EPIDEMIOLOGIC STUDY OF DYSENTERY CASES OF DACCA URBAN AREA

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PREFACE

The International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) is an autonomous, international, philanthropic and non-profit centre for research, education and training as well as clinical service. The Centre is derived from the Cholera Research Laboratory (CRL). The activities of the institution are to undertake and promote study, research and dissemination of knowledge in diarrhoeal diseases and directly related subjects of nutrition and fertility with a view to develop improved methods of health care and for the prevention and control of diarrhoeal diseases and improvement of public health programmes with special relevance to developing countries. ICDDR,B issues two types of papers: scientific reports and working papers which demonstrate the type of research activity currently in progress at ICDDR,B. The views expressed in these papers are those of authors and do not necessarily represent views of International Centre for Diarrhoeal Disease Research, Bangladesh. They should not be quoted without the permission of the authors.

ABSTRACT

To characterize the epidemiologic pattern of shigellosis 47 families from which *Shigellae dysenteriae* type 1 was isolated, 11 families from which *Shigellae flexneri* was isolated and 23 control families have been studied in urban Dacca.

The secondary infection rates in children less than 10 years were 29.3% for *Shigellae dysentery* type 1, 24.0% for *Shigellae flexneri* and 10.6% for control group. The secondary case rates were 22.9%, 8.0% and 3.8% respectively in these 3 groups. None of the contacts aged over 10 years who developed *Sh.flexneri* infections or members of the control group were symptomatic. 65.3% of the infected contacts of the *Shigellae dysentery* group became symptomatic. All 3 groups had rates for mixed infections ranging from 4.6% to 6.4%. Undiagnosed diarrhoea in all 3 groups exceeded the number of secondary cases. Six percent of the control family members had infection with *Shigellae* and 2% of them had symptoms compared with 14.1% who had diarrhoea of unknown etiology, suggesting the presence of an unseen epidemic of dysentery/diarrhoea in these families. The secondary attack rates were higher in a case of a female aged 10 years or older or children of both sexes less than 9 years. Higher secondary attack rates were associated with use of water from open and closed sources together and use of open latrines. Secondary case rates were higher in the lowest socioeconomic group. At the time of this study all *Shigellae* were sensitive to ampicillin, kanamycin, colistin and furazolidone. Extensive community based study is needed to explore the extent of disease and possible intervention measures.

INTRODUCTION

With a reported case fatality rate of 0.24 per 1000, dysentery was not considered a great medical problem in Bangladesh (1). However, strains of *Shigellae* that were sensitive to most antibiotics have become resistant to several antibiotics during the past decade (2). Shigellosis has now been shown to be associated with a high rate of morbidity and mortality in Bangladesh (3), similar in pattern to that seen in the United States during the 1940s (4). The mortality rate from shigellosis has been found to be higher than for cholera cases treated in the wards of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), Dacca (unpublished observation). During the past decade, the *Shigellae flexneri* was the most common type isolated (2). During the period of war (1971-73), the incidence of *Shigellae dysenteriae* type 1 increased manyfold. This species caused 8300 deaths in Guatemala in 1969 (5). Comparable statistics for shigella related deaths in Bangladesh are not presently available.

The hazards of shigellosis included prolonged illness, high death rates, development of drug resistance and an increase in the rate of *Shigellae dysenteriae* type 1 isolation prompted us to look more closely at the epidemiological features of shigellosis. We also explored the epidemiological characteristics of *Shigellae dysenteriae* type 1, *Sh.flexneri* and other dysentery-like illnesses not associated with *Shigellae* to see if differences could be found.

BACKGROUND

The population of Dacca, the capital of Bangladesh, has increased rapidly. In 1961 the population was 556,712 (6); by 1974 the population had increased to 1,310,975 (7). During the war of liberation (1971) majority of the residents left Dacca for the villages or West Bengal in India. After liberation, most of the refugees returned to Dacca. In addition, many villagers rushed to Dacca in search of employment. A marked upheaval of the urban population resulted in the deterioration of an already marginal sanitation system and created a severe housing problem in the city. People constructed innumerable bamboo or plastic-covered huts on any available public land, preferably near a source of surface water, with little or no attention to sanitation.

