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Interruption of shigellosis by hand washing

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Summary

High attack rates, increasing resistance to antibiotics and high mortality make shigellosis a serious problem. As *Shigella* is associated with poor hygiene we examined the effectiveness of a simple intervention, washing hands with soap and water, in checking the spread of the disease.

The study population was comprised of confirmed cases of shigellosis. These and matched controls were followed up for 10 days. Several pieces of soap and earthenware pitchers for storing water were provided to the study families and they were advised to wash their hands with soap and water after defaecation and before meals. Compliance was monitored daily by observing the size of the soap and residual water. Rectal swabs of contacts of both the groups were obtained daily for culture.

The secondary infection rate was 10·1% in the study group and 32·4% in the control group. The secondary case (symptomatic) rate was 2·2% in the study group and 14·2% in the control group. These results suggest that hand-washing has a positive interrupting effect, even in insanitary environments.

Introduction

Shigellosis is a problem in many countries including the USA (Rosenburg *et al.*, 1976). A study in Dacca showed that 13·3% of the contacts of *Shigella dysenteriae* type 1 index patients developed symptomatic illness (Khan *et al.*, 1979). Gangarosa *et al.* (1970) found that the secondary attack rate for shigellosis in Guatemalan villages was 36·5% for males and 30·5% for females. Mendizabal-Morris *et al.* (1971) reported that fatality due to shigellosis was 4·8% in villages and 10 to 15% in acute hospitalized cases. The mortality rate in the ICDDR, B hospital has been 5 to 8% (unpublished observation). This rate is 8 to 12 times higher than the mortality rate of cholera and other watery diarrhoeas. In an outbreak in St. Martin island, Bangladesh, the mortality rate was 6·4% (Khan *et al.*, 1975). Thus case fatality rates due to shigellosis, even under institutional treatment, are among the highest in diarrhoeal diseases.

Extensive data from the USA shows that access to water has an effect on shigellosis prevalence (Levine *et al.*, 1976; KHAN *et al.*, 1968; Sprunt *et al.*, 1973; Merson *et al.*, 1975). The conditions in Bangladesh favour water-borne disease (Levine *et al.*, 1976). Preventive measures with hand pump tubewell water have not been effective against the spread of diarrhoea and Shigellae (Curlin *et al.*, 1977). Immunization has not been found promising. In 1968, broad spectrum antibiotics were quite useful in treating shigellosis in Dacca, but many strains of *Shigella* have acquired resistance to most antibiotics (Rahaman *et al.*, 1974, 1975). Investigators from different parts of the world have observed that resistance of *Shigella* to multiple antibiotics is building up steadily. This resistance creates special problems for developing countries where the incidence of shigellosis is high. The ability of a small number of *Sh. dysenteriae* type 1 to cause disease is also a problem (Levine *et al.*, 1973).

Simple hand-washing in USA was effective in preventing infection in children (Sprunt *et al.*, 1973). Although the evidence is not rigorous, hand-washing with soap and water helps to prevent nosocomial infection (Steere *et al.*, 1975).

We decided to use this simple procedure to attempt to prevent the spread of shigellosis. Health workers were employed to educate families and maintain surveillance to make sure that people washed their hands after defaecating and before eating food.

Methods

In this prospective study, study and control groups were all culture-confirmed shigellosis cases from the ICDDR, B clinic and were matched for age, sex and socio-economic status. The cases were alternately selected into groups given both soap and water, controls groups, and groups given either only water pitchers or only soap.

The study families were provided with two to four pieces of soap and one to three water pitchers depending on the requirement and size of the families and were urged to wash their hands after wshing the anus following defaecation and before taking any food. The quantities of soap and left-over water were checked daily by observing the size of the soap pieces and measuring the water. Each family was observed for one to two hours daily to assess their compliance with instructions. A further 50 families provided with soap only, and another 50 with water containers only, were also studied to compare the efficacy of soap and water independently. Control families were not provided with either.

Rectal swabs of family contacts of study and control cases were obtained daily for 10 days for culture on SS and MacConkey's media. Left hand washings were cultured in Gram-negative broth (G. N. broth, BBL, USA). Domestic water was cultured after millipore filtration. Sensitivity tests were done on Muller-Hilton plates using standard techniques.

A history of dysentery was obtained from cases and contacts. Contacts yielding the same types of isolates as the index cases were termed as secondary infections. When these contacts with secondary infections had three or more episodes of diarrhoea/dysentery in 24 hours they were termed secondary cases.

The differences in secondary infection and case rate between study and control groups were tested for statistical significance by the chi square test.

