**Appendix Y**

**Waterborne Infections**

**Acanthamoeba**

Amoebae are found in bathing waters and have caused rare infections linked to spa pools. They can contaminate contact lenses and cause corneal ulcers.

**Adenoviruses**

Viruses causing pharyngoconjunctival fever in inadequate chlorinated pools.

**Cryptosporidium**

Protozoa that cause severe diarrhoea. Resistance to chlorination but removed by filtration. The commonest cause of swimming pool related outbreaks.

**Dermatophyte Fungi**

Athletes foot from surfaces contaminated by the fungi.

**Escherichia Coli**

Bacteria that can be spread by person to person, waterborne and foodborne route. Can cause outbreaks of gastric illness if chlorination is sub-optimal.

**Enteroviruses**

These viruses include poliovirus, echovirus and coxsackieviruses A and B. These viruses are rapidly inactivated by chlorine and enterovirus outbreaks associated with pools are due to inadequate chlorination.

**Giardia**

Protozoa that causes diarrhoea. Resistant to chlorination but removed by filtration.

**Hepatitis A Virus**

Infectious hepatitis spread through contaminated food and water; killed by chlorine.

**Legionella Pneumophila**

Respiratory infection spread by inhaling aerosols (Including sprays) containing the bacteria. Can cause outbreaks of pneumonia associated with spa pools (as well as hot and cold water systems).

**Leptospira**

Bacteria that can cause Weil’s disease associated with the use of natural waters. The bacteria are excreted in the urine of infected rats. They are sensitive to chlorine and do not cause outbreaks in swimming pools but can represent a risk in unchlorinated natural pools.

**Microsporidia**

These are small protozoa that are thought to cause diarrhoea in immunocompromised people.

**Molluscum Contagiosum Virus**

A pox virus that causes raised skin rash. It is not transmitted through pool water but can be transmitted directly from person to person through skin contact or by sharing towels.

**Mycobacterium Marinum**

Bacteria occasionally found in pools; causes a granulomatous skin condition. Killed by chlorine, though more resistant than other bacteria.

**Mycobacterium Avium**

Bacteria causing infection of immunocompromised people. Can cause respiratory symptoms of infection in spa pool users, this has been referred to as ‘hot tub lung’.

**Naegleria Fowleri**

Amoeba can cause meningitis in people swimming in thermal springs. Not a problem with mains water or swimming pools in the UK. Killed by chlorine.

**Papilloma Virus**

Plantar warts (verrucas) caused by contact with contaminated surfaces.

**Pseudomonas Aeruginosa**

Bacteria causing folliculitis, ear, eye and urinary tract infections. Transmission can occur in natural waters, spa pools and occasionally swimming pools and can contaminate pool play equipment. Killed by chlorine.

**Shigella**

Bacteria causing dysentery, occasionally in badly run pools. Killed by chlorine.

**Respiratory complaints**

In general, it is worth remembering that the bad smell which irritates eyes and nose as well as lungs is not chlorine but nitrogen trichloride - an avoidable disinfection by-product.

**Asthma**

Warm, humid air in a swimming pool should be comfortable for people with asthma. But some asthmatics need to take medicine before swimming. Asthma attacks are usually triggered either by the specific substance to which the person is allergic, e.g. pollen; or by larger amounts of an irritant in the air. Nitrogen trichloride and other irritant substances in the pool hall air can bring on an attack in someone already asthmatic, but they do not in themselves cause asthma. People do not become allergic to pool hall contaminants.

The same applies to what is called maturity onset asthma - i.e. asthma appearing in middle age, sometimes for the first time. Occasionally its appearance is blamed, wrongly, on pool conditions; in fact, other complex factors are responsible.

Nevertheless, high levels of nitrogen can cause respiratory discomfort. Prolonged frequent exposure of people bathing or working in such atmospheres can cause chest symptoms. The answer is to simply avoid the high chloramine levels that come with poor design, overloading, poor bather hygiene and bad management. There simply should not be a strong chlorine odour in the pool air.

Recent studies have suggested that the atmosphere of chlorinated pools may produce more childhood asthma. Further research is needed to prove or displace this hypothesis.

It is now possible (though not a cheap poolside test) to measure chloramines, including nitrogen trichloride, in the air and specify levels above which problems are more likely. A maximum safety level for nitrogen trichloride in the air of 0.5mg/m3 has been proposed in some parts of Europe. Certainly by the time this level is reached, the bathers and other pool users may have been irritated by the smell, and asthma sufferers may be affected at levels below this. A more realistic maximum is 02.mg/m3.

