THE HAZARD REVIEW

"TARGETING WATER CONTAMINATION"

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"IT WASN'T A CHOCOLATE COVERED CANDY BAR IN THE POOL"

It made a good sight gag in the movie "CADDYSHACK" but, fecal accidents in a pool are really not a laughing matter. A variety of illnesses ranging from minor and self-limiting to life-threatening have been reported as a result of using contaminated swimming pools, spa pools, and hot tubs. Increased use of spa pools and hot tubs and the discovery of more resistant strains of bacteria, viruses, and protozoa have led to recommendations of higher levels of disinfectant. In spa pools, elevated water temperature, turbulent water, and heavy bather load lead to the rapid depletion of disinfectants. Of the three, bather load is the most significant factor in the depletion of disinfectant.

FORMULA CT

The hardiness of an organism when exposed to a specific disinfectant can be quantitatively expressed by the formula CT, where C is the concentration in mg./L of the disinfectant and T is the time in minutes of exposure. This value typically represents the concentration of a particular disinfectant and the time required to inactivate 99.9% of the organisms. Depending on the organism and disinfectant, this can vary from low to high levels of disinfectant for short to long periods of exposure time.

PSEUDOMONAS AERUGINOSA

One of the most frequently isolated organisms found most often in spa pools ***is Pseudomonas aeruginosa.*** These hardy thermophilic bacteria have a slimy coating that makes them more resistant to disinfectants. ***Pseudomonas aeruginosa*** is most often responsible for outbreaks of folliculitis and skin dermatitis but can also cause otitis, pneumonia, and urinary tract infections. Symptoms of folliculitis usually last about seven days and include malaise, fatigue, fever, and a papulopustular rash. The onset of the illness is usually within two days to two weeks following exposure, and most cases are self-limiting requiring little or no medical treatment. The amount of time spent in the contaminated water is an important factor in determining whether or not a person will become ill. Most outbreaks can be traced to lack of proper disinfection, inadequate filtration, and/or lack of proper pool maintenance and cleaning practices. Many outbreaks have been associated with spa pools at health clubs, hotels and motels.

STAPHYLOCOCCUS

Another group of bacteria that are commonly found in swimming and spa pools are ***Staphylococci***. These bacteria originate from the pool user's skin and oral and nasal tracts. The coagulase positive varieties, e.g. ***Staphylococcus aureus***, can cause serious skin infections as well as conjunctivitis, otitis, and upper respiratory and urinary tract infections.

LEGIONELLA PNEUMOPHILA

Legionnaires' disease was reported in a 1994 incident but cleaning of the filter and superchlorination successfully ended the outbreak. A Vermont study in 1983 indicated that ***Legionella pneumophila*** was isolated from three out of seven whirlpool spas located at local inns. In 1982, 14 out of 23 Michigan church group members became ill with flu-like symptoms after using a spa pool. The illness was identified as pontiac fever, a milder form of Legionnaires' disease.

Legionella can be found in both raw and treated water. These bacteria are thermophilic and can survive temperatures up to 50 degrees C. ***Legionella*** may often be found in the plumbing systems of hospitals with no apparent cases of Legionnaires' disease, indicating that some strains are more virulent than others. The United States Environmental Protection Agency (EPA) recommends free chlorine residuals of 8 mg./L to control ***Legionella*** in hot water plumbing systems. The EPA also reports that in some cases, a level of 1.5-2.0 mg./L is sufficient to control the organism.

SHIGELLA

Shigellosis, caused by the bacteria ***Shigella***, is an acute bacterial illness involving the large intestine and is characterized by diarrhea, fever, nausea, and sometimes, vomiting, cramps, and toxemia lasting 4 to 7 days. Mild and asymptomatic infections do occur. An outbreak of Shigellosis occurred at a 70 acre man-made recreational swim area in Los Angeles County in 1985. The chlorination system was inactive resulting in an outbreak of 68 reported cases, 7 of which required hospitalization.

In addition to the bacteria mentioned above, a variety of viruses have been implicated in disease outbreaks at public pools including adenovirus, enterovirus, and hepatitis A virus. Adenovirus type 4 was identified as causing an outbreak of pharyngocojunctival fever at a swimming pool in Georgia and a summer camp in North Carolina. Pharyngocojunctival fever is characterized by fever, conjunctivitis, sore throat, headache, and chills. A major factor in both outbreaks was inadequate chlorination.

VIRUSES

In a 1981 study, municipal and wading pools in the Houston area were tested for viruses. Viruses, including enterovirus, echovirus, coxsackievirus, adenovirus, and poliovirus, were isolated in 10 out of 14 samples. Two of the pools that contained enterovirus had free chlorine residuals that exceeded 0.4 mg./L. The study suggested that viruses were generally more resistant to chlorine than coliform bacteria.

In 1989, an outbreak of hepatitis A associated with swimming pool use occurred at a Louisiana campground. Twenty people became ill approximately one month after swimming in one of the campground's swimming pools. It was theorized that hot weather and heavy bather loads depleted the free chlorine residual in the swimming pools. It is speculated that the pools were contaminated by either fecal contamination from one of the pool users or by sewage from a cross-connection.

GIARDIA & CRYPTOSPORIDIUM

Of great concern in the last decade have been outbreaks of illness caused by species of ***Giardia*** and ***Cryptosporidium***. Both organisms are protozoans and are transmitted from person-to-person through oral-fecal route. Giardia causes diarrhea, abdominal cramps, fatigue, and weight loss. The prevalence of stool samples that test positive for Giardia in the general population may range from 1% to 30% . An outbreak of Giardiasis occurred at a public swimming pool in New Jersey in the fall of 1985. The source of the contamination was most likely a handicapped child who had a fecal accident in the pool. Records indicated that no chlorine reading had been taken on the day of the contamination, and the following day the chlorine level was zero. At temperatures normally maintained in pools (>20 degrees C.), inactivation of Giardia cysts occurs at free chlorine concentrations of 1.5 mg./L for 10 minutes or a CT value of 15.

