CRYPTOSPORIDIOSIS
Course # DL-008

Adapted from Morbidity and Mortality Weekly Report, Vol 61/No. SS-5 Sept. 6, 2012
Cryptosporidiosis Surveillance-United States, 2009-2010,
Division of Foodborne, Waterborne, and Environmental Diseases,
National Center for Emerging and Zoonotic Infectious Diseases, CDC
and
Centers for Disease Control and Prevention. Parasites - Cryptosporidium

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Level of Difficulty: Basic

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CRYPTOSPORIDIOSIS

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OBJECTIVES:
At the end of this course the participant will be able to:
1. List the most common Cryptosporidium species that infect humans
2. Describe the life cycle of Cryptosporidium
3. Outline the ways Cryptosporidium may be spread
4. Discuss the characteristics of Cryptosporidium that make it easy to spread in drinking or
   recreational water
5. List the people at risk of becoming infected
6. Describe the symptoms of cryptosporidiosis
7. List the laboratory tests used to diagnose cryptosporidiosis
8. Outline the methods of prevention and control of cryptosporidiosis
9. Give the estimated number of cases and cost of the disease in the U.S.
10. Explain how swimming pool venues are regulated
11. List the agencies mentioned in the course that help control the spread of
    cryptosporidiosis
12. Discuss the CDC’s plans for public health interventions to prevent and control
    cryptosporidiosis

INTRODUCTION
Cryptosporidiosis is a gastrointestinal illness caused by protozoa of the genus
Cryptosporidium. Revised Cryptosporidium taxonomy based on recent advances in molecular
testing methods has revealed that multiple species can infect humans.
In immunocompetent persons, cryptosporidiosis is characterized by weight loss,
abdominal pain, diarrhea, which can be profuse, usually non-bloody, and watery, as well as
anorexia, fatigue, joint pain, headache, fever, and vomiting. However, asymptomatic infection
also can occur.
Cryptosporidium is transmitted by the fecal-oral route and results from the ingestion of
oocysts through the consumption of fecally contaminated food or water or through contact with
an infected person or animal.
Although cryptosporidiosis cases can occur sporadically, outbreaks have been well documented since the first reported U.S. drinking water-associated outbreak in 1984 and the first reported U.S. recreational water-associated outbreak in 1988. *Cryptosporidium* oocysts are extremely chlorine tolerant. More recent outbreaks of cryptosporidiosis have been reported between various hosts. Foodborne outbreaks of cryptosporidiosis, most notably associated with food handlers who are ill, have occurred. Outbreaks resulting from person-to-person transmission also have been reported.

In 1994 the Council of State and Territorial Epidemiologists called for the reporting of cryptosporidiosis as a nationally notifiable disease; 2005 marked the first full year of reporting. This means that health care providers and laboratories that diagnose cases of laboratory-confirmed cryptosporidiosis are required to report those cases to their local or state health departments, which in turn report the cases to CDC.

The CDC report covered in this course summarizes national cryptosporidiosis surveillance data. This data can be used to guide the revision, updating, and expansion of health communication efforts and other public health interventions to prevent and control cryptosporidiosis.

**DESCRIPTION OF CRYPTOSPORIDIUM**

Cryptosporidiosis is a nationally notifiable gastrointestinal illness caused by extremely chlorine-resistant protozoa of the genus *Cryptosporidium*, whose taxonomy continues to evolve. The discovery of *Cryptosporidium* is usually associated with E. E. Tyzzer who described a cell-associated organism in the gastric mucosa of mice in 1907. The first human case ascribed to the organism occurred in 1976. Electron microscopic examination of the intestinal mucosa showed that *Cryptosporidium parvum* was the infectious agent. In the early 1980s, cryptosporidiosis in AIDS patients emphasized the role of *Cryptosporidium* as a ubiquitous human pathogen.

