Waterborne diseases: Update on water quality assessment and control

WOK Grabow

Department of Medical Virology, University of Pretoria, PO Box 2034, Pretoria 0001, South Africa

Abstract

Water-borne diseases are the most important concern about the quality of water. The pathogens involved include a wide variety of viruses, bacteria and protozoan parasites. Due to differences in size, structure, composition and excretion by humans and animals, their incidence and behaviour in water environments differ. This constitutes difficult challenges for testing the safety of water and the efficiency of treatment processes. Further complications are that many water-borne pathogens, notably the great majority of viruses as well as protozoan cysts and oocysts, are not readily detectable. In addition, the prevalence of various water-borne pathogens changes as selective pressures change. In view of the diverse and variable goalposts, new epidemiotogical data, and progress in technology and expertise, the methods and strategies for quality monitoring and control of water-borne diseases are continually being revised and updated. This paper reviews the latest approaches to water quality monitoring using indicators of human and animal faecal pollution, and new methods for the detection of viruses. The importance of simple, economic and rapid methods for high frequency basic monitoring of water quality and the efficiency of treatment systems is emphasised. Reference is made to the fundamental need for microbiological quality data in the management of national and regional water resources and supplies.

Introduction

In a keynote address at the prestigious 1993 Stockholm Water Symposium, international authority Hillel Shuval illustrated the impact of water-borne diseases by comparing it to a 747 jumbo jet carrying 400 children and 100 adults crashing with no survivors every half hour around the clock (Editorial, 1993). This illustration is based on authentic estimates that some 50 000 people die each day in the world due to water-borne and water-related diseases (Ince, 1990; Schalekamp, 1990; Catley-Carlson, 1993). Extreme examples include the outbreak of 300 000 cases of hepatitis A and 25 000 cases of viral gastroenteritis in Shanghai caused in 1988 by shellfish harvested from a sewage-polluted estuary (Halliday et al., 1991). In 1991 an outbreak with 79 000 cases of hepatitis E in Kanpur was ascribed to polluted drinking water (Ray et al., 1991; Grabow et al., 1994), and in 1993 some 403 000 cases of cryptosporidium diarrhoea were caused by a conventional drinking water supply in Milwaukee, USA (MacKenzie et al., 1994). Although the mortality of many waterborne diseases is relatively low, the socio-economic impact even of non-fatal infections is phenomenal (Avendano et al., 1993; Payment, 1993). Further details on the public health and socio-economic implications of pathogenic micro-organisms in water, and the extent to which they outweigh the impact of diseases associated with the chemical quality of water, have been reviewed elsewhere (Bern and Glass, 1994;Craunetal., 1994a; b).

Little information is available on water-borne diseases in South Africa. This is probably due to the absence of an infrastructure for the detection and recording of such infections. The lack of information tends to create a false sense of security. There is no reason to believe that risks of water-borne diseases are any different from those in the rest of the world. In terms of escalating demands and pollution of the limited water sources, particularly in rural and developing communities, the risk may even be relatively high. This possibility is supported by data which show correlations of enteric infections in various communities to levels of sanitation, standard of living and education. The data reflect the incidence and public health impact of these diseases in the country (Von Schirnding et al., 1993). Anecdotal data and unpublished findings also point towards water-borne diseases.

The water industry has a long history of research and development aimed at supplying safe water and controlling water-borne diseases. In modem times certain principles for the treatment and disinfection of water have become established. However, evidence is mounting that drinking-water supplies which have been treated by processes generally accepted as sufficient and meeting conventional guidelines for bacterial indicators of faecal pollution, may play a meaningful role in the transmission of pathogens (Hejkal et al., 1982; Zmirou et al., 1987; Gerba and Haas, 1988; Bosch etal., 1991; Payment et al., 1991; Reglietal., 1991;MacKenzieetal., 1994). According to Payment et al. (1991) conventionally treated drinking water may be responsible for as much as 35% of household infectious gastroenteritis. The great majority of infections associated with drinking water which met criteria based on faecal bacteria, were caused by viruses and protozoan parasites (Grabow, 199I;Regli et al., 1991;Mooreetal., 1994). These observations disclose shortcomings in quality surveillance programmes often used.

Since world-wide there would not seem to be a meaningful decline in the significance of water-borne diseases, research on fail-safe treatment technology and reliable quality monitoring continues (Grabow, 1986; 1990; Gerba and Haas, 1988; Regli et al., 1991; Bellamy et al., 1993; Sobsey et al., 1993; Craun et al., 1994b). The challenges to accomplish these goals increase in complexity as populations of humans and domestic animals increase with concomitant escalation in demand for potable water and pollution of limited water resources. Special efforts are required to control water-borne diseases in developing communities and countries, which are most vulnerable to these diseases (Feachem, 1980; Feachem et al., 1983; Catley-Carlson, 1993).

(012) 319-2351; fax (012) 325-5550; e-mail wgrabow@medic.up.ac.za
Received 22 May 1995; accepted in revised form 29 February 1996.