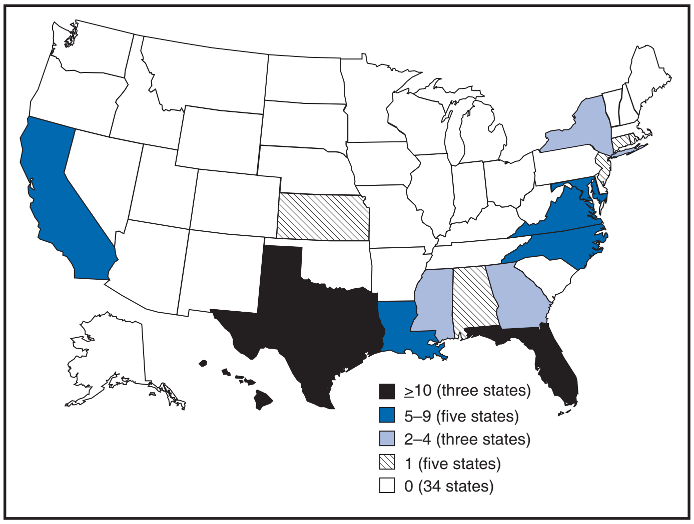
Exposures. Activities associated with *Vibrio* cases included swimming, diving, or wading in water (66.9%); walking or falling on the shore or rocks (32.3%); and boating, skiing, or surfing (21.8%). The majority of patients reported being exposed in the ocean (100 [70.4%]); 12 (8.5%) were exposed in a river, stream, or creek; seven (4.9%) were exposed in a lake or bay; eight (5.6%) were exposed to another water source; and 15 (10.6%) exposed a wound to an unknown water source.

TABLE 8. Number of illnesses associated with *Vibrio* isolation (n = 142) and recreational water exposure, by species and year — United States, 2003–2004

	Year								
	2003			2004			Total		
Species	Cases	Hospitalized	Deaths	Cases	Hospitalized	Deaths	Cases	Hospitalized	Deaths
Vibrio alginolyticus	24	4	1	19	4	0	**43**	**8**	**1**
V. cholerae non-O1, non-O139	3	0	0	4	2	1	**7**	**2**	**1**
V. cholerae, unknown type	0	0	0	1	0	0	**1**	**0**	**0**
V. damsela	1	0	0	1	1	0	**2**	**1**	**0**
V. fluvialis	1	1	0	0	0	0	**1**	**1**	**0**
V. parahaemolyticus	12	4	0	22	11	0	**34**	**15**	**0**
V. vulnificus	20	20	1	27	21	5	**47**	**41**	**6**
Multiple*	0	0	0	1	1	0	**1**	**1**	**0**
Vibrio, species not identified	2	0	0	4	1	1	**6**	**1**	**1**
Total (% of cases)	**63**	**29 (46.0%)**	**2 (3.2%)**	**79**	**41 (51.9%)**	**7 (8.9%)**	**142**	**70 (49.3%)**	**9 (6.3%)**
Percentage by year	**(44.4)**	**(41.4)**	**(22.2)**	**(55.6)**	**(58.6)**	**(77.8)**	**(100.0)**	**(100.0)**	**(100.0)**

* *V. alginolyticus/V. parahaemolyticus* coinfection.

FIGURE 6. Number of illnesses associated with *Vibrio* isolation and recreational water exposure (n = 142) — United States, 2003–2004*



* **Note:** These numbers are largely dependent on reporting and surveillance activities in individual states and do not necessarily indicate the true incidence in a given state.

Symptoms. Symptoms associated with *Vibrio* cases were cellulitis (54.9%), fever (41.5%), muscle pain (24.6%), ear infection (19.0%), nausea (18.3%), shock (12.7%), and bullae (12.0%) (Figure 8). *V. vulnificus* accounted for the majority of skin infections, including cellulitis, bullae, and other skin infections (56 [51.9%] of 108). *V. vulnificus* also accounted for the majority of severe illnesses, including those with fever (79.5%), bacteremia (80.6%), and shock (66.7%). *V. alginolyticus* accounted for the majority of ear infections (17 [63.0%] of 27). Other symptoms and infections were reported in low frequencies (e.g., bladder infections, hematuria, eye infections, respiratory symptoms, sinus infections, diarrhea, and vomiting).

Previously Unreported Outbreak

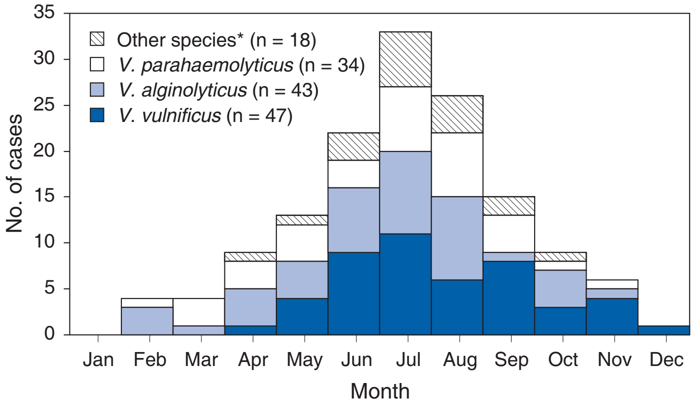
One previously unreported recreational water outbreak from 2002 was received. The outbreak is summarized but not analyzed in this *Surveillance Summary*. The outbreak occurred in Florida in December 2002 and involved two

TABLE 9. Number of recreational water-associated *Vibrio* isolations and deaths, by region/state and species — United States, 2003–2004

	Species									
	V. alginolyticus		*V. parahaemolyticus*		*V. vulnificus*		Other/unknown species*		Total	
Region/State	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Atlantic										
Connecticut	0	0	1	0	0	0	0	0	**1**	**0**
Georgia	1	0	0	0	0	0	1	0	**2**	**0**
Maryland	2	1	1	0	2	0	0	0	**5**	**1**
North Carolina	2	0	2	0	1	0	2	0	**7**	**0**
New Jersey	0	0	1	0	0	0	0	0	**1**	**0**
New York	2	0	0	0	0	0	0	0	**2**	**0**
Rhode Island	1	0	0	0	0	0	0	0	**1**	**0**
Virginia	1	0	2	0	2	0	0	0	**5**	**0**
Total	**9**	**1**	**7**	**0**	**5**	**0**	**3**	**0**	**24**	**1**
Gulf Coast										
Alabama	0	0	0	0	1	0	0	0	**1**	**0**
Florida†	9	0	17	0	21	2	4	0	**51**	**2**
Louisiana	0	0	0	0	6	1	0	0	**6**	**1**
Mississippi	1	0	1	0	1	1	0	0	**3**	**1**
Texas	5	0	6	0	8	1	9	2	**28**	**3**
Total	**15**	**0**	**24**	**0**	**37**	**5**	**13**	**2**	**89**	**7**
Noncoastal										
Kansas	0	0	0	0	0	0	1	0	**1**	**0**
Total	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**
Pacific										
California	4	0	0	0	0	0	1	0	**5**	**0**
Hawaii	15	0	3	0	5	1	0	0	**23**	**1**
Total	**19**	**0**	**3**	**0**	**5**	**1**	**1**	**0**	**28**	**1**
Total	**43**	**1**	**34**	**0**	**47**	**6**	**18**	**2**	**142**	**9**
Percentage	**(30.3)**	**(11.1)**	**(23.9)**	**(0)**	**(33.1)**	**(66.7)**	**(12.7)**	**(22.2)**	**(100.0)**	**(100.0)**

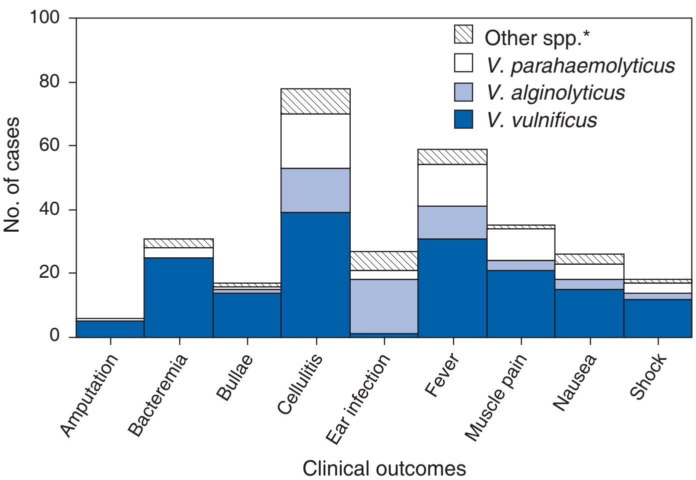
* Includes *V. cholerae* (non-O1, non-O139, and unknown serotype), *V. damsela*, *V. fluvialis*, *V. alginolyticus*/*V. parahaemolyticus* coinfection, and *Vibrio* species not identified.
† Five reports from Florida indicate Atlantic coast exposure.

FIGURE 7. Number of illnesses associated with *Vibrio* isolation and recreational water (n = 142), by species and month — United States, 2003–2004



* Includes noncholeragenic *V. cholerae* (eight), *V. damsela* (two), *V. fluvialis* (one), *V. alginolyticus/V. parahaemolyticus* coinfection (one), and *Vibrio* species not identified (six).

FIGURE 8. Number of illnesses associated with *Vibrio* isolation and recreational water (n = 142), by selected clinical outcomes and species — United States, 2003–2004



* Includes noncholeragenic *V. cholerae, V. damsela, V. fluvialis, V. alginolyticus/V. parahaemolyticus* coinfection, and *Vibrio* species not identified.

laboratory-confirmed cases of Legionnaires' disease (i.e., *Legionella pneumophila* serogroup 1) linked to a hotel spa. Both persons were hospitalized and recovered. No *Legionellae* were recovered from the spa, but epidemiologic evidence (Class III) implicated the spa as the probable source for this cluster of cases. Bromine tablets were used to disinfect the spa, but the tablets did not dissolve properly, leading to low bromine concentrations in the water and conditions favorable for the growth of *Legionella*.

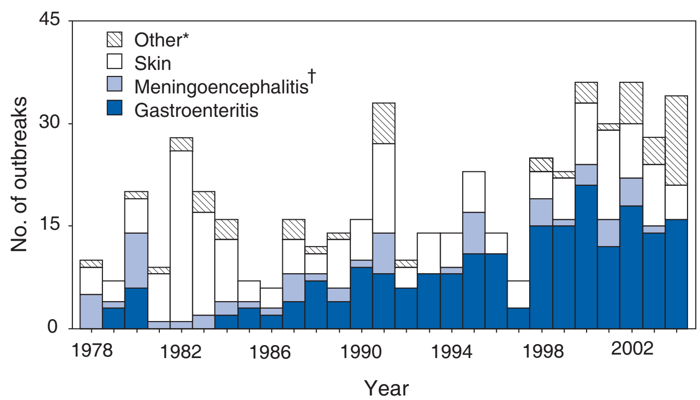
Discussion

Trends in Reporting Outbreaks

A total of 62 recreational water-associated WBDOs were reported to CDC during 2003–2004. This number is a slight decrease from the previous 2001–2002 *Surveillance Summary* in which a record number (65) of WBDOs were reported. Both the number of reported recreational water-associated WBDOs (Pearson's correlation = 0.59; p<0.01) and outbreaks of gastroenteritis (Pearson's correlation = 0.86; p<0.01) have increased significantly since 1978 when CDC first began receiving these reports (Figure 9). These increases are likely a result of a combination of factors such as the emergence of pathogens (e.g., *Cryptosporidium*), increased participation in aquatic activities, and increases in the number of aquatic venues. Increased recognition, investigation, and reporting of recreational water-associated outbreaks also might be contributing factors.

The number of reported WBDOs also differs substantially based on geographic location (Figure 2). This variation might be a result of several factors, including public awareness of the outbreak, availability of laboratory testing, requirements for reporting diseases, and resources available to local and state health departments for surveillance and investigation of probable outbreaks. Differences in the capacity of local and state public health agencies and laboratories to detect WBDOs probably result in reporting and surveillance bias. Therefore, the states with the majority of outbreaks reported for this period might not be the states in which the majority

FIGURE 9. Number of recreational water-associated outbreaks (n = 508), by year and illness — United States, 1978–2004



* Includes keratitis, conjunctivitis, otitis, bronchitis, meningitis, hepatitis, leptospirosis, Pontiac fever, acute respiratory illness, and combined illnesses.

† Also includes data from report of ameba infections (**Source:** Visvesvara GS, Stehr-Green JK. Epidemiology of free-living ameba infections. J Protozool 1990;37:25S–33S).

of outbreaks actually occurred. An increase or decrease in the number of WBDOs reported might reflect either an actual change in the incidence of outbreaks or a change in the sensitivity of surveillance practices.

Multiple other factors also might influence which WBDOs are reported. Larger outbreaks are more likely to be identified by public health authorities and to receive more rigorous investigations. Etiologic agents with shorter incubation periods might be more easily linked to water exposures, facilitating the recognition of outbreaks. In contrast, private residential pools and spas might experience problems that go undetected because they are not regulated or inspected by public health agencies. In addition, outbreaks of gastroenteritis at large venues that draw from a wide geographic range (e.g., the Great Lakes and ocean beaches) might be difficult to detect because potentially infected persons disperse widely from the site of exposure and, therefore, might be less likely to be identified as part of an outbreak. Such an effect is supported by data from EPA's NEEAR Water Study (*16*). This prospective study of large beaches on the Great Lakes has indicated that elevated rates of gastroenteritis have occurred in swimmers compared with nonswimmers on all four beaches studied, although outbreaks associated with the use of the beaches were not reported during this period. Consistent with this finding, WBDOs reported in *Surveillance Summaries* have not been ocean beach-associated outbreaks of gastroenteritis, and only one Great Lakes beach-associated outbreak of gastroenteritis has been reported since 1978 (*2*). Multiple other prospective studies of gastroenteritis associated with beach swimming have also indicated elevated rates of illness associated with swimming (*21*). This endemic recreational water-associated illness is not captured by the WBDOSS, supporting the need for more studies to be conducted to determine the magnitude of risk of illness for routine, nonoutbreak-associated exposures at recreational water venues.

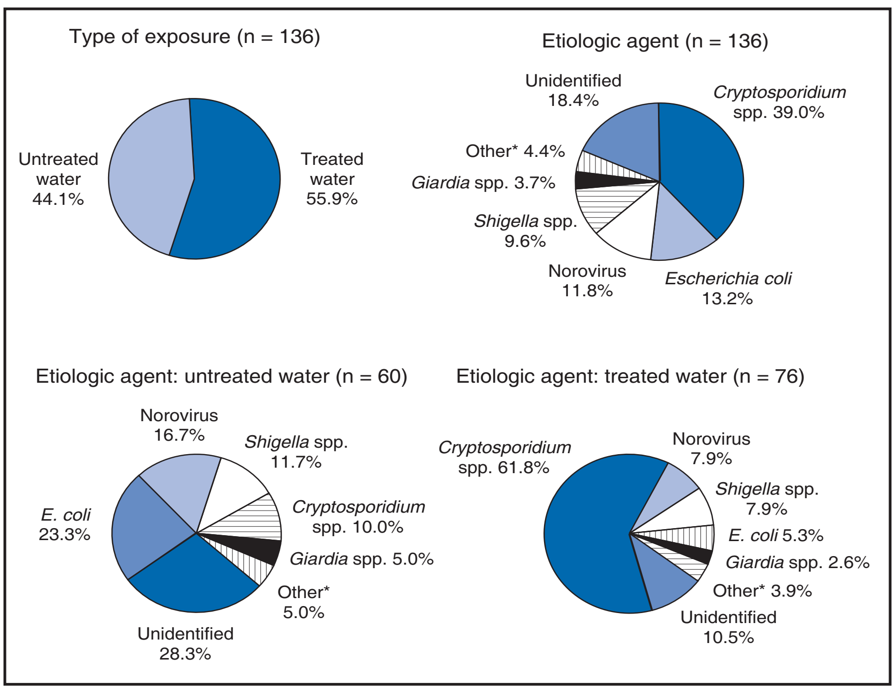
WBDOs associated with recreational water use occur year-round, but the number of reported WBDOs and cases are highest during the annual summer swim season (Figure 4). For public health professionals, these trends can help determine the allocation of resources so that health education messages are targeted to populations during times of the year when the highest risk for preventable illness occurs.

Swimming Pools

Infectious Gastroenteritis

During 2003–2004, *Cryptosporidium* caused the largest number of recreational water-associated outbreaks (n = 11). These outbreaks accounted for the largest number of ill persons included in this report (n = 1206); 99.7% of these cases were associated with treated water venues. During 1995–2004, *Cryptosporidium* was implicated in 39.0% of the recreational water-associated outbreaks of gastroenteritis and, although *Cryptosporidium* rarely was attributed to outbreaks in lakes and rivers (10% of outbreaks), it caused 61.8% of outbreaks associated with treated venues (Figure 10). This observation for treated venues is consistent with the finding that *Cryptosporidium* requires extended contact time with chlorine for inactivation; oocysts can survive for days in the chlorine levels that typically are recommended for swimming pools (1–3 ppm free chlorine; *22*). The continued reporting of cryptosporidiosis associated with the use of treated water venues underscores the importance of other prevention measures that reach beyond traditional pool chlorination, which is currently the primary barrier to infectious disease transmission. Cryptosporidiosis has stimulated the need for new technology to keep swimming venues safe (e.g., ultraviolet light irradiation, ozonation, chlorine dioxide use, or improved

FIGURE 10 . Recreational water-associated outbreaks of gastroenteritis, by type of exposure and etiologic agent — United States, 1995–2004



* These include outbreaks of *Salmonella, Campylobacter, Plesiomonas,* and mixed pathogens.

filtration). However, cryptosporidiosis outbreaks also highlight the need for improved operator training and continued education of the general public concerning appropriate healthy swimming practices to reduce the risk of future outbreaks.

Because *Cryptosporidium* is resistant to the chlorine levels used in pools, outbreaks can occur, even in facilities that are well-maintained. Therefore, a rapid public health response and increased community involvement is needed to prevent the expansion of these outbreaks (*23*). The *Cryptosporidium* outbreak (Ohio, July 2004) that occurred in a community swimming pool demonstrates that a rapid communitywide public health response during the early stages of an outbreak can help control the potential spread of illness into the community. In Ohio, detection and investigation started during the second week after exposure. The response included mitigating actions (e.g., hyperchlorination of all pools and providing instructions regarding proper water hygiene to pool staff and users, day care centers, restaurants, and other potentially affected facilities). In addition, the investigation indicated that no transmission had apparently occurred outside of the single community pool. In contrast, the outbreak in Kansas (July 2003) was not detected for multiple weeks. As a result, a full communitywide outbreak occurred when ill pool patrons and daycare center attendees continued their normal activities (despite their illness) exposing large numbers of persons to *Cryptosporidium*.

Approximately 60% of all cases of illness reported to this surveillance system during 2003–2004 were associated with infectious gastroenteritis outbreaks in treated pools. Several of these outbreaks (e.g., giardiasis, norovirus, and echovirus) could have been prevented or reduced in scale by using proper pool disinfectant procedures and by following existing operation, maintenance, and communication protocols because of the pathogens' chlorine sensitivities. The norovirus outbreak (Vermont, February 2004) demonstrated that when pool staff do not follow these protocols, outbreaks might occur. Despite complaints from patrons concerning water quality, on-duty staff failed to alert off-duty pool operation personnel. As a result, a malfunctioning chlorinator system was not detected for several days; norovirus transmission occurred for multiple days (which probably would have been hours or less with proper chlorination) before the breakdown was discovered and corrected (*24*). This outbreak emphasizes the need for both effective communication channels at aquatic facilities and trained personnel on site or accessible on weekends when pool use is highest.

Swimming behavior is also a critical component of pool operation. Because swimming is essentially communal bathing, when persons who are ill with infectious diarrhea continue to swim, a public health challenge is created that requires a focused public education effort. In addition, improved hygiene is essential to ensure the cleanliness of swimmers entering pools. Functioning and adequate hygiene facilities (i.e., toilets, diaper-changing areas, and showers) in adequate numbers should be located near pools and should provide hot water and handwashing access. Swimmers should be encouraged to shower thoroughly (i.e., washing the perianal surface in particular) before entering the pool. Diaper-changing facilities, with hand-washing stations, should be readily accessible to prevent diaper-changing at the poolside. These outbreaks demonstrate how pools can serve as ideal amplification venues for fecal-oral transmission of pathogens. As a result, facilities should be diligent about making patrons aware of these public health concerns and about making clear that "no diarrhea" policies apply to all pools. This policy is especially needed for young children visiting pools, particularly large groups (e.g., day care centers), which already have diarrhea exclusion policies but might not always enforce them (Kansas, July 2003). Diarrhea exclusion policies should apply to both pool employees when swimming and food workers when preparing food. For the waterpark-associated outbreak in California (August 2004), documentation revealed that employees were ill with diarrhea before the main outbreak, which involved patrons, and that employees admitted to swimming while symptomatic. All aquatic facilities need to establish standardized policies for keeping staff who are ill with diarrhea out of pools and should subsequently implement and enforce these policies.

Meningitis

Although gastroenteritis is the most common illness spread via pool outbreaks, it is not the only disease that can be contracted in this manner. In one outbreak, the transmission of an agent causing viral meningitis via a swimming pool at a recreational vehicle campground (Connecticut, July 2003) was reported. The implicated enterovirus, Echovirus 9, was the predominant enterovirus serotype circulating through the eastern United States during 2003 and is susceptible to chlorine if proper chlorine residuals are maintained (*25*). Properly monitored and maintained chlorination levels and pH control in pools should prevent this type of WBDO.

Chemical Toxicity

During 2003–2004, pool chemicals or disinfection by-products were confirmed (n = one) or suspected (n = eight) in nine pool-associated outbreaks. Chemicals are added to pool water to protect against microbial growth and improve the water quality and efficacy of the disinfection process (e.g., pH control). However, these same chemicals can become sources of illness if they are not properly handled or if water quality and ventilation are poor. One outbreak in New York (March 2003) involved an overflow and spill of muriatic (i.e., hydrochloric) acid, which is used for pH control of pool water. As a result, three persons developed ARI from exposure to fumes. Another outbreak (Illinois, July 2004) was suspected to be caused by ingestion of algaecide that was added to the pool before a swim meet, which resulted in nine persons becoming ill with gastroenteritis. These outbreaks underscore the need for safe chemical training (i.e., adding disinfectant, controlling pH levels, and using pool additives appropriately), handling, and safety practices at all aquatic facilities to protect the health of patrons and staff. These policies should include proper handling of chemicals in the pump room and application procedures for adding pool chemicals directly to the pool.

Six outbreaks of acute respiratory symptoms, eye irritation, and gastroenteritis were suspected to be a result of an accumulation of chloramines in the air and water of indoor pools. Chloramines are disinfection by-products that result from chlorine oxidation of nitrogenous waste compounds, commonly shed into pools by swimmers (e.g., perspiration, saliva, urine, and body oils) (*18*). These chemicals are produced in the water and volatilize in the air. In indoor pool settings, chloramines can also accumulate in the enclosed spaces if ventilation is inadequate (*19*). The resulting high levels of chloramines can cause respiratory tract and mucous membrane irritation (*20*); these high levels also are potentially linked to asthma in indoor pool settings (*26*).

Because of the shortage of laboratories that perform analyses for airborne chloramines and because of rapid shifts in indoor air quality over days, the investigators' ability to respond to reports of airborne chloramines and to quantitatively identify these chemicals is difficult. Investigators should always document the easily measured total chlorine concentration (i.e., free plus combined chlorine) and free chlorine levels of the pool water to obtain some indication of pool water quality and the potential for the presence of disinfection by-products, especially chloramines, which might be present in the water and air.

Multiple steps can be taken to address indoor pool problems, including swimmer behavior modification. Encouraging showering before entering any pool or spa and facilitating frequent bathroom breaks for swimmers, particularly young children (i.e., by instituting adult-only swim times and short closures for water-quality testing), might reduce the amount of 1) urine and other nitrogenous waste contaminating the water and 2) accumulation of chloramines. To encourage swimmers to refrain from urinating in public pools, they should be educated that stinging eyes from pool chemicals are actually caused by human waste (i.e., urine and sweat) in the pool water. Improved indoor pool ventilation is vital to increase air-turnover and to remove concentrated chloramines; however, new studies have suggested that installation of ultraviolet light treatment devices in pool water recirculation systems can reduce pool chloramine levels and inactivate chlorine-resistant pathogens (e.g., *Cryptosporidium*) (*27,28*).

Surveillance for recreational water-associated outbreaks of acute chemical poisonings is likely to have multiple barriers; therefore, the number of reported chemical/toxin WBDOs probably underestimates the true magnitude of the problem. Symptoms associated with chemical poisonings in recreational water settings might be substantially different from those associated with more familiar infectious microbes, which might lead to decreased chemical-related WBDO identification. By contrast, chemicals/toxins and infectious agents might cause similar symptoms (e.g., gastrointestinal illness), and investigators might fail to identify the etiologic agent because they do not suspect a chemical etiology. Multiple health departments use infectious disease epidemiologists for WBDO surveillance and investigation. However, chemical-related WBDOs and recreational WBDOs, in general, might be investigated by staff from different sections of the health department or by staff from different agencies. Because of the acute nature of certain chemical-related WBDOs, first responders will likely be called to the scene, and persons from these agencies might be less likely to report back through the traditional chain of health department infectious disease epidemiologists who report to the WBDOSS. Therefore, building strong and effective intra- and interagency communication networks between health departments and other groups (e.g., first responders and pool operators) to reduce the underreporting of recreational WBDOs is critical.

Spas

Spas are susceptible to contamination from persons infected with the same pathogens that cause gastroenteritis in swimming and wading pools. However, the increased temperature of the water also makes these venues susceptible to contamination with and amplification of thermophilic pathogens (e.g., *Pseudomonas* and *Legionella*) that naturally occur in the environment (i.e., contamination does not necessarily occur via ill swimmers).

Skin Infections

Spa-associated outbreaks are commonly associated with dermatitis and folliculitis; *P. aeruginosa* is the most commonly reported agent implicated in these settings (*29*). In this report, eight confirmed *Pseudomonas* WBDOs and two suspected *Pseudomonas* WBDOs were documented; five of these outbreaks involved spas, one involved a pool, and four involved both spas and pools. Because of the frequent use of both spas and pools at the facilities, determining whether the spa, pool, or both are implicated in transmission of illness is epidemiologically difficult, although amplification of *Pseudomonas* is more likely to occur in the higher temperatures of spas. One outbreak report (Ohio, July 2004) concluded that *Pseudomonas* growing in a spa was transferred to a pool through combined water circulation and that infection occurred in both settings.

Spas are a challenge to maintain and operate because they typically have reduced bather capacity compared with swimming pools, so they can more easily be overloaded and rapidly lose disinfectant concentrations when bather loads exceed recommended numbers of persons. In addition, depletion of disinfectant levels is increased at higher temperatures. Large gatherings at hotels and motels with spas (e.g., cheerleading competitions [North Carolina, March 2004], dance competitions [Ohio, July 2004], and school class outings [Michigan, February 2003]) can rapidly overload the disinfection capacity and lead to bacterial amplification. In addition to overloading the spas and depleting the disinfectant, these groups frequently arrive on weekends when hotel staff trained in spa maintenance are off duty. Hotels and motels should consider that employees with appropriate pool and spa operation training are needed on weekends, when usage is typically highest. Enhanced monitoring and maintenance should be implemented when a large group or event at a hotel is scheduled.