The ICDDR,B (former Cholera Research Laboratory) has been the principal facility to which most of the cases of diarrhoea and dysentery, occurring in and around Dacca, were referred for free investigation and treatment. This offered an unique situation for the study of dysentery occurring in an urban area. A prospective study of dysentery was conducted during the period August through December, 1972.

MATERIALS AND METHODS

Culture confirmed cases of shigellosis and patients with a clinical diagnosis of dysentery were identified on the CRL ward service. From this groups index cases and their families were randomly selected for study. Culture negative hospitalised dysentery like cases were similarly selected as controls. Steps followed were identical for all groups of families. Trained field workers interviewed the study cases and controls or their contacts in the hospital and then visited their families, taking one of the attendants as a guide. Every family was interviewed daily for 10 days and questioned concerning the presence of diarrhoeal illness. Rectal swabs were obtained for culture. Adult wage earners were not always available for culture. Family members who were cultured for less than 3 days were excluded from analysis unless a positive culture was obtained during the home visits. Demographic and socioeconomic data were collected. Sanitary facilities, water use, and housing were also noted.

Rectal swabs were cultured using Salmonella-Shigella agar (SS agar) and MacConkey's agar plates. After overnight incubation, suspected colonies were subcultured in Kliglar iron agar, motility indole urea (MIU) and Simmon's citrate media for confirmation. Slide bacterial agglutination tests were performed the following day with type specific *shigellae* antisera. Multodisks (Oxoid Ltd., London) were used to assess antibiotic sensitivity.

A mixture containing kaolin powder and tincture of cardamom was supplied to mild diarrhoea cases as a placebo. Family members having clinically significant diarrhoea/dysentery were referred to the ICDDR,B hospital for treatment. Contacts yielding positive cultures identical to index cases and having clinical findings consistent with dysentery (3 or more loose stools with or without mucous and/or blood within a 24 hour period) were defined as secondary cases. A contact yielding a positive culture was defined as "infection", a contact yielding

only positive culture but no symptom was termed "inapparent infection". Contacts having infection with *shigellae* different from the index cases were termed "infection with other types" and contacts suffering from diarrhoea without any *shigellae* or known infection were defined as "diarrhoea/dysentery of unknown cause".

Only a few index cases were infected with *Sh.boydii* or *Sh.sonnei* and they have been omitted from analysis.

RESULTS

Table 1 shows the number, age and sex distribution of the index cases admitted to the study. A total of 81 index cases and their families were followed. The index cases were distributed by etiology as follows: 47 *Shigellae dysenteriae* type 1, 11 *Shigellae flexneri*, and 23 Controls. Majority of the cases in all groups were infants below the age of 5 years. In the group *Shigellae dysentery* type 1, males were 66% and females 34%. In other two groups, male and female distribution were more or less identical.

Table 2 shows the age, sex and secondary infection rates in contacts of the index cases. In the group of patients with *Sh.dysenteriae* type 1, the secondary infection rate was 35.7% for male and 23.8% for female family members under the age of 5 years. It was identical in the age group 5-9. For the age groups 10 and over the rates were 14.0% and 12.3% for male and female family members respectively. The overall secondary infection rates were 25.5% for males and 16.7% for females. These differences were statistically significant ($P<.02$) when the age group 0-9 and 10 and over were compared.

In families where the index cases was infected with *Shigellae flexneri* the secondary infection rates in contacts were considerably less for the age group 0-4 years than in the age group 5-9 years. For the 5-9 years olds the rates were 40.0% for male and 27.3% for female. In persons aged 10 years and older, the infection rate for males was 16.7% and for females 18.8%. The overall rate for contacts infected with *Shigellae flexneri* was 25.0% for males and 19.4% for females which are similar to the rates seen with *Shigellae dysenteriae* type 1.

