Water, Sanitation, Hygiene, and Diarrheal Diseases Bibliography

EHProject Information Center

March 23, 2004

Citations and abstracts of journal articles published in 2003/2004 summarizing research studies on **household water treatment**, **sanitation**, **hygiene**, and **diarrheal diseases**

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Trop Med & Intl Health, January 2004, 9(1): 106.

Abstracts

Bajracharya, D.

Myanmar experiences in sanitation and hygiene promotion: lessons learned and future directions.

Int J Environ Health Res, June 2003, 13, Suppl. 1: S141-152.

Recent activities in connection with the National Sanitation Week (NSW) and Social Mobilisation for Sanitation and Hygiene have contributed to a significant increase in access to sanitary means of excreta disposal, from 45% in 1997 to 67% in 2001. Handwashing with soap and water after defecation has also increased from 18% in 1996 to 43% in 2001. Success is attributable to high level political commitment, state or division level action and community mobilisation by village level authorities. Multi-level efforts such as mass media, planning workshops, training sessions and house-to-house visits by village authorities and health officials have raised greater awareness of sanitation and hygiene issues and led to construction of latrines on a self-help basis. The challenge

ahead is to give greater attention to the 'hard to reach' who live in less accessible areas and are more resistant to change. The 2002 NSW has accordingly given special emphasis to activities in 73 of 324 townships where 50% or more of the households have no access to a sanitary latrine. The communication and social mobilisation package has been improved to upgrading unsanitary latrines and integrating handwashing more systematically with promotion of sanitary latrines. Programmatic follow-up to the NSW is being provided in selected townships through more intensive social mobilisation for 'hard to reach' households and activity-based school sanitation and hygiene education. This approach will contribute further towards improved hygienic practices and reduce diarrhoeal morbidity and mortality.

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Brooks, J.T.; Shapiro, R.L.; Kumar, L.; Wells, J.G.; Phillips-Howard, P.A.; Shi, Y.P.; Vulule, J.M.; Hoekstra, R.M.; Mintz, E.; Slutsker, L.

Epidemiology of sporadic bloody diarrhea in rural Western Kenya.

Am J Trop Med Hyg, June 2003, 68(6): 671-677.

Authors affiliation: Foodborne and Diarrheal Diseases Branch, and Biostatistics and Information Management Branch, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia 30333, USA. Email: zud4@cdc.gov

The authors conducted laboratory-based surveillance and a case-control study to characterize the epidemiology of bloody diarrhea in rural Western Kenya. From May 1997 through April 2001, we collected stool from 451 persons with bloody diarrhea presenting to four rural clinics. Cultures of 231 (51%) specimens yielded 247 bacterial pathogens: 198 Shigella (97 S. flexneri, 41 S. dysenteriae type 1, 39 S. dysenteriae type non-1, 13 S. boydii, 8 S. sonnei), 33 Campylobacter, 15 non-typhoidal Salmonella, and 1 Vibrio cholerae O1. More than 90% of the isolates (excluding Campylobacter) were resistant to trimethoprim-sulfamethoxazole and tetracycline, and more than 80% were resistant to ampicillin. Most (74%) ill persons received medication to which their isolate was resistant. Drinking Lake Victoria water and sharing latrines between multiple households increased risk of bloody diarrhea. Washing hands after defecating was protective. Providing safe drinking water and more latrines, and promoting hand washing could reduce the burden of illness from bloody diarrhea while limiting injudicious antimicrobial use.

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Clasen, Thomas F.; Bastable, Andrew

Faecal contamination of drinking water during collection and household storage: the need to extend protection to the point of use.

J Water Health, 2003, 01, 109-115.

Author affiliation: London School of Hygiene & Tropical Medicine, Keppel St, London WC1E 7HT, UK

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Paired water samples were collected and analysed for thermotolerant coliforms (TTC) from 20 sources (17 developed or rehabilitated by Oxfam and 3 others) and from the stored household water supplies of 100 households (5 from each source) in 13 towns and villages in the Kailahun District of Sierra Leone. In addition, the female head of the 85 households drawing water from Oxfam improved sources was interviewed and information recorded on demographics, hygiene instruction and practices, sanitation facilities and water collection and storage practices. At the non-improved sources, the arithmetic mean TTC load was 407/100 ml at the point of distribution, rising to a mean count of 882/100 ml at the household level. Water from the improved sources met WHO guidelines, with no faecal contamination. At the household level, however, even this safe water was subject to frequent and extensive faecal contamination; 92.9% of stored household samples contained some level of TTC, 76.5% contained more than the 10 TTC per 100 ml threshold set by the Sphere Project for emergency conditions. The arithmetic mean TTC count for all samples from the sampled households was 244 TTC per 100 ml (geometric mean was 77). These results are consistent with other studies that demonstrate substantial levels of faecal contamination of even safe water during collection, storage and access in the home. They point to the need to extend drinking water quality beyond the point of distribution to the point of consumption. The options for such extended protection, including improved collection and storage methods and household-based water treatment, are discussed.

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Curtis, V.; Cairncross, S.

Effect of washing hands with soap on diarrhoea risk in the community: a systematic review.

Lancet Infect Dis, May 2003, 3(5): 275-281.

Author affiliation: Department of Infectious and Tropical Diseases, DCVBU/ITD London School of Hygiene and Tropical Medicine, Kepple Street, London WCIE 7HT, UK, Email: val.curtis@lshtm.ac.uk

The researchers set out to determine the impact of washing hands with soap on the risk of diarrhoeal diseases in the community with a systematic review with random effects meta-analysis. Their data sources were studies linking handwashing with diarrhoeal diseases. Seven intervention studies, six case-control, two cross-sectional, and two cohort studies were located from electronic databases, hand searching, and the authors' collections. The pooled relative risk of diarrhoeal disease associated with not washing hands from the

intervention trials was 1.88 (95% CI 1.31-2.68), implying that handwashing could reduce diarrhoea risk by 47%. When all studies, when only those of high quality, and when only those studies specifically mentioning soap were pooled, risk reduction ranged from 42-44%. The risks of severe intestinal infections and of shigellosis were associated with reductions of 48% and 59%, respectively. In the absence of adequate mortality studies, we extrapolate the potential number of diarrhoea deaths that could be averted by handwashing at about a million (1.1 million, lower estimate 0.5 million, upper estimate 1.4 million). Results may be affected by the poor quality of many of the studies and may be inflated by publication bias. On current evidence, washing hands with soap can reduce the risk of diarrhoeal diseases by 42-47% and interventions to promote handwashing might save a million lives. More and better-designed trials are needed to measure the impact of washing hands on diarrhoea and acute respiratory infections in developing countries.

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Curtis, V.; Biran, A.; Deverell, K.; Hughes, C.; Bellamy, K.; Drasar, B.

Hygiene in the home: relating bugs and behaviour.

Soc Sci Med, August 2003, 57(4): 657-672.

Author affiliation: Department of Infectious and Tropical Diseases, DCVBU/ITD London School of Hygiene and Tropical Medicine, Kepple Street, London WCIE 7HT, UK, Email: val.curtis@lshtm.ac.uk

Much infectious intestinal disease (IID) arises in the home environment. If programmes to prevent infection are to be effective it is essential to both identify the particular practices that risk disease transmission, and to understand the reasons for these practices. An in-depth, multidisciplinary study of carer and child hygiene in the domestic environment in the Wirral, UK, employed structured observation, surface swabbing for polio vaccine virus and enteric marker organisms, semi-structured interviews, projective interviews and focus group discussions. Observations revealed that child carers washed hands with soap after changing a dirty nappy on 42% of occasions, and that one in five toilet users did not wash hands with soap afterwards. Microbiological samples were taken from household surfaces at sites thought likely to be involved in the transfer of faecal material. 15% of bathroom samples showed contamination with polio vaccine virus. Nappy changing took place mainly in living rooms. Contact with living room surfaces and objects during nappy changing was frequent and evidence of faecal contamination was found in 12% of living room samples. Evidence of faecal contamination was also found in kitchens, again on surfaces thought likely to be involved in the transmission of faeces (taps and soap dispensers). Key factors motivating hygiene were the desire to give a good impression to others, protection of the child and aesthetics. In this setting, the particular risk practices to be addressed included washing hands with soap after stool and nappy contact and preventing the transfer of pathogenic organisms to the kitchen. The occasion of the birth of a child may be a privileged moment for the promotion of safer home hygiene practices. Using polio vaccine virus as an indicator of faecal contamination produces results that could be used in large-scale studies of household disease transmission. A better

understanding of the household transmission of the agents of IID using multidisciplinary methods is needed if effective hygiene promotion programmes are to be designed.