Multiple aquatic facilities have transitioned to employing remote monitoring services to check pool chemistry (e.g., chlorine and pH) on a regular basis and to alert the facility of any problems that arise. Breakdowns in communication between these remote monitoring services and the aquatic facility seem to facilitate problems that occur for long periods, without correction, which was documented in a large outbreak of *Pseudomonas* dermatitis in Illinois (January 2003) and several previous outbreaks (*30*). Facilities should not rely on off-site monitoring companies as the sole overseers of their aquatic facilities. Although remote monitoring can be beneficial in detecting water-quality problems, the service should not take the place of routine water-quality checks, which are required in the majority of pool codes. To prevent adverse events, having 1) clear communication plans for relaying warnings concerning problems, 2) prompt alerts so corrections can be made, and 3) diligent staff who immediately respond to alerts are essential.

To prevent spa-associated outbreaks, understanding the risk factors and steps that can be taken is necessary to limit transmission of the bacteria. Proper chlorination or bromination is effective in killing *Pseudomonas* and other skin-infecting bacteria. However, sufficient chlorine and bromine levels must be maintained consistently along with adequate pH control to limit bacterial amplification. Poor maintenance of spas has been documented (*31*). Cycling between high and low disinfectant levels allows biofilms to proliferate on spa surfaces, creating an environment where *Pseudomonas* and other bacteria are protected from disinfection (*32*). A review of 18 *Pseudomonas* outbreaks has demonstrated that all spa-associated outbreaks had inadequate disinfection (*33*). The majority of *Pseudomonas* outbreaks can be prevented by properly maintaining spas and by ensuring that disinfectant levels remain >1 ppm and pH levels remain in a range of 7.2–7.8. In addition, elimination of potential sources of *Pseudomonas* (e.g., soil from potted plants in close proximity to the water) (Illinois, January 2003) is advisable.

Pseudomonas is not the only bacterium that can cause spa-related skin infections. MRSA was associated with an outbreak involving an athletic spa in Connecticut (August 2003; *34*). MRSA infections can have substantial consequences, as in this outbreak in which otherwise healthy young athletes were hospitalized. Factors contributing to this outbreak included the presence of skin abrasions on the athletes from "turf burns" and body shaving, and the communal use of an athletic spa that employed limited and unproven disinfection methods. Appropriate spa operation, maintenance, and cleaning should prevent outbreaks of this emerging infectious disease.

Legionellosis

Legionellae, which cause both Legionnaires' disease and PF, are ubiquitous in freshwater environments (*35*). However, certain environmental conditions in spas (e.g., high temperatures and water aerosolization) promote the amplification and transmission of the bacteria. Similar to outbreaks of *Pseudomonas* dermatitis associated with spas, transmission of *Legionella* is more likely to occur in the absence of adequate levels of disinfectant, underscoring the importance of maintaining disinfectant levels and pH control. When lapses in preventive measures occur and *Legionella* outbreaks occur, morbidity can be reduced by rapid recognition of the outbreak, identification of its source, and immediate implementation of remediation. These methods include cleaning and disinfecting the spa to eliminate *Legionella* colonization and performing follow-up cultures of *Legionella* to ensure that regrowth does not occur (*36*). Of the four *Legionella* WBDOs associated with recreational water during 2003–2004 (as well as one from 2002 which was previously unreported), all except one were associated with hotel spas. These travel-associated WBDOs highlight the importance of timely reporting of individual cases of legionellosis, which was recently recommended in a 2005 CSTE position statement (http://www.cste.org/PS/2005pdf/final2005/05-ID-01final.pdf).

Interactive Fountains/Wet Decks and Waterslides

Infectious Gastroenteritis

Certain treated water venues (e.g., interactive fountains, which are also called wet decks) might be overlooked as potential sites for disease transmission or pool regulation because they do not have the standing water found in traditional swimming pools. Outbreaks in this report continue to demonstrate the possibility of infection occurring in these settings. The use of interactive fountains has previously been associated with outbreaks of gastroenteritis (*37*). In two WBDOs in this report, contaminated interactive fountains are implicated; one involved a *S. sonnei*–contaminated fountain (Oregon, July 2003), and the other involved a *Cryptosporidium*-contaminated (Illinois, July 2004) fountain and swimming pool. In certain states, interactive fountains are not regulated as other recreational water venues, and fountain designs that include recirculation of the bathing water make these venues vulnerable to contamination. New designs that improve water treatment for these interactive fountains are needed so that visitors can enjoy them without risk from waterborne diseases.

The traditional use of tap water to fill or operate temporary aquatic venues (e.g., wading pools and waterslides) used by young children also needs to be reconsidered, particularly in institutional settings (e.g., day care centers and schools). If the water is not treated with adequate levels of disinfectant, residual disinfectant in the water is rapidly depleted; users are then at higher risk of exposure to infectious microbes in the untreated water. Special consideration needs to be given to kiddie pools, some of which have had unfavorable water-quality test results and associations with previous outbreaks (*38*). In one *Cryptosporidium* outbreak (Iowa, June 2003), a kiddie pool at a day care facility was filled with potable municipal water that had not received additional treatment, expediting infection of children and eventual expansion into a communitywide outbreak. In Kansas (July 2003), the communitywide outbreak also involved use of kiddie wading pools and in-ground pools at local day care centers. Portable waterslides in which municipal water is used also might be overlooked as sources of disease transmission because they can be set up, used, and taken down in a matter of hours. The outbreak in Florida associated with a waterslide (May 2004) demonstrated that the use of these slides by a person infected with a fecal-oral transmissible microbe (in this case, norovirus) contaminated the waterslide, so it became an ideal venue for spreading disease. As with pools, spas, and fountains, appropriate treatment of recreational water venues and exclusion of persons with diarrhea is needed to prevent disease transmission. Furthermore, the use of temporary pools filled with municipal water that do not include routine disinfection and filtration should be considered carefully by the public and, based on documented outbreaks, should be eliminated from institutional settings (e.g., day care centers and schools).

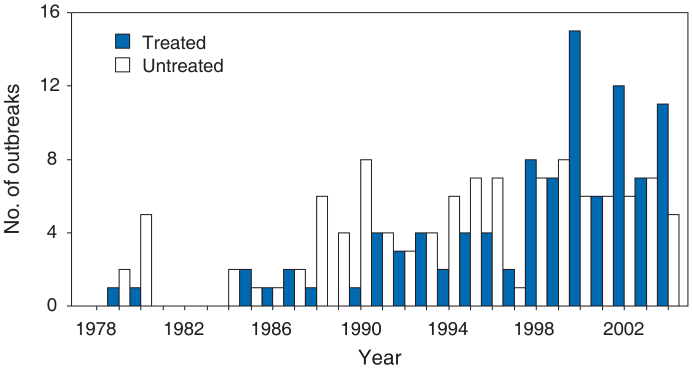
Lakes and Rivers

Infectious Gastroenteritis

Since the WBDOSS began collecting data on recreational water outbreaks, reports have implicated both treated and untreated venues. Since 1998, the numbers of reported outbreaks from treated water venues have surpassed those from untreated venues (Figure 11). For 2003–2004, a total of 12 outbreaks of gastroenteritis associated with untreated freshwater venues were reported; 11 of these outbreaks involved lakes, and one involved a reservoir. Freshwater outbreaks were more likely to be of a bacterial or viral origin than treated water outbreaks (Figure 5).

As with treated venues, human behavior plays a role in the spread of pathogens in untreated bodies of water. For example, in an outbreak in Maryland (July 2003), 5–10 diapers were reportedly retrieved from the lake each week. Modification of swimmer behavior might be a more critical factor because these natural water venues do not have the benefit of disinfection and filtration barriers. Recommendations for swimmer hygiene are the same for lakes, as

FIGURE 11. Number of recreational water associated outbreaks of gastroenteritis (n = 206), by water type and year — United States, 1978–2004



previously discussed regarding treated pools. In addition, beach managers and swimmers should be informed that shallow swimming areas with poor water circulation, although desirable to many swimmers, might pose a higher risk if a swimmer contaminates the water. Use of methods to improve circulation of water through these beach areas should be explored for the potential to reduce the risk for waterborne disease transmission. Additional reduction of risk might be accomplished by avoiding swimming immediately after a heavy rainfall when the water is at higher risk for transient contamination, and by avoiding swimming near storm drains or pipes that might release sewage into bodies of water. The use of water-quality monitoring (e.g., fecal indicator testing) by beach managers might also reduce risk (*15*), particularly when more rapid testing methods are implemented by EPA (*16*).

Primary Amebic Meningoencephalitis

Whereas infection with *Naegleria fowleri*, the cause of primary meningoencephalitis (PAM), is a rare occurrence in the United States (*39*), this disease has public health importance because of its high fatality rate. This free-living ameba proliferates in warm freshwater and hot springs. PAM is caused when the ameba coincidentally enters the nasal passages, travels to the olfactory lobe of the brain, and infects brain tissue. Only one fatality (North Carolina, July 2003) was reported for this 2003–2004 surveillance cycle (excluding *Vibrio* illnesses). During the summer, a young child was exposed to infection through warm lake water, similar to cases of PAM during previous years. PAM is difficult to predict, and prevention strategies might not prevent these tragic events. However, swimmers potentially can reduce their risk of PAM by wearing nose plugs, holding their nose while diving or jumping into the water, refraining from digging in sediment, and avoiding swimming in shallow waters during the warmest times of the year. Additional resources are needed to develop more evidence-based prevention measures.

Leptospirosis

Leptospirosis infection occurs worldwide, except in polar regions, and particularly in tropical and semitropical areas of the world, including several of the Pacific islands that report to this surveillance system (*40*). *Leptospira* can be found in the urine of infected wild and domesticated animals. Human infection can occur when contaminated water is ingested, aerosolized droplets are inhaled, or water enters the body through skin abrasions. One outbreak of leptospirosis was reported for 2003–2004 and involved three cases, which resulted from exposure to a river and waterfalls in Guam (April 2004). This outbreak occurred among U.S. military personnel in a remote area, and water buffalo moving through that region were suspected to have been the possible sources of contamination.

Blue-Green Algae Toxicity

Toxin or chemical-associated outbreaks can occur by natural mechanisms. Blue-green algae that bloom in freshwater lakes have been identified as sources of outbreaks of human waterborne diseases in multiple countries (*41*). The toxins involved include anatoxin (i.e., a potent neurotoxin) and microcystins (i.e., potent liver toxins), and poisonings can cause various symptoms. These symptoms were observed in two outbreaks (Nebraska, 2004) in which 22 persons became ill with ARI and dermatologic symptoms. The actual number of persons who become ill after exposure to blue-green algal toxins in drinking and recreational waters is not known; substantial research is needed to identify the actual extent of this public health threat. Toxin levels can be measured in samples collected from lakes where blooms occur. Currently no regulations exist that establish acceptable toxin levels in drinking or recreational water.

Cercarial Dermatitis

During the 2003–2004 surveillance period, two WBDOs of suspected cercarial dermatitis caused by avian schistosomes were reported (California, June 2003; Ohio, June 2003). Although the diagnosis was not confirmed, this self-limited disease is known to occur in lakes across America where the intermediate host snail species are found and a population of suitable bird hosts are present (*42*). Cases of cercarial dermatitis might be reduced by posting warning signs at lakes known to be infested, avoiding shallow swimming areas where infected snails reside, instituting a snail-control program, and by not attracting birds to swimming areas (e.g., by feeding them).

Marine Water

Vibrio Illness

A limited number of outbreaks at marine venues have been reported to the WBDOSS. Outbreaks in these settings can be difficult to detect because persons affected frequently travel from distant locations to visit these venues and might disperse before a health problem is recognized. However, single cases of *Vibrio* infections from recreational water exposure are captured through the Cholera and Other *Vibrio* Illness Surveillance System (http://www.cdc.gov/foodborneoutbreaks/vibrio_sum/cstevibrio2004.pdf) and represent an essential aspect of waterborne morbidity and mortality in the United States. As a result, recreational water-associated *Vibrio* illnesses will now be included in the WBDOSS to report the scope of waterborne disease in the United States in a more comprehensive manner.

During 2003–2004, the most commonly reported species were *V. vulnificus, V. alginolyticus,* and *V. parahaemolyticus.* Of these species, *V. vulnificus* illnesses had the highest hospitalization rate (87.2%) and mortality rate (i.e., 12.8% of infected patients with recreational water exposure). The predominant syndrome associated with *Vibrio* illness caused by recreational water was wound infection. *Vibrio* wound infections were characterized by cellulitis, muscle pain, and especially with *V. vulnificus*, bullae, and septicemia.

Vibrio illness caused by recreational water exposures occurs in all regions of the United States but most frequently occur along the Gulf Coast. However, the majority of *V. alginolyticus* cases occur in the Pacific coast states, where the most common exposures occur through surfing and swimming. Improved surveillance and analysis is needed to 1) assess the actual magnitude of *Vibrio* illness and other WBDOs at marine water venues, 2) better characterize the risk, and 3) educate the public concerning appropriate prevention measures (e.g., not swimming in warm water when a person has an open wound).

Prevention

Prevention of recreational water illnesses is likely to be accomplished only through a concerted team effort by public health professionals and swimming venue operators to educate all persons involved in recreational water activities, including the general public, concerning appropriate prevention measures. Operators at treated water venues are equipped with various methods that should be employed to prevent outbreaks. The traditional reliance on two water-treatment barriers at treated water venues, chlorination and filtration, might need to be expanded to include in-line (i.e., usually installed after filtration and before chlorination) supplemental disinfection (e.g., ultraviolet light irradiation, ozonation, or chlorine dioxide use). In-line supplemental disinfection can be used to improve the level of protection against pathogens, particularly *Cryptosporidium*. Improved monitoring of water-quality and facility maintenance programs and improved policies to educate the public and decrease body waste contamination of aquatic facilities should also reduce the risk for waterborne diseases. Because of the lack of protective barriers at swimming beaches, beach managers and public health officials should implement water-quality testing programs and educate swimmers concerning appropriate prevention measures, particularly measures addressing environmental pathogens unlikely to be prevented by current water-quality guidelines (e.g., illnesses caused by *Vibrio* and otitis media infections).

Public health professionals should 1) improve training for pool inspectors, 2) update and improve pool codes to stay current with changing designs and needs demonstrated by outbreaks summarized in this report, and 3) lead the educational efforts with aquatic staff and the general public. Safe handling and use of chemicals at aquatic facilities needs to be taught and reinforced. In addition, to improve overall indoor air quality, public health professionals and pool managers need to understand the importance of indoor air quality so that improvements in pool water quality, swimmer hygiene, air-turnover rates, and ventilation will be implemented.

Educating swimmers can play a vital role in reducing recreational water illness by instructing them to follow basic guidelines for healthy swimming. Fecal shedding of pathogens is common (*43*), so reducing the risk of water-related infection is best achieved by implementing diarrhea exclusion policies, using appropriate hygiene measures, and advising the public to minimize the swallowing of recreational water.

Conclusion

Data collected by the WBDOSS are used to characterize the epidemiology of waterborne disease and outbreaks associated with both drinking and recreational water. Swimming is a common activity in the United States (*44*). Certain disease-causing agents are spread through shared bodies of water, and new waterborne pathogens that infect humans (e.g., *Cryptosporidium* and toxigenic *E. coli*) have emerged in the previous three decades. Recreational water illness and outbreaks are associated with both treated and untreated water and with every type of aquatic venue. Common themes derived from the outbreaks in this report include 1) low disinfectant levels, 2) inadequate water-quality monitoring, 3) high bather loads during large events, 4) breakdowns of equipment and lengthy detection times, 5) lack of essential cleaning of spas to minimize biofilm buildup, 6) accumulation of combined chlorines in pools accompanied by inadequate indoor air ventilation, 7) inadequately trained aquatic staff, 8) unclear communication chains for resolving problems, 9) outbreaks occurring on weekends when trained staff might be off duty, and 10) a lack of awareness by the general public of appropriate healthy swimming behaviors.

Whereas no easy solution exists for reducing recreational water WBDOs, a sustained effort by the swimming public, the pool sector, and public health agencies can reduce the associated risk. The millions of persons in the United States who use recreational water every year can best reduce their risk by staying informed regarding the health and safety concerns associated with swimming. Public health officials should lead this educational effort to promote healthy swimming behaviors. Prevention methods discussed in this report should help make swimming experiences both safe and enjoyable. The aquatic sector also can benefit from the recommendations, which address changes that are needed in operation, maintenance, and chemical handling procedures. Large numbers of violations of state pool codes occur each year (*14,31*), indicating that improved pool operation, disinfection policies, and enforcement are needed to prevent recreational water illness (*45*). In addition, improvements in indoor air quality monitoring and widespread dissemination of validated testing protocols are needed to support improved air quality in indoor swimming pool settings.

Public health professionals at all levels of government should lead a multidisciplinary approach to prevent recreational water illness that includes surveillance, health education, epidemiologic studies, laboratory support, and environmental health research. Educational resources and campaigns are needed for swimmers, parents, aquatic venue operators, and public health staff. Improved communications, particularly during outbreak investigations, between all levels of the public health system (e.g., infectious disease, environmental health, and surveillance staff) and between agencies in neighboring jurisdictions can 1) enhance awareness concerning ongoing occurrences of recreational water illness, 2) facilitate reporting to the WBDOSS in a more timely manner, and 3) strengthen WBDO investigations and responses to protect the public. The timely collection of clinical specimens and water samples for testing during a WBDO investigation and the initiation of an environmental investigation will result in more rapid identifications of the etiologic agent and determination of the conditions leading to the outbreak. However, the capacity of public health departments and laboratories to detect and investigate potential WBDOs varies and needs to be strengthened to meet these challenges. WBDO investigations typically require input from a variety of disciplines, including infectious disease epidemiology, environmental health, clinical medicine, water and sanitation engineering, and microbiology. Additional cross-training of existing personnel in these areas or additional staffing and resources are needed to improve WBDO detection, investigation, and reporting.

CSTE passed a position statement at its 2006 annual meeting making waterborne disease outbreaks, as a unit of reporting, nationally notifiable and reportable to CDC starting in 2007. Adoption of this CSTE recommendation at the state level through state-specific legislative action might improve reporting of waterborne outbreaks at the state and local levels. CDC and EPA were also asked to develop training resources for WBDO investigations that are targeted to local and state/territorial public and environmental health workers responsible for WBDO detection, investigation, and reporting. In addition, CDC and EPA should collaborate with CSTE and developed national WBDO investigation and surveillance guidelines. The position statement is available at http://www.cste.org/PS/2006pdfs/PSFINAL2006/06-ID-12FINAL.pdf (Box).

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References

1. Craun GF, ed. Waterborne diseases in the United States. Boca Raton, FL: CRC Press, Inc.; 1986.
2. Yoder JS, Blackburn BG, Craun GF, et al. Surveillance for recreational water-associated outbreaks—United States, 2001–2002. In: Surveillance Summaries, October 22, 2004. MMWR 2004;53(No. SS-8):1–21.

BOX. Organizations that provide assistance in investigations of waterborne disease and outbreaks (WBDOs) associated with recreational water exposure

State health departments can request epidemiologic assistance and laboratory testing from CDC to investigate WBDOs. CDC and the U.S. Environmental Protection Agency (EPA) can be consulted regarding engineering and environmental aspects of recreational water treatment and collection of proper water samples to identify pathogenic viruses, bacteria, and parasites, which require special protocols for their recovery.

National WBDO Investigation and Surveillance Guidelines
CDC, EPA, and CSTE Position Statement
Internet: http://www.cste.org/PS/2006pdfs/PSFINAL2006/06-ID-12FINAL.pdf

How to Report WBDOs
Waterborne Disease Outbreak Coordinator
Division of Parasitic Diseases
National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC
Telephone: 770-488-7775
Fax: 770-488-7761
CDC Reporting Form (CDC 52.12, rev.01/2003)
Internet: http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf

Requests for Testing for Viral Organisms
Division of Viral Diseases
National Center for Immunization and Respiratory Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC
Telephone: 404-639-3607

Requests for Testing for Bacterial Enteric Organisms
Division of Foodborne, Bacterial, and Mycotic Diseases
National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC
Telephone: 404-639-1798

Requests for Testing for Parasites
Division of Parasitic Diseases
National Center for Zoonotic, Vector-borne, and Enteric Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC
Telephone: 770-488-7775

Requests for Information or Testing for *Legionella*
Division of Bacterial Diseases
National Center for Immunization and Respiratory Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC
Telephone: 404-639-2215
Internet: http://www.cdc.gov/legionella

Information Regarding Legionellosis
Internet: http://www.cdc.gov/legionella

CDC provides public health professionals, clinicians, laboratorians, and persons in other allied health fields with background and clinical information, guidance on investigations, and resources concerning Legionnaires' disease and Pontiac fever cases or potential outbreaks. Resources include outbreak investigative tools, environmental sampling protocols, fact sheets, clinical evaluation and management guides, and laboratory testing protocols.

Information Regarding Healthy Swimming
CDC Internet: http://www.cdc.gov/healthyswimming
- Recreational water health communication and education resources for the general public and aquatic staff
- Pool and spa operation guidelines, including disinfection and fecal accident response
- Outbreak investigation toolkit and technical information concerning laboratory diagnostics

Information Regarding Beaches
EPA Internet: http://www.epa.gov/OST/beaches

3. Blackburn BG, Craun GF, Yoder JS, et al. Surveillance for waterborne-disease outbreaks associated with drinking water—United States, 2001–2002. In: Surveillance Summaries, October 22, 2004. MMWR 2004;53(No. SS-8):23–45.
4. Lee SH, Levy DA, Craun GF, Beach MJ, Calderon RL. Surveillance for waterborne disease outbreaks—United States, 1999–2000. In: CDC Surveillance Summaries, November 22, 2002. MMWR 2002;51(No. SS-8):1–47.
5. Barwick RS, Levy DA, Craun GF, Beach MJ, Calderon RL. Surveillance for waterborne disease outbreaks—United States, 1997–1998. In: CDC Surveillance Summaries, May 26, 2000. MMWR 2000;49(No. SS-4):1–35.
6. Levy DA, Bens MS, Craun GF, Calderon RL, Herwaldt BL. Surveillance for waterborne-disease outbreaks—United States, 1995–1996. In: CDC Surveillance Summaries, December 11, 1998. MMWR 1998;47(No. SS-5):1–34.

7. Kramer MH, Herwaldt BL, Craun GF, Calderon RL, Juranek DD. Surveillance for waterborne-disease outbreaks—United States, 1993–1994. In: CDC Surveillance Summaries, April 12, 1996. MMWR 1996;45(No. SS-1):1–33.
8. Moore AC, Herwaldt BL, Craun GF, Calderon RL, Highsmith AK, Juranek DD. Surveillance for waterborne disease outbreaks—United States, 1991–1992. In: CDC Surveillance Summaries, November 19, 1993. MMWR 1993;42(No. SS-5):1–22.
9. Herwaldt BL, Craun GF, Stokes SL, Juranek DD. Waterborne-disease outbreaks, 1989–1990. In: CDC Surveillance Summaries, December 1991. MMWR 1991;40(No. SS-3):1–21.
10. Levine WC, Stephenson WT, Craun GF. Waterborne disease outbreaks, 1986–1988. In: CDC Surveillance Summaries, March 1, 1990. MMWR 1990;39(No. SS-1):1–9.
11. St. Louis ME. Water-related disease outbreaks, 1985. In: CDC Surveillance Summaries, June 1, 1988. MMWR 1988;37(No. SS-2):15–24.
12. Liang JL, Dziuban EJ, Craun GF, et al. Surveillance for waterborne disease and outbreaks associated with drinking water and water not intended for drinking—United States, 2003–2004. In: Surveillance Summaries, December 22, 2006. MMWR 2006;55(No. SS-12):31–65.
13. Chastel C. When the Egyptian mummies are speaking about the infections that have made them ill. Hist Sci Med 2004;38:147–55.
14. CDC. Surveillance data from swimming pool inspections—selected states and counties, United States, May–September 2002. MMWR 2003;52:513–6.
15. Environmental Protection Agency. Bacterial ambient water quality criteria for marine and fresh recreational waters. Cincinnati, OH: National Service Center for Environmental Publications; 1986. EPA publication no. 440584002.
16. Wade TJ, Calderon RL, Sams E, et al. Rapidly measured indicators of recreational water quality are predictive of swimming-associated gastrointestinal illness. Environ Health Perspect 2006;114:24–8.
17. Rao PV, Gupta N, Bhaskar AS, Jayaraj R. Toxins and bioactive compounds from cyanobacteria and their implications on human health. J Environ Biol 2002;23:215–24.
18. Hery M, Hecht G, Gerber JM, Gendre JC, Hubert G, Rebuffaud J. Exposure to chloramines in the atmosphere of indoor swimming pools. Annals of Occupational Hygiene 1995;39:427–39.
19. Emanuel BP. The relationship between pool water quality and ventilation. Environmental Health 1998;61:17–20.
20. Massin N, Bohadana AB, Wild P, Hery M, Toamain JP, Hubert G. Respiratory symptoms and bronchial responsiveness in lifeguards exposed to nitrogen trichloride in indoor swimming pools. Occup Environ Med 1998;55:258–63.
21. Pruss A. Review of epidemiological studies on health effects from exposure to recreational water. International J Epidemiol 1998;27:1–9.
22. Korich DG, Mead JR, Madore MS, Sinclair NA, Sterling CR. Effects of ozone, chlorine dioxide, chlorine, and monochloramine on *Cryptosporidium parvum* oocyst viability. Appl Environ Microbiol 1990;56:1423–8.
23. Mohle-Boetani JC, Stapleton M, Finger R, et al. Communitywide shigellosis: control of an outbreak and risk factors in child day-care centers. Am J Public Health 1995;85:812–6.
24. CDC. An outbreak of norovirus gastroenteritis at a swimming club—Vermont, 2004. MMWR 2004;53:793–5.
25. CDC. Aseptic meningitis outbreak associated with echovirus 9 among recreational vehicle campers—Connecticut, 2003. MMWR 2004;53:710–3.
26. Lagerkvist BJ, Bernard A, Blomberg A, et al. Pulmonary epithelial integrity in children: relationship to ambient ozone exposure and swimming pool attendance. Environ Health Perspect 2004;112:1768–71.
27. Cassan D, Mercier B, Castex F, Rambaud A. Effects of medium-pressure UV lamps radiation on water quality in a chlorinated indoor swimming pool. Chemosphere 2006;62:1507–13.
28. Clancy JL, Marshall MM, Hargy TH, Korich DG. Susceptibility of five strains of *Cryptosporidium parvum* oocysts to UV light. Journal AWWA 2004;96:84–93.
29. Berger RS, Seifert MR. Whirlpool folliculitis: a review of its cause, treatment, and prevention. Cutis 1990;45:97–8.
30. CDC. *Pseudomonas dermatitis*/folliculitis associated with pools and hot tubs—Colorado and Maine, 1999–2000. MMWR 2000;49:1087–91.
31. CDC. Surveillance data from public spa inspections—United States, May–September 2002. MMWR 2004;53:553–5.
32. Donlan RM. Biofilms: microbial life on surfaces. Emerg Infect Dis 2002;8:881–90.
33. Gustafson TL, Band JD, Hutcheson RH Jr, Schaffner W. *Pseudomonas* folliculitis: an outbreak and review. Rev Infect Dis 1983;5:1–8.
34. Begier EM, Frenette K, Barrett NL, et al. A high-morbidity outbreak of methicillin-resistant *Staphylococcus aureus* among players on a college football team, facilitated by cosmetic body shaving and turf burns. Clin Infect Dis 2004;39:1446–53.
35. Fields BS, Benson RF, Besser RE. *Legionella* and Legionnaires' disease: 25 years of investigation. Clin Microbiol Rev 2002;15:506–26.
36. CDC. Final recommendations to minimize transmission of Legionnaires' disease from whirlpool spas on cruise ships. Atlanta, GA: US Department of Health and Human Services, CDC; 1997.
37. CDC. Outbreak of gastroenteritis associated with an interactive water fountain at a beachside park—Florida, 1999. MMWR 2000;49:565–8.
38. CDC. Shigellosis outbreak associated with an unchlorinated fill-and-drain wading pool—Iowa, 2001. MMWR 2001;50:797–800.
39. Visvesvara GS, Stehr-Green JK. Epidemiology of free-living ameba infections. J Protozool 1990;37:25S–33S.
40. Bharti AR, Nally JE, Ricaldi JN, et al. Leptospirosis: a zoonotic disease of global importance. Lancet Infect Dis 2003;3:757–71.
41. Zurawell RW, Chen H, Burke JM, Prepas EE. Hepatotoxic cyanobacteria: a review of the biological importance of microcystins in freshwater environments. J Toxicol Environ Health B Crit Rev 2005;8:1–37.
42. Verbrugge LM, Rainey JJ, Reimink RL, Blankespoor HD. Swimmer's itch: incidence and risk factors. Am J Public Health 2004;94:738–41.
43. Gerba CP. Assessment of enteric pathogen shedding by bathers during recreational activity and its impact on water quality. Quant Micrbiol 2000;2:55–68.
44. US Bureau of the Census. Statistical abstract of the United States: 1995. 115th ed. Washington, DC: US Bureau of the Census; 1995.
45. CDC. Responding to fecal accidents in disinfected swimming venues. MMWR 2001;50:416–7.