In patients with clinical dysentery who were culture negative, the highest rate of subsequent infection was 9.1% in male and

TABLE 1

DISTRIBUTION OF INDEX CASES STUDIED BY AGE, SEX

AND FOR SHIGELLAE TYPE AND CONTROL

Age groups	Sh. dyst. type 1			Sh. Flexneri			Controls (dysentery like)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
All ages	31	16	47	5	6	11	13	10	23
0-4	24	12	36	4	4	8	8	5	13
5-9	5	1	6	-	1	1	4	2	6
10 and over	2	3	5	1	1	2	1	2	4

TABLE 2

SECONDARY INFECTION RATES(PER 100 CONTACT) BY AGE, SEX

FOR SHIGELLAE TYPE AND CONTROL

Age	Shigellae dysentery type 1				Shigellae flexneri				Control (dysentery like)			
	Male		Female		Male		Female		Male		Female	
	No.Cont.	Rate	No.Cont.	Rate	No.Cont.	Rate	No.Cont.	Rate	No.Cont.	Rate	No.Cont.	Rate
All ages	102	25.5	138	16.7	16	25.0	31	19.4	43	4.7	56	7.1
0-4	28	35.7[1]	21	23.8	5	20.0	4	0.0	15	6.7	13	7.7
5-9	24	37.5[2]	36	22.2	5	40.0	11	27.3	11	9.1	13	15.4
10 & over	50	14.0[3]	81	12.3	6	16.7	16	18.8	17	0.0	30	3.3

(1 + 2 Vs 3 $p<0.02$)

15.4% in female in the age group 5-9 years. Children aged 0-4 years had the next highest rates of infection. The overall rate for males was 4.7% and for females 7.1%. These differences were not statistically significant.

In the first 2 groups, the males less than 10 years of age had higher secondary attack rates than females of the same age. The rate for female children of the control group was higher than for male. The attack rates however, in persons greater than 10 years of age were nearly equal for both sexes.

Table 3 shows the development of secondary cases among the contacts who had acquired the same types of infections as the index cases. For *Sh. dysenteriae* type 1, 100% of the infected children aged less than 5 years developed sysptoms. In the age group 5-9 years and 10 years or older, the secondary case rates among the infected contacts were 58.8% and 41.2% respectively. The secondary case rate among all infected contacts was 65.3%. The overall secondary infection rate and secondary case rates (including all contacts) were 20.4% and 13.3% respectively.

In the *Shigella flexneri* infected group, the secondary case rate among infected contacts was highest in the age group 5-9 years (40.0%). The combined secondary case rate for infected contacts of all ages was 20.0%. The overall secondary infection rate among all contacts was 21.2% and secondary case rate was 4.3%, considerably less than the rates for patients infected with *Sh.dysenteriae* type 1. The differences in the attack rates between *Sh.dysenteriae* type 1 and *Sh.flexneri* were not however, statistically significant, but the difference in the infection to case rate was statistically significant ($P = <.01$).

In the control group the subsequent case rates among infected contacts, was 50.0% in 0-4 years age group, and 33.3% in the 5-9 years age group. The overall subsequent infection and case rates among all contacts were 6.1% and 2.0% respectively.

Table 4 shows the rates of mixed infection, secondary case rates and the rates of diarrhoea of unknown causes among the family contacts of different groups by age. In all three groups, the rates of mixed infections, the rates of subsequent cases due to same type of infection, and the rate of diarrhoea of unknown causes were about twice the rate in children up to 9 years, compared to contacts 10 years and older. Shigella species different from the index case were isolated in 4.6% of

SECONDARY CASE RATES (PER 100 INFECTION) BY AGE, SEX, FOR SHIGELLAE TYPE AND CONTROL

Age	Shig. dyst. type 1		Shig. flexneri		Control	
	No. of infection	Rate (1)	No. of infection	Rate (2)	No. of infection	Rate (3)
All ages	49	65.3[a]	10	20.0[b]	6	33.3
0-4	15	100.0	1	0.0	2	50.0
5-9	17	58.8	5	40.0	3	33.3
10 & over	17	41.2	4	0.0	1	0.0

a Vs. b * $p < 0.01$

TABLE 4

MIXED INFECTION RATE AND DIARRHOEAL ATTACK RATE(PER 100 CONTACTS)

