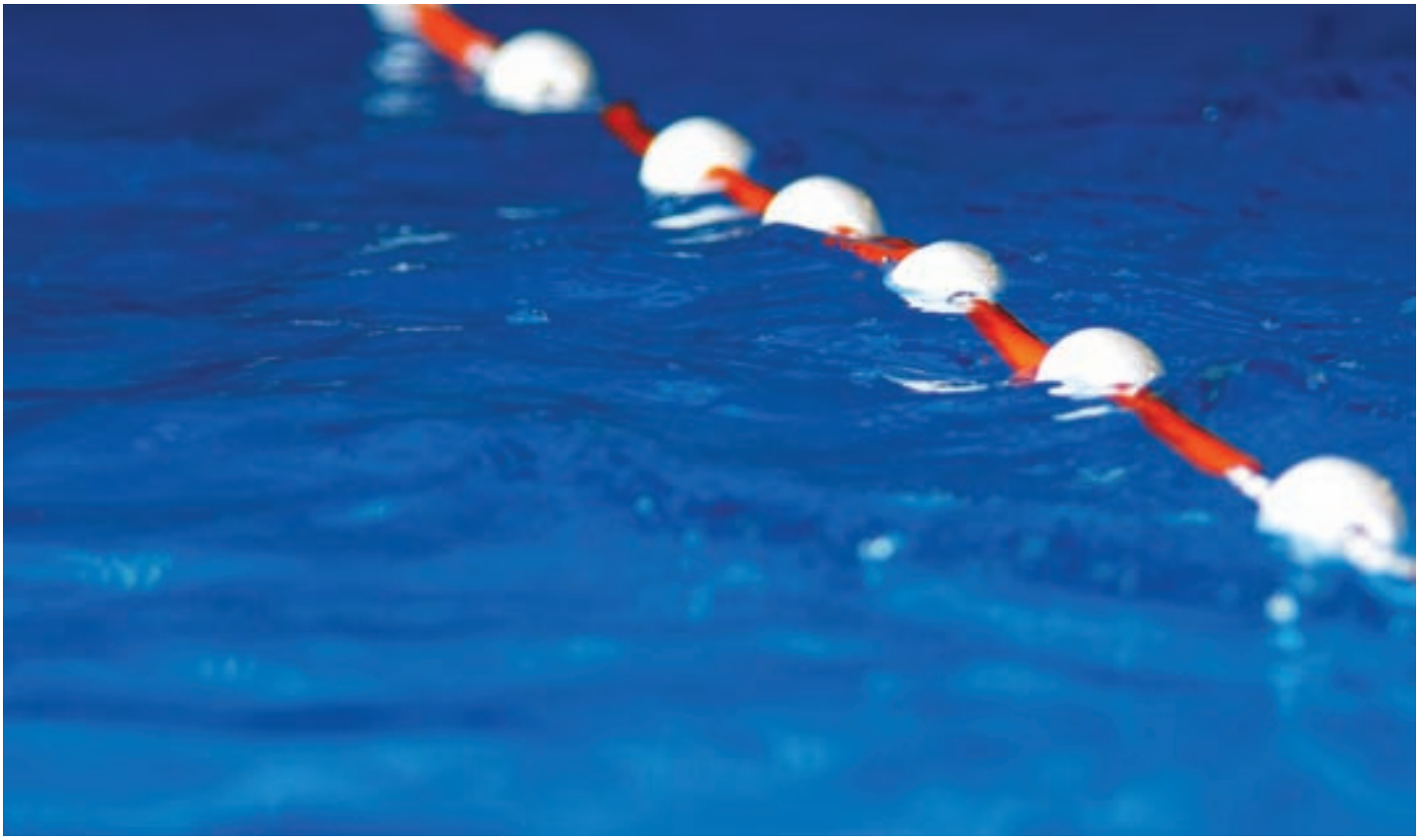

Cryptosporidia – the methodology for effective action in the UK

An extract from a paper ***Ralph Riley*** *presented to the World Water Park symposium 2008*

In the Crypto outbreaks in the UK there is no clear pattern to the pools affected, and specific reasons for the outbreaks may not always be identified. Cryptosporidium presents a particular challenge, compared with bacteria and viruses because its resistant form is not killed by the chlorine levels used in pools. Four hours at 30mg/l free chlorine would be necessary, so typical pool values ranging from 0.5 to 2mg/l are no use. Hence our methodology in using filters to remove the Crypto within the plant room, mainly by effective filtration (and coagulation).