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Curtis, V.

Talking dirty: how to save a million lives.

Int J Environ Health Res, June 2003, 13, Suppl 1: S73-79.

Author affiliation: Department of Infectious and Tropical Diseases, DCVBU/ITD London School of Hygiene and Tropical Medicine, Kepple Street, London WCIE 7HT, UK, Email: val.curtis@lshtm.ac.uk

Infectious diseases are still the number one threat to public health in developing countries. Diarrhoeal diseases alone are responsible for the deaths of at least 2 million children yearly - hygiene is paramount to resolving this problem. The function of hygienic behaviour is to prevent the transmission of the agents of infection. The most effective way of stopping infection is to stop faecal material getting into the child's environment by safe disposal of faeces and washing hands with soap once faecal material has contaminated them in the home. A review of the literature on handwashing puts it top in a list of possible interventions to prevent diarrhoea. Handwashing with soap has been calculated to save a million lives. However, few people do wash their hands with soap at these critical times. Obtaining a massive increase in handwashing worldwide requires a sea-change in thinking. Initial results from a new programme led by the World Bank, with many partner organisations, suggest that health is low on people's list of motives, rather, hands are washed to remove dirt, to rinse food off after eating, to make hands look and smell good, and as an act of motherly caring. Professional consumer and market research agencies are being used to work with the soap industry to design professional communications programmes to reach whole populations in Ghana and India. Tools and techniques for marketing handwashing and for measuring the actual impact on behaviour will be applied in new public-private handwashing programmes, which are to start up soon in Nepal, China, Peru and Senegal.

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Deodhar, N.S.

Epidemiological perspective of domestic and personal hygiene in India.

Int J Environ Health Res, June 2003, 13, Suppl 1: S47-56.

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When the application of epidemiology moves from mass phenomenon in a society or community to the specific family or individual level occurrences, new vistas unfold. The

classical epidemiological triad, with its multi-mode influences and interactions, becomes modified as a result of several lifestyle factors coming into operation. It is well known that even under severely adverse climatic conditions, microbes are able to survive, and even propagate, if an appropriate micro-climate is encountered. This principle also applies to human beings. Many incidences of disease or ailments, occurrence or absence, can be traced to the home habitat, micro-ecosystem, human behaviour and lifestyles. Hygienic practices are largely a matter of behaviour and usually have biological and social origin. Human behaviour is influenced and determined by social traditions, customs and culture. Furthermore, factors such as health consciousness, practical knowledge of health sciences, motivation and concern for taking steps for promoting health and preventing disease, can change behaviour and make the lifestyle conducive to health. In a village or slum area, families live in more-or-less the same environment. However, in the event of an outbreak of a communicable disease, many escape the attack. While some experience frequent episodes of illness, others continue to live fairly healthily. Obviously, several social and cultural factors and associated human behaviours seem to make the difference between health and disease. This discussion examines the domestic and personal hygiene in its epidemiological perspective.

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Faulkner, C.T.; Garcia, B.B.; Logan, M.H.; New, J.C.; Patton, S.

Prevalence of endoparasitic infection in children and its relation with cholera prevention efforts in Mexico.

Rev Panam Salud Publica, July 2003, 14(1): 31-41.

Author affiliation: University of Tennessee, Department of Comparative Medicine, Knoxville, Tennessee 37796-4543, United States of America. Email: ctfaulkner@utk.edu

OBJECTIVE: To investigate whether increased knowledge and use of public health measures promoted for cholera prevention is reflected in lower prevalence of parasitic infection in households in a community in the state of Tamaulipas, Mexico, that is close to the border with the United States of America. METHODS: Between 1994 and 1997, fecal samples from 438 children were collected through convenience sampling and then examined for helminth eggs/larvae and protozoan cysts as biologic indicators of household compliance with recommended cholera prevention measures. The suggested measures were to wash hands before meals and after defecation, to drink purified water, to wash fruits and vegetables, and to eat well-cooked food. In addition, information on the knowledge of and the use of cholera preventive measures was collected by interviews with adult informants in 252 households (186 of those households also provided a fecal sample for analysis). RESULTS: Parasitic infections occurred in 131 of the 438 children (30%), who resided in 79 of the 186 households (42%) that provided fecal samples. Giardia lamblia accounted for 12.5% of all infections. Infections with Hymenolepis nana, Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis, Ancylostoma/Necator, Strongyloides stercoralis, Entamoeba coli, Entamoeba hartmanni, Entamoeba histolytica, Endolimax nana, and Iodamoeba butschlii were also noted. Infected children were older

and more often had an infected sibling. Households with three or more children were also more likely to have an infected child. The primary caregivers in the households where at least one child had a parasitic infection were distinguished by their inability to list at least three cholera prevention measures from memory. CONCLUSIONS: The 42% household prevalence of parasitic infection was relatively high and indicates that some residents of this community may not have fully embraced the public health education efforts promoted for prevention of cholera. The occurrence of nonpathogenic protozoan parasites such as Endolimax nana, Entamoeba coli, Entamoeba hartmanni, and I. butschlii are important bioindicators for the persistence of unhygienic behaviors that increase the risk of cholera and other infectious diseases dependent on fecal-oral transmission. Information obtained by similar studies can be useful for monitoring compliance with community health and hygiene programs and may indicate the need to intensify educational efforts for the prevention of diarrhea associated with enteric pathogens that cannot be controlled by drugs alone.

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Griffith, John F.; Weisberg, Stephen B.; McGee, Charles D.

Evaluation of microbial source tracking methods using mixed fecal sources in aqueous test samples.

J Water Health, 2003, 01, 141-151.

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Microbiological source tracking (MST) methods are increasingly being used to identify fecal contamination sources in surface waters, but these methods have been subjected to limited comparative testing. In this study, 22 researchers employing 12 different methods were provided sets of identically prepared blind water samples. Each sample contained one to three of five possible fecal sources (human, dog, cattle, seagull or sewage). Researchers were also provided with portions of the fecal material used to inoculate the blind water samples for use as library material. No MST method that was tested predicted the source material in the blind samples perfectly. Host-specific PCR performed best at differentiating between human and non-human sources, but primers are not yet available for differentiating between all of the non-human sources. Virus and F+ coliphage methods reliably identified sewage, but were unable to identify fecal contamination from individual humans. Library-based isolate methods correctly identified the dominant source in most samples, but also had frequent false positives in which fecal sources not in the samples were incorrectly identified as being present. Among the library-based methods, genotypic methods generally performed better than phenotypic methods.

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Guerrant, R.L.; Carneiro-Filho, B.A.; Dillingham, R.A.

Cholera, diarrhea, and oral rehydration therapy: triumph and indictment.

Clin Infect Dis., August 2003, 1;37(3): 398-405.

