Giardia and Water Quality in Colorado, What Direction to Head

Jeremy Nichols

ABSTRACT

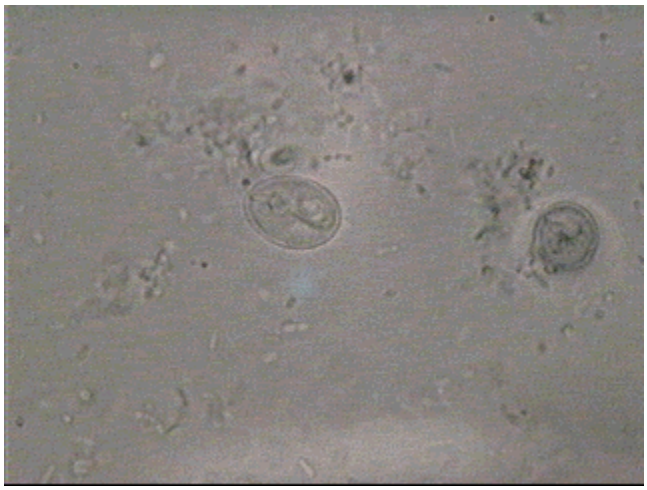
Giardia lamblia is the single agent that is most commonly identified in association with waterborne disease in the United States. The Rocky Mountain region is known to be a high risk area for giardiasis outbreaks for many reasons. The problem is that most of the surface water sources are contaminated with these giardia cysts. These readily available water sources are then used as principle sources of drinking water. There is research that shows the giardia cysts can remain active for up to two months in cold water. Therefore cold mountain streams are the best places for the cysts to survive until they can pass through to the state water distribution systems. The recent outbreaks of giardiasis in the U.S. have demonstrated a need for better understanding of the various factors affecting the removal of *giardia lamblia* cysts from water (LeChevallier, 1991). Many municipalities that use surface water as a source are equipped to provide effective treatment of water. But if the source becomes contaminated with giardia cysts, the existing treatment facility may not be able to assure prevention of waterborne giardiasis with its current operating procedures. Thus, water treatment has become a subject of concern in areas where giardia has been detected.

KEYWORDS

Giardia, filtration, pathogen, Colorado, pain, cysts

INTRODUCTION

Giardiasis is an intestinal disease that occurs when cysts of the protozoan *giardia lamblia* are ingested (Lin, 1985). These cysts can be as long as 8 to 12 um with a diameter of 7 to 10 um (Finch, 1994). Giardiasis is the most commonly reported parasitic disease of humans in the United States (Lin, 1985). The parasite is generally transmitted by the fecal-oral route using person to person contact for the majority of cases. If an infected animal or human defecates in or near a stream, the cysts can then spread via the water. If the water containing the cysts is consumed then the disease is ultimately contracted. Therefore, concern for waterborne transmission of giardia has become gradually more important. It is the pathogen that is responsible for most of the outbreaks of waterborne disease over the past twenty five years. The statistics show that most of the outbreaks were due to consumption of untreated surface water or surface water with disinfection as the only treatment (Hibler, 1987).



Giardia lamblia cysts

Colorado and its streams and watersheds are tied closely with this disturbing pathogen. In these mountain environments, where the water appears crystal clear, it is sometimes difficult to treat water with rapid rate sand filtration (Lin, 1985). In fact the first outbreak suspected to be caused by giardia was in Aspen, Colorado during the 1965-66 winter season (LeChevallier, 1991). The Colorado Department of Health has also conducted several studies that show a widespread presence of giardia lamblia cysts in surface waters throughout the state. They obtained these results using standard methods of cyst recovery on different filters. Their study concluded that all Colorado surface waters are at risk (Lin, 1985). Because giardia lamblia cysts can remain viable for up to sixty days in cold water, Colorado's frigid climate does nothing to stand in the way of this pathogen.

HEALTH EFFECTS

There are many symptoms associated with acute giardiasis. The most common symptom is diarrhea, followed by weakness, weight loss, abdominal cramps, nausea, greasy stool, abdominal distention, flatulence, vomiting, and fever. The main reason for the diarrhea is because of inflammation of the intestine due to the attachment of the parasites to the mucosa, which is moist tissue that lines particular organs and body cavities throughout the body. If the giardia becomes heavily infested, malabsorption can occur. This condition leads to vitamin deficiencies, increased fat content of the feces, and interference with protein absorption. It has also been reported that the parasite causes low levels of all forms of gamma globulin and diseases of the bile tract, liver, pancreas, and large bowel. Some studies have even reported cases of persons carrying the parasite for up to five years. These patients suffered from alternating stages of constipation and diarrhea along with nasal allergy, asthma and milk intolerance. Thankfully there are four drugs on

the market capable of treating infected individuals. These are Atabrine, Flagyl, Furoxone, and Humatin. All come with there own set of side effects too. None offer immunity, just a cure for the disease (Lin, 1985).

