Washington State Department of Health (DOH)
Cryptosporidium in Drinking Water
Position Paper

Purpose

Cryptosporidium is a micro-organism which has gained increased public health significance as a result of a number of disease outbreaks reported within the past thirteen years. Although the level of understanding regarding the occurrence, testing, clinical control, and mitigation of this protozoan has been increasing over the past decade, it is clear that considerable effort remains before this organism and its environmental relationships can be fully characterized. This position paper is intended to provide Department of Health (DOH) staff and local health officials with a synopsis of some key elements regarding the current state of knowledge for *Cryptosporidium* and to present recommendations useful for public information within local jurisdictions.

Background

Originally considered to be a parasite only of non-human mammals, reptiles, and birds, *Cryptosporidium* was first reported as a disease agent in humans in 1976. Since that time, it is now believed the *Cryptosporidium* has been causing illness in humans for a very long time, but due to difficulties in testing and diagnosis, had been overlooked. The organism gained public health importance through a series of waterborne disease outbreaks during the mid-1980s through the early 1990s, in which it was identified as the confirmed or probable etiologic agent. This organism captured special public health attention in 1987 when it was determined to be responsible for an epidemic impacting an estimated 13,000 people in Carrollton, Georgia (approximate population 16,000). Especially notable in the Carrollton waterborne outbreak was that the water quality from the treatment process met all federal and state standards, although some operational irregularities were noted at the time. At least eight other outbreaks of waterborne cryptosporidiosis occurred sporadically in the United States and Great Britain following the Carrollton incident. Then in 1993 a waterborne outbreak in Milwaukee, Wisconsin, underscored the public health severity which could be associated with *Cryptosporidia*. National attention was focused on this organism inasmuch as it was determined to have caused an estimated 400,000-plus cases of diarrhea in a population of about a million, and was considered responsible for more than 100 deaths for especially susceptible individuals. As with the Carrollton outbreak, the water quality delivered to the customers met all federal and state standards. Since the Milwaukee outbreak, there have been additional reported *Cryptosporidia*-related outbreaks (Las Vegas; Washington, D.C.; Walla Walla proximity; etc.) which emphasize its importance as an organism of public health significance and for which health protection professionals must become increasingly aware and vigilant.

Only a few states include cryptosporidiosis as a reportable disease. Cryptosporidiosis is currently not reportable in Washington State. On a nationwide basis, it has been estimated that from one to four percent of all gastrointestinal illnesses may be due to *Cryptosporidium* ("Facts about *Cryptosporidium*", U.S.E.P.A., 1995). Estimates on a worldwide basis

suggest an incidence approaching twenty percent for developing countries ("Facts about *Cryptosporidium",* U.S.E.P.A., 1995).

Source of Contamination and Routes of Exposure

Excreted from infected animals or humans to the environment (streams, lakes, rivers, soils, etc.) in its environmentally-resistant lifecycle form (termed "oocyst", a form capable of persisting in the environment for long periods of time), *Cryptosporidium* may subsequently be ingested by humans, most commonly in contaminated drinking water. Once ingested, the oocysts release another lifecycle stage (called "sporozoites") which invade and proliferate in the lining of the intestines causing gastrointestinal illness in susceptible individuals. The cycle is then repeated upon discharge of the intestinal contents into the environment.

All surface waters are potentially contaminated by *Cryptosporidia.* Groundwaters which are directly influenced by surface waters would also be at risk. Drinking water which comes from surface sources must be treated with sophisticated methods to reduce the risks associated with consumption of *Cryptosporidia.*

Another mode of transmission is through person-to-person contact (directly by fecal-oral routes, or indirectly by contact with contaminated surfaces or objects). This may pose an especially important mode of transmission for children, particularly in daycare settings.

It is unknown just how many oocysts are sufficient upon ingestion to produce clinical disease, although it is generally conceded that it would take very few. Estimates have been reported for infective doses ranging from ten to one hundred oocysts, and some studies suggest even lower doses may result in disease.

Known Health Effects

Clinical Aspects

Most people who contract cryptosporidiosis generally experience diarrhea and stomach cramps. A person may also experience vomiting, weakness, fever, gas production, and weight loss. Stools are frequently watery, somewhat yellowish, and odorous. It should be recognized, however, that many people infected with *Cryptosporidium* exhibit no overt symptoms.

This disease may be quite serious for persons with compromised immune systems, especially those with HIV/AIDS, those on immunosuppressive therapy, or those with an immunoglobulin deficiency. These individuals may be subject to prolonged diarrhea, resulting in severe dehydration and possibly death.

For the rest of the population, the very young, older persons, and those with pre-existing debilitating conditions are at greater risk for more pronounced illness than the general population.

Public Health Aspects

Evidenced in recent history by a number of epidemiologically significant outbreaks of cryptosporidiosis, it is clear that this organism can manifest extreme impacts on an exposed

population. Once introduced into a population from an environmental source, the spread of the disease can be compounded through person-to-person modes of transmission, even though the environmental sources may show dissipated levels of the organism.

The prevalence of cryptosporidiosis is not well known, although some studies have suggested this disease to have infection frequencies that rival those associated with more commonly identified enteric pathogens.

The risk of infection in general populations is difficult to characterize since many factors are involved in determining occurrence of the organism, the manifold reservoirs for *Cryptosporidium*, the various modes of transmission (drinking water, person-to-person, animal-to-person, recreation use of land and water, etc.), and the relative susceptibilities throughout a populace. Populations most at risk are generally those using untreated or poorly treated drinking water, those located in environments subject to agricultural pollution from livestock, those employing marginal hygienic practices, and those with immunocompromised or poor health.