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Cholera drove the sanitary revolution in the industrialized world in the 19th century and now is driving the development of oral rehydration therapy (ORT) in the developing world. Despite the long history of cholera, only in the 1960s and 1970s was ORT fully developed. Scientists described this treatment after the discovery of the intact sodium-glucose intestinal cotransport in patients with cholera. This new understanding sparked clinical studies that revealed the ability of ORT to reduce the mortality associated with acute diarrheal disease. Despite the steady reductions in mortality due to acute dehydrating diarrheal diseases achieved by ORT, the costly morbidity due to these diseases remains, the result of a failure to globalize sanitation and to control the developmental impact of diarrheal diseases and their associated malnutrition. New advances in oral rehydration and nutrition therapy and new methods to recognize its costs are discussed in this review.

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Gundry, Stephen; Conroy, Ronan; Wright, Jim

A systematic review of the health outcomes related to household water quality in developing countries.

J Water Health, 2003, 02, 1-13.

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In developing countries, the microbial contamination of household drinking water is implicated in the prevalence of various diseases. This systematic review is concerned with two health outcomes, general diarrhoea and cholera, and their relationship with water

quality at point-of-use. Observational studies investigating this relationship are reviewed, as well as studies of home water treatment and storage interventions. For cholera, a clear relationship was found with contaminated water. Home water treatment and storage interventions were also found to reduce cholera. For general diarrhoea, no clear relationship was found with point-of-use water quality, although interventions did significantly reduce diarrhoeal incidence. Reasons for these apparently contradictory results concerning general diarrhoea are discussed and suggestions for further research offered. The policy implications of the findings are also discussed.

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Halvorson, S.J.

Women's management of the household health environment: responding to childhood diarrhea in the Northern Areas, Pakistan.

Health Place., March 2004, 10(1): 43-58.

Author affiliation: Department of Geography, The University of Montana, 59812, Missoula, MT, USA

This paper examines mothers' management of water, sanitation, hygiene, and childhood diarrhea in a mountain community in the Northern Areas, Pakistan. It draws upon qualitative data obtained from 65 in-depth interviews and other ethnographic field methods. The analysis shows that respondents were familiar with diarrhea control interventions carried out in the study site, and associated childhood diarrhea with oral-fecal transmission routes such as poor water quality, unhygienic behaviors, contaminated food, and inadequate sanitation practices. Findings also demonstrate the continuance of long-established cultural patterns of perception and behavior with regard to childhood diarrhea and the influence of socio-economic constraints to instituting new management practices.

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Harvey, S.A.; Winch P.J.; Leontsini, E.; et al.

Domestic poultry-raising practices in a Peruvian shantytown: implications for control of Campylobacter jejuni-associated diarrhea.

Acta Trop., April 2003, 86(1): 41-54.

Author affiliation: Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD 21025, USA. Email: sharvey@jhsph.edu

Raising poultry at home is common in many periurban communities in low-income countries. Studies demonstrate that free-range domestic poultry increase children's risk of infection with diarrhea-causing organisms such as Campylobacter jejuni. Corralling might

reduce risk, but research on the socioeconomic acceptability of corralling is lacking. To explore this issue, we studied local knowledge and practices related to poultry-raising in a Peruvian shantytown. Our objectives were to understand: (1). motives for raising domestic poultry; (2). economic and cultural factors that affect the feasibility of corralling; and (3). local perceptions about the relationship between domestic poultry and disease. During 1999-2000, we met with community health volunteers and conducted ethnographic and structured interviews with residents about poultry-raising practices. We then enrolled 12 families in a 2-month trial of corral use during which field workers made biweekly surveillance visits to each family. Most participants reported that they raise birds because home-grown poultry and eggs taste better and are more nutritious and because they enjoy living around animals. Some want to teach their children about raising animals. To prevent theft, many residents shut their birds in provisional enclosures at night, but most stated that birds are healthier, happier, and produce better meat and eggs when let loose by day. Many view bird feces in the house and yard as dirty, but few see a connection to illness. Residents consider chicks and ducklings more innocuous than adult birds and are more likely to allow them inside the house and permit children to play with them. After extensive orientation and technical assistance, participants were willing to corral birds more often. But due to perceived disadvantages, many kept birds penned only intermittently. Additional food and water costs were a significant obstacle for some. Adequate space, bird care and corral hygiene would also need to be addressed to make this intervention viable. Developing a secure, acceptable and affordable corral remains a challenge in this population.

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Hecht, Alan D.

International efforts to improve access to water and sanitation in the developing world: a good start, but more is needed.

Water Policy, 2004, 6, Number 1, 67-85.

Author affiliation: Office of Research and Development, US Environmental Protection Agency, 1200 Pennsylvania Avenue NW Mail Code 8101, Washington, DC 20460, USA

Considerable international efforts are underway to address water and sanitation needs in developing countries. The 2003 G8 Action Plan on water sets the right tone, but more is needed. Three activities deserve additional support and greater cooperation between government and non-government organizations. These are: immediate steps to improve health and sanitation, multilateral efforts to foster good governance, and the development of innovative financial mechanisms to make local and investment capital available for water infrastructure development. Public understanding of these three approaches is often misunderstood, as evinced by the Stakeholder Dialogue at the 2003 World Water Forum. Achieving the Millennium goals on water and sanitation requires greater public and private sector cooperation in these three areas. A significant accomplishment for the next G8 meeting would be to strengthen partnerships between public and private sectors in these areas.

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Heller, L.; Colosimo, E.A.; Antunes, C.M.

Environmental sanitation conditions and health impact: a case-control study.

Rev Soc Bras Med Trop., January/February 2003, 36(1): 41-50.

Author affiliation: Departmento de Engenharia Sanitaria e Ambiental, Escola de Engenharia, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brasil.

This epidemiological investigation examines the impact of several environmental sanitation conditions and hygiene practices on diarrhea occurrence among children under five years of age living in an urban area. The case-control design was employed; 997 cases and 999 controls were included in the investigation. Cases were defined as children with diarrhea and controls were randomly selected among children under five years of age. After logistic regression adjustment, the following variables were found to be significantly associated with diarrhea: washing and purifying fruit and vegetables; presence of wastewater in the street; refuse storage, collection and disposal; domestic water reservoir conditions; feces disposal from swaddles; presence of vectors in the house and flooding in the lot. The estimates of the relative risks reached values up to 2.87. The present study revealed the feasibility of developing and implementing an adequate model to establish intervention priorities in the field of environmental sanitation.

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Hoque, B.A.

Handwashing practices and challenges in Bangladesh.

Int J Environ Health Res., June 2003, 13, Suppl 1: S81-7.

Author affiliation: Environment and Population Research Center, EPRC, Bangladesh. Email: eprc@bol-online.com

Handwashing is universally promoted in health interventions. Studies in Bangladesh and elsewhere have shown a 14 - 40% reduction of diarrhoeal diseases with handwashing. The perceptions and methods related to washing of hands vary widely in Bangladesh. Socio-economic factors are also associated with methods practised. In general, the effectiveness of handwashing practices is poor. Faecal coliform bacteriological counts were reported to be high for both left and right hands. About 85% of women studied who lived in slums and 41% of rural women washed their hands using only water. However, most women rubbed their hands on the ground, or used soil, and rinsed them with water during post-defecation handwashing. Most women claimed that they could not afford to buy soap. Experimental trials showed that use of soap, ash or soil gave similar results when women washed their hands under the same conditions. The washing of both hands,

rubbing of hands, and the amount and quality of rinsing water used were found to be important determinants in the reduction of bacterial counts on hands. Although handwashing messages have been revised by most of the main programmes after these studies, there is scope for further improvement, as well as evaluation of their impact.

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Hosain, G.M.; Saha, S.; Begum, A.

Impact of sanitation and health education on intestinal parasite infection among primary school aged children of Sherpur, Bangladesh.

Trop Doct., July 2003, 33(3): 139-43.

