

Future Emerging Issues in waterborne diseases and microbial agents

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Infectious water related diseases are a major cause of morbidity and mortality worldwide. Newly-recognized pathogens and new strains of existing pathogens are being discovered that present important challenges to both water and public health sectors- between 1972 and 1999, 35 new agents of disease were discovered and many more have re-emerged after long periods of inactivity or are expanding into areas where they have not previously been reported.

Relevant water-related pathogens have included *Escherichia coli* O157:H7, *Giardia*, *Cryptosporidium*, *Cyclospora*, hepatitis E virus and legionella. Others now being evaluated include *Helicobacter pylori*. Drivers of emergence of 'new' pathogens include microbial evolution, creation of new environments introduction of new technologies and developing abilities to detect and study the microorganisms themselves^{1,2}.

In 2003, Sharma et al³ have defined an emerging pathogen as "any new, reemerging, or drug resistant infection whose incidence in humans has increased within the past two decades or whose incidence threatens to increase in the future." This definition is derived from a report published by the Institute of Medicine of the National Academies in the USA in 1992³. In 2003, Smolinski et al have published another work entitled *Microbial Threats to Health: Emergence, Detection and Response* to address current concerns associated with emerging pathogens⁴. Emerging pathogens are characterized by their increasing prevalence and have the potential to become endemic, epidemic, and even pandemic in nature. Clinical illness associated with these emerging pathogens, compared with other closely related pathogens, may be more severe, transmitted more rapidly or widely within populations, or more difficult to prevent or treat⁵.

Many classes of pathogens excreted in feces are able to initiate waterborne infections. There are bacterial pathogens, including enteric and aquatic bacteria, enteric viruses, and enteric protozoa, which are strongly resistant in the water environment and to most disinfectants⁶. The infectious dose of viral and protozoan agents is lower than bacteria, in the range of one to ten infectious units or oocysts. Waterborne outbreaks of bacterial origin (particularly typhoid fever)

in the developing countries have declined dramatically from 1900s. However, some early bacterial agents such as *Shigella sonnei* remain prevalent and new pathogens of fecal origin such as zoonotic *Campylobacter jejuni* and *E. coli* O157:H7 may contaminate pristine waters through wildlife or domestic animal feces. These bacteria even in low inoculums (few hundred cells) have the capacity and trigger disease. In early 1992 the emergence of serotype O139 of *Vibrio cholerae* with epidemic potential in Southeast Asia suggests that other serotypes other than *V. cholerae* O1 could also trigger on epidemic^{7,8}. Some new pathogens include environmental bacteria that are capable of surviving and proliferating in water distribution systems. The general population is refractory to infection with ingested *Pseudomonas aeruginosa*, however specific hosts are still at risk. The significance of *Aeromonas* spp. in drinking water to the occurrence of acute gastroenteritis remains a debatable point and has to be evaluated in further epidemiological studies. *Legionella* and *Mycobacterium avium* complex (MAC) are environmental pathogens that have found an ecologic niche in drinking and public water supplies. Numerous studies have reported Legionnaires' disease caused by *L. pneumophila* occurring in residential and hospital water supplies. *M. avium* complex frequently causes disseminated infections in AIDS patients and drinking water has been suggested as a source of infection; in some cases the relationship has been proven⁹. More and more numerous reports show that *Helicobacter pylori* DNA can be amplified from feces samples of infected patients, which strongly suggests fecal-to-oral transmission. Therefore, it is possible that *H. pylori* infection is waterborne, but these assumptions need to be substantiated. Giardiasis has become the most common cause of human waterborne disease in developed and developing countries. The transmission of *Cryptosporidium* and *Giardia* through treated water supplies that meet water quality standards demonstrates that water treatment technologies have become inadequate, and that a negative coliform no longer guarantees that water is free from all pathogens, especially from protozoan agents. Substantial concern persists that low levels of pathogen occurrence may be responsible for the endemic transmission of enteric disease. In addition to *Giardia* and

Cryptosporidium, some species of genera Cyclospora, Isospora, and of family Microsporidia are emerging as opportunistic pathogens and may have waterborne routes of transmission^{10,11}. More than 15 different groups of viruses, encompassing more than 140 distinct types can be found in the human gut. Some cause illness unrelated with the gut epithelium, such as Hepatitis A virus (HAV) and Hepatitis E virus (HEV). Hepatitis E is mostly confined to tropical and subtropical areas, but recent reports indicate that it can occur at a low level in Europe. A relatively small group of viruses have been incriminated as causes of acute gastroenteritis in humans and fewer have proven to be true etiologic agents, including rotavirus, calicivirus, astrovirus, and some enteric adenovirus^{12,13}. These enteric viruses have infrequently been identified as the etiologic agents of waterborne disease outbreaks, because of inadequate diagnostic technology, but many outbreaks of unknown etiology currently reported are likely due to viral agents. Actually, Norwalk virus and Norwalk-like viruses are recognized as the major causes of waterborne illnesses world-wide. The most striking concern is that enteric viruses such as caliciviruses and some protozoan agents, such as Cryptosporidium, are the best candidates to reach the highest levels of endemic transmission, because they are ubiquitous in water intended for drinking, being highly resistant to relevant environmental factors, including chemical disinfecting procedures. Other concluding concerns are the enhanced risks for the classic group of debilitated subjects (very young, old, pregnant, and immunocompromised individuals) and the basic requirement of to take specific measures aimed at reducing the risk of waterborne infection diseases in this growing, weaker population¹⁴.

Moreover, numbers of new risks for waterborne zoonotic diseases are identified, in which the concern authorities need to be able to respond in a scientifically based manner to address the threat where it occurs. This will require cooperation, sharing of information and resources, sound risk assessment, and multiple prevention and control strategies that are scalable and can be applied in low- and high-resource environments. Increased risks of the transmission of waterborne diseases can be related to mobility of population, high density and close proximity of domestic animal and human populations, agricultural practices, heavy rainfall events, and demographic factors. Improved surveillance and monitoring and greater commitments to sanitation and water management are needed to detect global and ecological changes and to ensure protection from associated re-emerging and emerging infectious diseases.

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