

Preventing E.coli Transmission Through Swimming Pool Water

Alison Osinski, Ph.D.

The recent occurrence of E.coli at White Water Atlanta sparked national concern about transmission of E.coli through swimming pool water. Due to the many phone calls she received seeking information, Dr. Osinski prepared the following paper on E.coli, and gave us permission to use it in this issue of the E&A News. Ed.

Escherichia coli (commonly referred to as E.coli) are a form of coliform bacteria. (See insert) Some strains of E.coli can cause severe, life threatening symptoms. E.coli can be transmitted from an infected individual through introduction of fecal matter into pool water. Because of their mobility, the constant circulation of pool water, and aerosolization of organisms from splashing by patrons, and agitation of water from hydrotherapy jets, sprays, fountains, geysers and other water features, E.coli can move easily and rapidly throughout the pool or waterpark area.

Fecal contamination of pool water can result from any of the following sources:

- Human fecal matter intentionally or accidentally being deposited in the pool,
- Animal, rodent & bird droppings
- Fecal matter tracked into the pool area on shoes,
- Fertilizers or grass blown into the pool from adjoining landscaping,
- Contaminated ground water, reservoirs or wells,
- Rain and storm water run-off into the pool
- Illegal cross connections between the pool circulation and sewage systems.

Fecal contamination of pool water

can cause serious illnesses. Ingestion of contaminated water while swimming, inhalation of water vapor above the pool surface and body contact with pathogenic organisms, absorption through body orifices or open wounds while swimming can result in transmission of a variety of diseases. Some pathogens may cause mild gastrointestinal discomfort. E.coli causes gastroenteritis with symptoms of diarrhea, cramping, nausea and vomiting. Some strains of E.coli, such as O157:H7, responsible for the June outbreak at Atlanta's White Water waterpark, and the Jack-in-the-Box tainted hamburger outbreak a few years ago, result in life-threatening symptoms. Bacterial infections may, or may not, be successfully treated with antibiotics.

If fecal matter is introduced into pool water, it can be neutralized through proper sanitation and oxidation. However, sanitizer efficacy depends on several factors, including:

- Residual disinfectant levels maintained in the water
- oxidation reduction potential
- 24-hour uniform circulation patterns and absence of dead spots
- Physical characteristics of the water such as TDS level and amount of suspended colloidal solids present
- whether settled materials are being removed through vacuuming
- the percentage of water circulating through the perimeter overflow system
- frequency of dilution and draining of the pool
- filter media effectiveness
- pH levels & water temperature
- bather load to water volume

The length of bather exposure to the pathogenic organism, whether pathogens are imbedded in higher organisms such as algae, the density or number of organisms present in a specific volume of water, and the microbe strength or virulence will also determine the likelihood of disease transmission.

To lessen the probability of fecal

Pathogenic, or disease causing, organisms include bacteria, viruses, protozoa and fungi. Bacteria are single-celled micro organisms which do not contain chlorophyll, divide by simple division, and can only be seen with a microscope. (They are typically 0.5-1.0 microns in size.) Some bacteria cause disease in humans, (pathogens), while others have beneficial purposes (for example: fermentation, removal of harmful gasses from the air, or decay of dead organic matter). Bacteria occur in three forms: spherical (cocci), rod shaped (bacilli), and spiral (spirilla).

Bacteria are further classified as: aerobic (oxygen breathing) vs. anaerobic (CO2 breathing); motile vs. nonmotile (whether they can move or not); sporulating vs. non-sporulating (whether they form spores); and gram negative, gram positive, or acid fast - which relates to results of chemical staining tests used to distinguish cell wall thickness, chemistry and permeability of bacterial cells.

Coliform bacteria belong to Enterobacteriaceae, a family of aerobic and anaerobic, gram-negative, rod shaped, non-spore forming, high motile bacteria that are found in the intestines of warm-blooded animals, including humans.