Author affiliation: Department of Community Medicine, Community Based Medical College, Gono University, Mirzanagar, Savar, Dhaka 1344, Bangladesh. Email: monawarhosain@hotmail.com

This study was carried out in 1999-2000 in the northern part of Bangladesh to determine the impact of sanitary latrine use and of health education on intestinal parasites in school-aged children. The children were between 5 and 13 years of age and stool samples revealed that more than half (53%) of the study sample was still infected with one or more intestinal parasites even after 4 years of intervention. Ascariasis was found to have the highest prevalence rate (36.2%) and hookworm the lowest (10.7%). Intestinal parasite infection was significantly lower ($P < 0.05$) among those who used a sanitary latrine and received health education. This result is consistent with observations that the effect of sanitation and health education is slow to develop. Concerted primary healthcare activities with community development efforts should be undertaken to improve the overall living condition of the people of this area to control this problem.

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Howard, G.; Pedley, S.; Barrett, M.; Nalubega, M.; Johal, K.

Risk factors contributing to microbiological contamination of shallow groundwater in Kampala, Uganda.

Water Res., August 2003, 37(14): 3421-3429.

Author affiliation: WEDC, Loughborough University, LE11 3TU, Leicestershire, UK.

A study of water quality variation in shallow protected springs in Kampala was undertaken over a 12-month period to assess the causes of microbiological contamination. The microbiological quality of water was assessed using thermotolerant coliforms and faecal streptococci. Sanitary inspections and hazard assessments were undertaken to identify faecal sources (hazards), contaminant pathways and contributory factors. Data were collected on rainfall and population as additional factors potentially exerting an influence on microbiological quality. Initial analysis of the data showed a significant relationship

between median level of contamination and rainfall, in particular to short-term rainfall events. Total sanitary risk score showed a significant relationship with median level of contamination, but population density may be a confounding factor. The raw microbiological data were transformed into five water quality targets: <1 and </=10cfu100ml(-1) for faecal streptococci; and <1, </=10 and </=50cfu100ml(-1) for thermotolerant coliforms. The presence of individual risk factors as well as variables for rainfall and population density were analysed with respect to failure to meet these water quality targets using contingency tables. Logistic regression models were developed for each of the five water quality targets. The analysis strongly suggested that there is rapid recharge of the springs after rainfall and this leads to microbiological contamination. On-site sanitation was less important than other sources of faecal matter, which was consistent with a low sanitation coverage in the study area. The study suggested that improving sanitary completion and local environmental hygiene was more important than controlling on-site sanitation in improving the quality of these springs.

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Hunter, Paul R.

Drinking water and diarrhoeal disease due to Escherichia coli.

J Water Health, 2003, 01, 65-72.

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Escherichia coli have had a central place in water microbiology for decades as an indicator of faecal pollution. It is only relatively recently that the role of E. coli as pathogen, rather than indicator, in drinking water has begun to be stressed. Interest in the role of E. coli as a cause of diarrhoeal disease has increased because of the emergence of E. coli O157:H7 and other enterohaemorrhagic E. coli, due to the severity of the related disease. There are enterotoxigenic, enteropathogenic, enterohaemorrhagic, enteroinvasive, enteroaggregative and diffusely adherent strains of E. coli. Each type of E. coli causes diarrhoeal disease through different mechanisms and each causes a different clinical presentation. Several of the types cause diarrhoea by the elaboration of one or more toxins, others by some other form of direct damage to epithelial cells. This paper discusses each of these types in turn and also describes their epidemiology, with particular reference to whether they are waterborne or not.

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Hutin, Yvan; Luby, Stephen; Paquet, Christophe

A large cholera outbreak in Kano City, Nigeria: the importance of hand washing with soap and the danger of street-vended water.

J Water Health, 2003, 01, 45-52.

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This study identified risk factors for cholera during an outbreak in Nigeria. Cases were defined as recent onset of acute diarrhoea with dehydration in a patient hospitalised at the Infectious Diseases Hospital in Kano City. Meningitis patients admitted concurrently at the same hospital were recruited as unmatched controls. Data were collected on age, sex, place of residence, hygienic practices, and on food and water consumption. A total of 5600 cholera cases and 340 cholera deaths were reported between December 1995 and May 1996 (attack rate & equals; 86.3 per 100,000 population) in the state of Kano. Compared to the 77 controls, the 102 cases were more likely to have drunk street-vended water (age-adjusted odds ratio (AAOR) & equals; 3.2; 95% confidence interval (CI): 1.4–7.1) and less likely to have drunk tap water in their homes (AAOR & equals; 0.2; 95% CI: 0.1–0.7) or to have washed hands with soap prior to eating food (AAOR & equals; 0.2; 95% CI: 0.1–0.6). While no data suggested that the municipal water supply was contaminated, safe water systems and hand hygiene practices might have prevented a high proportion of cases if implemented early during this outbreak.

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Jagals, P.; Jagals, C.; Bokako, T. C.

The effect of container-biofilm on the microbiological quality of water used from plastic household containers.

J Water Health, 2003, 01, 101-108.

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Studies in Southern Africa have shown that even when microbiologically safe water is supplied to developing communities at communal standpipes, contamination by high

numbers of pathogenic microorganisms may occur during the processes of fetching water from the supply source and storage during use at home, rendering such waters unsafe for human consumption. This study investigated the occurrence of biofilm in PVC storage containers as one possible reason for this deterioration, using heterotrophic bacteria and total coliform counts as well as turbidity as indicators. A second objective was to determine whether biofilm in water-storage containers could contribute to hazardous microbiological contamination indicated by Escherichia coli and Clostridium perfringens. Results indicated that increased microbiological contamination is associated with biofilm. The biofilm harbours heterotrophic bacteria, total coliforms and C. perfringens. E. coli could not be associated directly with the levels of biofilm in containers but rather appears to be introduced intermittently from the ambient domestic environment. When dislodged with the biofilm, these bacteria contributed substantially to the deterioration of the microbiological quality of supplied water stored in plastic containers.

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Jensen, P.K.; Ensink, J.H.; Jayasinghe, G.; et al.

Effect of chlorination of drinking-water on water quality and childhood diarrhoea in a village in Pakistan.

J Health Popul Nutr., March 2003, 21(1): 26-31.

Author affiliation: Department of Veterinary Microbiology, The Royal Veterinary and Agricultural University, Stigbojlen 4, 1870 Frederiksberg C, Denmark.

To evaluate the importance of public-domain transmission of pathogens in drinking-water, an intervention study was carried out by chlorinating the public water-supply system in a village in Pakistan. The water quality improved and reached a geometric mean of 3 Escherichia coli per 100 ml at the last standpipe of the water-supply system. Drinking-water source used and the occurrence of diarrhoea were monitored on a weekly basis over a six-month period among 144 children aged less than five years in the village. In this group, the children using chlorinated water from the water-supply scheme had a higher risk of diarrhoea than children using groundwater sources, controlled for confounding by season and availability of a toilet and a water-storage facility. The incidence of diarrhoea in the village (7.3 episodes per 10(3) person-days) was not statistically different from that in a neighbouring village where most children used water from a non-chlorinated water-supply system with very poor water quality. In this study area, under non-epidemic conditions, the reduction of faecal bacteria in the public drinking-water supply by chlorination does not seem to be a priority intervention to reduce childhood diarrhoea. However, the study was of limited size and cannot provide conclusive evidence.

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Lanata, C.F.

Studies of food hygiene and diarrhoeal disease.

Int J Environ Health Res., June 2003, 13, Suppl 1: S175-183.

