East African Medical Journal Vol. 76 No 5 May 1999
INTRAFAMILIAL PERSON-TO-PERSON SPREAD OF BACILLARY DYSENTERY DUE TO *SHIGELLA DYSENTERIAE* IN SOUTHWESTERN SAUDI ARABIA
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ABSTRACT

Objective: To identify the factors that influence transmission of bacillary dysentry (BD) within families during a propagated outbreak of bacillary dysentery.
Design: A retrospective cohort study.
Setting: Eighteen neighbouring villages in rural Gizan, southwestern Saudi Arabia.
Subjects: Two hundred and thirty three cases of BD were identified among seventy nine families.
Results: Secondary cases of BD occurred in 57 of 79 families with a primary case of BD. The secondary attack rate per cent (AR%) within families ranged between 7.7% and 80%. Age of primary cases did not correlate with degree of secondary AR% in exposed families (p>0.04; p>0.05); however, within households, the age of the first secondary cases (median = two years) was usually less than the age of the primary case (median = six years). Children under five years of age constituted 43% of secondary cases. The median interval between successive cases within a house ranged from three and seven days. Two hundred and twenty cases (94.4%) gave history of close contact within another case of BD. Cases of BD were exposed to close relatives with BD (79.1%), neighbours (11.4%), and friends (9.5%). Risk factors influencing the spread of BD within families included two rooms or fewer per house (OR = 4.3, 9.5% CI 1.3-14.3), family size of five or more (p = 0.012, two-tailed Fisher's exact test), and presence of more than two persons per room (OR=11.2, 95% CI 3.1-42.4).
Conclusion: Person-to-person secondary transmission can amplify the spread of bacillary dysentery within households and neighbouring villages. Crowding was a risk factor that amplified transmission of BD within families.

INTRODUCTION

Bacillary dysentery (BD) is an acute infectious disease mainly of the large bowel, caused by bacteria of the genus *Shigella* and enteroinvasive *Escherichia coli*(1). *Shigellae* require a small ineffective dose and are transmitted via children's fingers and to food, to water that is being transported or stored, to the hands of other children, and ultimately to the mouths of other susceptible individuals. The spread of BD could be person-to-person(2) or mechanically by insects(1). Studies have shown that about 20% of persons will acquire infection when an index case is introduced into the family(3). Secondary person-to-person transmission of shigellosis has resulted in disseminated outbreaks(4). The risk of communication exists until the organism is no longer in faeces(5). The rate of secondary infection has been shown to be high in children under five years of age(3). Major epidemics of shigellosis have been reported in Guatemala, Bangladesh, Somalia and Scotland(6).

The incubation period for shigellosis is one to seven (usually three) days(1). Application of isolation techniques and widespread administration of antimicrobial agents have failed to completely control institutional shigellosis(8). Nevertheless, hand washing has been found to be an effective control measure even in areas with poor environmental sanitation(9). Also, protection of food supplies and adequate refrigeration were found important in reducing the possibility of common-source infection(7).

In Saudi Arabia, *Shigella* spp are important aetiological agents of childhood gastroenteritis(10). In May 1993, a series of dysentery episodes within two families was reported in Tabuk, northwestern Saudi Arabia; illness ensued after a visit to Gizan in southwestern Saudi Arabia. *S. dysenteriae* type 1 was isolated from 12 family members with BD. More cases of BD due to *S. dysenteriae* type 1 associated with travel to southwestern Saudi Arabia were reported from hospitals in other parts of Saudi Arabia (Najran, Dammam and Asir) around the same time(11).

The purpose of this study was to investigate the spread of BD within families, characterise the epidemic features and to identify the factors that influence transmission of BD within families.

MATERIALS AND METHODS

Gizan, a relatively densely populated region in southwestern Saudi Arabia (over 1.2 million people), is predominantly rural and encompasses more than 4,000 villages. Administratively, it is divided into nine sectors. People are relatively poor and uneducated. The level of environmental sanitation in the villages is generally inadequate.

