A WELL FACTSHEET

The effectiveness of water quality interventions in preventing diarrhoea

Introduction and background

Diarrhoeal diseases kill an estimated 1.8 million people each year, the majority children under five (WHO 2005). Young children are especially vulnerable, bearing 68% of the total burden of diarrhoeal disease (Bartram 2003). Among children under 5 years in developing countries, diarrhoeal disease accounts for 17% of all deaths (WHO 2005a).

Health authorities generally accept that safe water plays an important role in preventing outbreaks of diarrhoeal disease. Accordingly, the most widely accepted guidelines for water quality allow no detectable level of harmful pathogens at the point of distribution (WHO 2004). However, in those settings in which diarrhoeal disease is endemic, much of the epidemiological evidence for increased health benefits following improvements in the quality of drinking water has been equivocal (Cairncross 1989). Since many of these same waterborne pathogens are also transmitted via ingestion of contaminated food and other beverages, by person-to-person contact, and by direct or indirect contact with faeces, improvements in water quality alone may not necessarily interrupt transmission (Briscoe 1984).

Two decades ago, Esrey and colleagues reviewed previous studies on the impact of environmental interventions on diarrhoea, and found improvements in water quality to be considerably less effective than those aimed at water quantity, accessibility and sanitation (Esrey 1985). The median reduction in diarrhoea from interventions to improve water quality was 16% (9 studies), compared to 22% (10) for sanitation, 25% (17) for water quantity and 37% (8) for water quality and availability. The review was subsequently updated and expanded to include hygiene interventions where the median reduction was 33% (6 studies) (Esrey 1991). Important as these reviews have been, there are reasons to consider anew the extent to which interventions to improve water quality impact diarrhoeal disease. First, recent evidence suggests that interventions (e.g., chlorination, filtration, solar disinfection, combined flocculation/disinfection) at the household level or other point of use are considerably more effective in preventing diarrhoea than conventional non-piped interventions at the source or point of distribution (e.g., protected wells, boreholes, communal tap stands) (Clasen & Cairncross 2004). These household-based interventions were described in a recent WELL Fact

Sheet (Clasen 2005). As Esrey's conclusions about the impact of water quality improvements were based exclusively on studies involving interventions at the point of distribution, they did not reflect interventions designed to ensure the microbial integrity of water at the point of use. Second, the Esrey reviews presented a number of methodological issues, including, i) the limited scope of the reviews' search strategies and the resulting number of studies included, ii) their reliance on observational studies rather than higher-quality interventional studies, iii) their simple use of the median (rather than meta-analysis) to pool study results, and (iv) their homologous treatment of studies despite important differences in settings, study populations, risk factors, case definitions, measures of effect, etc.

An update of Esrey's reviews addresses some of these shortcomings (Fewtrell 2005). By using subgroup analysis, for example, Fewtrell and colleagues found that interventions to improve water quality at the household level reduced the relative risk of diarrhoea by 35% (12 studies), compared to only slight, statistically non-significant improvement for source-based interventions. They also observed that interventions were effective even in the absence of improved sanitation (a new finding that challenged the view expressed by Esrey 1986 and VanDerslice 1995) and that there was apparently no cumulative effect from multiple environmental interventions. At the same time, this review also omitted a number of studies that would seem to have met the inclusion criteria and presented certain methodological issues, such as the inclusion of observational studies and studies where the outcome was other than endemic diarrhoea.