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Contamination of weaning foods and water with enteropathogenic micro-organisms has been recognised in the past, but its link with the development of diarrhoea by young children in developing countries is lacking. This may explain the unavailability of effective interventions to reduce the risk of diarrhoeal diseases from this contamination. The frequency of contamination of weaning foods with enteropathogens is high in developing countries, and is dependent on the food type, storage time and ambient temperature of storage, the method used, and the temperature reached on re-warming before re-feeding. Other considerations are the bacterial content of cooking and feeding utensils. Fruit and raw vegetables can become contaminated with enteropathogenic micro-organisms by sewage-containing irrigation water, by washing produce and fruits in contaminated water, and how they are processed at home. In most studies reviewed, the level of contamination is higher in weaning foods than in drinking water. Since there is a need to reach a critical level of contamination before illness can occur after the ingestion of an enteropathogen, it is postulated that weaning foods are probably more important than drinking water for transmission of diarrhoeal diseases in developing countries. Several potential interventions have been identified, which should be developed and tested in controlled trials in developing countries. These interventions are needed to reduce contamination of weaning foods in households from developing countries, while adequate facilities for the provision of clean water and sanitation to those communities are placed.

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Larsen B.

Hygiene and health in developing countries: defining priorities through cost - benefit assessments.

Int J Environ Health Res., June 2003, 13, Suppl 1: S37-46.

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Presented here are the four preliminary conclusions in the assessment of health and hygiene in developing countries: (a) child mortality, and disease burden associated with hygiene, water and sanitation in the developing and the developed regions of the world, has declined substantially in the past two decades, but substantial inter-regional and cross-country differences persist; (b) while child mortality and disease burdens decline

with higher income levels, a substantial number of countries have been performing far better in reducing child mortality and disease burdens than their income levels would indicate, suggesting that active policy and investment interventions can yield significant health improvements without necessarily jeopardising economic growth; (c) despite the evidence of the role of water and sanitation services in reducing mortality and morbidity, service coverage at the country level has not increased as much as one may have expected in the past decade, in part because of the substantial resource requirements; (d) the paper will provide some new perspectives and evidence on the cost-effectiveness of interventions to reduce the disease burden of poor water and sanitation services and inadequate hygiene practices, in particular with regard to economic evaluation and in reference to hygiene programmes.

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Merchant, A.T.; Jones, C.; Kiure, A.; et al.

Water and sanitation associated with improved child growth.

Eur J Clin Nutr., December 2003, 57(12): 1562-1568.

OBJECTIVE: To examine the relation between household water and sanitation, and the risk of stunting and reversal of stunting in Khartoum and Crezira regions Sudan.

DESIGN: Prospective cohort study.

SETTING: A total of 25 483 children aged 6-72 months from rural Sudan enrolled in an 18-month field trial in 1988 to study the effect of vitamin A supplementation on child health and survival.

RESULTS: The mean height-for-age z-scores at baseline and the end of study were -1.66 and -1.55, respectively, for the group with water and sanitation facilities, and -2.03 and -1.94 for the group without water and sanitation, after adjustment for age, region, gender, mother's literacy, intervention group (vitamin A vs placebo), family wealth, breastfeeding and cleanliness. Among children of normal height-for-age at baseline, the risk of stunting (<-2 height-for-age z-score) was lowest in the group that came from homes that had both water and sanitation compared to children from homes without these facilities (multivariate RR=0.79, 95% CI 0.69-0.90). Among children stunted at baseline, those coming from homes with water and sanitation had a 17% greater chance of reversing stunting than those coming from homes without either facility (adjusted RR=1.17, 95% CI 0.99-1.38). We did not detect a synergistic association between access to water and sanitation.

CONCLUSIONS: Water and sanitation are independently associated with improved growth of children.

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Moffat, T.

Diarrhea, respiratory infections, protozoan gastrointestinal parasites, and child growth in Kathmandu, Nepal.

Am J Phys Anthropol., September 2003, 122(1): 85-97.

Author affiliation: Department of Anthropology, McMaster University, Hamilton, Ontario L8S 4L9, Canada. Email: moffatcs@mcmaster.ca

The differential impact of diarrhea, respiratory infections, and protozoan parasitism on growth is investigated among children under five years of age living in periurban Kathmandu, Nepal. The children's parents are all carpet-making workers who live in an environment with crowded living conditions, poor sanitation, and contaminated water. Anthropometric data, both cross-sectional and longitudinal, were collected over a 9-month period. Morbidity data were gathered from maternal reports and a subsample of children's stools were examined for gastrointestinal parasites. In a comparison of current growth status and growth velocity for children with and without diarrhea and respiratory infections, it is found that body weight is most affected by infections, particularly for children under 24 months of age. For a subsample of children whose stools were tested for parasites, there is a statistically significant association between stunting (low height-for-age) and the presence of a protozoan gastrointestinal parasite. It is concluded that although growth faltering is associated with diarrhea and respiratory infections, the impact of these infections is of less importance for long-term linear growth retardation than is infection by protozoan gastrointestinal parasites.

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Moraes, L.R.; Cancio, J.A.; Cairncross, S.; Huttly, S.

Impact of drainage and sewerage on diarrhoea in poor urban areas in Salvador, Brazil.

Trans R Soc Trop Med Hyg., March/April 2003, 97(2): 153-158.

Author affiliation: Polytechnic School, Federal University of Bahia, Salvador, Brazil.

A longitudinal prospective study of the effect of drainage and sewerage systems on diarrhoea in children aged < 5 years was conducted in 9 poor urban areas of the city of Salvador (population 2.44 million) in north-east Brazil in 1989-90. Due to complex political and administrative reasons, 3 areas had benefited from drainage improvements, 3 from both drainage and sewerage improvements, and 3 from neither. An extensive questionnaire was applied to collect information on each child and on the conditions of the household, and mothers recorded diarrhoea episodes in their children aged < 5 years

daily for 1 year, using calendars. Fortnightly home visits were made to collect the data. The incidence of diarrhoea in children in neighbourhoods with drainage was less than two-thirds, and in neighbourhoods with drainage and sewerage less than one-third, of the incidence in neighbourhoods with neither. After controlling for potential confounders, the proportion of children with 'frequent diarrhoea' showed the same significant trend across the study groups. Though the groups were not exactly comparable, more than one child was monitored per household, and it was not possible to rotate fieldworkers between study groups, the study provides evidence that community sanitation can have an impact on diarrhoeal disease, even without measures to promote hygiene behaviour.

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Nanan, D.; White, F.; Azam, I.; Afsar, H.; Hozhabri, S.

Evaluation of a water, sanitation, and hygiene education intervention on diarrhoea in northern Pakistan.

Bull World Health Organ., 2003, 81(3): 160-165.

Author affiliation: Department of Community Health Sciences, The Aga Khan University, Karachi, Pakistan. Email: debra.nanan@aku.edu

OBJECTIVE: Inadequate water and sanitation services adversely affect the health and socioeconomic development of communities. The Water and Sanitation Extension Programme (WASEP) project, undertaken in selected villages in northern Pakistan between 1997 and 2001, was designed to deliver an integrated package of activities to improve potable water supply at village and household levels, sanitation facilities and their use, and awareness and practices about hygiene behaviour.

METHODS: A case-control study was conducted during July-September 2001 to evaluate whether, after selected confounders were controlled for, children aged <6 years with diarrhoea were more or less likely to reside in villages that participated in the project than in villages that did not participate. Descriptive and logistic regression analyses were performed.

FINDINGS: Children not living in WASEP villages had a 33% higher adjusted odds ratio for having diarrhoea than children living in WASEP villages (adjusted odds ratio, 1.331; P<0.049). Boys had 25% lower odds of having diarrhoea than girls (adjusted odds ratio, 0.748; P<0.049). A 2.6% decrease was found in the odds of diarrhoea for every yearly increase in the mother's age (adjusted odds ratio, 0.974; P<0.044) and a 1.4% decrease for every monthly increase in the child's age (adjusted odds ratio, 0.986; P<0.001).

CONCLUSIONS: The findings in this study may help refine the approach to future water, sanitation, and hygiene initiatives in northern Pakistan. The integrated approach taken by WASEP, which incorporates engineering solutions with appropriate education to maximize facility usage and improve hygiene practices, is a useful example of how desired health benefits can be obtained from projects of this type.