BY AGE, SHIGELLA TYPE AND CONTROL

Age group	Sh. dyst. type 1			Sh. Flexneri			Control(dysentery like)		
	Inf. with other Shig.	Diar. with other Shig.	Diarr.of unknown cause	Inf. with other shig.	Diarr.with other shig.	Diarr.of unknown cause	Inf. with any shig.	Diar.with any shig.	Diar.of unknown cause
All ages	4.6(11)	2.1(5)	21.2(15)	6.4(3)	2.1(1)	14.9(7)	6.0(6)	2.0(2)	14.1(14)
0-4	8.2(4)	4.1(2)	30.6(15)	11.1(1)	11.1(1)	44.4(4)	7.1(2)	3.6(1)	17.8(5)
5-9	5.0(3)	3.3(2)	33.3(20)	12.5(2)	0.0(0)	12.5(2)	12.5(3)	4.2(1)	20.8(5)
10 & over	3.0(4)	0.8(1)	12.2(16)	0.0(0)	0.0(0)	4.5(1)	2.1(1)	0.0(0)	8.5(4)

contacts where the index case was infected with *Shigella dysenteriae* type 1. Similarly 6.4% of contacts in the *Shigella flexneri* exposure group and 6.0% in control group had infections with different Shigella species. The subsequent case rates for mixed infections for the three groups were 2.1%. Rate of the diarrhoea of unknown etiology were 21.2% in the *Shigella dysenteriae* type 1 group, 14.9% in *Shigella flexneri* group and 14.1% in control group. Mixed infection rates were also higher among children than adults.

The rate of hospitalisation of contacts with dysentery is shown in Table 5. The hospitalisation rate of contacts of *Shigella dysenteriae* type 1, was 2.1%. None of the contacts of *Shigella flexneri* group or the control group required hospitalisation. The ratio of infection to secondary cases and hospitalisation were not uniform.

The percentage of families in the three different groups, who had mixed infections is shown in Table 6. Of the 47 families affected with *Shigella dysenteriae* type 1, 9 families had mixed infection or one out of every five families. In these families 9 contacts had infection with *Shigella flexneri*, one had *Shigella boydii* and three *Shigella sonnei*.

Out of the 11 families in the *Shigella flexneri* group three had mixed infections. All three had infection with *Shigella dysenteriae* type 1.

In the control group, one out of 23 or 4.3% had mixed infection. Two contacts had infection with *Shigella dysenteriae* type 1 and three had infection with *Shigellae flexneri*.

Table 7 shows the secondary infection rates by age and sex of the index cases. For index cases less than 10 years of age, the secondary infection rate for *Shigella dysenteriae* was 19.9% for *Shigella flexneri* 20.0% and in the control group 5.0%. If the index cases were males aged 10 and over, the secondary infection rates were zero in all the three groups. When the index cases were females 10 years of age and older, the secondary infection rates were 35.0% for *Shigella dysenteriae*, 50% for *Shigella flexneri* and 14.3% for the control group. The difference in the secondary infection rates between families where children were index cases and families with adult male index cases were, highly statistically significant ($P = <.001$).

Isolation of shigella from contacts were common during the 10 day follow-up period. Serial isolation data is shown in

TABLE 5

SECONDARY INFECTION, CASE AND HOSPITALISATION RATES BY SHIGELLA TYPE AND CONTROL

Contacts of Index cases	Secondary Inf. rate per 100 contacts	Secondary Case rate per 100 infection	Hospitalisation Rate per 100 infection	Infect: Case Hospitalisation Ratio
Shig. dyst. type 1	20.4	13.3	2.1	9.8:6.4:1
Shig. flexneri	21.3	4.2	0	5:1:1
Control (dysentery like)	6.1	2.0	0	3:1:0

