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Cryptosporidium: Public Health Problems and Environmental Indicators

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Abstract

Cryptosporidium still remains a public health problem, and cryptosporidiosis exists as an emerging and reemerging infectious conundrum of morbidity and mortality with increased transmission, dissemination and gross under ascertainment of its global encumbrance. This paper relates the public health, environmental attributes and clinical features of Cryptosporidium spp in contemporaneous and spatiotemporal settings.

Keywords: Watery diarrhea; Symptoms, Enteric pathogen; Distal small intestine; Stool; Contaminated food

Introduction

Cryptosporidium is an emerging/reemerging highly infectious disease threat whose transmission has increased. Cryptosporidium spp consist of coccidian, obligate, intracellular, protozoan parasites of phylum Apicomplexa [1] of which twenty-two recognized species infect vertebrates [2], with the zoonotic Cryptosporidium parvum and the anthroponotic Cryptosporidium hominis constituting the principal global aetiologic agents of human cryptosporidiosis.

Cryptosporidiosis outbreak afflicted more than four hundred thousand persons in Milwaukee, USA in 1993 [3]. The extent of the outbreak with linkage to water fetched from a municipal water plant that was operating duly within extant State and Federal laws and regulations necessitated enhanced surveillance of public health agencies for the prevention and detection of unforeseen outbreaks; and coordination among communities, groups and agencies for appropriate response to such future outbreaks as well as stimulus for the development of regulatory standards for Cryptosporidium in drinking water to minimize the public health risks and to advance the elucidation of waterborne cryptosporidiosis [3].

Environmental and Public Health Issues

In a contemporaneous setting, Cryptosporidium has been detected to be the most common enteric parasite in immune compromised patients with decreasing order of magnitude in detecting cystoisospora, endameba histolytic, and strongyloides stercoralis [4]. The human infection of this intestinal protozoa parasite, Cryptosporidium poses a major public health and environmental challenge, and the epidemics in humans have not been clearly elucidated, especially in non-industrialized parts of the world. The current Cryptosporidium high prevalence rate is related to retarded awareness and inadequate routine-based testing to identify the parasite, as well as difficulty in unraveling possible risk factors associated with the parasitic protozoon using laboratory-based observational studies for the development of enhanced dynamic estimation of the burden of cryptosporidiosis in any defined precinct [5]. Cryptosporidium spp has actually not been accorded pertinence as a perturbative pathogen of increased morbidity and mortality associated with diarrhea in children, HIV-infected persons, elderly and vulnerable populations [6-8]. Numerous symptomatic infections are evident in childhood and immune compromised adults in endemic ambient. The immune status of the subject is inextricably linked to the resultant impact of cryptosporidiosis. Infection may be self-limited in immune competent subjects but may be persistent, deleterious with increased severity in immune compromised HIV/AIDS patients and malnourished children. Globally, cryptosporidiosis is a debilitating dilemma of major consequences of acute, chronic or persistent diarrhea in children resulting in growth impairment, deterioration in physical prowess, dysfunctional cognitive ability as well as death. However, correlates of protective immunity in the parasitic invasions of Cryptosporidium spp in animals and Man is not clearly elucidated [7].

Risk Factors

Findings have made provisions for risk factors in contracting childhood cryptosporidiosis in niches having poor environmental sanitation, contaminated public potable water systems, and proximity in animal-human relationships, which will necessitate infectious disease control modalities of a multidimensional feature [9].

Cryptosporidiosis transmits and disseminates via oral ingestion of contaminated food and water, especially where humans and animals are invariably in contact, thus necessitating full and proper epidemiological surveillance of food, water and faucal deposits with stringent attention on pathogen source, such as tracking undergirded by molecular studies for the identification and elucidation of defined human and animal attributes for conduits of infection transmission and dissemination.

