Literature Review
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Cryptospordiosis: An infectious emerging protozoan zoonosis of public health significance

Abstract

Zoonoses caused by diverse etiological agents, are important from public health and economic point of view, and are reported in humans and animals from developing and developed nations of the world. Cryptosporidiosis is an emerging food and waterborne zoonotic protozoan disease that has been detected in both human and animal populations all over the world. The source of infection is exogenous, and the ingestion of contaminated food and water is the principal mode of transmission. The oocysts of *Cryptosporidium* are abundant and pervasive in ambient water, where they can survive for months. It prefers epithelial cells found in the digestive tracts of a wide range of hosts. Waterborne transmission through drinking water or a swimming pool is common, resulting in outbreaks in several nations throughout the world. The disease can manifest itself in sporadic or epidemic forms. The infection has been recorded in immunocompetent and immunocompromised individuals. The watery diarrhea, abdominal cramps, nausea, anorexia and low grade fever are most commonly observed symptoms. The laboratory help is required to make an unequivocal diagnosis of disease. The preventive strategies include excellent hygienic measures to avoid the contamination of food and water by oocysts of *Cryptosporidium*. In addition, the role of veterinarian is highly imperative for the management of disease in domestic animals.

Keywords: cryptosporidium, oocysts, public health, transmission, worldwide, zoonosis

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Introduction

Zoonoses have emerged as significant causes of morbidity and mortality both in immunocompetent as well as in immunosuppresed subjects throughout the world.[1-3] Currently, there are more than 300 zoonotic diseases of diverse etiologies that are reported in humans and animals including birds.[4] Cryptosporidiosis is an infectious emerging and re-emerging protozoan zoonosis that has been described from the developed as well as developing nations of the world.[5] The disease is caused by *Cryptosporidium* species, which are obligate intracellular protozoan parasites that belong to the phylum *Apicomplexa*.[5,6] Cryptosporidiosis is a disease that affects both humans and animals and produces an infection in their intestines.[7] Humans and animals become infected when they eat food or drink water that contains oocysts of the protozoa.[5] Due to food and water transmission, the incidence and prevalence of cryptosporidiosis are higher in undeveloped countries where people lack basic infrastructure or foundations.[7] A massive outbreak of cryptosporidiosis that affected about 403000 people was recorded in Milwuakee, Wisconsin, USA in 1993.[8] In this context, Smith and co-workers (2007) mentioned that around 10 % of all cases of cryptosporidiosis in the USA are considered as foodborne.[9]

Cryptosporidiosis is the sixth most frequent parasite infection transmitted through food in people and domestic animals across the world. In low-resource nations, *Cryptosporidium* infection is on the rise in malnourished children and is a primary cause of mortality.[10] The most often used screening test for cryptosporidiosis is the microscopic study of feces with acid-fast staining, with or without stool concentration. The human infection of this intestinal protozoa parasite is a serious public health and environmental concern, and human epidemics have yet to be fully understood, particularly in less-developed regions of the world.[11] Cryptosporidiosis is a serious problem that results in growth retardation, a decline in physical prowess, defective cognitive capacity, and mortality in children who have had acute, chronic, or persistent diarrhea. However, the correlates of protective immunity in *Cryptosporidium* species parasite invasions in animals and humans are not well understood.[12] However, in many nations throughout the world, such recorded information to start investigations and design control measures is minimal or non-existent.[13] Even though *Cryptosporidium* infection is quite common, there was a lack of well-documented information about the economic and public health implications of this zoonotic parasite. Therefore, the objective of this communication is to delineate the public health importance of cryptosporidiosis, an emerging zoonosis of global distribution.

Literature review

Etiology

Cryptosporidiosis is a coccidian parasitic disease caused by members of the Cryptosporidium genus, which belongs to the family *Cryptosporidiidae*, subclass *Cryptogregaria*, and Phylum *Apicomplexa*. *Cryptosporidium* species are represented by 23 species and 61 genotypes which have been found in a variety of vertebrates including humans, mammals, wildlife, domestic livestock, reptiles, birds, amphibians, and fish, and have been linked to asymptomatic or mild-to-severe gastrointestinal sickness in their hosts.[12] *Cryptosporidium* is a common gastrointestinal infection that is chlorine resistant, difficult to filter, and found in a variety of animal species.[5]

Life cycle

In most cases, the incubation period (the time between infection and the first appearance of oocysts in the stool) is four days (3 days in heavy infections). The time it takes for oocysts to be shed in the feces

is usually 6-18 days (4-10 days of diarrhea) in immunocompetent people, but it can be longer in immunosuppressed people. Some people shed oocysts but do not show any symptoms, which is known as subclinical cryptosporidiosis.[5]

Transmission

Cryptosporidium transmission routes can be split into two types: direct and indirect transmissions. Accidental consumption of *Cryptosporidium* oocyts secreted from feces causes direct transmission from animal to animal, animal to human (zoonosis), or vice versa, from human to animal (anthroponotic or reverse zoonosis).[13] Cross-contamination of foodstuffs, food materials, drinking water, and several fomites, such as clothing and footwear worn in a livestock farm or wildlife park that have been exposed to the excrement of an infected human or animal, are all examples of indirect transmission. It can infect and live in epithelial surfaces of the intestine in humans, as well as a wide range of vertebrate animals, and is passed from feces or stool into the environment (environmental contamination) such as soil and water sources, such as ponds, rivers, wastewater, sewage, or slurry, and even many water containers, particularly inadequately treated public water supplies. Following a high rate of rainfall, transmission and distribution are demonstrated.[14]