In any case all public pools need an effective ventilation system that removes any irritants from above the water and expels them. Ventilation systems that rely wholly on recirculated air tend to build up these irritants. The fact that disinfectant by-products affect respiratory complaints should be included in COSHH assessments.

**Legionnaires’ Disease**

This severe form of pneumonia is caused by the Legionella bacteria. For Legionella to be spread, contaminated water must first form a spray (technically, an aerosol) that can be inhaled. Infections are typically from cooling showers and spa pools. No cases of Legionnaires’ disease (legionellosis) have been associated with swimming in conventional pools.

Poorly managed spa pools can become contaminated and spread the disease, through the fine spray generated at the turbulent water surface. Careful maintenance, regular filter cleaning and close attention to disinfection levels is critical.

Showers too are a potential source of infection spray. Supply water to showers should be stored above 60°C, piped at temperatures close to 60°C and never less than 50°C – to prevent the survival and growth of Legionella.

Pool water features with spray effects - rain sprays, fountains, etc. – should be checked for scale or other deposits, the heads cleaned and periodically disinfected by soaking with 10mg/l chlorine. Shower heads and associated flexible hoses, too, should be similarly treated.

**Granulomatous Pneumonitis**

There have been a number of reports of diffuse granulomatous pneumonitis associated with spa pools/hot tubs and water sprays. This condition has been referred to as ‘hot tub lung’ or ‘lifeguard lung’ and is thought to be linked to contamination of the water with Mycobacterium avium.

**Infections of the skin and feet**

Some viral and fungal infections can be transmitted through contaminations of feet from floors. Viruses causing warts and verrucas can contaminate pool surrounds and the floor of changing rooms. Regular cleaning and disinfection of these is important. Athlete’s foot (tinea Pedis) is a ringworm infection caused by dermatophyte fungi (usually Trychophyton Mentagrophytes) that causes itchy scales between the toes. It can be picked up during visits to swimming pools, spread by contact with floor surfaces contaminated by skin fragments infected with the fungus. Floor cleaning reduces the number of infective particles. People with severe “athlete’s foot” should not attend swimming pools, but it is impractical for pool staff to try and distinguish infected people and exclude them.

Verrucas (plantar warts) are common and can be acquired through contact with floor surfaces contaminated by papillomavirus. Immunity to infection appears to develop readily, as verrucas are uncommon in adults, including those who participate regularly in barefoot activities. Historically, efforts have been made to exclude verruca sufferers from swimming pools in the hope that the spread of the virus could be reduced. Yet it is very doubtful if a firm exclusion policy influences the incidents of verrucas. Exclusion is difficult to implement (as well as distressing to the children) and medical opinion considers that it cannot be justified.

**Eye irritation**

Eye irritation in pools normally results from exposure to disinfectant by-products. It will be reduced by anything that lowers the combined chlorine residual, such as minimising contamination, operating with lower free chlorine residuals, generous routine dilution with fresh water, or the use of ozone or UV. Although chlorine itself is not an irritant, high free chlorine residuals may contribute to eye irritation, even in non-contaminated water, which is another argument for minimising free chlorine, as long as bacteria are controlled.

pH values outside the recommended range are also a factor in eye irritation, as may be other pool chemicals. In general, dosing via skimmer baskets, and slug dosing, may also increase the chances of eye irritation.

Eye inflammation may result simply from prolonged immersion - especially if the eyes are kept open – because of the difference in the concentration of the various salts between the fluid of the eye and pool water.

Viral infections are not spread in well-managed and adequately disinfected pools. Nevertheless, some viruses, including the adenoviruses that cause pharyngo-conjunctival fever (which affects nose and eyes), have been isolated from pools with absent or inadequate disinfection. These viruses cause naso-pharyngeal and respiratory infections and can be spread by person to person transmission as well as through contaminated pool water. Temporary nose and sinus congestion may also result from osmotic pressure differences, or chemical irritation.

Bacterial or viral conjunctivitis is more likely to come, not from the pool water, but from close contact with infected people, or infected articles such as towels.

**Contact lenses**

People who wear soft contact lenses can occasionally get corneal ulcers. This is usually caused by trauma to the eye and/or using tap water or dirty contact lens fluid for washing lenses. Acanthamoeba, the organism usually involved, is commonly found in pool water (spas particularly) and its cysts are resistant to chlorine.

