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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 maintained a collaborative surveillance system for collecting and periodically reporting data related to occurrences and causes of waterborne-disease outbreaks (WBDOs) related to drinking water; tabulation of recreational water-associated outbreaks was added to the survillance system in 1978. This surveillance system is the primary source of data concerning the scope and effects of waterborne disease outbreaks on persons in the United States**.**

Reporting Period Covered: This summary includes data on WBDOs associated with recreational water that occurred during January 2001--December 2002 and on a previously unreported outbreak that occurred during 1998.

Description of the System: Public health departments in the states, territories, localities, and the Freely Associated States are primarily responsible for detecting and investigating WBDOs and voluntarily

reporting them to CDC on a standard form. The surveillance system includes data for outbreaks associated with both drinking water and recreational water; only outbreaks associated with recreational water are reported in this summary.

Results: During 2001--2002, a total of 65 WBDOs associated with recreational water were reported by 23 states. These 65 outbreaks caused illness among an estimated 2,536 persons; 61 persons were hospitalized, eight of whom died. This is the largest number of recreational water-associated outbreaks to occur since reporting began in 1978; the number of recreational water-associated outbreaks has increased significantly during this period ($p<0.01$). Of these 65 outbreaks, 30 (46.2%) involved gastroenteritis. The etiologic agent was identified in 23 (76.7%) of these 30 outbreaks; 18 (60.0%) of the 30 were associated with swimming or wading pools. Eight (12.3%) of the 65 recreational water-associated disease outbreaks were attributed to single cases of primary amebic meningoencephalitis caused by *Naegleria fowleri*; all eight cases were fatal and were associated with swimming in a lake (n = seven; 87.5%) or river (n = one; 12.5%). Of the 65 outbreaks, 21 (32.3%) involved dermatitis; 20 (95.2%) of these 21 outbreaks were associated with spas or pools. In addition, one outbreak of Pontiac fever associated with a spa was reported to CDC. Four (6.1%) of the 65 outbreaks involved acute respiratory illness associated with chemical exposure at pools.

Interpretation: The 30 outbreaks involving gastroenteritis comprised the largest proportion of recreational water-associated outbreaks during this reporting period. These outbreaks were associated most frequently with *Cryptosporidium* (50.0%) in treated water venues and with toxigenic *Escherichia coli* (25.0%) and norovirus (25.0%) in freshwater venues. The increase in the number of outbreaks since 1993 could reflect improved surveillance and reporting at the local and state level, a true increase in the number of WBDOs, or a combination of these factors.

Public Health Action: CDC uses surveillance data to identify the etiologic agents, types of aquatics venues, water-treatment systems, and deficiencies associated with outbreaks and to evaluate the adequacy of efforts (e.g., regulations and public awareness activities) for providing safe recreational water. Surveillance data are also used to establish public health prevention priorities, which might lead to improved water-quality regulations at the local, state, and federal levels.

Introduction

During 1920--1970, statistical data regarding U.S. waterborne-disease outbreaks (WBDOs) 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 maintained a collaborative surveillance system that tracks the occurrences and causes of WBDOs associated with drinking water; tabulation of recreational water-associated outbreaks was added to the surveillance system in 1978 (*2*--*7*). The surveillance system includes data regarding outbreaks associated with drinking water, recreational water, and other types of water exposures. This *MMWR Surveillance Summary* includes data on recreational water-associated outbreaks that occurred during 2001--2002 and for a previously unreported outbreak that occurred in 1998. Data on drinking water-associated outbreaks are presented in a separate *MMWR Surveillance Summary* (*8*).

These surveillance activities are intended to 1) characterize the epidemiology of WBDOs; 2) identify changing trends in the etiologic agents that caused WBDOs and determine why the outbreaks occurred; 3) encourage public health personnel to detect and investigate WBDOs; and 4) foster collaboration among local, state, federal, and international agencies on initiatives to prevent waterborne disease transmission. Data obtained through this surveillance system are useful for identifying major deficiencies in the provision of safe recreational water. Surveillance information can influence prevention recommendations and research priorities and lead to improved water-quality regulations. However, the statistics reported in this surveillance summary represent only a portion of the burden of illness associated with recreational water exposure. The

surveillance information does not include endemic waterborne disease risks, nor are reliable estimates available of the number of unrecognized WBDOs and associated cases of illness.

Background

Regulation of Recreational Water

State and local governments establish and enforce regulations to protect recreational water against naturally occurring or human-made contaminants. Standards for operating, disinfecting, and filtering public swimming and wading pools are regulated by state and local health departments and, as a result, vary throughout the United States. In 1986, EPA published guidelines for microbiologic water quality for recreational freshwater (e.g., lakes and rivers) and marine water (*9*). For freshwater, the guideline recommends 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, the guideline recommends that the monthly geometric mean water-quality indicator concentration be ≤35 CFU/100 mL enterococci. States have latitude regarding their guidelines or regulations and can post warning signs to alert potential bathers until water quality improves. Unlike treated venues, in which disinfection can be used to address the majority of problems with the microbiologic quality of water, contaminated freshwater can require weeks or months to improve or return to normal. However, pools in treated venues might need to be closed until the water has been adequately treated and filtered or the pool drained and refilled to remove protozoan contamination. Prompt identification of potential sources of contamination and remedial action is necessary to return bathing water to an appropriate quality for recreational use.

EPA's Action Plan for Beaches and Recreational Waters (Beach Watch) was developed as part of the Clean Water Action Plan (http://www.cleanwater.gov) . The intent of Beach Watch is to assist state, tribal, and local authorities in strengthening and extending programs that protect users of fresh and marine recreational waters. As part of the Beaches Act of 2000, the U.S. Congress directed EPA to develop a new set of guidelines for recreational water based on new water-quality indicators. In 2002, EPA, in collaboration with CDC, began conducting a series of epidemiologic studies at fresh and marine water recreational beaches in the United States. The National Epidemiologic and Environmental Assessment of Recreational (NEEAR) Water Study (available at http://www.epa.gov/nerlcwww/neearnerl.htm) is testing rapid new water-quality methods that produce results in <2 hours and is correlating these indicators with health effects among beachgoers. The results will be used to develop new EPA water-quality guidelines for freshwater and marine water use.

Methods

Data Sources

Public health departments in the states, territories, localities, and the Freely Associated States* (FAS) 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 outbreak, including person, place, time, and location; results from epidemiologic studies conducted; specimen and water sample testing; and other factors potentially contributing to the outbreak (e.g., environmental concerns, disinfection, and filtration [Glossary]). CDC annually requests reports from state, territorial, and FAS epidemiologists or persons designated as WBDO surveillance coordinators. Numeric and text data are abstracted from the outbreak form and supporting documents and entered into a database for analysis.

Definitions†

The unit of analysis for the WBDO surveillance system is an outbreak, not an individual case of a waterborne disease. Two criteria must be met for an event to be defined as a recreational water-associated disease outbreak. First, ≥2 persons must have experienced a similar illness after exposure to water or air encountered in a recreational water setting. This criterion is waived for single cases of laboratory-confirmed primary amebic meningoencephalitis (PAM), single cases of wound infections, and single cases of chemical poisoning if water-quality data indicate contamination by the chemical. Second, epidemiologic evidence must implicate recreational water or the recreational water setting as the probable source of the illness.

Recreational settings include swimming pools, wading pools, whirlpools, hot tubs, spas, waterparks, interactive fountains (Glossary), and fresh and marine surface waters. When outbreak causes are analyzed, outbreaks are separated by venue. Fresh and marine waters are considered untreated venues. Treated venues refer to the remaining settings; occasionally, a private pool or wading pool involved in an outbreak is a drain-and-fill type with no additional disinfection or treatment.

If primary cases (i.e., illness among persons exposed to contaminated water or air at a recreational water setting) and secondary cases (i.e., illness among persons who became ill after contact with a person with a primary case) are distinguished on the outbreak report form, only primary cases are included in the total number of cases. If both actual and estimated case counts are included on the outbreak report form, the estimated case count may be used if the population was sampled randomly or the estimated count was calculated by applying the attack rate to a standardized population.

