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Hand Washing with Soap Reduces Diarrhoea and Spread of Bacterial Pathogens in a Bangladesh Village

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ABSTRACT

Hand washing with soap and water can prevent the spread of diarrhoeal diseases in areas where comparatively costly interventions, such as supply of safe water and improved sanitation, are not possible. In this study, the practice of hand washing with soap and water was instituted in a periurban slum of Dhaka city, and the surveillance for diarrhoea sustained for a one-year period. Rates of primary and secondary attacks were compared to those of a non-intervention area similar in age structure, economic status, education, and other relevant variables. Rectal swabs of cases and contacts established aetiologies. There was a large (2.6 fold) reduction in diarrhoeal episodes in the intervention area during the observation period. Rates of bacterial pathogens were also lower in the intervention area. Significant reduction in diarrhoeal incidences was observed in all age groups for all pathogens except for rotavirus. These observations if implemented as health policy could reduce the spread of diarrhoeal diseases at low cost in high risk areas.

Key Words: Diarrhoea; Dysentery, Bacillary; Disease transmission; Hand washing; Soap; Interventions

INTRODUCTION

Hand washing with soap is a low-cost intervention of documented efficacy that has been of proven worth for more than a century, but has often been neglected for more glamorous, expensive, and less-effective alternatives (1). Marked reduction in the spread of shigellosis was observed in an earlier study in the urban slums of Dhaka, Bangladesh when families were provided with soap and a container for water shortly after the identification of an index case of *Shigella dysenteriae* (2). There were fewer secondary cases and lower rates of infection without improvements in water or sanitation. Another study in Calcutta, India has yielded similar results (3). A recent behavioural study has discussed some of the social and cultural issues that must be addressed to achieve successful hand washing practice (4). Hand washing with soap has long been known to interrupt the spread of iatrogenic and nosocomial infections (5-6). This

inexpensive method, effective even under adverse conditions, deserves as much attention as more complex and often unattainable high-technology interventions, such as installation of comprehensive pure water supply systems, systems for waste disposal, vaccines, or prophylaxis with antimicrobial agents (7). A recent study has demonstrated that even materials of lower cost than soap may reduce the chance of contamination by hands and could be suitable alternatives to soap (8).

The present study, carried out in an economically depressed periurban village, provided soap and containers for water, together with careful instructions on hand washing followed by reinforcement with visits every other day. The effect on the incidence of diarrhoea due to specific pathogens and on their spread in the community was observed for one year.

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MATERIALS AND METHODS

The study was conducted in a periurban village (Nandipara) of Dhaka City in Bangladesh selected because of its accessibility and known high rates of diarrhoea. It was located 3 km away from the Diarrhoea Treatment Centre of the International Centre for Diarrhoeal Diseases Research, Bangladesh in Dhaka. Access to this facility was by a dirt road merging with paved city roads and by waterways. Men went to the city principally as construction workers or rickshaw pullers. Women attended to household and agricultural tasks close to their homes. The village had a population of two thousand people and was divided naturally into four separate areas or "paras." There were no functioning tubewells in any of the areas during the study period, and all drinking, bathing or cooking water was obtained from the nearest ponds or canals. There was little attention given to separating areas used for human wastes from the water used for all other purposes. Thus, all areas were exposed to a very high risk of faecal-oral contamination. Socioeconomic data from previous studies were available (9). In 1980, the two populations studied were similar with respect to age structure, economic status, education, and other crucial variables. Two of the four "paras" were chosen as having sufficient diarrhoea cases expected for the purpose of this study which was carried out from January through December 1983. All residences of these two paras were enrolled in the study.

Diarrhoea was defined as two or more watery stools or four or more loose stools in 24 hours. A primary case was defined as the first case of diarrhoea discovered by a health worker in any family. Families were defined as those individuals who ate from the same cooking pot consistently. A secondary case was any case observed subsequent to the first case with the same aetiology as the first case. Secondary cases were required to be in the same family and onset of diarrhoea within two weeks of the primary case.

Before the intervention was begun, a two-week baseline survey was carried out by the same teams that conducted the subsequent study to define the prevalence of diarrhoea and aetiological agents. The results were comparable for both the areas.