Revised *Cryptosporidium* taxonomy based on recent advances in molecular testing methods has revealed that multiple species can infect humans. *C. hominis* (previously known as *C. parvum* genotype I) primarily exists in a human-to-human transmission cycle. *C. parvum* (previously known as *C. parvum* genotype II) can infect both humans and ruminants, such as pre-weaned calves, each with their own transmission cycles that intersect in zoonotic disease. Molecular techniques are needed to distinguish the morphologically indistinguishable oocysts of the two species. To a lesser extent, human infections caused by *C. felis*, *C. canis*, *C. meleagris*, *C. suis*, *C. muris*, *C. andersoni*, and *Cryptosporidium* corvine, horse, rabbit, skunk, and chipmunk genotypes also have been documented. Illnesses caused by infection with the different *Cryptosporidium* species and subtypes within species can differ clinically.

**Life Cycle:**

Sporulated oocysts, containing 4 sporozoites, are excreted by the infected host through feces and possible other routes. Following ingestion (and possibly inhalation) by a suitable host, excystation occurs. The sporozoites are released and parasitize epithelial cells of the gastrointestinal tract or other tissues such as the respiratory tract. In these cells the parasites undergo asexual multiplication and then sexual multiplication producing microgamonts (male) and macrogametes (female). Upon fertilization between these, oocysts develop that sporulate in the infected host. Two different types of oocysts are produced, the thick-walled, which is commonly excreted from the host, and the thin-walled oocyst, which is primarily involved in autoinfection. Oocysts are infective upon excretion, thus permitting direct and immediate fecal-oral transmission.
EPIDEMIOLOGY
An infected human or animal sheds *Cryptosporidium* parasites in the stool. Millions of parasites can be released in a bowel movement from an infected host. Shedding begins when the symptoms begin and can last for weeks after the symptoms stop. Oocysts may be found in soil, food, water, or surfaces that have been contaminated with the feces from infected humans or animals. *Cryptosporidium* is not spread by contact with blood.

*Cryptosporidium* cysts can be spread by

- oral contact with a fomite that has come in contact with the stool of a person or an animal infected with *Cryptosporidium*.
- swallowing recreational water contaminated with *Cryptosporidium* from sewage or feces from humans or animals.
- eating uncooked food contaminated with *Cryptosporidium*. All raw fruits and vegetables should be thoroughly washed with uncontaminated water.
- touching the mouth with contaminated hands. Hands can become contaminated through a variety of activities, such as:
  - Touching surfaces such as toys, bathroom fixtures, changing tables, diaper pails that have been contaminated by stool from an infected person
  - Changing diapers
  - Caring for an infected person
  - Handling an infected cow or calf

People more at risk of infection include

- children who attend day care centers, including children in diapers
- child care workers
- parents of infected children
- caretakers of people with cryptosporidiosis
- international travelers
- backpackers, hikers, and campers who drink unfiltered, untreated water
- people who drink from untreated shallow unprotected wells
- swimmers who swallow water from contaminated pools
- people who handle infected cattle
- people exposed to human feces through sexual contact

Contaminated water may include water that has not been boiled or filtered, as well as contaminated recreational water sources.

*Cryptosporidium* parasites are found in every region of the United States and throughout the world. Travelers to developing countries may be at greater risk for infection because of poorer water treatment and lack of good sanitation. In the United States, an estimated 748,000 cases of cryptosporidiosis occur each year.

People with decreased immunity, such as AIDS patients, infected with *Cryptosporidium* are most at risk for severe disease. The risk of developing severe disease may differ, depending on the degree of immune suppression. The use of highly active antiretroviral therapy has decreased the severity of the disease in AIDS patients.

