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Interventions for the control of diarrhoeal diseases among young children: promotion of personal and domestic hygiene*

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The effects of improving personal and domestic hygiene on diarrhoea morbidity are reviewed using data from studies in hospitals, day-care centres, and communities. There is evidence that low educational attainment and certain religious customs predispose to diarrhoea, presumably because of behavioural factors. The specific hygiene-related behaviour that has been most studied is hand-washing. Hospital studies suggest that enteric infections can spread via contaminated hands and that hands can be decontaminated by washing with soap and water. Three studies from Bangladesh, the USA, and Guatemala on the impact of hygiene education programmes on diarrhoea are reviewed in detail. Reductions in diarrhoea incidence rates of between 14% and 48% were documented in these studies. Little is known on the impact of hygiene education programmes on diarrhoeas of specific etiology or of their impact on diarrhoea mortality. Information is lacking on the optimal design of such programmes, on their costs, and on their dependence on pre-existing levels of sanitary facilities. The available evidence suggests that hygiene education programmes may be a cost-effective intervention for diarrhoea morbidity reduction. Research is necessary to fill the current gaps in understanding and to clarify the operational aspects of these programmes.

Most of the pathogenic organisms that cause diarrhoea, and all the pathogens that are known to be major causes of diarrhoea in many countries, are transmitted primarily or exclusively by the faecal-oral route. For some enteric pathogens, man is the principal reservoir and thus most transmission originates from human faeces; examples are enterotoxigenic *Escherichia coli*, *Shigella* spp., *Vibrio cholerae*, *Giardia lamblia* and *Entamoeba histolytica*. For other enteric pathogens, animals are important reservoirs and transmission originates from both human and animal faeces; examples are *Campylobacter jejuni*, *Salmonella* spp. and *Yersinia enterocolitica*. For viral agents of diarrhoea the role of animal reservoirs in human disease remains uncertain.

Faecal-oral transmission may be water-borne, food-borne, or direct. Water-borne transmission may occur when water contaminated by faeces is drunk. Food-borne transmission may occur when food contaminated by faeces is eaten. Direct transmission is used here to describe an array of other faecal-oral routes such as via fingers, or objects such as eating utensils, or bed linen, or dirt which may be ingested by young children.

The interruption of water-borne and food-borne transmission requires specific measures which will be reviewed separately. Interrupting direct transmission depends primarily on improved hygiene and on improved facilities, such as better water supplies and latrines that facilitate improved hygiene. Such improved hygienic behaviour may also lessen the chances of contamination of food by food handlers, and may therefore reduce food-borne transmission. Ideally governments will promote educational measures to improve hygiene, as well as water and sanitation projects to improve the physical facilities, in integrated programmes. Such integrated programmes are advocated as part of the International Drinking Water Supply and Sanitation Decade. In practice, however, there are substantial operational differences between hygiene education programmes and water supply and sanitation projects: the two are usually implemented by different ministries and agencies, they require different types of personnel and, in particular, they have very different costs. It is useful therefore to review the effectiveness of hygiene education alone as an intervention for the reduction

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of diarrhoea morbidity or mortality. This review of the role of hygiene education in diarrhoeal disease control is the fourth in a series of reviews of potential anti-diarrhoea interventions being published in the *Bulletin of the World Health Organization* (*6–9*).

EFFECTIVENESS

For hygiene promotion to be an effective diarrhoea control intervention it must be true that:

either

the transmission of enteric pathogens, and thus the incidence of diarrhoea, are increased by specific behaviours	*hypothesis 1*

and

these specific behaviours can be altered by appropriate hygiene education programmes	*hypothesis 2*

or

appropriate hygiene education programmes can cause behavioural changes which can reduce the transmission of enteric pathogens and thereby reduce diarrhoea morbidity or mortality rates	*hypothesis 3*

Most of the literature on this topic deals with one or more of these specific hypotheses. The potential effectiveness of hygiene education would be suggested by a demonstration either of the correctness of hypotheses 1 and 2 or of the correctness of hypothesis 3. The evidence for and against these hypotheses is examined below.

