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## **“Just Keep Swimming -- While Avoiding RWIs”**

One of the most popular seasonal activities in the United States is swimming with an estimated 360 million visits a year to recreational waters. (1) Recreational water illnesses (RWIs) are caused by bacteria, viruses, protozoa, and chemicals found in the recreational water source. Infectious agents can be spread by swallowing, breathing in mists, or having contact with contaminated water in swimming pools, hot tubs, water parks, water play areas, interactive fountains, lakes, rivers, or oceans. RWIs can also be caused by chemicals in the water. Indoor air quality problems can arise at indoor aquatic facilities when pool chemicals mix with water to form gases. The CDC estimates that the majority of outbreaks associated with RWIs are among treated recreational water facilities (69% or greater) and that 90% of the cases of actual illnesses associated with a recreational water source occur at treated recreational water facilities. (2)

Knowing the facts about RWIs can make the difference between your guests having an enjoyable time at a facility, or getting a rash, having diarrhea, or developing other, potentially serious illnesses

### **I. Definition of a Healthy Pool**

RWIs have been associated with a wide variety of infections, including gastrointestinal, skin, ear, respiratory, eye, neurologic, and wound infections. The most commonly reported symptom of a RWI is diarrhea. Diarrheal illnesses can be caused by bacteria, viruses, and protozoa such as *Cryptosporidium*, *Giardia*, *Shigella*, norovirus and *E. coli*. Chlorine does not kill all bacteria, viruses, and protozoa instantly and today, there are several strains of bacteria, viruses, and protozoa that have moderate to high resistance to chlorination (1). Once these bacteria, viruses, and protozoa get in a recreational water system, it may take minutes to days for the infectious agent to be killed. Swallowing even a small amount of the water from the recreational water system or having the water come in contact with the skin can make your guests sick.

According to the US Centers for Disease Control and Prevention (CDC), in the past two decades, there has been a substantial increase in the number of RWI outbreaks. CDC has tracked RWIs through the

Waterborne Disease and Outbreak Surveillance System since 1978. (2) CDC defines an outbreak of RWI as the occurrence of two or more cases of similar illnesses epidemiologically linked by location and time of exposure to either the recreational water or chemicals associated with the water. (2) The CDC reports that RWI outbreaks associated with pools or other aquatic facilities has increase from an average of 15 a year (1993-2002) to 34 a year (2003-2012). (3) Pathogens that are hazards treated recreational waters can be broken down into two categories, fecally derived and non-fecally derived. Fecally derived hazards include protozoa such as Giardia and Cryptosporidium, bacteria such as E.coli and Shigella, and viruses such as adenoviruses, hepatitis A, and noroviruses.

One of the most common infectious hazards found in treated recreational waters is Cryptosporidium, which is a fecally derived hazard. Cryptosporidium is microscopic, ubiquitous parasite that can cause watery diarrhea in individuals. As few as 10 oocysts of Cryptosporidium can cause illness. Transmission of Cryptosporidium is through drinking contaminated food or water and by fecal-oral contact. Cryptosporidium has been shown to have the ability to sicken a large proportion of the population after contamination of a point source of water. (4;5) Cryptosporidium is also able to stay alive for greater than 10 days or more even in well-maintained recreational water facilities (chlorine levels of 1–3 mg/L and pH levels of 7.2–7.8). Cryptosporidium has become the leading cause of swimming pool-related outbreaks of diarrheal illness. (4) From 2004 to 2008, the CDC reported that Cryptosporidium cases increased over 200% 3,411 to 10,500 cases. (5) The CDC also reported for 2011–2012 in June through August, greater than 90% of the gastrointestinal illnesses associated with treated recreational waters were caused by Cryptosporidium. (6) Several notable outbreaks have occurred from Cryptosporidium. In a large outbreak in California, accidental fecal releases in a swimming pool lead to 73% of the swimmers at the pool becoming infected with Cryptosporidium. (7) Another outbreak occurred in Louisiana at water spray/splash park where young children were observed sitting on sprinkler heads. (7)

E. coli are large, diverse group of bacteria that live in the digestive tracts of people and animals. Several serotypes of E. coli can produce illness in people including E. coli O157:H7. A large outbreak of E. coli O157:H7 occurred in the Atlanta area in 1998 at a waterpark. (8) 26 children were culture confirmed to be infected with E. coli O157:H7. The source was determined to be inadequate chlorination of the facility. Several other outbreaks have been documented in the literature associated with improper chlorination in water parks and swimming pools.