Appendix A

Glossary of Definitions

bather load	The maximum number of bathers who may use a swimming pool or spa at any one time. This limit is usually determined by state or local pool code, based on surface area and depth of the pool or spa.
biofilm	Microbial cells that adhere to a surface through a matrix of primarily polysaccharide materials in which they are encapsulated. These can grow on piping and surfaces of aquatic venues and can be notoriously difficult to remove. They offer protection to microbes from disinfectants (e.g., chlorine) in the water.
cercarial dermatitis	Dermatitis caused by contact/skin perforation by the cercariae (larval stage) of certain species of schistosomes, a type of parasite, for which the normal hosts are birds and nonhuman mammals. This allergic response does not lead to parasitic infestation in humans and produces no long-term disease.
class	Waterborne disease and outbreaks are classified according to the strength of the epidemiologic and water-quality data implicating recreational water as the source of the disease or outbreak (see Table 1).
chloramines	A group of disinfection by-products or weak disinfectants formed when free chlorine combines with nitrogen-containing compounds in the water (e.g., urine or perspiration). Tri- and di-chloramine can cause eye, skin, lung, and throat irritation and can accumulate in the water and air over treated-water pools. In drinking water treatment, monochloramine is used for disinfection to reduce formation of disinfection by-products created when using chlorine as a disinfectant.
coliforms	All aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 95°F (35°C).
combined chlorine level	See chloramines. Chlorine that has combined with organic compounds in the water and is no longer an effective disinfectant for recreational water. This value is derived by subtracting the free chlorine test level from total chlorine test level.
contact time	The length of time water (and pathogens) is exposed to a disinfectant; usually measured in minutes (e.g., chlorine contact time).
Cryptosporidium	The taxonomy of *Cryptosporidium* has evolved as a result of advancements in molecular methodology and genotyping. The former *C. parvum* now refers to a species that is zoonotic and infects ruminants and humans. *C. hominis* refers to the species of *Cryptosporidium* that is infective only in humans, primates, and monkeys. Both species were referred to previously as *C. parvum*.
dermatitis	Inflammation of the skin. In this surveillance summary, the term dermatitis is used to denote a broad category of skin-related symptoms (e.g., folliculitis, cellulitis, burns, or rash).
disinfection by-products	Chemicals formed in water through reactions between organic matter and disinfectants. Includes chloramines.
etiologic agent	The pathogen, chemical, or toxin causing a waterborne disease or outbreak. Infectious etiologic agents include bacteria, parasites, and viruses.

fecal coliforms	Coliforms that grow and ferment lactose to produce gas at 112.1°F (44.5°C) within 24 hours.
filtration	The process of removing suspended particles from water by passing it through one or more permeable membranes or media of limited pore diameter (e.g., sand, anthracite, or diatomaceous earth).
folliculitis	Inflammation of hair follicles. Spa-associated folliculitis is usually associated with infection by *Pseudomonas aeruginosa.*
free chlorine	The chlorine in water not combined with other constituents; therefore, it is able to serve as an effective disinfectant (also referred to as free available chlorine or residual chlorine). A common water-quality test.
freshwater (untreated water)	Surface water (e.g., water from lakes, rivers, or ponds) that has not been treated in any way to enhance its safety for recreational use.
interactive fountain	A fountain or water/spray feature intended for (or accessible to) recreational use. They usually do not have standing water as part of the design. These are sometimes called spray pads, splash pads, wet decks, or spray grounds. In contrast, noninteractive (ornamental) fountains intended for public display rather than recreational use are often located in front of buildings and monuments, and their water is not easily accessible for public use.
marine water	Untreated recreational water at an ocean or estuarine setting.
microcystin toxin	A secondary metabolite of blue-green algae (cyanobacteria) that can have toxic effects on humans and animals, potentially causing a wide range of illness or even death when exposure to accumulated toxins in fresh or marine water occurs.
mixed agent outbreak	More than one type of etiologic agent is identified in clinical specimens from affected persons and each etiologic agent is found in ≥5% of positive clinical specimens (e.g., an outbreak with *Giardia* spp. [parasites] and *Salmonella* spp. [bacteria] with each agent identified in ≥5% of stool specimens).
oocyst	The infectious stage of *Cryptosporidium* species and certain other coccidian parasites with a protective wall that facilitates survival in water and other environments and renders the parasite extremely resistant to chlorine.
predominant illness	The category of symptoms most commonly expressed in a substantial proportion (≥50%) of patients (e.g., gastroenteritis, dermatitis, acute respiratory illness). When more than one illness category seems to define the character of the waterborne disease and outbreak, they are listed together as predominant illnesses.
recreational water venue	A body of water used for the purpose of recreation (e.g., swimming, soaking, or athletics) including any structure that encloses this water. It can include lakes and ponds, rivers, springs, the ocean, and man-made venues (e.g., swimming pools, spas, and waterparks) that do not necessarily include standing water (e.g., interactive fountains).
reservoir, impoundment	An artificially maintained lake or other body of water created for the collection and storage of water. This body of water may be available for recreational use.
spa	Any structure, basin, chamber or tank (located either indoors or outdoors) containing a body of water intended to be used for recreational or therapeutic purposes that usually contains a waterjet or aeration system. It is operated at high temperatures and is usually not drained, cleaned, or refilled after each use. Sometimes referred to as a hot tub or whirlpool.

total chlorine	The chlorine in water that is free for disinfection (free chlorine) plus that combined with other organic materials (combined chlorine). A common water quality test. The combined chlorine level is derived by subtracting the free chlorine test result from the total chlorine test result.
total coliforms	Nonfecal and fecal coliforms that are detected by using a standard test.
treated water	Water that has undergone a disinfection or treatment process (e.g., chlorination and filtration) for the purpose of making it safe for recreation. Typically, this refers to any recreational water in an enclosed, manufactured structure but may include swimming or wading pools, fountains, or spas filled with treated tap water (e.g., small wading "kiddie" pool) or untreated water (e.g., mineral spring water) that receives no further treatment.
untreated water	Surface water that has not been treated in any way (i.e., lakes, rivers, and reservoirs).
Vibrio species	A genus of comma-shaped, gram-negative Proteobacteria that include a variety of human pathogens. Some of these species are found in salty or brackish water and can cause illness by contamination of a wound or epithelial site (e.g., eardrums or sinus cavities). Sequelae can include sepsis and death.
water-quality indicator	A microbial, chemical, or physical parameter that indicates the potential risk for infectious diseases associated with using the water for drinking, bathing, or recreational purposes. The best indicator is one with a density or concentration that correlates best with health effects associated with a type of hazard or pollution (e.g., turbidity, coliforms, fecal coliforms, *Escherichia coli*, enterococci, free chlorine level).

Appendix B

Selected Descriptions of Waterborne Disease and Outbreaks (WBDOs) Associated with Recreational Water

Date of WBDO	State in which WBDO occurred	Etiologic agent	No. of cases (deaths)	Description of WBDO
Parasites				
June 2003	Massachusetts	*Giardia intestinalis*	149	A community outbreak of giardiasis was traced to a membership club. The investigation demonstrated an association with use of a kiddie pool at the facility, where at least 30 persons had primary exposures. Another 105 cases had links to those primary cases, indicating secondary person-to-person transmission. No violations of water or safety regulations were found by inspection of the membership club, although the pool closed for the season before the investigation was conducted.
June 2003	Iowa	*Cryptosporidium* and *Giardia* spp.	63	A kiddie wading pool at a child care center, filled with the municipal water supply, was implicated as the original source of this outbreak. This was followed by expansion into a communitywide outbreak via secondary transmission. An estimated 100 persons became ill, although the reported number of confirmed cases was 63; 20 persons had *Giardia*, 35 had *Cryptosporidium*, and eight had coinfections.
July 2003	Kansas	*C. hominis*	617	An increased incidence of laboratory-confirmed cryptosporidiosis alerted a local health department, and the subsequent inquiry revealed an ongoing communitywide outbreak with multiple clusters identified. Although the initial point of transmission could not be identified, transmission was associated with swimming pools (different swim teams, day camps), and multiple day care facilities where water activities were prevalent. Children who continued to swim while ill with diarrhea likely contributed to the continued spread of disease.
July 2003	North Carolina	*Naegleria fowleri*	1 (1)	A child aged 12 years swam at a popular recreational freshwater lake with frequent splashing, diving, and swimming underwater giving ample opportunity for the ameba to enter the nasal cavities. The child had a headache 2 days later, was hospitalized 4 days after the headache, and died 3 days later.
July 2004	Ohio	*C. hominis*	160	A health-care professional alerted the health department about a cluster of cryptosporidiosis cases. The health department responded rapidly through community health alerts, hyperchlorination of the community pool, and expanded public health activity at a county festival. An estimated 85% of patients swam at a community pool in the 2 weeks leading up to their onset of illness. Two peak days of attendance in August 2004 were identified as the likely time of exposure for the majority of cases, which was only 1 week before the initial health department response. Although ill persons resided in three different Ohio counties, the investigation indicated a low rate of transmission in any of the affected counties and that little transmission occurred beyond the municipal pool. Hyperchlorination of the pool appeared to be effective in stopping transmission, and a rapid response and containment of the outbreak were likely responsible for preventing further spread.
August 2004	California	*Cryptosporidium* spp.	336	A recreational waterpark was implicated as the source of this outbreak. Approximately 80% of persons calling the county health department to report illness had visited the park before their onset of symptoms. Many of the employees of the waterpark were ill with a median onset date that preceded that for ill members of the public. Park policy required employees to be in the water regularly, and no policy was in place for reassigning employees who were ill with diarrhea.
Bacteria				
December 2002	Florida	*Legionella pneumophila* serogroup 1	2	Two non-Florida residents had Legionnaires' disease and were epidemiologically linked to a Florida hotel at which they had both stayed during their incubation periods. In addition, the spa was the only common location identified at the hotel in which transmission could have occurred. Both patients had spent several hours each day in the spa. Though no *Legionella* species were recovered from the spa, the levels of bromine disinfectant were low and resulted in an environment where the pathogen was more likely to grow.
January 2003	Illinois	*Pseudomonas aeruginosa*	52	Multiple guests of a large hotel contracted dermatitis and/or ear infections and an investigation associated spa usage with illness. Records from an off-site monitoring company demonstrated that chlorine (oxidation reduction potential was actually measured) and pH levels were well below recommended levels. Communication between the monitoring company and hotel did not result in prompt maintenance of the spa. The hotel eventually discovered that the chlorinator pump switch had been turned off. A potted plant and soil near the spa might have contributed to contamination, and *Pseudomonas* was detected in multiple environmental samples from the spa.
February 2003	Wisconsin	*L. pneumophila* serogroup 1	3	Three cases of Legionnaires' disease were linked to a hotel spa. *Legionella* was isolated from the spa water that had insufficient disinfectant concentrations. Active case-finding also identified persons with potential signs and symptoms of Pontiac fever, each of whom was exposed to the implicated spa.

Date of WBDO	State in which WBDO occurred	Etiologic agent	No. of cases (deaths)	Description of WBDO
May 2003	Georgia	*Shigella sonnei*	13	Contact with or having water from a freshwater lake in the mouth was associated with increased risk for shigellosis. Attack rates ranged from 38%–58% and increased with prolonged exposure. Fecal coliform measurements exceeded recommended standards. The man-made lake had no outlets, and septic systems were adequate. Investigators concluded that contamination was likely caused by fellow bathers.
July 2003	Maryland	*S. sonnei* and *Plesiomonas shigelloides*	65	Visitors from four different states swam in a state park lake and became ill with gastroenteritis. Fecal coliform and *Escherichia coli* levels exceeded standards on at least one sample collection time. Lifeguards at the lake reported that 5–10 diapers were pulled from the lake each week, and on one occasion, a camper was observed dumping waste into a drain that flowed into the lake instead of into the dump station. Both behaviors were suggested as contributing to contamination of the lake. The bathing beach permit was temporarily suspended during the investigation and partially obstructed sewer lines repaired.
July 2003	Oregon	*S. sonnei*	56	After a physician reported seeing five unrelated children with diarrhea, an investigation linked transmission to a local interactive fountain commonly visited by community children. A case-control study indicated that 39% of children who played in the fountain subsequently experienced diarrhea, compared with 3% of those who did not visit the fountain. Fecal coliforms and *E. coli* were detected in the water, and zero chlorine residual could be measured. This particular fountain was subsequently redesigned to include an automated chlorinator and was required to be licensed and regulated as a public wading pool.
August 2003	Connecticut	Methicillin-resistant *Staphylococcus aureus*	10	In an investigation of a MRSA outbreak within a college football team of 100 players, 10 cases were detected, two needing hospitalization. Risk factors included abrasions from artificial grass (“turf burns”), player positions with more frequent body-to-body contact (cornerbacks and wide receivers), and body shaving (particularly groin/genital shaving). Infection also was associated with sharing the whirlpool spa at the team’s athletic training center. The water in this spa used a single daily addition of povidone for disinfection. This practice of adding disinfectant did not meet Connecticut pool code regulations nor was the disinfectant approved for this use.
March 2004	Oklahoma	*L. pneumophila* serogroup 1	107	A hotel hosted participants of a youth basketball tournament over several days. Many of the guests were using the hotel spa throughout this period, leading to occasional bather overload. Disinfectant levels in the water were not being consistently monitored or maintained during this time. Four cases required hospitalization; however, the majority of ill persons had symptoms of Pontiac fever. Urine antigen testing and serology were used for laboratory confirmation. Environmental testing of the spa and its surroundings, which was performed after extensive decontamination measures took place, did not reveal evidence of *Legionella* growth.
July 2004	Ohio	*P. aeruginosa*	119	Two pools and a spa at a resort hosting an interstate dance competition were all associated with this large *Pseudomonas* outbreak. Symptoms included rash, eye and ear infections, fever, nausea, vomiting, and diarrhea. The water from an indoor pool and the spa could co-mingle because of specific design features (e.g., waterfalls) connecting the features, and water samples from both were positive for the *Pseudomonas*. This contamination, along with the high bather load resulting from the dance competition, provided the opportunity for widespread transmission.
Viruses				
July 2003	Connecticut	Echovirus 9	36	An outbreak of meningitis was associated with swimming at an RV campground pool. The investigation identified 36 cases; 12 of which were categorized as aseptic meningitis and 24 that had enterovirus-like illness (acute illness with any of several meningitis-like symptoms). Pool disinfectant levels were inadequate to support a high bather load. Chlorine testing was only performed in the early morning and evening after heavy bather use.
February 2004	Vermont	Norovirus	70	The state health department was notified of a group of children with gastroenteritis who had all attended the same swimming club during the previous weekend. The investigation revealed several more cases, including an adult who was hospitalized for severe vomiting. Multiple lapses in pool staff training and maintenance contributed to the outbreak. Staff lacked formal training in pool operation, disinfectant levels and monitoring were inadequate, the pool operator was off for the weekend, and the pool staff did not call for maintenance when patrons complained about the water quality. This led to a delay in identifying a chlorinator pump tube malfunction. As a result, norovirus was transmitted via the pool water for much longer (multiple days) than would have occurred if disinfectant levels were appropriately maintained.
March 2004	Idaho	Norovirus	140	A regional swim meet at a community pool facility was associated with this outbreak of gastroenteritis. Although cases occurred amongst swimmers (approximately 450) and nonswimmers (approximately 550) at the event, swimming in the pools was a significant risk factor. Certain proper hygiene measures, such as showering before entering the pool and having functional hand washing sinks in the restrooms, were not being consistently followed and could have amplified spread of the disease. Both pools were found to be within normal operating limits for free chlorine (1.0–3.0 ppm) and pH (7.2–7.8) before and during the meet, although this would be unlikely to prevent short-term transmission.
May 2004	Florida	Norovirus	42	An elementary school “game day” included two water slides that were wet down with municipal tap water so that the water was likely to be disinfectant free in a short period. After one of the slides was used by a child with diarrhea, several classmates continued to use the slide, as students from another class did while the original class ate lunch. Students from both classes, as well as household contacts, became ill.

Date of WBDO	State in which WBDO occurred	Etiologic agent	No. of cases (deaths)	Description of WBDO
July 2004	Oregon	Norovirus	39	Swimming beaches at a lake were closed after initial reports of several cases of gastroenteritis were received. This popular recreational lake had been receiving routine bacterial water quality testing since 1991, when it was the site of a 59-case outbreak of *E. coli* O157:H7 and *Shigella sonnei* (**Source:** Keene WE, McAnulty JM, Hoesly FC, Williams LP Jr, Hedberg K, Oxman GL, Barrett TJ, Pfaller MA, Fleming DW. A swimming-associated outbreak of hemorrhagic colitis caused by *Escherichia coli* O157:H7 and *Shigella sonnei*. N Engl J Med 1994;331:579–84).
Chemicals/Toxins				
March 2003	New York	Muriatic (hydrochloric) acid	3	Acid, used to adjust pool water pH, was spilled on the floor of an indoor swimming pool/ membership club. The resulting fumes caused respiratory symptoms among three persons in the vicinity, all of whom were taken to an emergency department for treatment and were subsequently released.
July 2004	Nebraska	Microcystin toxin (blue-green algae)	20	All affected persons were swimming in a lake that was experiencing a blue-green algae bloom, a common occurrence in Nebraska lakes during late summer months. Symptoms included rashes, diarrhea, cramps, nausea, vomiting, and fevers. The lake was found to have >15 ppb of microcystin toxin. The lake was closed to public use while the toxin levels remained high. A nearby lake in the same county reported a similar outbreak during July, with two ill persons involved.
Unidentified				
March 2004	Illinois	Suspected chloramines	57	A physician reported six members of a family experienced respiratory illness after a visit to a local hotel's indoor pool area. The subsequent investigation uncovered 51 additional cases related to this pool. Symptoms included burning eyes (77%), cough (47%), and fatigue (25%), among others. Exposure to pool water was a risk factor for illness. One child with asthma was hospitalized after the exposure. Chloramines were suspected as the source of the "strong chlorine-like odor" that visitors noticed in the pool area. A similar outbreak at another Illinois hotel in January 2004, with 22 cases, also was attributed to chloramines in the indoor pool area underscoring the importance of air quality at indoor recreational water facilities.
August 2004	New Mexico	Suspected chloramines	16	A chlorinated, indoor pool at a membership club was the site of an outbreak suspected to involve inhaled chloramines. Inadequate ventilation in the pool area was believed to be a contributing factor. Symptoms included both acute respiratory and gastrointestinal complaints, reinforcing the concept that diarrhea and vomiting associated with recreational water can have chemical etiologies as well as infectious ones. Five other outbreaks described in this report have similar characteristics to this one, including illness suspected to be caused by chemicals in the indoor pool area's air and water. Because of the difficulty of measuring transient airborne chloramine levels exact etiologies were not confirmed. All these outbreaks (with a total of 104 cases) demonstrate the need for good disinfection and maintenance of water quality along with adequate ventilation of indoor recreational water venues.
***Vibrio* infections**				
July 2004	Mississippi	*Vibrio vulnificus*	1 (1)	An adult male with a history of hepatitis C and cirrhosis of the liver sustained an injury to his chest wall from a bottle rocket while at a marine beach with a group of friends. He used ocean water to clean the wound and was hospitalized 2 days later with infection of the injured site. The *Vibrio* was cultured from his blood. After 2 days in the hospital, the patient died from complications of the infection; this was the only reported death from Vibrio site infection during 2003–2004 in Mississippi.
August 2004	North Carolina	*V. alginolyticus* and *V. parahaemolyticus*	1	A teenaged female was surfing at a coastal beach and cut her left calf on the fin of her surfboard while in the water. The wound was sutured at a local emergency department. After a 3-day incubation period, the patient reported to a Maryland hospital with cellulitis at the injury site. Incision and drainage was performed, and the surfer was treated with antibiotics and hospitalized for 5 days. Both species of *Vibrio* were cultured from the wound exudate (this was the only reported recreational water case during 2003–2004 to have two separate *Vibrio* species identified).
August 2004	Virginia	*V. parahaemolyticus*	1	An adult male was fishing at a coastal salt water site, when he was accidentally hit in the eye with his fishing hook while cutting his line. The eye became watery and irritated and days later he saw a physician for treatment. Antibiotics were successfully administered and the patient fully recovered without the need to be hospitalized.
September 2004	Florida	*V. parahaemolyticus*	1	An elderly man was found in the water of a brackish lagoon in the aftermath of Hurricane Ivan. He had sustained an injury on his left leg from the debris. Incision, drainage, and a skin graft were all eventually needed. His infection, which was confirmed by culturing the wound exudate, was probably exacerbated by additional risk factors: diabetes and use of prednisone for arthritis, both of which can lead to an immunocompromised state.

Surveillance for Waterborne Disease and Outbreaks Associated with Drinking Water and Water not Intended for Drinking — United States, 2003–2004

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Abstract

Problem/Condition: Since 1971, CDC, the U.S. Environmental Protection Agency (EPA), and the Council of State and Territorial Epidemiologists have maintained a collaborative Waterborne Disease and Outbreaks Surveillance System for collecting and reporting data related to occurrences and causes of waterborne disease and outbreaks (WBDOs). This surveillance system is the primary source of data concerning the scope and effects of WBDOs in the United States.

Reporting Period: Data presented summarize 36 WBDOs that occurred during January 2003–December 2004 and nine previously unreported WBDOs that occurred during 1982–2002.

Description of System: The surveillance system includes data on WBDOs associated with drinking water, water not intended for drinking (excluding recreational water), and water of unknown intent. Public health departments in the states, territories, localities, and Freely Associated States (i.e., the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau, formerly parts of the U.S.-administered Trust Territory of the Pacific Islands) are primarily responsible for detecting and investigating WBDOs and voluntarily reporting them to CDC by using a standard form.

Results: During 2003–2004, a total of 36 WBDOs were reported by 19 states; 30 were associated with drinking water, three were associated with water not intended for drinking, and three were associated with water of unknown intent. The 30 drinking water-associated WBDOs caused illness among an estimated 2,760 persons and were linked to four deaths. Etiologic agents were identified in 25 (83.3%) of these WBDOs: 17 (68.0%) involved pathogens (i.e., 13 bacterial, one parasitic, one viral, one mixed bacterial/parasitic, and one mixed bacterial/parasitic/viral), and eight (32.0%) involved chemical/toxin poisonings. Gastroenteritis represented 67.7% of the illness related to drinking water-associated WBDOs; acute respiratory illness represented 25.8%, and dermatitis represented 6.5%.

The classification of deficiencies contributing to WBDOs has been revised to reflect the categories of concerns associated with contamination at or in the source water, treatment facility, or distribution system (SWTD) that are under the jurisdiction of water utilities, versus those at points not under the jurisdiction of a water utility or at the point of water use (NWU/POU), which includes commercially bottled water. A total of 33 deficiencies were cited in the 30 WBDOs associated with drinking water: 17 (51.5%) NWU/POU, 14 (42.4%) SWTD, and two (6.1%) unknown. The most frequently cited NWU/POU deficiencies involved *Legionella* spp. in the

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drinking water system (n = eight [47.1%]). The most frequently cited SWTD deficiencies were associated with distribution system contamination (n = six [42.9%]). Contaminated ground water was a contributing factor in seven times as many WBDOs (n = seven) as contaminated surface water (n = one).

Interpretation: Approximately half (51.5%) of the drinking water deficiencies occurred outside the jurisdiction of a water utility in situations not currently regulated by EPA. The majority of the WBDOs in which deficiencies were not regulated by EPA were associated with *Legionella* spp. or chemicals/toxins. Problems in the distribution system were the most commonly identified deficiencies under the jurisdiction of a water utility, underscoring the importance of preventing contamination after water treatment. The substantial proportion of WBDOs involving contaminated ground water provides support for the Ground Water Rule (finalized in October 2006), which specifies when corrective action is required for public ground water systems.

Public Health Actions: CDC and EPA use surveillance data to identify the types of water systems, deficiencies, and etiologic agents associated with WBDOs and to evaluate the adequacy of current technologies and practices for providing safe drinking water. Surveillance data also are used to establish research priorities, which can lead to improved water-quality regulation development. The growing proportion of drinking water deficiencies that are not addressed by current EPA rules emphasizes the need to address risk factors for water contamination in the distribution system and at points not under the jurisdiction of water utilities.