Hypothesis 1. *The transmission of enteric pathogens, and thus the incidence of diarrhoea, are increased by specific behaviours.*

The anecdotal and descriptive evidence on this topic is extensive; the rigorous and quantified evidence is very limited. The evidence is mainly from three sources:

— studies that show an association between diarrhoea rates and levels of education;

— studies of diarrhoea epidemiology that incidentally comment upon behavioural factors in transmission;

— studies of behaviour and the transmission of enteric pathogens.

These three types of study are considered in turn.

Diarrhoea rates and educational levels. The literature contains many observations that diarrhoea rates are highest in families with the lowest levels of educational attainment. Hygiene and literacy may be closely related (*22*). Such observations in themselves are not useful because families with the lowest educational attainment will tend to be those with the lowest income, poorest housing, most crowding, and worst sanitary facilities. These confounding variables will also promote the transmission of enteric pathogens.

In Bangladesh, Levine et al. (*15*) showed that families with no formal education had a 1.7 times higher incidence of non-cholera diarrhoea, and a 1.8–3.4 times higher incidence of cholera, than families with at least one high-school graduate. Although these comparisons were controlled for tubewell usage, they were not controlled for socioeconomic factors. Levine et al. stated that families with high-school graduates were relatively wealthy, judged by living space, type of house construction, and possession of a radio or watch. An interesting finding from earlier studies on cholera in rural Bangladesh (*17*) was that cholera incidence was higher among Hindus than among Muslims. The incidence among Hindus was 3.0 times higher in 1963–64, 1.1 times higher in 1964–65, and 5.3 times higher in 1965–66 than among Muslims.

This evidence is fragmentary and inconclusive. Studies are required that compare diarrhoea rates by literacy, educational attainment, or religious customs, with the environmental and wealth variables controlled. If significant differences are found, the most likely reason is that the educational or religious differences cause behavioural differences that affect the transmission of enteric pathogens. Detailed anthropological studies will be needed to describe these behavioural differences. If such differences are found, it remains to be shown whether the specific behaviours can be changed by hygiene education in the short-term (rather than by general education in the longer-term or by changing certain religious customs).

Behavioural factors in diarrhoea epidemiology. Numerous studies of diarrhoeal disease epidemiology, and investigations of diarrhoea outbreaks, comment on behavioural factors that may have in-

fluenced the pattern of spread. An exhaustive review of these comments would be unproductive since in general they are speculative and do not firmly associate specific behaviours with specific levels of risk. Most comments in studies from developing countries draw attention to a complex of poverty, ignorance, illiteracy, and crowding and suggest that associated with these circumstances are behaviours that promote the transmission of enteric pathogens. In developed countries the two most commonly mentioned factors are crowding, as may occur among lower socioeconomic groups or during exceptionally cold weather, and poor hygienic practices of young children and those who care for them. The risk of pathogen spread from young children to other members of the family, either directly or via the hands of the parent who cleans them, is stressed repeatedly. The importance of hand-washing by staff in controlling the spread of enteric infections in hospitals, day-care centres, and other institutions is also emphasized.

Behaviour and the transmission of enteric pathogens. The specific behaviours that have received most attention with regard to their role in promoting the transmission of enteric pathogens are water-handling behaviour, food-handling behaviour, and hand-washing. Water-handling and food-handling behaviours will be treated separately in the context of interrupting water-borne and food-borne transmission and will be discussed in later reviews in this series. Here, information on hand-washing is reviewed.

Concern about the possible role of hospital staff in the spread of nosocomial infections has led to several studies of hand-washing behaviour in medical institutions in developed countries. Three such studies are summarized in Table 1. In some settings hand-washing was found to be inadequate, both in frequency and thoroughness. The data from Seattle are particularly striking and suggest a lax attitude to personal hygiene even among those, such as physicians, with a high level of theoretical understanding of the need to maintain scrupulous hygiene in intensive care units. This illustrates that knowledge is not necessarily translated into practice. No studies on hand-washing behaviour in the home, either in developed or developing countries, have been located.