Surveillance was established on a continuing basis immediately following the initial survey and continued for one year. Community volunteers identified from among village residents were trained as health educators. Every family in each area was visited on alternate days by two male and one female health workers. Health workers asked whether any family member had diarrhoea. Rectal swabs were obtained from every diarrhoea case and from all family members present in the house at the time of the visit. Family members missing at the time of the visit were asked to provide specimens of their stool the

following morning. In the area in which hand washing with soap was implemented (the intervention area), residents were provided with two kinds of soap. One bar was white, to be used exclusively for hand washing. The second bar was yellow and could be used for clothes, utensils, or any other purpose desired by the family. Half bar of each soap was given to each family twice a week. The workers confirmed consumption of the soap used for hand washing by inspection. A pitcher was also provided to each family to facilitate the use of water in the home. On each visit instructions were reinforced and problem-solving carried out to enhance compliance with hand washing to the maximum extent attainable. Special emphasis was placed on the use of soap before eating or handling food and after urination and defecation. Health workers involved in the study visited the village every day and made direct observations of the extent that hand washing was practised. The pitcher was filled at each visit, and the amount of water used was noted the following morning.

The rectal swabs or stool samples were plated in the field on *Salmonella/Shigella*, McConkey, Campy-BAP, Taurocholate Tellurite Gelatin Agar and examined for *Salmonella*, *Shigella* (10), *Campylobacter jejuni*, and vibrios (11-12). Enterotoxigenic *Escherichia coli* were identified by picking five lactose-positive colonies with morphology typical of *E. coli* on the McConkey's agar plate. The five colonies were pooled and tested for the production of heat-labile (13) toxin by the Chinese hamster ovarian cell assay and heat-stable toxin by the infant mouse assay (14). Rotavirus assays were done by the indirect ELISA technique (15). Data were entered on an IBM System 34 computer and tabulated. Incidence density (ID = incidence/person time), incidence density ratio (IDR = ratio of two IDs in the two groups, i.e., intervention vs control groups). Test-based confidence intervals were calculated (16).

RESULTS

The intervention and control areas were comparable regarding age, sex and socioeconomic indicators, and the rates of diarrhoea incidence for a two-week period before the intervention were comparable between the areas. The number of individual pathogens in diarrhoea cases, isolated during the brief survey period, was too small in number to assess comparability.

During the year of continuing surveillance, substantially lower rates of diarrhoea were found for both primary and secondary cases in the intervention area. The overall rates of infection were significantly lower for each agent studied in the intervention areas excepting rotavirus.

The risk of developing diarrhoea in the population of the intervention area was about a third of that of the

control area once effective hand washing with soap and water was instituted. There was no reduction in the primary case rates for rotavirus, but the attack rates were very low. The largest difference observed was in primary and secondary cases of shigellosis. There was 60-69% lower rate of cases of ETEC, *Shigella*, *C. jejuni*, and all diarrhoeas (Table I). The low incidence rate of rotavirus may account for the non-significant reduction rates. No secondary cases were observed for ETEC in either area during the year of study. In every age group the intervention resulted in reduction of diarrhoeal incidence. The reduction ranged from 47-73%. The highest reduction was seen in the 5-9 year age group (Table II).

The rates of diarrhoea incidence observed in the control areas of the present study are comparable to those reported by Black *et al.* in rural Bangladesh in children (17) and those reported from Brazil by Guerrant (18).

country, variations are common. Thus, in studying the effect of any interventions to reduce morbidity, or mortality it is important to insure that conclusions are based upon populations that are comparable with respect to variables that determine the rates of diarrhoea incidence. These include socioeconomic status, education of mothers, equivalent risk of exposure, e.g. sanitation and water sources, similar diet and nutritional state, similar child-rearing practices – especially as regards breast feeding which is very influential in lowering the incidence of diarrhoea in the first two years of life (21), and common cultural and behavioural practices. The populations studied in this research were comparable. The study design used could not be "blind" because of the nature of the intervention. Worker bias was assessed by frequent spot checking by the principal investigator and by the objective nature of microbiological tests done by technicians who were independent of the study and remote from the study areas.

Table I. Frequency of primary and secondary cases in the intervention and control areas by individual pathogens

Study areas										
Diarrhoeal pathogen	Intervention (n = 671)				Control (n = 695)				IDR	95% CI
	Primary cases	Secondary cases	Total	ID	Primary cases	Secondary cases	Total	ID		
ETEC	16	0	16	0.024	54	0	54	0.078	0.31	0.19 - 0.52
<i>Shigella</i>	17	0	17	0.025	37	7	44	0.063	0.40	0.23 - 0.69
<i>C. jejuni</i>	29	3	32	0.048	73	14	87	0.125	0.38	0.26 - 0.56
Rotavirus	4	0	4	0.006	5	0	5	0.007	0.83	0.22 - 3.08
Unknown	183	31	214	0.319	362	222	584	0.840	0.38	0.33 - 0.44
All	249	34	283	0.422	531	243	774	1.114	0.38	0.33 - 0.43

Data from a full year of continuous observation. ID = incidence density; IDR = incidence density ratio; 95% CI = χ^2 test-based confidence interval.