Introduction

During 1920–1970, statistical data regarding U.S. waterborne-disease outbreaks were collected by researchers and federal agencies (*1*). Since 1971, CDC, the U.S. Environmental Protection Agency (EPA), and the Council of State and Territorial Epidemiologists (CSTE) have maintained a collaborative Waterborne Disease and Outbreak Surveillance System (WBDOSS) that tracks the occurrences and causes of waterborne disease and outbreaks (WBDOs) associated with drinking water. WBDOs associated with recreational water were added to the surveillance system in 1978 (*2*); WBDOs associated with occupational settings, water not intended for drinking (WNID)* and commercially bottled water were added in 1999 (*3*); and WBDOs associated with drinking water contaminated at the point of use, contaminated ice and beverages made with contaminated water, and beverages contaminated as a result of plumbing failures in drink mix/soda machines have been added to this report. This *Surveillance Summary* includes data from 30 WBDOs related to drinking water, three WBDOs related to WNID, and three WBDOs related to water of unknown intent (WUI). Nine previously unreported outbreaks also have been included in this report. Recreational water-associated disease and outbreaks have been presented in a separate report (*4*). This *Surveillance Summary* also introduces multiple changes in the WBDOSS to better characterize the breadth of waterborne-disease challenges in the United States.

* Additional terms have been defined (Appendix A, Glossary of Definitions).

Waterborne disease and outbreak surveillance activities 1) characterize the epidemiology of WBDOs; 2) identify changing trends in the etiologic agents and other risk factors associated with WBDOs; 3) identify major deficiencies in providing safe drinking water; 4) encourage public health personnel to detect and investigate WBDOs; and 5) foster collaboration among local, state, federal, and international agencies on initiatives to prevent waterborne disease. Data from this surveillance system are useful for identifying major deficiencies in providing safe drinking water, can influence research priorities, and can lead to improved focus in water-quality regulation development. However, the statistics reported in this report represent only a portion of the burden of illness associated with water exposure. In general, the surveillance information does not include endemic, nonoutbreak-related waterborne-disease risks, and reliable estimates of the number of unrecognized WBDOs are not available.

Background

U.S. Environmental Protection Agency Drinking Water Regulations

Public water systems are regulated under the Safe Drinking Water Act (SDWA) of 1974 and its subsequent 1986 and 1996 amendments (Table 1) (*5–7*). SDWA authorizes EPA to set national standards to protect public drinking water and its sources against naturally occurring or manmade contaminants. Previously set standards by which

TABLE 1. U.S. Environmental Protection Agency regulations regarding drinking water, by year enacted — United States, 1974–2006

Regulation	Year
Safe Drinking Water Act (SDWA)	1974
Interim Primary Drinking Water Standards	1975
National Primary Drinking Water Standards	1985
SDWA Amendments	1986
Surface Water Treatment Rule (SWTR)	1989
Total Coliform Rule	1989
Lead and Copper Regulations	1990
SDWA Amendments	1996
Information Collection Rule	1996
Interim Enhanced SWTR	1998
Disinfectants and Disinfection By-Products (D-DBPs) Regulation	1998
Contaminant Candidate List	1998
Unregulated Contaminant Monitoring Regulations	1999
Ground Water Rule (proposed)	2000
Lead and Copper Rule — action levels	2000
Filter Backwash Recycling Rule	2001
Long Term 1 Enhanced SWTR	2002
Unregulated Contaminant Monitoring Regulations	2002
Drinking Water Contaminant Candidate List 2	2005
Long Term 2 Enhanced SWTR	2006
Stage 2 D-DBP Rule	2006
Ground Water Rule finalized	2006

microbial contamination is regulated include the Total Coliform Rule (TCR), Surface Water Treatment Rule (SWTR), Interim Enhanced SWTR (IESWTR), and Long Term 1 Enhanced SWTR (LT1ESWTR). In addition, EPA's lead, copper, and arsenic rules prescribe action levels at which a system must take corrective steps (*8,9*). These rules have been described in more detail in a previous report (*3*).

All public water systems are required by TCR to monitor for total coliforms at a prescribed frequency (*10,11*). SWTR (*12*) and IESWTR (*13*) apply to public systems that serve ≥10,000 persons and surface water or ground water under the direct influence of surface water. These two rules are intended to protect the public against exposure to *Giardia intestinalis*, *Cryptosporidium* spp., viruses, *Legionella* spp., and other selected pathogens. LT1ESWTR applies to public systems that serve <10,000 persons and is intended to improve the control of microbial pathogens, especially *Cryptosporidium* spp. (*14*). An additional regulation, the Filter Backwash Recycling Rule, requires the return of recycle flows to the water treatment process so that microbial contaminant removal is not compromised (*15*).

Recently finalized microbial and disinfection by-products regulations include the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) and the Stage 2 Disinfectants and Disinfection By-products Rule (DBPR2). These regulations were developed simultaneously to address risk tradeoffs between the control of pathogens and limiting exposure to disinfection by-products (DBPs) that can form in water from the disinfection process used to control microbial pathogens (*16*).

LT2ESWTR (*17,18*) requires the use of treatment techniques and monitoring, reporting, and public notification for all public water systems that use surface water sources. Key provisions include the following: source water monitoring for *Cryptosporidium* spp.; additional treatment for filtered systems on the basis of source-water *Cryptosporidium* concentrations; inactivation of *Cryptosporidium* by all unfiltered systems; disinfection profiling and benchmarking to ensure continued levels of microbial protection while system operators take steps to comply with new DBP limits; and covering, treating, or implementing a risk management plan for uncovered finished water storage facilities.

DBPR2 applies to all community and all nontransient, noncommunity water systems that use a disinfectant other than ultraviolet light (*17*). DBPR2 requires systems to meet maximum contaminant levels for total trihalomethanes and five haloacetic acids at each monitoring site in the distribution system, determine if they are experiencing short-term peaks in DBP levels, and better identify monitoring sites at which customers are exposed to high DBP levels.

The 1996 SDWA amendments require EPA to develop regulations that mandate disinfection of public ground water systems, as necessary, to protect the public health. The Ground Water Rule (GWR) (finalized by EPA in October 2006) specifies when corrective action, including disinfection, is required to protect consumers from bacteria and viruses (*19*). Additional information is available at http://www.epa.gov/safewater/gwr.html. Requirements include periodic sanitary surveys to identify deficiencies, hydrogeologic sensitivity assessments for nondisinfected systems, source-water microbial monitoring from certain systems, and compliance monitoring for systems that disinfect to ensure adequate inactivation or removal of viruses. SDWA Wellhead Protection Program requires every state to develop a program to delineate wellhead protection areas in which sources of contamination are managed to minimize ground water contamination (*19*).

Every 5 years, EPA is required to publish a list of contaminants that are known or anticipated to occur in public water systems and that might need to be regulated. The first drinking water Contaminant Candidate List (CCL1) was issued in 1998 and included 50 chemical and 10 microbial contaminants (*20*). However, EPA decided not to regulate *Acanthamoeba*, which was on the first list. The second Contaminant Candidate List 2 (CCL2) carried forward nine microbiologic contaminants from CCLl, excluding *Acanthamoeba* (*21*). EPA also must establish criteria for a program to monitor unregulated contaminants and publish a list of contaminants to be monitored (*22–25*). Microorganisms on this list include those for which analytical methods are available (*Aeromonas*) and those for which analytical methods are being developed (i.e., *Helicobacter pylori*, cyanobacteria, coxsackieviruses, microsporidia, adenoviruses, and caliciviruses). An ongoing screening survey for *Aeromonas* and selected chemical contaminants will help determine whether these should be considered for or excluded from regulation.

Methods

Data Sources

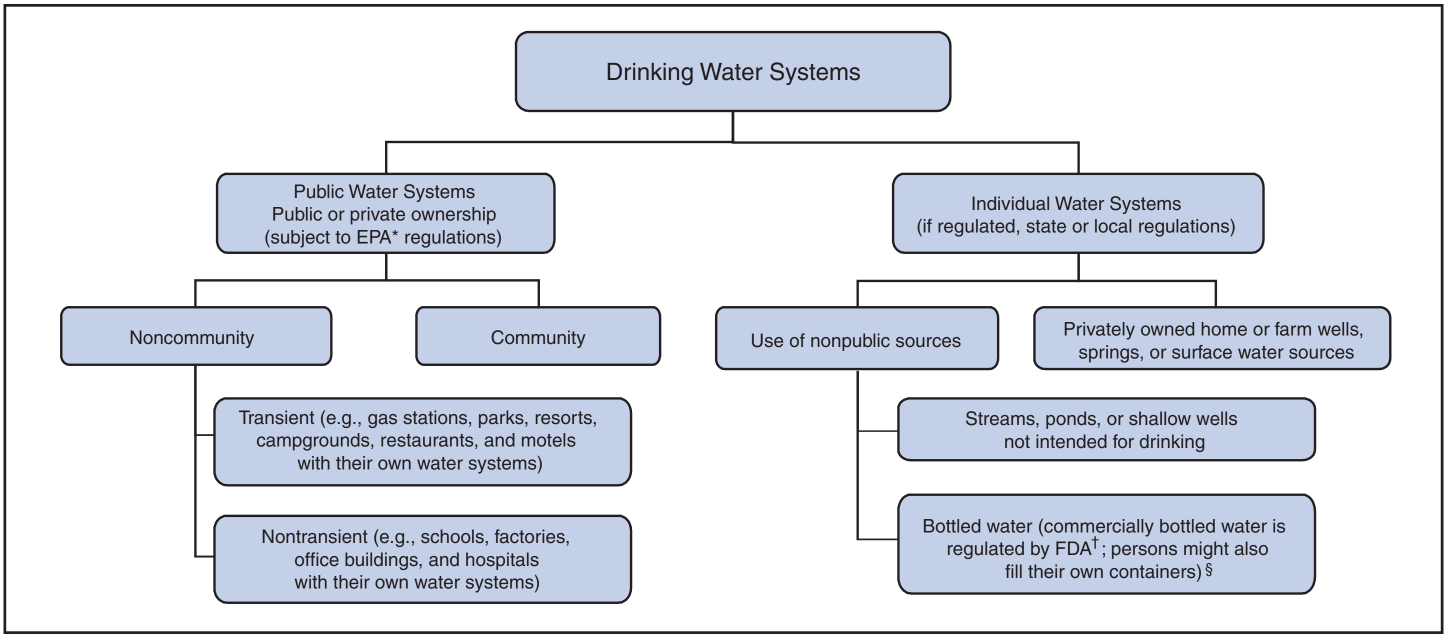
Public health departments in the states, territories, localities, and Freely Associated States (FAS) (i.e., the Republic of the Marshall Islands, the Federated States of Micronesia, and the Republic of Palau, formerly parts of the U.S.-administered Trust Territory of the Pacific Islands) have primary responsibility for detecting and investigating WBDOs, which they report voluntarily to CDC by using a standard form (CDC form 52.12, available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf). The form solicits data on characteristics of the WBDO (e.g., cases, time, and location); results from epidemiologic studies; results from clinical specimen and water sample testing; and other factors potentially contributing to the WBDO (e.g., environmental concerns, disinfection deficiencies, and filtration problems). CDC annually requests reports from state, territorial, and FAS epidemiologists or persons designated as WBDO surveillance coordinators and obtains additional information regarding water quality and water treatment as needed. Information also can be solicited from other CDC surveillance systems and confirmed with the state, territory, locality, or FAS for inclusion as a WBDO. Numerical and text data are abstracted from the WBDO report form and supporting documents and entered into a database for analysis. Although reports of WBDOs are collected through the WBDOSS, the cases and outbreaks associated with drinking water, WNID, and WUI are analyzed and published separately from the cases and outbreaks associated with recreational water (*4*).

Definitions

The unit of analysis for the WBDOSS is typically an outbreak, not an individual case of a waterborne disease. Two criteria must be met for an event to be defined as a waterborne outbreak associated with drinking water, WNID (excluding recreational water) or WUI. First, two or more persons must be epidemiologically linked by location of exposure to water, time, and illness. This criterion is waived for single cases of laboratory-confirmed primary amebic meningoencephalitis (PAM) and for single cases of chemical/toxin poisoning if water-quality data indicate contamination by the chemical/toxin. Second, the epidemiologic evidence must implicate water as the probable source of illness. Reported cases and outbreaks associated with contaminated drinking water; contaminated commercially bottled water, ice, or beverages made with contaminated water; and deficiencies of equipment/devices for which water is used or distributed (e.g., beverages contaminated by plumbing failures in drink mix/soda machines) are classified as WBDOs. WBDOs associated with cruise ships are not summarized in this report. Tabulation of WBDOs and associated cases is based on location of water exposure, not on state of residence of the ill persons.

Numerous types of drinking water systems exist and have been outlined (Figure 1). Public water systems, which are classified as either community or noncommunity , are regulated under SDWA. Of the approximately 167,012 public water systems in the United States, 112,948 (67.6%) are noncommunity systems, including 93,210 transient systems and 19,738 nontransient systems; 54,064 (32.4%) are community systems. Despite representing a minority of water systems, community systems serve 264 million persons (approximately 93.9% of the U.S. population) (*26*). Furthermore, a limited number of community systems (15%) provide water to 90% of the community system population (*26*). Noncommunity, nontransient systems provide water to 6.9 million persons, and noncommunity, transient systems provide water to 12.9 million persons (by definition, these populations also use another type of water system at their residences, except for the limited number of permanent residents of nontransient systems) (*26*). Although the majority of public water systems (91.6%) are supplied by ground water, more persons (63.4%) drink from public systems served by surface water (*26*). Approximately 15.0% of the U.S. population relies on individual water systems that are privately owned (*27*). In previous *Surveillance Summaries*, commercially bottled water, when linked with a WBDO, was classified as an individual water system; these WBDOs are now classified as bottled water. WNID is defined as water used in occupational settings; lakes, springs, and creeks used as drinking water by campers and boaters; irrigation water; and other nonpotable water sources with or without taps. WNID does not include recreational water, which is dis-

FIGURE 1. Types of drinking water systems



* U.S. Environmental Protection Agency.
† Food and Drug Administration.
§ In certain instances, bottled water is used in lieu of a community supply or by noncommunity systems.

cussed in a separate *Surveillance Summary* (*4*). WBDOs with more than one implicated water system type are tabulated and analyzed as mixed water systems (e.g., noncommunity and individual).

Source water is defined as the untreated water (i.e., raw water) used to produce drinking water. WBDOs with more than one implicated water source are tabulated and analyzed as mixed water sources (e.g., lake and well). For WNID or WUI, primary water exposure is defined as the source of contaminated water.

Water setting is defined as the location of ill person's exposure to the contaminated water. The setting applies to drinking water, WNID, and WUI.

The purpose of this surveillance system is not only to evaluate the relation between water and reported outbreaks and disease, but also to identify system breakdowns, operator errors, and other engineering-related activities that lead to outbreaks. To understand the circumstances and system breakdowns that lead to illness, each WBDO is classified as having one or more deficiencies (Table 2).

Waterborne Disease and Outbreak Strength of Evidence Classification

All WBDOs reported to the surveillance system have been classified according to the strength of the evidence implicating water as the vehicle of transmission (Table 3). The classification scheme (i.e., Classes I–IV) is based on the epidemiologic and water-quality data provided with the WBDO report form. Although WBDOs without water-quality data might have been included in this report, reports that lacked epidemiologic data, linking the outbreak to water, have been excluded.

A classification of I indicates that adequate epidemiologic and water-quality data were reported. However, this classification does not necessarily imply that the investigation was optimally conducted nor does a classification of II, III, or IV imply that the investigation was inadequate or incomplete. WBDOs and their resulting investigations occur under different circumstances, and not all WBDOs can or should be rigorously investigated. In addition, WBDOs that affect few persons are more likely to receive a classification of III or IV because of the limited sample size available for analysis.

Changes in the 2003–2004 *Surveillance Summary*

Names, definitions, and other parameters in this report have been modified and expanded to better reflect the changing epidemiology of WBDOs and capture the wide scope of water-related disease. This section highlights those changes.

TABLE 2. Deficiency classification for drinking water, water not intended for drinking (excluding recreational water), and water of unknown intent

Deficiency
Contamination of water at/in the water source, treatment facility, or distribution system (SWTD)*
1: Untreated surface water intended for drinking
2: Untreated ground water intended for drinking
3: Treatment deficiency (e.g., temporary interruption of disinfection, chronically inadequate disinfection, or inadequate or no filtration)
4: Distribution system deficiency, including storage (e.g., cross-connection, backflow, contamination of water mains during construction or repair)
Contamination of water at points not under the jurisdiction of a water utility or at the point of use (NWU/POU)†
5: *Legionella* spp. in water system
A: Water intended for drinking
B: Water not intended for drinking (excluding recreational water)
C: Water of unknown intent
6: Plumbing system deficiency after the water meter or property line (e.g., cross-connection, backflow, or corrosion of pipes)
7: Deficiency in building/home-specific water treatment after the water meter or property line
8: Deficiency or contamination of equipment/devices using or distributing water (e.g., drink-mix machines)
9: Contamination during commercial bottling
10: Contamination during shipping, hauling, or storage
A: Water intended for drinking – Tap water
B: Water intended for drinking – Commercially bottled water
11: Contamination at point of use
A: Tap
B: Hose
C: Commercially bottled water
D: Container, bottle, or pitcher
E: Unknown
12: Drinking or contact with water not intended for drinking (excluding recreational water)
Unknown/Insufficient information
99: Unknown/Insufficient information
A: Water intended for drinking – Tap water
B: Water intended for drinking – Commercially bottled water
C: Water not intended for drinking (excluding recreational water)
D: Water of unknown intent

*Contamination of water and deficiencies occurring in the drinking water system at/in the water source, treatment facility, or distribution system of pipes and storage facilities. For a community water system, the distribution system refers to the pipes and storage infrastructure under the jurisdiction of the water utility before the water meter or property line (if the system is not metered). For noncommunity and nonpublic individual water systems, the distribution system refers to the pipes and storage infrastructure before entry into a building or house.

† Contamination of drinking water and deficiencies occurring after the water meter or outside the jurisdiction of a water utility (e.g., in a service line leading to a house or building, in the plumbing inside a house or building, during shipping or hauling, during storage other than in the distribution system, or at point of use).

TABLE 3. Classification of investigations of waterborne disease and outbreaks — United States

Class	Epidemiologic data	Water-Quality data
I	Adequate Data provided concerning exposed and unexposed persons, with relative risk or odds ratio ≥ 2 or $p \leq 0.05$	Provided and adequate Laboratory data or historical information (e.g., reports of a chlorinator malfunction, a water main break, no detectable free-chlorine residual, or the presence of coliforms in the water)
II	Adequate	Not provided or inadequate (e.g., laboratory testing of water not conducted and no historical information)
III	Provided but limited Epidemiologic data provided that did not meet the criteria for Class I, or claim made that ill persons had no exposures in common besides water but no data provided	Provided and adequate
IV	Provided but limited	Not provided or inadequate

Title

The title of this *Surveillance Summary* has been changed. The change in the title of this report emphasizes and better represents the public health importance of single cases of waterborne disease and disease associated with water exposures other than drinking water and recreational water.

Etiologic Agents

Etiologic agents are typically identified through clinical specimen testing. If more than one agent is identified, only those agents that individually represent ≥5% of positive clinical specimens appear in the tables and calculations as etiologic agents for that WBDO. Occasionally, clinical specimen data are unavailable, but water sample testing implicates a particular etiologic agent that is consistent with the presenting illness. In these situations, the agent identified by water testing is listed as the etiologic agent for that WBDO. WBDOs in which the etiologic agent is unconfirmed or unknown are listed as unidentified, even when other data (e.g., clinical findings) are suggestive of a particular pathogen or chemical/toxin. In previous reports, the term "acute gastrointestinal illness (AGI)" was used to indicate WBDOs of unidentified etiology associated with gastrointestinal symptoms. Because AGI refers to a type of illness and not to an etiologic agent, the term "unidentified" is now used to describe WBDOs with unknown etiology.

When each etiologic agent is of the same agent type (i.e., bacterial, chemical/toxin, parasitic, or viral), the WBDO is analyzed within that category (e.g., an outbreak with both *Cryptosporidium* spp. and *Giardia* spp. will be analyzed as a parasitic outbreak). When agents represent more than one type, the WBDO is analyzed as a mixed-agent WBDO (e.g., an outbreak with both *Giardia* spp. and *Salmonella* spp. will be analyzed as a mixed parasitic and bacterial outbreak).

Predominant Illness

All WBDOs are categorized according to predominant illness. Whereas the illness associated with a WBDO generally includes only one category of symptoms (e.g., gastroenteritis), WBDOs do occur where the symptoms cluster into more than one category (e.g., gastroenteritis and dermatitis). Therefore, in this report, any illness symptom reported by ≥50% of patients will be listed; multiple illnesses will be listed for a single WBDO, if applicable. Mixed illness WBDOs are analyzed separately from single illness WBDOs.

Case Counts and Deaths

The number of deaths associated with each WBDO has been added to the case counts. No deaths occurred unless noted. This change provides greater information on the severity of illness associated with each WBDO.

Deficiencies

Water utilities manage the drinking water in public systems before the water reaches the water meter (or before the property line if the distribution system is not metered). These public drinking water systems are subject to EPA regulations. Drinking water concerns arising after the meter or property line (e.g., *Legionella* colonization in plumbing, plumbing contamination and cross-connections within buildings and homes, and drink mix/soda machine deficiencies) might not be under the jurisdiction of water utilities and might not be regulated under current EPA drinking water rules. To characterize drinking water concerns that might have different oversight, the classification of deficiencies leading to WBDOs has been modified in this report. The new deficiency classification (Table 2) provides greater detail concerning the circumstances and risk factors that led to illness and clarifies deficiencies that might require different types of public health responses.

In the old deficiency classification (formerly deficiencies 1–5), antecedent circumstances related to WBDOs that occurred outside the jurisdiction of a water utility were 1) classified with water distribution system deficiencies that were within the jurisdiction of a water utility (formerly deficiency 4); 2) classified as miscellaneous deficiencies (formerly deficiency 5); or 3) not classified at all (e.g., *Legionella* colonization in plumbing). In the new deficiency classification, a clear distinction is made between contamination occurring at or in the source water, treatment facility, or distribution system (SWTD) (deficiencies 1–4), which are under the jurisdiction of a water utility if a public water system is involved versus contamination at points not under the jurisdiction of a water utility or at the point of use (NWU/POU) (i.e., deficiencies 5A, 6–11, and 99A and 99B). The NWU/POU deficiencies include WBDOs associated with drinking water contaminated during shipping, hauling, storing, or use; commercially bottled water; ice or beverages made with contaminated water; and deficiencies of equipment/devices in which water is used or distributed (e.g., beverages contaminated by plumbing failures in drink mix/soda machines). For WBDOs involving consumption or contact with WNID and WUI, separate deficiency classifications (i.e., deficiencies 5B, 5C, 12, 99C, and 99D) are used.

The reporting and analysis of deficiencies also have changed to emphasize that individual WBDOs might be associated with more than one deficiency. Instead of reporting and analyzing only the primary deficiency when multiple deficiencies have been identified, all deficiencies are now considered. Identifying only the primary deficiency might be difficult because more than one deficiency might have resulted in contamination of water that would result in illness. To reflect this complexity, tables and figures that report deficiency information report all deficiencies that have likely contributed to the WBDO. Therefore, the total number of deficiencies is greater than the total number of WBDOs.

Water System Type

Drinking water systems remain categorized as community, noncommunity, or individual systems. For the 1999–2000 and 2001–2002 *Surveillance Summaries,* WBDOs linked to commercially bottled water and WNID were classified as individual water systems for analysis purposes (*3,28*). For 2003–2004, to distinguish between piped and nonpiped drinking water, the definition of an individual drinking water system no longer includes commercially bottled water and WNID. WBDOs associated with commercially bottled water are now classified separately (i.e., bottled). Separating piped from nonpiped water also distinguishes between drinking water systems regulated by EPA (community and noncommunity) and the FDA (i.e., bottled). WBDOs associated with WNID no longer have a water system type designation because the risk factors associated with these WBDOs are not relevant to drinking water systems.

Analyses involving water system types have also changed. If a WBDO involving more than one water system type occurs, the WBDO is classified and analyzed as a mixed water system. Furthermore, all analyses that involve water system types are limited to WBDOs with deficiencies 1–4 and deficiency 99 when a water system can be identified but insufficient information concerning the deficiency is available. Under the revised deficiency classification, the only deficiencies relevant to the type of drinking water system associated with the WBDO are deficiencies 1–4 (i.e., surface water contamination, ground water contamination, water treatment deficiencies, and distribution system contamination).

Water Source

The only deficiencies relevant to the type of drinking water source involved in the WBDO are deficiencies 1–3 (i.e., surface water contamination, ground water contamination, and water treatment deficiencies). Therefore, all analyses presented in this report that involve source water type are limited to WBDOs with deficiencies 1–3. If a WBDO involves more than one source water type, the WBDO is classified and analyzed as a mixed source WBDO.

Legionella

Although outbreaks of Pontiac fever (PF) have been included in the WBDOSS since 1981, outbreaks of Legionnaires' disease (LD) only have been included since the 2001–2002 surveillance period (*28*). During this period, all PF and LD outbreaks were listed in the drinking water *Surveillance Summary* in a table separate from the tables listing other drinking water-associated WBDOs; the single PF outbreak associated with recreational water was discussed in the recreational water *Surveillance Summary* (*29*). Beginning with the 2003–2004 *Surveillance Summary*, PF and LD outbreaks associated with drinking water are included in the same line lists with other drinking water-associated WBDOs. Similarly, PF and LD outbreaks associated with recreational water are listed and discussed in the 2003–2004 *Surveillance Summary* of recreational water-associated WBDOs (*4*). Inclusion and analysis of PF and LD outbreaks with other drinking water-associated WBDOs is a reflection of the changing epidemiology of WBDOs. *Legionella* outbreaks that occur in association with WNID or WUI also are listed and discussed in this report.

Water Not Intended for Drinking and Water of Unknown Intent

In previous *Surveillance Summaries*, WBDOs (excluding *Legionella* outbreaks) associated with WNID or with WUI were integrated into the drinking water WBDO line lists. Beginning with this report, WBDOs (including *Legionella* outbreaks) associated with WNID or with WUI are listed in separate tables to distinguish the different water types.

Strength of Evidence Classification for Waterborne Disease and Outbreaks

Single cases of PAM or chemical/toxin poisoning are now given strength of evidence classifications (Table 3) along with the other WBDOs. These single cases do not receive rankings higher than III because relative risks, odds ratios, and p values are not calculated from single cases.

Results

During 2003–2004, 19 states reported 36 WBDOs (i.e., 14 for 2003 and 22 for 2004). These WBDOs were associated with water intended for drinking (n = 30), WNID (n = three), and WUI (n = three) and are tabulated by year and state (Tables 4–6).