Studies on the occurrence and survival of enteric pathogens on the hands are summarized in Table 2. The hands of hospital staff in developed countries are commonly contaminated and contamination takes place easily during a variety of nursing procedures. The hands of children were readily contaminated by *Shigella sonnei* during shigellosis outbreaks in England. Enteric bacteria on hands survive for at least 3 hours in detectable numbers and can be transferred to food and to other hands. A study in Dhaka (*26*) found that the hands of attendants of hospitalized children with rotavirus diarrhoea were commonly contaminated with rotavirus, and that this contamination was more likely among those who attended younger children.

Studies on the cleansing of hands by washing with water and soap are summarized in Table 3. Hand-washing with water and unmedicated soap removes 90–100% (below the limits of detection) of inoculated bacteria. Washing with water alone removes a considerable but lesser proportion. Some washing procedures with disinfectants do not achieve greater bacterial removals than washing with water and soap. The opinion is often expressed in the literature that the effectiveness of hand-washing is determined more by its thoroughness (time taken and attention to all parts of the hands) than by the types of soap or water used. No data have been located on the effectiveness of hand-washing in the home, or in developing countries, or using other procedures such as rubbing the hands with sand or soil.

The studies summarized in Tables 1–3 are mainly conducted in hospital settings. They indicate that

Table 1. Hand-washing and enteric pathogen transmission: hand-washing behaviour

Study	Findings	Reference
1. Hand-washing frequency by medical staff at an intensive care unit in Seattle, USA, was covertly observed.	Hand-washing occurred after only 41% of patient contacts. Physicians washed after significantly fewer contacts (28%) than nurses (43%).	*1*
2. Hand-washing behaviour among staff at a radiotherapy clinic and a neonatal unit in Helsinki, Finland, was observed over several weeks.	Average hand-washing frequencies per person per 8-hour shift were 10–20 at the radiotherapy clinic and 27–42 at the neonatal unit.	*21*
3. Thoroughness of hand-washing by nurses in England was studied by inviting them to wash with a dye.	89% of nurses missed some part of the hand surface; the most neglected areas were the thumbs, backs of the fingers, and backs of the hands. Right-handed nurses washed the left hand better than the right hand, and vice versa.	*28*

Table 2. Hand-washing and enteric pathogen transmission: occurrence and survival of enteric pathogens on the hands