Diagnosis and Treatment

Clinical Aspects

Persons with gastrointestinal illness must have a stool specimen analyzed in the laboratory to determine if *Cryptosporidium* is the causative organism. If oocysts are not observed, another stool specimen examination may be needed a day or two later (oocysts may not be excreted every day, even if a person is infected). It should be recognized that the identification of *Cryptosporidium* oocysts requires high levels of skill, experience, and internal laboratory quality control to ensure accuracy. These attributes may be variable from one laboratory to another, and may offer opportunity for inconsistencies in the confirmed identification of the organism.

Currently, there is no specific clinical treatment for cryptosporidiosis which has been demonstrated to be uniformly effective. Infected individuals exhibiting diarrhea should drink large amounts of fluids to minimize dehydration. Generally, the disease must "run its course" before recovery is finally experienced in infected individuals. However, for persons with underlying medical conditions, *Cryptosporidium* may be life-threatening.

Environmental Aspects

Cryptosporidium oocysts may be found in all types of water sources, although predominately more associated with open surface waters. It has been very difficult, however, to provide quantification of this organism in the environment since the current sampling and analysis protocols lack desired degrees of precision. This is further compounded by the often scarcity of the organism in large volumes of water necessitating unusually large sample volumes, and the inability to easily determine oocyst viability microscopically. Complex analytical procedures involving concentration of samples to manageable volumes and rigorous, sophisticated microscopical examination requiring highly trained technicians further complicate development of standardized recovery/evaluation mechanisms.

Drinking water treatment methods in current application have been primarily designed for control of bacterial pathogens. *Cryptospordium*, more than with other protozoan parasites, has shown high levels of resistance to disinfection practices normally employed with water treatment. It has been demonstrated that disinfection levels for such protozoans as *Giardia* are only marginally effective for *Cryptosporidium*. Whereas the combination of filtration and chlorine disinfection is considered fundamental for treatment of surface sources of supply, treatment for *Cryptosporidium* appears to rely solely upon a "well-operated" and "controlled" filtration process. This is underscored by the fact that several *Cryptosporidium* outbreaks have occurred in water systems employing filtration and chlorination treatment, but because of unusual conditions or inattentive operation, failed to control the introduction of the organism into the distribution system.

Currently, aside from the well-operated filtration process, it appears that ozonation (as a primary treatment/disinfection process) may offer the best alternative treatment method for *Cryptosporidium*, especially for larger scale operations. Although generally viewed more appropriate for smaller scale operations, some membrane filtration processes or reverse osmosis treatment may also be successful for *Cryptosporidium* removal.

Legal Standards or Requirements

The 1996 Safe Drinking Water Act Amendments address *Cryptosporidia* as an agent of disease which shall be regulated in the future, but currently no rule, requirement, or regulation is in place which governs the monitoring and control of this organism in public water systems or in private, individual residences. Under the "Information Collection Rule" recently promulgated by the EPA, large water systems throughout the nation which use surface sources of supply will be required to perform monitoring for *Cryptosporidium* starting in 1997. In addition, there is currently a national effort to evaluate the effectiveness of more stringent approaches to treatment of waters containing *Cryptosporidium*, which will be subsequently evaluated in the development of federal rules for surface water treatment (Enhanced Surface Water Treatment Rule, expected for promulgation by the year 2000).

Preventive Measures and Response Actions Recommended by DOH

* The best means for preventing cryptosporidiosis, aside from avoidance of contaminated food or water or contact with infected individuals, is to routinely wash hands following contact with potentially contaminated materials or objects.

* For the majority of the population there is only minimal concern regarding cryptosporidiosis. However, for immunocompromised individuals, special care would be advised to avoid lifestyle or environmental activities that would place the individual at greater risk to infection.

* Whenever situations occur which may require cautionary approaches to mitigate disease outbreak potential (such as line breaks, cross connections, flooding, etc.) and notice is provided advising emergency treatment of drinking water, it is recommended that water be brought to a rolling boil for at least three minutes prior to cooling and consuming. It is generally acknowledged that boiling of water is the surest means for destroying *Cryptosporidium* oocysts.

* Persons with weakened immune systems are advised to discuss proper precautions with their health-care provider. Although not categorical, advice may include such actions as the routine boiling of drinking water, or the use of bottled water (NOTE: it should be recognized, however, that bottled water is not routinely tested for this organism and cannot be absolutely guaranteed to be *Cryptosporidia* -free). Individuals may also use special filter units for household tap water, but would be cautioned to use only those devices rated effective for removal of particles one micron in size or smaller (ensure rating is absolute and not nominal).

* Proper and attentive operation of filtration treatment for all surface waters or waters directly impacted by surface water is recommended at all times. This is particularly important when conditions are such that treatment plants may be stressed to provide effective removal of *Cryptosporidium*. Special attentiveness would be advised when raw water quality is impacted by high rains (runoff).

References

For those interested in more detailed information, the Department can provide copies of the federal Drinking Water Health Advisory (HA) for *Cryptosporidium*. Also available upon request is a copy of publication authored by Patricia Meinhardt, entitled "Epidemiological Aspects of Human Cryptosporidiosis and the Role of Waterborne Transmission," which provides an excellent summary of the current state of knowledge regarding this organism.

DOH Point of Contact:

Division of Drinking Water	- Jim Hudson (360) 236-3131
Office of Epidemiology	- Paul Stehr-Green (360) 236-4240
WEBSITE:	- http://www.doh.wa/gov/ehp/dw