E.coli cont.....

contamination, ask swimmers to use the toilet before entering the pool and to wash their hands with soap and hot water, or preferably take a hot, soapy shower in the nude, prior to entering the pool or re-entering the pool after using the toilet. Do not permit diaper changing at poolside. Request that patrons not use the pool if they are suffering from an illness that causes diarrhea or have had diarrhea in the past two weeks. Require the wearing of "swimsuit diapers" or tight fitting rubber/plastic pants by children who are not yet toilet trained. Request that patrons remove their street shoes when walking on the pool deck.

In addition, do not allow pets to swim in the pool, and try to prevent wild animals, birds and ducks from using the pool as a watering hole. Good pool and deck design will prevent grey water, waste water or sewage from draining or backing up into your pool.

If a fecal accident does occur:

- Have swimmers exit the pool and close the pool for 24 hours or a minimum of 3-4 complete turnovers.
- Remove as much of the solid fecal matter from the pool as possible
- Dispose of the fecal matter to a sanitary sewer
- Disinfect the skimmer net, leaf rake or vacuum equipment used to remove the fecal matter
- Raise the free chlorine residual to at least 20ppm, and monitor and maintain the 20ppm FAC residual for a minimum of 9 hours in order to achieve an effective CT value
- Keep the pH between 7.2 and 7.4 to increase the percentage of hypochlorous acid formation
- Backwash the filters and disinfect filter media or elements with a solution of 20 parts of water to

1 part of 10-15 sodium hypochlorite (liquid pool chlorine) prior to re-opening the pool.

In small wading pools and spas, it may be more effective to follow the above listed recommendations, but at the end of the fourth superchlorinated, 30 minute to 1-hour turnover period, drain the pool. The pool shell and filters should be scrubbed with a sodium hypochlorite disinfectant solution (20 parts of water to 1 part of 10-15% sodium hypochlorite), prior to reassembling the filters and refilling the pool with water.

Perform bacteriological analysis on water samples taken from the pool whether your state or local health codes require that tests be performed by an independent laboratory on a regular weekly or monthly basis or not. Simple tests are now available for on-deck testing by pool operators. If a pool operator only tests for chemical levels in the water, and does not monitor bacterial growth, he/she will probably be unaware of a bacterial contamination problem until bathers start complaining of infection.

Follow the manufacturer's or lab's directions to avoid contaminating samples during the collection procedure. Use a neutralizing buffer solution (often sodium thiosulfate or quaternary ammonia compounds) to inhibit residual sanitizers that might be in the sample. Do not touch parts of collection devices that come into contact with the sample. Collect water samples from 12-18 inches below the water surface to obtain a representative sample. Disperse the sample onto the treated growth medium. For surface monitoring, swab the surface to collect microorganisms. Place the sample in an environment favorable to microorganism cultivation. Incubate (usually at room or specified warm temperature) for 24 hours for bacterial tests. Try to prevent the formation of condensation

inside samples since the liquid condensate will drop into the sample and disperse the microorganism.

Examine the results without opening the sample after the culture has been incubated. Count the colonies to determine the concentration of microbial contamination. Or, determine the presence or absence of the particular microorganism in the sample. If using the membrane filtration technique for testing total coliforms, fewer than one colony per 100 milliliters should develop. Presence-absence tests should indicate absence of the organism. If the multiple tube fermentation method is used, none of the five standard ten milliliter portions should show the presence of organisms of the coliform group at any time. Coliform presence in test samples indicates fecal contamination of the pool. If total coliforms are present in the sample, then testing for E.coli should also be performed.

Just a reminder — handle carefully when disposing of bacterial cultures. Do not open the vials or petri dishes before sterilization in a microwave oven (not used for cooking food), in an autoclave, by sterilization in bleach, or by approved disposal as a bio waste. And, do not allow swimmers back in the pool until tests show the water is not contaminated.

In addition to the preventative measures suggested in the above article, we would suggest signage in dressing rooms to reinforce the use of soap showers, and continued efforts at public education through the news media and educational hand-out literature.

The knowledgeable people at WhiteWater Atlanta acted/reacted rapidly, or that occurrence could have been much worse. We must all make an effort at public education on this and similar problems.
Ed.