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PROTOZOA CAUSING FOOD POISONING

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Food poisoning also called foodborne illness, or illness caused by eating contaminated food is a term used to cover an unpleasant range of illnesses. Food poisoning symptoms vary with the source of contamination. Most types of food poisoning cause one or more of the following signs and symptoms: nausea, vomiting, watery diarrhea, abdominal pain and cramps and fever Signs and symptoms may start within hours after eating the contaminated food, or they may begin days or even weeks later. Sickness caused by food poisoning generally lasts from a few hours to several days.

Key words: Food poisoning, Protozoa

Introduction

Food poisoning can be caused by bacteria, viruses, protozoa, chemicals, metals and poisonous plants. Here, only protozoan parasites are encountered

Review, Discussion and Comment

Protozoa: *Cyclospora cayetanensis* was reported as a protozoan cause of diarrheal illness within the United States, in travelers to other countries, and in patients with AIDS (Ortega *et al*, 1993), and caused large outbreaks of food borne illness there (Herwaldt, 2000). *C. cayetanensis* was recognized in stool and preliminarily described as blue-green algae, or cyanobacterium-like bodies, or other protozoan forms and recognized as a distinct genus (Bendall *et al*, 1993). The molecular phylogeny of the three coccidial organisms, *Isospora belli, Cryptosporidium*, and *C. cayetanensis*, has not yet been clarified. But, studies indicate that *Cyclospora* is a member of *Eimeria* family (Pieniazek and Herwaldt, 1997).

C. cayetanensis is worldwide distributed illness reported in the Caribbean (Pape *et al*, 1994), the United States (Huang *et al*, 1995), Latin America (Madico *et al*, 1997), the United Kingdom (Cann *et al*, 2000), Germany (Doller*et al*, 2002), Canada (Ooi *et al*, 2005), and cause of often prolonged travelers' diarrhea from Asia and Africa (Kansouzidou *et al*, 2004). Disease was more severe in children younger than five years of age, who were more likely to have fever and tended to have diarrhea for up to 15 days, a higher median number of stools per day, and a higher probability of mucous stools. Soil contact was a strong risk factor for disease in small children. Several sources of cyclosporiasis were from contaminated water in Egypt (el-Karamany *et al*, 2005). In the United States, outbreaks in 1995 to 1996 and continued to 2000 were traced to contaminated raspberries imported from Guatemala (Ho *et al*, 2002). Other garden produce, including mesclun lettuce was linked to outbreaks, Basil seasoning in two different catered salads was responsible for two separate outbreaks in Missouri in 1999 (Lopez *et al*, 2001), while an outbreak of cyclosporiasis associated with Guatemalan snow peas occurred in Pennsylvania in 2004 and an outbreak in Canada was also linked with imported Thai basil (CDC, 2004).

Oocysts of *Cyclospora* passed in the feces require several days before they become infectious. Despite extensive publicity about the 1996 outbreak, 762 cases of cyclosporiasis were reported in a two-month period in 1997 from 13 states in the United States and a province in Canada; careful epidemiologic evaluation again linked these case clusters to imported Guatemalan raspberries. The outbreak was halted only by the cessation of importing this fruit. The median attack rate was 92% among individuals who consumed

raspberries; serving sizes were between 1 & 12 berries (Herwaldt *et al*, 1999). Since the fruit came from a number of farms, it appeared probable that environmental contamination had occurred (Osterholm, 1999).