**Blood-borne viruses**

Hepatitis B virus and the human deficiency virus (HIV) are carried in the blood and other body fluids. Infections are transmitted by inoculation into body tissue - by sexual intercourse, injection, cuts etc. The viruses are susceptible to the action of disinfectant and neither of these can be transmitted as the result of using a swimming pool or spa. Because HIV and hepatitis B viruses can be blood borne, however, blood spillages should be taken seriously.

**Skin**

Skin irritation and rashes can be linked to swimming pools and spas. The causes of rashes remain diverse, and it can often be difficult whether a rash is due to the water quality or other factors in the sufferer’s physical makeup and environment. All pool operators should be made aware of the issue and if two or more bathers have rashes at the same time it is worth investigating whether there is a common cause. The most important safeguard against skin problems is good water management, disinfectant and adequate dilution. Skin rashes associated with pools are mainly due to one or more of the following factors:

* Wetting and degreasing of the skin - especially with warm water and prolonged exposure.
* Degreasing – with most disinfectants
* Chemical irritations - usually trivial in chlorinated pools but more common in pools using bromochlorodimethylhydantoin (BCDMH)
* Pseudomonas infection – which rarely causes rashes in swimming pools but may do so in spa pools and from some play equipment.

These four factors contribute to the three commonest skin conditions – new pool rash, bromine itch and folliculitis.

**Bromine itch**

This is associated with the use of Bromochloro-5, 5-dimethylhydantoin, which for some people in some pools produces intense itchy dermatitis (i.e. eczema). The itching usually precedes a visible rash within 12 hours of exposure. The frequency of the rash increases with age, being unusual in children and more common in bathers of more than 50 years of age. It is also more frequent and severe with prolonged exposure e.g. hydro therapists.

The distinction between bromine itch and folliculitis (next section) is not difficult:

* The chemical irritation of bromine itch invariably appears within 12 hours of exposure; folliculitis usually takes at least 24 hours to appear,
* Itching, sometimes severe, is the main symptom of bromine rash and is minimal with folliculitis,
* For those who are susceptible, bromine itch continues in a pool with levels of disinfectant which are incompatible with large numbers of Pseudomonas Aeruginosa.

**Folliculitis**

This is due to infection of the hair follicles, usually of the torso and limbs, with the pathogenic bacterium, Pseudomonas Aeruginosa. A combination of skin wetting and high concentrations of P Aeruginosa in the pool water are necessary conditions for this complaint. The risk is increased by prolonged exposure (1 or 2 hours) to warm water (over 32°C), commonly associated with disinfectant failure, thus allowing heavy bacterial growth within the water treatment system. These conditions are more commonly found in spa pools, but infections have also been linked to swimming pools. Routine testing for P Aeruginosa in pool water is recommended. Where high levels are found, action should be taken to reduce the contamination.

**Molluscum Contagiosum**

The molluscum contagiosum virus is transmitted either by direct skin contact from person to person or through towels. Proper washing of towels at 60°C or more (and discourage towel sharing) should reduce the risk of transmission.

**Swimming Pool Granuloma**

Mycobacterium marinum is a relatively chlorine resistant bacterium that can occasionally grow in warm swimming pools and tropical aquaria. It can infect skin rubbed by rough surfaces such as worn grout, concrete and rough tiling. Swimming pool granuloma is rare. The risk of infection can be avoided by regular cleaning and disinfection of pool tiling.

**Staphylococcus Aureus and MRSA**

Staphylococcus Aureus can cause boils, abscesses and infected wounds. Where S Aureus is resistant to methicillin and other antibiotics it is termed MRSA. There is no evidence that S Aureus or MRSA can be transmitted through normal swimming use. There is no evidence to justify the exclusion of MRSA carriers from swimming pools or hydrotherapy pools but people with wounds contaminated with MRSA should be excluded from using pools, particularly hydrotherapy pools.

**Ear and sinus infections**

Swimmers ear (otitis externa) is caused by wetting, dewaxing and degreasing of the outer ear. High numbers of P. Aeruginosa in a swimming pool may cause more severe cases of otitis externa. The risks of infection are low if adequate disinfection is in place. Infection of the middle ear (otitis media) and sinusitis are most likely to have been caused by infected mucus forced into the nasal passages whilst swimming.