Outbreak Classification

WBDOs reported to the surveillance system are classified according to the strength of the evidence implicating 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 outbreak report form. Epidemiologic data are weighted more than water-quality data. Although outbreaks without water-quality data might be included in this summary, reports that lack epidemiologic data were excluded. Outbreaks of dermatitis, PAM, wound infections, or chemical poisonings are not classified according to this scheme. Weighting of epidemiologic data does not preclude the relative importance of both types of data. The purpose of the outbreak system is not only to implicate water as the vehicle for the outbreak but also to understand the circumstances and system breakdowns that led to the outbreak.

A classification of I indicates that adequate epidemiologic and water-quality data were reported (Table 1). However, the classification does not necessarily imply that an investigation was conducted optimally, 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 a classification of III rather than I because of the relatively limited sample size available for analysis.

For the reporting period 2001--2002, WBDOs associated with drinking water and with recreational water are reported separately for the first time. The *MMWR Surveillance Summary* for drinking water-associated outbreaks (*8*) includes WBDOs related to drinking water and occupational exposures as defined in the methods section of that summary. This *MMWR Surveillance Summary* includes only outbreaks related to recreational water.

Although outbreaks of Pontiac fever have been included in previous *MMWR Surveillance Summaries*, this summary is the first to include outbreaks of Legionnaires disease (LD). Because nearly all outbreaks caused by *Legionella* species share characteristics that are distinct from other types of WBDOs, all *Legionella* outbreaks have been compiled into a single table in the drinking water-associated outbreak *MMWR Surveillance Summary* (*8*) that identifies the presumed primary use of the water implicated in the outbreak.

Although all *Legionella* outbreaks are listed in that table, those related to recreational water exposure are discussed in this summary. Outbreaks of LD that occurred in association with water primarily intended for drinking or occupational use are discussed in the summary of drinking water-associated outbreaks (*8*).

Results

During 2001--2002, a total of 65 outbreaks (30 during 2001 and 35 during 2002) associated with recreational water were reported by 23 states (Tables 2--7). (Selected case descriptions are provided in the Appendix). These 65 outbreaks caused illness among 2,536 persons, resulting in 61 hospitalizations and eight deaths. Of the 65 outbreaks, 30 (46.2%) were outbreaks of gastrointestinal illness (Tables 2 and 3); 21 (32.3%) were outbreaks of dermatitis (Table 4); eight (12.3%) were outbreaks of meningoencephalitis; and six (9.2%) were outbreaks of acute respiratory illness (including one of unknown etiology, one of Pontiac fever, and four caused by chemical exposure) (Tables 5 and 6).

The median outbreak size was 15 persons (range: 1--767). Although outbreaks were distributed throughout the United States (Figure 1), Florida and Minnesota reported the largest number of outbreaks (seven and nine, respectively).

Outbreaks occurred throughout the calendar year (Figure 2) but peaked during warm weather months (May--August). Of the 30 outbreaks involving gastrointestinal illness, 23 (76.7%) occurred during the summer (June--August); the eight cases of PAM also occurred during June--August (Figure 2).

Of the 65 recreational water outbreaks, 21 (32.3%) were associated with fresh water and 44 (67.7%) with treated (e.g., chlorinated) water (Table 7). Of the 30 outbreaks of gastroenteritis, 12 (40.0%) were associated with fresh or surface water and 18 (60%) with treated (e.g., chlorinated) water venues (Figure 3).

Etiologic Agents

The infectious agent was identified or suspected in 53 (81.5%) of the 65 recreational water-associated outbreaks (Table 7). Of the 30 outbreaks involving gastroenteritis, 12 (40.0%) were caused by parasites, six (20.0%) by bacteria, and five (16.7%) by viruses; the remaining seven (23.3%) were of unknown etiology (Figure 3) (Table 7). *Cryptosporidium* species remained the most common cause of outbreaks associated with treated swimming water (50.0%), and toxigenic *E. coli* serotypes and norovirus were the most commonly identified causes (25.0% each) of outbreaks associated with fresh water exposure (Figure 3).

The etiologic agent was suspected or identified in 34 (97.1%) of the 35 nongastroenteritis-related recreational outbreaks: 18 were caused by *Pseudomonas aeruginosa*, eight by *Naegleria fowleri*, one by *Legionella* species, one by *Bacillus* species, one by *Staphylococcus* species, one by avian schistosomes, and four by chlorine-based pool chemicals (Tables 4--7). One outbreak of unknown etiology was consistent with *Legionella* species on the basis of observed symptoms resembling Pontiac fever and the epidemiologically implicated mode of transmission.

Gastroenteritis Outbreaks

Parasites. Of the 12 parasitic recreational water-associated outbreaks of gastroenteritis, 11 (91.6%) were caused by *Cryptosporidium* species, and one was caused by *Giardia intestinalis*. Nine (75.0%) of these 12 parasitic outbreaks occurred in chlorinated venues.

During the 2001--2002 summer swim seasons, three outbreaks of *Cryptosporidium* species occurred that were related to fecal contamination; each outbreak affected >100 persons. In July 2001, an outbreak occurred in a Nebraska community, causing 157 illnesses. In this outbreak, contamination was introduced

into a wading pool by a fecal accident and subsequently spread via infected swimmers to multiple community pools. At an Illinois waterpark (July 2001), 358 persons became ill with cryptosporidiosis after the introduction of fecal contamination into facility pools. A sustained outbreak of cryptosporidiosis (July 2002) at a Massachusetts health club sickened 767 persons. Epidemiologic evidence indicated that infections associated with pool use occurred throughout the summer, with transmission peaking during a heat wave in mid-August.

Bacteria. Six recreational water-associated outbreaks of gastroenteritis were attributed to bacterial pathogens, three of which were linked to freshwater sources. Twenty cases (Minnesota, July 2001) of *E. coli* O157:H7 occurred among persons who had visited a lakefront beach located in a metropolitan area. The environmental investigation at the lake identified high fecal coliform levels, and the beach was closed for the rest of the season. Five of the ill persons subsequently reported attending child care centers during or shortly after their illness, and a secondary outbreak resulted.

Three bacterial outbreaks of gastroenteritis (two of *Shigella sonnei* and one of *E. coli* O157:H7) occurred in venues using chlorinated tap water with no additional disinfection. In June 2001, an outbreak of *S. sonnei* in Iowa affected 45 persons, and 24 secondary infections occurred (*10*). Illnesses were linked epidemiologically to use of a drain-and-fill municipal wading pool. The pool was filled each day with drinking water, had no recirculation or disinfection system, and was frequented by diaper-aged children. Pool water tested positive for fecal coliforms (Glossary) and *E. coli*. Subsequent to the outbreak, a communitywide outbreak of shigellosis involving multiple local child care centers occurred. Another outbreak (Maine, July 2002) affecting nine persons at a private home was caused by *E. coli* O157:H7 in a toddler wading pool. One child was hospitalized. The pool was filled with tap water but was not additionally treated (i.e., filtered or recirculated). High bather density and a fecal accident might have contributed to the outbreak. In July 2001 in Colorado, 33 persons were infected by *S. sonnei* after exposure to an interactive fountain, which was at sidewalk level with no barriers to public access. The fountain, which was used frequently for recreation, especially by young children, used chlorinated city water that was recirculated with no additional treatment.