Clinical manifestations: After ingestion of infectious oocysts, an incubation period of about seven days ensued before symptoms develop. Patients experience diarrhea, flu-like symptoms, and symptoms common to other small bowel pathogens, such as flatulence and burping, pronounced fatigue and malaise and frequent symptoms with weight loss. Patients might be a single self-limited episode, but a prolonged waxing and waning course or sustained diarrhea, anorexia, and upper gastrointestinal symptoms for weeks or months was common (Hoge *et al*, 1995). Among patients with AIDS, infections with *Cyclospora* caused prolonged diarrhea, similar to infections with *Isospora* and *Cryptosporidium*, and, infrequently, biliary tract disease (Sifuentes-Osornio *et al*, 1995). Some immunocompetent hosts or even patients with AIDS who were passing oocysts of *Cyclospora* remain asymptomatic (Maggi *et al,* 1995). Small bowel biopsies were performed in symptomatic patients. They show the several developmental forms of the parasite within epithelial cells; there is also jejunal inflammation with heightened numbers of intraepithelial lymphocytes and degrees of villous atrophy and crypt hyperplasia (Sun *et al*, 1996). Mansfield and Gajadhar (2004) in USA stated that food- and waterborne coccidia including *Cryptosporidium parvum*, *C. cayetanensis*, *Sarcocystis hominis* and *Sarcocystis suihominis*, and *Isospora belli* are cyst-forming apicomplexan protozoa cause intracellular infections, predominantly in the epithelial cells of the intestine. Transmission is by oocysts from person-to-person by the fecal-oral route or via contaminated water or food. The commonest symptom was diarrhea, however, asymptomatic infections occur. Infections are associated with intestinal inflammation, with pathological lesions such as villus blunting, and abnormal function such as malabsorption. Mild-to-moderate, self-limiting diarrhea is common in healthy individuals ingesting infective stages of these organisms. However, patients with immune dysfunction can have severe intestinal injury and prolonged diarrhea. They added coccidia were considered to be an emerging pathogen. From 1990 to 2000, there were 11 cyclosporosis foodborne outbreaks in North America that affected about 3600 persons. There were many outstanding questions regarding this parasite and under-reporting was common because general diagnostic methods for intestinal parasites are inadequate for detection of *Cyclospora*. Sánchez-Vega *et al.* (2014) in Germany reported that a 26-year-old man from Mexico City had clinical manifestations of illness after a five-day stay in Lima, Peru. The patient was an airline pilot and reported episodes of diarrhea without mucus, pus, or blood. He had a history of periumbilical colic-like abdominal pain, push, tenesmus, meteorism, audible borborygmi, semi-liquid to pasty feces, and 5–8 explosive bowel movements a day. He also reported malaise, asthenia, adynamia, moderate headache, dizziness, nausea, but no emesis; these conditions lasted approximately 14 days. Symptoms became worse and patient had persisting dizziness, blurred vision, orthostatic hypotension, and sensation of postprandial fullness with colic pain, tenesmus, and right sacroiliac burning pain. He had frequent bowel movements (2-3/day) with traces of blood in feces. After 10 days of disease progression, the patient had deep pain in the right upper quadrant, a hypersensitive vesicular region, fever, diaphoresis, malaise, paresthesias, and belt-like pain in right hypochondrium from D11 to L3. Bowel movements increased again to 6-8/ day, and the patient had severe diffuse abdominal pain, chills, and myalgia.

Diagnosis of *C. cayetanensis* is by detecting oocysts in stool which, like those of *Cryptosporidium* are acid-fast positive (Eberhard *et al*, 1997), also modified acid-fast stains, fluorescence microscopy can detect

autofluorescent oocysts. Oocysts in a symptomatic patient are presumptive evidence of infection. PCR-based diagnostic tests were developed but not generally available (Verweij *et al*, 2003). Health care personnel should be aware that stool specimens examined for ova and parasites usually are not examined for *Cyclospora* unless such testing is specifically requested, and infection is treated with trimethoprim-sulfamethoxazole