**Meningitis**

Most forms of meningitis cannot be transmitted through swimming. Naegleria fowleri is a pathogen, free-living amoeba and a very rare cause of meningitis associated with swimming. Swimming pool make-up must be clean and come from secure sources. Circulation systems, including balance tanks, should be kept clean and designed to avoid long periods of stagnation.

**Gastro-intestinal infections**

In a well-managed and adequately disinfected pool, most microorganisms responsible for diarrhoeal diseases, if introduced into the water, will be diluted in a very large volume of pool water and inactivated by the disinfectant residual. However, some organisms are resistant to the commonly used disinfectants. Bacterial infections that can cause diarrhoea. as a result of swimming in contaminated water, include; Shigella and Escherichia coli. Enteroviruses, including poliovirus, echovirus and coxsackieviruses A and B are commonly transmitted from person to person but could also be transmitted through contaminated pool water. Some enteroviruses have caused pool-related outbreaks, as have adenoviruses, astroviruses, hepatitis A virus and noroviruses. These bacteria and viruses are rapidly inactivated by chlorine and outbreaks associated with pools are due to inadequate chlorination.

**Cryptosporidium**

Cryptosporidium is a protozoan parasite. A protozoan is a microscopic, single-celled organism about 4-6µm in size. Cryptosporidium can infect both humans and animals. The parasite reproduces in the intestines producing oocysts (an oocyte is a cell from which an egg or ovum develops) that are excreted through faecal matter. Millions of Cryptosporidium parasites can be released in a single bowel movement from an infected person which will contaminate the water if this occurs in a swimming pool. The parasite is transmitted to other swimmers if they swallow contaminated water and ingest the oocysts.

When ingested the Cryptosporidium oocyst releases sporozoites (a cell form that infects new hosts) that are released through the oocyte membrane. These sporozoites infect and multiply, asexually, in the intestine of the host. When mature, the organism either forms a thin-walled oocyst or a thick-walled oocyst. The thin-walled oocyst remains within the host and repeats the infection cycle. The thick-walled, environmentally-resistant oocyst is passed in the faeces that can infect others. There are two main species of Cryptosporidium that cause infection in humans, Cryptosporidium hominis (C. hominis) and Cryptosporidium parvum (C. parvum) both species cause significant contamination if found in swimming pools. Swimming pools used by babies and young people are at higher risk of contamination as there is a higher probability of faecal fouling incidents occurring.

Symptoms

The disease caused by Cryptosporidium is called Cryptosporidiosis. It can be caused by the ingestion of as few as one to ten oocysts. Once the Oocytes are ingested it can infect a person’s bowels and cause cryptosporidiosis. It can take between three to twelve days after contact with cryptosporidium before symptoms develop. The main symptoms of cryptosporidiosis are watery diarrhoea with abdominal cramps; vomiting, fever and loss of appetite are also common.

Some people who become infected with cryptosporidium actually have no symptoms. However, they can still pass on the infection to others. Symptoms usually last around twelve to fourteen days but can sometimes last for as long as one month. The symptoms may go in cycles in which people may seem to get better for a few days, then feel worse again before the illness ends. Certain groups are more likely to become seriously ill when infected with Cryptosporidium, young children, pregnant women and individuals with weakened immune systems.

Control Measures

Cryptosporidium is a particular problem for swimming pools because unlike most other pathogens the oocysts are resistant to chlorine and bromine based disinfectants. Oocytes can survive for months in moist environments with ambient temperatures and will therefore survive in pool water and present an infection risk unless removed. Removal of oocytes from pool water relies on good circulation with optimum filtration and flocculation. Some pools have ultraviolet light which is a physical disinfectant which inactivates cryptosporidium oocysts.

Swimming pools operators should make aware that persons diagnosed with, or where there is a suspicion that they have had, cryptosporidiosis should not swim in swimming pools for at least two weeks after the diarrhoea stops, this is because cryptosporidium can still be present in stools during this time.

Headteachers and managers must:

* Complete a generic risk assessment for Cryptosporidium (Appendix D) so that it reflects the current control measures for the pool and any further action needed to be taken,
* Refer to and follow the Faecal Contamination Technical guidance from PWTAG <http://pwtag.org/technicalnotes/1229/>,
* Ensure all hirers and pool plant operatives understand the procedures after faecal contamination occurs,
* Ensure the details of any faecal contamination are recorded,
* Ensure that the pool procedures are inspected termly for indoor pools and at least annually for outdoor pools,
* Request and retain maintenance records for any work undertaken, as these will be required when the pool is inspected,
* Ensure the number of bathers is recorded and the records available when the pool is inspected,
* Ensure all bathers are made aware of the restrictions to swimming by improving signage if necessary and adding information to hiring agreements and newsletters to parents.