Study	Findings	Reference
1. The transmission of *Klebsiella* spp. in an intensive care unit in London, England, was studied.	*Klebsiella* were commonly passed from patients (especially patients' hands) to nurses' hands during simple and 'clean' nursing procedures. Over 90% of *Klebsiella* on dry hands could survive for at least 2.5 hours.	*4*
2. Occurrence and survival of *Shigella sonnei* on the hands of children in Southampton, England, during shigellosis outbreaks were investigated.	In 4 studies, 0–49% children had *S. sonnei* on their hands following a visit to the toilet for urination. *S. sonnei* on the hands survived for at least 3 hours. *S. sonnei* in stools passed through double thickness of several brands of toilet paper onto the hands.	*10*
3. Contamination by Gram-negative bacteria of the hands of nurses at an intensive care nursery in Florida, USA, was studied.	151 hand cultures were made from 13 nurses. 86% of cultures and 100% of nurses were positive for Gram-negative bacteria. *Klebsiella pneumoniae* and *Escherichia coli* accounted for 55% of isolates. Evidence was obtained that some Gram-negative bacteria, including *E. coli*, could multiply and persist on the hands of some nurses.	*13*
4. Occurrence and survival of enteric bacteria on finger-tips were studied at the Central Public Health Laboratory in London, England.	*Escherichia coli* were not isolated from the finger-tips of 100 laboratory staff but were isolated from the finger-tips of 12% of butchers in a meat factory. *E. coli* inoculated onto finger-tips decreased by 99% or more after 1 hour. *Salmonella* inoculated onto finger-tips decreased by 96–99.8% after 1 hour. With an initial inoculum of 530 per finger-tip, *S. anatum* were still detectable after 3 hours. *S. anatum* were frequently isolated from corned beef and cooked ham that had been touched for 5 seconds by contaminated finger-tips.	*23*
5. A known number of coliforms were placed on the hands of the author.	After three hours the number of coliforms was "virtually unchanged".	*24*
6. Bacterial contamination of the hands of staff on the general surgical and medical wards at a hospital in New York, USA, was investigated.	Coliforms were found in 23% of hand rinses from physicians, 55% from nurses, 67% from nurse aides, and 67% from other staff. 18% of cultures revealed $> 10^3$ coliforms per 2 hands. 88% of coliforms isolated were in the *Klebsiella–Aerobacter* group and the remainder were *Escherichia coli*. 92% of coliforms isolated were resistant to one or more antibiotics.	*25*
7. Contamination of the hands of the attendants of 147 children under 5 years hospitalized with acute diarrhoea in Dhaka, Bangladesh, was studied. 70 of the children had rotavirus diarrhoea.	Rotavirus antigen was detected in the hand rinses from 79% of the attendants of children with rotavirus diarrhoea, and from 20% of the attendants of children with non-rotavirus diarrhoea.	*26*
8. Effect of baby handling on hand bacteria of nurses was studied in a hospital nursery in New York, USA.	Changing soiled diapers increased the coliforms on the hands by 10^1–10^5-fold.	*27*

knowledge of the importance of hand-washing does not necessarily lead to adequate hand-washing; that hands become easily contaminated by faecal bacteria and viruses even under conditions of good hygiene and high awareness; that enteric bacteria on hands can survive for at least 3 hours and can be transferred to food and other hands; and that washing with soap and water is an effective method of cleansing the hands.

Conclusions on hypothesis 1. Much of the evidence presented bears only indirectly on hypothesis 1. Low educational attainment and certain religious customs predispose to diarrhoea, presumably because of behavioural factors. The specific behaviour that has been most studied is hand-washing. Hospital studies suggest that enteric infections can spread via contaminated hands and that hands can be decontaminated by washing with soap and water. Thus it is probable that

Table 3. Hand-washing and enteric pathogen transmission: cleansing the hands by washing with water and soap