Transmission and Clinical Manifestations

Cryptosporidium is an enteric pathogen, resistant to chlorine, minute, difficult to filter, and ubiquitous in several animals. The parasite is transmitted environmentally by hardy microbial cysts or oocytes which when ingested reside in the small intestine with resultant infection of intestinal epithelial tissue. The small intestine is the usual primary site of infection in Man whereas extra intestinal cryptosporidiosis presents in immune compromised hosts in the biliary tract, lungs and pancreas [10]. Cryptosporidiosis may be

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asymptomatic in certain hosts but with clinical manifestations of profound watery diarrhea, nausea and vomiting with abdominal pains and cramps with resultant digestive carcinogenesis in Man [11].

The parasite is transmissible directly from person to person via drinking or swimming in contaminated water, such as swimming pools, consumption of unwashed, inadequately unwashed and uncooked foods, such as fruits and vegetables; (b) if hands, objects and surfaces are contaminated or polluted with faucal matter of infected humans or animals or both; and (c) also via fomites in respiratory infections [12]. The major symptom is watery diarrhea accompanied by stomach cramps, fever, and vomiting, less common presentation of loss of appetite, general malaise and prostration. Persons with normal immune systems have symptoms, which last for not more than two weeks. Those presenting with debilitating immune suppression, especially advanced HIV infections are susceptible to severe and prolonged diarrhea.

Detection, Identification and Diagnosis

Since Cryptosporidium spp constitute one of the ubiquitous opportunistic enteric parasites in the immune compromised hosts, it is pertinent to diagnose the infection early via the application of rapid tests, such as antigen detection by immune chromatographic test (ICT), ELISA and microscopy which are, however, liable to depict variations in sensitivity and specificity on the usage of disparate methods and kits. Even though, ICT is a rapid test, it is suggested to be less sensitive and more expensive than semi quantitative polymerase chain reaction (PCR) [4]. However, supplementary studies of PCR testing at predefined intervals with incorporated symptom surveillance are pertinent to elucidate the duration of pathogen detection following travelers' diarrhea (TD) treatment and the value of quantitative assays for the identification of the linkage between pathogen city of detected organisms on application of these modalities which have become endorsed in vaccine and drug research, development and clinical implementation [13]. Morph metric identification of Cryptosporidium is usually cumbersome due to its miniature size and obfuscating internal structure. Predominantly, Cryptosporidium identification is realizable via continuation technique incorporating data from morph metrics, molecular modalities, and host specificity. Extant restriction to these methods includes pecuniary constraints, duration, competence, technical and information configuration expertise, reliability and validity [14].

Treatment

Application of drug combination is important for the treatment of cryptosporidiosis, such as the efficient paromomycin, an aminocyclitol antibiotic isolate of Streptomyces; and effective protease inhibitors or recombinant IL-12, as well as supportive therapy required in both humans and animals in non-achievement of complete eradication of the parasite from the host [14]. Cryptosporidiosis normally presents as a self-limiting disease in healthy individuals with duration of about 9-15 days, whereas the presentation is more severe in immune compromised hosts as life threatening with ostensibly no complete effective drug treatment and control [11]. Thus, treatment is not pertinent in patients with normal immune systems, while there is no effective and efficient treatment for diarrheal mitigation in immunologically suppressed individuals. Oral rehydration and fluid replacement therapy may be relevant in children. Daily or frequent environmental and personal sanitation must be stringently adhered to.