A case of bacillary dysentery was defined as development of clinical disease with diarrhoea and/or bloody mucoid stools (if parasitologic stool examination had excluded amoebiasis) during the study period (November 20, 1992 to May 13, 1993). Sources of data for this investigation were: the regional referral hospital (at Gizan City), district hospitals (secondary care hospitals at sectors), primary health care centres (PHCCs) in the affected villages, and family members of the identified cases. We reviewed medical records of all cases of bloody diarrhoea during the study period for parasitologic and bacteriologic testing. We visited all the houses of BD patients and interviewed members of affected families to assess risk factors for secondary transmission of BD. We identified new or unreported cases of BD through interviews and school visits. Dates of occurrence of BD episodes within families were ascertained. Patients were asked about contact with other BD patients prior to the onset of their illness. Mothers of children under two years of age were asked how they fed their children.

Identified cases were subdivided into primary (the first case of BD in a household) and secondary cases of BD (cases of BD other than the first one in the same household). The secondary attack rate per cent (AR%) was calculated as follows: (number of cases of BD in a family minus 1) divided by (total number of family members minus 1) multiplied by 100(12).

Risk factors for having more than one case of BD in the same house were identified. We used Epi Info (version 5.01b) for data entry and analysis(13). We compared housing and family conditions to identify reasons why families would have more than one case. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. Statistical differences between groups were assessed by the Student's t-test or by Fisher's exact test where indicated. Correlation coefficient (r) was calculated on examining the relationship between the age of the primary cases and secondary AR% within the affected families.

RESULTS

During the study period, 233 cases of BD comprising 133 males (57.1%) and 100 females (42.9%) were identified among 29 families from over 18 villages. Five sectors were affected, but most cases (68.4%) occurred in two neighbouring sectors, Abu-Arish and Samtah. The epidemic curve showed that outbreak of BD spread from one village to another (Figure 1). Majority of all cases (92.3%) were Saudi; the remaining 7.7% were Yemeni (Table 1). One hundred and ninety cases (81.5%) were seen at PHCCs, and 115 patients with BD were referred to or admitted directly to provincial or regional referral hospitals.

Figure 1

A graph showing sequential appearance of bacillary dysentery (BD) in two administrative health sectors (Abu-Arish and Samtah) in Gizan, southwestern Gizan. 1992-1993. Each graph represents data from one village. Each column of graph represents an administrative health sector

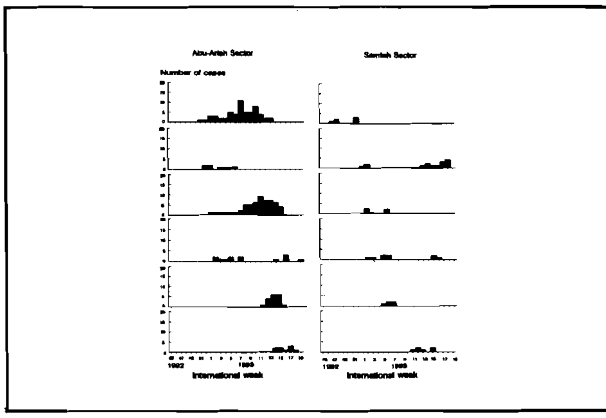

Table 1

Profile of cases of bacillary dysentery, Gizan, Saudi Arabia November 1992 - June 1993

Demographic profile of all cases of bacillary dysentery:	
Number of families	79
Family size (mean, SD)	9.0 (3.4)
Total number of cases	233
Nationality (N, %)	
Saudi	215 (92.3)
Yemeni	18 (7.7)
Male/female ratio (primary and secondary case)	1.3
Mean age in years (SD)	9.7 (11.3)
Profile of the first (index) cases of bacillary dysentery:	
Number of cases less than 30 years of age	74 *
Age (mean, SD): **	
Males (N=39)	6.7 (4.8)
Females (N=35)	8.6 (5.7)
Median age:	
Males	5.5
Females	7.0
Male/female ratio (index cases only)	1:1
Housing conditions [(mean ± SD (range)] of families with BD (N=79):	
Number of rooms	2.6 ± 1.5 (1-9)
Persons per room	4.0 ± 2.5 (1-11)
Number of kitchens	1.1 ± 0.4 (0-3)
Number of bathrooms	1.7 ± 0.9 (0-6)

* 5 Cases of BD were above 30 years of age and were excluded in calculation of the mean and SD.