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Nath, K.J.

Home hygiene and environmental sanitation: a country situation analysis for India.

Int J Environ Health Res., June 2003, 13, Suppl 1: S19-28.

Author affiliation: The Institution of Public Health Engineers, India. Email: Iphe@cal3.vsnl.net.in

Problems of the environment and of domestic hygiene are always related to poverty of population and the sanitation of settlements. Most cities and towns in developing countries, like India, are characterised by over-crowding, congestion, inadequate water supply and inadequate facilities of disposal of human excreta, waste water and solid wastes. Inadequacy of housing for most urban poor invariably leads to poor home hygiene. Personal and domestic hygiene practices cannot be improved without improving basic amenities, such as water supply, waste water disposal, solid waste management and the problems of human settlements. But even under the prevailing conditions, there is significant scope of improving hygiene practices at home to prevent infection and cross-infection. Unfortunately, in developing countries, public health concerns are usually raised on the institutional setting, such as municipal services, hospitals, environmental sanitation, etc. There is a reluctance to acknowledge the home as a setting of equal importance along with the public institutions in the chain of disease transmission in the community. Managers of home hygiene and community hygiene must act in unison to optimise return from efforts to promote public health. Current practices and perceptions of domestic and personal hygiene in Indian communities, the existing levels of environmental and peri-domestic sanitation and the 'health risk' these pose will be outlined, as well as the need for an integrated action for improving hygiene behaviour and access to safe water and sanitation.

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Nielsen, M.; Hoogvorst, A.; Konradsen, F.; et al.

Causes of childhood diarrhea as perceived by mothers in the Punjab, Pakistan.

Southeast Asian J Trop Med Public Health., June 2003, 34(2): 343-351.

Author affiliation: International Water Management Institute (IWMI), Lahore, Pakistan.

This study was carried out in the southern Punjab, Pakistan, to outline the causes of childhood diarrhea as perceived by mothers. Two hundred households in ten villages were randomly selected. Information was obtained from mothers, through a questionnaire, in-depth interviews, and direct observations. The focus was on obtaining information from mothers of children who were below five years of age. Causes of diarrhea reported by mothers were categorized in seven different domains. Causes relating to the digestive

system, especially consumption of too much food, were the most important, followed by causes pertaining to contamination and those pertaining to the humoral theory of 'hot' and 'cold'. The mothers' health status was perceived as determining the health of her child through her breast milk. Through in-depth interviews, diarrhea as a symptom of envy and malice was brought up. The study draws attention to the complexity and heterogeneity of beliefs, attitudes and practices concerning diarrhea. This makes it difficult to come up with general rules for health education campaigns. Rather, in health education, the outstanding 'good' and 'bad' behavior should be selected and should be the focus. On the other hand, the heterogeneity of beliefs, attitudes and practices prevailing in the community could make mothers more receptive to new ideas than when a small set of rigid cultural norms would dominate thinking on disease transmission and hygiene. The study found that despite the mother's central role as caretaker one should not focus only on the traditional mother-child relationship, but also include the husband-wife relationship, and target other individuals involved in setting norms within the household or within the nearby community.

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Nunez, F.A.; Lopez, J.L.; de la Cruz, A.M.; Finlay, C.M.

Risk factors for Giardia lamblia infection in children in daycare centers in Havana, Cuba.

Cad Saude Publica, March/April 2003, 19(2): 677-682.

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We conducted a longitudinal study on giardiasis in three daycare centers in Havana City for a period of 18 months and described a group of children with a "predisposition" or tendency towards re-infection with Giardia lamblia. This group was found to be more frequently associated with clinical symptoms such as diarrhea. A case-control study was designed to determine whether socioeconomic factors and hygiene were associated with this phenomenon. We found no differences between the groups with regard to overcrowding rates, number of persons per bed, absence of certain electric appliances, mother's schooling, or mean family income. However, there were proportionally more fathers with less than complete secondary education among cases as compared to controls. In addition, we found no differences in lack of hand-washing before eating and after defecation; however, we found a higher percentage of families who washed vegetables insufficiently among predisposed children. Finally, a lower percentage of families with predisposed children boiled their water. Our results demonstrate the important role of water as a vehicle for transmission of giardiasis and the importance of various epidemiologic factors.

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Parkinson, Adele; Roddick, Felicity A.; Hobday, Malcolm D.

UV photooxidation of NOM: issues related to drinking water treatment.

J Water SRT – Aqua, 2003, 52, 577-586.

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Department of Applied Chemistry, RMIT University, GPO Box 2476V, Melbourne 3001, VIC, Australia

The effect of UVA (300-400 nm), UVB (260-340 nm) and UVC (254 nm) wavelengths on absorbance spectra, dissolved organic carbon (DOC) levels, molecular size distributions, bacterial regrowth potentials (BRP) and trihalomethane formation potentials (THMFP) of aquatic natural organic matter (NOM) from a number of sources was examined to ascertain the use of photooxidation for the removal of NOM from drinking water. Differences were observed in the normalised UV spectra of the NOM samples, and UVC-irradiation resulted in the largest reduction in absorbance at 254 nm and DOC levels. The various UV wavelengths appeared to reduce the molecular size in a similar fashion with sequential degradation from high molecular weight to low molecular weight by-products. Treatment by UVA-, UVB- and UVC-radiation also resulted in increased BRP for all NOM samples. The THMFP of the UV-treated NOM samples HV MIEX and HV Raw appeared to be dependent on the characteristics of the NOM sample and the UV dose. The THMFP of UVA- and UVB-irradiated HV MIEX increased and an initial increase was observed for UVC-irradiated HV MIEX before decreasing with further treatment, while UVC-irradiated HV Raw showed decreased THMFP for all treatment times.

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Petrusevski, B.; et al.

Family filter with iron-coated sand: solution for arsenic removal in rural areas.

Water Supply, Vol 2, No 5-6, pp. 127-133.

The presence of arsenic in groundwater is recognised as a threat to public health world-wide and specifically in rural areas of several developing countries due to variety of health-related problems observed in populations ingesting arsenic-containing water. Several arsenic removal technologies suitable mainly for centralised treatment are available or under investigation. However, point-of-use arsenic removal systems, suitable for application at household level appear to be the only feasible solution under conditions

prevailing in rural areas of developing countries characterised in general by the absence of centralised water supply systems. Several household level arsenic removal units are commercially available and some of them are currently under testing in Bangladesh. Nevertheless there is still need to develop a more efficient and sustainable point-of-use arsenic removal unit. Very promising results were recently obtained in laboratory experiments with a simple "family filter" with iron-coated sand (ICS) or iron-impregnated granular activated carbon. The objective of this study was to establish methodology for assessment and selection of appropriate ICS for arsenic removal with "family filter". An additional objective was to optimise and test further "family filter" with selected ICS. Batch and filtration laboratory adsorption experiments were conducted with five types of ICS originating from Dutch groundwater treatment plants and model and natural groundwater with high arsenic concentration. All ICSs tested demonstrated arsenic removal potential with removal efficiencies ranging from 50 to 100%. Short adsorption experiments can be applied to screen the suitability of different ICSs. Adsorption isotherm and filter runs are, however, needed to establish arsenic adsorption capacity of a particular ICS. Contact time was found to be the critical parameter for "family filter" design and performance. The "family filter", very simple point-of-use treatment unit, equipped with an appropriate ICS demonstrated high arsenic removal potential and could be very attractive for arsenic removal in rural areas of developing countries.

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Plate, David K.; Strassmann, Beverly I.; Wilson, Mark L.

Water sources are associated with childhood diarrhoea prevalence in rural east-central Mali.

Trop Med & Intl Health, March 2004, Vol. 9, Issue 3, p. 416.

