Institute of Food Science & Technology

Cryptosporidium

The Institute of Food Science & Technology has authorised the following Information Statement dated April 2008, replacing that dated September 2001.

SUMMARY

Cryptosporidium is a genus of parasitic protozoans that causes cryptosporidiosis, an enteric infection in humans and animals. In people, it causes abdominal pain, profuse diarrhoea, weight loss, loss of appetite and anorexia, but the infection is usually self-limiting and resolves within a few weeks. In immunocompromised patients, the infection is more serious; it can become chronic and is sometimes fatal. These protozoa complete their life cycles in one host and their oocysts (spores) are highly infectious.

The oocysts are usually transmitted by contaminated drinking water, infected animals, person-to-person spread or contaminated food or beverages (Cryptosporidium requires a host in which to multiply and cannot grow in foods or water). The majority of water treatment plants cannot completely guarantee to remove all Cryptosporidium from water because the oocysts are very small and resistant to the levels of chlorine used in these plants. Control of water supplies depends on catchment management to limit contamination of raw waters by animals, manure or human sewage, through the use of ultra filtration, ozonisation and careful maintenance of water treatment systems. Cryptosporidium is inactivated by heat, freezing and drying, so heat-treated, frozen and dried foods should be safe unless contaminated after processing. Precautions should be taken to prevent contamination of raw foods that are to be consumed without heating.

BACKGROUND

Cryptosporidium is a genus of protozoans belonging to the Coccidia subclass. In humans it causes cryptosporidiosis, an intestinal infection. It also infects many animal species, causing symptomatic illnesses mainly in young animals. Older animals may be carriers.

The organism was discovered early in the twentieth century but its importance was only realised in the 1970s by veterinary workers investigating the causes of scours (severe and serious diarrhoea) in young farm animals. The first cases in humans were recognised amongst young children and, in the 1980s, it was recognised as causing serious infections in severely immunocompromised patients including patients with AIDS. Human cryptosporidiosis is now widely recognised as an endemic enteric pathogen with a world-wide distribution. Infection rates are highest in developing countries and amongst children under 5 years of age in developed countries. The majority of human infections are due to *Cryptosporidium hominis* and *Cryptosporidium parvum*. *C. hominis* is probably specific to humans, so transmission is via direct person to person contact or via faecal contamination,

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including that with sewage. Many animal species can be infected with *C. parvum* (particularly young livestock animals), and transmission is via animals to humans, as well as from humans to humans.

CRYPTOSPORIDIOSIS

An incubation period of 2-14 days follows ingestion of oocysts. Very low doses are able to initiate an infection, probably fewer than 100 oocysts. The protozoa attach to the wall of the gut and multiply, completing their entire life cycle in a single host. The illness is characterised by profuse, watery diarrhoea with abdominal pain. It can also cause vomiting, weight loss, loss of appetite and a low-grade fever. Typically, the illness resolves in 2-3 weeks but it can last for up to 6 weeks. Only supportive treatment is available, and this will only be required in serious cases. However, in severely immunocompromised patients, e.g. AIDS sufferers, the infection may become chronic and serious, sometimes fatal. In these cases, other organs and tissues may become infected, e.g. the biliary tract and respiratory system. No antibiotic treatment has yet been shown to be effective in clinical use, although some encouraging results following the use of paromomycin have been reported.

Mature oocysts are excreted in faeces in very high levels during diarrhoea and are immediately infectious. Excretion may continue for some weeks after the cessation of diarrhoea.

The parasite is transmitted by the faecal oral route and infection may be acquired in a number of ways from:

- contaminated drinking water;
- animal contact, particularly from lambs and calves, but also pets;
- person to person contact and via sewage contamination;
- contaminated raw foods or beverages, e.g. raw meat, unpasteurised milk, fruit, fruit juices and vegetables; and
- contaminated recreational water use, including swimming pools.

Farmyard manure may contain high numbers of cryptosporidial oocysts and, consequently, water may be contaminated by manure or slurry washed from fields into rivers; vegetable crops may be contaminated by direct manuring of the fields in which they are grown. Well-managed and stored manure and slurry is effective in reducing infectivity through raised temperature and ammonia levels.

OUTBREAKS

The number of reported cases in England and Wales is approximately one-tenth of the reported cases of infection with *Salmonella spp*. However, as many cases are thought to be unreported, the actual number is probably several times higher. Cryptosporidiosis may show a seasonal distribution and, at its peak, is the most common enteric pathogen in children under 5 years old. In one 2-year UK study, *Cryptosporidium* was found twice as often as *Salmonella spp.* in children aged 1 to 5 years. It is also recognised as a frequent cause of "traveller's diarrhoea" especially after travel to parts of Southern Europe. In developing

countries where water supplies are often contaminated, malnutrition is evident, sanitation non-existent and close contact with animals is normal, infection rates can be high.