TABLE 6

RATES OF MIXED INFECTION BY TYPE OF SHIGELLAE OF INDEX FAMILIES AND CONTROL

Shigella type	No. of families	No. of family with mix inf.	Rate of mix inf. families	Inf. other than indexes			
				Sh.D.T$_1$	Sh.Flex	Sh.Boyd.	Sh.Sonnie
Shig. dyst. type 1	47	9	19.1	-	9	1	3
Shig. flexneri	11	3	27.3	3	-	-	-
Control (dysentery like)	23	1	4.3	2	3	-	-

TABLE 7

SECONDARY INFECTION RATES* (PER 100 CONTACT) BY AGE AND SEX OF INDEX AND FOR SHIGELLAE TYPE AND CONTROL

Age/Sex of Index	Shig.dyst. type 1		Shig. flexneri		Control	
	Persons	Rate	Persons	Rate	Persons	Rate
Both sexes (0-9)	211	19.9	40	20	79	5.0
Males 10 and over	9	0.0	3	0.0	6	0.0
Females 10 and over	20	35.0	4	50.0	14	14.3

* The rates of children(both sexes 0-9) differ from those of males 10 and over significantly($P < 0.001$) Shigdyst. type 1, flexneri and control

Table 8. In the *Shigella dysenteriae* group, 51% of isolations were obtained on the first and second day of follow-up. Isolation were made as late as 10 days. In the *Sh.flexneri* group, 30% of the isolations were obtained on the first day and isolation were made as late as the 8th day. In the control group 66.7% isolations were on the first day. In all the three groups the isolations were not continuous in character and there were some days when there were no isolations.

The relationship between the secondary infection rate and the number of persons per room of the house is shown in Table 9. In families where the total number of persons including the index case does not exceed 5 per room the rate of infection was 21.6% for *Shigella dysenteriae* type 1, 22.6% for *Shigella flexneri* and 2.5% for controls. If there were six persons per room or over, the secondary infection rates were 18.9% for *Shigella dysenteriae* type 1, 17.6% for *Shigella flexneri* and 20.0% for controls. In families with shigella infected index cases, the rates were higher in smaller families than the larger ones. But in the cases of non-shigella index families the secondary infection rate was higher in larger families.

Table 10 compares family income to secondary infection rates. The families have been grouped arbitarily into three income groups. In the group with a *Shigella dysenteriae* type 1 index case, the highest rate of secondary infection (23.6%) was found in the lowest income group and the lowest rate of secondary infection (13.8%) was found in the highest income group. In the *Shigella flexneri* and control groups all the cases were from the lowest income groups. These differences were not statistically significant.

The spread of shigellosis through water has not been clearly demonstrated. Table 11 shows the pattern of association of water used either from closed sources and open and closed sources together. Families infected with *Shigella dysenteriae* type 1 who used water from both closed and open sources had a secondary infection rate of 28.2% as compared to 12.0% among users of closed water sources.

In families infected with *Shigella flexneri*, the users of water from mixed sources had a higher rate (23.8%) of secondary infection when compared to users of water from closed sources (17.7%). In the control group the same pattern was observed. This indicates a potential association of water quality with the spread of shigellosis. The differences for the *Shigella dysenteriae* group was statistically significant ($P = <.01$).

TABLE 8

RATES OF ISOLATION OF SECONDARY INFECTION FROM CONTACTS ON DAYS 1 - 10

Type of Index	- D A Y S -									
	1	2	3	4	5	6	7	8	9	10
Percent	26.5	24.5	10.2	8.2	6.1	-	4.1	2.0	8.2	10.2
Sh. dyst. type 1	13	12	5	4	3	-	2	1	4	5
Percent	30.3	-	-	-	10.0	30.0	20.0	10.0	-	-
Sh. Flex	3	-	-	-	1	3	2	1	-	-
Percent	66.7	16.7	-	-	-	-	-	16.7	-	-
Control	4	1	-	-	-	-	-	1	-	-

TABLE 9

SECONDARY INFECTION RATES (PER 100 CONTACTS) BY CROWDING AND FOR SHIGELLAR TYPE AND CONTROL

No. of persons per room	Shig. dyst. type 1		Shig. flexneri		Control	
	Persons	Rate	Persons	Rate	Persons	Rate
2-5	134	21.6	30	23.3	79	2.5
6 +	106	18.9	17	17.6	20	20.0

