Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

hpsc

Drinking Water Supplies, Cryptosporidiosis and Severely Immunocompromised Patients

PUBLIC HEALTH RECOMMENDATION FOR CLINICIANS

RECOMMENDATION

It is not possible to be absolutely sure that tap water, whether from a public or private source, is free of *Cryptosporidium* sp.

If your patient is severely immunocompromised and at risk of a severe illness (see section 2 below), it is recommended that they boil their drinking water.

The boiling of water before consumption can be a great personal burden for the individual. It is not a decision to be taken lightly. Clinician and patient should carefully discuss its implication if deciding to proceed with the recommendation.

1. What are the risks and public health implications of *Cryptosporidia* in a water supply?

The *Cryptosporidium* parasite is common in lakes and rivers (surface water) which are the source of many Irish public drinking water supplies.[1] It is highly resistant to disinfection and even well-operated treatment systems cannot ensure that drinking water will be completely free of *Cryptosporidium.*

The public health implications of the presence of *Cryptosporidium* species in drinking water, and the necessary actions to protect public health, are not as clear or as straightforward as for other pathogens such as *E. coli*, for the following reasons;

- There is no threshold level of *Cryptosporidium* contamination of drinking water that indicates that human illness is likely to occur. Consequently, there are no operational guideline levels for *Cryptosporidium* in drinking water.[2] [3] [4]
- Very low levels of *Cryptosporidium* oocysts are sometimes found in public water supplies.[1, 5, 6, 7, 8, 9, 10, 11] Laboratory tests cannot yet determine if the cysts are alive or dead and therefore whether they can actually cause illness. [3, 4, 12]
- In immunocompetent individuals cryptosporidiosis may be asymptomatic or a self-limiting gastro-intestinal illness. In some severely immunocompromised individuals an infection may result in a severe, protracted and potentially fatal illness. [13, 14, 18, 19, 20, 21]
- Cell-mediated immunity appears to be the major mechanism governing human immunity to *Cryptosporidium*. As a result, conditions that impair cell mediated immunity, particularly in relation to the functioning of CD4+T cells, are those that increase the likelihood of developing severe cryptosporidiosis. [16, 17, 18, 19, 20, 21]
- The public health significance of detection of low levels *Cryptosporidium* oocysts in drinking water is not clear.[3, 4] Illness does not necessarily occur. It is not known if these very low levels can cause infection among persons with severely compromised immune systems.
- If low levels of *Cryptosporidium* oocysts are detected in a sample of drinking water, a risk assessment followed by appropriate actions are undertaken to protect public health. In the

absence of reported human illness amongst users of that water supply, a boil water notice may not be put on the supply. [15]

- **Some severely immunocompromised individuals who are at risk of life threatening illness from cryptosporidial infection may need to take additional measures to protect their health on the advice of their clinician.**
- **Not all persons with weakened immune systems are at a higher risk of severe cryptosporidiosis and hence do not need to take extra precautions.**

2. Immunocompromised Patients

In immunocompetent individuals cryptosporidiosis may be asymptomatic or a self-limiting gastro-intestinal illness. However, severely immunocompromised individuals may be at risk of a severe, protracted and potentially fatal illness. [18, 19, 20,21]

The understanding of host factors that are associated with variations in both severity and risk of infection has increased dramatically, although the mechanisms that lie behind these observations remain for the most part to be determined:[16 20]

- Not all forms of immune suppression lead to an increased disease severity of cryptosporidiosis. *The effect of a particular immunosuppressive disorder on the severity of Cryptosporidium infection remains difficult to predict but there is a link between an increased severity of disease and certain types of immune suppression.* [16, 17]
- Cell-mediated immunity appears to be the major mechanism governing immunity to *Cryptosporidium*.[16, 18, 19, 20, 21] Conditions that impair cell mediated immunity, particularly in relation to the functioning of CD4+T cells, are those that increase the likelihood of severe cryptosporidiosis.
- Patients with HIV infection and CD4+ counts less than 50 cells/mm^3 are more likely to have a fulminant form of the disease, while those with CD4+ counts of 180 cells/mm^3 or more tend to have less severe self-limiting disease.[16, 20, 21, 22]
- Of the primary immune deficiencies, those diseases most clearly linked to an increased severity of cryptosporidiosis include severe combined immunodeficiency syndrome, X-linked hyperimmunoglobulin M syndrome and CD4 lymphopoenia. All three of these deficiencies are characterised by impaired T cell function.[16,18]
- The evidence appears to indicate that *Cryptosporidium* does not pose a particularly special risk to cancer patients generally. The exception to the rule appears to be patients with leukaemia and other haematological malignancies, whilst on treatment or post bone marrow transplant..[16, 18, 19, 23, 24]
- Cryptosporidiosis in solid organ recipients and in patients with non-haematological malignancies has been described but does not seem to be as problematic as it is in the risk groups discussed above. [16, 18, 23]