Table II. Frequency, total cases (primary plus secondary) in the intervention and control areas by age group

Age group	Intervention area			Control area			IDR	95% CI
	Person years	Total cases	ID	Person years	Total cases	ID		
0-11 months	44	49	1.11	33	95	2.88	0.39	0.29 - 0.54
12-23 months	19	37	1.95	27	99	3.67	0.53	0.37 - 0.77
24-59 months	68	67	0.99	79	175	2.22	0.44	0.34 - 0.59
5-9 years	112	36	0.32	113	137	1.21	0.27	0.19 - 0.37
10-14 years	74	13	0.18	91	57	0.63	0.28	0.16 - 0.49
Over 15 years	354	81	0.23	352	211	0.60	0.38	0.30 - 0.49
All	671	283	0.42	695	774	1.11	0.38	0.33 - 0.43

Data from a full year of continuous observation. ID = incidence density; IDR = incidence density ratio; 95% CI = χ^2 test-based confidence interval.

DISCUSSION

Acute diarrhoeal diseases are a major cause of poor health and death in the developing countries, and children are the most vulnerable. The incidence of diarrhoea varies according to the definitions used, intensity of surveillance, and the particular geographic distribution of the different causative agents (18-20). Even in the same

The intervention selected was simple and within the economic reach even of very poor households. It required education to influence the household practices and was congruent with the cultural and behavioural practices and beliefs in Bangladesh with respect to cleanliness. This represents a more appropriate and easily implemented approach than technologically advanced or costly interventions.

Previous literature has not focused on the influence of soap itself in preventing the spread of diseases in large populations or communities despite the early knowledge of its effectiveness in reducing the spread of iatrogenic and nosocomial infections (1,5,6). In diarrhoeal diseases, it is known that contagion rests on the transmission of the causative organisms from human wastes to food, water, or directly to the mouth (22-24). In the most adverse circumstances of an urban slum in a congested city of a poor country, such as Bangladesh, the use of soap even with water of poor quality before handling food and after urination and defaecation resulted in a very sharp reduction of the spread of *Shigella* without any other improvement in living conditions or environmental sanitation or water supplies (2). The present research extends these observations, and suggests that hand washing with soap may lower diarrhoeal episodes of most other aetiologies and even to the substantial number of cases where a specific pathogen was not isolated.

Two adjacent communities were observed in a "block" design in this study. We acknowledge that biases could have led to a decrease in the incidence of diarrhoea in the population due to spreading effects of the health messages of the workers from the intervention to the control area. However, this bias would tend to decrease the difference in rates of diarrhoea incidence observed between the intervention and control areas. Regular unannounced field checks by the principal investigator make it very unlikely that under-reporting of cases from the intervention area occurred or could explain the very large differences observed.

Although soap is inexpensive and hand washing culturally acceptable, it is clear that it is not being widely used in the very settings where it could have the greatest impact. The intensity of worker-effort in the present study and in the previous ones indicates that a considerable effort may be required for full implementation. In Dhaka city, however, a strategy of using volunteer mothers as the person to implement training in a community has been highly successful in the case of early use of oral rehydration therapy and has also been applied to the implementation of hand washing (25). Thus, there is no intrinsic barrier to the widespread application of soap and water, but social mobilization of communities and political support are essential, using schools and many other channels of communication, including the media. Four bars of hand washing soap were required for a family and would cost an additional US\$ 1.2 per month, i.e. Taka fifty.

Although the spread of enteroviruses was also decreased by hand washing in the present study, we have not measured these (26-27). We also did not observe other important causes of ill health and death which might also be reduced by hand washing. While much has been said about the effects of soap in controlling diarrhoea

(2,3,25,26), there are urgent indications of a need to carefully define the effects of soap in controlling other infectious diseases. Of particular importance in this regard are the aetiologic agents of acute respiratory diseases.

In light of the results of this study, we would urge those interested in controlling the spread of the causative agents of diarrhoea to investigate the full impact of increased use of soap and hand washing. We also hope that studies will address the best community-based approaches to introducing soap or alternative local products (4) of proven efficacy for cleaning hands. Acute respiratory illnesses should also be studied as a common group of diseases which may be diminished by hand washing. The cost-effective and simple power of hand washing with soap has been demonstrated in the few such investigations to date. These studies and the results of the current one strongly recommend a subsequent extension of the scope of such research and further large-scale application of such low-cost community interventions.

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