

Health and hygiene

1. Overview

Pool users can become affected by disease-causing microorganisms (pathogens) transmitted by contaminated pool water, contaminated surfaces or person-to-person contact. Resulting illnesses include gastroenteritis and infections of the skin, eyes or respiratory system. Although most pools and facilities are well maintained, pathogens such as *Cryptosporidium* can remain infectious in pool water. Patrons with diarrhoea and nappy-aged children pose the largest risk of contamination to pools and facilities.

Pool operators are encouraged to adopt a risk management approach to preventing contamination. Strategies include staff and patron education, encouraging hygienic practices, and maintaining optimal control and management of pool operations.

Cryptosporidium resists normal levels of disinfectants and can survive for days in pool water

2. Sources of contamination

Contamination is mainly introduced by pool users, but also via the environment. It can occur within the pool itself, on the pool deck, or in facilities such as changing rooms.

Environment

Environmental contamination is especially relevant to outdoor pools, where organic material such as dust, soil, sand, leaves and grass is constantly around and in the pool. Birds and other animals can also contaminate the pool with droppings, reducing the levels of available disinfectant in the pool.

Pool users

Most pool water contamination is introduced by patrons as faecal material, but also includes body fluids, hair, skin and lotions and cosmetics. Swimmers with diarrhoea and nappy-aged children may have faecal accidents in the pool, or faecal material on their bottoms. Diarrhoeal faecal accidents are often mostly liquid, and are very difficult to see. Bathers may continue shedding infectious pathogens for days or weeks after their symptoms cease.

Staff or patrons with diarrhoea should not use the pool for at least one week after their symptoms cease, as they could infect other users

The risk of pool contamination is increased by:

- high bather-loads during peak periods

- swimmers with a diarrhoeal illness or faecal incontinence
- use by nappy-aged children
- inadequate levels of disinfectant in the water, or inadequate filtration.

3. Infections spread in swimming pools

Even in well-maintained pools, patrons may become infected by a variety of pathogens. Remember that although the normal level of disinfectant will inactivate most pathogens, it does take time to work. Variations in deactivation time for a range of pathogenic organisms are shown in *Figure 5*. Bacteria are usually deactivated quickly by disinfectants, but viruses and parasites may persist for a range of time – up to a week for *Cryptosporidium*. Pool facilities and shared equipment, such as swimming aids, can also become contaminated and transmit pathogens.

Figure 5: Deactivation times for selected pathogens in pools

Contaminant	Disinfection time*
<i>E. coli</i> bacteria	< 1 minute
Hepatitis A virus	16 minutes
<i>Giardia</i> parasite	45 minutes
<i>Cryptosporidium</i> parasite	9600 minutes (6.7 days)
*1mg/L (1 ppm) chlorine at pH 7.5 and 25°C	

Source:
Centres for Disease Control
<http://www.cdc.gov/healthyswimming/fecalacc.htm>
Accessed 04/12/2006

The risk of transmission increases if the pool water disinfectant is not maintained at appropriate levels, or if pool facilities are not cleaned adequately. To prevent contamination, pool users who have had a diarrhoeal illness, including staff, should not use any swimming pool for at least one week after symptoms cease.

Bacteria

Maintaining routine disinfection levels can inactivate bacteria in pool water. However, pathogenic bacteria can quickly proliferate if disinfectant levels drop.

Pseudomonas aeruginosa bacteria can cause eye, ear and skin infections and has been associated with waterborne disease outbreaks where the pool water was inadequately disinfected. Particular care should be taken with spa pools, as the water turbulence, temperature and heavy bather-loads increase the risk of *Pseudomonas* growth.

Legionella pneumophila bacteria are found in soil, rivers and creeks. Infection with *Legionella* can cause Legionnaires' disease, a severe respiratory illness caused by the inhalation of

contaminated aerosols. Legionnaires' disease has not been associated with conventional swimming pools, but can be transmitted by poorly maintained and disinfected spa pools.

Mycobacterium marinum causes skin ulcerations (granulomas) and can be found on wet pool surrounds. Adequate floor cleaning and wearing pool shoes or thongs in showers and at poolside can help to reduce transmission.