The infectious dose of *Cryptosporidium* is low; studies have demonstrated that the ingestion of ≤10 *C. hominis* or *C. parvum* oocysts can cause infection in healthy persons. Infected persons have been reported to shed 10^7 -10^8 oocysts in a single bowel movement and can excrete infectious oocysts for up to 60 days after cessation of gastrointestinal symptoms.
Although cryptosporidiosis cases can occur sporadically, outbreaks have been well documented since the first reported U.S. drinking water-associated outbreak in 1984 and the first reported U.S. recreational water-associated outbreak in 1988. During late March and early April, 1993 Milwaukee, Wisconsin experienced the largest waterborne disease outbreak in United States history. Although drinking water was suspected because of the widespread nature of the illness, at first stool testing was negative for bacterial or viral agents. Finally, the Milwaukee health department lab decided to test for parasites, revealing the cause to be the little known protozoan, Cryptosporidium. Since most of the reported illnesses were concentrated on the city’s south side, officials found water from one of Milwaukee’s two water filtration plants to be contaminated. Operators had lost control of the treatment process in late March, which allowed Cryptosporidium to break through the filters. The plant was immediately shut down on April 7 and the population advised to boil all drinking water. Over the span of about two weeks over 403,000 of an estimated 1.61 million residents (of which 880,000 were served by the malfunctioning treatment plant) became ill with the disease. Over 100, mostly immunocompromised, died. The treatment plant was restored to proper function and Milwaukee has not experienced an outbreak since.

Cryptosporidium oocysts are extremely chlorine tolerant and can survive for 3.5-10.6 days in water where free chlorine levels are maintained at CDC-recommended levels of 1-3mg/L. More recently outbreaks of cryptosporidiosis have been reported between various hosts. Foodborne outbreaks of cryptosporidiosis are most notably associated with food handlers who are ill or with ingestion of unpasteurized apple cider. Outbreaks resulting from person-to-person transmission and from animal-person transmission also have been reported.

In 1994 the Council of State and Territorial Epidemiologists called for the reporting of cryptosporidiosis as a nationally notifiable disease; 2005 marked the first full year of reporting. This CDC report summarizes national cryptosporidiosis surveillance data for 2009-2010 and analyzes cryptosporidiosis rates and the annual percentage change in national rates for the years 1995-2010. (see Surveillance and Outbreaks)

SYMPTOMS

In immunocompetent persons, cryptosporidiosis is characterized by
- diarrhea, which can be profuse, usually non-bloody, and watery
- weight loss
- abdominal pain
- anorexia
- fatigue
- joint pain
- headache
- fever
- vomiting

However, asymptomatic infection also can occur. The illness is self-limiting, and symptoms most frequently completely resolve within 2-3 weeks in persons with healthy immune systems. Recurrence of symptoms after apparent resolution has been frequently reported and may be intermittent for up to 30 days.

Clinical presentation of cryptosporidiosis in HIV-infected patients, as well as others with weakened immune systems, varies with the level of immunosuppression. The illness ranges from no symptoms or transient disease to relapsing, chronic diarrhea or cholera-like diarrhea, which
can lead to life-threatening wasting and malabsorption. Extraintestinal cryptosporidiosis (in the biliary or respiratory tract or rarely in the pancreas) has been documented among immunocompromised persons. The incidence of cryptosporidiosis among HIV-infected persons has decreased since the introduction of highly active antiretroviral therapy for HIV infection.

LABORATORY DIAGNOSIS

Tests for Cryptosporidium are not routinely done in most laboratories. Therefore, healthcare providers should specifically request testing for this parasite.

Diagnosis of cryptosporidiosis is made by examination of stool samples. Because detection of Cryptosporidium can be difficult, three stool samples are collected within a 10-day period while the patient is symptomatic or within 2 weeks after diarrhea resolves.

Stool specimens may be submitted fresh, preserved in 10% buffered formalin, or suspended in a storage medium composed of aqueous potassium dichromate. Oocyst numbers can be quite variable even in liquid stools, therefore multiple stool samples should be tested before a negative diagnostic interpretation is reported. To maximize recovery of oocysts, stool samples should be concentrated prior to microscopic examination. Formalin-ethyl acetate sedimentation is the recommended stool concentration method for clinical laboratories. Two potential shortcomings of oocyst concentration are

1. sedimentation methods are generally performed using low speed centrifugation. Given their small size and mass, cryptosporidial oocysts may become trapped in the ether or ethyl acetate plug and fail to sediment properly. Increased centrifugation speed or time (500 x g, 10 minutes) may be warranted.
2. resolution of cryptosporidial infections is accompanied by increasing numbers of non-acid-fast, oocyst “ghosts”. Such oocysts may not float or sediment as expected giving rise to false-negative results.