Treatment: Double-strength trimethoprim-sulfamethoxazole (160mg/800mg) tablets PO twice daily for seven days is effective for cyclosporiasis. This regimen was illustrated in a controlled trial of 40 patients from Nepal: at seven days, the percentage of patients with *Cyclospora* in stool was much lower in those treated with trimethoprim-sulfamethoxazole (6 vs. 88% with placebo). Eradication of the organism correlated with an improvement in symptoms. A randomized controlled study from Haiti compared trimethoprim-sulfa-methoxazole to ciprofloxacin in treatment and prophylaxis of chronic diarrhea in 42 HIV-infected patients, 20 of whom had *Cyclospora* (Verdier *et al*, 2000). Response to trimethoprim-sulfamethoxazole was superior to ciprofloxacin (100 vs. 90% with cessation of diarrhea and 100 vs. 64% with a negative stool culture, both at day 7 of therapy). Four patients received ciprofloxacin were switched to trimethoprim-sulfamethoxazole for continued positive stool cultures with successful eradication of the organisms after the change. Both regimens were successful in preventing recurrent diarrhea when administered over a 10-week period for prophylaxis although one of seven patients receiving ciprofloxacin had a relapse. There were no alternative agents in the past for patients with *Cyclospora* who could not take the trimethoprim-sulfamethoxazole. Based upon the above study, it is reasonable to try ciprofloxacin. There is also some evidence that nitazoxanide (500mg twice daily for 3 days) may be effective (Fox and Saravalatz, 2005).

Cryptosporidiosis: *Cryptosporidium* is an intracellular protozoan associated with gastrointestinal diseases in all classes of vertebrates including mammals, reptiles, birds, and fish. Along with *Giardia*, it is among the commonest zoonotic parasitic enteric pathogens. The organisms infect and reproduce in the epithelial cells of the digestive or respiratory tracts. Infection is predominantly associated with severe diarrhea and biliary tract disease (Chen *et al*, 2002), with more than ten species, including species that infect mammals, birds, reptiles and fish (Xiao *et al*, 2004). *C. parvum* (4mcm diameter) was the main species responsible for clinical disease in humans. *C. parvum* was divided into two separate species: *C. hominis* (formerly *C. parvum* genotype 1) and *C. parvum* (formerly *C. parvum* genotype 2). *C. hominis* apparently infects only humans, while *C. parvum* is found in humans and a number of other animals (Morgan-Ryan *et al*, 2002). *C. felis, C. muris, C. canis, C. suis,* and *C. meleagridis* were identified in man (Caccio, 2005). Additional heterogeneity within species may lead to variations in infectivity and clinical expression in different hosts (Tanriverdi *et al*, 2006).

Cryptosporidium was first identified as a cause of gastrointestinal disease in humans in 1976, and is now recognized globally as an important cause of diarrhea in both children and adults. It was described as the etiologic agent in three main epidemiologic scenarios: Sporadic, often water-related outbreaks of self-limited diarrhea in immunocompetent hosts chronic, life-threatened illness in immunocompromised patients, particularly those with HIV infection diarrhea and malnutrition in young children in developing countries (Mor and Tzipori, 2008). The risk of severe and/or prolonged disease is increased in patients with cellular and humoral immune deficiencies, include HIV, organ transplantation, immunosuppressive drugs, IgA deficiency, and hypogammaglobulinemia. Cryptosporidiosis declined in HIV patients, largely because of immune reconstitution with highly active antiretrovi-

ral therapy (Le Moing *et al*, 1988). Cryptosporidiosis is more common in countries that have increased crowding and poor sanitary conditions. In endemic areas, the incidence increases during rainy periods (Huang and White, 2006). The prevalence increased in dairy farmers, which is probably because *C. parvum* causes diarrhea in cattle (Lengerich et *al*, 1993). It was also more frequent in children less than two years old, although outbreaks occurred worldwide in all age groups (Mannheimer and Soave, 1994).

Cryptosporidium is present in 1 to 3% of immunocompetent patients with diarrhea in industrialized countries and 7 to 10%in developing countries (Jelinek *et al*, 1997). In a 2005 survey from Food-Net of laboratory-confirmed causes of acute foodborne illnesses in 10 states in the United States, *Cryptosporidium* occurred in 8%, an annual incidence of 3.0 cases/ 100,000 persons (CDC, 2006). Seroprevalence rates are higher, being approximately 25 to 60% in the United States and 65 to 95% in some developing countries (Ungar *et al*, 1989). Population-based laboratory surveillance data from Canada showed that *Cryptosporidium* sp. occurred at an overall rate of 6.0/100,000 populations per year. Incidence was significantly higher in children than in adults (17.8 /100,000/year occurred among those <20 years of age, compared to 1.25/100,000/ year for adults ≥ 20 years of age (Laupland and Church, 2005). Cryptosporidiosis is a notified disease in the European Union, and surveillance data in Europe for 2005 showed 7960 cryptosporidiosis cases reported from 16 countries. Crude incidence was 1.9 cases/100,000 overall, with considerable differences in rates of cryptosporidiosis among countries (Semenza and Nichols, 2007). Prevalence was much higher in HIV-patients. In HIV-patients in the United States and Europe, 8 to 30% and in developing countries 15 to 50% excreted *Cryptosporidium* oocysts (Conlon *et al*, 1990), making it one of the commonest enteropathogens.

