

Cryptosporidiosis: an emerging microbial threat in the Pacific

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Introduction

A hardy and ubiquitous protozoan, *Cryptosporidium* is responsible for an increasing amount of severe gastrointestinal disease in both developed and developing countries. In New Zealand the number of reported cases has been increasing continuously since cryptosporidiosis became notifiable in June 1996. This paper looks at some environmental and social-political factors that play a role in the emergence of this disease in the community, discusses the potential impact of *Cryptosporidium* in the Pacific, and highlights the need for both effective surveillance systems and ecologically based public health interventions.

Status of cryptosporidiosis

Cryptosporidium is a major enteric pathogen, affecting people living in developed and developing countries including New Zealand and Pacific^{1,2}. The first human case was diagnosed in 1976 and for the next six years cryptosporidiosis appeared mainly to affect people with compromised immune systems. This perception of cryptosporidiosis as an opportunistic infection only found in the immunocompromised was

challenged and expanded in the eighties to include the immunocompetent, as it was realised that increasing numbers of otherwise healthy people (particularly children) were becoming infected. It is now known that the infection can be transmitted from animals (mainly cattle and sheep)^{3,4} from person to person (via the faecal-oral route) and through contaminated food and water.

The water-borne route is of particular concern as infections transmitted in this way may involve a very large number of people. For example, approximately 403,000 people became ill during the Milwaukee waterborne outbreak of 1993⁵, after exposure to drinking water from the city's public supply which had become contaminated with

Cryptosporidium oocysts. During this outbreak 4,000 people were hospitalised and it was estimated that cryptosporidiosis contributed to 104 deaths in immunocompromised individuals. There is substantial evidence that water may be the most important vehicle for transmission of *Cryptosporidium*. Epidemiological research and micro-

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biological studies indicate that water supplies are frequently a primary source of infection. These supplies include rivers, streams, spring water, surface water, ground water, well water, recreational water and importantly, treated disinfected potable water⁶⁻¹⁷. The biological characteristics of *Cryptosporidium* favour transmission by water. The infective dose is small (as little as 10 oocysts¹⁸), the oocysts are hardy, resistant to chlorine¹⁹ and able to remain viable in water for months^{20,21}. Also, *Cryptosporidium* is resistant to filtration due to the small size of the oocysts. Contamination of a water source may easily arise as a result of runoff from farmland or animal industry, or from sewage effluent contamination⁷.

Countries in the South Pacific have historically been vulnerable to waterborne disease. This vulnerability has resulted from several factors, including the problems of maintaining clean water, effective sanitation and hygiene – all compounded by disastrous climatic events such as cyclones, floods, droughts and tidal waves²². Approximately 11% of the world's total cyclones occurs in the South-West Pacific region every year, leaving many homeless and severely

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affecting access to drinking and bathing water²³. Environmental changes, such as global warming will see an increase in the frequency and severity of these events and as such play an important role in the emergence of infectious disease^{24,25} and contributing to the South Pacific's vulnerability²⁶. Our geographical isolation also makes us more vulnerable to infectious diseases and natural disasters, because the effects of these are aggravated and inescapable in isolated societies, especially those with small populations like the Tokelau Islands²⁷. In order to reduce this vulnerability, we should seek to better understand environmental factors and use climatological information to prepare for natural disasters which are detrimental to our water quality²⁷, for example heavy rains and flooding which increase the chance of contamination of water by animal and human faeces²⁸.

Cryptosporidium is becoming increasingly common in New Zealand's water supplies, as evidenced by a recent waterborne outbreak in Te Aroha in the Waikato (September, 1997)¹. There are many population centres in New Zealand that may be particularly susceptible to waterborne disease (both endemic and epidemic) including cryptosporidiosis. For example, 68 of the 137 New Zealand communities with more than 2,000 people face a high level of risk from their drinking water as recorded by Ministry of Health water quality gradings. Many New Zealand cities and towns obtain their drinking water supplies from surface catchments and systems which rely on chlorination treatment alone for disinfection³⁰. Yet there is a lack of information about the prevalence of *Cryptosporidium* in our waters, little is known about effective methods to remove *Cryptosporidium* from the water, and the current waterborne disease surveillance systems capture only a small percentage of actual cases. Some Pacific countries do not yet have cryptosporidiosis registered as a notifiable disease, despite international recommendations to do so^{24, 27, 31, 32}.

Economics of cryptosporidiosis

Levins (1994)³³ succinctly noted that "sometimes we face a rather bizarre situation, where we have to prove the disease is costing money before we can convince somebody to do something about it" (p. 325). That disease-causing protozoa make people unwell is not in itself sufficient reason for governments to spend money on preventative measures

(such as monitoring water quality for oocysts) or surveillance systems. It is not until the disease is couched in monetary terms that government expenditure becomes a priority (and often then only if the disease creates more expense than prevention). Sadly, those most at risk from contracting gastrointestinal diseases like cryptosporidiosis are children and subsequently, their carers whose illness often does not impact on the workforce and who, in terms of government balance sheets, are generally without economic worth. Indeed, true understanding of the economic value of microbially safe water supplies has been cited as one of the main points that needs to be made in order to motivate governments into action²⁷. The direct impact of cryptosporidiosis on public health (doctor's fees, hospital admissions, etc) is only one dimension of the fiscal drain this waterborne disease contributes to. Contaminated water is a risk to the armed forces (diarrhoeal illness leads the list of infectious diseases that affect the military³¹), to the food industry – as water is used to clean and process products, and in products themselves¹. Of particular importance in the Pacific is the risk contaminated water poses to tourism. This industry is significantly affected by waterborne disease outbreaks and 'boil water' notices^{27, 32}.