Study	Findings	Reference
1. Experiments were conducted to determine whether ordinary toilet soap, without antibacterial additives, could act as a vehicle for the dissemination of bacteria. Bacteria used were *Escherichia coli*, *Staphylococcus aureus*, two Gram-positive micrococci and *Serratia marcescens*.	Bacteria inoculated onto the surface of soap bars declined in number by at least 5 $\log_{10}$ units in 15 minutes. Washing massively contaminated hands transferred bacteria to the soap bar, but these bacteria did not subsequently transfer to the hands of the next user. Bars of soap under ordinary heavy use did not accumulate appreciable bacterial populations, although bars kept in non-draining trays became somewhat more contaminated than those which were allowed to drain.	*2*
2. Effect of hand-washing with water (rubbing hands together under 45 °C running tap water for 20 seconds) and soap and water (rinsing in warm water for 5 seconds, washing with soap for 15 seconds, rinsing for 5 seconds) on removal of inoculated *Klebsiella* from hands of staff in an intensive care unit was studied.	Washing with water alone removed < 98% of *Klebsiella*. Washing with plain soap removed > 98% of *Klebsiella* in 50% of experiments. Washing with medicated soap removed > 98% of *Klebsiella* in 77% of experiments.	*4*
3. Hands were contaminated with *Staphylococcus aureus* or *Pseudomonas aeruginosa* and then washed for 30 seconds with soap and running water. Bacterial counts were compared with those on unwashed (control) hands that had been similarly contaminated.	Washing with soap and water reduced the geometric mean counts of *S. a.* by 99.7%, and of *P. a.* by 99.8%. Some washing procedures using disinfectants did not remove more bacteria than did washing with soap.	*16*
4. Hands were contaminated with *Staphylococcus aureus* and then rinsed for 30 seconds in distilled water. Bacterial counts were compared with those on unrinsed (control) hands that had been similarly contaminated.	Rinsing with distilled water reduced the geometric mean counts of *S. a.* by 89.8%. Rinsing with hypochlorite solution did not remove significantly more *S. a.* than did distilled water.	*16*
5. Effect of hand-washing (with soap and running water for 15 seconds and then drying on a paper towel) on removing inoculated *Salmonella anatum* from finger-tips was studied.	Proportion of experiments in which *S. anatum* could be isolated from the finger-tips after hand-washing depended on the initial inoculum and was 100% for 10^6 *S. anatum*/finger-tip, 30% for 10^3–10^4 *S. anatum*/finger-tip, and 0% for < 10^3 *S. anatum*/finger-tip.	*23*
6. A variety of experiments on the removal of resident and transient skin flora from hands by scrubbing with soap and water were conducted.	Bacterial removal was not affected by water temperature (24–56 °C), type of soap, drying on a sterile towel or bacteriological water quality. Inoculated bacteria were reduced by 50% after washing with soap and warm water for 30 seconds.	*24*
7. Effect of rapid hand-washing with soap and water, or water alone, on removing naturally acquired coliforms from the hands of nurses in a hospital nursery was studied.	Hand-washing with soap and water removed 67–100% of coliforms (median, 96%). Hand-washing with water alone removed 93–100% of coliforms (median, 98%). The use of disinfectants in rapid hand-washing did not improve coliform removal.	*27*

certain specific behaviours do promote the transmission of enteric pathogens and that failure to wash the hands is one such behaviour.

Hypothesis 2. *Specific behaviours (that promote the transmission of enteric pathogens) can be altered by appropriate hygiene education programmes.*

The literature on the methods and efficacy of hygiene education is mainly comprised of theoretical discussions of approaches likely to succeed or of qualitative descriptions of field experience (*11*, *20*, *29*). Few reports that quantify the impact of a given hygiene education programme on a specific set of personal or domestic hygiene behaviours have been located.

Torún (*30*) reports an evaluation of a hygiene education programme in a village in the Pacific lowlands of Guatemala during 1979–80. The programme was directed at 106 mothers, all of whom had a child under 6 years old; 32 similar mothers acted as controls. The programme consisted of nine 1-hour sessions between educators and groups of mothers

(9–27 per group), using stories and discussions assisted by radio plays and evocative pictures. The mothers were encouraged to reflect upon their hygiene problems and to commit themselves to specific actions. The content of the educational programme covered the recognition and treatment of diarrhoea, excreta disposal, hand-washing, breast-feeding, food hygiene, care of drinking water, and diet. The proportions of mothers giving correct answers to questions on prevention were 56% before the programme, 90% immediately after the programme, and 88% 6 weeks later. A significant increase was observed in the proportion of target families that were judged to have correct hygiene behaviour with respect to diaper disposal, kitchen hygiene, water storage, latrine hygiene, garbage disposal, and child cleanliness. Hygiene practices that would have required expenditure (e.g., improvements to wells and animal enclosures) were not significantly changed. Diarrhoea incidence was reduced in the children of target mothers compared to control mothers, and these data are reviewed below under hypothesis 3.

The body of both theoretical and qualitative evidence, taken together with evidence from other spheres of health education (for instance, smoking, obesity, breast-feeding), strongly suggests that the adoption of hygienic behaviour can be achieved by sustained and culturally appropriate educational programmes. Research is urgently needed to measure the behavioural impact of various types of hygiene education in various cultural and socioeconomic settings. Such research should not prove unduly difficult or expensive.