Transmission of cryptosporidiosis occurs via spread from an infected person or animal, or from a fecal contaminated environment such as a food or water source (Framm and Soave, 1997). Cryptosporidiosis outbreaks were associated with drinking water supplies, animal contact, travel, swimming pools, and/or recreational water facilities (Yoder and Beach, 2007). Ingestion of only a few oocysts (10 to 50) led to severe disease and persistent infection, particularly in immunodeficient patients. The ID50 for healthy people without serological evidence of previous cryptosporidiosis has been estimated at 132 oocysts for *C parvum* and 10 to 83 oocysts for *C hominis*; infected individuals can excrete up to a billion oocysts per infection. Previous exposure and immunologic health also influence host susceptibility (Chappell *et al*, 2006). A major source of infection is contaminated drinking or swimming water, which causes community outbreaks and travelers' diarrhea. *Cryptosporidium* oocysts were found in 65 to 97% of surface waters and are difficult to eradicate since oocysts are resistant to many disinfectants, are not effectively removed by many filtration systems, and can survive in the environment for months and oocysts can be intermittently detected in tap-water (Chappell *et al*, 1996). Thus, swimming pools and other recreational water sources are significant sources of infection (Barwick *et al*, 2000). Numerous waterborne outbreaks were reported, the largest occurred in 1993, when 403,000 residents of Milwaukee developed gastrointestinal symptoms after their drinking water became contaminated (Fricker and Crabb, 1988). The extent of this outbreak may actually have been underappreciated; antibody determinations to two *C. parvum* antigens were made in children 6 months to 12 years of age who had routine lead screening performed during March to May of 1993. The prevalence of antibodies during a five-week period rose from 15 to 82% and 17 to 87% in two southern zip codes in the city, which were close to the implicated water treatment plant. Outbreaks

associated with apple cider contaminated by oocysts were reported (CDC, 1997).

Foodborne outbreaks are uncommon. But, one outbreak associated with consumption of food in a university cafeteria linked a *C. parvum* genotype 1 isolate to an infected food handler who prepared raw produce. Eighty-eight students and four employees became ill; *C parvum* was isolated from 16 of 23 ill students (70%) and two of four employees; all isolates were genotype 1 (Causer *et al*, 2006). Person-to-person transmission was common particularly among household members, sexual partners, children in the daycare centers and their caretakers, and healthcare workers (Quiroz *et al*, 2000). In 19% of household contacts of index cases of cryptosporidiosis developed acute infection. Also, 27% of asymptomatic children attending a day care center in New York excreted oocysts (Musher and Musher, 2004).

Pathogenesis of *Cryptosporidium* cause a secretory diarrhea associated with malabsorption. The intracellular nature of the infection interferes with intestinal absorption and secretion. Parasites spread via intestinal lumen to involve biliary system, where they can cause stricturing and cholangitis. No specific toxin was identified, but young children in Haiti showed increased presence of systemic and intestinal proinflammatory cytokines (e.g., tumor necrosis factor and interleukin-8) compared to healthy controls (Sealock and Patel, 2016).

Cryptosporidia are found within epithelial cells associated with distortion of the villus architecture. Inflammatory changes may be present. The progressive morphological and functional abnormalities of the small intestine occur as parasite numbers increase, although intensity of infection and inflammation does not correlate well with the severity of clinical disease. Whether differences in organism's virulence or level of host immunity primarily account for the variable course of infection in different people was not well understood (Kirkpatrick*et al*, 2006).