Modified Ziehl Neelson acid fast stain, direct fluorescent antibody (DFA) and/or enzyme immunoassays are used for detection of Cryptosporidium species antigens. For greatest sensitivity and specificity, immunofluorescence microscopy is the method of choice, followed closely by enzyme immunoassay.

Traditional parasitology stains (e.g., Giemsa) are of limited value. They do not differentiate between oocysts and similarly-sized fecal yeasts and other fecal debris. Modified acid-fast staining technique is a simple and effective method: the oocysts stain bright red against a background of blue-green fecal debris and yeasts.

Immunofluorescence microscopy for detection of oocysts offers increased sensitivity and specificity compared to staining techniques. The assays generally work well with fresh or formalin or potassium dichromate preserved stools. Several commercial IFA products are presently available, including MeriFluor™ Cryptosporidium/Giardia (Meridian Diagnostics Inc., Cincinnati, OH, 45244); Detect IF Cryptosporidium (Shield Diagnostics, Ltd., Dundee DD1 SW, Scotland, UK); and Crypto IF Kit (Techlab, Blacksburg, VA, 24060). These assays exhibit broad reactivity with C. parvum and other Cryptosporidium species, so they should be applicable to both human and veterinary specimens. [http://dpd.cdc.gov/dpdx/HTML/Cryptosporidiosis.htm](http://dpd.cdc.gov/dpdx/HTML/Cryptosporidiosis.htm)

A commercial PCR-enzyme-linked immunosorbent assay (ELISA) (Cryptodiag; Bio Advance, France) for the diagnosis of cryptosporidiosis and the identification of Cryptosporidium hominis and Cryptosporidium parvum from stool samples is based on PCR amplification of Cryptosporidium DNA extracted from stools, followed by an ELISA based on hybridization with Cryptosporidium species—C. hominis or C parvum specific probes. This is
usually done in public health reference laboratories in outbreak investigations and infection- or contamination-source tracking to differentiate *Cryptosporidium* species and subtypes. If stool is preserved in formalin, *Cryptosporidium* isolates cannot be reliably genotyped or subtyped.

**TREATMENT**

Most people who have healthy immune systems will recover without treatment. Diarrhea can be managed by drinking plenty of fluids to prevent dehydration. People who are in poor health or who have weakened immune systems are at higher risk for more severe and prolonged illness. Young children and pregnant women may be more susceptible to dehydration resulting from diarrhea and should drink plenty of fluids while ill. Rapid loss of fluids from diarrhea may be especially life threatening to babies. Therefore, parents should talk to their health care providers about fluid replacement therapy options for infants.

Anti-diarrheal medicine may help slow down diarrhea, but a health care provider should be consulted before such medicine is taken.

Nitazoxanide has been FDA-approved for treatment of diarrhea caused by *Cryptosporidium* in people with healthy immune systems and is available by prescription. However, the effectiveness of nitazoxanide in immunosuppressed individuals is unclear.

HIV positive individuals who suspect they have cryptosporidiosis should contact their health care provider. For those persons with AIDS, anti-retroviral therapy that improves the immune status will also decrease or eliminate symptoms of cryptosporidiosis. However, even if symptoms disappear, cryptosporidiosis is often not curable and the symptoms may return if the immune status worsens.

**PREVENTION AND CONTROL OF CRYPTOSPORIDIOSIS**

**Practice Good Hygiene**

**Everywhere**

Wash hands with soap and water for at least 20 seconds, rubbing hands together vigorously and scrubbing all surfaces

- before preparing or eating food
- after using the toilet
- after changing diapers or cleaning up a child who has used the toilet
- before and after tending to someone who is ill with diarrhea
- after handling an animal or animal waste

**At child care facilities**

To reduce the risk of disease transmission, children with diarrhea should be excluded from child-care settings until the diarrhea has stopped.

**At recreational water venues (pools, interactive fountains, lakes, ocean)**

Protect others by not swimming if you are experiencing diarrhea (this is essential for children in diapers). If diagnosed with cryptosporidiosis, do not swim for at least 2 weeks after diarrhea stops. Shower before entering the water.