ANALYSIS

Analysis of giardia cysts is full of obstacles. First of all, giardia cysts can not be cultured or grown. This makes it difficult to obtain and maintain a source of cysts for research. That is why a lot of research is done on cysts obtained from dogs. Apparently dogs and humans produce similar giardia cysts which are capable of causing infection in both species (Lin, 1985).

The main technique available for analyzing giardia samples is to count the cysts. But with no suitable culturing technique like there is for bacteria, it makes it more difficult. The hemocytometer, particle counter, and microscopic technique are the only options available. Particle counting only works when the cysts are the primary particle in the 5 to 10 um size range. The cover slip technique is good for lab work identification. The hemocytometer technique is good for when analysis of a grab sample or wash water from a filter is being analyzed. Several agencies have studied the accuracy of these tests and came up with differing conclusions. These are the best tests we have at the moment, despite their heavy consumption of time and money (Lin, 1985).

DETECTION

It is difficult to detect the giardia cysts in water due to their typically small concentration. Currently the detection method consists of concentration and separation techniques. The process involves a filtering device with a time frame of 18 to 24 hours. The filter contains a cartridge which is removed, sealed in bags, and then refrigerated. It then goes to a laboratory and undergoes the long and drawn out process of separation. Specialized laboratory technicians are required to carry out this costly and time consuming process (Lin, 1985). This whole ordeal obviously does not facilitate the quick and easy detection of the giardia cysts. Without an easy detection method, research is thus disadvantaged.

TREATMENT METHODS

Since there are so many problems associated with the laboratory culture techniques, it is difficult to obtain solid research on the treatment processes. It is difficult to work with giardia in the lab. A lot of the information used to remove giardia from municipal water supplies comes from field evaluations of treatment inadequacies at the outbreak sites. Data is collected when something goes wrong and then analyzed to figure out what went wrong and what was overlooked. This process is similar to working a problem backwards until the correct answer is determined. It seems that to effectively inactivate giardia, one must come at it from all angles. Most treatment facilities only go halfway in there treatment for this pathogen.

The knowledge right now points in the direction of providing effective particulate removal processes coupled with effective disinfection. It seems that many outbreaks have occurred due to:

-lack of or failure of filtration
-lack of or failure of disinfection
-lack of or failure of a chemical coagulation processes (Ongerth, 1989)

FILTRATION

Filtration does offer promising optimism for giardia cyst removal. If 90% or better turbidity reduction can be achieved from well conditioned water, then we can expect a cyst removal of at least 99%. Water quality conditions as well as chemical adjustments still must be monitored and adjusted to achieve favorable coagulation for consistent water quality (Ongerth, 1989). By no means is successful turbidity synonymous with giardia eradication. At the same time, treatment plants must be cognizant to the fact that hydraulic surges can cause cysts to break through filters. This in turn introduces the cysts to another area of the facility. Well trained operators can decrease the risk of this happening by keeping the flows as continuous as possible. Adding polymers might also be useful in minimizing the floc shear associated with these hydraulic changes (Lin, 1985). These filters need to be properly maintained to ensure peak performance.

DISINFECTION

Bottom line, filtration is not going to be 100% effective when there is poor quality source water. This means that the emphasis is placed on disinfection in these cases. Chlorine treatment seems to be popular (LeChevallier, 1991). Even lime softening, which takes the pH up to at least 9, will not disinfect giardia without the aid of disinfectant such as free chlorine (Logsdon, 1994). Studies have also shown that disinfectant levels need to be increased during colder weather in order to reach acceptable CT guidelines (LeChavallier, 1991). But this increase may cause issues with disinfectant contact basins. This is another reason why source water giardia levels need to be analyzed on a plant to plant basis. Therefore recommendations can be made for plant improvements when opportunity arises.

OPERATORS

Plant operators are integral to the success of giardia removal when chemical additions are required. Optimum chemical conditioning must be maintained in order for these systems to operate successfully. When an operator is poorly trained or under qualified, it shows up in the plants water quality. Small, relatively inflexible water treatment plants are especially sensitive to operator judgments because there is less room for error. In these small plants, super-chlorination may be necessary to compensate for lack of operator training (Ongerth, 1989). That way the level of safety can be maintained in the event of poor judgement.

CONCLUSION

Treatment and prevention of giardia cysts for the Colorado area needs to be a top priority. With the obvious presence of giardia, water treatment must take an offensive position toward this problem. The cold temperatures are a safe haven for these cysts which accumulate in Colorado's crystal clear water environment. In the cold temperatures these cysts move around like armored tanks. Rocky mountain water needs to go through a filtration process with its evident giardia problem. Bare minimum treatment should consist of an effective particulate removal process followed by an effective disinfection process. It might seem like overkill, but to fight giardia means preparing for the worst scenarios. Operator training should also be a priority. Well trained operators will be able to offer the increased quality control that giardia necessitates. It seems that chlorine does a good job with giardia but further research is necessary to provide efficiency. Giardia is a difficult organism to detect. It is important for the water industry to gain further knowledge about giardia so that the public can be served with the highest quality drinking water possible. 100% giardia inactivation should be Colorado's goal.

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