The immune response associated with cryptosporidiosis involves cellular and humoral components. The T-lymphocyte cellular responses are important in controlling infection, as evidenced by the increased disease severity in HIV-infected patients with CD4 counts less than 100 cells/microL. Specific IgM, IgG, and/or IgA responses develop during infection. Epidemiologic evidence for protective immunity to *Cryptosporidium* was suggested by the observation that residents in areas where *Cryptosporidium* is endemic have milder symptoms with subsequent infections (Petersen, 1995). However, the development of antibodies is not necessarily associated with clearance of infection, as illustrated in studies of HIV-infected patients, who developed serum and intestinal antibodies but failed to clear the infection. Production of IFN-gamma was involved in infection resolution (Okhuysen *et al*, 1998)

The life cycle of *Cryptosporidium* can be completed within a single host. Oocysts are ingested, undergo excystation in the small bowel, and release four banana-shaped motile sporozoites that attach to the epithelial cell wall. Sporozoites mature asexually into meronts, which release merozoites intraluminally. These can reinvade host cells, resulting in autoinfection, or can undergo sexual maturation to form new oocytes that can excyst within the gastrointestinal tract or can pass out into the environment. Oocysts are infectious and can remain viable for many months at a wide range of temperatures.

Clinical manifestations: *Cryptosporidium* can cause an asymptomatic infection, a mild diarrheal illness, or severe enteritis with or without biliary tract involvement. Asymptomatic infection can occur in immunocompetent and immunodeficient patients. About 30% of childhood infections were asymptomatic. Infection in elderly patients can lead to severe volume depletion in association with high case-fatality rates. The incubation period is usually 7 to 10 days (from 5 to 28 days). The number of oocysts ingested appears to be related to the time to and duration of infection, but not the severity of ill-

ness (Tilley *et al*, 1995).

Patients who develop diarrhea frequently have associated malaise, nausea and anorexia & crampy abdominal pain. Diarrhea may be acute or chronic, transient, intermittent or continuous, and scant or voluminous with up to 25 L/day of watery stool. Fecal blood or leukocytes are rare unless there is co-infection with another enteric pathogen. Patients with chronic diarrhea can develop profound weight loss. Illness usually reso-lves without therapy in 10 to 14 days in immunologically healthy people, but it can persist longer. Oocysts excretion after resolution of clinical symptoms can continue for long periods. There is evidence in non-immunocompromised infants that infection can lead to persistent diarrhea with a lasting adverse effect on nutritional status and growth.

In immunocompromised hosts, the illness is more frequently protracted and severe, and can lead to significant wasting, particularly when the CD4 count was <100 cells/ microL. There was also evidence that specific species or subtype families were associated with different clinical manifestations. For example, in a cross-sectional study of 230 HIV-infected patients in Peru, infection with *C. hominis* was associated with diarrhea alone while infection with *C. parvum* was associated with diarrhea and vomiting (Mor *et al*, 2009). The American Gastroenterological Association (AGA) technical reviewed for malnutrition and cachexia, chronic diarrhea, and hepatobiliary disease in patients with HIV (Cama *et al*, 2007). A number of other clinical manifestations of cryptosporidiosis in AIDS patients were described, including cholecystitis, cholangitis, hepatitis, pancreatitis, and respiratory tract involvement. Biliary tract involvement affects 10 to 30 percent of patients with AIDS and could result in acalculous cholecystitis or sclerosing cholangitis, also right upper quadrant pain and fever (Gross *et al*, 1986). Pulmonary involvement was described, but it was unclear whether a true pathogen or merely colonizes respiratory tract (Moore and Frenkel, 1991), and the non-specific respiratory symptoms as cough (Meynard *et al*, 1996).