In the US, they adopt a different approach to both a solid stool incident and a diarrhoeal incident. For solid stools, the advice is to clear the pool and close it for 30 minutes, assuming a level of 2mg/l of free chlorine. In a diarrhoeal incident, they superchlorinate to 20 mg/l and close it for 13 hours.

Both UK and US approaches involve closure for what amounts to a day's use, and in the States they then have the issue of how to bring the chlorine level down again. In the UK, we recognise that for major public pools, controlling superchlorination is not practical and has the added problems of creating toxic by-products, that is, trihalomethanes. Adding more chemicals to remove the chlorine creates a chemical soup of pool water which may have a harmful effect on both the bathers and the pool structure.

In Europe, Crypto is not a recognised problem, and we are not sure entirely why this is – but perhaps they just don't look for it.

Why close for six turnovers?

The PWTAG-funded pilot plant work at Swansea University showed that the best swimming pool filter, with good coagulation, might remove up to 99 per cent of Cryptosporidium oocysts in one pass. With poor

coagulation, that figure might fall to 90 per cent; without coagulation, it might fall to less than 50 per cent. So if we could pass all the pool water through an effective filter in one turnover, then we could virtually remove all the Crypto in one pass.

But pools don't work like that. As we take out water to treat it through the filter, at the same time we are putting an equivalent amount of treated water back into the pool. This is called progressive dilution. It's is an important principle in understanding swimming pool water treatment and accounts for why it is almost impossible to deal with any problem in the pool instantly.

Pool water treatment works on a continuous recycling process and all treatments of the pool should bear this in mind. Small amounts of chemical additions are, because of the effect of progressive dilution, the essential method of treatment. The pool water must be given time to respond and as you will see, this can take many hours, even days.

The law of progressive dilution says that just 66 per cent of the pool water is treated during each turnover. For example, if there were 50 grams of diarrhoea (two ounces) in a pool, then according to WHO, this would equate to 500 million oocysts in the water. Sixty six per cent of these would be removed in a good filter in one turnover, leaving 170 million in the

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water, then next turnover removes 66 per cent of these, leaving 56 million. The next turnover would remove 66 per cent of these, leaving 19 million. So even after three turnovers or around nine hours, there are still 19 million oocysts – in theory – in the water.

In a 25m pool, which holds 375,000 litres, that's 148 oocysts per litre. In a water park with two million litres, that's still 28 oocysts in every litre of water. It needs just one oocyst to cause an infection. This is why closing the pool for six pool turnovers is recommended after a fouling with diarrhoea. Following the theory, after six turnovers, 99.85 per cent of oocysts will be removed.

Effective filtration

To filter out the oocysts the filters must be effective. Here are just a few of the requirements to get the filtration right:

- Pool sand filters operate best at filtration rates of 10-25m/h. And the deeper the bed of sand, the better the filtration (1m is a typical depth). Shallow-bed filters operating at 30-50m/h (sometimes called high-rate filters, commonly used in domestic pools) may not usually be used with coagulants, and so could not be expected to be good at coping with Cryptosporidium. In the UK, they are not recommended for publicly-used pools.
- A coagulant should always be used prior to filtration, ideally dosed continuously and precisely (not by hand or via the strainer box). The coagulation injection should ensure good mixing and provide at least 10 seconds for the coagulant to operate before the flow gets to the filter media. The injection point should be, as far as practicable, before the filter.
- Aluminium-based coagulants (eg. aluminium sulphate) operate best at pH values towards the bottom of the pH range for disinfection (ie towards 7.2 rather than 7.8). They should be dosed continuously at a minimum of 0.05mg/l as aluminium, except polyaluminium chloride (PAC), which is dosed at a minimum of 0.1ml/m3. Iron coagulants are dosed at a minimum of 0.1mg/l, as iron.
- Filters should be backwashed when the pressure loss across the bed reaches the level specified by the manufacturer (but at least once a week). Filters should also be backwashed if the circulation has to be stopped because of a power failure or for maintenance.
- Rapid changes in flow rate reduce filter performance, forcing dirt and bacteria through the bed and should be avoided. If a filter is being backwashed while other filters are still in service, flow to the filter should start and stop slowly (over 15-20 seconds) to avoid rapid flow rate change in the in-service filters.
- The backwash flow must be fast enough to fluidise the sand bed (usually at least 30m/h); air scouring first (at about 32m/h) can help. Flow meters should be fitted.
- Fluidisation of the bed should be checked visually if possible, through a viewing window. In any case, backwashing should continue until the backwash water is clear; keep on sampling it in a clear glass container until it shows clear. The manufacturer's recommendations should also be taken into account.
- Every year the filters should be opened and the top of the bed examined for tell-tale signs of problems with the under-drains or an ineffective backwash regime such as, frequency insufficient, period insufficient or flow rate insufficient. Tell-tale signs include dirt remaining on and engrained in the bed, mud balling, fissures and a very uneven bed.
- After backwash, the first few minutes of flow should run to waste. As a backwashed filter benefits from a further ripening period (as the sand settles and returns to full working efficiency) of perhaps 30 minutes, backwashing at the end of the day is good practice. This allows the filter to return to optimum efficiency over a number of hours when there are no bathers in the pool.