Viruses. During 2001--2002, five recreational water-associated outbreaks of gastroenteritis were attributed to norovirus (Glossary), causing illness in 146 persons. An outbreak of gastroenteritis in July 2001 in Minnesota that affected 40 persons was linked to a community swimming beach at a lake. Epidemiologic evidence indicated that this waterborne outbreak might have been part of a larger communitywide norovirus outbreak occurring during that time. An outbreak (Wisconsin, July 2002) of 44 primary cases was reported among persons swimming at a Lake Michigan state park, and 22 secondary cases were reported among park visitors. Of the 44 persons with primary cases, 21 (49%) continued to use the beach and swim after illness onset. Although the majority of illnesses were consistent with norovirus infection, the outbreak was attributed to three pathogens: norovirus, *S. sonnei*, and *Cryptosporidium* species. The county health department closed the beach to swimming after finding 2,419 *E. coli* CFU/100 mL in beach water samples. Water samples collected before the outbreak had not exceeded EPA's 235 CFU/100 mL single-sample maximum guideline. Although the source of the fecal contamination was not identified, multiple sources were suspected; high levels of bacteria in Lake Michigan can also be affected by weather conditions and low lake levels. The same beach was closed on five other occasions during the summer when water samples exceeded the guideline; each closing occurred ≤48 hours after a rainfall event. This is the first documented outbreak associated with use of a Great Lakes beach since this surveillance system was created.

Two outbreaks of norovirus infection were associated with swimming pools. In one such outbreak, 36 persons (Minnesota, March 2002) associated with three youth sports teams became ill after swimming in a hotel pool and spa.

Other. During 2001--2002, seven recreational water outbreaks involving gastroenteritis of unknown etiology were reported, including four in swimming pools, two in lakes, and one in a water puddle. In one

outbreak (New Hampshire, August 2001), 42 children became ill with nausea, vomiting, and diarrhea after swimming in a state park lake. *Oscillatoria* was isolated from the lake water in high concentrations, which was consistent with the clinical symptoms manifested. An estimated 33 children became ill (Maine, November 2001) after playing in a large puddle, an activity not usually associated with illness. The puddle was caused by an overflowing septic tank and excessive rain; high levels of *E. coli* were identified in the water.

Nongastroenteritis Outbreaks

Dermatitis. During 2001--2002, a total of 21 outbreaks of dermatitis were identified (Table 4). An outbreak in Oregon during 2002 that sickened 19 persons was associated with swimming in freshwater lakes and rivers and was consistent with cercarial dermatitis (Glossary).

The 20 remaining outbreaks were associated with pool and spa use and affected 416 persons. *P. aeruginosa* was confirmed in water or filter samples from eight outbreaks, three of which also had a clinical isolate of *P. aeruginosa*. In the remaining 12 outbreaks, *Pseudomonas* was suspected on the basis of the clinical syndrome and setting. In eight dermatitis outbreaks, the affected persons (e.g., members of youth sports teams traveling for a tournament or persons attending birthday parties) were attending events at a hotel and used a hotel spa during the event.

In multiple outbreaks in Pennsylvania (May 2001), participants in a youth soccer tournament had folliculitis (Glossary), and ≥3 different local hotel spas were implicated. Although 64 cases were identified, officials estimated that >150 persons became ill. Determining the number of affected persons was difficult because players from other states participated in the tournament. Contributing factors to these outbreaks included inadequate spa maintenance, nonadherence to the bather load limit, and failure to shower before and after spa use.

Meningoencephalitis. Eight cases of laboratory-confirmed PAM attributed to *N. fowleri* occurred during 2001--2002 (Table 5). All eight persons died from infection after having summertime contact with lake or river water. In three cases, the infected person was reported to have had contact with sediment from the lake or river bottom while diving or stirring up the soil (*11*).

Chemical. During 2001--2002, four outbreaks that affected 102 persons were attributed to chemical exposure in recreational water settings (Table 6). Two outbreaks that occurred in outdoor pool settings were attributed to buildup of chloramines (Glossary), a class of disinfection byproducts/irritants (*12--14*). In pools, chloramines result from the combination of chlorine used for disinfection and organic compounds (e.g., saliva, perspiration, urine, body oils) deposited in the water. Chloramines can accumulate in the pool water and volatilize into the air. In indoor pools with inadequate ventilation, levels can increase to the point that respiratory irritation occurs; contact with water with high levels can cause dermatitis and irritation of mucous membranes (*12--14*). In October 2002, a total of 32 hotel guests in West Virginia who were exposed to an indoor pool and surrounding area reported symptoms of cough, eye and throat irritation, and difficulty breathing. The proportion of exposed persons who became ill increased with duration of indoor pool air or water exposure. Illness was likely caused by the buildup of chloramines in the pool area.

Two chemical outbreaks were related to respiratory exposures to chlorine gas at swimming pools. In Alaska (September 2002), a maintenance worker mistakenly mixed chlorine and hydrochloric acid, leading to the release of chlorine gas, and in Ohio (June 2002), workers failed to shut down the chlorine feed system during waterline repairs.

Other. One outbreak of acute respiratory illness identified as Pontiac fever (Illinois, 2002) sickened 68 persons and was linked epidemiologically to use of a hotel spa (Table 5). Another outbreak (Georgia, June 2002) involved acute respiratory infections of unknown etiology. Four persons affected in this outbreak

reported symptoms that included nausea, headache, chills, and fever after bathing in a spa at a private residence. Although urine specimens were tested for *L. pneumophila*, no infectious agent was identified.

Previously Unreported Outbreaks

A previously unreported recreational water-associated outbreak occurred in Colorado in June 1998. Five family members became ill with nontuberculous mycobacterial respiratory disease; two were hospitalized (*15*). Illness was linked epidemiologically and environmentally to an in-home spa exposure, both by contact and inhalation. Multiple species of nontuberculous mycobacteria were isolated from the spa water, including *Mycobacterium avium* complex and *M. fortuitum*. Inadequate disinfection levels, lack of monitoring of pH and disinfection levels, and having the spa inside the living area were contributing factors to this outbreak. This type of spa-associated pneumonitis has been described previously (*16*).

Discussion

Trends in Outbreak Reporting

The number of recreational water-associated outbreaks has increased significantly since 1993 (Pearson's correlation = 0.77; $p<0.01$) and is at the highest 2-year level (65 outbreaks for 2001--2002, compared with 59 outbreaks for 1999--2000 [*2*]) since CDC began receiving such reports in 1978 (Figure 4). The increase since 1993 is also significant for reported outbreaks of gastrointestinal illness (Pearson's correlation = 0.67; $p = 0.034$) (Figure 5) and for outbreaks of nongastrointestinal illness (Pearson's correlation = 0.74; $p = 0.014$). Whether this reflects a true increase in the number of outbreaks or reflects increasing attendance at aquatics venues (e.g., waterparks, [*17*]), increased recognition of the potential health concerns associated with recreational water (which has led to improved surveillance and investigation), or a combination of these factors is unknown. Factors influencing the sensitivity of this reporting system have been discussed previously (2). The increased reporting of gastrointestinal illness outbreaks since 1993 might reflect a true increase in the number of outbreaks occurring. This is indicated because the reported increase is associated primarily with treated venues (Figure 6) as a result of contamination of pool water by *Cryptosporidium* (Figure 7), reflecting the emergence of the naturally chlorine-resistant *Cryptosporidium* as a human pathogen since 1980 (*18*). In contrast, the high numbers of outbreaks reported by Florida and Minnesota might be attributable to enhanced surveillance and investigative activities rather than to a higher incidence of WBDOs compared with other states.

One key limitation of the data collected as part of the WBDO surveillance system is that the information pertains only to disease outbreaks rather than endemic illness. The epidemiologic trends and water-quality concerns observed in outbreaks might not necessarily reflect or correspond with trends associated with endemic waterborne illness. To address this problem, EPA and CDC are collaborating on the NEEAR Water Study to assess the magnitude of waterborne illness associated with routine, nonoutbreak-associated exposure to marine and freshwater recreational areas.