TABLE 4. Waterborne-disease outbreaks associated with drinking water (n = 12), by state — United States, 2003

State	Month	Class	Etiologic agent	Predominant illness	No. of cases* (n = 819)	Type of system†	Deficiency§	Water source	Setting
Florida	Jan	II	Unidentified¶	Gastroenteritis	419	Bottle	11C	Spring	Sports complex
Florida	Nov	III	Bromate and other byproducts of disinfection	Gastroenteritis	2	Bottle	9	Unknown	Private residence
Illinois	Jul	I	Unidentified	Gastroenteritis	180	Ncom	99A	Well	Water park
Maine	Dec	III	Cleaning product	Gastroenteritis	2	Bottle	10B	Spring	Unknown
Maryland**	Oct	III	*Legionella pneumophila* serogroup 1	Acute respiratory	7	Com	5A	Well	Hotel
Michigan	Sep	I	Unidentified	Gastroenteritis	4	Com	11D	Well	Worksite
Minnesota	Jun	I	Copper	Gastroenteritis	4	Com	8	River, stream	Restaurant
Minnesota	Nov	I	Copper	Gastroenteritis	5	Com	8	Lake	Restaurant
New York	Mar	III	Sodium hydroxide	Dermatitis	4	Com	3	Well	Community
Ohio	Nov	I	*Campylobacter jejuni* and *Shigella* spp.††	Gastroenteritis	57	Ind	1	Pond	Worksite
Utah	Jul	III	Unidentified	Gastroenteritis	25	Ncom	99A	Unknown	Camp
Washington	May	III	*Campylobacter* spp.§§	Gastroenteritis	110	Ind	2, 4	Well	Farm

* No deaths were reported.
† Com: community; Ncom: noncommunity; Ind: individual; Bottle: commercially bottled water. Community and noncommunity water systems are public water systems that have ≥15 service connections or serve an average of ≥25 residents for ≥60 days/year. A community water system serves year-round residents of a community, subdivision, or mobile home park. A noncommunity water system serves an institution, industry, camp, park, hotel, or business and can be nontransient or transient. Nontransient systems serve ≥25 of the same persons for >6 months of the year but not year-round (e.g., factories and schools), whereas transient systems provide water to places in which persons do not remain for long periods (e.g., restaurants, highway rest stations, and parks). Individual water systems are small systems not owned or operated by a water utility that have <15 connections or serve <25 persons.
§ Refer to Table 2 - Deficiency classification for drinking water, water not intended for drinking (excluding recreational water), and water of unknown intent.
¶ Etiology unidentified; norovirus suspected based on incubation period, symptoms, and duration of illness.
** **Source:** CDC. Legionnaires' disease associated with potable water in a hotel—Ocean City, Maryland, October 2003–February 2004. MMWR 2005;54:165–8.
†† Sixteen persons had stool specimens that tested positive for *C. jejuni*, and two persons had stool specimens that tested positive for *Shigella* spp.
§§ Nine persons had stool specimens that tested positive for *Campylobacter* spp., and three persons had stool specimens that tested positive for *C. jejuni*.

Waterborne Disease and Outbreaks Associated with Water Intended for Drinking

The 30 drinking water-associated WBDOs (i.e., 12 during 2003 and 18 during 2004) were reported by 18 states (Figure 2). The number of drinking water-associated WBDOs reported for 2003–2004 is similar to that reported for 2001–2002 (n = 36, including the five previously unreported outbreaks for 2002 [Table 7; Figure 3]). WBDOs associated with drinking water occurred throughout the year (Figure 4). Five states (Florida, New Jersey, New York, Ohio, and Pennsylvania) reported the highest number of drinking water-associated WBDOs (three each) for 2003–2004. Selected WBDO descriptions have been reported (Appendix B, Descriptions of Selected Waterborne Disease and Outbreaks (WBDOs) Associated with Drinking Water, Water Not Intended for Drinking, and Water of Unknown Intent).

The 30 drinking water-associated WBDOs reported for 2003–2004 caused illness among approximately 2,760 persons and resulted in four deaths. The median number of persons affected in a WBDO was seven (range: 1–1,450). Twenty-nine WBDOs were associated with either acute respiratory illness (ARI) or AGI, and one WBDO was associated with both ARI and AGI. All ARI outbreaks were associated with exposure to *Legionella* spp. (Figure 5).

Seven (23.3%) of the 30 drinking water-associated WBDOs were given a strength of evidence Class I ranking on the basis of epidemiologic and water-quality data; one (3.3%) was ranked as Class II; 20 (66.7%) were ranked as Class III; and two (6.7%) were ranked as Class IV. Drinking water-associated WBDOs are tabulated by etiologic agent and type of water system (Table 8), etiologic agent and type of water source (Table 9), type of deficiency and type of water system (Table 10), type of deficiency and type of water source (Table 11), predominant illness and type of water system (Table 12), and predominant illness and type of water source (Table 13). WBDOs were included (Tables 8–13) only if the type of deficiency involved in each WBDO was associated with the summarized variable. WBDOs were not included if the type of deficiency did

TABLE 5. Waterborne-disease outbreaks associated with drinking water (n = 18), by state — United States, 2004

State	Month	Class	Etiologic agent	Predominant illness	No. of cases (deaths)* (n = 1,941)	Type of system†	Deficiency§	Water source	Setting
Florida	Oct	III	Gasoline byproducts	Gastroenteritis	1	Bottle	99B	Unknown	Private residence
Maryland	Dec	III	*Legionella pneumophila* serogroup 1	Acute respiratory	6 (2)	Com	5A	Well	Condominium
Montana	Aug	III	*Salmonella typhimurium*	Gastroenteritis	70	Ncom	3, 4	Well	Restaurant
New Jersey	Apr	III	Sodium hydroxide	Dermatitis	2	Com	3	Well	Community
New Jersey	Jun	III	*L. pneumophila* serogroup 1	Acute respiratory	2	Com	5A	River	Apartment
New Jersey	Jul	III	*L. pneumophila* serogroup 1	Acute respiratory, Gastroenteritis¶	2 (1)	Com	5A	River	Senior housing center
New York	Jan	III	*L. micdadei*	Acute respiratory	2	Com	5A	Reservoir	Hospital
New York	May	III	*L. pneumophila* serogroup 1	Acute respiratory	2	Com	5A	Reservoir	Hospital
Ohio	Jan	III	*Campylobacter jejuni*, *Campylobacter lari*, *Cryptosporidium* spp., and *Helicobacter canadensis***	Gastroenteritis	82	Com	4	Well	Factory
Ohio	Jul	I	*C. jejuni,* norovirus, and *Giardia intestinalis*††	Gastroenteritis	1450	Ncom/Ind	2, 4	Well	Restaurant, bar camp, and tourist attraction
Pennsylvania	Jan	I	Norovirus	Gastroenteritis	70	Ncom	6	Pond	Ski resort
Pennsylvania	Jun	III	Unidentified	Gastroenteritis	174	Ncom	3	Well	Camp
Pennsylvania	Apr	III	*L. pneumophila* serogroup 1	Acute respiratory§§	3 (1)	Com	5A	Well, lake, and creek	Nursing home
South Carolina	Jul	III	Copper	Gastroenteritis	7	Com	8	Lake	Restaurant
Texas	Sep	IV	*L. pneumophila* serogroup 1	Acute respiratory	3	Com	5A	Well	Hospital
Virginia	Aug	IV	*Campylobacter* spp.	Gastroenteritis	34	Com	4	Well	Community
Vermont	Jun	III	*G. intestinalis*	Gastroenteritis	11	Ncom	4	Well	Camp
Wisconsin	Dec	III	*C. jejuni*	Gastroenteritis	20	Ncom	2	Well	Restaurant

* Deaths are indicated in parentheses if they occurred.
† Com: community; Ncom: noncommunity; Ind: individual; Bottle: commercially bottled water. Community and noncommunity water systems are public water systems that have ≥15 service connections or serve an average of ≥25 residents for ≥60 days/year. A community water system serves year-round residents of a community, subdivision, or mobile home park. A noncommunity water system serves an institution, industry, camp, park, hotel, or business and can be nontransient or transient. Nontransient systems serve ≥25 of the same persons for >6 months of the year but not year-round (e.g., factories and schools), whereas transient systems provide water to places in which persons do not remain for long periods (e.g., restaurants, highway rest stations, and parks). Individual water systems are small systems not owned or operated by a water utility that have <15 connections or serve <25 persons.
§ Refer to Table 2 - Deficiency classification for drinking water, water not intended for drinking (excluding recreational water), and water of unknown intent.
¶ Two persons had cough, fever, and diarrhea.
** Seven persons had stool specimens that tested positive for *C. jejuni,* one person had a stool specimen that tested positive for *C. lari*, one person had a stool specimen that tested positive for *Cryptosporidium* spp., and one person had a stool specimen that tested positive for *H. canadensis*.
†† Sixteen persons had stool specimens that tested positive for *C. jejuni*, nine persons had stool specimens that tested positive for norovirus, and three persons had stool specimens that tested positive for *G. intestinalis*. Only one person (<5%) had a stool specimen that tested positive for *S. typhimurium* — this pathogen is not included in the table.
§§ Legionnaires' disease was diagnosed in two persons, and Pontiac fever was diagnosed in one person.

not reflect the summarized variable (e.g., the source of raw untreated water would unlikely be relevant for a *Legionella* outbreak associated with a building plumbing system).

Etiologic Agents

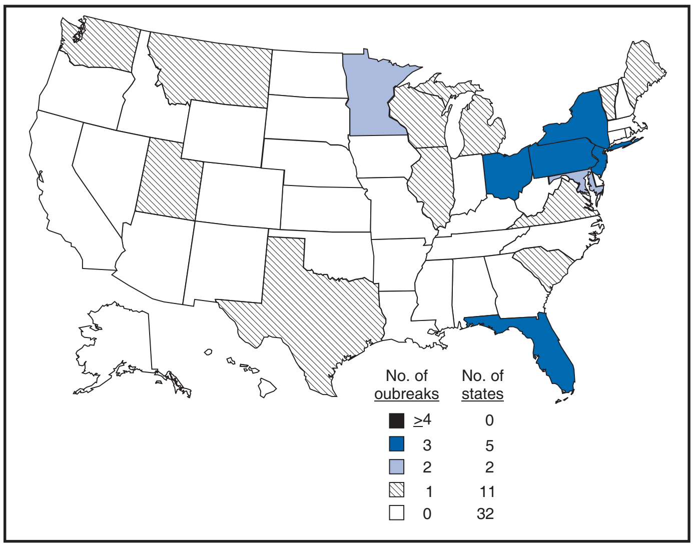
Twenty-five (83.3%) of the 30 drinking water-associated WBDOs were of known etiology; 17 (68.0%) were attributed to an infectious etiology, and eight (32.0%) were attributed to chemical/toxin poisoning. Of the 17 WBDOs with known infectious etiology, 13 (76.5%) were caused by bacteria (eight [61.5%] of which were caused by *Legionella* spp.), two (11.8%) were caused by more than one etiologic agent type, one (5.9%) was caused by a parasite, and one (5.9%) was caused by a virus. Five (16.7%) of the 30 drinking water-associated WBDOs were of unknown etiology. The distribution of etiologic agents for

TABLE 6. Waterborne-disease outbreaks associated with water not intended for drinking (excluding recreational water) and water of unknown intent (n = six), by state — United States, 2003–2004

State	Month/ Year	Class	Etiologic agent	Predominant illness	No. of cases (deaths)* (n = 36)	Deficiency†	Primary water exposure	Setting
New York	Jul 2003	IV	*Legionella pneumophila* serogroup 1	Acute respiratory	2	5C	Unknown	Nursing home
New York	Jul 2004	III	*L. pneumophila* serogroup 1	Acute respiratory	2 (1)	5B	Cooling tower	Nursing home
North Carolina	Sep 2004	I	*L. pneumophila* serogroup 1	Acute respiratory	7 (3)	5B	Cooling tower	Nursing home, hospital, and factory
Ohio	Jul 2004	I	*L. pneumophila* serogroup 1	Acute respiratory§	13	5C	Unknown	Worksite
Texas	Oct 2004	IV	*L. pneumophila* serogroup 1	Acute respiratory	2	5C	Unknown	Hotel
Wisconsin	Jul 2003	IV	*Escherichia coli* O157:H7	Gastroenteritis	10	12	Broken septic line	Camp

* Deaths are indicated in parentheses if they occurred.
† Refer to Table 2 - Deficiency classification for drinking water, water not intended for drinking (excluding recreational water), and water of unknown intent.
§ Two confirmed cases of Legionnaires' disease and 11 probable cases with symptoms consistent with Pontiac fever.

FIGURE 2. Number* of waterborne-disease outbreaks associated with drinking water — United States, 2003–2004



* n = 30; numbers are dependent on reporting and surveillance activities in individual states and do not necessarily indicate that more outbreaks occurred in a given state.

the 30 drinking water-associated WBDOs has been reported (Figure 6).

Bacteria. Thirteen WBDOs affecting 318 persons were attributed to bacterial infections: eight *Legionella* spp. outbreaks, three *Campylobacter* spp. outbreaks, one *Salmonella typhimurium* outbreak, and one outbreak involving two different bacteria (16 persons had stool specimens that tested positive for *C. jejuni,* and two persons had stool specimens that tested positive for *Shigella* spp.). Illnesses from these 13 WBDOs resulted in four deaths, all of which were associated with *Legionella* spp.

Chemicals/Toxins. Eight WBDOs affecting 27 persons were attributed to chemical/toxin poisoning; no deaths were reported. Three WBDOs involved high levels of copper associated with drink mix/soda machines; three WBDOs were a result of contamination of commercially bottled water with bromate and other by-products of disinfection, cleaning products, and gasoline by-products; two WBDOs were a result of large volumes of sodium hydroxide discharged into community water supplies.

Mixed agents. Two WBDOs were attributed to more than one type of etiologic agent; no deaths were reported. The largest reported outbreak affected 1,450 persons and involved at least one bacterium (i.e., *C. jejuni*, although one clinical specimen with *S. typhimurium* also was reported), one virus (norovirus), and one parasite (*Giardia intestinalis*). The second mixed-agent outbreak affected 82 persons and involved infection with three different bacteria (i.e., *C. jejuni*, *C. lari*, and *Helicobacter canadensis*) and one parasite (*Cryptosporidium* spp.).

Parasites. One WBDO attributed to *G. intestinalis,* affected 11 persons. No deaths were reported.

Viruses. One WBDO attributed to norovirus affected 70 persons. No deaths were reported.

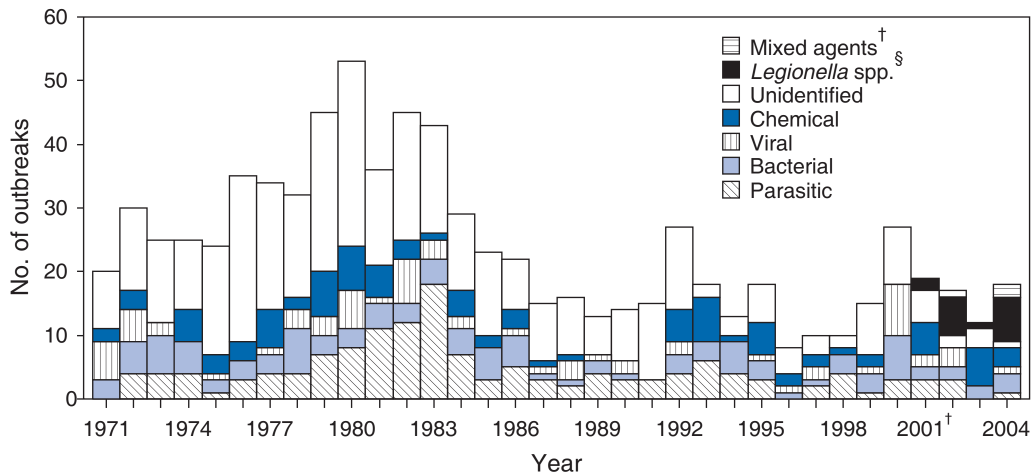
Unidentified etiologic agents. Five WBDOs involving AGI of unidentified etiology affected 802 persons; no deaths were reported. Stool testing to identify a causative agent was attempted in four of the five outbreaks. In one outbreak at a volleyball tournament, norovirus was suspected on the basis of incubation period, symptoms, and duration of illness (Florida, January 2003). However, the implicated water tested negative for norovirus, and patient samples were not collected for confirmatory testing.

TABLE 7. Waterborne-disease outbreaks that were not included in previous surveillance summaries (n = nine), by state/territory — United States, 1982–2002

State/Territory	Month/ Year	Class	Etiologic agent	Predominant illness	No. of cases* (n = 217)	Type of system†	Deficiency§	Water source	Setting
Maryland	Nov 2002	III	*Legionella pneumophila* serogroup 1	Acute respiratory	3	Com	5A	Reservoir	Club
New York	May 1982	III	Unidentified	Gastroenteritis	16	Ncom	3	Well	Restaurant
New York	May 1984	II	Copper	Gastroenteritis	15	Com	4	Reservoir	Restaurant
New York	Aug 1995	I	Unidentified¶	Gastroenteritis	30	Ncom	2, 11E	Well	Motel
New York	Aug 1996	I	Unidentified**	Gastroenteritis	58	Ncom	2	Well	Camp
New York	Jul 2002	III	*Escherichia coli* O157:H7	Gastroenteritis	6	Ind	2	Well	Private residence
New York	Dec 2002	I	*Campylobacter jejuni*, *Entamoeba* spp., and *Giardia* spp.††	Gastroenteritis	27	Com	2	Well	Apartment
Palau	Apr 2002	III	*Entamoeba histolytica*	Gastroenteritis	59	Ncom	99A	Stream	Unknown
Virgin Islands§§	Nov 2002	III	*L. pneumophila* serogroup 1	Acute respiratory	3	Ncom	5A	Reservoir, cistern¶¶	Hotel

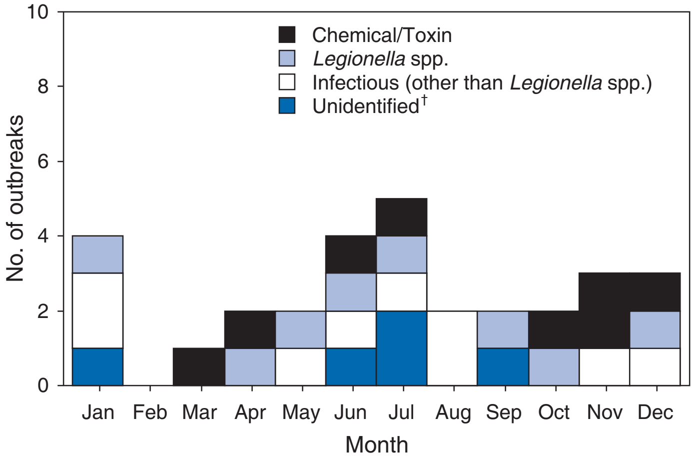
* No deaths were reported.
† Com: community; Ncom: noncommunity; Ind: individual; Bottle: commercially bottled water. Community and noncommunity water systems are public water systems that have ≥15 service connections or serve an average of ≥25 residents for ≥60 days/year. A community water system serves year-round residents of a community, subdivision, or mobile home park. A noncommunity water system serves an institution, industry, camp, park, hotel, or business and can be nontransient or transient. Nontransient systems serve ≥25 of the same persons for >6 months of the year but not year-round (e.g., factories and schools), whereas transient systems provide water to places in which persons do not remain for long periods of time (e.g., restaurants, highway rest stations, and parks). Individual water systems are small systems not owned or operated by a water utility that have <15 connections or serve <25 persons.
§ Refer to Table 2 - Deficiency classification for drinking water, water not intended for drinking (excluding recreational water), and water of unknown intent.
¶ Etiology unidentified; Norwalk-like virus suspected based on incubation period, symptoms, and duration of illness.
** Etiology unidentified; viral etiology suspected based on incubation period, symptoms, and duration of illness.
†† Three persons had stool specimens that tested positive for *C. jejuni*; two persons had stool specimens that tested positive for *Entamoeba* spp., and one person had a stool specimen that tested positive for *Giardia* spp.
§§ **Source:** Cowgill KD, Lucas CE, Benson RF, et al. Recurrence of Legionnaires' disease at a hotel in the United States Virgin Islands over a 20-year period. Clin Infect Dis 2005;40:1205–7.
¶¶ Rainwater cistern sometimes was supplemented with community water.

FIGURE 3. Number* of waterborne-disease outbreaks associated with drinking water, by year and etiologic agent — United States, 1971–2004



* n = 803.
† Beginning in 2003, mixed agents of more than one etiologic agent type were included in the surveillance system. However, the first observation is a previously unreported outbreak in 2002.
§ Beginning in 2001, Legionnaires' disease was added to the surveillance system, and *Legionella* spp. were classified separately in this figure.

FIGURE 4. Number* of waterborne-disease outbreaks associated with drinking water, by etiologic agent and month — United States, 2003–2004



* n = 30.
† Unidentified etiology includes suspected etiologies not confirmed during the outbreak investigation.

Reports for the other four WBDOs did not note a suspected etiologic agent.

Deficiencies

Thirty-three deficiencies were cited in the 30 drinking water-associated WBDOs. Fourteen (42.4%) deficiencies involved the source water, treatment facility, or distribution system (SWTD); 17 (51.5%) deficiencies occurred at points not under the jurisdiction of a water utility or at the point of use (NWU/POU); and two (6.1%) were unknown deficiencies (Figure 7; Table 14).

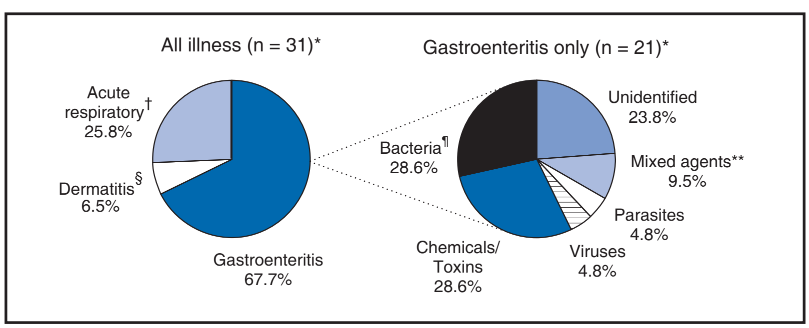
Deficiencies 1-4: Contamination of Water at/in the Water Source, Treatment Facility, or Distribution System

Water-quality data. Water-quality data (e.g., data regarding the presence of coliform bacteria, pathogens, or chemical/toxin contaminants; or data regarding levels of disinfectants, such as chlorine) were available for all 11 WBDOs given a deficiency classification of 1-4. Bacterial water-quality data were available for the eight WBDOs with confirmed infectious etiologies, and positive total or fecal coliform results from the implicated water were reported for seven (87.5%). The implicated water was tested for specific pathogens in two (25.0%) of the eight WBDOs with confirmed infectious etiologies. However, a pathogen was isolated from water in only one of these outbreaks; in this mixed-agent outbreak, the implicated water tested positive for *Cryptosporidium* spp., but the other three implicated infectious agents (*C. lari, C. jejuni,* and *H. canadensis*) were not recovered from the water samples.

Two (18.2%) of the 11 WBDOs with water-quality data were attributed to chemical/toxin poisoning. In both WBDOs, sodium hydroxide was the implicated agent and the water had a high pH level. One (9.1%) of the 11 outbreaks did not have an etiologic agent identified. However, the implicated water tested positive for both total and fecal coliforms.

Water systems. Four (36.4%) of 11 WBDOs with deficiencies 1-4 involved community water systems, four (36.4%) involved noncommunity water systems, two (18.2%) involved individual water systems, and one (9.1%) involved both noncommunity and individual water systems (Tables 8, 10, and 12; Figure 6). Among the four outbreaks involving community water systems, two (50.0%) were associated with a treatment deficiency, and two (50.0%) were associated with problems with the water distribution system or water storage. Among the four outbreaks involving noncommunity water systems, one (25.0%) was associated with contaminated untreated ground water intended for drinking; one (25.0%) was associated with a treatment deficiency; one (25.0%) was associated with a deficiency in the water distribution system; and one was associated with both a treatment and a distribution system deficiency. Among the two outbreaks involving individual water systems, one (50.0%) was associated with contaminated untreated surface water intended for drinking; and one (50.0%) was associated with both contaminated untreated ground water intended for drinking and deficiencies in the water distribution system. The single outbreak involving

FIGURE 5. Percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water, by illness and etiology — United States, 2003–2004



* One of the WBDOs had two predominant illnesses: acute respiratory illness and gastroenteritis.
† All acute respiratory illness was attributed to *Legionella* spp.
§ All dermatitis was attributed to chemicals/toxins.
¶ Including one *Legionella* spp. outbreak that involved both acute respiratory and gastrointestinal illnesses.
** Each outbreak involves more than one etiologic agent.

TABLE 8. Number of waterborne-disease outbreaks (WBDOs) associated with drinking water (n = 11),* by etiologic agent and type of water system — United States, 2003–2004

	Type of water system†									
	Community		Noncommunity		Individual§		Mixed system		Total	
Etiologic agent	WBDOs	Cases	WBDOs	Cases	WBDOs	Cases	WBDOs	Cases	WBDOs	Cases
Bacteria	**1**	**34**	**2**	**90**	**2**	**167**	**0**	**0**	**5**	**291**
Campylobacter spp.	1	34	1	20	1	110	0	0	**3**	**164**
C. jejuni and *Shigella* spp.	0	0	0	0	1	57	0	0	**1**	**57**
Salmonella typhimurium	0	0	1	70	0	0	0	0	**1**	**70**
Parasites	**0**	**0**	**1**	**11**	**0**	**0**	**0**	**0**	**1**	**11**
Giardia intestinalis	0	0	1	11	0	0	0	0	**1**	**11**
Chemicals/Toxins	**2**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**6**
Sodium hydroxide	2	6	0	0	0	0	0	0	**2**	**6**
Mixed agents¶	**1**	**82**	**0**	**0**	**0**	**0**	**1**	**1,450**	**2**	**1,532**
C. jejuni, *C. lani*, *Cryptosporidium* spp., and *Helicobacter canadensis*	1	82	0	0	0	0	0	0	**1**	**82**
C. jejuni, norovirus, and *G. intestinalis*	0	0	0	0	0	0	1**	1,450	**1**	**1,450**
Unidentified	**0**	**0**	**1**	**174**	**0**	**0**	**0**	**0**	**1**	**174**
Unidentified	0	0	1	174	0	0	0	0	1	174
Total	**4**	**122**	**4**	**275**	**2**	**167**	**1**	**1,450**	**11**	**2,014**
Percentage	**(36)**	**(6)**	**(36)**	**(14)**	**(18)**	**(8)**	**(9)**	**(72)**	**(100)**	**(100)**

* WBDOs with deficiencies 1–4 (i.e., surface water contamination, ground water contamination, water treatment deficiency, and distribution system contamination) were used for analysis.

† Community and noncommunity water systems are public water systems that have ≥15 service connections or serve an average of ≥25 residents for ≥60 days/year. A community water system serves year-round residents of a community, subdivision, or mobile home park. A noncommunity water system serves an institution, industry, camp, park, hotel, or business and can be nontransient or transient. Nontransient systems serve ≥25 of the same persons for >6 months of the year but not year-round (e.g., factories and schools), whereas transient systems provide water to places in which persons do not remain for long periods of time (e.g., restaurants, highway rest stations, and parks). Individual water systems are small systems not owned or operated by a water utility that have <15 connections or serve <25 persons.

§ Excludes commercially bottled water, therefore not comparable to previous summaries.

¶ Multiple etiologic agent types (e.g., bacteria, parasite, virus, and/or chemical/toxin) identified.