3. What is done to prevent Cryptosporidia in drinking water supplies? [1, 12]

In Ireland, the majority (82%) of drinking water supplies originate from surface water (water from rivers, lakes and streams, which drain the land). Such supplies are vulnerable to contamination with *Cryptosporidium* oocysts from infected animal or human excreta. *Cryptosporidium* is resistant to disinfection with chlorine (chlorination). Surface waters require further treatment in addition to disinfection to ensure that the water is clean and free from cryptosporidium.

A small number of public water supplies in Ireland do not have adequate treatment for C*ryptosporidium* oocysts. In the past, few private supplies had treatment for *Cryptosporidium* but many have installed

ultraviolet light treatment in the last few years. Any treatment method, however, can be subject to failure. Treatment methods may be overwhelmed when dealing with very high levels of naturally occurring contaminants (including *Cryptosporidium* oocysts) in the source water as can occur following heavy rainfall.

Cryptosporidium oocysts are most effectively removed by *filtration* of the source water in the water treatment plant. *Ultraviolet* treatment will inactivate any oocysts that are present without removing them from the water.

Ireland has adopted a multi-barrier approach to reduce the risk of drinking water contamination:

- The protection of the source water
- Treatment of source water at a water treatment plant
- The protection of the supply through the distribution system.

Whilst not all water supplies have sufficient barriers in place, the strength of the multi-barrier approach is that a failure of one barrier may be compensated by effective operation of the remaining barriers. The combined effectiveness of these measures is assessed in two ways, by monitoring water quality and by surveillance for water borne infections.

4. Limitations in Monitoring Drinking-water for Cryptosporidium [2, 3, 4, 12]

Large public supplies are routinely monitored for *Cryptosporidium* but some smaller supplies may not be. No reliable methods are available to detect the presence of oocysts (or their pathogenicity) routinely and quickly. *Routine monitoring may not detect Cryptosporidium in drinking water before an outbreak of human illness occurs*:

- It may take a week or longer before the sample results are available from the laboratory.
- Optimum sampling requires running at least 1,000 litres of water thorough a filter over a 24 hours period. Sometimes only a 10 litre "grab" sample is taken. Oocysts may be missed resulting in a false negative result. Equally there could be an overestimate of the concentration of oocysts.
- Reliable laboratory methods for testing oocyst viability are still being developed and are not generally available. A non-viable oocyst will not cause disease.
- Speciation of oocysts requires a large number of oocysts and can take a number of weeks. Not all species of *Cryptosporidium* cause human illness.

The public health significance of detection of low levels of Cryptosporidium oocyst in drinking water is not clear. Illness does not necessarily occur.

5. Limitations in Surveillance of Human Cryptosporidiosis [14, 15]

The incubation period for cryptosporidiosis is 1-12 days (average 7 days). The majority of individuals with a diarrhoeal illness self-manage their symptoms. A small percentage may seek medical attention but may not do so until a number of days into the illness.

Of those who present to a doctor, only a proportion will be asked to provide a stool sample. Laboratory practices vary and not all stool samples are tested for *Cryptosporidium* oocysts.

It is likely that at least two weeks will have elapsed between the time of symptom onset to laboratory confirmation and notification to the Department of Public Health. This time lag makes the application of early interventions to prevent an outbreak problematic.

6. Public Health Recommendation

It is not possible to be absolutely sure that tap water, whether from a public or private source, is free from *Cryptosporidium* sp. The boiling of drinking water kills cryptosporidial oocysts and removes any potential threat of cryptosporidial infection from that source.

If your patient is severely immunocompromised and at risk of a severe illness (see section 2 above), it is recommended that they boil their drinking water.

Note: The boiling of water before consumption can be a great personal burden for the individual. It is not a decision to be taken lightly. Clinician and patient should carefully discuss its implication if deciding to proceed with the recommendation.