Wash children thoroughly (especially their bottoms) with soap and water after they use the toilet or their diapers are changed and before they enter the water.

Take children on frequent bathroom breaks and check their diapers often.

Change diapers in the bathroom, not at the poolside.

**Around Animals**
Minimize contact with the feces of all animals, particularly young animals. When cleaning up animal feces, wear disposable gloves, and always wash hands when finished. Wash hands after any contact with animals or their living areas.

**Outside**
Wash hands after gardening, even if wearing gloves.

**Immunocompromised persons**
Avoid close contact with any person or animal that has cryptosporidiosis. Cryptosporidiosis can become a life-threatening disease for immunocompromised persons.

**Avoid water that might be contaminated**
Note: you may not be protected in a chlorinated recreational water venue (swimming pool, water park, water play area, splash pad, spray pad) because *Cryptosporidium* is chlorine-resistant and can live for days in chlorine-treated water.
Do not swallow water while swimming in swimming pools, hot tubs, interactive fountains, lakes, rivers, springs, ponds, streams, or the ocean. Reduce contamination of treated recreational water venues by having pool operators install in-line secondary disinfection systems (for example, ultraviolet light, ozone) to inactive this chlorine-tolerant parasite.
Do not drink untreated water from lakes, rivers, springs, ponds, streams, or shallow wells.
Do not drink inadequately treated water or ice made from water during communitywide outbreaks caused by contaminated drinking water.
Do not use or drink inadequately treated water or use ice when traveling in countries where the water supply might be unsafe.
If the safety of drinking water is questionable (for example, outbreak, poor sanitation, lack of water treatment systems):
- drink bottled water
- disinfect it by heating the water to a rolling boil for 1 minute
- use a filter that has been tested and rated by National Safety Foundation Standard 53 or 58 for cyst and oocyst reduction; filtered water will need additional treatment to kill or inactivate bacteria and viruses.

**Avoid eating food that might be contaminated**
Use safe, uncontaminated water to wash all food that is to be eaten raw. After washing vegetables and fruit in safe, uncontaminated water, peel them if you plan to eat them raw. Avoid eating uncooked foods when traveling in countries with poor water treatment and food sanitation.

**Practice extra caution while traveling**

**Prevent contact and contamination with feces during sex**
Using a barrier during oral-anal sex
Wash hands immediately after handling a condom used during anal sex and after touching the anus or rectal area.
SURVEILLANCE AND OUTBREAKS

Cryptosporidiosis is a nationally notifiable disease. This means that health care providers and laboratories that diagnose cases of laboratory-confirmed cryptosporidiosis are required to report those cases to their local or state health departments, which in turn report the cases to CDC. Fifty state and two metropolitan public health agencies voluntarily report cases to CDC. National surveillance data are used to help characterize the epidemiology of cryptosporidiosis in the United States.

The number of reported cases and cost of cryptosporidiosis in the United States are substantial. Approximately 748,000 cryptosporidiosis cases occur annually. Each year, hospitalizations resulting from cryptosporidiosis cost an estimated $45.8 million; additionally, each ambulatory care visit for cryptosporidiosis costs $267-$757, depending on the patient’s type of health-care coverage. The high incidence and cost of cryptosporidiosis underscores the need for a better understanding of cryptosporidiosis epidemiology in the United States, particularly of risk factors, to optimize prevention and control.

The geographic variation, age distribution, and early-summer through early-fall seasonality are consistent with findings of previous reports on U.S. national cryptosporidiosis surveillance data. Cryptosporidiosis is widespread geographically in the United States, with all 50 states and two metropolitan jurisdictions reporting cryptosporidiosis cases during 2009-2010. The cryptosporidiosis rate in the Midwest region was 1.3-2.9 times greater than that of the other regions in 2009 and 1.8-4.6 times greater than that of other regions in 2010. It is difficult to determine whether this disparity is the result of regional differences in the capacity to detect, investigate, or report cases, or if true regional differences exist in the transmission of Cryptosporidium. If the latter is correct, the increased cryptosporidiosis rate in the Midwest region might be linked to increased contact with pre-weaned calves.