Gastroenteritis-Associated Outbreaks

Fecal contamination of recreational water that can lead to outbreaks of gastroenteritis occurs through different means. Because swimming is essentially communal bathing, rinsing of soiled bodies and fecal accidents from swimmers can cause contamination of the water. Unintentional ingestion of recreational water contaminated with pathogens can then lead to gastrointestinal illness, even in nonoutbreak settings (*19,20*). Fresh and marine waters are also subject to fecal contamination from point sources (i.e., sewage releases), watersheds (i.e., runoff from agricultural, forest, and residential areas), and floods. Wild and domestic animals, as well as infected humans, can be sources of certain pathogens, including *Giardia*

intestinalis, *Cryptosporidium*, and toxigenic *E. coli*. Weather conditions (e.g., wind, rain, and drought) can also affect the water quality, and high air temperatures can cause overcrowding and decreased water quality in pools and lakes.

Of the 65 recreational WBDOs reported during 2001--2002, the largest proportion reported (46.2%) involved gastroenteritis, compared with 61.0% during 1999--2000 (*2*). As during the previous reporting period, *Cryptosporidium* accounted for the largest percentage of outbreaks involving gastroenteritis (36.7%) (Figure 3) (Table 7). Of the 30 outbreaks involving gastrointestinal illness, 18 (60.0%) occurred in treated systems (i.e., pools). In treated venues, 50% of the outbreaks were attributed to *Cryptosporidium* (Figure 3). During 1993--2002, *Cryptosporidium* accounted for >65% of outbreaks occurring in treated venues (Figure 7).

Unlike other organisms, which are more susceptible to the levels of chlorine typically maintained in a pool, *Cryptosporidium* oocysts (Glossary) are highly chlorine-resistant and require increased levels of chlorine and longer contact times (Glossary) with chlorine for inactivation. *Cryptosporidium* can survive for days in public health--mandated chlorine concentrations required for pools (1--2 ppm free chlorine). Certain outbreak reports noted inadequate pool maintenance as a contributing factor to the outbreak. Although low chlorine levels are unlikely to have been the cause of cryptosporidiosis outbreaks, the deficiency serves to indicate deterioration of water quality caused by overcrowding or the introduction of fecal contamination.

The frequent reporting of low chlorine levels in outbreaks indicates a disturbing lack of awareness among pool operators concerning the role of chlorine and pH control as the major protective barrier against infectious disease transmission in pools. In addition, inadequate disinfectant levels in any pool increases the risk for transmission of chlorine-susceptible pathogens (e.g., *E. coli* O157:H7 and *Shigella* species) if an infected swimmer contaminates the pool. Analysis of >22,000 pool-inspection records indicated that the majority of pool inspections had ≥1 pool code violation for water quality, recirculation system, or pool management, and 8.3% of inspections resulted in immediate pool closure (*21*). This emphasizes the need for increased vigilance to ensure that pool operators and staff are appropriately trained regarding the need to follow guidelines (available at http://www.cdc.gov/healthyswimming/poolstaff.htm) to prevent the spread of recreational water illnesses and to ensure proper pool maintenance (i.e., disinfection, pH control, and filtration) (*22*).

The treated-venue outbreaks of chlorine-susceptible pathogens (e.g., *S. sonnei* and *E. coli* O157:H7) reported in this summary all occurred in pools that were not adequately chlorinated. Two *S. sonnei* outbreaks were in public venues (i.e., an interactive fountain without water treatment and a drain-and-fill wading pool), which underscores the need for health authorities and operators to be vigilant about the necessity for including disinfection and filtration in all designs for public swimming venues (including interactive fountains and wading pools) that are easily used and accessed by the public, particularly young children. The outbreak of *E. coli* O157:H7 occurred in a home wading pool with no disinfection or filtration. The use of tap water to fill these wading pools means that the water is essentially untreated upon filling (i.e., when unchlorinated tap water from a home well is used) or shortly thereafter (i.e., when chlorinated tap water is used, and the chlorine dissipates rapidly) and offers little protection against the spread of pathogens. Thus, these venues present a high risk for exposure if persons ill with diarrhea swim and fecal contamination occurs. These pools should be used with caution and, at a minimum, should be drained and cleaned after each use. Education of users should alert them to the potential for disease transmission and stress that children with diarrhea should refrain from swimming in them. Use of these pools in institutional settings (e.g., child care centers that have substantial numbers of toddler and diaper-aged children) should be avoided.

Use of recreational water venues can lead to amplification of disease and to communitywide transmission. Communal use of recreational water makes it ideal for amplification of enteric illness circulating in communities. Whether swimming venues serve as the initial exposure event or an intermediary

amplification mode for community enteric illness, public health officials might wish to alert pool operators, child care centers, schools, and other establishments that include recreational water facilities when increases in enteric illness are noted in the community. These community alerts would serve to increase awareness and improve vigilance regarding maintenance and water-quality parameters (i.e., disinfection, pH levels, and filtration) needed to prevent further amplification of most enteric pathogens.

During 2001--2002, a total of 12 gastroenteritis outbreaks were reported after freshwater exposure. Certain outbreaks occurred in beach areas that had substantial numbers of families bathing and swimming in the water. A common element noted in these reports was the presence of diaper-aged children in the water, diaper changing on the beach, and washing of young children in the water. Reports of infants and children swimming when they have diarrhea is a problem common to both freshwater systems and treated venues. Although health communication messages have been targeted in the past for treated venues, similar messages should be provided to those who swim in fresh or marine water venues. As part of its Beaches Action Plan, EPA is developing guidelines and information for users of fresh and marine waters (available at http://www.epa.gov/waterscience/beaches).

Use of untreated geothermal or hot spring water in recreational venues should be examined closely by public health officials. In one outbreak of cryptosporidiosis (Wyoming, 2001), untreated hot spring water was used to fill flow-through swimming pools. Hot springs, which feature high levels of minerals and elevated temperatures, are potentially ideal venues for pathogen growth (e.g., *Naegleria, Acanthamoeba,* and *Legionella*) or contamination by users with enteric illness. Two outbreaks of gastroenteritis have been reported previously at waterparks that used untreated mineral spring water (*2*,*4*). Compared with disinfected pools, these geothermal water-supplied pools pose an increased risk to swimmers because of their confined volume and lack of disinfection and filtration. Improved consumer education about the natural state of this water, guidelines to raise awareness about swimmer hygiene and health restrictions, and exploration of supplementary treatment might help prevent future outbreaks in these enclosed, untreated mineral-water pools.

The number of norovirus outbreaks increased from three during 1999--2000 to five during 2001--2002 (*2*). This increase might be attributable to improvements in the awareness, availability, and use of laboratory detection methods for norovirus over previous years. During 2001--2002, tests for norovirus and other possible agents of viral origin appeared to be more routinely performed and documented in the outbreaks that were reported to CDC compared with previous reporting periods. A viral etiology was suspected in certain outbreaks of acute gastrointestinal illness of unknown etiology. Viral outbreaks are still likely to be underreported because improved technology for detection of viruses in stool and water samples is still not widely practiced. Investigators are encouraged to submit clinical specimens to CDC or state laboratories that conduct these tests. Guidelines for collecting stool specimens for identification of viral pathogens are available from CDC (*23*). Investigators are also encouraged to contact CDC and EPA regarding testing of water samples.

Outbreaks Involving Dermatitis

This summary describes 21 outbreaks of dermatitis, continuing the increase in reported outbreaks documented in the previous two summaries (1997--1998: eight outbreaks [*3*]; 1999--2000: 15 outbreaks [*2*]). Of the 21 dermatitis outbreaks, 20 (95.2%) were associated with spa or pool use, and 18 were thought to result from *P. aeruginosa* infections. In addition to skin infections, spas have also been associated with ear infections (*Pseudomonas*), Pontiac fever/acute respiratory illness (*Legionella*), and a previously unreported outbreak of *Mycobacterium avium* complex/*M. fortuitum* (*15*). The majority of these reports noted inadequate disinfection of the water or deficient maintenance. Because the higher temperatures commonly used in spas deplete disinfectant levels at a more rapid rate, greater vigilance is required to maintain optimal spa water-quality parameters. Analysis of data from 5,209 spa inspections indicated that

2,958 (56.8%) identified ≥1 violation, and 11% of spa inspections resulted in immediate closure (*24*). This finding highlights the need for spa operators to actively check and maintain adequate disinfectant levels and other maintenance parameters. Strict adherence to maintaining optimal spa water quality (free chlorine: 3--5 ppm; pH: 7.2--7.8) should prevent the majority of such outbreaks (*25*).