The largest recognised outbreak was in 1993, in Milwaukee, USA, when it was estimated that more than 400,000 people were affected by contaminated drinking water. In the UK, there have been several outbreaks associated with farm visits and some well-publicised water-borne outbreaks.

LIFE CYCLE

Cryptosporidium are obligate parasites, which have a complex life cycle that is completed in a single host animal. The transmissible stage is the oocyst (spore). After ingestion, each oocyst releases four motile sporozoites into the gut, primarily in the small intestine. These attach to the gut wall and multiply considerably by asexual reproduction. This is followed by a sexual stage that results in the production of oocysts. Multiplication and development of *Cryptosporidium* occurs in a special membrane-bound compartment on the outer surface of the cells lining the gut; the infection is intracellular but it is extracytoplasmic, i.e. the protozoa do not penetrate deeply into the host's cells.

Oocysts mostly sporulate within the gut and two types are produced. The thin-walled type releases more sporozoites in the gut (auto infection) and the thick-walled types are excreted in faeces in a fully infective form. They do not need any further maturation, unlike many other Coccidian protozoa.

RESISTANCE OF OOCYSTS

Oocysts can remain viable for about 18 months in a cool, damp or wet environment, including in sea water. They are quite common in rivers and lakes, especially where there has been sewage or animal contamination. However, drying at ambient temperatures effectively reduces their infectivity. They are destroyed by freezing and they are also heat sensitive. A temperature of 65°C inactivates oocysts in 5-10 minutes.

Oocysts are remarkably resistant to many common disinfectants, including chlorine-based compounds. Very high concentrations of most disinfectants may be effective, but such levels are not practical for water treatment. This parasite is however susceptible to ozone and UV light.

WATER TREATMENT

The complete removal of *Cryptosporidium* oocysts from water supplies is difficult in conventional water treatment plants. The oocysts are resistant to the normal chlorine disinfection treatment and, as they are very small (4-6 µm diameter), some pass through the flocculation and sand filtration systems. Control measures may be different in supplies from bore holes as compared to those derived from surface waters, although even those from bore holes may be susceptible to oocyst contamination. Sources derived from surface water will inevitably be susceptible to run-off from land contaminated by animals as well as, on occasion, human sewage. Good maintenance and design of the filtration systems and

careful control of the treatment facility and processes, especially during back-flushing to clear the filtration beds, are essential. The use of 1 µm pore size filtration systems is capable of eliminating the parasite and these, together with ozonization systems (which may already be in use where pesticide residues are present), are used in some water treatment plants. In practice, many conventional water treatment plants cannot guarantee the complete removal of these protozoa from water supplies.

In view of this, both English and American public health authorities have advised severely immunocompromised people to boil drinking water in order to reduce the chance of acquiring waterborne cryptosporidiosis. It is sufficient simply to bring water to the boil to eliminate *Cryptosporidium*. It should be stressed that, to be effective, the guidance must be followed consistently for all water used for drinking or for washing foods intended for consumption without cooking. It should also be noted that bottled water is not guaranteed free of *Cryptosporidium*.

Guidelines for the UK food and beverage industries were published in 2000 by the Campden and Chorleywood Research Association Group. These Guidelines list these food processes and products which are at risk from *Cryptosporidium* in the event of a 'Boil Water Notice', i.e. in the event of a breakdown of the (municipal) water supply. See also the IFST Advisory Statement "Contamination of Water Supplies: Boil Water Advice" issued in 2004.

FOOD

Cryptosporidium cannot grow in food. Although no commercial foodborne outbreaks have been recorded, oocysts will survive in wet/moist foods if they become contaminated. Raw milk, raw sausages and offal together with fruit, vegetables, salad products and filter feeding shellfish are at risk if in contact with manure, sewage or contaminated water and therefore may become contaminated. Cooked foods are not thought to be at risk; the normal recommended time and temperature for controlling bacterial food poisoning (cooking to an internal temperature of 70^0C for 2 minutes) will probably inactivate *Cryptosporidium*. Heat processed foods have never been shown to be a source of infection. Oocysts will not survive freezing.

There is a potential danger that infected food handlers could contaminate food; people with symptoms must not handle foods and advice should be taken on when they can restart such work (usually at least 48 hours after symptoms resolve). Personal hygiene is very important with this illness because the infective dose is so low.

DETECTION

Unlike most bacterial enteric pathogens, it is not possible to grow *Cryptosporidium* routinely in foods or beverages to levels where they may be readily detected; hence, examination of foods for this protozoan has in the past been considered impractical.

Organisms in water samples can be concentrated by filtration and by immunomagnetic separation. Deposits are then usually examined by microscopy and differential staining techniques are available to distinguish viable from non-viable oocysts. Immunoassays and PCR-based procedures are also used.

FURTHER READING

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