Escherichia coli colonise human intestines and indicate that there is faecal contamination in the pool. Some types of *E. coli* can cause serious disease in humans.

Shigella, *Salmonella* and *Campylobacter* are pathogens that can cause gastroenteritis.

Viruses

Many viruses can be transmitted person-to-person via pool water, and although normal disinfection concentrations will eventually inactivate them, they are more resistant to chlorine than bacteria.

Enteroviruses and *norovirus* are more resistant to chlorine than bacteria, and are a common cause of gastroenteritis. They are most frequently found in pools used by young children, where hygiene is poor and the volume of water is low.

Adenoviruses can cause respiratory illness, conjunctivitis and fever, frequently accompanied by diarrhoea.

Molluscum contagiosum is a viral disease of the skin that causes round, firm lesions persisting for up to two years, if left untreated. Lesions on adults are more common on the lower abdomen, genitalia or inner thighs. In children, lesions are more common on the face, trunk, and limbs. *Molluscum* may also be transmitted through contaminated surfaces and shared equipment, such as towels. Adequate floor cleaning and wearing pool shoes or thongs in showers and at poolside can reduce transmission. Exclusion from the pool is not necessary for patrons with *Molluscum*.

Plantar warts (*Verrucae*) are caused by the Human Papilloma Virus (HPV), and can be transmitted through contaminated floor surfaces. Adequate floor cleaning and wearing pool shoes or thongs in showers and at poolside can reduce transmission.

Parasites, (including *Cryptosporidium*)

Cryptosporidium and *Giardia* are protozoal parasites that cause the gastrointestinal diseases cryptosporidiosis and giardiasis, respectively. Infection occurs when they are shed in the faeces of an infected person, and are ingested by another, such as when swallowing contaminated water. These diseases can cause profuse, watery diarrhoea, fatigue, vomiting, nausea and abdominal pain. Sometimes they produce no symptoms at all, but the parasites may still be excreted in large numbers by the infected person. Pool water disinfectants at recommended residual levels have only a limited effect on *Giardia*, and are ineffective against *Cryptosporidium*. Normal filtration processes take time to remove these organisms, and testing for the parasites in water is difficult. If *Cryptosporidium* is suspected, the level of disinfectant may need to be increased in accordance with Chapter 4. Adding coagulant to the water and frequent backwashing of filters is highly recommended.

Raise the levels of free disinfectant to inactivate the pathogen, if contamination with *Cryptosporidium* is suspected

Acanthamoeba and *Naegleria fowleri* are protozoan pathogens that occur naturally in the environment, such as in mineral springs and thermal bores. Although unlikely to be a problem in normal swimming pools, operators of facilities that use natural water sources should be aware of the potential hazard. These protozoa can infect a swimmer through the nasal cavity and cause a fatal form of meningo-encephalitis. Maintaining the required level of disinfectant (see *Health (Infectious Diseases) Regulations 2001 – Part 7*) in pool water will rapidly kill these organisms. Circulation systems, including balance tanks, should be designed to avoid prolonged periods of stagnation.

Fungal infections

Tinea pedis ('athlete's foot') is a fungal infection causing an itchy scaling between the toes. *Tinea* is spread by contact on damp floor surfaces, such as showers or poolside, where there are infected fragments of skin. Usual maintenance levels of disinfection in the pool water will kill fungus associated with foot infections. Adequate floor cleaning and wearing pool shoes or thongs in showers and at poolside can reduce transmission of the fungus. Exclusion from the pool is not necessary.

Chemical irritants

There are a variety of skin, eye and respiratory irritants associated with the swimming pool disinfectants. High levels of chloramines (free chlorine bound to ammonia compounds such as sweat and urine – gives pools their 'chlorine smell') can cause stinging eyes, nasal irritation, respiratory difficulties and asthma attacks, particularly in indoor pools. This can be managed by increasing the air turnover in the pool area with fresh air, and ensuring that pools are

regularly treated with raised levels of disinfectant to remove the chloramines (see Chapter 4), particularly after periods of high bather load.