Viruses are another hazard that can be associated with fecal contamination in recreational waters. Viruses cannot multiply in water; therefore, the contamination in a treated recreational water source is from an infected source such as a child or an adult. Adenovirus outbreaks in recreational waters have been associated with conjunctivitis (eye infections), throat infections, and fever in children and adults. In a large outbreak of 72 cases, adenovirus was associated with throat and eye infections in swimmers at a large community pool. (8) Swimmers who reported swallowing water more likely to be ill than swimmers who did not report water ingestion. It was later determined that the pool chlorine level was below the recommended levels of 1 ppm or greater of free chlorine. The outbreak was stopped when the pool was closed for the remainder of the swimming season and thoroughly cleaned. Several other large outbreaks have been associated with another virus, hepatitis A. Hepatitis A is a viral infection of the liver and typically does not cause chronic liver disease. A large swimming pool related outbreak of

hepatitis A was reported among more than 800 summer campers. The source of hepatitis A was more than likely cross contamination between a sewer line and the pool water intake line. The pool was maintained at proper chlorination levels. (8)

A common non-fecally derived infectious agent in treated recreational waters is *Pseudomonas aeruginosa* (*Pseudomonas*). *Pseudomonas* is also ubiquitous in the environment and it can be easily spread from person to person in treated recreational waters by people transferring the organism from the environment on their hands and feet into the recreational water. The warm, moist environment on decks, drains, benches, and floors around swimming pools can provide an ideal environment for *Pseudomonas* to grow in. In 2009-2010, CDC estimates that half of the 57 RWI outbreaks reported were associated with hotel (19 outbreaks) or waterpark (14 outbreaks) settings. Outbreaks associated with the hotel setting most frequently started in February, March, or April. The outbreaks reported in hotels or waterparks were outbreaks of dermatologic illnesses, conditions, or symptoms caused by *Pseudomonas* and were epidemiologically linked, at least in part, to a hot tub or spa (11 outbreaks). (2) *Pseudomonas* is frequently found in whirlpools and hot tubs, sometimes in 94-100% of those tested (9). The high concentrations found in spas and whirlpools probably result from the relatively high temperatures which favor the growth of *Pseudomonas* and the aeration which also enhances its growth. The organism is usually found in recreational water environments when the chlorine concentrations are low, but it has been isolated even in the presence of 3.00 ppm residual free chlorine (many states require at least 1 ppm or greater of free chlorine). Outbreaks of folliculitis (swimmers rash) and ear infections (swimmer's ear) have been reportedly associated with the use of whirlpools, spas, and hot tubs. In addition, it has been recognized as a serious cause of keratitis (eye infections), especially in persons wearing contact lenses. Folliculitis typically appears 48 hours after exposure and can last up to 5 days and is more likely to be associated with a hot tub or spa. (7) Outbreaks have also been reported from exposure to *Pseudomonas* in swimming pools and water slides. Swimmer's ear is more commonly associated with swimming pools, water parks, and water slides. *Pseudomonas* in spas, hot tubs, whirlpools, swimming pools, and other recreational waters tends to live in a biofilm. A biofilm is a film of bacteria that creates a large colony in the oils and residues that collect on the water surface, the walls of the pool or spa, filter tank bodies and impellers, piping, and plumbing. Bacteria can attach to a surface and have rapid colonization and produce an exopolysaccharide film that is can be highly resistant to chlorine or bromine disinfection.