Although cryptosporidiosis affects persons in all age groups, the number of reported cryptosporidiosis cases and rates were highest among children aged 1-4 years, followed by those aged 5-9 years and adults aged 25-29 years. Similar findings also have been noted in U.S. state, Canadian provincial, Australian state, and national Finnish and United Kingdom surveillance data. Among patients aged 1-4 years, the rate was higher in males; among those aged 20-39 years, the rate was higher in females. These data might reflect Cryptosporidium transmission from young children to their caregivers (e.g., childcare staff, family members, and other household contacts).

The five-fold increase in cryptosporidiosis symptom onset during the summer, observed in reports from the U. S. and other countries, is consistent with increased use of treated recreational water venues during the summer, particularly among younger children. Cryptosporidium has become the leading cause of reported treated recreational water-associated outbreaks of gastroenteritis. Transmission through recreational water is facilitated by the substantial number of Cryptosporidium oocysts that can be shed by a single person, the extended periods of time that oocysts can be shed, the low infectious dose, and the tolerance of Cryptosporidium oocysts to chlorine.

Recreational water can amplify smaller outbreaks into communitywide transmission when persons who are ill visit multiple recreational water venues or introduce the parasite to other settings (e.g., child care centers or schools). To prevent communitywide outbreaks, CDC has collaborated with state health departments to
develop guidelines for rapidly implementing communitywide control measures once an increase in case reporting exceeds a pre-outbreak disease action threshold (an outbreak or a two-fold to three-fold increase in cases over baseline) rather than waiting for an outbreak investigation to implicate a specific source of transmission.

Reducing the transmission of this highly infectious, extremely chlorine-tolerant pathogen in treated recreational water venues (swimming pools) requires a multipronged approach. Effective prevention requires that swimmers practice healthy swimming behaviors—keeping the parasite out of the water by not swimming while ill with diarrhea and, if diagnosed with cryptosporidiosis, at least 2 weeks following recovery. Once the parasite has been introduced into the water, secondary or supplemental disinfection systems or enhanced filtration can minimize contamination and help control Cryptosporidium transmission.

Low infectious dose and extreme chlorine tolerance also make Cryptosporidium ideally suited for transmission through drinking water. To prevent Cryptosporidium transmission through drinking water, the U.S. Environmental Protection Agency (EPA) has implemented regulations designed to enhance the treatment of surface water supplies, including multiple regulatory changes enacted following a massive outbreak of cryptosporidiosis in 1993 in Milwaukee, Wisconsin. Subsequently no cryptosporidiosis outbreaks associated with the use of community surface water supplies have been detected in the United States, highlighting the potential benefits of these regulations. To address the risk for outbreaks and illness associated with use of groundwater sources, EPA also is implementing the Groundwater Rule, which requires additional treatment and filtration of certain public ground water (well) systems.

In the United States, no federal agency regulates the design, construction, operation, and maintenance of treated recreational water venues. Pool codes are reviewed and approved by state or local public health officials. This lack of uniform national standards has been identified as a barrier to the prevention and control of outbreaks associated with treated recreational water venues. To provide support to state and local health departments, CDC sponsors development of the Model Aquatic Health Code (MAHC), [www.cdc.gov/healthywater/swimming/pools/mahc](http://www.cdc.gov/healthywater/swimming/pools/mahc). MAHC is a collaborative effort between local, state, and federal public health and the aquatics sector to develop a data-driven, knowledge-based resource for state and local jurisdictions reviewing and updating their existing pool codes to optimally prevent and control recreational water-associated illness.