Other indirect costs of cryptosporidiosis (which may last up to two weeks in an otherwise healthy person) include the impact on industry through absenteeism³⁵ and loss of productivity. Calculating the exact cost of cryptosporidiosis is difficult, but implementing effective surveillance systems in the Pacific would provide a better basis for estimating the economic significance of *Cryptosporidium* in the region. Surveillance for *Cryptosporidium* involves stool samples being routinely collected and tested (the modified acid-fast stain test is commonly used in New Zealand), if oocysts are detected the case should be promptly notified to the relevant public health official and recorded on a nationwide database. The case should be followed up to discuss management and to prevent the spread of cryptosporidiosis, ideally also with an assessment of the likely source of infection.

Discussions

The surveillance data available (for cases of cryptosporidiosis in New Zealand and reported diarrhoeal disease in some South Pacific countries) are shown in Table 1. These data are

Table 1. Diarrhoeal disease in the South Pacific and New Zealand

Countries	Population (Year / Reference)	Reported diarrhoeal disease (Year / Reference)	Reported cases of cryptosporidiosis (Year / Reference)
Member countries of the South Pacific Commission*	2,329,981 (1994 / 50)	69,255 (Jan. 1993 – Dec 1993 / 50)	no data
New Zealand	3,618,392 (1996 / 51)	12,398 (Sept. 1996 – Sept 1997 / 2, 52, 53, 54)	248 (Sept. 1996 – Sept. 1997 / 2)

* Excludes Papua New Guinea, Palau, Guam and Nauru (no notification data available for these countries)

likely to represent only a fraction of the true incidence of diarrhoeal disease in the community as much goes unreported. The financial cost of monitoring water borne disease such as cryptosporidiosis can be recovered by the benefits generated from efficient surveillance systems and accompanying timely public health interventions²⁷ particularly in nations that are, especially vulnerable to such diseases. Unfortunately, these same nations are usually those that can least afford to set up and maintain reliable surveillance systems. Nevertheless, public health surveillance of cryptosporidiosis is vital for the early control of waterborne outbreaks to prevent secondary transmission¹⁶: index cases resulting from the consumption of contaminated water once introduced into the population, can quickly lead to spread by person to person transmission.

Cryptosporidium has a complex relationship with its host and the disease outcome is often unpredictable. Some people are more vulnerable to infection (e.g. AIDS patients³⁷, children and travellers³⁸) than others who may have immunity through low level continual exposure to oocysts in the environment^{39,40}. In addition cryptosporidiosis, like most environmental hazards, has an equally complex relationship with the many social, economic, political and demographic factors which in turn influence the health of the host¹¹.

Cryptosporidiosis can occur at all ages but is most common in children^{42,43}. Societal changes such as the increase of single parent families have seen an expanding use of childcare facilities³⁴ which in turn maximises the potential for further spread of cryptosporidiosis. *Cryptosporidium* was detected in stool specimens in over 6% of childcare facilities in Brazil⁴⁴, a rate which may arguably be at least equalled in Pacific communities with close communal living. The declining rate of the duration of breastfeeding, which could arguably be related to inadequate government maternity leave policies (women in New Zealand are currently not entitled to any paid leave) also contributes to the susceptibility of children to diarrhoeal diseases. An increased risk of cryptosporidiosis in weaned children has been found^{45,46,47} possibly as a result of contaminated water being used in bottles. In June 1996, the proportion of mothers in New Zealand giving any breastfeeding to infants at six months was approximately 50% for Pacific and European women, and around 45% for Maori women⁴⁸, these proportions are well below the Ministry of Health's breastfeeding goals⁴⁹. Furthermore, malnutrition (and the subsequent lowering of a person's immunity to communicable disease) and poverty-induced overcrowding all add to the threat of *Cryptosporidium* as an emergent

infection. Like all emergent waterborne infections cryptosporidiosis must be seen in a socio-economic context⁴¹ particularly where this context relates to the use of microbially safe water for drinking, washing, food preparation and ablution.

Conclusion

Because of the complexities of the interactions between humans and sources of *Cryptosporidium*, public health education campaigns aimed at reducing water and foodborne transmission are often ineffective. Therefore, our efforts would perhaps be better aimed at stopping *Cryptosporidium* at its source. For example, it may be more cost effective to concentrate public health interventions on means of reducing

the frequency with which the organism contaminates water, thereby reducing the hazard rather than focusing on decreasing exposure. To effectively decrease the hazard in this way requires a detailed local analysis of the ecology of the disease, including the relationship between climate, vegetation, geology, pathogens, animals and humans. Such an ecological approach has proven effective in developing novel

intervention strategies for mosquito borne disease⁵⁵, and would have the potential to result in a better environment for all users of drinking and recreational water in the Pacific.

The financial cost of monitoring water borne disease such as cryptosporidiosis can be recovered by the benefits generated from efficient surveillance systems and accompanying timely public health interventions particularly in nations that are, especially vulnerable to such diseases.

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**An increased risk of
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being used in bottles.**

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The first possibility of rural cleanliness
lies in the water supply.

Florence Nightingale (1820-1910)