Hypothesis 3. *Appropriate hygiene education programmes can cause behavioural changes which can reduce the transmission of enteric pathogens and thereby reduce diarrhoea morbidity or mortality rates.*

Three studies (from Bangladesh, the USA, and Guatemala), documenting the impact on diarrhoea rates of hygiene education programmes, have been located. In two cases, Bangladesh and USA, the education focused exclusively on hand-washing, while in the third, in Guatemala, the programme sought to improve several aspects of personal and domestic hygiene.

The Bangladesh study. In Dhaka, Khan (*12*) selected patients with culture-confirmed shigellosis attending a clinic and allocated their families to four groups: a soap and water group that were provided with 2–4 pieces of soap and 1–3 water pitchers and were urged to wash their hands after defecation and before eating; a soap group that was provided with soap only; a water group that was provided with pitchers only; and a control group that was provided with nothing. Rectal swabs of family contacts of the index shigellosis cases in the four groups were obtained daily for 10 days. Contacts infected by the same type of *Shigella* as the index case were termed secondary infections, and those who were also sick (3 or more episodes of diarrhoea or dysentery in 24 hours) were termed secondary cases. The secondary case rate was 2.2% for the soap and water group and 14.2% for the control group, and Khan concluded that the intervention had lowered the secondary case rate by 84%. In the soap and water group, secondary infection rates were significantly higher among those who used less water for washing and bathing. This difference was less apparent among the control group. The reduction in secondary infection rates was less for *Sh. dysenteriae* type 1 than for other *Shigella* species, possibly because of the lower infectious dose of that organism. Attack rates of non-*Shigella* diarrhoea were 37% lower in the soap and water group than in the control group over the 10-day period of surveillance.

To make the reduction in the shigellosis secondary case rate more nearly comparable with the reduction in the non-*Shigella* diarrhoea attack rate, the secondary case rate reduction was converted to an attack rate reduction.[a] On the assumption that the hand-washing promotion had no influence on the incidence rate of index cases, an 84% secondary case rate reduction is equivalent to a 35% reduction in attack rate in the families under study.

The USA study. In Atlanta, GA, Black et al. (*3*) investigated the impact of hand-washing on diarrhoea incidence in four day-care centres. Two groups of children, one aged 6–17 months and the other aged 18–29 months, were studied at each day-care centre. Two of the centres were randomly selected to receive a hand-washing promotion campaign which encouraged staff to wash their hands after arriving at the centre, before handling food, and after helping a child to use the toilet or using the toilet themselves. When children entered the centre, used a toilet, had their diapers changed, or were prepared to eat, staff washed the children's hands using bar soap and paper towels. Children using the toilet were supervised by staff to ensure that they did not place their hands in their mouths. These practices were rigorously monitored. The other two day-care centres received no hygiene promotion and served as controls. It had been observed, prior to this investigation, that the practice of hand-washing and of toilet supervision of young children in these centres was generally lax. The incidence of diarrhoea among the selected children in the four centres was monitored for 10 months; this incidence among children aged 6–29 months was reduced

[a] Assumptions and computations used to make this conversion are available on request from the author.

Table 4. The effect of hygiene education on diarrhoea incidence and the percentage of days ill with diarrhoea in a village in Guatemala[a]

Age group (months)	Full year[b] or peak diarrhoea season[c]	Target or control group	Diarrhoea incidence			Proportion of days ill		
			Mean number of children studied per month	Mean monthly incidence (episodes/ 100 children/ month)	Percentage reduction in incidence	Mean number of child-days studied per month	Mean monthly % of days with diarrhoea[d]	Percentage reduction in % of days with diarrhoea
0–23	Full year	Target	49	36	14	1433	4.5	24
		Control	32	42		906	5.9	
	Peak season	Target	60	38	36	1752	4.1	55
		Control	32	59		872	9.2	
0–71	Full year	Target	152	25	14	4457	3.0	12
		Control	92	29		2577	3.4	
	Peak season	Target	185	25	32	5378	2.7	48
		Control	82	37		2253	5.2	

[a] Reanalysis of data from Torún (*30*).
[b] September 1979 to August 1980.
[c] March–June 1980.
[d] (Number of child-days with diarrhoea × 100) ÷ Total number of child-days observed.

by 48% in the hand-washing day-care centres compared with the control centres.