If all of the pool's filters are backwashed on the same day, maximum efficiency is maintained. The feasibility of this may depend on how quickly the pool's temperature can be restored afterwards.

TAKING PROACTIVE ACTION

The only way we can help to eliminate Crypto is by better hygiene. These are some of our recommended practices in UK pools to improve hygiene:

- Discourage babies under six months old from swimming in pools too big to be drained if there is a fouling accident. Pools for young children should ideally have separate filtration.
- Ensure pollution from outdoor shoes is not brought into the vicinity of pools; thoroughly clean changing rooms and pool surrounds daily; pool surrounds should be washed down with pool water frequently.
- Make sure young children use the toilet and have a shower before they swim. Adults should ideally shower, too. Nude showering is best, but you need private showering facilities to achieve this. Encourage swimmers to shower with soap and water: this can reduce the risk of Crypto by removing invisible faecal matter.
- Encourage very young children to use special swimming costumes, not nappies, which help to contain liquid or solid matter. They do not, however, enable a child with diarrhoea to swim. Nappy changing areas should be convenient – in changing areas, they should be cleaned regularly and equipped with sinks nearby for hand washing and with special bins for nappy disposal.
- GPs should advise children (or adults) not to swim if they've been ill with diarrhoea caused by Cryptosporidia (the oocysts may still be around) for 14 days. But for non-illness diarrhoea, advise people not to swim for one to two days.

Better disinfection

Both ozone and ultraviolet have been shown to kill Cryptosporidium as effectively as optimal filtration removes it (ie. perhaps 99 per cent in one pass). Using either ozone or UV brings many other benefits such as reduced chloramine levels and the need for only low levels of free chlorine in the pool. What is surprising is the performance of UV for Cryptosporidia treatment. It is so successful that water companies all around the world are evaluating its use for drinking water treatment, for this purpose alone. In a recent outbreak in drinking water in the Midlands, UV was installed to deal with the problem.

For whatever reason these systems are installed, it is important that the full flow is treated in the plant room. The ozone concentration should be at 0.8-1mg/litre and the contact time at least two minutes. The minimum UV

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dose should be 60mJ/cm2, based on the actual circulation rate.

As with filtration, because of the law of progressive dilution, it would take a number of pool turnovers for a reassuring proportion of the pool water to pass through the plant room. But either system seems likely to provide valuable additional protection by combining inactivation with the essentials of good filtration.

The best defence

1 *Evaluate pool hygiene design*
2 *Encourage bather awareness of healthy swimming practices*
3 *Educate children in a simple, effective pre-swim routine*
4 *Ensure effective pool water management*
5 *Enable staff to promote good hygiene and safety*

There is only so much a pool operator can do about Cryptosporidia, but being proactive is the best defence to prevent it happening in the first place. But if and when you get Cryptosporidia in a pool, it can only be dealt with by closing the pool and carrying out the procedure recommended by PWTAG, ISRM and the HPA. In time, with more research, we may find other solutions. I am not convinced that all our customers go around ingesting (ie drinking pool water). I am a swimmer, and have been all my life, and I can honestly say that if I have ever ingested pool water it has been a very, very infrequent event. Mostly I spit it out. But don't forget you have to ingest pool water with a Cryptosporidia oocsyt in it to become infected.

Neither am I convinced that people suffering with Cryptosporidia come along to use our pools and then pass infected diarrhoea in them. I have had this disease and believe me, the last thing you want to do is to go swimming. People with this infection can be very ill indeed and are unlikely to want to participate in any form of physical exercise. So we need more research, and research that is focused upon the specific circumstances of swimming pools. Yes, Cryptosporida can without doubt happen in a pool and when it does, it needs to be treated seriously.

However, every suspected fouling incident is not a reason to close pools arbitrarily. To always err on the side of safety and assume a Cryptosporidia incident has taken place is in nobody's best long-term interests – instead, a proper risk assessment should take place to determine the most appropriate response.