SECONDARY INFECTION RATES (PER 100) CONTACT BY FAMILY INCOME

AND FOR SHIGELLAE TYPE AND CONTROL

Monthly Income (taka)	Shig. dyst. type 1		Shig. flexneri		Control	
	No. contacted	Rate	No. contacted	Rate	No. contacted	Rate
All incomes	230	20.4	47	21.2	99	6.1
Upto 400	154	23.6	47	21.2	83	7.2
401-600	57	15.8	0	0.0	11	0.0
601 and over	29	13.8	0	0.0	5	0.0

TABLE 11

SECONDARY INFECTION RATE (PER 100 CONTACT) BY WATER SOURCE

AND FOR SHIGELLAE TYPE AND CONTROL

Water Source	Shig. dyst. type 1		Shig. flexneri		Control	
	Persons	Rate	Persons	Rate	Persons	Rate
Mixed source Tap/T.well/Dw	124	28.2[a]	35	23.8	38	10.5
Closed source	116	12.0[b]	12	17.7	61	3.3

a vs b : $P < 0.01$

The use of closed versus opened latrines by the members of the affected families is compared with secondary attack rates in Table 12. In all three groups those who used open latrines had a higher secondary attack rate than users of closed latrines. The secondary attack rates for open latrine users ranged from 11.3% to 23.5% compared to rates of zero to 20.0% in closed latrine users. These differences were not statistically significant.

Table 13 shows the antibiotic sensitivity patterns of shigella isolates. The three isolates tested, *Shigella dysenteriae* type 1, *Shigella flexneri* and *Shigella sonnei* were uniformly sensitive to Ampicillin, Kanamycin, Colistin, and Furazolidone. All *Shigella sonnei* isolates were sensitive to chloramphenicol. All three species had isolates resistant to Tetracycline and Streptomycin with the most resistant strain being *Shigella dysenteriae* type 1. This was the pattern up to the time of this study.

DISCUSSION

As observed earlier by Reller *et al.*, (9) shigellosis is most common in the age group 0-9. Over 65% of all the secondary infections and 78% of the secondary cases of *Shigella dysenteriae* type 1 occurred in this age group. This pattern was also seen for *Shigella flexneri* and the control groups. Male children had higher attack rates than female children, confirming the sex specific prevalence rates (9) in the U.S.A. A possible explanation for the high prevalence rate among children is poor hygiene including lack of hand washing at meal time. Other factors which might play a role in the prevalence of shigellosis in young children include close social contact with adult carriers or other children, more frequent exposure to contaminated water sources through frequent swimming and lack of acquired immunity.

Secondary infection rates are higher in families with female index cases despite the overall lower secondary infection rate in females compared to males. This finding may be due to their association with preparation and distribution of food and drink.

65.3% of the contacts infected with *Shigella dysenteriae* type 1 developed symptoms compared to only 20% of the contacts infected with *Shigella flexneri*. The relative rates of

TABLE 12

SECONDARY INFECTION RATE(PER 100 CONTACT) BY PLACE OF DEFAECATIONS AND FOR SHIGELLAE TYPE AND CONTROL

Place of defaecation	Shig. dyst. type 1		Shig. flexneri		Control	
	Persons	Rate	Persons	Rate	Persons	Rate
Open latrine	170	23.5	42	21.4	53	11.3
Closed latrine	70	12.9	5	20.0	46	0.0