References

[1] Environmental Protection Agency. The Provision and Quality of Drinking Water in Ireland. A Report for the Year-2012. www.epa.ie

[2] European Communities (Drinking Water) (No. 2) Regulations 2007. S.I. No. 278 of 2007

[3] Fairley CK, Sinclair M, Rizak S 1999. Monitoring drinking water: the receding zero. The Medical Journal of Australia. 171: 397-398

[4] Sinclair M, Fairley CK, Hellard M. 1998. Protozoa in drinking water: is legislation the best answer? The Medical Journal of Australia; 169:296-297

[5] Cummins E, Kennedy R, Cormican M. Quantitative risk assessment of *Cryptosporidium* in tap water in Ireland. Science of the Total Environment 2010; 408:740-753

[6] Byleveld PM, Hunt A, McAulty JM. Cryptosporidiosis in the immunocompromised: weighing up the risk. MJA 1999; 171:426-428

[7] British Columbia. HealthLinkBC. Preventing Water-Borne Infections for People with Weakended Immune Systems. Number 56. June 2013. http://www.healthlinkbc.ca/healthfiles/pdf/hfile56.pdf

[8] New York State Department of Health. Cryptosporidiosis (Last Reviewed: October 2011). http://www.health.ny.gov/diseases/communicable/cryptosporidiosis/fact_sheet.htm

[9] The New York City Department of Health and Mental Hygiene. Cryptosporidiosis. http://www.nyc.gov/html/doh/html/diseases/cdcry.shtml

[10] Illinois Department of Public Health. Health Beat. Cryptosporidiosis in immunocompromised persons. http://www.idph.state.il.us/public/hb/hbcrypto.htm

[11] Virginia Department of Health. May 2013. Preventing Cryptosporidiosis in People who are Immunocompromised. http://www.vdh.virginia.gov/Epidemiology/factsheets/pdf/Cryptosporidiosis_additional_info.pdf

[12] Environmental Protection Agency. EPA Drinking Water Advice Note. Advice Note No. 9. *Cryptosporidium* Sampling & Monitoring.Verson 1; Issued 26/09/2011. www.epa.ie

[13] Sunnotel O et al. Cryptosporidium. Letters in Applied Microbiology 2006; 43:7-16

[14] HPSC Cryptosporidium and the protections of human health (currently in draft 17.02.14)

[15] HSE Drinking Water and Health. A Review and Guide for Population Health Service Executive. 2008 www.hse.ie

[16] Bouzid M, Hunter PR, Chalmers RM, Tyler KM. Crytposporidium Pathogenicity and Virulence. Clin. Microbiol. Rev. 2013, 26(1):115. DOI:10.1128/CMR.00076-12. Accessed January 6, 2014.

[17] Hoxie NJ, Davis JP, Vergeront JM et al. Cryptosporidiosis-Associated Mortality Following a Massive Waterborne Outbreakin Milwaukee, Wisconsin. Am J Public Health. 1997;87:2032-2035. Accessed 6th January 2014

[18] Hunter PR, Nichols G. Epidemiology and Clinical Features of *Cryptosporidium* Infection in Immunocompromised Patients. *Clin. Microbiol. Rev. 2002, 15(10:145. DOI:10.1128/CMR.15.1.145-154.2002.* Accessed January 6, 20014.

[19] Davies AP, Chalmers RM. Clinical Review: Cryptosporidiosis. *BMJ 2009;339:b4168. doi:http//dx.doi.org/10.1136/bmj.b4168 Accessed 6th January 2014.*

[20] Borad A, Ward H. Human immune responses in cryptosporidiosis. *Future Microbiol. 2010 March 5:507-519 DOI: 10.2217/fmb.09.128. Accessed 7th January 2014*

[21] Leitch GJ, Qing He. Cryptosporidiosis-an overview. *J Biomed Res. 2011 January; 25(1):1-16. DOI:10.1016/S1674-830(11)60001-8*

[22] Dillingham RA, Lima AA, Guerrant RL. Cryptosporidiosis: Epidemiology and Impact. Microbes Infect 2002 Aug;1056-66

[23] Vythelingum K, Cheesbrough J, Woywodt A. Teaching Point. A day at the pool. *Clin Kidne J (2012) 5:265-268 Accessed 6th January 2014*

[24] Tomblyn M etal 2009. Guidelines for Preventing infectious complications among Hematopoietic Cell Transplant Recipients. A global perspective. American Society for Blood and Marrow Transplantation. Biol Blood Marrow Transplant 15:11430123

This document was developed by Consultants in Public Health Medicine in consultation with haematological and oncological colleagues.