Pool rash is a mild dermatitis caused by prolonged immersion and the effect of the disinfectant creating a dry, irritated skin. It responds well to unperfumed moisturising creams and reduced exposure to the pool.

Bromine itch is another form of dermatitis caused by sensitisation to bromine and other byproducts, used to disinfect the pool. It is intensely itchy and occurs within 12 hours of exposure. It often recurs with repeated exposure to brominated pools.

Outbreaks

The Department of Human Services conducts surveillance for a range of notifiable infectious diseases that may be transmitted by swimming pools. Common linkages between cases of particular diseases, such as a history of swimming at the same pool within their incubation periods, may lead to further investigation. In the case of *Cryptosporidium*, the Department considers that cases may be linked to a public swimming facility if two or more confirmed cases of cryptosporidiosis have used the same pool within two weeks of their illness. In this situation, pool operators may need to close the affected swimming pool until it has been treated with increased levels of disinfectant, in accordance with the procedure in Chapter 4.

It is important to ensure that the total chlorine level in a treated pool is less than 8 mg/L before re-opening it to the public. If an outbreak is large or ongoing, the department may request additional steps to be undertaken.

4. Risk management

The most effective way to prevent swimming pool contamination is to improve swimmer practices, educate staff and patrons about the health issues, and undertake optimal pool management processes.

Patron hygiene

All patrons should be reminded and encouraged by staff to shower with soap before entering the pool, and after going to the toilet, shower before re-entering the pool. Most people have small amounts of faecal material on their perianal region, which can transfer pathogens into the water. Appropriate signage in change rooms and toilets can encourage patrons to adopt more hygienic behaviours.

The pre-swim shower will wash contaminants down the drain, not into your pool, but is still not enough for patrons with diarrhoeal illness

It is also important for pool operators to ensure that they have adequate hygiene facilities available for patrons. Hand washing facilities, including soap dispensers and hand-dryers or disposable hand towels, should be available at hand basins. Shower facilities should have warm water available and be provided with soap. Sanitary and nappy changing facilities and nappy bins should be provided in the change rooms. Hygiene facilities should be sited close to the pool to allow easy access, and be well stocked and maintained. Regular inspections and cleaning should be part of routine management, and operators should plan to increase the frequency of these according to patron volume.

Patrons with diarrhoea

People with diarrhoeal illness can experience liquid faecal accidents, often undetectable in swimming pool settings. These types of accidents may contain huge amounts of pathogens, which may then infect other bathers. Furthermore, patrons who have recovered from their diarrhoeal illness can continue to shed pathogens for days or even weeks. Pool users and staff who have a diarrhoeal illness should not enter the pool until at least one week after symptoms stop. All change rooms and toilet facilities should contain appropriate signs with this message.

Non-toilet trained infants

The use of aqua nappies and swim pants is common with infants. However, they may give parents and pool staff a false sense of security about faecal contamination. There is no scientific evidence to suggest that they can prevent faeces, particularly if liquid, from leaking into the pool.

Parents should be reminded of the importance of not swimming with diarrhoea; they and their children should wait for one week after the symptoms stop before swimming again. Regular nappy changing and frequent trips to the toilet can further reduce the chance of a faecal accident. Pools should also prohibit the changing of nappies at poolside, as this may contaminate the surfaces of the pool deck.

Education and signs

Pool operators are encouraged to promote healthy swimming behaviours amongst staff and patrons, in accordance with their duty of care. An important aspect of public education is the use of signage, with key messages displayed in the entrance foyer and amenities areas. During outbreaks, the Department of Human Services may request that pools display an increased number of signs, to further increase awareness.

Key messages to feature on signs include:

1. Do not use this pool if you have had diarrhoea in the past week.
2. Avoid swallowing or putting pool water in your mouth.

3. Everyone should shower with soap before entering the pool and after using the toilets.
4. Take children to the toilets regularly.
5. Change nappies in change rooms, not poolside.

Children's pool design and filtration

Children's pools are at high risk of faecal accidents and should ideally have a separate filtration system. If the children's pool's filtration system is linked to other pools, faecal contamination can disperse and expose other bathers. Similarly, infant pool activities should be restricted to toddler pools, where possible. If pools are not on separate systems, consider separating pool circulation systems when facilities are upgraded.