** Noncommunity and individual water systems.

TABLE 9. Number of waterborne-disease outbreaks (WBDOs) associated with drinking water (n = eight),* by etiologic agent and water source — United States, 2003–2004

	Water source									
	Ground water		Surface water		Unknown		Mixed source		Total	
Etiologic agent	WBDOs	Cases	WBDOs	Cases	WBDOs	Cases	WBDOs	Cases	WBDOs	Cases
Bacteria	**3**	**200**	**1**	**57**	**0**	**0**	**0**	**0**	**4**	**257**
Campylobacter spp.	2	130	0	0	0	0	0	0	**2**	**130**
C. jejuni and *Shigella* spp.	0	0	1	57	0	0	0	0	**1**	**57**
Salmonella typhimurium	1	70	0	0	0	0	0	0	**1**	**70**
Chemicals/Toxins	**2**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**6**
Sodium hydroxide	2	6	0	0	0	0	0	0	**2**	**6**
Mixed agents†	**1**	**1,450**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1,450**
C. jejuni, norovirus, and *Giardia intestinalis*	1	1,450	0	0	0	0	0	0	**1**	**1,450**
Unidentified	**1**	**174**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**174**
Unidentified	1	174	0	0	0	0	0	0	1	174
Total	**7**	**1,830**	**1**	**57**	**0**	**0**	**0**	**0**	**8**	**1,887**
Percentage	**(88)**	**(97)**	**(13)**	**(3)**	**0**	**0**	**0**	**0**	**(100)**	**(100)**

* WBDOs with deficiencies 1–3 (i.e., surface water contamination, ground water contamination, and water treatment deficiency) were used for analysis.

† Multiple etiologic agent types (e.g., bacteria, parasite, virus, and/or chemical/toxin) identified.

TABLE 10. Number and percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water (n = 11),* by type of deficiency (n = 14)† and type of water system — United States, 2003–2004

	Type of water system§									
	Community		Noncommunity		Individual¶		Mixed system		Total	
Type of deficiency	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
1: Untreated surface water intended for drinking	0	(0)	0	(0)	1	(33.3)	0	(0)	**1**	**(7.1)**
2: Untreated ground water intended for drinking	0	(0)	1	(20.0)	1	(33.3)	1**	(50.0)	**3**	**(21.4)**
3: Treatment deficiency	2	(50.0)	2	(40.0)	0	(0)	0	(0)	**4**	**(28.6)**
4: Distribution system deficiency, including storage	2	(50.0)	2	(40.0)	1	(33.3)	1**	(50.0)	**6**	**(42.9)**
Total	**4**	**(100.0)**	**5**	**(100.0)**	**3**	**(100.0)**	**2**	**(100.0)**	**14**	**(100.0)**

* WBDOs with deficiencies 1–4 (i.e., surface water contamination, ground water contamination, water treatment deficiency, and distribution system contamination) were used for analysis.
† Some WBDOs have multiple deficiencies that are tabulated separately. This table reports 14 deficiencies from 11 WBDOs.
§ Community and noncommunity water systems are public water systems that have ≥15 service connections or serve an average of ≥25 residents for ≥60 days/year. A community water system serves year-round residents of a community, subdivision, or mobile home park. A noncommunity water system serves an institution, industry, camp, park, hotel, or business and can be nontransient or transient. Nontransient systems serve ≥25 of the same persons for >6 months of the year but not year-round (e.g., factories and schools), whereas transient systems provide water to places in which persons do not remain for long periods of time (e.g., restaurants, highway rest stations, and parks). Individual water systems are small systems not owned or operated by a water utility that have <15 connections or serve <25 persons.
¶ Excludes commercially bottled water, therefore, not comparable to previous summaries.
** Noncommunity and individual water systems.

TABLE 11. Number and percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water (n = eight),* by type of deficiency (n = eight)† and source of water — United States, 2003–2004

	Water source									
	Ground water		Surface water		Unknown		Mixed system		Total	
Type of deficiency	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
1: Untreated surface water intended for drinking	0	(0)	1	(100.0)	0	(0)	0	(0)	**1**	**(12.5)**
2: Untreated ground water intended for drinking	3	(42.9)	0	(0)	0	(0)	0	(0)	**3**	**(37.5)**
3: Treatment deficiency	4	(57.1)	0	(0)	0	(0)	0	(0)	**4**	**(50.0)**
Total	**7**	**(100.0)**	**1**	**(100.0)**	**0**	**(0)**	**0**	**(0)**	**8**	**(100.0)**

* WBDOs with deficiencies 1–3 (i.e., surface water contamination, ground water contamination, and water treatment deficiency) were used for analysis.
† Each of these WBDOs is associated with a single deficiency.

TABLE 12. Number and percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water (n = 11),* by predominant illness and type of water system — United States, 2003–2004

	Type of water system†														
Predominant	Community			Noncommunity			Individual§			Mixed system			Total		
illness	WBDOs	Cases	(%)	WBDOs	Cases	(%)	WBDOs	Cases	(%)	WBDOs	Cases	(%)	WBDOs	Cases	(%)
Acute respiratory	0	0	(0)	0	0	(0)	0	0	(0)	0	0	(0)	**0**	**0**	**(0)**
Dermatitis	2	6	(4.9)	0	0	(0)	0	0	(0)	0	0	(0)	**2**	**6**	**(0.3)**
Gastroenteritis	2	116	(95.1)	4	275	(100.0)	2	167	(100.0)	1¶	1,450	(100.0)	**9**	**2,008**	**(99.7)**
Total	**4**	**122**	**(100.0)**	**4**	**275**	**(100.0)**	**2**	**167**	**(100.0)**	**1**	**1,450**	**(100.0)**	**11**	**2,014**	**(100.0)**

* WBDOs with deficiencies 1–4 (i.e., surface water contamination, ground water contamination, water treatment deficiency, and distribution system contamination) were used for analysis.
† Community and noncommunity water systems are public water systems that have ≥15 service connections or serve an average of ≥25 residents for ≥60 days/year. A community water system serves year-round residents of a community, subdivision, or mobile home park. A noncommunity water system serves an institution, industry, camp, park, hotel, or business and can be nontransient or transient. Nontransient systems serve ≥25 of the same persons for >6 months of the year but not year-round (e.g., factories and schools), whereas transient systems provide water to places in which persons do not remain for long periods of time (e.g., restaurants, highway rest stations, and parks). Individual water systems are small systems not owned or operated by a water utility that have <15 connections or serve <25 persons.
§ Excludes commercially bottled water, therefore, not comparable to previous summaries.
¶ Noncommunity and individual water systems.

TABLE 13. Number and percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water (n = eight),* by predominant illness and water source — United States, 2003–2004

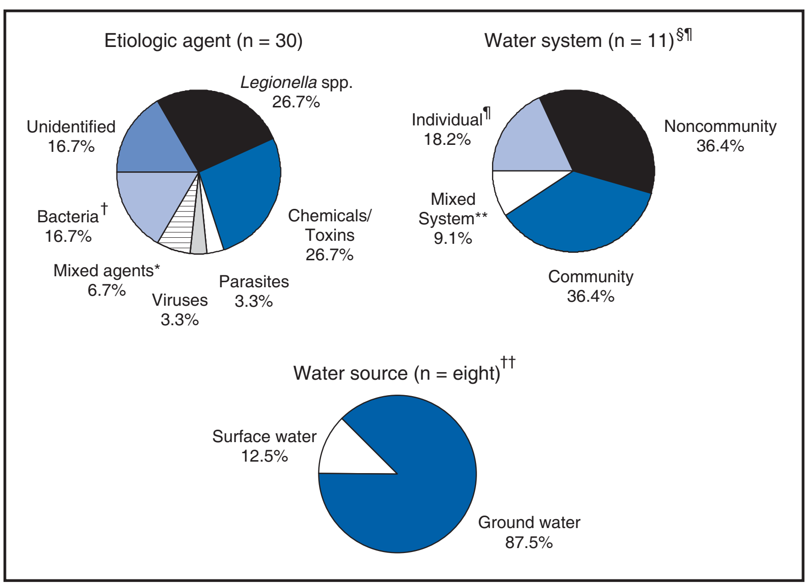
Predominant illness	Water source: Ground water			Surface water			Unknown			Mixed source			Total		
	WBDOs	Cases	(%)	WBDOs	Cases	(%)	WBDOs	Cases	(%)	WBDOs	Cases	(%)	WBDOs	Cases	(%)
Acute respiratory	0	0	(0)	0	0	(0)	0	0	(0)	0	0	(0)	**0**	**0**	**(0)**
Dermatitis	2	6	(0.3)	0	0	(0)	0	0	(0)	0	0	(0)	**2**	**6**	**(0.3)**
Gastroenteritis	5	1,824	(99.7)	1	57	(100.0)	0	0	(0)	0	0	(0)	**6**	**1,881**	**(99.7)**
Total	**7**	**1,830**	**(100.0)**	**1**	**57**	**(100.0)**	**0**	**0**	**(0)**	**0**	**0**	**(0)**	**8**	**1,887**	**(100.0)**

* WBDOs with deficiencies 1–3 (i.e., surface water contamination, ground water contamination, and water treatment deficiency) were used for analysis.

both noncommunity and individual water systems was associated with both contaminated untreated ground water intended for drinking and deficiencies in the water distribution system.

Water sources. Seven (87.5%) of the eight WBDOs with deficiencies 1-3 were associated with ground water sources involving wells, and one (12.5%) WBDO was associated with surface water derived from a spring-fed pond. Among the seven outbreaks related to ground water sources, three (42.9%) were associated with consumption of untreated ground water, and four (57.1%) were associated with treatment deficiencies (Tables 9, 11, and 13; Figure 6).

FIGURE 6. Percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water, by etiologic agent, water system, and water source — United States, 2003–2004



* Each WBDO involves more than one etiologic agent.
† Other than *Legionella* spp.
§ Deficiencies 1–4. See Table 10.
¶ Does not include commercially bottled water, therefore, not comparable to previous summaries.
** Noncommunity and individual systems.
†† Deficiencies 1–3. See Table 11.

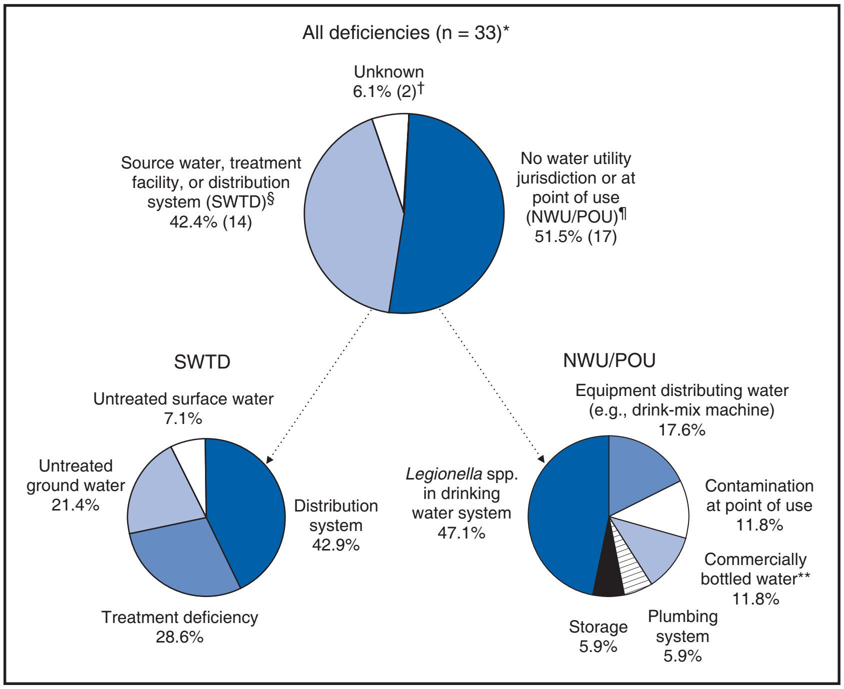
Deficiencies 5A, 6-11, and 99B: Contamination of Water at Points Not Under the Jurisdiction of a Water Utility or at the Point of Use

Water-quality data. Water-quality data indicating a problem with the water were available for 16 (94.1%) of 17 WBDOs with an NWU/POU deficiency. Among the nine WBDOs with an infectious etiology, eight (88.9%) were associated with *Legionella* spp., and one (11.1%) was associated with norovirus (Pennsylvania, January 2004). *Legionella* spp. were isolated from the implicated water sampled in all of the *Legionella* outbreaks. The implicated water in the norovirus outbreak tested positive for fecal coliforms.

Water-quality data were provided with the reports from all six WBDOs with chemical etiologies. In all six WBDOs, the contaminants causing the WBDO were recovered from the implicated water: copper in three WBDOs (Minnesota, June and November 2003; and South Carolina, July 2004); bromate and other by-products of disinfection in one WBDO (Florida, November 2003); a multiple-chemical cleaning product in one WBDO (Maine, December 2003); and gasoline by-products in one WBDO (Florida, October 2004). In the latter, the mechanism by which gasoline by-products got into the commercially bottled water was unknown, and this WBDO was given a deficiency of 99B. This WBDO is included with the other NWU/POU WBDOs for analysis purposes because commercially bottled water was involved.

Water-quality data also were provided with the reports from two WBDOs with unidentified etiologies. In one outbreak, the implicated water tested positive for total coliforms. In the other outbreak, the implicated water was tested specifically for norovirus, but it was not isolated.

FIGURE 7. Percentage of waterborne-disease outbreaks (WBDOs) associated with drinking water, by deficiency* — United States, 2003–2004



* A total of 30 WBDOs but 33 deficiencies.
† Deficiency 99A. See Table 14.
§ Deficiencies 1–4. See Table 14.
¶ Deficiencies 5A, 6–11, 99B. See Table 14.
** Two WBDOs, one with contamination during bottling and one with unknown location or mechanism of contamination.

Deficiency 5A: *Legionella* in water intended for drinking. All eight of the drinking water-associated *Legionella* WBDOs occurred in large buildings or in institutional settings and were related to the multiplication of *Legionella* spp. in the plumbing. Among the 27 cases attributed to these *Legionella* outbreaks, one case was reported to have symptoms consistent with PF. The majority of cases of legionellosis were diagnosed by urinary antigen testing, which is specific for *L. pneumophila* serogroup 1 (*30*).

Deficiencies 6-11. Of the eight WBDOs associated with deficiencies 6-11, three (37.5%) were associated with drink mix/soda machine deficiencies resulting in copper intoxication; three (37.5%) were associated with commercially bottled water; one (12.5%) was associated with a cross-connection in the plumbing inside a building; and one (12.5%) was associated with point-of-use contamination of a communal water jug at a worksite. All of these WBDOs have been described (Appendix B).

Deficiency 99A: Unknown/ Insufficient Information Concerning Contamination of Water Intended for Drinking Tap Water

The deficiencies involved in two (6.7%) of the 30 WBDOs could not be identified because of insufficient information or unknown cause of contamination. Water samples from both of these noncommunity water systems and tap-water–associated WBDOs tested positive for *E. coli* and total coliforms, but etiologic agents were not identified. One outbreak involved ground water (i.e., well water), and one involved tap water from an unknown water source. However, because the mechanism of contamination was unknown and the point of contamination might not have been under the jurisdiction of a water utility, these two WBDOs are analyzed separately from the SWTD and NWU/POU deficiencies.

Waterborne Disease and Outbreaks Associated with Water Not Intended for Drinking and Water of Unknown Intent

Six WBDOs were associated with either WNID (n = three) or WUI (n = three) (Table 6). More WNID/WUI outbreaks were reported for 2003–2004 (n = six) than during 2001–2002 (n = one). The six WNID/WUI outbreaks caused illness among approximately 36 persons and resulted in four deaths. One (16.7%) WNID/WUI outbreak involved AGI, and five (83.3%) involved ARI. Two (33.3%) of the six WNID/WUI outbreaks were categorized as a strength of evidence Class I ranking; one (16.7%) was ranked as Class III; and three (50.0%) were ranked as Class IV.

Etiologic Agents

Five (83.3%) of the six WNID/WUI outbreaks were attributed to *L. pneumophila* serogroup 1, affected 26 persons, and resulted in four deaths. Fifteen of the cases were associated with LD, and 11 were associated with PF. The other WNID/WUI outbreak was attributed to *E. coli* O157:H7; 10 persons were reported ill.

TABLE 14. Waterborne-disease and outbreaks associated with drinking water (n = 30), by deficiency (n = 33)* — United States, 2003–2004

Deficiency	No.
Contamination of water at/in the water source, treatment facility, or distribution system (SWTD)†	**14**
1: Untreated surface water intended for drinking	1
2: Untreated ground water intended for drinking	3
3: Treatment deficiency	4
4: Distribution system deficiency, including storage	6
Contamination of water at points not under the jurisdiction of a water utility or at the point of use (NWU/POU)§	**16**
5: *Legionella* spp. in water system	
A: Water intended for drinking	8
B: Water not intended for drinking (excluding recreational water)	0
C: Water of unknown intent	0
6: Plumbing system deficiency after the water meter or property line	1
7: Deficiency in building/home-specific water treatment after the water meter or property line	0
8: Deficiency or contamination of equipment/devices using or distributing water	3
9: Contamination during commercial bottling	1
10: Contamination during shipping, hauling, or storage	
A: Water intended for drinking – Tap water	0
B: Water intended for drinking – Commercially bottled water	1
11: Contamination at point of use	
A: Tap	0
B: Hose	0
C: Commercially bottled water	1
D: Container, bottle, or pitcher	1
E: Unknown	0
Unknown/Insufficient Information	**3**
99: Unknown/Insufficient information	
A: Water intended for drinking – Tap water	2
B: Water intended for drinking – Commercially bottled water	1
C: Water not intended for drinking (excluding recreational water)	0
D: Water of unknown intent	0
Total no. of deficiencies*	**33**

* More than one deficiency might have been identified during the investigation of a single waterborne disease or outbreak.
† Contamination of water and deficiencies occurring in the drinking water system at/in the water source, treatment facility, or distribution system of pipes and storage facilities. For a community water system, the distribution system refers to the pipes and storage infrastructure under the jurisdiction of the water utility before the water meter or property line (if the system is not metered). For noncommunity and nonpublic water systems, the distribution system refers to the pipes and storage infrastructure before entry into a building or house.
§ Contamination of drinking water and deficiencies occurring after the water meter or outside the jurisdiction of a water utility (e.g., in a service line leading to a house or building, in the plumbing inside a house or building, during shipping or hauling, during storage other than in the distribution system, at point of use).

Deficiencies 5B, 5C, 12, 99C, and 99D

The six WNID/WUI outbreaks each had one known deficiency: five (83.3%) involved *Legionella* spp. in the water system (deficiencies 5B and 5C), and one (16.7%) involved WNID unrelated to *Legionella* (deficiency 12). Two (40.0%) of the five *Legionella* outbeaks involved WNID (deficiency 5B). In these outbreaks, the aerosolized water from cooling towers was tested and identified as the source of *Legionella* spp. Three *Legionella* outbreaks (60.0%) involved WUI (deficiency 5C). In these outbreaks, environmental water testing failed to determine the source of *Legionella* spp. The one outbreak unrelated to *Legionella* involved *E. coli* O157:H7 infection after exposure to sewage from a broken septic line at a camp. Campers might have been exposed in a wash house in which a septic backup occurred or might have been exposed to surface sewage seepage near the housing area. Campers were observed playing in a wet area near the sewage seepage. No water testing was performed in this outbreak. However, soil from the area of the sewage leakage tested negative for the pathogen.

Previously Unreported Outbreaks

Reports of nine previously unreported drinking water-associated WBDOs that occurred during 1982–2002 were received for this surveillance period (Table 7). An outbreak of diarrheal illness occurred among six attendants of a graduation party (New York, July 2002); two had laboratory-confirmed *E. coli* O157:H7 infections. This pathogen was isolated from a private well that provided drinking water and matched the two laboratory-confirmed cases by pulsed-field gel electrophoresis pattern. The well water supply was reportedly not disinfected.

An outbreak of gastroenteritis occurred among 15 students on a class trip (New York, May 1984). During the trip, 15 (30.6%) of 49 students became ill and experienced nausea and vomiting within 1–2 hours of eating at a restaurant. The ill students had ingested soda from a soda fountain that was described as having a metallic taste. Samples from the soda fountain machine were analyzed for copper, iron, and other metals and were within the normal range. However, testing of urine samples collected 2 days after illness onset demonstrated elevated levels of copper in some students' urine samples. Heavy use of fire hydrants nearby caused pressure problems in the community water main while students were being served at the restaurant. These pressure fluctuations might have stirred up sediment in the distribution system, resulting in excess copper being delivered to the restaurant water supply.

During April 2002, an outbreak of gastroenteritis in 59 persons occurred in Palau. *Entamoeba histolytica* was isolated from nine (30.0%) of 30 stool specimens. All ill persons reported consuming untreated drinking water from the same portable water catchment tank that collected water from a stream. Water sampled from the tank tested positive for total and fecal coliform bacteria.

Three outbreaks of gastroenteritis (New York, May 1982, August 1995, and August 1996) involved unidentified etiologic agents. During the 1982 outbreak, drinking water at a restaurant was linked to illness. Samples of water and ice were negative for pathogens, but the raw well water tested positive for fecal coliform bacteria. In addition, although the well water received ultraviolet light treatment before entering the restaurant plumbing system, fecal and total coliforms were found in water samples after treatment. The 1995 outbreak report implicated water and ice served at a hotel restaurant. An untreated well was the source of drinking water and water used to make ice. Water samples from the kitchen faucet were positive for both total coliforms and *E. coli*. On the basis of the incubation period, symptoms, and duration of illness, norovirus was suspected. Investigators speculated that the well water might have been contaminated or that an ill person might have contaminated the ice after production. During the 1996 outbreak among campers, a viral etiology was suspected based on incubation period, symptoms, and duration of illness. The source of illness was unconfirmed, but a fecally contaminated unchlorinated water supply (i.e., well water) was suspected. Water samples from the untreated well tested positive for *E. coli*. The well had tested positive the previous year for *E. coli* after a gastroenteritis outbreak.

Reports of two *Legionella* outbreaks (Maryland and the U.S. Virgin Islands, November 2002) and one mixed-agent outbreak (New York, December 2002) were also received for this surveillance period. These WBDOs have been described (Appendix B).

Surveillance Reports Not Classified as Waterborne Disease and Outbreaks

Three surveillance reports potentially implicating drinking water were submitted during 2003–2004 but had insufficient epidemiologic or laboratory evidence to warrant inclusion in this report as WBDOs. One surveillance report included only one confirmed case of *Legionella* infection; the second suspected case was not laboratory confirmed. Regarding the second report, the investigation did not reveal a common point source of *Legionella* transmission. However, because of the potential link to drinking water, a brief description of the third report has been provided. In July 2003, multiple persons attending a family reunion developed AGI. *E. coli* O157:H7 was isolated from the stool of four attendees. Lemonade made with untreated water was cited, but other common food and water sources were identified. No epidemiologic studies were conducted.

Discussion

Considerations Regarding Reported Results

WBDOSS provides information concerning epidemiologic and etiologic trends in outbreaks related to drinking water. However, not all outbreaks are recognized, investigated, or reported to CDC, and studies have not been conducted that assess the sensitivity of this system. Furthermore, outbreaks occurring in national parks, tribal lands, or military bases might not be reported to state or local authorities. For these reasons, the true incidence of WBDOs is probably greater than is reflected in surveillance system data. Multiple factors influence whether WBDOs are recognized and investigated by local or state public health agencies, including public awareness of the outbreak, availability of laboratory testing, requirements for reporting diseases, and resources available to local and state health departments for surveillance and investigation of probable outbreaks. In addition, because differences in the capacity of local and state public health agencies and laboratories to detect WBDOs might result in reporting and surveillance bias, the states with the majority of outbreaks reported for this period might not be the states in which the majority of outbreaks actually occurred. An increase or a decrease in the number of WBDOs reported might reflect either an actual change in the incidence of outbreaks or a change in the sensitivity of surveillance practices. As with any passive surveillance system, the accuracy of the data depends substantially on the reporting agencies (i.e., state, local, and territorial health departments). Therefore, independent of the recognition or investigation of a given outbreak, reporting bias also can influence the final data.

The outbreaks most likely to be recognized and investigated are those involving acute illness characterized by short incubation periods, serious illness or symptoms requiring medical treatment, or recognized etiologies for which laboratory methods have become more sensitive or widely available. Increased reporting frequently occurs as etiologies become better recognized, water system deficiencies are identified, and state surveillance activities and laboratory capabilities increase (*31–33*). Consequently, recommendations for improving WBDO investigations include enhancing surveillance activities, increasing laboratory support for clinical specimen and water sample testing, and assessing sources of potential bias (*34–36*).

The identification of WBDO etiologic agents depends on multiple factors. Investigators must recognize the WBDO in a timely manner so that appropriate clinical specimens and environmental samples can be collected. Collection of water samples further depends on local and state statutory requirements and the availability of investigators. Methods for concentrating large volumes of water for testing are being developed and disseminated to multiple sites in the United States as standard protocols (*37*). The laboratories involved must have the capacity to concentrate large volumes of water for testing, in addition to the ability to test for the organism, chemical, or toxin in the clinical specimens and environmental samples. For example, routine testing of stool specimens at laboratories includes tests for the presence of enteric bacterial pathogens and also might include ova and parasite examination. However, testing for viral agents is rarely conducted, although norovirus testing is now being performed more commonly. In addition, clinicians and public health officials must know the correct tests to order. For example, testing for *Cryptosporidium* spp., one of the most commonly reported waterborne pathogens, is frequently not included in standard ova and parasite examinations and therefore must be specifically requested (*38*).

One key limitation of the data collected by the WBDOSS is that the information pertains only to outbreaks of waterborne illness and not to endemic waterborne illness. The epidemiologic trends and water-quality concerns observed in outbreaks might not necessarily reflect or correspond with trends associated with endemic waterborne illness. In response to the Congressional Safe Drinking Water Act Amendments of 1996, in 2005, EPA and CDC completed a series of epidemiologic studies and a national workshop designed to assess the magnitude of endemic waterborne AGI associated with consumption of public drinking water. A joint report on the results of these studies is available at http://www.epa.gov/nheerl/articles/2006/waterborne_disease.html. The report includes multiple documents that discuss various methods for estimating the number of endemic waterborne AGI cases associated with public drinking water systems in the United States. In particular, the authors of two reports used current data and made various assumptions for missing data to derive two different but overlapping estimates of 1) 4.3–11.7 million annual AGI cases (confidence interval unknown) (*39*) and 2) 16.4 million annual AGI cases (range: 5.5–32.8) (*40*). These estimates should be interpreted with an understanding that information concerning endemic waterborne-disease risks is imprecise and uncertain and that substantial data gaps remain. The wide range in the number of estimated cases suggests a high level of uncertainty. Nonetheless, workshop participants agreed that enough data were available for rough estimates and that these estimates should be made at this time, with all assumptions and limitations fully described so the approaches can be evaluated.