TABLE 13

SENSITIVITY OF SHIGELLAE TO ANTIBIOTICS

Shigellae type	Number examined	Percent (Number) sensitive to						
		Tetra-cycline	Ampi-cilline	Chloro-mycetin	Strepto-mycin	Kanamycin	Colist Meth. Sul.	Furazolidone (Furoxone)
Shigella dyst.type 1 (A)	93	2.1 (2)	100.0 (93)	65.0 (61)	6.4 (6)	100.0 (93)	100.0 (92)	100.0 (88)
Shigellae flexneri (B)	34	79.0 (27)	100.0 (34)	94.0 (32)	50.0 (17)	100.0 (34)	100.0 (34)	100.0 (34)
Shigella sonnie (D)	5	80.0 (4)	100.0 (5)	100.0 (5)	20.0 (1)	100.0 (5)	100.0 (5)	100.0 (5)

pathogen virulence and host susceptibility needs to be explored. The presence of shigella infection among the contacts of non-shigella controls is interesting. The rate of secondary infection in controls is about one third of that of the shigella infected families. This indicates that shigellosis is widespread in the community. It is calculated that for every 100 people 219 episodes of shigella infection per year may be expected and 73 episodes of clinical dysentery result. A thorough community based study is needed to further clarify these findings.

Another interesting finding is the large number of diarrhoea cases not explained by the usual pathogens, i.e. *Shigella*, *V.cholerae*, *Salmonella* and *E.coli*. The rate of diarrhoea of unknown etiology was higher than the secondary case rates with known organisms in all three groups. Some of these diarrhoea cases might be caused by the same organisms as the index cases which were not detected. The other possible cause is ETEC, a possibility not explored in this study. Another possible cause is rotavirus infection. The facility for identification of rotavirus did not exist at the time of this study in our laboratory. Supporting this hypothesis, many of the undiagnosed diarrhoeas of infants are, now, found to be rotavirus diarrhoea (10). If the rate of diarrhoeas of unknown origin is calculated on annual basis than there would be 511 episodes of diarrhoea annually for every 100 in addition to the diarrhoeas of known origin. The total loss of working days per year can be imagined. Therefore, the extent and route of spread of rotavirus and other infections in the community needs to be investigated thoroughly.

In a few cases, two types of shigella existed in one patient. This may indicate that *Shigella* do not involve cross-resistance as is seen in cholera.

Secondary case rates, case to infection ratios and hospitalisation rates due to *Shigella dysenteriae* type 1, are all higher than the *Shigella flexneri*. It may be inferred that the severity and virulence of *Shigella dysenteriae* type 1 is greater than the *Shigella flexneri* group as has been reported earlier (11).

The high secondary infection rates, among the contacts of female index cases aged 10 years and over is best explained by the social practice of women being responsible for preparing food and drink for all family members. Adult males, on the otherhand, work outside the home and pass stool where the possibility of infecting other family members are rare.

From data on isolation of subsequent infections in the three study groups, it is evident that the first waves of infection were succeeded by second waves. In fact, some of the subsequent infections may be co-primary cases. Infections occurring later are most likely due to spread of infection from an infected family member to a susceptible.

On the 10th day of follow-up, 10% of cases were still positive for *Shigella dysenteriae* type 1. Had further, follow-up occurred, it might be possible to establish that the wave of secondary infection would not subside until the exhaustion of susceptible family members.

The association between the subsequent infection rates in the *Shigella dysenteriae* type 1 and *Shigella flexneri* families, and the crowding could not be established from this study. The association between the income and secondary infection rates indicates that hygienic conditions, which would be expected to vary with income, may have some role in the spread of disease. But factors other than income obviously have a role as shigellosis has not been eradicated from highly developed countries.

Though other investigators have suggested that shigellosis might be waterborne we could not thoroughly examine this possibility. It is clear from our data that water quality has direct role. We could not establish directly the relationship between use of open latrines and disease. There are several hypotheis. It is the poor who use open latrines. They often do not have the means to adequately cleans their hands after defecation, as soap is often lacking. Flies may act as a mechanical carrier, transporting bacteria direct from the stool or open latrine to the food. During a shigella epidemic on St. Martin Island (8) this mode of spread was considered the most probable.

There is a world wide trend for the development of antibiotic resistance by all shigella species. We have observed a marked change in sensitivity patterns over the past 7 years. There are reports of development of resistance against Ampicillin, by *Shigella* species. One has to be very cautious in diagnosing diarrhoea and treating shigellosis, especially in prescribing a drug without sensitivity testing.

In summary, we need further exploration of the extent of diarrhoea and dysentery, their causes, routes of spread and possible intervention measures.

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