Pool staff

Pool staff need to have a good understanding of the range of illnesses and health conditions transmitted through pool water, particularly the fact that *Cryptosporidium* is a microscopic parasite which is resistant to normal levels of disinfectant, and that people with diarrhoea should not use the pool until at least one week after the end of their symptoms. All staff should be trained in the relevant operational procedures, particularly the faecal accident policy.

Operational control and management

Optimal control and management of swimming pools and spas is essential for maintaining the required water quality.

Bather load

The bather load generally introduces pollution to a pool. High bather loads can place additional demands on disinfectant levels and filters, so extra care should be taken during these times to ensure optimal water quality.

Maintenance

Filtration systems should be maintained to provide optimum efficiency and operate 24 hours a day.

Hot water systems serving showers and hand basins should deliver water at less than 43°C, to prevent scalding. The main boilers should be maintained at temperatures not below 60°C, to prevent colonisation by *Legionella* bacteria. The temperature reduction required can be achieved by mixing valves. Tepid water systems (or modified tepid water systems that maintain water below 60°C) must be maintained in accordance with the Standards prescribed by the Health (Legionella) Regulations 2001. Instantaneous hot water systems can be controlled to provide water at these ranges, without the need for storage or mixing valves.

Figure 6 Instantaneous hot water systems



Instantaneous hot water systems can be set to provide warm water without mixing valves, or having to store hot or warm water.

Microbiological testing

Swimming pools should be tested in accordance with the Health (Infectious Diseases) Regulations. Specific pathogens, such as *Cryptosporidium*, cannot be detected by these methods, so routine testing for these organisms is not recommended.

Faecal accident policies

Pool operators should develop a formal faecal accident policy that should be used to train staff and be available at all times. The treatment required will depend upon the condition of the faecal matter introduced. Loose or liquid faecal matter (diarrhoea) requires greater treatment than a firm stool, as it is more likely to contain a large number of microorganisms, will spread rapidly over a large area and is not easily retrieved from the pool. Pool operators will need to assess each situation and make a judgment about the exact action to be taken.

Action for solid faeces, blood and vomit:

- All pool users in the immediate area should be asked to exit the pool.
- As much solid material as possible should be immediately removed from the pool, with a fine mesh scoop. If necessary, the immediate area should be vacuumed and the waste directed to the sewer or other approved waste disposal system. Vacuum equipment and scoop should be cleaned and disinfected before reuse.
- If the pool is a low volume pool, such as a paddling pool, consider closing and draining the pool.
- Spa pools must be closed, drained and cleaned, as the faecal matter will have dispersed.
- Once the solid matter has been removed, check that chlorine levels and water clarity are within regulatory limits. The affected area may be reopened, after allowing 10 minutes contact time with the disinfectant.

- Log the incident and the action taken.

Action for liquid faeces:

- The pool should be immediately cleared of people.
- If there are multiple pools connected to the same filter as the contaminated pool, all pools will have to be cleared of people.
- As much faecal material as possible should be immediately removed from the pool, with a fine mesh scoop. The immediate area should also be vacuumed, with waste being directed to the sewer or other approved waste disposal system. Vacuum equipment and scoop should be cleaned and disinfected before reuse.
- If the pool is a low volume pool, such as a paddling pool, consider closing, draining and cleaning the pool. Spa pools should be closed, drained and cleaned.
- Raise and maintain the free-chlorine level of the pool to 14 mg/L for 12 hours, or 20 mg/L for 8 hours.
- A coagulant should be added (if appropriate), to improve the removal of pathogens by the filtration system
- The final level of chlorine and pH should be checked, and if within limits of the Health (Infectious Diseases) Regulations, the pool may be reopened.
- Log the incident and the action taken.

Disinfecting contaminated surfaces

Contaminants on the pool deck should **not** be washed into the pool water circulation system.

Chlorine based disinfectants are commonly used for dealing with blood or body fluid spills. For example, a 1:10 dilution of sodium hypochlorite in water can be used. Dangerous Goods (Storage and Handling) Regulations should be consulted before preparing chemical dilutions.