The Guatemalan study. In Florida Aceituno, a village in the Pacific lowlands of Guatemala, Torún (*30*) promoted health awareness and hygienic behaviour among mothers and studied the impact on their knowledge and behaviour and the effect on diarrhoea rates in their children under 6 years old. The promotion, and its impact on knowledge and hygienic practice, are reviewed above under hypothesis 2. The impact on diarrhoea rates in children is summarized in Table 4. The target group comprised the children of 106 mothers who participated in the educational programme, and the control group comprised the children of 32 mothers who did not participate. Twelve (38%) of the 32 control mothers were of above average socioeconomic status, being the wives of store-owners, preachers or community leaders. The impact on the proportion of days with diarrhoea (a measure combining possible impacts on incidence and duration of episodes) was higher than the impact on incidence. For both impact measures, impact was 2–4 times greater in the peak diarrhoea season (March to June) than throughout the whole year.

Conclusions on hypothesis 3. These 3 studies from Bangladesh, the USA, and Guatemala provide 5 measures of the impact of hygiene education on diarrhoea rates:

— a 35% reduction in the incidence rate of shigellosis among all ages in urban families in Bangladesh;
— a 37% reduction in the incidence rate of non-*Shigella* diarrhoea among all ages in urban families in Bangladesh;
— a 48% reduction in the incidence rate of all diarrhoea among children aged 6–29 months in day-care centres in the USA;
— a 14% reduction in the incidence rate of all diarrhoea among children aged 0–71 months throughout the year in a Guatemalan village;
— a 32–36% reduction in the incidence rate of all diarrhoea among children aged 0–71 months during the peak diarrhoea season in a Guatemalan village.

Thus the reduction of diarrhoea incidence rate to be anticipated from hygiene education lies in the range 14–48%. Other studies support the general contention that hygiene education can reduce diarrhoea

rates, but do not allow a calculation of the reduction in incidence achieved by a clearly defined educational intervention (*14*, *18*, *19*).

It might be supposed that the commonness of direct person-to-person transmission of *Shigella* would make shigellosis especially sensitive to reduction by hand-washing. The evidence presented here does not support this. First, the computed reduction in the shigellosis incidence rate in Dhaka was 35%, whereas in the same families the reduction in the incidence rate of non-*Shigella* diarrhoea was 37%. Second, in the Atlanta study a 48% reduction was recorded and, out of 85 diarrhoea stools cultured, none contained *Shigella*.

The three studies summarized above suggest that hygiene education, especially hand-washing promotion, has a marked impact on diarrhoea morbidity rates. These studies should be repeated in different socioeconomic and environmental settings and should also quantify the impact on diarrhoea due to rotavirus, enterotoxigenic *Escherichia coli*, *Campylobacter jejuni*, *Shigella*, *Giardia lamblia* and other agents that are of known local importance.

FEASIBILITY AND COST

There is such little documented experience of hygiene education programmes that their feasibility is difficult to judge and their costs are unknown. Experience with other types of health education suggests that such programmes are feasible on either a national or local level and that they can employ a combination of mass media techniques and direct interaction between target families and hygiene promoters (*5*). Costs of hygiene education are probably low compared to some other interventions for diarrhoea morbidity reduction—such as the provision of improved water supplies and sanitation facilities. The effectiveness of hygiene education may depend, however, upon the presence of such facilities. In Dhaka the provision of soap, which would be costly on a continuing basis, may have been an essential part of the intervention, and in Atlanta modern facilities for washing and defecation were already available. Operational research is needed to clarify the most effective and feasible types of hygiene education programme, to detail their costs, and to assess their dependence on pre-existing levels of sanitary facilities.