Environmental Indicators

Recent spatial modeling techniques are suggestive in the determination of the impact of environmental exposures, such as climate change and land consumption in combination with socioeconomic attributes, which promote sustenance of infectious disease transmission and dissemination in humans. Spatiotemporal models and variations may be relevant for interactions on both local and global dimensions, geographic clustering and interminable presentations of the exposure surfaces as significant features of numerous environmental effects [15]. Spatial modeling or tools may be applicable to cryptosporidiosis in resource endowed contemporaneous settings to inform targeted intervention strategies in forecasting disease risk patterns or scenarios in environmental alterations. When coupled with molecular studies, these have assisted in the determination of location-specific sources of infection, and pathways of environmental transmission or dissemination [15]. There is extant expansive latitude to apply these methods for data identification or infrastructure gaps for the evaluation and establishment of baseline disease burden in resource-restricted settings. These will contribute in the composite integration of public health and environmental paradigms in the identification of inextricable linkages in the physicochemical, socioeconomic, environmental, safety and health concomitant impacts. The elucidation of the socio environmental context of disease dissemination and transmission is crucial in the assessment of the public health implications of projected environmental alterations and perturbations.

Zoonotic transmission of Cryptosporidium from animals to humans through the environment suggest that spatiotemporal environmental conditions regarding case occurrence is biologically feasible in the distribution of cryptosporidiosis in a given precinct, and in the determination of human cryptosporidiosis distribution in relation to domestic animal farms, hydrological attributes and weather events [16]. The universal encumbrance of cryptosporidiosis remains uncertain because of ostensibly indeterminable transmission paradigm that is incompletely ascertained even though undergirded with detection, identification and diagnostic tools for global surveillance [17].

Cryptosporidium burden in children is at best anecdotal, misleading and misinterpreted because of physiological attributes, such as early-age unpaired immunologic response. Furthermore, malnutrition in non-industrialized countries or clinical obfuscation and under ascertainment of protozoan aetiology in industrialized countries may be contributory to the underestimation of the global burden of Cryptosporidium. Major indicators of Cryptosporidium dissemination have been associated with environmental factors, such as spatiotemporal clusters [7] and host determinants of the infection, for instance, age, community norms, immune status and travels [17].

Discussion

Cryptosporidiosis is a parasitic disease perturbing domestic animals and humans that extends from isolated events to epidemic proportions. Opportunistic infections with the parasite, Cryptosporidium spp may result in enteric disorders and other debilitating conditions culminating in high morbidity and mortality rates. Contemporary research has delved into the understanding of Cryptosporidium spp and cryptosporidiosis. Following the upsurge in research activity on Cryptosporidium in the 1990s [7], there have been developments in surface receptors, host-parasite interface, developmental biology, phytogenetic affinities and their relatedness with the unique biology of Cryptosporidium spp [18].

WHO propounded recommendations for the evaluation of household water treatment options in 2011 [19]. Household water treatment programmes for HIV persons which solely make provision for chlorine do not absolutely address Cryptosporidium risk among the population because of the resistance of the parasite to chlorination. The WHO recommendations provides the latitude for optimal selection of household water treatment strategies but HIV programmes ought to incorporate those which are effective against Cryptosporidium spp in order to protect vulnerable populations [20].

Conclusion

Cryptosporidium is one of the emerging and reemerging increasingly infectious dilemma with high transmission rate, and ubiquitous in several animals as hosts. Cryptosporidiosis or crypto is the parasitic disease whose aetiologic agent is Cryptosporidium that infects the distal small intestine and respiratory tract in both immune competent and immune compromised individuals resulting in watery diarrhea sometimes accompanied by unexplained cough. Transmission is via faucal-oral route of ingested contaminated food and water, and *via* fomites in respiratory infections. The infection is diagnosed by microscopical examination or detection of Cryptosporidium in a stool sample using a PCR test. Inoculation period varies for not more than twelve days with infectious period lasting up to several weeks. Treatment is not necessary in patients having normal immune status. There is no available efficient and effective treatment to ameliorate diarrhea in immunologic constrained patients. However, the correlates of protective immunity and the parasitic invasion of Cryptosporidium spp in animals and Man is not clearly elucidated, and its prevention, especially in food and water sources and current treatment paradigms are not expansive; self-resolution of the diarrhea occurs within two to three days, though. Environmental sanitation and personal hygiene are important to obviate transmission of the parasites and dissemination of the disease.

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