BACKGROUND: Water supply improvements generally reduce the incidence of diarrhoea. However, populations with limited access to a safe water supply may continue to draw water from unimproved sources, thereby increasing their risk of diarrhoea. Furthermore, young children who are not breastfed may be even more susceptible to water-borne diarrhoeal pathogens. Our study explored the interactive protective effects against diarrhoea of exclusively using improved water sources and breastfeeding among children in rural Mali.

METHODS: Interviews were conducted with parents or guardians of children under 7 years of age in seven villages with access to a variety of water supplies. Water sources used, breastfeeding status, demographics and recent diarrhoea symptoms were determined for 1117 children. The cross-sectional findings were used to compare diarrhoea prevalence among exclusive and non-exclusive users of improved water sources. Variation in prevalence by age and exclusive breastfeeding status was evaluated using chi-square and multivariate analyses.

RESULTS: Children whose water was drawn exclusively from wells had a significantly lower prevalence of diarrhoea as compared with children whose water was drawn from a

spring or stream (5.9%vs. 8.7%; P = 0.04). The exclusive use of improved water sources had no impact on diarrhoea prevalence among children who were exclusively breastfed. Similarly, the strongest protective effect was observed among children who were not exclusively breastfed.

CONCLUSIONS: Our results indicate that using surface water as a primary or secondary water source exposes children to greater risk of diarrhoeal disease than using only improved sources such as wells. It is particularly beneficial for young children who are not exclusively breastfed to be supplied with water drawn from improved sources.

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Prado, M.S.; Strina, A.; Barreto, M.L.; et al.

Risk factors for infection with Giardia duodenalis in pre-school children in the city of Salvador, Brazil.

Epidemiol Infect., October 2003, 131(2): 899-906.

Author affiliation: Instituto de Saude Coletiva, Universidade Federal da Bahia, Brazil.

A cross-sectional study of 694 children aged 2 to 45 months selected from 30 clusters throughout the city of Salvador, Bahia (pop. 2.3 million) was carried out as part of a longitudinal study of diarrhoea in order to identify risk factors for infection with Giardia duodenalis. Variables studied included three social and demographic factors (such as mother's education and marital status), five relating to the peri-domestic environment (rubbish disposal, open sewers, paving of the street), seven relating to the home itself (house construction, susceptibility to flooding, water supply and sanitation) as well as a score for hygiene behaviour based on structured observation. After multivariate analysis using a hierarchical model, only four significant risk factors were found: (a) number of children in the household under five years (b) rubbish not collected from the house (c) presence of visible sewage nearby, and (d) absence of a toilet. All four were significant at the 1% level.

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Quick, R.

Changing community behaviour: experience from three African countries.

Int J Environ Health Res., June 2003, 13, Suppl 1: S115-121.

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In the developing world, more than 1 billion people lack access to safe water. To address this problem, the US Centers for Disease Control and Prevention developed the Safe Water System (SWS), a household-based intervention with three elements: water disinfection, safe storage and behaviour change techniques, and tested these in three countries. In Zambia, social marketing (SM) was used to implement the SWS, and 100 randomly selected households also received motivational interviewing (MI). In Madagascar, the SWS was implemented using SM and community mobilisation (CM). In rural Western Kenya, the SWS was also implemented with SM and CM. In Zambia, 3 months after the SM project launch, 14% of households in the SM-only group had adopted the disinfectant compared with 78% of households in the SM plus MI group. Through SM, over 1 million bottles of disinfectant were sold in 3 years in Zambia. In Antananarivo, Madagascar, 6 months after launch of the water disinfectant, 8% of households in an early stage of the CM process were using the disinfectant compared with 20% in households at a late stage of the CM process. In 1 year, over 500,000 bottles of disinfectant were sold in Madagascar. In Kenya, adoption of the water disinfectant exceeded 60% in intervention households and diarrhoea rates decreased by 58% in children < 5 years. Social marketing permits widespread dissemination of interventions, but may have limited penetration into economically disadvantaged communities. Additional, targeted interventions, such as MI and CM, can increase product adoption. A combination of behaviour change interventions can increase project impact.

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Rangel, Josefa M.; Lopez, Beatriz; Mejia, Maricruz Alvarez; Mendoza, Carlos; Luby, Stephen

A novel technology to improve drinking water quality: a microbiological evaluation of in-home flocculation and chlorination in rural Guatemala.

J Water Health, 2003, 01, p. 15-22.

Author affiliation: Josefa M. Rangel, Stephen Luby (corresponding author) Foodborne and Diarrheal Diseases Branch, Mailstop A38, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, GA, 30333, USA, Tel.: +1 404 639-2206, Fax: +1 404 639-2205, E-mail: sxl2@cdc.gov

Beatriz Lopez, Maricruz Alvarez Mejia, Carlos Mendoza: Medical Entomology Research and Training Unit, Guatemala City, Guatemala

An estimated 1 billion persons in low-income countries do not have access to improved drinking water. Chlorine, a useful water treatment agent, is less effective in turbid water, and lacks a visible effect, limiting its acceptability. A product incorporating precipitation, coagulation, flocculation, and chlorination technology (combined product) to reduce microbial, organic and heavy metal contaminants in water was evaluated. The combined product's microbiological efficacy in Guatemalan villagers' households was evaluated. One hundred randomly selected households from four neighboring Guatemalan villages were enrolled. Three groups received the combined product and either the Centers for Disease Control (CDC) water storage vessel, a covered bucket with spigot, or no vessel. One group received chlorine bleach and the CDC water storage vessel, and one group no intervention. Household water samples were collected for 4 weeks and *Escherichia coli*, chlorine, and turbidity levels were measured. Potable water was defined as having less than one *E. coli* per 100 ml. Eight (8%) baseline water samples were potable. Follow-up water samples were more likely to be potable than control samples (combined product and traditional vessel 83%; combined product and CDC vessel 92%; combined product and covered bucket with spigot 93%; chlorine and CDC vessel 92%; versus control 5%). Among combined product users, 98% reported improved water clarity compared with 45% of chlorine bleach users ($p<0.0001$). The combined product technology improved water potability as effectively as chlorine bleach; improved water clarity could motivate more persons to effectively treat their water.

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Reller, M.E.; Mendoza, C.E.; Lopez, M.B.; et al.

A randomized controlled trial of household-based flocculant disinfectant drinking water treatment for diarrhea prevention in rural Guatemala.

Am J Trop Med Hyg., October 2003, 69(4): 411-419.

Author affiliation: Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia 30333, USA.

We conducted a study to determine if use of a new flocculant-disinfectant home water treatment reduced diarrhea. We randomly assigned 492 rural Guatemalan households to five different water treatment groups: flocculant-disinfectant, flocculant-disinfectant plus a customized vessel, bleach, bleach plus a vessel, and control. During one year of observation, residents of control households had 4.31 episodes of diarrhea per 100 person-weeks, whereas the incidence of diarrhea was 24% lower among residents of households receiving flocculant-disinfectant, 29% lower among those receiving flocculant-disinfectant plus vessel, 25% lower among those receiving bleach, and 12% lower among households receiving bleach plus vessel. In unannounced evaluations of home drinking water, free chlorine was detected in samples from 27% of flocculant-disinfectant households, 35% of flocculant-disinfectant plus vessel households, 35% of bleach

households, and 43% of bleach plus vessel households. In a setting where diarrhea was a leading cause of death, intermittent use of home water treatment with flocculant-disinfectant decreased the incidence of diarrhea.

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Sobsey, M.D.; Handzel, T.; Venczel, L.

Chlorination and safe storage of household drinking water in developing countries to reduce waterborne disease.

Water Sci Technol., 2003, 47(3): 221-228.