The parasite is spread through the environment by hardy microbial cysts or oocyts that, if consumed, settle in the small intestine, infecting intestinal epithelial tissue. In humans, the small intestine is the most common location of infection, although extra-intestinal cryptosporidiosis affects the biliary system, lungs, and pancreas in immune-compromised host.[15]

Clinical spectrum

Cryptosporidiosis may be asymptomatic in certain hosts, but it causes profuse watery diarrhea, nausea, vomiting, stomach aches low-grade fever, and dehydration and cramps in humans, as well as intestinal carcinogenesis.[16]

Diagnosis

Due to absence of characteristic clinical signs and symptoms, the help of laboratory is imperative to confirm an unequivocal diagnosis of cryptosporidiosis. To increase sensitivity, wet mount followed by staining with a specific dye such as acid-fast dye, fluorescence, or immunofluorescence can be used to detect oocysts in the stool samples.[17] Acid-fast stained oocysts have crescent-shaped sporozoites and are occasionally red with a size of 4-6 µm. The modified Ziehl–Neelsen method, modified dimethyl sulfoxide, safranin-methylene blue, and modified Koster are all acid-fast dyes that are commonly utilized. Fluorochrome stains are improving sensitivity, although they can sometimes stain oocyst-like entities in fecal debris.[18] Microscopic examination is time-consuming and ineffective, with low sensitivity and specificity, and misinterpretation is common due to a lack of understanding of oocyst morphology and biological features. As a result, immunological-based techniques such as direct fluorescent antibody, enzyme immunoassay, and enzyme-linked immunosorbent assay (ELISA), indirect ELISA, and dipstick-like assays have been developed as alternate methods of detection.[19] DNA-based detection methods such as PCR restriction fragment length polymorphism, real-time PCR tests, nested PCR, multiplex PCR, and other modified PCR methods have all been used to identify Cryptosporidium species.[5,6,20,21]

Treatment

Supportive therapy such as fluid and electrolyte replacement, anti-nausea medicines, anti-emetic drugs, or analgesic drugs can help with various clinical symptoms like watery fever, vomiting, nausea, stomach cramps, and dehydration. These drugs can relieve the symptoms of cryptosporidiosis, although in some situations, antiprotozoal therapy is required. Nitazoxanide is the most effective medicine for treating cryptosporidiosis patients, and it is the only anti-cryptosporidium agent licensed by the US Food and Drug Administration for the treatment of cryptosporidiosis in humans.[10]

Prevention and control

Cryptosporidiosis can be transmitted and infect vulnerable hosts by a fecal-oral route as cross-contamination in raw food and water from reservoir animals in the community, farms, or abattoirs, as well as mechanical vectors like cockroaches and flies. Humans can then be infected by their oocysts through swallowing the contaminated food and drink that has been unprocessed or has been handled improperly. As a result, the greatest option for human prevention is to prevent some animals or livestock. Before eating or drinking raw food or water, it must be thoroughly cleansed, washed, heated, cooked, or boiled (5).Furthermore, patients with diarrhea symptoms should be aware that they should not swim in a public pool, public water park, or river to avoid spreading the disease to others, and people who swim in a pool, water park, or river should be aware of the risk of disease infection if they swallow the water.[10]

Primary prevention, which reduces or eliminates causative risk factors by limiting the amount of animals density in farms or stocks, minimizing a contraction between personnel, calves, and other herds, and keeping young animals from adult animal or susceptible hosts with a high risk should be emphasized. Children can avoid cryptosporidiosis by practicing proper personal hygiene, such as hand washing before preparing and eating food, after using the toilet, and after contacting diarrhea sufferers.[5,22] It is crucial to note that anyone with an immune compromised person, as well as children, should avoid handling animals who have diarrhea. Furthermore, public health education on the environment and personal cleanliness should be provided.[2]

Conclusion and recommendations

Cryptosporidiosis is a worldwide zoonotic parasitic disease that infects a wide variety of animals and humans while infected animals and humans shed a very high number of oocysts. Its transmission occurs through direct or indirect contact with the feces of these shedders. Outbreaks illustrate the person-to-person spread in institutions; animal contact during farm visits and contact with recreational waters, swimming pool visits, municipal drinking water, and food are also different routes of transmission. Fatal diarrhea with malabsorption and dehydration occurs in young and immune-compromised hosts.

Staining oocysts and examine under the microscopy are commonly used in the laboratory to diagnose *Cryptosporidium* infection. However, these methods cannot differentiate the morphology of each *Cryptosporidium* species, so immunological methods and molecular techniques are playing more roles in the identification of species. Still, there is no effective therapeutic agent for *Cryptosporidium* infection but following adequate management and hygienic practices isof paramount importance in the control and prevention of the disease. Based on the above conclusion the following recommendations are forwarded:-

i. Awareness creation and extension service should be provided including healthy education to the farmers and other attendants.

ii. Swimming and direct drinking of water from the lakes, streams, and rivers should be avoided.

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iii. Water should be properly boiled before consumption.

iv. Manure management can help reduce the level of exposure to oocysts.

v. Steam cleaning and disinfection, or thorough cleaning with hot water, followed by drying to promote desiccation, may be useful.

vi. Good nutrition and management (provision of adequate colostrum, avoidance of overcrowding) are highly imperative at the livestock farm.

vii. Further studies are needed for effective treatment and implementation of sound prevention and control measures.

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Contribution of authors

All the authors contributed equally. They read the final version, and approved it for the publication.

Conflicts of interest

The authors declare that they do not have conflict of interest.

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