These estimates, however, only describe a portion of the annual incidence of endemic waterborne-disease cases. To describe the overall incidence, estimates also would need to include the number of cases of waterborne disease other than AGI and the number of cases associated with nonpublic drinking water systems, commercially bottled water, recreational water, WNID, and WUI. If these other types and sources of waterborne disease were considered, the estimated number of cases of endemic waterborne disease would be higher than the figures previously presented in this report.

WBDOs Associated with Water Intended for Drinking

Etiologic agents

Legionella spp. and chemicals were the most commonly reported etiologic agents in drinking water-associated WBDOs. During 2003–2004, eight reported drinking water-associated WBDOs involved *Legionella* spp. and comprised 26.7% of the total, which is only the second time that data concerning *Legionella* outbreaks have been included in a *Surveillance Summary*.

Chemical/toxin drinking water-associated WBDOs (n = eight) comprised 26.7% of the total, an increase from the previous surveillance period and the largest number of chemical/toxin-related drinking water WBDOs since the 1993–1994 surveillance period. Of the eight chemical/toxin WBDOs, three (37.5%) resulted from deficiencies related to drink mix/soda machines, and two (25.0%) resulted from deficiencies related to recent maintenance work. These outbreaks stress the importance of proper installation and maintenance of water systems and equipment. The increased number of chemical/toxin-related outbreaks also emphasizes the need for increased awareness among the public and public health officials concerning the role that chemicals and toxins play in WBDOs.

During the 2003–2004 surveillance period, five drinking water-associated WBDOs involved only bacteria (other than *Legionella* spp.), an increase in the number of reported non-*Legionella* bacterial drinking water outbreaks compared with the 2001–2002 surveillance period (n = three). The ongoing occurrence of bacterial WBDOs, despite available and efficacious treatment practices, underscores the continuing need for protection and treatment of drinking water (*41*).

In addition, two mixed-agent outbreaks occurred during the 2003–2004 surveillance period, which included bacteria (one bacterial/parasitic outbreak and one bacterial/parasitic/viral outbreak). The occurrence of mixed-agent outbreaks emphasizes the importance of considering more than one etiologic agent in outbreak investigations, collecting appropriate specimens for each agent type, and requesting appropriate diagnostic testing for each agent type. In addition, both outbreaks were associated with sewage contamination of wells, underscoring the importance of proper waste management and proper drinking water system and waste water system designs.

One viral outbreak involving norovirus was reported for the 2003–2004 surveillance period (Pennsylvania, January 2004). Norovirus was also one of the etiologic agents identified in one of the mixed-agent outbreaks (Ohio, July 2004) and was the suspected etiologic agent in one of the outbreaks of unknown etiology (Florida, January 2003), based on incubation period, symptoms, and duration of illness. Sewage contamination was suspected in both outbreaks in which norovirus was identified. Point-of-use contamination of a water dispenser was a contributing factor in the suspected norovirus outbreak. These three outbreaks represent a decrease in viral drinking water-associated WBDOs compared with the previous surveillance period (n = five) and might reflect a true decrease in viral outbreaks, a lack of outbreak investigation and detection, a lack of viral testing, or a combination of factors.

Compared with the previous surveillance period, the number of reported parasitic outbreaks decreased for 2003–2004. Parasites were identified in one single-agent outbreak (*G. intestinalis*) and two mixed-agent outbreaks (*Cryptosporidium* spp. and *G. intestinalis*). All three outbreaks were associated with distribution system deficiencies, but only one also was associated with the use of untreated source water (ground water under the influence of surface water in Ohio, July 2004). No parasitic outbreaks were associated with surface water systems. Both surface water systems and ground water systems under the influence of surface water are regulated under SWTR to protect the public against exposure to *Giardia* and *Cryptosporidium*, among other pathogens.

The etiologic agent was unidentified in five (16.7%) of the 30 drinking water-associated WBDOs reported during 2003–2004 (Figure 6). This finding is the lowest number and percentage of outbreaks caused by an unknown etiology in any surveillance period since the beginning of the surveillance system in 1971. Five drinking water-associated outbreaks of unknown etiology occurred during 1997–1998, but this number represented 29.4% of the reported non-*Legionella* outbreaks. This decrease probably reflects the improved diagnostic capability of laboratories and better outbreak investigations, resulting in more rapid and more appropriate specimen collection.

Deficiencies 1–4: Contamination of Water at/in the Water Source, Treatment Facility, or Distribution System

In general, EPA regulates the public drinking water supplies from the source water up to the water meter (or before the property line if the distribution system is not metered). This segment of the drinking water supply system is associated with deficiencies 1–4: 1) consumption of untreated surface water intended for drinking, 2) consumption of ground water intended for drinking, 3) treatment deficiencies, and 4) distribution system deficiencies before the water meter or property line. During the 2003–2004 surveillance period, 36.7% of drinking-water related outbreaks (n = 11) and 42.4% of deficiencies (n = 14) involved deficiencies 1–4. A single WBDO can be associated with more than one deficiency.

Source water. Discussions regarding source water type only include those WBDOs with deficiencies 1–3 because distribution system deficiencies (deficiency 4) are not dependent upon the source water type. Also excluded from discussion involving source water types are drinking water-associated WBDOs with unknown or insufficient information (deficiencies 99A) and outbreaks associated with contamination at points not under the jurisdiction of a water utility or at the point of use (deficiencies 5A, 6–11, and 99B).

Surface water. One (12.5%) of the eight outbreaks with deficiencies 1–3 was associated with consumption of untreated surface water (deficiency 1) from a spring-fed pond supplying an individual water system (Ohio, November 2003). This emphasizes the importance of public awareness that surface water, despite its clarity, is prone to contamination by pathogens and should not be directly consumed without first being treated. If water treatment is not available as part of the water system, treatment can be provided at the point of use (e.g., filtration, disinfection by chemicals, or boiling). Manufacturers of point-of-use treatment devices and the National Sanitation Foundation (http://www.nsf.org) provide information regarding different devices, including instructions for their use and their ability to make water safe for human consumption.

The WBDO in Ohio in 2003 is the first outbreak associated with consumption of untreated surface water intended for drinking (deficiency 1) since 1999 (*3*). Since the early 1990s, a decrease has occurred in the percentage of reported WBDOs associated with either untreated or inadequately treated surface water. This decrease is likely attributed to increasingly stringent EPA regulations for treatment of surface water. However, outbreaks might still occur, particularly in water systems that are not subject to EPA regulations.

Ground water. Seven (87.5%) of the eight outbreaks with deficiencies 1–3 were associated with consumption of contaminated ground water from wells. This is the smallest number and percentage of ground water-associated WBDOs with deficiencies 1–3 in the previous four surveillance periods (1997–1998 through 2003–2004). Among these seven outbreaks, three (42.9%) involved consumption of untreated ground water (deficiency 2), and four (57.1%) involved treatment deficiencies associated with contaminated ground water (deficiency 3). The highest proportion of these outbreaks (n = three [42.9%]) were associated with noncommunity water systems, but other water system types also were implicated: community (n = 2), individual (n = one), and mixed noncommunity and individual (n = one).

The mixed-system outbreak involving noncommunity and individual water systems was the largest outbreak during this surveillance period (Ohio, July 2004). The outbreak occurred on an island in Lake Erie frequented by vacationers. It also was associated with the use of untreated contaminated ground water (deficiency 2) by noncommunity and individual drinking water systems and cross-connections to the community water distribution system (deficiency 4). The environmental investigation identified sewage-contaminated ground water wells used for drinking water as the likely source of exposure to the etiologic agents. Sewage reached the drinking water aquifer because the karst limestone geology of the island forms an aquifer that is vulnerable to contamination. Cracks and fractures in the limestone allow contaminants from upper soil layers to flow through to ground water sources. The severe soil limitations and the karst geology of the island connect sewage system effluent, lake water, and precipitation runoff to the aquifer. In addition to soils and geology, other possible contributing factors include cross-connections in the water distribution system; an increase in precipitation before the outbreak; the volume of wastewater flowing to sewage treatment systems during periods of heavy island visitation; the number, type and maintenance of sewage disposal systems; and groundwater well construction.

The seven ground water-associated outbreaks indicate that contaminated ground water that leads to illness is a continuing problem, and efforts should be intensified to identify and remove possible sources of contamination and provide adequate, continuous treatment for those systems that need treatment. Wells and springs must be protected from contamination, even if disinfection is provided, because ground water can become contaminated with pathogens that might overwhelm the disinfection process. EPA requires appropriate treatment, including filtration and disinfection, for public water systems that use ground water under the direct influence of surface water (e.g., those involved in the Ohio outbreak). EPA's GWR establishes multiple barriers for protection against pathogen contamination of drinking water derived from ground water sources. GWR will also establish a targeted strategy to identify ground water systems at high risk for fecal contamination. The multiple barrier approach should begin with protection of the wellhead, an assessment of potential sources of contamination, and periodic sanitary surveys to ensure that wells remain protected. Periodic monitoring of source water is necessary to identify water-quality deterioration, which if discovered, might require mandatory testing. In addition, continuous water treatment is needed for wells that are identified as being vulnerable.

Only public water systems will be directly covered by GWR; therefore, protections offered by GWR will not extend to individual ground water systems unless they are regulated by state or local authorities. The quality of water in wells and springs used by individuals and nonpublic systems remains a public health concern; approximately 17 million persons in the United States rely on private household wells for drinking water each year, and >90,000 new wells are drilled annually throughout the United States (*42*). In addition, contamination of a household well is not only a health concern for the family served by the well but is also a concern for households and other water systems that draw from the same aquifer. To safeguard the quality of well water, homeowners should seek information on needed protective measures and implement recommended operation and maintenance guidelines for private well usage. Homeowners may also choose to protect their own health by purchasing appropriately designed point-of-use devices and by following instructions for operating and maintaining these treatment devices. Although EPA does not regulate individual water systems, EPA recommendations for protecting private wells are available at http://www.epa.gov/safewater/pwells1.html. Additional efforts should be taken by public health officials to educate well owners, users, drillers, and local and state drinking water personnel to encourage practices that best ensure safe drinking water for private well-users.

Water treatment. During 2003–2004, four drinking water-related WBDOs associated with water treatment deficiencies were reported. Two outbreaks resulted in burns after the discharge of sodium hydroxide into the distribution system during well maintenance. The other two outbreaks involved temporary interruptions of disinfection (one resulting from a broken chlorine pump [Pennsylvania, June 2004] and one resulting from a faulty ultraviolet light water-treatment apparatus [Montana, August 2004]). All four outbreaks indicate the need for proper equipment handling, maintenance, and postmaintenance safety checks.

Distribution system. Distribution system deficiencies make up the largest proportion of the SWTD deficiencies occurring before the water meter or property line during this surveillance period. During 2003–2004, six drinking water-related WBDOs involving distribution system deficiencies occurred. Four (66.7%) of the six WBDOs involved cross-connections to nonpotable water sources. As the use of nonpotable water increases in the United States (e.g., for landscape and agricultural irrigation, toilet flushing, industrial processing, and power plant cooling), the risk for cross-connections between potable and nonpotable water supplies will also probably increase (*43*). These four outbreaks demonstrate the importance of identifying and clearly labeling potable and nonpotable water lines to prevent cross-connections, which can result in illness.

Water systems. Discussions regarding water system types (i.e., community, noncommunity, and individual) include drinking water-associated WBDOs with deficiencies 1–4. Deficiencies in the distribution system are included in these discussions because distribution system problems might be dependent on the type of water system involved. Among the 11 drinking water-associated WBDOs with a deficiency of 1–4, four (36.4%) were associated with community water systems, four (36.4%) with noncommunity water systems, two (18.2%) with individual water systems, and one (9.1%) with both noncommunity and individual water systems (Ohio, July 2004). The proportion (27.3%) of drinking water-related WBDOs associated with unregulated individual water systems (including the Ohio, July 2004 WBDO) is the lowest proportion of outbreaks within the last three surveillance periods (i.e., 1999–2000, 2001–2002, and 2003–2004). This decrease in the proportion of WBDOs associated with individual drinking water systems might reflect a detection bias (given the limited number of persons who are usually affected by these WBDOs), limited resources available to investigate these outbreaks, and the limited number of regulations that govern these systems.

Deficiencies 5A, 6-11, and 99B: Contamination of Water at Points Not Under the Jurisdiction of a Water Utility or at the Point of Use

By creating additional deficiency classifications, a clear distinction can be made between deficiencies that occur at points NWU/POU and SWTD. During the 2003–2004 surveillance period, more WBDOs were associated with NWU/POU (17 [51.5%]) than with SWTD (14 [42.4%]) (Figure 7).

Deficiency 5A: *Legionella* in Water Intended for Drinking. Legionellosis includes two clinically distinct syndromes: LD, a form of pneumonia, and PF, an influenza-like illness without pneumonia. When outbreaks of legionellosis occur in the setting of contaminated drinking water, they typically manifest as cases of LD rather than PF. Regardless of the syndrome, all legionellosis outbreaks share the common features of warm stagnant water, usually documented inadequate biocide concentrations, and aerosolization, which provides the mechanism for inhalation into the lungs. The outbreaks of legionellosis described in this report highlights multiple challenges related to the detection and prevention of legionellosis.

LD, the more severe form of legionellosis, is underdiagnosed because multiple patients with community-acquired pneumonia can be treated empirically with broad-spectrum antibiotics (*44*). However, because *Legionella* spp. are not transmitted from person-to-person and are always acquired from an environmental source, even a single case of LD implies the presence of a contaminated aquatic source to which others can be exposed. Because host factors, (e.g., underlying lung disease and immunodeficiencies) are essential for the development of disease, the attack rate during documented LD outbreaks is <5%. Identification of two or more cases of LD in association with a potential source is adequate justification for an investigation. All of the outbreaks described in this report involved seven or fewer cases. Nonetheless, in all instances except for one, the epidemiologic and laboratory data were compelling enough to implicate point sources that were subsequently remediated.

Three outbreaks occurred among persons in residential settings (i.e., a condominium complex [Maryland, December 2004], an apartment building [New Jersey, June 2004], and a senior housing center [New Jersey, July 2004]). Approximately 70% of sporadic cases of residentially acquired LD occur among persons living in single family homes (*45*). However, because persons living in multiple-unit settings can be epidemiologically linked to each other, outbreaks that occur in these settings have a higher potential to be recognized by public health authorities. The plumbing systems that serve such buildings tend to be colonized with *Legionella* spp. in multiple locations, which could increase the risk of LD to other residents of such buildings (*46*). Guidelines for reducing the risk for legionellosis associated with building water systems are available (*47*). Providing these guidelines to managers of large residential buildings in addition to other settings more commonly associated with outbreaks of legionellosis might be a useful practice for local and state public health authorities.

Three outbreaks demonstrate the propensity for *Legionella* spp. to colonize potable water systems and cause disease over prolonged periods. *Legionella* spp. colonize the biofilm layer frequently found inside large, complex plumbing systems (*48*). This biofilm protects *Legionella* from biocides and allows the bacteria to amplify to levels sufficient to be transmitted. One outbreak (Maryland, November 2002) previously unreported in any *Surveillance Summaries* was associated with a health club and resulted in apparent disease transmission during an 8-week period; all ill persons were men aged ≥65 years. In 2004, the potable water system of a long-term–care facility, which also had experienced an outbreak in 2002, was the source of three additional cases, including one fatality, despite aggressive remediation after the 2002 outbreak (Pennsylvania, April 2004). Finally, LD detected among three guests of a hotel led to an epidemiologic and environmental investigation that identified the potable water system as the likely source (U.S. Virgin Islands, November 2002). The comparison of strains of *Legionella* spp. isolated during this outbreak with strains recovered from an outbreak at the same hotel that occurred during 1981–1982 revealed remarkable similarity, suggesting that the same strain had colonized the system continuously (*49*). In summary, *Legionella* is a hardy organism that resists remediation efforts and therefore can colonize the same potable water system for years or decades. This hotel-associated outbreak also highlights the importance of timely reporting of individual cases of travel-associated legionellosis, as was recently recommended in a 2005 CSTE position statement (http://www.cste.org/PS/2005pdf/final2005/05-ID-01final.pdf).

Legionella outbreaks represented >25% of all drinking water-associated WBDOs reported during 2003–2004 and 47.1% of all NWU/POU deficiencies, indicating that *Legionella* as a public health threat requires further attention. Concerted action is necessary to maintain systems according to published guidelines and to detect and respond to clusters of cases of legionellosis when they occur (*47*).

Deficiencies 6–11. Deficiencies involving water intended for drinking that occur at points after the water meter or the property line include 1) problems with the plumbing; 2) problems with water treatment after the water meter or property line; 3) problems with equipment/devices that use or distribute water (e.g., beverages contaminated by plumbing failures in drink mix/soda machines); 4) contamination of ice or beverages as a result of the use of contaminated water; 5) contamination during commercial bottling; 6) contamination during shipping, hauling, or storage; and 7) contamination at the point of use. The latter three deficiencies frequently involve commercially bottled water. Commercially bottled water is assumed to be a safe source of drinking water; however, the WBDOs associated with commercially bottled water reported during 2003–2004 are examples of the different situations in which contamination can occur. In one WBDO (Florida, November 2003), contamination by disinfection by-products occurred at the plant during production and bottling, indicating that the process of disinfection of bottled water must be closely monitored. In another WBDO (Maine, December 2003), a cleaning product spilled near the bottled water and leached through the plastic bottle to contaminate the water, demonstrating that plastic bottles are permeable to chemicals and therefore commercially bottled water is vulnerable to chemical contamination after production but before the seal is broken. Proper shipping, hauling, and storage of commercially bottled water can prevent this route of contamination. Commercial vendors and the general public need to be aware that commercially bottled water should be stored off the floor and away from any chemical products. In a third WBDO (Florida, January 2003), a large container of commercially bottled water from which multiple persons were served was contaminated at the point of use after the bottle had been opened, underscoring the vulnerability of shared bottles or containers and the importance of practicing good hygiene. A similar outbreak involving a shared container (Michigan, September 2003) further illustrates this problem; however, this WBDO was not associated with commercially bottled water.

Three WBDOs were associated with illness attributed to ingestion of copper from drink mix/soda machines. In two of these outbreaks (Minnesota, June 2003; South Carolina, July 2004), problems occurred with backflow of highly acidic, carbonated water from the carbonators back into the building piping and resulted in copper leaching from the pipes. The cause of the malfunction in the third WBDO (Minnesota, November 2003) was less clear and appeared to be a problem with the internal plumbing of a juice machine. Proper installation and maintenance of drink mix/soda machines, with particular attention given to check valves, are critical.

One WBDO (Pennsylvania, January 2004) involved a drinking water pipe being inappropriately cross-connected with a nonpotable water source within a building. This WBDO illustrates that cross-connections can be problematic, not only within the distribution system, as illustrated by four outbreaks discussed regarding deficiency 4, but also within building/home plumbing. Potable and nonpotable water lines should be clearly labeled, and plumbing systems should be assessed to prevent and ensure that opportunities for cross-connections do not exist. Approved devices can prevent both the backflow of nonpotable water into the potable water system from backpressure and backsiphonage, but the devices must be maintained and periodically tested (*50*). The risk for contamination can be reduced by water utilities 1) being cognizant of the potential for the intrusion of contaminants into the water distribution system during transient low or negative water pressure, 2) maintaining an effective disinfectant residual throughout the distribution system, and 3) detecting and repairing pipeline leaks (*51*).

Waterborne Disease and Outbreaks Associated with Water Not Intended for Drinking

During the 2003–2004 surveillance period, three WBDOs occurred that were associated with WNID. Two of these outbreaks were associated with *Legionella* spp. and involved water in cooling towers. The remaining WBDO was associated with *E. coli* O157:H7 and involved a broken septic line at a camp, which resulted in sewage seepage near the housing area and a septic back-up in a wash house. Whereas WNID outbreaks are less commonly reported than drinking water-related WBDOs, these three outbreaks illustrate that, whether through inhalation or contact, WNID is still associated with disease and requires attention. Broken septic lines, sewage seepage, and improper sewage disposal are public health threats because direct contact with sewage and contamination of drinking water can occur from either ground water or surface water sources. Sewage disposal systems must be properly sited and maintained. If drinking water contamination is suspected, public health officials should 1) institute appropriate measures to prevent consumption of contaminated water (e.g., issuances of boil-water advisories and recommendations to use commercially bottled water), 2) evaluate the sewage disposal system, and 3) address any deficiencies that are identified.

Additional Reporting of Historical Outbreaks

This report discusses information concerning nine previously unreported drinking water outbreaks. Six of these outbreaks occurred during 1980–2002 in New York State. Inclusion of the information regarding New York was facilitated by a CDC-funded pilot project to improve waterborne-disease surveillance and waterborne outbreak investigations in New York. In 2005, CDC initiated the project in partnership with the New York State Department of Health (NYSDOH) as part of CDC's Environmental Health Specialist Network (EHS-Net). One element of the project was the hiring of a new full-time employee within the NYSDOH to coordinate the EHS-Net water pilot project. Initial efforts of the pilot project were focused on characterizing the reporting system for waterborne disease in New York State, including reviewing different databases that might contain information concerning waterborne-disease outbreaks. Databases maintained by multiple organizations within NYSDOH and data housed in certain local health departments were reviewed, which resulted in the verification of nine outbreaks associated with water intended for drinking during 1980–2002. Three of these outbreaks had been previously reported to CDC. One outbreak that occurred in 2002 was reported to CDC along with the 2003–2004 outbreaks. The five remaining outbreaks had not been reported to CDC.

The EHS-Net water pilot project activities indicate that increased effort and resources, specifically directed at waterborne disease reporting, could result in the identification of previously unreported historical outbreaks. As the EHS-Net water pilot project refines the process for identifying and investigating current waterborne-disease incidents, these efforts might result in enhanced reporting of waterborne outbreaks from New York. In addition, the experience of NYSDOH could provide a template for improving waterborne-disease reporting in other locations.

Conclusion

Data collected as part of the national WBDOSS are used to describe the epidemiology of waterborne disease in the United States. Trends regarding water systems and deficiencies implicated in these WBDOs are used to assess whether regulations for water treatment and water-quality monitoring are adequate to protect the public's health. Identification of the etiologic agents responsible for these outbreaks also is critical because new trends might necessitate different interventions and changes in policies and resource allocations.

Surveillance for waterborne agents and WBDOs occurs primarily at the local and state levels (including territories and FAS). Public health authorities at these levels should be able to detect and recognize drinking water-associated WBDOs and implement appropriate prevention and control measures. Improved communication among local and state public health departments, regulatory agencies, and water utilities would aid the detection and control of WBDOs. Routine reporting or sharing of water-quality data within the health department is recommended. Other means of improving surveillance at the local, state, and federal levels might include the additional review and follow-up of information gathered through other mechanisms (e.g., issuances of boil-water advisories or reports of illness associated with agents thought to be waterborne). CSTE passed a position statement at the 2006 annual meeting making waterborne-disease outbreaks, as a unit of reporting, nationally notifiable and reportable to CDC starting in 2007. Adoption of this CSTE recommendation at the state level through state-specific legislative action might improve reporting of waterborne outbreaks at the state and local levels. CSTE also asked CDC and EPA to 1) develop training for WBDO investigations for local and state/territorial public and environmental health workers responsible for WBDO detection, investigation, and reporting; and 2) work with CSTE and EPA to develop national WBDO investigation and surveillance guidelines. The position statement is available at http://www.cste.org/PS/2006pdfs/PSFINAL2006/06-ID-12FINAL.pdf (Box).

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References

1. Craun GF, ed. Waterborne diseases in the United States. Boca Raton, FL: CRC Press, Inc.; 1986.
2. CDC. Water-related disease outbreaks annual summary 1978. Atlanta, GA: US Department of Health and Human Services, Public Health Services, CDC; May 1980.
3. Lee SH, Levy DA, Craun GF, Beach MJ, Calderon RL. Surveillance for waterborne-disease outbreaks—United States, 1999–2000. In: Surveillance Summaries, November 22, 2002. MMWR 2002;51 (No. SS-8):1–47.
4. Dziuban EJ, Liang JL, Craun GF, et al. Surveillance for waterborne disease and outbreaks associated with recreational water—United States, 2003–2004. In: Surveillance Summaries, December 22, 2006. MMWR 2006;55:1–30.
5. Environmental Protection Agency. Water programs: national interim primary drinking water regulations. 40 CFR Part 141. Federal Register 1975;40:59566–74.
6. Pontius FW, Roberson JA. The current regulatory agenda: an update. Major changes to USEPA's current regulatory agenda are anticipated when the SDWA is reauthorized. Journal of the American Water Works Association 1994;86:54–63.
7. Pontius FW. Implementing the 1996 SDWA amendments. Journal of the American Water Works Association 1997;89:18–36.
8. Environmental Protection Agency. National primary drinking water regulations; arsenic and clarifications to compliance and new source contaminants monitoring. 40 CFR Parts 9, 141, and 142. Federal Register 2001;66:6976–7066.
9. Environmental Protection Agency. National primary drinking water regulations for lead and copper; final rule. 40 CFR Parts 9, 141, and 142. Federal Register 2000;65:1949–2015.
10. Environmental Protection Agency. Drinking water; national primary drinking water regulations; total coliforms (including fecal coliforms and *E. coli*); final rule. 40 CFR Parts 141 and 142. Federal Register 1989;54:27544–68.

BOX. Organizations that provide assistance in investigations of waterborne disease and outbreaks (WBDOs)

State and territorial health departments may request epidemiologic assistance and laboratory testing from CDC to investigate WBDOs. CDC and the U.S. Environmental Protection Agency (EPA) may be consulted regarding engineering and environmental aspects of drinking-water treatment during and after outbreaks and collection of large-volume water samples to identify pathogens that require special protocols for their recovery. EPA and the U.S. Geological Survey may be consulted for assistance with hydrogeologic investigations of outbreaks where untreated ground water is suspected.