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Table I—Study and control groups compared

Groups	Household population excluding index	Percentage < 5 years	Average room/ family	Average member/ family	Average member/ room	Drink TW/Tap water	Used mixed sources of water for domestic use	Used Sanitary latrine
Study (soap + water)	279	23·3	1·56	5·6	3·1	94%	26%	36%
Control (no soap or water)	318	24·8	1·78	6·4	4·0	98%	20%	42%
Only soap	300	21·6	1·58	6·0	3·7	92%	32%	50%
Only water	299	23·1	1·72	6·0	3·3	93%	28%	56%

Table II—Secondary infection rates according to quantities of water used

Average quantity of water used		Study			Control		
		No. of Contacts cultured	No. Infected	Secondary Infection rate	No. of Contacts cultured	No. Infected	Secondary Infection rate
Drinking and Cooking	≤4·5 kg	25[a]	2	(8·0)	101[e]	35	(34·6)
	≥5·5 kg	165[b]	7	(4·2)	50[f]	15	(30·0)
Bathing and Washing	≤20 kg	41[c]	6	(14·6)	95[g]	21	(22·1)
	≥25 kg	66[d]	1	(1·5)	21[h]	3	(14·3)

a v. b N.S.*
c v. d (P<·01)
* Not Significant
e v. f N.S.
g v. h N.S.

Table III—Incidence of diarrhoea of unknown origin

Groups	No. of contacts who had diarrhoea of unknown cause	No. of contacts who had no diarrhoea of unknown cause	Total No.
Soap+water group	16[a]	213	229
Control group	30[b]	238	268
Total	46	451	497

χ^2 of a v. b = 2·6 = N.S.

Table IV—Prevalence of *Shigella* species other than that of index case

Groups	No. of Contacts	Number Infected	Infection rate	No. of symptomatic cases	Symptomatic case rate
Control group	268	15	(5·6)[a]	5	(1·9)
Excess water users group	249	15	(6·0)[b]	5	(2·0)
Total	517	30	(5·8)	10	(1·93)

a v. b = N.S.

Table V—Minimum cost of one hospitalized case of shigellosis

Item	Cost in Taka
Hospitalization, average stay 7 days @ 150 taka/day	1050
Patients Transport 2 trips @ 20 taka	40
Visitors Transport 7 days @ 5 taka	35
Attendant's wage loss (minimum) 7 days @ 20 taka	140
Patients wage loss 7 days @ 4 taka*	28
Total	1293 (US$ 83)

*Since 4 of 5 cases are children, only one out of 5 would be wage earners.

Table VI—Annual savings per family by adoption of the interruption technique

Group	No. of secondary cases in 10 days	No. of other shigellosis in 10 days	Expected annual cases in 100 families	Expenses for treatment of cases of 100 families	Annual expenses for intervention of shigellosis in 100 families	Net annual savings per 100 families
Study group 100 families	17	4	(17 + 4) × 36 = 756	Tk. 756 × 1293 = Tk. 977508ª = US$ 63065	Tk. 20 × 100 × 36 Tk. 72000ᶜ = US$ 4645	(b-a-c) ÷ 5* Tk. 646600 = US$ 41700
Control group 100 families	82	10	(82 + 10) × 36 = 3312	Tk. 3312 × 1293 = Tk. 4282416ᵇ = US$ 276285	—	—

*Since only one in 5 cases require hospitalization this figure is reduced by 80%.

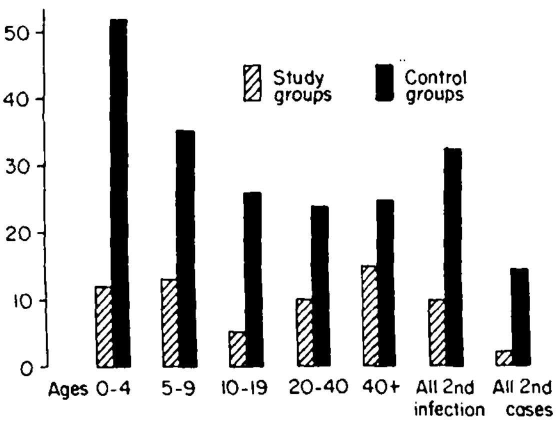

Fig. 1. Age-specific subsequent infection rates in study and control groups as percentages.

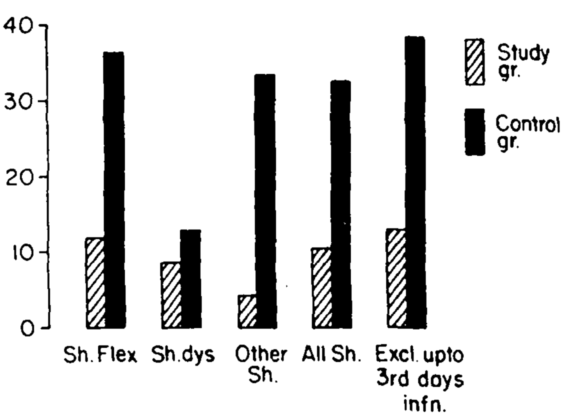

Fig. 2. Secondary infection rates in study and control groups by types and percentage of *Shigella* spp.

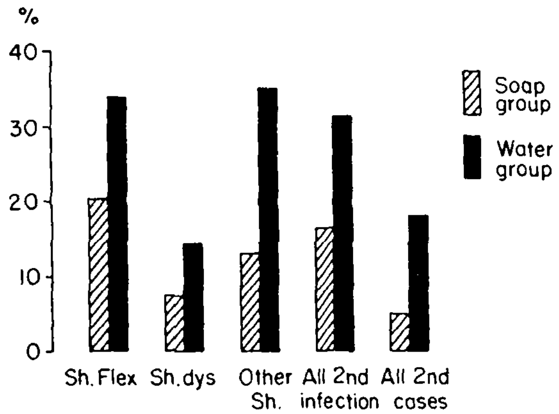

Fig. 3. Secondary infection of *Shigella* spp. in groups who used only soap or only water as percentages.