Laboratory abnormalities of cryptosporidiosis: The presence of laboratory abnormalities depends upon the severity and duration of infection. The serum alkaline phosphatase may be elevated in patients with biliary tract involvement. In such patients, ultrasound and CT imaging may show an enlarged gallbladder with a thickened wall and dilated intra- and extrahepatic biliary ducts. Diagnosis of biliary involvement is confirmed by histology or by examination of bile for oocysts, since stool specimens may or may not be positive. Lalancette *et al*. (2010) in Canada stated that inactivation of the *Cryptosporidium* oocysts was a main driver in the selection of water treatment disinfection strategies, and microbial risk analysis provides a sound basis for optimizing water treatment processes. They developed a dual direct detection method using differential immunofluorescent staining to detect oocysts and cell culture infection foci for each sample. The key trigger for oocyst stimulation was acidification. Addition of a low concentration of D-glucose (50mM) to the infection media increased rates of infectivity, while a higher dose (300mM) was inhibitory. The total number of oocysts in each sample was determined by counting the oocysts remaining on a cell monolayer and the oocysts recovered from cell monolayer washes during processing using a simple filtration technique. With the dual direct detection on cell culture with immunofluorescence assay method, it is now possible to determine the numbers of total and infectious oocysts for a given sample in a single analysis. Direct percentages of infectivity are then calculated, which allows more accurate assessments of risk. Patients with severe, protracted disease can have evidence of malabsorption. Behera *et al*. (2008) found that celiac disease is the most common cause of malabsorption syndrome in both adults and children with significantly sever pathogenic parasites (*C. cayetanensis, Giardia lamblia, C.*

parvum, E. histolytica/ dispar, Isospora belli) were more frequently colonized with harmless commensals as compared to healthy ones. Intestinal coccidian was associated with malabsorption syndrome, mainly in the malnourished children.

Diagnosis of cryptosporidiosis is made by microscopic identification of oocysts in stool or tissue. The organisms may also be present in duodenal aspirates, bile secretions, biopsy specimens from affected gastrointestinal tissue, or respiratory secretions. *Cryptosporidium* species can-not be cultivated in vitro. So, diagnosis is based on microscopic identification. Laboratory should be alerted to potential diagnosis and specific stains for the organisms should be requested, since routine examination for ova and parasites usually does not detect cryptosporidia spores. Specimens can be examined fresh or formalin-fixed, by light or phase-contrast microscopy. Modified acid-fast stains are usually used, although the organisms also can be seen using Hematoxylin and Eosin, Giemsa, or Malachite green staining. With the modified acid-fast stain, oocysts stain red or pink and are 4 to 6 mcm in diameter. Light microscopy does not distinguish between genetically distinct parasites. The accuracy of the acid-fast stain depended in part upon the number of stool specimens examined, since the number of oocysts shed in feces is not constant. In one report, examination of a single stool specimen identified only 30% of intestinal cryptosporidiosis. The number of specimens required to conclusively exclude the diagnosis was studied, but in chronic infections, examining up to three specimens is reasonable. Also, examination of unformed and/or concentrated specimens increased diagnostic value. Fecal specimens usually lack leukocytes and erythrocytes (Blanshard *et al*, 1992).

Histopathology: Cryptosporidial enteritis can be diagnosed from hematoxylin and eosin staining; *Cryptosporidium* appears basophilic and occurs either alone or in clusters on the brush border of the mucosal surface. Because infection can be patchy, biopsy specimens may be less sensitive than stool examination.

Monoclonal antibodies against oocyst wall and antigen capture ELISA tests were used in fluorescent assays (e.g., Meridian Merifluor assay and the Tech-Lab Crypto IF kit) to detect *Cryptosporidium* in fecal specimens or in tissue specimens. These techniques increase the sensitivity compared to routine light microscopy and are easy to perform (Kehl *et al*, 1995). Enzyme immunoassay kits include the Alexon ProSpect Assay, the Seradyn Color Vue and the Meridian Premier Cryptosporidium, which have been evaluated in a number of studies: The ProSpect T kit had a sensitivity of 100% and specificity of 99% when compared to the modified acid-fast stain. The Meridian Premier and the ProSpect T kits had sensitivities of 98 and 99 percent, respectively, and specificities of 100 for both when compared to the Meridian Merifluor assay as the reference method. The ProSpecT and Color Vue had sensitivities of 96 and 76 percent, and specificities of 98 and 100 %, respectively, when using the Merifluor stain as the reference method. The acid-fast stain and EIA had sensitivities of 94 &100%, and specificities of 76 & 100%, respectively, compared to direct immunofluorescence (Garcia and Shimizu, 1997). Advantages of ELISA tests are that they are easy to use, are not affected by preservatives, and do not require the degree of technical skill needed for microscopy. However, a major disadvantage is their high cost. Furthermore, faulty ProSpecT kits have been associated with false positive results (Doing *et al*, 1999).