Environmental Protection Agency Safe Drinking Water Hotline
Telephone: 800-426-4791
E-mail: hotline-sdwa@epa.gov
Internet: http://www.epa.gov/safewater

Testing for Bacterial Enteric Organisms
Telephone: 404-639-1798
Division of Foodborne, Bacterial and Mycotic Diseases
National Center for Zoonotic, Vector-borne, and Enteric Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC

Information or Testing for *Legionella*
Telephone: 404-639-2215
Internet: http://www.cdc.gov/legionella
Division of Bacterial Diseases
National Center for Immunization and Respiratory Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC

Testing for Parasites
Telephone: 770-488-7775
Division of Parasitic Diseases
National Center for Zoonotic, Vector-borne, and Enteric Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC

Testing for Viral Organisms
Telephone: 404-639-3607
Division of Viral Diseases
National Center for Immunization and Respiratory Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC

State Reporting of Waterborne Disease and Outbreaks
All WBDOs at the local level should be reported to the state health department.
Telephone: 770-488-7775
Fax: 770-488-7761
Division of Parasitic Diseases
National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed)
Coordinating Center for Infectious Diseases, CDC

CDC Reporting Form CDC 52.12 (rev.01/2003)
Internet: http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf

11. Environmental Protection Agency. Drinking water; national primary drinking water regulations; total coliforms; corrections and technical amendments; final rule. 40 CFR Parts 141 and 142. Federal Register 1990;55:25064–5.
12. Environmental Protection Agency. Drinking water; national primary drinking water regulations; filtration, disinfection; turbidity, *Giardia lamblia*, viruses, *Legionella*, and heterotrophic bacteria; final rule. 40 CFR Parts 141 and 142. Federal Register 1989;54:27486–541.
13. Environmental Protection Agency. National primary drinking water regulations: interim enhanced surface water treatment; final rule. 40 CFR Parts 9, 141, and 142. Federal Register 1998;63:69478–521.
14. Environmental Protection Agency. National primary drinking water regulations: long term 1 enhanced surface water treatment rule; final rule. 40 CFR Parts 9, 141, and 142. Federal Register 2002;67:1812–44.
15. Environmental Protection Agency. National primary drinking water regulations: filter backwash recycling rule; final rule. 40 CFR Parts 9, 141, and 142. Federal Register 2001;66:31086–105.
16. Environmental Protection Agency. National primary drinking water regulations: monitoring requirements for public drinking water supplies: *Cryptosporidium, Giardia*, viruses, disinfection byproducts, water treatment plant data and other information requirements; final rule. 40 CFR Part 141. Federal Register 1996;61:24353–88.
17. Environmental Protection Agency. National primary drinking water regulations: stage 2 disinfectants and disinfection byproducts rule. 40 CFR Parts 9, 141, and 142. Federal Register 2006;71:387–493.
18. Environmental Protection Agency. National primary drinking water regulations: long term 2 enhanced surface water treatment rule. 40 CFR Parts 9, 141 and 142. Federal Register 2006;71:653–702.
19. Environmental Protection Agency. National primary drinking water regulations: ground water rule; proposed rules. 40 CFR Parts 141 and 141. Federal Register 2000;65:30194–274.
20. Environmental Protection Agency. Announcement of the drinking water contaminant candidate list; notice. Federal Register 1998;63:10274–87.

21. Environmental Protection Agency. Drinking water contaminant candidate list 2; final notice. Federal Register 2005;70:9071–7.
22. Environmental Protection Agency. Unregulated contaminant monitoring regulation for public water systems; analytical method for list 2 contaminants; clarifications to the unregulated contaminant monitoring regulation. 40 CFR Part 141. Federal Register 2001;66:2273–308.
23. Environmental Protection Agency. Unregulated contaminant monitoring regulation for public water systems; amendment to the list 2 rule and partial delay of reporting of monitoring results. 40 CFR Part 141. Federal Register 2001;66:46221–4.
24. Environmental Protection Agency. Unregulated contaminant monitoring regulation for public water systems; establishment of reporting date. 40 CFR Part 141. Federal Register 2002;67:11043–6.
25. Environmental Protection Agency. Unregulated contaminant monitoring regulation: approval of analytical method for *Aeromonas*; national primary and secondary drinking water regulations: approval of analytical methods for chemical and microbiological contaminants. 40 CFR Part 141. Federal Register 2002;67:65888–902.
26. Environmental Protection Agency. Public drinking water systems: facts and figures. February 28, 2006. Available at http://www.epa.gov/safewater/pws/factoids.html.
27. Environmental Protection Agency. Private drinking water wells. February 21, 2006. Available at http://www.epa.gov/safewater/privatewells/index2.html.
28. Blackburn B, Craun GF, Yoder JS, et al. Surveillance for waterborne-disease outbreaks associated with drinking water—United States, 2001–2002. In: Surveillance Summaries, October 22, 2004. MMWR 2004;53(No. SS-8):23–45.
29. Yoder JS, Blackburn BG, Craun GF, et al. Surveillance for waterborne-disease outbreaks associated with recreational water—United States, 2001–2002. In: Surveillance Summaries, October 22, 2004. MMWR 2004;53(No. SS-8):1–21.
30. Benin AL, Benson RF, Besser RE. Trends in Legionnaires' disease, 1980–1998: declining mortality and new patterns of diagnosis. Clin Infect Dis 2002;35:1039–46.
31. Frost FJ, Calderon RL, Craun GF. Waterborne disease surveillance: findings of a survey of state and territorial epidemiology programs. J Environmental Health 1995;58:6–11.
32. Frost FJ, Craun GF, Calderon RL. Waterborne disease surveillance. Journal of the American Water Works Association 1996;88:66–75.
33. Hopkins RS, Shillam P, Gaspard B, Eisnach L, Karlin RJ. Waterborne disease in Colorado: three years' surveillance and 18 outbreaks. Am J Public Health 1985;75:254–7.
34. Craun GF, Frost FJ, Calderon RL, et al. Improving waterborne disease outbreak investigations. Int J Environ Health Res 2001;11:229–43.
35. Frost FJ, Calderon RL, Craun GF. Improving waterborne disease surveillance. In: Pontius FW, ed. Drinking water regulation and health. New York, NY: John Wiley & Sons; 2003:25–44.
36. Hunter PR, Waite M, Ronchi E, eds. Drinking water and infectious disease: establishing the links. Boca Raton, FL: CRC Press; 2003:221.
37. Hill VR, Polaczyk AL, Hahn D, et al. Development of a rapid method for simultaneous recovery of diverse microbes in drinking water by ultrafiltration with sodium polyphosphate and surfactants. Applied and Environmental Microbiology 2005;71:6878–84.
38. Jones JL, Lopez A, Wahlquist SP, Nadle J, Wilson M. Survey of clinical laboratory practices for parasitic diseases. Clin Infect Dis 2004;38(Suppl 3):S198–S202.
39. Colford JM, Roy SL, Beach MJ, Hightower A, Shaw SE, Wade TJ. A review of household drinking water intervention trials and an approach to the estimation of endemic waterborne gastroenteritis in the United States. Journal of Water and Health 2006;4(Suppl 2):71–88.
40. Messner M, Shaw S, Regli S, Rotert K, Blank V, Soller J. An approach for developing a national estimate of waterborne disease due to drinking water and a national estimate model application. Journal of Water and Health 2006;4(Suppl 2):201–40.
41. Environmental Protection Agency, Office of Water. The history of drinking water treatment. Available at http://www.epa.gov/safewater/consumer/pdf/hist.pdf.
42. US General Accounting Office. Drinking water: information on the quality of water found at community water systems and private wells. Washington, DC: US General Accounting Office; 1997. GAO publication no. GAO/RCED-97-123.
43. Environmental Protection Agency. Guidelines for water reuse. Washington, DC: Environmental Protection Agency; 2004. Publication no. EPA/625/R-04/108. Available at http://www.epa.gov/ORD/NRMRL/pubs/625r04108/625r04108.pdf.
44. Bartlett JG. Decline in microbial studies for patients with pulmonary infections. Clin Infect Dis 2004;39:170–2.
45. Straus WL, Plouffe JF, File TM Jr, et al. Risk factors for domestic acquisition of Legionnaires disease. Arch Intern Med 1996;156:1685–92.
46. Flannery B, Gelling LB, Vugia DJ, et al. Reducing *Legionella* colonization of water systems with monochloramine. Emerg Infect Dis 2006; 12:588–96.
47. ASHRAE Standard Project Committee. Minimizing the risk of legionellosis associated with building water systems. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2000.
48. Fields BS, Benson RF, Besser RE. *Legionella* and Legionnaires' disease: 25 years of investigation. Clinical Microbiology Reviews 2002;15:506–26.
49. Cowgill KD, Lucas CE, Benson RF, et al. Recurrence of Legionnaires disease at a hotel in the United States Virgin Islands over a 20-year period. Clin Infect Dis 2005;40:1205–7.
50. Levy DA, Bens MS, Craun GF, Calderon RL, Herwaldt BL. Surveillance for waterborne-disease outbreaks—United States, 1995–1996. In: Surveillance Summaries, December 11, 1998. MMWR 1998; 47(No. SS-5):1–34.
51. LeChevallier MW, Gullick RW, Karim MR, Friedman M, Funk JE. The potential for health risks from intrusion of contaminants into the distribution system from pressure transients. Journal of Water and Health 2003;1:3–14.

Appendix A
Glossary of Definitions

action level	A specified concentration of a contaminant in water. If this concentration is reached or exceeded, certain actions (e.g., further treatment and monitoring) must be taken to comply with a drinking water regulation.
agent	See etiologic agent.
aquifer	A geologic formation or part of a formation (e.g., gravel, sand, or porous stone) that yields water to wells or springs.
backflow	A hydraulic condition caused by a difference in water pressure that causes nonpotable water or other liquid to enter the potable water system by either backpressure or backsiphonage. See cross-connection.
backpressure	Backflow occurs when pressure from a customer's water system (e.g., potentially nonpotable water) is higher than pressure in the public water system.
backsiphonage	Backflow caused by negative or subatmospheric pressure within a water system.
biofilm	Microbial cells that adhere to a surface through a matrix of primarily polysaccharide materials in which they are encapsulated. These can grow on piping and surfaces of water systems and can be difficult to remove. They offer protection to microbes from disinfectants (e.g., chlorine) in the water.
boil-water advisory	A statement to the public advising that tap water must be boiled before drinking.
bottled water	Commercially produced bottled water.
class	Waterborne disease and outbreaks are classified according to the strength of the epidemiologic and water-quality data implicating water as the source of the disease or outbreak (see Table 3).
coliforms	All aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria that ferment lactose with gas formation within 48 hours at 95°F (35°C). Coliforms are mostly harmless bacteria that live in soil and water as well as the gut of humans and animals.
community water system	A public water system that has at least 15 service connections used by year-round residents or regularly serves at least 25-year-round residents. The system might be owned by a private or public entity providing water to a community, subdivision, or mobile home park.
cross-connection	Any actual or potential connection between a drinking water supply and a possible source of contamination or pollution (i.e., nonpotable water). Under this condition, contaminated water might flow back into the drinking water system. See backflow.
deficiency	An antecedent event or situation contributing to the occurrence of a waterborne disease or outbreak.
dermatitis	Inflammation of the skin. In this report, the term dermatitis is used to denote a broad category of skin-related symptoms (e.g., folliculitis, cellulitis, chemical burns, or rash).

disinfection by-products	Chemicals formed in water by the reaction between organic matter and other waste products and disinfectants.
disinfection	A treatment that kills microorganisms (e.g., bacteria, viruses, and protozoa); in water treatment, a chemical (commonly chlorine, chloramine, or ozone) or physical process (e.g., ultraviolet light) may be used.
distribution system	Water pipes, storage reservoirs, tanks, and other means used to deliver drinking water to consumers or to store finished water before delivery to a customer. In community water systems, the distribution system is under the jurisdiction of a water utility and ends at the water meter or at the customer's property line (if the system is not metered). In noncommunity and nonpublic individual water systems, the distribution system ends at the point where water enters the building or house. See plumbing.
etiologic agent	The pathogen, chemical, or toxin causing a waterborne disease or outbreak. Infectious etiologic agents are bacteria, parasites, viruses, or fungi.
fecal coliforms	Coliform bacteria that grow and ferment lactose to produce gas at 112.1°F (44.5°C) in $\leq$24 hours. These bacteria are associated with human and animal wastes, and their presence in water is a strong indication of recent sewage or animal waste contamination.
filtration	In water treatment, the process of passing water through one or more permeable membranes or media of small diameter (e.g., sand, anthracite, and diatomaceous earth) to remove suspended particles from the water. Filters might be effective in removing pathogens, depending on the type and operation.
finished water	The water (e.g., drinking water) delivered to the distribution system after treatment, if any.
free chlorine	The chlorine in water that is not combined with other constituents, therefore, serving as an effective disinfectant (also referred to as free available chlorine and residual chlorine).
ground water	Water that is contained in interconnected pores in an aquifer.
ground water system	A system that uses water extracted from an aquifer (i.e., a well or spring) as its source.
ground water under the direct influence of surface water	As defined by the U.S. Environmental Protection Agency (EPA), any water beneath the surface of the ground with substantial occurrence of insects or other macrooganisms, algae, or large-diameter pathogens (e.g., *Giardia intestinalis* or *Cryptosporidium*), or substantial and relatively rapid shifts in water characteristics (e.g., turbidity, temperature, conductivity, or pH) that closely correlate with climatologic or surface water conditions. Direct influence must be determined for individual sources in accordance with criteria established by the state.
individual water system	A water system that does not meet the EPA definition for a public water system. The system might serve a single family or farm not having access to a public water system, or it might regularly serve as many as 24 persons or 14 connections. States are responsible for regulating these water systems.
karst aquifer	An aquifer characterized by water-soluble limestone and similar rocks in which fractures or cracks have been widened by the dissolution of the carbonate rocks by ground water; the aquifer might contain sinkholes, tunnels, or even caves.

maximum contaminant level	The maximum permissible concentration (i.e., level) of a contaminant in water supplied to any user of a public water system.
mixed-agent outbreak	More than one type of etiologic agent is identified in clinical specimens from affected persons, and each etiologic agent is found in ≥5% of positive clinical specimens (e.g., an outbreak with *Giardia* spp. [parasites] and *Salmonella* spp. [bacteria] with each agent identified in ≥5% of stool specimens).
mixed-illness outbreak	More than one type of illness is reported by ≥50% of patients in a single outbreak (e.g., a combination of gastroenteritis and dermatitis).
mixed-source outbreak	More than one type of source water is implicated in the outbreak (e.g., a combination of ground water and surface water).
mixed-system outbreak	More than one type of water system is implicated in the outbreak (e.g., a combination of noncommunity and individual water systems).
noncommunity water system	A public water system that is not a community system; it does not serve year-round residents. There are two types: transient and nontransient noncommunity systems.
nontransient noncommunity water system	A public water system that is not a community system and that regularly serves at least 25 of the same persons for more than 6 months per year (e.g., a school, a factory, or a business with its own water supply).
plumbing	Water pipes, storage reservoirs, tanks, and other means used to deliver drinking water to consumers inside buildings or houses or to store drinking water inside buildings or houses before consumption. In community water systems, the plumbing begins after the water utility's water meter or at the property line (if the distribution system is not metered). In noncommunity and nonpublic individual water systems, the plumbing begins at the point where water enters the building or house. See distribution system.
predominant illness	The category of illness reported by at least 50% of ill respondents (e.g., gastroenteritis, dermatitis, or acute respiratory illness). When more than one illness category is reported for a single waterborne disease and outbreak (WBDO), they are listed together as predominant illnesses. These mixed illness WBDOs are analyzed separately from WBDOs with single illnesses.
primary water exposure	For use in this report, a classification used for the source of contaminated water for water not intended for drinking or water of unknown intent.
public water system	A system, classified as either a community water system or a noncommunity water system, that provides piped water to the public for human consumption and is regulated under the Safe Drinking Water Act. Such a system must have at least 15 service connections or regularly serve at least 25 persons daily for at least 60 days per year.
raw water	Surface water or ground water that has not been treated in any way.
reservoir, impoundment	An artificially maintained lake, created for the collection and storage of water. This body of water may be available as a source of raw water for drinking purposes and/or recreational use. In some instances, a finished water storage facility in the distribution system might also be called a reservoir.
setting	Location where exposure to contaminated water occurred (e.g., restaurant, water park, and hotel).
source water	Untreated water (i.e., raw water) used to produce drinking water.

surface water	All water on the surface (e.g., lakes, rivers, reservoirs, ponds, and oceans) as distinguished from subsurface or ground water.
total coliforms	Fecal and nonfecal coliforms that are detected by using a standard test. The extent to which total coliforms are present in water can indicate the general quality of that water and the likelihood that the water is fecally contaminated by animal and/or human sources.
transient noncommunity water system	A public water system that that is not a community system and that does not regularly serve at least 25 of the same persons over 6 months per year. These systems provide water to places where persons do not remain for long periods (e.g., restaurants, campgrounds, highway rest stations, and parks with their own public water systems).
untreated water	Surface water or ground water that has not been treated in any way (i.e., raw water).
water not intended for drinking	Water that has not been treated for human consumption in conformance with EPA drinking water standards and that is provided for uses other than for drinking.
water of unknown intent	The information about the water is insufficient to determine for what purpose it is being provided or used and whether is has been treated for human consumption in conformance with EPA drinking water standards.
water system	A system for the provision of water for human consumption through pipes or other constructed conduits. This includes any collection, treatment, storage, and distribution facilities used primarily in connection with such a system.

Appendix B

Descriptions of Selected Waterborne Disease and Outbreaks (WBDOs) Associated with Drinking Water, Water Not Intended for Drinking, and Water of Unknown Intent

WBDO date	State/Territory in which WBDO occurred	Etiologic agent	No. of cases (deaths)	WBDO description
Bacteria				
May 2003	Washington	*Campylobacter* spp.	110	Attendees of a tent revival experienced gastrointestinal illness. Participants were from British Columbia, Idaho, Montana, Oregon, and Washington. A case-control study suggested an association between illness and consumption of farm water. The farm had both domestic and irrigation wells. Water samples from both wells were positive for fecal coliforms. Leaking valves and backsiphonage through cross-connections might have contributed to contamination of the domestic well water.
November 2003	Ohio	*C. jejuni* and *Shigella* spp.	57	An unlicensed caterer prepared food for several luncheons at her home to be served at a worksite. Iced tea made from untreated water from a spring-fed pond was associated with gastrointestinal illness. Tests performed on water from the caterer's kitchen sink and pitcher carbon filter were positive for total coliforms and *Escherichia coli* but negative for *Campylobacter* and *Shigella*.
December 2004	Wisconsin	*C. jejuni*	20	Restaurant patrons experienced gastrointestinal illness. A well supplying water for the restaurant tested positive for total coliforms and *E.coli*. The well water was untreated and taken from a karst aquifer. Years before this outbreak, the restaurant water also tested positive for coliform bacteria and had been issued with a boil-water advisory.
November 2002	Maryland	*Legionella pneumophila* serogroup 1	3	Health club patrons became ill with laboratory-confirmed Legionnaires' disease during an 8-week period. *L. pneumophila* serogroup 1 was isolated from a locker room shower. No clinical isolates were available for comparison.
November 2002	Virgin Islands	*L. pneumophila* serogroup 1	3	Three Danish travelers had laboratory-confirmed Legionnaires' disease after staying at a hotel implicated in a Legionnaires' disease outbreak during 1981–1982. All three cases were reported to local authorities by the European Surveillance Scheme for Travel-Associated Legionnaires' disease (http://www.ewgli.org), a surveillance program in place since 1987. Comparison of environmental strains collected from the hotel suggests that the potable water system was colonized with the same strain of *Legionella* for over 20 years. (**Source:** Cowgill KD, Lucas CE, Benson RF, et al. Recurrence of Legionnaires' disease at a hotel in the United States Virgin Islands over a 20-year period. Clin Infect Dis 2005;40:1205–7.)
October 2003	Maryland	*L. pneumophila* serogroup 1	7	Seven laboratory-confirmed cases were detected among guests of a hotel. This outbreak was detected by enhanced surveillance conducted by a single state (**Source:** CDC. Legionnaires' disease associated with potable water in a hotel—Ocean City, Maryland, October 2003–February 2004. MMWR 2005;54:165–8.)
January 2004	New York	*L. micdadei*	2	One definite health-care–associated case and one possible health-care–associated case were hospitalized at the same facility. Comparison of clinical and environmental isolates of *L. micdadei* revealed that they were related.
April 2004	Pennsylvania	*L. pneumophila* serogroup 1	3 (1)	Three laboratory-confirmed cases of Legionnaires' disease were residents of a long-term–care facility that was the source of an outbreak in 2002. In that outbreak and this one, *L. pneumophila* serogroup 1 was isolated from the facility's potable water system.
July 2004	Ohio	*L. pneumophila* serogroup 1	2	Two laboratory-confirmed cases of Legionnaires' disease occurred among workers at a street maintenance garage. The source of the cluster was not identified.
September 2004	North Carolina	*L. pneumophila* serogroup 1	7 (3)	The presence of laboratory-confirmed cases of Legionnaires' disease among residents of a long-term–care facility suggested that the potable water system of the facility was the source. However, further investigation revealed that a cooling tower approximately one quarter of a mile away was the likely source of these cases as well as community-acquired cases.
August 2004	Montana	*Salmonella typhimurium*	70	Restaurant patrons experienced diarrheal illness. Investigators determined that well water samples were positive for coliform bacteria and the ultraviolet disinfection unit was out of service. In addition, an existing cross-connection in the distribution system might have resulted in the backflow of water supplying a poultry pen.
Viruses				
January 2004	Pennsylvania	Norovirus	70	Visitors to a ski facility experienced gastrointestinal illness after drinking beverages from a soda fountain that had been cross-connected with a nonpotable water line drawing water from a pond. The pond water was untreated and tested positive for fecal coliforms. Potential sources of contamination of the pond water included snow melt and an adjacent septic system.

WBDO date	State/Territory in which WBDO occurred	Etiologic agent	No. of cases (deaths)	WBDO description
Chemicals/Toxins				
November 2003	Florida	Bromate and other disinfection by-products	2	Two persons consuming commercially bottled water experienced gastrointestinal illness. The water had a chemical odor. Testing of both opened and sealed bottles revealed above standard levels of bromate and other byproducts of chemical disinfection. This contamination likely occurred during the bottling process.
December 2003	Maine	Cleaning product	2	Two persons consuming commercially bottled water experienced gastrointestinal illness. Testing indicated contamination of both the water and the outside of the bottles. The bottles were purchased at the same grocery store. The bottom of one of the boxes containing the bottles showed evidence of a spill. An investigation into possible contamination revealed that boxes of commercially bottled water were stored in direct contact with the floor. During the investigation, a store employee reported that a cleaning product had been spilled near the boxes of bottled water and that two to three bottles had to be wiped off during the clean up.
June 2003	Minnesota	Copper	4	Restaurant patrons had gastrointestinal illness after consuming soda from a fountain machine. Beverage samples from the machine had copper levels above the acceptable 1.3 parts per million (ppm). A faulty check valve on the carbonator was found, suggesting that carbon dioxide was leaking into the water supply, reducing the pH of the water, resulting in copper leeching from the pipes.
November 2003	Minnesota	Copper	5	Restaurant patrons experienced gastrointestinal illness after consuming lemonade from a juice machine receiving frozen concentrated lemonade and diluting it with water before dispensing. Copper levels in samples from the machine were elevated (6.4 to 12.8 mg/L). Installation of a check valve and attachment to a different water supply did not reduce copper levels below the EPA action level (1.3 mg/L), suggesting internal plumbing problems.
July 2004	South Carolina	Copper	7	Restaurant patrons had gastroenteritis after consuming beverages from a soda fountain machine. Official samples collected from the soda fountain machines were within normal limits for metals. However, a pooled sample of three left-over beverages consumed by patrons had a copper level (8.1 mg/L) exceeding EPA standards. Copper levels in two serum specimens and six urine specimens from ill patrons were within normal limits (dates of specimen collection not reported). An inspection of the soda fountain machines did not reveal any critical violations.
March 2003	New York	Sodium hydroxide	4	Four persons suffered chemical burns after repairs were made on a check valve in the discharge line of a well supplying a community water system. While the discharge line was depressurized during maintenance, caustic soda had siphoned into the discharge main. When the well was placed back into service, approximately 50–100 gallons of 50% sodium hydroxide flowed into the distribution system. The water utility received complaints of “dirty water” and “burning sensation” from members of the community following well maintenance. An investigation found that a high pH was responsible.
April 2004	New Jersey	Sodium hydroxide	2	One person received a first degree chemical burn while showering and another person suffered an esophageal chemical burn after consuming water from a community water system. Failure of a check valve for the sodium hydroxide feed on a well resulted in discharge of this chemical into the distribution system. The pH meter at the well treatment plant recorded a maximum pH of 12.5.
Mixed agents				
December 2002	New York	*C. jejuni*, *Entamoeba* spp., and *Giardia* spp.	27	Residents and visitors in an apartment complex experienced gastrointestinal illness. A broken sewer line from an on-site sewage disposal system had flooded the basement of the main building in which a well supplying drinking water for the complex was located. Several inches of water and sewage covered the well head resulting in fecal contamination of the well water. Because of its relatively small size, the facility had not been identified or regulated as a community water supply before the reports of illness.
January 2004	Ohio	*C. jejuni, C. lari, Cryptosporidium* spp., and *Helicobacter canadensis*	82	Workers at a factory experienced gastrointestinal illness. Contamination of the potable water supply occurred through an open valve connecting the plant’s municipal water supply with the coolant line drawing nonpotable water from holding ponds behind the plant. The pond water was used to cool the plant’s machinery and tested positive for *Cryptosporidium* spp.
July 2004	Ohio	*C. jejuni*, norovirus, and *G. intestinalis*	1,450	Residents and visitors at a resort island in Lake Erie experienced gastrointestinal illness. A number of noncommunity public and private wells tested positive for total coliforms and *E. coli*, among other microorganisms (e.g., other bacteria, parasites, and viruses). Investigators concluded that substantial microbiological contamination of the ground water in the karst aquifer from multiple land uses was present, such as on-site septic systems, land application of septage, infiltration of land run-off, and possibly from the direct hydraulic connection with Lake Erie. Water quality degradation most likely occurred over a long period. Other possible contributing factors included cross-connections in the water distribution system; an increase in precipitation before the outbreak; the volume of wastewater flowing to sewage treatment systems during periods of heavy island visitation; the number, type, and maintenance of sewage disposal systems; and groundwater well construction.

WBDO date	State/Territory in which WBDO occurred	Etiologic agent	No. of cases (deaths)	WBDO description
Unidentified				
January 2003	Florida	Norovirus suspected	419	Players, coaches, and spectators who attended a volleyball tournament experienced gastrointestinal illness. The incubation period, clinical presentation, and duration of illness suggested norovirus as the etiologic agent. During the tournament, numerous opportunities existed for contact between players. Some also reported touching their refillable water bottles to the spouts of 5-gallon commercially bottled water containers beside the courts. The only statistically significant relative risk (RR = 2.24; confidence interval = 1.14–4.41) in a cohort study among the players was drinking water from these containers. While the water tested negative for norovirus, contaminated spouts or levers on the containers that the players depressed to dispense water might have contributed to the spread of illness. Person-to-person transmission, fomite transmission, and aerosolization of vomitus likely also played roles.
July 2003	Illinois	Unidentified	180	Visitors to a water park experienced gastrointestinal illness. Testing of stool samples from eight persons failed to identify an etiologic agent. An epidemiologic study implicated drinking water at the park. Chlorinated drinking water was supplied from 13 on-site wells. *E. coli* was detected in 10 of 29 water samples.
September 2003	Michigan	Unidentified	4	Construction workers installing sewer lines experienced gastrointestinal illness. Stool cultures for each ill worker were negative. All ill workers drank from a communal water jug that might also have been used to wash parts.
June 2004	Pennsylvania	Unidentified	174	Attendees of a camp experienced gastrointestinal illness. Testing of stool samples from five persons failed to identify an etiologic agent. Sometime in the week before the outbreak, a vehicle damaged a sewer pipe and sewage flowed into a lake. A shallow well supplying drinking water was located near the edge of this lake. Two days before the onset of the first case, camp staff discovered that the chlorine pump on this well was broken. Testing of the well water revealed high coliform levels, suggesting that the well water was under the influence of surface water.

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