Disinfectants are essential in preventing an infectious disease outbreak in recreational waters. But, the disinfectant process itself can also become a hazard. The most common disinfectant used in recreational waters is chlorine. Hypochlorite, the most common form of chlorine used in recreational water facilities, can react with sweat, urine, and other organic matter in a swimming pool and form chloramines. Chloramines are volatile and easily form a gas. Chloramine gases have been associated with several respiratory disease outbreaks. There are also documented cases of occupational asthma as a result of exposure to swimming pool chemicals in individuals who work at swimming pools. (11)

## **II. Issues Associated with a Waterborne Illness Claim**

Swimmers and their illnesses share the water with every person who enters a recreational water source. On average, people have about 0.14 grams of feces still on their body that can contaminate recreational water. The concentration of *Cryptosporidium* in feces of infected persons can range from  $10^5$  to  $10^7$  oocysts per gram and enteric viruses (enteroviruses, adenoviruses, and rotavirus) from  $10^5$  to  $10^{12}$  per gram. (12) Some infectious agents such as *Cryptosporidium* require only 10 oocysts or so to produce illness. CDC undertook a large sample of commercial pool and spa filters (161 locations) in the metro Atlanta area to estimate potential exposures to recreational water contamination. (13) In 75% of the sampled waters, some type of microbe such as *E. coli*, *Cryptosporidium*, viruses, or *Pseudomonas* was present. 58% of the locations were positive for *E. coli* alone indicating that fecal contamination had occurred. Public swimming pools (70%), water parks (66%), and private swimming clubs (49%) all tested positive for *E. coli* in their water. In addition, 42% of the recreational water venues had both *E. coli* and *Pseudomonas*. One individual having a diarrheal incident can contaminate a large water park or swimming pool. While there is no standing water in interactive fountains/splash pad areas, the spray water will rinse any contaminants down into the water holding area where the water is recycled to be sprayed again. In previous outbreaks at splash pads, the outbreak has been traced back to a single child with a dirty diaper sitting on a fountain head. Also, not all decorative fountains are chlorinated or filtered.

A 2010 study found that 1 in 8 public pool inspections resulted in pools being closed immediately due to serious code violations such as improper chlorine levels. And while some infectious hazards like *Cryptosporidium* tends to be tolerant to chlorine, most bacteria, protozoa, and viruses are not. Proper maintenance of the recreational water area is key step in preventing a RWI outbreak.

Public health codes for recreational water facilities in the United States are independently written and enforced by individual state or local agencies and can vary from location to location. This variation can make it difficult for a large, multi-location organization to ensure their recreational water facilities meet all codes. But there is science based federal guidance such as the Model Aquatic Health Code that contains information on prevention.

Some simple steps are listed below:

- Use Signage- The CDC study on pool water samples found that less than only 35 of the 161 swimming pools had signs instructing patrons not to swim if they had diarrhea. Also include warnings on open wounds.
- Have showers available- Encouraging patrons to rinse prior to swimming can reduce pool contamination. Also encouraging patrons to shower after swimming can reduce *Pseudomonas* infection rates.
- Provide changing areas for diapers away from the recreational water along with providing adequate soap and water for hand washing.
- Increase pool maintenance- the risk of contamination increases with lower chlorine or bromine levels. Hot tubs, spas, and whirlpools need frequent maintenance checks due to the increased water temperatures.
- Maintain pool pH between 7.2-7.8

- Maintain free chlorine concentration of at least 3 ppm in hot tubs/spas and at least 1 ppm in other places with treated water.
- Maintain free bromine concentration of at least 4 ppm in hot tubs/spas and at least 3 ppm in other places with treated water.
- Consider having duplicate disinfection systems such as filters, UV radiation, and chlorination.
- Remove pool chemicals from the areas where patrons have access.
- Consider adoption of federal guidelines such as the Model Aquatic Health Code.

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