Eight reported outbreaks of spa-associated rashes occurred among persons attending events (youth sports tournaments or birthday parties) who were exposed at hotel facilities during the events. These outbreaks might have been detected because the close relationship among event participants allowed discussion of shared illness and facilitated reporting. However, outbreak reports also cited inadequate disinfection, bather overload, and improper hygiene (no showering after activities and before water entry) as contributing factors to these outbreaks. Combining inadequate maintenance with substantial numbers of users who can easily overload the disinfection capacity of the spa water might facilitate bacterial amplification and the spread of disease. As a result, spa and pool operators should consider enhancing maintenance levels, making water-quality checks more frequently, enhancing health education, and enforcing bather loads, particularly during heavy bather use (e.g., large sports tournaments or other events).

One presumed outbreak of cercarial dermatitis occurred among persons who swam in a freshwater lake. This syndrome is caused by an allergic response after penetration of the epidermis by avian larval schistosomes. Although the extent of the problem of cercarial dermatitis caused by freshwater exposure is unknown, it probably occurs more frequently than is reported to the WBDO surveillance system. Schistosomes occur naturally in ecosystems in which snails, birds, or aquatic mammals coexist, and a substantial number of freshwater lakes in the United States are therefore potential sources of illness among swimmers. To prevent further illnesses, swimmers should pay careful attention to where they swim, avoid shallow swimming areas known to be snail habitats in lakes associated with cercarial dermatitis (particularly areas with onshore winds), and report any incidents to their local health department (*26*).

Outbreaks Involving PAM

The eight deaths associated with PAM reported during 2001--2002 were all linked to freshwater exposure. Typically, these infections are associated with swimming in freshwater bodies in the late summer months because the free-living ameba *N. fowleri* is thermophilic (i.e., it proliferates in warmer waters). The amebae are believed to enter through the nasal passage and then travel to the olfactory lobe of the brain. The mortality associated with infection by *N. fowleri*, particularly among young children, indicate that greater resources should be devoted to educating the public and investigating the efficacy of potential prevention measures. To reduce risk, swimmers might wish to avoid swimming in freshwater venues when water temperatures are high and water levels are low, and should minimize forceful entry of water up the nasal passages during jumping or diving activities (i.e., by holding one's nose or wearing nose plugs) and avoid digging in the sediment while under water (*11*).

Outbreaks Associated with Chemical Exposure

Four outbreaks resulted from chemical exposures in treated aquatics venues resulting in acute respiratory symptoms. Two were a result of release of chlorine gas (used for disinfection) subsequent to improper maintenance and handling. The extreme health effects that might be caused by exposure to chlorine gas underscore the need for better training of pool operators who deal with gaseous chlorine as part of their daily activities. Two other outbreaks appeared to be related to accumulation of chloramines, a class of pool disinfection chemical byproducts or irritants (*12--14*), in the water and air surrounding indoor pools. These outbreaks illustrate that optimal indoor air quality at pools is critical to a safe and healthy swimming experience (*12--14*). More data are needed on indoor pool air quality so air-handling systems can be better designed to rid these venues of contaminating chloramines. Pool operators should be made aware that ventilation of these disinfection byproducts is key to avoiding future outbreaks and that effective pool

management and education of swimmers about safe hygiene practices (e.g., showering before swimming and refraining from urinating in the pool) will minimize chloramine formation.

The mechanism for reporting chemical outbreaks is not as straightforward as it is for infectious disease outbreaks. Because communicable disease specialists are in different sections of health departments or in different agencies from environmental health or emergency response personnel, they might not learn about acute recreational water-related chemical exposures. As a result, water-related chemical outbreaks are more likely than infectious disease outbreaks to be underreported. Closer communication and cross-training between these groups to recognize and investigate outbreaks might serve to improve future detection and reporting.

Prevention

Prevention and control of recreational water-associated outbreaks requires a multifaceted approach. This approach should combine appropriate public health practices, environmental remediation, improved beach/pool maintenance and staff training, and enhanced education of the swimming public about infectious disease transmission at aquatic venues combined with simple, implementable protection measures.

Conclusion

Data collected as part of the national WBDO surveillance system are used to describe the epidemiology of waterborne diseases in the United States. Identification of the etiologic agents and deficiencies responsible for these outbreaks is also critical because new trends might necessitate different interventions and changes in policies and resource allotment.

Surveillance for waterborne agents and outbreaks occurs primarily at the local and state level. Local and state public health authorities should be able to detect and recognize recreational water-associated outbreaks and implement appropriate prevention and control measures. Improved communication among local and state public health departments, regulatory agencies, recreational water facilities, and the public would aid the detection and control of outbreaks. Routine reporting or sharing of inspection data between environmental health, infectious disease, and surveillance staff located within one or more agencies at the local or state level and with agencies in neighboring jurisdictions is recommended.

When an outbreak occurs, the timely collection of clinical specimens and water samples for testing and commencement of an environmental investigation might lead to more rapid detection of the etiologic agent and the source of water contamination. However, the course of an investigation reflects the ability and capacity of public health departments and laboratories to recognize and investigate potential outbreaks of illness. Even when personnel are available to investigate a potential outbreak in a timely manner, investigations cannot always be completed thoroughly. WBDO investigations typically require input from persons trained in different disciplines, including infectious disease epidemiology, environmental epidemiology, clinical medicine, sanitation, water engineering, and microbiology. Either further cross-training of existing personnel needs to be implemented, or additional personnel and resources need to made available or linked to those who typically investigate reports of WBDOs.

State health departments can request epidemiologic assistance and laboratory testing from CDC to investigate WBDOs. CDC and EPA can be consulted regarding engineering and environmental aspects of recreational water treatment and collection of large-volume water samples to identify pathogenic viruses, bacteria, and parasites, which require special protocols for their recovery. Requests for tests for viral organisms should be made to CDC's Viral Gastroenteritis Section, Respiratory and Enterovirus Branch, Division of Viral and Rickettsial Diseases, National Center for Infectious Diseases (NCID), at 404-639-3577. Requests for information or testing for *Legionella* should be made to CDC's Respiratory

Diseases Branch, Division of Bacterial and Mycotic Diseases, at 404-639-2215. Requests for tests for parasites should be made to CDC's Division of Parasitic Diseases, NCID, at 770-488-7756.

Additional information is available from

- CDC's Healthy Swimming website at http://www.healthyswimming.org, which includes recreational water health communication and education materials for the general public and pool maintenance staff (e.g., information regarding disinfection, guidelines on response to fecal accidents [27], and fact sheets concerning recreational water illnesses); technical information regarding laboratory diagnostics; and an outbreak investigation toolkit that can be used by public health professionals;
- EPA's Beach website at http://www.epa.gov/OST/beaches;
- CDC's Voice and Fax Information System, 888-232-3228 (voice) or 888-232-3299 (fax) (choose cryptosporidiosis in the disease category); and
- for reporting WBDOs, CDC's Division of Parasitic Diseases, NCID, at 770-488-7756 or FAX at 770-488-7761; an electronic version of CDC's reporting form (CDC 52.12, rev. 01/2003) is available at http://www.cdc.gov/healthyswimming/downloads/cdc_5212_waterborne.pdf.

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* 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 are defined in the Glossary.