Cryptosporidiosis is characterized by prolonged diarrhea, abdominal cramps, malaise, and fever. Cryptosporidiosis is usually a self-limiting illness but can be life-threatening to immunocompromised individuals, such as persons with AIDS or persons receiving chemotherapy. In developed areas such as the United States or Europe, prevalence of infection with Cryptosporidium is found to be between 2.2% and 4.5%. Due to the many possible diagnosis of patients with diarrhea, Cryptosporidiosis may often go unrecognized. Infectivity is high, with as little as 10 oocysts causing illness. A single fecal accident in even a large pool is sufficient to cause illness in a great number of people. It has been estimated that 1ml of feces can contain as much as 5×10^7 oocysts. Put in perspective, an infected child having a loose bowel movement of 150 ml into a 100,000 gallon swimming pool, would result in a concentration of 20 oocysts/mll of pool water. A swimmer swallowing just 10 ml of water in that pool would ingest 200 oocysts, a dose capable of causing infection.

In 1988, an outbreak in Los Angeles County involved 60 cases of Cryptosporidiosis resulting from individuals swimming in a 100,000-gallon swimming pool in which there was a single fecal accident. The overall attack rate was 73%. In a second outbreak reported in British Columbia, 66 clinical and 23 confirmed cases of Cryptosporidiosis were shown to have resulted from swimming in a 70,000 gallon swimming pool. The children's pool was closed when it was found to be the probable source of infection. The pool in question had experienced an increase in the number of fecal accidents from the usual one or two per month to one or two per week, with three known diarrheal episodes. Recent outbreaks of Cryptosporidiosis were reported at a wave pool in Lane County, Oregon, in 1992 and at a swimming pool in Dane County, Wisconsin, in 1993. Cryptosporidium oocysts are extremely resistant to

chlorine and it has been reported that a CT value of 9,600 is required to inactivate them.

BACKFLOW PREVENTERS

To best protect the public health, Watts Regulator recommends a reduced pressure principle type backflow preventer, such as the No. 909QT, be installed on all feed lines into the pool facility. An inspection of all toilet, urinal and sink fixtures should be made to insure proper airgaps and antisiphon devices are in place and functional. Each wall faucet or hose connection should be protected with a non removable hose bibb vacuum breaker such as the No. 8B. Chemical vats, feeders, mixing units or other similar hazards should be isolated using the appropriate vacuum breaker Series 288A, pressure vacuum breaker Series 008QT or reduced pressure principle type assembly Series 909QT depending on the piping and type of possible backflow (backsiphonage only or backpressure and backsiphonage). A site inspection should not overlook other typical hazards such as food service areas, boilers, air-conditioning units and janitorial sinks.

POOL/SPA OPERATION

It is also recommended that:

1) All persons maintaining or operating public pools should be properly trained Certified Pool/Spa Operators as offered by the National Swimming Pool Foundation.

2) The recirculation and filtration system should be maintained on a posted schedule that varies with the demands of bather loads. Gauges and flowmeters should be frequently monitored and filters promptly cleaned when required.

3) Pool water should always be kept in chemical balance. The pH should be maintained between 7 . 2 and 7.8, the alkalinity between 80 and 150 ppm and the calcium hardness at 200-400ppm.

4) Free chlorine residual and pH should be tested at least twice daily, and in heavily used pools, hourly. A log should be kept of all chemical tests and maintenance procedures performed.

5) The free chlorine residual in swimming pools should be continually maintained at a minimum of 2.0 mg./L, and in spa and wading pools at 3.0 mg./L. All pools using chlorine as a disinfectant should be superchlorinated when combined chlorine levels exceed 0.5 mg./L.

6) It should be posted and enforced that instructors, lifeguards, and the general public should not use the pool if they are suffering from a diarrheal type illness or other communicable disease. Diaper-age children or children who are not toilet-trained should be prohibited from using the pool.

In the event of fecal contamination, the following procedures should be performed:

a) The pool should be closed.

b) As much fecal material as possible should be removed from the pool. If the pool is vacuumed, waste should be directed to a sanitary sewer or other approved waste disposal system and not through the filtration system. The vacuum equipment should be cleaned and disinfected before reuse.

c) The free chlorine residual should be raised to 20.0 mg./L, and the pH adjusted to between 7.2 and 7.5. This chlorine level should be maintained for at least nine hours. This is the equivalent to an approximate CT value of 10,000.

d) The filtration system should be operated for a minimum of three to four turnovers. At public swimming pools, the turnover rate, or the amount of time it takes to filter all of the water in the pool, is usually six to eight hours; therefore, three turnovers can be achieved within 24 hours.

e) After three to four turnovers, thoroughly backwash the filter.

f) Disinfect the filter tank and filter media with a 20:1 solution of sodium hypochlorite.

g) Restart the filtration system

NOTE:

With permission, this review of a common hazard is based in large part on an article written by Richard Kebajian, M.P.H., R.E.H.S.: Kebabjian, R.S. (1995) Disinfectation of Public Pools and Management of Fecal Accidents. Journal of Environmental Health, vol. 58, No. 1. Reprints of the original article can be obtained by writing the Journal of Environmental Health at 720 S. Colorado Blvd. Suite 970 , South Tower , Denver , Co. 80222

Additional copies of this article or a full list of additional reference materials can be obtained by contacting Watts Regulator at 978-688-1811.

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