PCR: Although diagnosis of cryptosporidiosis is generally based on microscopy, this method offers no information on the infecting species, which can be helpful in epidemiologic investigations. Some specialized research laboratories use PCR testing, which is more sensitive than microscopy and has the ability to differentiate between *Cryptosporidium* genotypes, thereby having a poten-

tial use to detect outbreaks' source. A commercially available PCR-ELISA-based allowed detection and genotyping of *Cryptosporidium* in biological samples (Morgan *et al*, 1998). Compared to microscopy, a study of this hybrid assay in 33 stool samples gave 97% sensitivity and 100% specificity.

Treatment of immunocompetent patients: Cryptosporidiosis recovery depends largely upon host immune. Immunological healthy patients usually have a spontaneous recovery within a few weeks and parasitologic cure within a few months without requiring any specific therapy (Abubakar *et al*, 2007). When therapy is required, nitazoxanide, a nitrothiazole benzamide, is preferred drug in children 1 to 11 years of age and was studied in adults (Fox and Saravolatz, 2005). A multicenter, randomized, double-blind, placebo-controlled trial was conducted in 90 outpatients 12 years of age and older from Egypt (Rossignol *et al*, 2006). Aboul-Noor *et al*. (2016) in Egypt found that the cryptosporidiosis histopathological patterns were corrected with plant extracts in descending order was as follow ginger, mirazid and garlic respectively, which extracts proved to have a direct and powerful impact on *C. parvum* and minimized its pathology complications as compared to Metronidazole.

Treatment in HIV-patients: The most important part was initiating HAART in order to reconstitute immunity. In such patients, clinical resolution may occur, but was unclear whether organisms were completely eliminated. Carr *et al.* (1998) in Austria found that combination antiretroviral therapy that includes a protease inhibitor can restore immunity to *E bieneusi* or *C parvum* in HIV-1 infected individuals, and result in complete clinical, microbiological, and histological responses. The persistent CD8 cell and macrophage infiltrate, and the rapid time to relapse in patients with declining CD4 lymphocyte counts, suggested that neither infection was eradicated. Girma *et al.* (2014) *Cryptosporidium* spp and *I. belli* are the intestinal opportunistic infections associated with HIV/AIDS. A decline in the incidence of these opportunistic infections due to HAART was reported. They reported that there was high burden of infection with *Cryptosporidium* spp among HIV infected individuals in southern Ethiopia but that of I. belli is low. They recommended considering infection with *Cryptosporidium* spp in HIV patients with chronic diarrhea, weight loss and vomiting for HAART naïve patients and/or for patients who are within the first year of starting HAART. Asma *et al.* (2015) in Malaysia stated that the cryptosporidiosis is a particular concern in immunocompromised individuals where symptoms might be severe. They used modified Ziehl-Neelsen acid fast stain to test for oocysts in stools of 346 HIV/AIDS patients in Malaysia. Highest rates were in adult males of Malay background, intravenous drug users, and those with low CD4 T cell counts (i.e., <200 cells/mm3). Most were asymptomatic and had concurrent opportunistic infections mainly with the *Mycobacterium tuberculosis*. DNA sequence analysis of 32 isolates identified *C. parvum* (84.3%), C. *hominis* (6.3%), *C. meleagridis* (6.3%), and *C. felis* (3.1%). The results showed the high prevalence of cryptosporidiosis in hospitalized HIV/AIDS patients, and also confirmed the potential significance of zoonotic transmission of *C. parvum* in HIV- patients. The patients were susceptible to a wide range of *Cryptosporidium* species. Epidemiological and molecular characterization of all isolates provided clinicians and researchers with more information as to infection origin, and enhances treatment and control strategies.