Table 1

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

Class	Epidemiologic data	Water-quality data
I	Adequate Data were provided about exposed and unexposed persons, with relative risk or odds ratio ≥2, or p-value ≤0.05	Provided and adequate Historic information or laboratory data (e.g., the history that a chlorinator malfunctioned or the filter system broke, no detectable free-chlorine residual, or the presence of fecal indicator organisms in the water)
II	Adequate	Not provided or inadequate (e.g., stating that a lake was crowded)
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

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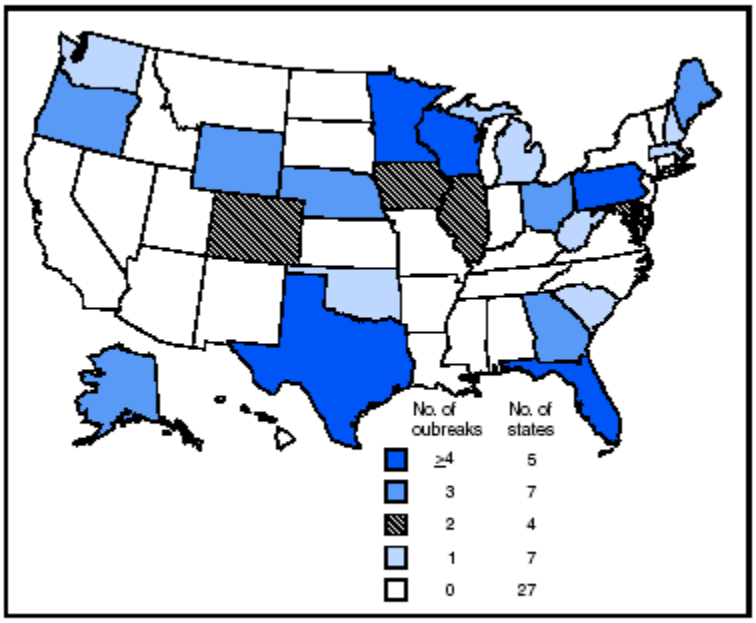
Figure 1

FIGURE 1. Number of waterborne-disease outbreaks (n = 65) associated with recreational water, by state — United States, 2001–2002*



*Numbers are dependent on reporting and surveillance activities in individual states and do not necessarily indicate that more outbreaks occur in a given state.

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Table 2

TABLE 2. Waterborne-disease outbreaks of gastroenteritis (n = 12) associated with recreational water — United States, 2001

State	Month	Class*	Etiologic agent	No. of cases (n = 782)	Source	Setting
Colorado	Jul	III	*Shigella sonnei*	33	Interactive fountain	Community
Iowa	Jun	I	*S. sonnei*	45	Wading pool	Public park
Illinois	Jul	I	*Cryptosporidium hominis*†	358	Pool	Waterpark
Minnesota	Jul	III	*Escherichia coli* O157:H7§	20	Lake	Public beach
Minnesota	Jul	IV	Norovirus	40	Lake	Public beach
Minnesota	Aug	IV	*E. coli* O26:NM	4	Lake	Community park
Nebraska	Jul	IV	*Cryptosporidium* species	157	Pools	Community
Nebraska	Jul	IV	*Cryptosporidium* species	21	Pool	Community
New Hampshire	Aug	III	AGI¶**	42	Lake	State park
Oregon	May	IV	AGI	15	Pool	Lodge
South Carolina	Jul	I	*E. coli* O157:H7	45	Lake	State park
Wyoming	Aug	III	*Cryptosporidium* species	2	Flow-through pool/hot spring††	State park

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12.

† The species of *Cryptosporidium* that infects humans and monkeys (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).

§ Counted as an *E.coli* O157:H7 outbreak in all statistics. Ten persons had stool specimens that tested positive for *E.coli* O157:H7, and one person had a stool specimen that tested positive for *Campylobacter jejuni*.

¶ Acute gastrointestinal illness of unknown etiology.

** *Oscillatoria* was isolated from the lake water in high concentrations, which is consistent with clinical symptoms.

†† Counted as freshwater venue in statistics.

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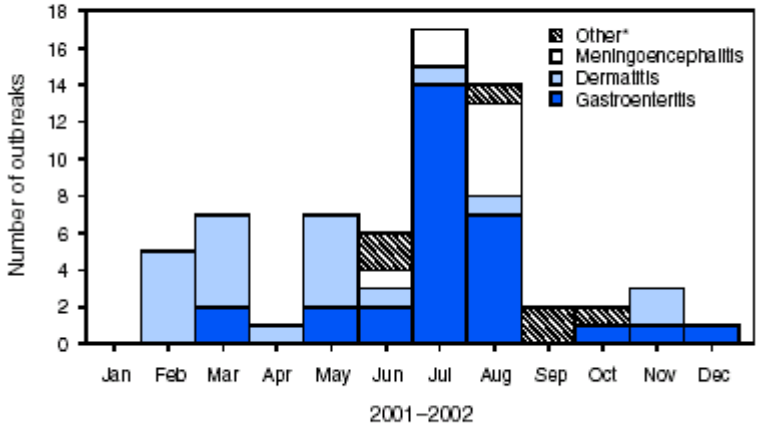
Figure 2

FIGURE 2. Number of waterborne-disease outbreaks (n = 65) associated with recreational water, by illness and month — United States, 2001–2002



* Acute respiratory illness, Pontiac fever, or chemical exposure.

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Table 3

TABLE 3. Waterborne-disease outbreaks of gastroenteritis (n = 18) associated with recreational water — United States, 2002

State	Month	Class*	Etiologic agent	No. of cases (n = 1,137)	Source	Setting
Florida	Jul	I	AGI†	7	Lake	Public beach
Florida	Oct	III	AGI	3	Pool	Apartment complex
Georgia	Jul	III	*Cryptosporidium* species	3	Wading pool	Child care center
Maine	Jul	IV	*Escherichia coli* O157:H7	9	Wading pool	Private home
Maine	Nov	III	AGI	33	Puddle	School
Massachusetts	Jul	II	*Cryptosporidium* species	767	Pool	Membership sport club
Michigan	Dec	IV	AGI	32	Pool	Hotel/motel
Minnesota	Jun	IV	Norovirus	11	Lake	Public beach
Minnesota	Mar	II	Norovirus	36	Pool	Hotel/motel
Minnesota	Jul	II	*Cryptosporidium* species	52	Indoor pool	Health club
Minnesota	Aug	II	*Cryptosporidium* species	41	Pool	Hotel/motel
Minnesota	Aug	II	*Cryptosporidium* species	16	Pool	Resort
Oregon	Aug	II	AGI	9	Pool	Apartment complex
Texas	Aug	IV	*Cryptosporidium hominis*§	54	Wading pool	Hotel/motel
Wisconsin	Mar	IV	Norovirus	15	Pool	Hotel/motel
Wisconsin	Jul	III	Norovirus¶	44	Lake	State park
Wyoming	May	IV	*Cryptosporidium* species	3	Lake	Lake
Wyoming	Jul	IV	*Giardia intestinalis*	2	River	River

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12.
† Acute gastrointestinal illness of unknown etiology.
§ The species of *Cryptosporidium* that infects humans and monkeys (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).
¶ Counted as a norovirus outbreak in all statistics. Two persons with primary cases had stool specimens tested; one person had a stool specimen that tested positive for norovirus, and one person had a stool specimen that tested positive for *Cryptosporidium*. Stool specimens from two persons with secondary cases were tested; one person had a stool specimen that tested positive for norovirus, and one person had a stool specimen that tested positive for *Shigella sonnei*. Illness in persons with primary cases was most consistent with norovirus infection.