Results

Table I presents data on the essential comparability of the groups under study.

The age-specific secondary infection rates among the family contacts are shown in Fig. 1. The over-all infection rate was 10·1% for the study and 32·4% for the control group. Total reduction in secondary infection was 67%. This difference was highly significant (P<·01).

The over-all secondary case rate was 2·2% for the study and 14·2% for the control group. The over-all reduction in secondary case rate was 84%. This difference was also highly significant (P<·01).

The effectiveness of the intervention in the case of different types of *Shigella* is seen in Fig. 2. *Sh. flexneri* could be reduced by 67%, *Sh. dysenteriae* type 1 by 33% and other *Shigella* by 87%. Even if the possible co-primary positive isolates were excluded, the difference was statistically significant. The number of cases of the other two groups being small have been combined into one and is shown as other *Shigella*.

The relation between the quantity of water used per person per day and rates of secondary infection is shown in Table II. In the study group, the secondary infection rates were independent of the amount of water used for drinking and cooking, but were highly associated with the amount of water used for bathing and washing (P<·01). Among the controls however there was no association with the amount of water used and secondary infection rates.

Rates of infection in families who were provided with only soap or water pitchers are shown in Fig. 3. The *Shigella flexneri* secondary infection and case-rates for the soap-using group were significantly lower than the water-using group (P<·01). There was no significant difference for *Sh. dysenteriae* type 1 in this regard. There was, however, a suggestive difference for other *Shigella* species.

None of the 579 study and soap individuals whose left hand washings were cultured was positive for *Shigella*. Out of the 617 control and water group individuals seven were positive for *Shigella* (P<·025). Additionally, among the 432 sources of household water tested, two were culture positive for *Shigella*, one from each group.

In some diarrhoea cases no pathogen could be isolated (Table III). 7% of contacts in the study group and 11·2% in the control group developed diarrhoea. The differences were not significant.

In order to estimate the probable prevalence of shigellosis in the community we chose to analyse the non-intervention groups (control and water only). By looking at the contacts' frequency of isolation of *Shigella* species, other than that found in the index case, we can estimate community prevalence. The infection rate was 5·8% of whom 1·9% developed symptoms of dysentery from these two non-intervention groups (Table IV).

Discussion

The occurrence of shigellosis is directly related to sanitation yet even in developed countries it has not been eradicated. Confirming our previous study, this study shows that in any given 10 days nearly two out of 100 are sick with shigellosis, and four out of 100 are infected but asymptomatic. Thus extrapolating, in every hundred persons there are 70 shigellosis attacks annually.

We have also found that over any given 10 days 11·2% of the people suffer from diarrhoea of unknown origin which extrapolates to 403 additional episodes of diarrhoea per 100 persons per year. Also, considering the prevalence of NCV diarrhoea (0·3%), cholera (0·3%), rotavirus, ETEC and campylobacter it is not hard to see why over 20% of all deaths, especially of children, are claimed by diarrhoeal disease alone.

Practical solutions are needed when proper sanitation is not feasible and immunization does not help. Antibiotics are expensive and changing resistance patterns make drugs less efficacious. People use surface water which may transmit the organisms of diarrhoeal disease. Hand pump tubewells for drinking alone did not help in reducing diarrhoeal disease and cholera since other sources are used for bathing and washing.

Hand-washing seemed an effective and practical alternative. This study has shown that an additional quantity of water does not help much. Washing the hands with soap, however, markedly reduces the secondary infection and case rates. It is most effective in vulnerable younger groups possibly because mothers feed them. Adults often go out and do not have soap available for washing. The effects were most significant in all *Shigella* species except *Shigella dysenteriae* type I. Failure in *Sh. dysenteriae* type I might be due to its greater virulence and smaller dose requirement for infection (LEVINE *et al.*, 1973). Diarrhoeas due to other causes were also reduced (37%) by the use of soap and water.

The practice of using the left hand to wash the anus after defaecation is prevalent in this area. The results of the hand cultures show the distinct possibility of contamination of food or the right hand. If the few water-borne transmissions could have been prevented, a more dramatic success by the interruption could have been achieved.

The approximate cost of one hospitalized case of shigellosis is shown in Table V. Though shigellosis is said to be a self-limiting infection, mortality is about 10 to 15% of all affected hospitalized cases, in spite of the best institutional treatment. Even if only one of every five symptomatic cases need hospital treatment, the annual savings of a family brought about by this intervention would be significant. In addition, we suggest that adopting this type of intervention would result in an 80% reduction of hospitalization of dysentery cases due to shigellosis and a 37% reduction in occurrence of other diarrhoeas as well as producing significant financial savings (Table VI). Prerequisities are proper motivation and easily available soap. The practice needs to be implemented as a part of the national diarrhoeal disease control programme.

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