Author affiliation: Dept of Environmental Sciences & Engineering, University of North Carolina, Chapel Hill, NC 27599-7400, USA. Email: sobsey@email.unc.edu

Simple, effective and affordable methods are needed to treat and safely store non-piped, gathered household water. This study evaluated point-of-use chlorination and storage in special plastic containers of gathered household water for improving microbial quality and reducing diarrhoeal illness of consumers living under conditions of poor sanitation and hygiene. Community families were recruited and randomly divided into intervention (household water chlorination and storage in a special container) and control (no intervention) households. Microbes in stored household water were extensively inactivated by 1-5-mg/L doses of hypochlorite. Escherichia coli levels in stored household waters were < 1/100 ml in most intervention households but readily detectable at high levels in control households. Stored water of intervention households was also lower in Clostridium perfringens and heterotrophic plate count bacteria than in control households. The intervention reduced household diarrhoeal illness. In Bolivia, monthly episodes of household diarrhoeal illness were 1.25 and 2.2 in intervention and control families, respectively (P = < 0.002) indicating that 43% of community diarrhoea was preventable by using the intervention. In Bangladesh, mean episodes of child diarrhoea/1,000 d were 19.6 and 24.8 in intervention and control groups respectively (P = < 0.03) indicating that about 24% of observed diarrhoea was preventable by using the intervention. Chlorine disinfection and storage in an appropriate container significantly improved the microbiological quality of non-piped household drinking water and reduced community diarrhoeal disease. Widespread use of this simple treatment and storage system for non-piped domestic water has the potential to dramatically reduce the global burden of waterborne diarrhoeal disease.

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Souter, Philip F.; Cruickshank, Graeme D.; Tankerville, Melanie Z.; Keswick, Bruce H., et al.

Evaluation of a new water treatment for point-of-use household applications to remove microorganisms and arsenic from drinking water.

J Water Health, 2003, 01, 73-84.

Contact: Bruce H. Keswick, The Procter & Gamble Health Sciences Institute, 8700 Mason-Montgomery Rd, Mason, OH 45440, USA, Tel: +1 513-622-4333, Fax: +1 513 622-4226, E-mail: Keswick.bh@pg.com

Contamination of drinking water by microorganisms and arsenic represents a major human health hazard in many parts of the world. An estimated 3.4 million deaths a year are attributable to waterborne diseases. Arsenic poisoning from contaminated water sources is causing a major health emergency in some countries such as Bangladesh where 35 to 77 million people are at risk. The World Health Organization (WHO) has recently recognized point-of-use water treatment as an effective means of reducing illness in developing country households. A new point-of-use water treatment system that is based on flocculation, sedimentation and disinfection was evaluated for the removal of bacterial, viral and parasitic pathogens as well as arsenic from drinking water to estimate its potential for use in developing countries. Tests were conducted with United States Environmental Protection Agency (EPA)-model and field- sample waters from developing countries. Samples were seeded with known numbers of organisms, treated with the combined flocculation/disinfection product, and assayed for survivors using standard assay techniques appropriate for the organism. Results indicated that this treatment system reduced the levels from 108/l to undetectable (<1) of 14 types of representative waterborne bacterial pathogens including Salmonella typhi and Vibrio cholerae. No Escherichia coli were detected post-treatment in 320 field water samples collected from five developing countries. In addition, the water treatment system reduced polio and rotavirus titres by greater than 4-log values. Cyrptosporidium parvum and Giardia lamblia inocula were reduced by greater than 3-log values following use of this water treatment system. Arsenic, added to laboratory test waters, was reduced by 99.8%, and naturally occurring arsenic in field samples from highly contaminated Bangladeshi wells was reduced by 99.5% to mean levels of 1.2 µg/l. This water treatment system has demonstrated the potential to provide improved drinking water to households in developing countries by removing microbial and arsenic contaminants.

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Srikanth, R.[1]; Naik, Durgadas[2]

Prevalence of Giardiasis due to wastewater reuse for agriculture in the suburbs of Asmara City, Eritrea.

Intl Jnl of Environ Health Research, February 2004, 14(1): 43–52.

Author affiliation: [1]Department of Environment Asmara Eritrea; [2]Central Health Laboratory Ministry of Health Asmara Eritrea

A study was undertaken to assess the health impact of utilization of the raw domestic sewage for vegetable cultivation in the suburbs of the capital city of Asmara, Eritrea. Standard techniques were adopted for the analysis of the samples. Results showed heavy

contamination of vegetables by faecal coliforms as well as with Giardia cysts. Stool samples of 75 farmers who were occupationally exposed revealed that 45% of them were harbouring giardia cysts. The dietary intake of raw salads (lettuce, cabbage) grown on the raw sewage appear to be a causative factor of Giardiasis in the farming community as well as in the town of Tsadachristian located on the suburbs of the capital city of Asmara. The hospital data of the affected town is compared with other towns of Eritrea. The result indicates agriculture reuse of untreated wastewater is a major cause for the increase in Giardasis.

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Strina, A.; Cairncross, S.; Barreto, M.L.; Larrea, C.; Prado, M.S.

Childhood diarrhea and observed hygiene behavior in Salvador, Brazil.

Am J Epidemiol., June 1, 2003, 157(11): 1032-1038.

Author affiliation: Institute of Public Health, Federal University of Bahia, Salvador, Brazil.

Brief biweekly home visits, made as part of a cohort study of diarrhea in young children under age 5 years that was carried out in Salvador, Brazil, in 1998-1999, were used as a low-cost way to collect structured observation data on domestic hygiene behavior. Field-workers were trained to check a list of 23 forms of hygienic or unhygienic behavior by the child or the child's caretaker, if any behaviors were seen during the visit. Children were grouped according to whether mainly unhygienic behavior or mainly hygienic behavior had been recorded. This permitted study of the determinants of hygiene behavior and of its role in the transmission or prevention of diarrheal disease. Observations were recorded on roughly one visit in 20. Households with adequate excreta disposal were significantly more likely to be in the "mainly hygienic" group. The prevalence of diarrhea among children for whom mainly unhygienic behavior was recorded was 2.2 times that among children in the "mainly hygienic" group. The relative risk for prevalence was 2.2 (95% confidence interval: 1.7, 2.8). The relative risk fell to 1.9 (95% confidence interval: 1.5, 2.5) after data were controlled for confounding, but the difference was still highly significant.

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Thompson, T.; Sobsey, M.; Bartram, J.

Providing clean water, keeping water clean: an integrated approach.

Int J Environ Health Res., June 2003, 13, Suppl 1: S89-94.

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Millions of people, most of whom are children in developing countries, die of basic hygiene-related diseases every year. Interventions in hygiene, sanitation and water supply

have been shown to control disease burden. Universal access to improved water sources and basic sanitation remains elusive but is an important long-term goal. Studies have shown that improving the microbiological quality of household water by on-site or point-of-use treatment and safe storage in improved vessels reduces diarrhoeal and other waterborne diseases in communities and households of developing and developed countries. The extent to which improving drinking water quality at the household level reduces diarrhoeal disease probably depends on a variety of technology-related and site-specific environmental and demographic factors that require further investigation, characterisation and analyses.

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Wright, Jim[1]; Gundry, Stephen[1]; Conroy, Ronan[2]

Household drinking water in developing countries: a systematic review of microbiological contamination between source and point-of-use.

Trop Med & Intl Health, January 2004, 9(1): 106.

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E-mail: rconroy@rcsi.ie

OBJECTIVE: To assess the extent and causes of microbiological contamination of household drinking water between source and point-of-use in developing countries.

METHODS: A systematic meta-analysis of 57 studies measuring bacteria counts for source water and stored water in the home to assess how contamination varied between settings.

RESULTS: The bacteriological quality of drinking water significantly declines after collection in many settings. The extent of contamination after water collection varies considerably between settings, but is proportionately greater where faecal and total coliform counts in source water are low.

CONCLUSIONS: Policies that aim to improve water quality through source improvements may be compromised by post-collection contamination. Safer household water storage and treatment is recommended to prevent this, together with point-of-use water quality monitoring.