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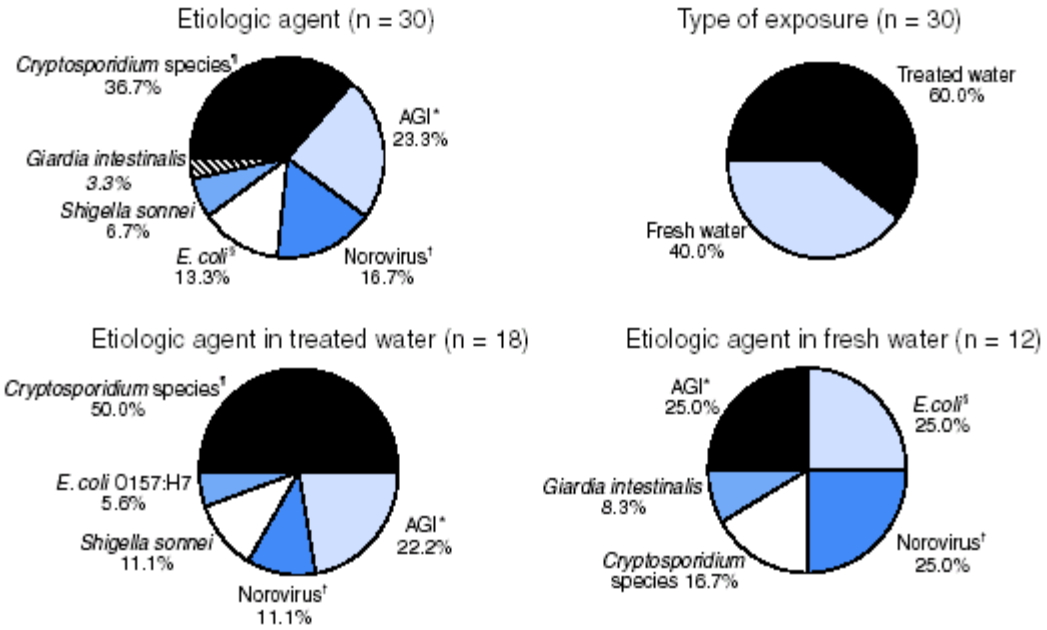
Figure 3

FIGURE 3. Waterborne-disease outbreaks of gastroenteritis associated with recreational water, by etiologic agent and type of exposure — United States, 2001–2002



* Acute gastrointestinal illness of unknown etiology.
† Includes one mixed pathogen outbreak.
§ Includes outbreaks of *Escherichia coli* O157:H7 and O26:NM.
¶ Includes two outbreaks of *Cryptosporidium hominis*.

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Table 4

TABLE 4. Waterborne-disease outbreaks of dermatitis (n = 21) associated with recreational water — United States, 2001–2002

State	Year	Month	Etiologic agent	No. of cases (n = 435)	Source	Setting
Alaska	2002	Feb	*Pseudomonas aeruginosa*[*†]	110	Pool/spa	Hotel/motel
Alaska	2002	Feb	*P. aeruginosa*[§]	3	Pool/spa	Hotel/motel
Colorado	2002	May	*P. aeruginosa*[†]	12	Pool/spa	Hotel/motel
Florida	2001	Mar	*P. aeruginosa*[§]	34	Pool	Hotel/motel
Florida	2001	Mar	*P. aeruginosa*[†]	53	Spa	Hotel/motel
Florida	2001	Apr	*P. aeruginosa*[§]	7	Spa	Apartment complex
Iowa	2002	Mar	*P. aeruginosa*[§]	24	Pool/spa	Hotel/motel
Maine	2001	Feb	*P. aeruginosa*[§]	21	Spa	Hotel/motel
Maryland	2001	Nov	*P. aeruginosa*[§]	8	Spa	Private residence
Maryland	2002	Feb	*P. aeruginosa*[§]	3	Spa	Membership club
Minnesota	2001	May	*P. aeruginosa*[*†]	6	Spa	Resort
Nebraska	2001	Mar	*P. aeruginosa*[§]	9	Pool/spa	Hotel/motel
Ohio	2002	Feb	*P. aeruginosa*[†]	18	Spa	Hotel/motel
Ohio	2002	Mar	*P. aeruginosa*[*†]	31	Pool/spa	Hotel/motel
Oregon	2002	Jul	Avian schistosomes[§]	19	Lake	Lake
Pennsylvania	2001	May	*P. aeruginosa*[†]	2	Spa	Hotel/motel
Pennsylvania	2001	May	*P. aeruginosa*[§]	42	Spa	Hotel/motel
Pennsylvania	2001	May	*Bacillus* species[†]	20	Spa	Hotel/motel
Pennsylvania	2001	Jun	*Staphylococcus* species[§]	3	Spa	Hotel/motel
Washington	2001	Aug	*P. aeruginosa*[†]	3	Spa	Hotel/motel
Wisconsin	2001	Nov	*P. aeruginosa*[§]	7	Spa	Hotel/motel

[*] Laboratory-confirmed case.
[†] Organism isolated from water.
[§] Suspected etiology on the basis of clinical syndrome and setting.

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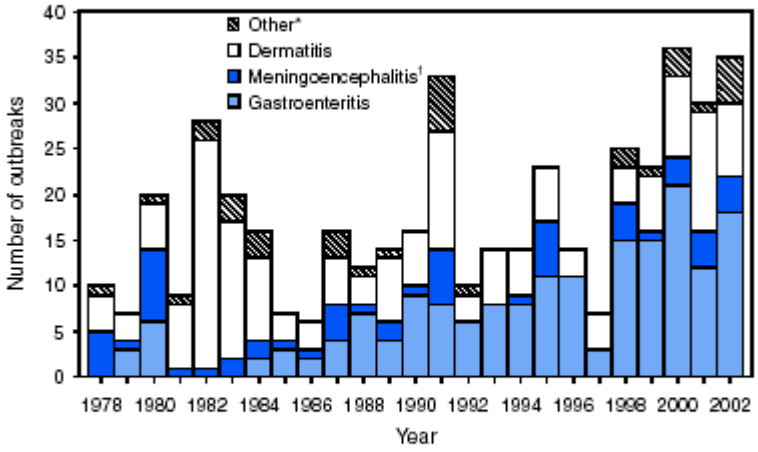
Figure 4

FIGURE 4. Number of waterborne-disease outbreaks (n = 445) associated with recreational water by year and illness — United States, 1978–2002



[*] Includes keratitis, conjunctivitis, otitis, bronchitis, meningitis, hepatitis, leptospirosis, Pontiac fever, and acute respiratory illness.
[†] 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).

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Table 5

TABLE 5. Waterborne-disease outbreaks of meningoencephalitis, acute respiratory infection, and Pontiac fever (n = 10) associated with recreational water — United States, 2001–2002

State	Year	Month	Class*	Etiologic agent	Illness	No. of cases (n = 80)	Source	Setting
Florida	2002	Jul	NA†	*Naegleria fowleri*	Meningoencephalitis	1	Lake	Park
Florida	2002	Jul	NA	*N. fowleri*	Meningoencephalitis	1	Lake	Lake
Georgia	2002	Aug	NA	*N. fowleri*	Meningoencephalitis	1	River	River
Georgia	2002	Jun	IV	ARI§	Acute respiratory	4	Spa	Private residence
Illinois	2002	Aug	I	*Legionella* species¶**	Pontiac fever	68	Spa	Hotel/motel
Oklahoma	2001	Jun	NA	*N. fowleri*	Meningoencephalitis	1	Lake	Lake
Texas	2001	Aug	NA	*N. fowleri*	Meningoencephalitis	1	Lake	Lake
Texas	2001	Aug	NA	*N. fowleri*	Meningoencephalitis	1	Lake	Lake
Texas	2001	Aug	NA	*N. fowleri*	Meningoencephalitis	1	Lake	Lake
Texas	2002	Aug	NA	*N. fowleri*	Meningoencephalitis	1	Lake	Lake

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12.
† Not applicable.
§ Acute respiratory infection of unknown etiology; *Legionella* species suspected.
¶ Also listed in Table 2 in 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 but only counted in statistics pertaining to this summary.
** The spa filter was positive for *Legionella dumoffii*.