The procedure for dealing with a contaminated surface is:

1. Wear rubber gloves and remove excess contaminant, using disposable paper towels or similar.
2. Wipe non-porous surfaces with hot water and detergent, then flood with a chlorine based disinfectant and leave for ten minutes.
3. Porous surfaces, such as the pool deck, are more difficult to clean. Wash the area thoroughly with detergent and allow the run-off to go down the drain. Flood with a chlorine based disinfectant and leave for ten minutes.
4. Towels, gloves, excess contamination and other items should be placed in a bag and sealed. All contaminated items should be disposed of appropriately.

Pool cleaning

Cleaning in and around the pool and changing rooms

To prevent transmission of infection, the pool surrounds and change rooms need to be cleaned regularly. Frequency will again depend on the number of swimmers attending, but should be monitored as part of routine management. Minimising dirt from shoes can be controlled with good design. The use of cleaning agents needs to be strictly controlled and storage should comply with the Dangerous Goods (Storage and Handling) Regulations 2000.

Floors need to be hosed, mopped, washed or scrubbed at least once each day. Keeping cleaning products out of the pool water is almost impossible, particularly with wet-deck pools. Pool surrounds should therefore only be cleaned by washing and scrubbing with pool water, or with chemical cleaners specifically formulated for pool-side use. On the sides of the pool, deposits of dirt just above the water line can be cleaned off with a scourer, using sodium bicarbonate solution. Goggles and gloves should be worn. Tanks and channels should be inspected and cleaned frequently.

It is extremely important that commercial products used for cleaning in and around the pool are compatible with pool water and the chemicals used for disinfecting it. Care needs to be taken that cleaning chemicals do not affect residual levels or interfere with monitoring. Chlorine and pool chemicals can also interact with other chemicals in a way that can be hazardous. Care should be taken to avoid outright incompatibility between cleaning and pool chemicals, by always following manufacturers' instructions.

Bottom of pool

There should be some way of cleaning debris and algae from the pool floor. The simplest method is a long-handled, wide, weighted brush used to sweep the debris to the deepest outlet grating. Algae or staining requires suction to remove it. There are a number of suction vacuum units on the market, some requiring manual handling and others remote-controlled. Some will pump out through the pool's filtering system; some have built-in filters that need cleaning after each use. All electrical systems need to comply with Australian Standards (AS3000).

Emptying the pool

Generally speaking, the pool should not be emptied, due to potential structural damage. Detailed information about this process is included in the chapter on 'Maintenance'.

When emptied, the walls and floor can be assessed for cracked, broken or loose tiles or vinyl and these mended or replaced. The surfaces can then be cleaned with a chlorine-based disinfectant. Acid washing may be necessary to get the tiles clean – refer to the manufacturer's advice, as this can damage the grouting. In either case, the solution needs to be neutralised then rinsed to waste, prior to the pool being refilled.

Cleaning spa pools and water features

Body oils become deposited on the insides of the piping system, restricting water flow and harbouring pathogens. Public spa pools should be drained and the surfaces and pipe work cleaned weekly. Commercially formulated degreasing solutions (specifically manufactured for spas) should be used to remove the pipe deposits.

5. Further information

Environmental Health Unit (Public Health Group)

Department of Human Services

Tel: 1300 761 874

Fax: 1300 768 874

Swimming pools and spas information

<http://www.health.vic.gov.au/environment/water/swimming.htm>

Pool Operators Handbook

<http://www.health.vic.gov.au/environment/water/pooloperators.htm>

***Cryptosporidium* and Cryptosporidiosis fact sheet**

<http://www.health.vic.gov.au/environment/water/cryptosporidium.htm>

Faecal accident policy

<http://www.health.vic.gov.au/environment/water/faecal.htm>

Cleaning of spa baths

<http://www.health.vic.gov.au/environment/water/spa.htm>

Swimming pool public health legislation

http://www.health.vic.gov.au/ideas/regulations/id_regs.htm

Centres for Disease Control and Prevention – healthy swimming advice

<http://www.cdc.gov/healthyswimming/>