CONCLUSIONS

Interest in the role of education in disease control has increased considerably in recent years. It is probable that better educated communities enjoy relative protection against several diseases compared to less educated, but otherwise similar communities. This protection may be conferred both by general education (as measured, for instance, by school attendance, adult literacy or education of heads of households) and by disease-specific education. Disease-specific education can be preventive or therapeutic in content.

The evidence marshalled in this paper suggests that hygiene education can improve hygiene and can reduce diarrhoea morbidity rates by 14–48%. These are hopeful findings. Many countries, especially in sub-Saharan Africa and Asia, are having extreme difficulty in sustaining the development of their health infrastructure. In the water and sanitation sector, for instance, the rate of construction of new projects barely keeps pace with population growth and the rate of breakdown is alarming. In these circumstances, educational interventions appear especially attractive. They may be cheap compared to infrastructure projects and they may achieve lasting changes in health-related behaviour. Most importantly, as indicated by this review, they may achieve substantial impacts.

Hygiene education programmes are being conducted in many countries and should continue. Countries not having such programmes should seriously consider launching them. Research is necessary, however, to improve the cost-effectiveness of hygiene education. This research is of three main types. First, more information is needed on the associations between specific behaviours and risks of diarrhoea morbidity and mortality of known etiology. Second, operational research is needed to clarify the most effective and feasible types of hygiene education programme, to detail their costs, and to assess their dependence on pre-existing levels of sanitary facilities. Third, impact studies should be conducted to clarify the impact on diarrhoea of carefully designed hygiene education programmes. These impact studies should be etiology-specific and, where possible, should document impacts on diarrhoea mortality rates as well as morbidity rates.

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RÉSUMÉ

LUTTE CONTRE LES MALADIES DIARRHÉIQUES CHEZ LES JEUNES ENFANTS: PROMOTION DE L'HYGIÈNE PERSONNELLE ET DOMESTIQUE

Cet article est le quatrième d'une série portant sur les mesures qui permettraient de réduire la mortalité et la morbidité par diarrhée chez les enfants de moins de 5 ans dans les pays en développement. On a étudié les effets d'une meilleure hygiène personnelle et domestique sur la morbidité par diarrhée en se basant sur des données recueillies dans des hôpitaux, des garderies d'enfants et des collectivités. Ces données montrent qu'un faible niveau d'instruction et certaines coutumes religieuses prédisposent aux maladies diarrhéiques, probablement en raison de certains facteurs comportementaux. La pratique d'hygiène qui a été le plus étudiée à cet égard est celle qui consiste à se laver les mains. Les études faites en milieu hospitalier démontrent que les infections intestinales peuvent être propagées par des mains contaminées et que l'on peut éliminer ce risque en se lavant les mains à l'eau et au savon. Trois études faites au Bangladesh, aux Etats-Unis d'Amérique et au Guatemala sur l'impact que les programmes de promotion de l'hygiène ont sur la diarrhée sont passées en revue dans l'article. Ces études ont mis en évidence des réductions des taux de morbidité par diarrhée allant de 14% à 48%. On sait peu de chose des effets des programmes d'hygiène sur les diarrhées d'étiologie déterminée ou sur la mortalité par diarrhée. On ne dispose pas non plus de renseignements sur la conception optimale de tels programmes, sur leurs coûts, non plus que sur la mesure dans laquelle leur succès dépend de l'existence préalable d'installations sanitaires. D'après les données disponibles ces programmes constituent probablement une mesure d'un bon rapport coût-efficacité pour la réduction de la morbidité par diarrhée. Des recherches doivent être faites pour combler les lacunes existantes dans les connaissances et pour éclairer les aspects opérationnels des programmes d'éducation en matière d'hygiène.

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