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Figure 5

FIGURE 5. Number of waterborne-disease outbreaks of gastroenteritis (n = 176) associated with recreational water, by year — United States, 1978–2002

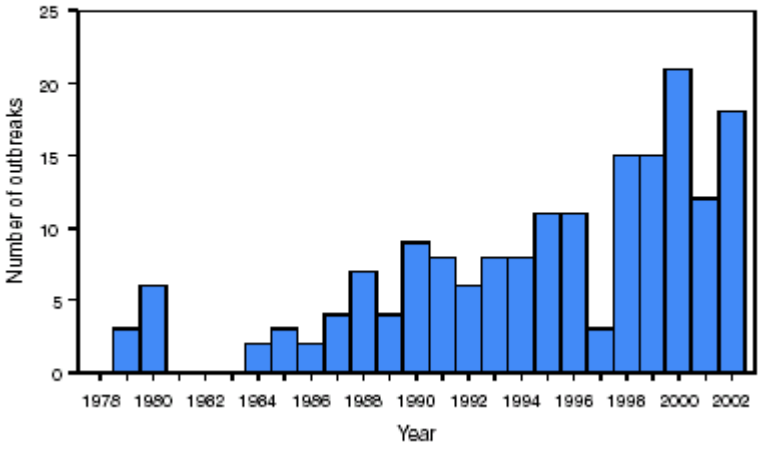

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Table 6

TABLE 6. Waterborne-disease outbreaks involving chemical exposures* (n = 4) associated with recreational water — United States, 2001–2002

State	Year	Month	Etiologic agent	Illness	No. of cases (n = 102)	Source	Setting
Alaska	2002	Sep	Chlorine gas	Acute respiratory	30	Pool	University
Ohio	2002	Jun	Chlorine gas	Acute respiratory	20	Wave pool	Waterpark
West Virginia	2002	Oct	Chloramines†	Acute respiratory	32	Indoor pool	Hotel/motel
Wisconsin	2001	Sep	Chloramines†	Acute respiratory	20	Indoor pool	School

* On the basis of epidemiologic and water-quality data provided on CDC form 52.12.
† Suspected etiology on the basis of clinical syndrome and setting.

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Figure 6

FIGURE 6. Number of waterborne-disease outbreaks of gastroenteritis (n = 176) associated with recreational water, by water type — United States, 1978–2002

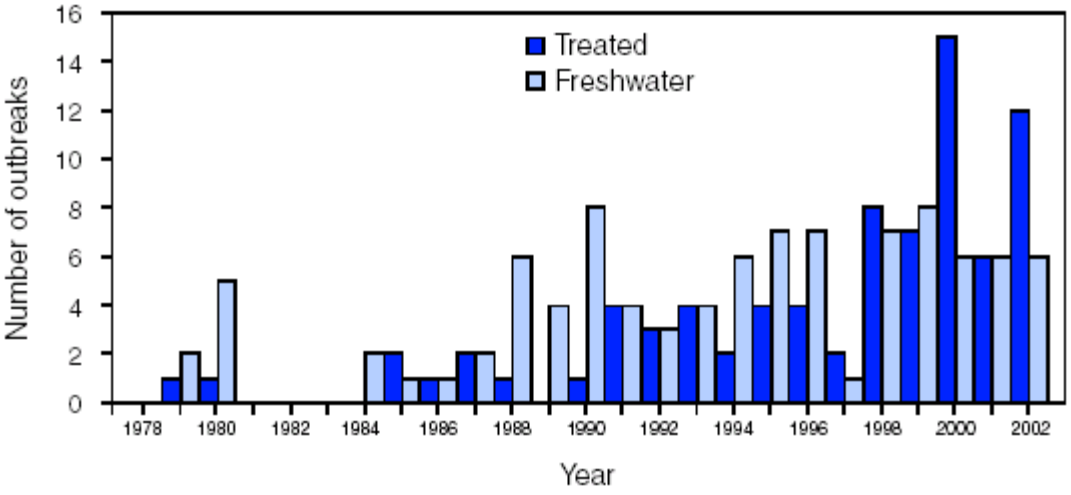

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Table 7

TABLE 7. Waterborne-disease outbreaks (n = 65) associated with recreational water, by etiologic agent and type of water — United States, 2001–2002

	Type					
	Treated		Fresh		Total	
Etiologic agent	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
Bacterial	24	571	3	69	27	640
Pseudomonas aeruginosa	18*	393	0	0	18	393
Escherichia coli (O157:H7, O26:NM)	1	9	3†	69	4	78
Shigella sonnei	2	78	0	0	2	78
Bacillus species	1	20	0	0	1	20
Legionella species	1	68	0	0	1	68
Staphylococcus species	1	3	0	0	1	3
Parasitic	9	1,469	12	34	21	1,503
Cryptosporidium species	9	1,469	2	5	11	1474
Naegleria fowleri	0	0	8	8	8	8
Giardia intestinalis	0	0	1	2	1	2
Avian schistosomes	0	0	1*	19	1	19
Unknown	5	63	3	82	8	145
AGI§	4	59	3	82	7	141
ARI¶	1	4	0	0	1	4
Viruses	2	51	3†	95	5	146
Norovirus	2	51	3†	95	5	146
Chemical	4	102	0	0	4	102
Chlorine gas	2	50	0	0	2	50
Chloramines	2*	52	0	0	2	52
Total	44	2,256	21	280	65	2,536
Percentage	(67.7)	(89.0)	(32.3)	(11.0)	(100)	(100)

* Includes outbreaks of suspected etiology on the basis of clinical syndrome and setting.
† Includes one mixed-pathogen outbreak.
§ Acute gastrointestinal illness of unknown etiology.
¶ Acute respiratory illness of unknown etiology.

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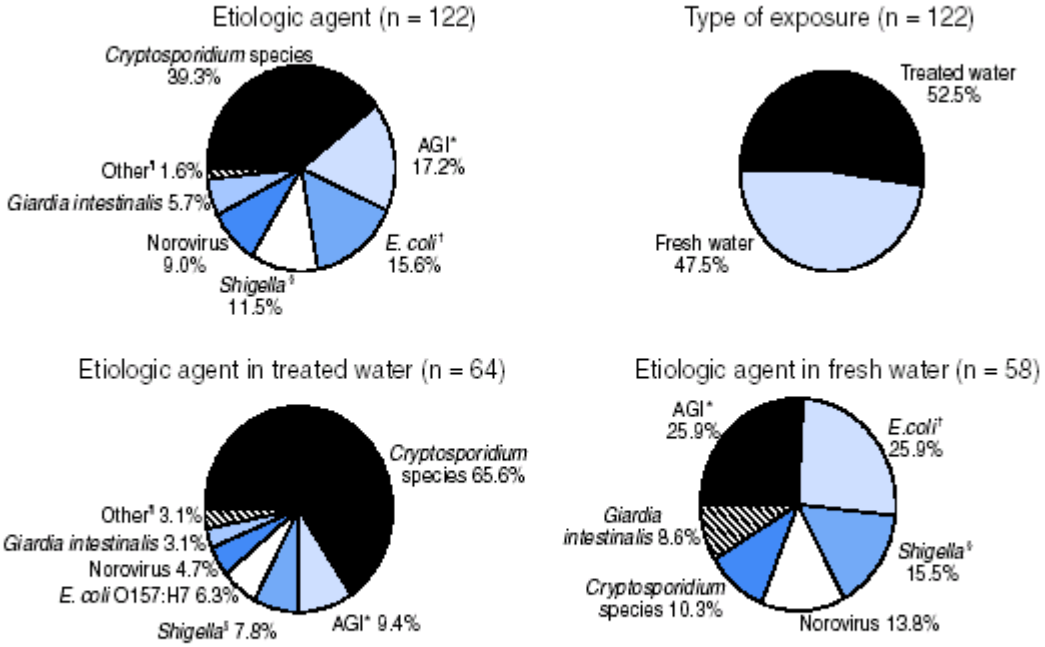
Figure 7

FIGURE 7. Waterborne-disease outbreaks of gastroenteritis associated with recreational water, by etiologic agent and type of exposure — United States, 1993–2002



* Acute gastrointestinal illness of unknown etiology.
† Includes *Escherichia coli* O157:H7, *E. coli* O26:NM, and *E. coli* O121:H19.
§ Includes *Shigella sonnei* and *Shigella flexneri*.
¶ These included outbreaks of *Salmonella* and *Campylobacter*.

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