Sequelae of cryptosporidiosis in immunocompetent patients, Hunter *et al*. (2004) reported that 40% had recurrence of intestinal symptoms (mild to moderate) after resolution of acute illness with either *C. hominis* or *C. parvum* infection. Late the development of extraintestinal symptoms, such as joint pain, eye pain, headache, dizzy spells, and fatigue all occurred two to three times as often in patients compared to controls. The

late symptoms, particularly eye pain and recurrent headache were commonest with *C. hominis* infection.

Prevention: Good hygiene, such as handwashing and proper disposal of the contaminated materials, is the most important ways to prevent infection. The oocysts are resistant to most standard purification techniques, including the filtration and the chlorination. Spores can be eliminated with freezing, boiling, and by high concentrations of ammonia or formalin. Asymptomatic family or other contacts do not routinely require any specific investigation or therapy, but these individuals should be aware that they may be excreting cysts and therefore should take care with their personal hygiene. Boiling or filtering water may decrease the risk of infection in immunosuppressed patients. However, impact of oocysts low concentrations in drinking water on human illness is not adequately understood. As a result, this approach is not universally recommended. Immunocompromised patients at high risk for severe infection limit their exposure by minimizing oral exposure to water from lakes, streams, and public swimming pools (Goodgame, 1996).

The prophylaxis was not routinely recommended. But, clarithromycin or rifabutin given for MAC prophylaxis or therapy gave than 75% protective against cryptosporidiosis, and no effect with azithromycin (Holmberg *et al*, 1998).

To prevent food poisoning at home: 1- Wash your hands, utensils and food surfaces often. Wash your hands well with warm, soapy water before and after handling or preparing food. Use hot, soapy water to wash utensils, cutting boards and other surfaces you use. 2- Keep the raw foods separate from ready-to-eat foods. When shopping, preparing food or storing food, keep raw meat, poultry, fish and shellfish away from other foods. This prevents cross-contamination. 3- Cook foods to a safe temperature. The best way to tell if foods are cooked to a safe temperature is to use a food thermometer. One can kill the harmful organisms in most foods by cooking them to the right temperature. Cook the ground beef to 160^{o}F (71.1^{o}C), steaks, roasts chops, such as lamb, pork and veal to at least 145^{o}F (62.8^{o} C), and cook chicken and turkey to 165^{o}F (73.9^{o}C). Make sure that the fish and shellfish were cooked thoroughly. 4- Refrigerate or freeze perishable foods promptly-within two hours of purchasing or preparing them. If room temperature was above 90^{o}F (32.2^{o}C) refrigerated perishable foods within an hour. 5- Defrost food safely, and don't thaw food at room temperature. The safest way to thaw food is to defrost it in refrigerator. If you microwave frozen food using the "defrost" or "50% power" setting, be sure to cook it immediately. 6- Throw it out when in doubt. If you aren't sure if a food has been prepared, served or stored safely, discard it.

The food left at room temperature too long may contain bacteria or toxins that can't be destroyed by cooking. Don't taste food that you're unsure about- just throw it out. Even if it looks and smells fine, it may not be safe to eat.

Conclusion

General speaking, the food poisoning is especially serious and potentially life-threatening for you, young children, pregnant women and their fetuses, older adults, and people with the weakened immune systems.

These individuals should take the extra precautions by avoiding the following foods: 1- Raw or rare meat and poultry. 2- Raw or undercooked fish or shellfish, including oysters, clams, mussels and scallops. 3- Raw or undercooked contaminated eggs or foods, as cookie dough and homemade ice cream. 4- Raw sprouts, as alfalfa, bean, clover and radish sprouts. 5- Unpasteurized juices and ciders. 6- Unpasteurized milk and milk products. 7- Soft cheeses, as feta, Brie and Camembert; blue-veined cheese; and unpasteurized cheese. 8- Refrigerated pates and meat spreads. 9- Uncooked hot dogs, luncheon meats and deli meats.

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