CONCLUSION

The quality and completeness of national cryptosporidiosis data can be improved by enhancing the capacity of state and local jurisdictions to detect, investigate, and voluntarily report cases. Existing state and local public health infrastructure supported through CDC (FoodNet and Environmental Health Specialists Network Water Program) could facilitate enhancement of surveillance efforts. Although many jurisdictions investigate cryptosporidiosis cases, risk-factor data are not available for all jurisdictions via National Notifiable Diseases Surveillance Systems (NNDSS). Collaborating with reporting jurisdictions to improve CDC’s ability to access jurisdictional risk factor data would enhance national collection efforts while simplifying analysis of these data as well as their comparison with data from other sources such as FoodNet. The systematic collection and molecular characterization Cryptosporidium isolates
would further the understanding of U.S. cryptosporidiosis epidemiology by revealing transmission patterns and potential risk factors. Such an effort would require phasing out the practice of preserving stool specimens with formalin, which decreases the ability to perform molecular amplification methods. CDC is preparing to pilot Crypto Net, the first U.S. molecular surveillance system for parasites, to better understand the transmission of cryptosporidiosis in the United States.

Improving the completeness and quality of national surveillance data will better direct the design and evaluation of health communication and policy efforts to prevent and control cryptosporidiosis. In response to the increased case counts and rates of cryptosporidiosis and treated recreational water-associated outbreaks of cryptosporidiosis, CDC has developed two websites: Cryptosporidiosis (available at www.cdc.gov/parasites/crypto) and Healthy Swimming (available at www.cdc.gov/healthywater/swimming/index.html). The websites target multiple audiences and provide resources and recommendations on inactivation of Cryptosporidium in treated recreational water or preventing and controlling Cryptosporidium transmission in child care settings. National surveillance data can be used to guide the revision, updating, and expansion of health communication efforts and other public health interventions to prevent and control cryptosporidiosis.

REFERENCES:
1. Morbidity and Mortality Weekly Report, Vol. 61/No. SS-5 Sept. 6, 2012 Cryptosporidiosis Surveillance-United States, 2009-2010, Division of Foodborne, Waterborne, and Environmental Diseases, National Center for Emerging and Zoonotic Infectious Diseases, CDC
REVIEW QUESTIONS
Course #DL-008
Choose the one best answer

1. The infectious dose of Cryptosporidium oocytes can be
   a. 100
   b. fewer than 10
   c. at least 1000
   d. gametes cause infection

2. Characteristics that make Cryptosporidium easy to spread by water are all but which of the following:
   a. long period of oocyst shedding by infected individuals
   b. large numbers of oocysts excreted in each bowel movement
   c. chlorine susceptibility
   d. low infectious dose

3. Cryptosporidium DNA hybridization from stool samples
   a. may be used on formalin preserved specimens
   b. is one of the procedures used in clinical laboratory diagnosis
   c. is used to differentiate C. hominis from C. parvum
   d. is used to detect infection in pre-weaned calves

4. Personal prevention of Cryptosporidium infection includes all but
   a. washing hands for 20 seconds after using the bathroom
   b. avoiding drinking untreated water from streams and lakes
   c. covering the mouth if coughing
   d. washing fruit in uncontaminated water and peeling before eating

5. The recommended treatment for most cases of cryptosporidiosis is
   a. use of anti-diarrheal medicine
   b. administration of nitazoxamide
   c. restriction of food intake
   d. drinking plenty of fluids

6. HIV patients are
   a. best benefited by nitazoxamide
   b. cured by Cryptosporidium treatment
   c. most helped by anti-retroviral medications
   d. not unduly affected by cryptosporidiosis

7. Recreational (swimming pool) water codes are regulated by
   a. the Environmental Protection Agency
   b. the Centers for Disease Control and Prevention
   c. the Environmental Health Specialists Network Water Program
   d. state and local public health officials
8. In oocyst concentration all but which of the following occur:
   a. sedimentation of oocysts in formalin-ethyl acetate solution
   b. the small oocysts may get trapped in the ether or ethyl acetate plug
   c. oocyst ghosts may not float or sediment
   d. oocysts are ruptured, releasing 4 sporozoites

9. The hospitalization cost of cryptosporidiosis annually in the U.S. is
   a. 45.8 million dollars
   b. 267 million dollars
   c. 748,000 dollars
   d. 75.7 million dollars

10. The probable increased number of cases of cryptosporidiosis in the Midwest may be due to
    a. common use of well water for drinking
    b. frequent swimming pool use
    c. exposure to irrigation water in corn fields
    d. increased contact with pre-weaned calves