Cochrane review

A new systematic review, conducted under the auspices of the Cochrane Collaboration, provides perhaps the most complete evidence to date regarding the effectiveness of water quality interventions in preventing diarrhoea (Clasen 2006). This section summarizes the methods, results and conclusions of the review and includes 3 new studies published since the date2006). Tw, cond602 [i)1.2 (n)5.7 (t)7

income study (Colford 2005) increases the estimate of effect and also removes the heterogeneity associated with the pooled estimate for both all ages and children under 5. Trials of household chlorination also generally reported the intervention to be protective against diarrhoea for both all ages and children under 5, though with a large number of studies reporting on this intervention, pooled estimates remained highly heterogeneous. Three trials of solar disinfection, on the other hand, were consistently protective, yielding homogenous pooled estimates for both all ages and children under 5. Household interventions using flocculation/disinfection were also effective in reducing diarrhoea (-52%), but the pooled effect as well as the strong heterogeneity were driven by a single study (Doocy 2004) which the Cochrane review identified as a possible outlier. Household chlorination.

Conclusions

Interventions to improve the microbiological quality of drinking water, particularly at the household level, are more effective in preventing diarrhoea in endemic settings than previously reported. There is strong evidence that household interventions are as effective at preventing diarrhoea as other environmental approaches, such as improved sanitation, hygiene (handwashing with soap), and improved water supply (Curtis 2003; Fewtrell 2005). Thus they should be strongly encouraged, particularly because of evidence that they are cost-effective and that the target population may in fact be willing to pay for all or a portion of their cost. At the same time, however, substantial heterogeneity in pooled estimates of effect make clear that single estimates of the effectiveness of water quality interventions against endemic diarrhoea, appealing as they may be to policy makers, donors, and programme implementers, are not warranted by the evidence. Rigorous, longer-term, blinded trials should help clarify the circumstances under which water quality interventions may be most effective.

References

Bartram J (2003). New water forum will repeat old message. Bull WHO 83:158

Briscoe J (1984). Intervention studies and the definition of dominant transmission routes. *Am. J. Epidemiol*. 120(3): 449-55.

Cairncross S (1989). Water supply and sanitation: an agenda for research. *J. Trop. Med. Hyg.* 92:301-14.

Clasen, T, Cairncross S (2004). Household water treatment: refining the dominant paradigm. *J. Trop. Med. Hyg* 9:187-191.

Clasen T (2005). Household Water Treatment (WELL Fact Sheet, January 2005) (available at http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/hwt.htm

Clasen T, Roberts I, Rabie T, Schmidt W, Cairncross S (2006). Interventions to improve water quality for preventing infectious diarrhoea (a Cochrane Review). In: The Cochrane Library, Issue 3, 2006. Oxford: Update Software

Curtis V, Cairncross S (2003). Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. *Lancet Infect Dis* 2003:3:275-81

Doocy S (2004). Point of use water treatment in the emergency context: a randomized intervention trial in Liberia. Data on file. 2006.

Esrey SA, Feachem RG & Hughes, JM (1985). Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities. Bull. WHO 64, 776-72.

Esrey SA & Habicht J-P (1986). Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. Epidemiol. Rev. 8: 117-128

Esrey SA, Potash JB, Roberts L & Shiff, C (1991). Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and tracoma. *Bull. WHO* 69, 609-21.

Fewtrell L, Kaufmann R, Kay D, Enanoria W, Haller L , Colford J (2005). Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and menta-analysis. *Lancet Infect. Dis.* 5:42-52

Van Derslice J, Briscoe J (1995). Environmental interventions in developing countries: interactions and their implications. *Am J Epidemiol* 141:135-144

WHO (2002). The World Health Report 2002. Geneva: The World Health Organization.

WHO (2004). Guidelines for Drinking Water Quality. Third Edition. Geneva: The World Health Organisation

WHO (2005). *The World Health Report : 2005 : make every mother and child count.* Geneva: World Health Organization, 2005.

WHO (2005a). *Progress towards the Millennium Development Goals*, 1990-2005. (downloaded from http://unstats/un.org/unsd/mi/goals_2005/goal_4.pdf on 15 November 2005)

WHO/UNICEF. *Global Water Supply and Sanitation Assessment*. Geneva: The World Health Organization and the United Nations Children's Fund, 2000

Wright J, Gundry S, Conroy (2003). Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use.

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