CRYPTOSPORIDIUM AND SWIMMING POOL WATERS

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Abstract

Cryptosporidium has served as a vehicle in obtaining funding for water detection and sample analysis, it was the 'driving force' for almost all of research related to *Cryptosporidium* for a long period. Prior to the recognition of *Cryptosporidium* as an important human pathogen in the early 1980s and the first indications as clinical important pathogen, interest in research into the parasite was stimulated by the occurrence of community outbreaks of gastroenteritis. Monitoring efforts were conducted to determine the presence and distribution of *Cryptosporidium* in the water and to develop a risk assessment framework for the water industries to address *Cryptosporidium*. Most of the activities were directed towards helping to determine the risk posed by the presence of oocysts in drinking and recreational waters. Disinfection studies created distrust between the related research, governmental authorities and water industries, perhaps most of the studies failed to reach the goal due to the rudimentary nature of background information regarding the biological peculiarities of the parasite and it's life cycle stages.

Cryptosporidium is one of the four major contributors to moderate-to-severe diarrhoeal disease during the first 5 years of life in low-to-middle income countries; it is only second to rotavirus as a cause of moderate-to-severe diarrhoea in children under 2 years and it is associated with a two to three times higher risk of mortality among children aged 12–23 months with moderate-to-severe diarrhoea, than in controls without diarrhea. However, a meta-analysis results showed that the substantial short-term burden of diarrhoea from *Cryptosporidium* infection on childhood growth and wellbeing is an underestimate of the true burden.

This pathogen is prevalent in industrialized countries with high standards of water quality levels and although considerable efforts were achieved to establish surveillance systems outbreaks continue to occur; swimming pools are the most setting for *Cryptosporidium* where the majority of all outbreaks linked to swimming pools are caused by *Cryptosporidium*. In many cases, *Cryptosporidium* oocysts have been detected in the pool water or in the filter backwash water, confirming the source of the outbreak. Although water treatment technologies are effective to remove *Cryptosporidium* during the treatment process, the results from the past clearly show that the oocysts evade the filter barriers in the absence of treatment deficiencies and contaminate swimming and pool water. *Cryptosporidium* oocysts

are resistant to chlorine and chlorine dioxide at the dosage levels that can be used for disinfection of drinking and pool water. Disinfection by UV-light seems to be not reliable for parasites and/or it needs re-evaluation. Swimming and therapeutic pools are considered to be a more important transmission route for gastrointestinal illness than drinking water in high-income countries. *Cryptosporidium* oocysts can survive for 3.5–10.6 days in swimming pool water where free chlorine levels are maintained.

Prevention of waterborne transmission of *Cryptosporidium* and particularly swimming pool water is hampered by the parasite's resistance to chemical disinfection. Previously, finding oocysts in only a very small percentage of water samples suggested that they were only present intermittently, rather than continuously and that their dispersal through water was always perhaps 'only by accident'; it was a parasite that was mainly prevalent in underdeveloped countries and water authorities in developed countries finally denied to have it in their water. *Cryptosporidium* infections are still underreported and/or underdiagnosed, even though, cryptosporidiosis is one of the most common communicable diseases.The fact that *Cryptosporidium* is underdiagnosed is due to several factors, including healthcare-seeking behavior by patients, access to relevant services, poor awareness in the primary care setting of its role as a cause of gastrointestinal symptoms leading to a low request rate for specific testing, little sensitization and little knowledge of the pathogen, as well as insufficient skills regarding the detection of the pathogen in the microscope, variable provision of diagnostic tests and reporting practices and the lack of harmonized, EU-wide, surveillance or monitoring programs. The fact that some laboratories don't include *Cryptosporidium* in their routine examination of stools, contributes clearly to underreporting of this parasite. Many labs all over the world suffer from mistaken detection or no detection at all. In contrast to drinking water regulations, there is a lack of uniform national and international standards for public treated recreational water venues/swimming pools. State and local governments need to establish and enforce regulations for protecting swimming pools from *Cryptosporidium* contamination, including legislation on minimum design standards, operation, disinfection, filtration and AFR (accidental faecal release) management. This is a major barrier to the prevention and control of illness associated with swimming pools as many swimming pool outbreaks are due to failures in policies and procedures. Timely interventions in specific events of a rapid increase in notifications of disease linked to swimming pools can reduce the probability and scale of a community-wide outbreak. The interventions include communication with local medical services to increase vigilance and rate of confirmatory testing and to give patient appropriate hygiene and exclusion advice. Swimming pools can be encouraged to increase chlorination. Aquatic facilities practicing proper operation and maintenance can protect the public's health. Educational and health promotion efforts to improve awareness and change swimmer behavior, is a critical component of infections and outbreak prevention. Provision of clean toilets, stocked with toilet paper, with ample soap for hand washing as well as clean shower areas and child changing rooms will also promote better hygiene practices by patrons. The pool water uptakes *Cryptosporidium* through contaminated feces of animals, or stool of

humans, or contaminated other materials (water, soil, food, see other chapters of this report). An accidental faecal release (AFR) from a person(s) infected with *Cryptosporidium* in a swimming pool can result in an infective dose for a child or adult, especially for those whose immune system is weakened. Usually the infectious *Cryptosporidium* oocysts, which are released with diarrheal stool by the infected swimmer in the pool, would be dispersed throughout the pool due to the currents created by other swimmers, especially in a heavily used venue. The infectious *Cryptosporidium* oocysts are usually incorporated by ingestion of pool water. A rapid and adequate response by staff to known and suspected faecal contamination events is one essential measure to prevent infections or outbreaks. Management of faecal and diarrhoeal episodes should adhere to recommended guidelines and should include hyper-chlorination for 24 h or longer and if necessary to repeat.

Pool management and staff should ensure the facility complies with current codes and standards of operation and insist on patrons' adherence with regulations and practice of good hygiene, when using the pool facilities. Staff at recreational facilities, play a key role in controlling cryptosporidiosis outbreaks via an informed and timely response to AFRs and by adhering to strict hygiene standards themselves. Pool operators need to be educated on the risks of *Cryptosporidium* contamination and best practice management procedures, including an AFR response policy and keeping records of all faecal accidents, chlorine and pH level measurements, and any major equipment repairs or changes. Education measures include also development and distribution of healthy (less risky) swimming education materials season pass holders, daily patrons, prior to the 'pool use', that focus on avoiding swimming for two weeks after experiencing diarrhea, intentional pool water ingestion, and splashing others in the face.

Broader recognition by public health authorities of *Cryptosporidium* as an infectious agent important particularly to childhood diarrhea in areas is needed. We recommend that physicians be aware of *Cryptosporidium* as a cause of diarrhea in children and that procedure for the diagnosis of this parasite be included in the routine diagnostic procedure for diarrheal stool specimens in all laboratories. There are increasing policy requirements to safeguard clean water for drinking and recreational purposes and to cope with growing pressure for introduction of reclaimed sewage to supplement water supplies. There is an urgent need to develop rapid, specific and sensitive detection method for *Cryptosporidium* from water and these methods must also allow assessing the in vitro cultivation of the parasite in terms of viability or infectivity of detected oocysts in water samples. Pathogenic *Cryptosporidium* parasites are cultivable, however, the optimal conditions and strategies to establish the rapid screening system has to be developed. Proliferation in suitable culture media and quick screening systems can be achieved for *Cryptosporidium* and in combination with new discoveries on the parasite's basic biology and new life cycle stages, essential steps can be done towards significant progress in the control of cryptosporidiosis including to avoid the transmission via swimming pools.