Recommended signage

If you currently have or have had diarrhoea in the last 48 hours or have been diagnosed with or think you have had Cryptosporidiosis within the last two weeks you are not permitted to enter the pool.

**Giardia**

Giardia is a microscopic protozoan single celled organism about 8-14 µm in size. Giardia, also referred to as Giardia Intestinalis, Gardia Lamblia or Giardia Duodenalis, causes infection of the upper gastrointestinal tracts referred to as Giardiasis.

While in the gut it multiplies by producing cysts, the infective form of the parasite, and is excreted in faeces to infect others mainly through direct contact, or by ingestion of a faecal contamination from swimming pools etc. Giardia has a tough outer coating that allows it to survive up to 45 minutes even in properly chlorinated pools.

Symptoms

Giardia creates symptoms that mimic other gastrointestinal infections; the common symptoms are persistent diarrhoea, weight loss, abdominal cramps, nausea, and dehydration. In general, the symptoms begin within a week after exposure and can last for up to 2 weeks, but chronic symptoms can last for up to 2 months. The infection can be particularly severe for individuals with weakened immune systems, small children and the elderly.

Control Measures

* Persons diagnosed with, or where there is a suspicion that they have had Giardiasis, should not swim for at least two weeks after the diarrhoea stops, because the organism can still be present in stools during this time.
* Refer to the Faecal Contamination <http://pwtag.org/technicalnotes/1229/>
* Ensure the details of faecal contamination are recorded
* Ensure that the pool procedures are inspected termly for indoor pools and at least annually for outdoor pools.
* Request and retain maintenance records for any work undertaken, as these will be required when the pool is inspected
* Ensure good hygiene prior to swimming.
* Ensure all bathers are made aware of the restrictions to swimming by clear signage and clear information in hiring agreements and in newsletters to parents.

Recommended signage

If you currently have or have had diarrhoea in the last 48 hours or have been diagnosed with or think you have had Giardiasis within the last two weeks you are not permitted to enter the pool.

**Pseudomonas Aeruginosa**

Pseudomonas Aeruginosa is an opportunistic free living bacterium that lives in soil and water, including chemically treated environments such as swimming pools and spas. It’s a rod shaped bacteria, size varying from 0.5-1.0mm by 1.5 mm that thrives in warm moist conditions such as that of the swimming pool. It can develop into Biofilms which are groups of microorganisms that stick together and may appear as slime.

The exact source and way of spreading Pseudomonas Aeruginosa is unclear; it's found in soil, water, on the skin, and most man-made environments throughout the world. The most common source of this bacterium in swimming pools and spas is believed to be the transfer of the organism on the hands and feet into the pool. It occurs in swimming pools where chlorine and pH levels are not well regulated and is a sign of a poorly managed pool. It is often present as a result of inadequate cleaning and disinfection of the pool’s surfaces and inflatable equipment.

Symptoms

For most people in good health, Pseudomonas Aeruginosa is an opportunistic pathogen that seldom poses a problem. However occasionally it may be responsible for causing eye and ear infections (Swimmers Ear) as well as skin irritations. For people with weak immune systems, the bacteria can cause more serious illness.

Pseudomonas Aeruginosa is responsible for causing infection of the hair follicle referred to as Pseudomonas Folliculitis. It first appears as itchy bumps and develops into dark red tender nodules and/or small pus filled pimples. Typically, it affects the trunk and upper parts of the arms and legs. The rash may be accompanied by headache, nausea, vomiting, abdominal cramps, sore throat, sore eyes and fever. The incubation period is usually 48 hours after exposure to the pathogen before symptoms emerge.

Control Measures

When Pseudomonas Aeruginosa is found in water it suggests relatively unclean water conditions. If the count is over 10 parts per 100ml, repeat microbiological testing should be undertaken. When repeated samples contain Pseudomonas Aeruginosa, the filtration and disinfection process should be examined to determine whether there are areas in the pool circulation system, where the organism is able to multiply. Where counts exceed 50 parts per 100ml the pool should be closed until levels return to acceptable values. Properly maintained and controlled pH and disinfection levels of the pool water will prevent the growth of Pseudomonas Folliculitis.