** There is no statistical difference between boys and girls (t-test between 2 means, p>0.05).

Community- and hospital-based interviews showed that the sequence of symptoms was almost identical in all BD cases. The condition starts with sudden onset of abdominal pain, cramps, fever, and watery diarrhoea due to jejunal involvement, followed by a second diarrhoea characterised by frequent scanty stools containing blood, mucus and pus. Tenesmus was reported in seven patients (3.0%). Four isolates of *S. dysenteriae* type 1 were obtained from four cases of BD in different villages. Isolates showed the same antibiogram; they were resistant to cotrimoxazole, chloramphenicol, tetracycline and ampicillin but sensitive to nalidixic acid and gentamicin. No other bacteria or parasite was isolated.

The mean (SD) size of the affected families was 9.0 (3.4) persons living in 2.6 (1.5) rooms. Within households, the age of the first secondary cases (median = two years) was usually less than the age of the primary case (median = six years). There were 45 cases of BD in children under two years of age. Of those, only two children (4.4%) were on exclusive breast-feeding, 22 (48.9%) on bottle feeding, 16 (35.6%) on both (breast- and bottle-feeding), and five (11.1%) on regular table food.

Secondary cases of BD occurred in 57 families (72.2% of all families affected). The secondary AR% within families ranged between 7.7% and 80%. Children under five years of age constituted 43.5% of secondary cases (Table 2). The first secondary case was usually a child under two years of age (15.2%). There were up to seven secondary cases in the same household. The median duration between successive cases within a house ranged between three and seven days, the intervals between cases became relatively shorter as the number of secondary cases within families increased (Table 3). Two hundred and twenty patients (94.4%) gave a history of close contact with another person who had bloody diarrhoea; 13 (5.6%) could not recall being exposed to BD. Sources of infection were close relatives (parents, brother or sister) (79.1%), neighbours (11.4%), and friends (9.5%).

Table 2

Age/sex distribution of all cases of bacillary dysentery, Gizan region, Saudi Arabia November 1992- June 1993

	Primary cases of BD				Secondary cases of BD					
	Male		Female		Male		Female		Total	
Age (years)	N	%	N	%	N	%	N	%	N	%
0-0.9	3	7.1	1	2.7	4	4.4	4	6.3	12	5.2
1.0-1.9	4	9.5	4	10.8	16	17.6	9	14.3	33	14.2
2.0-2.9	2	4.8	1	2.7	3	3.3	1	1.6	7	3.0
3.0-3.9	2	4.8	2	5.4	10	11.0	6	9.5	20	8.6
4.0-4.9	3	7.1	3	8.1	8	8.8	6	9.5	20	8.6
5.0-5.9	6	14.3	2	5.4	1	1.1	4	6.3	13	5.6
6.0-6.9	2	4.8	2	5.4	3	3.3	5	7.9	12	5.2
7.0-7.9	2	4.8	3	8.1	5	5.5	4	6.3	14	6.0
8.0-8.9	2	4.8	0	0	4	4.4	2	3.2	8	3.4
9.0-9.9	4	9.5	3	8.1	5	5.5	2	3.2	14	6.0
10.0-19.9	8	19.0	11	29.7	22	24.2	13	20.6	54	23.2
20.0-29.9	1	2.3	3	8.1	1	1.1	2	3.0	7	3.0
30 or more	3	7.1	2	5.4	9	9.9	5	7.9	19	8.2
Total	42	100	37	100	91	100	63	100	233	100

Table 3

*Transmission of bloody diarrhoea within affected families community-based cases of bloody diarrhoea, Gizan, 1992-1993***

	N	Median period
Duration (in days) between:		
first and second cases	57	7.0
second and third cases	41	5.0
third and fourth cases	26	3.0
fourth and fifth cases	14	4.5
fifth and sixth cases	5	5.0
sixth and seventh cases	4	6.0
seventh and eighth cases	4	4.5

Table 4

Factors influencing spread of bloody diarrhoea within families

Risk factor	>1 BD case (N=57 families)	1 BD case (N=22 families)	OR(95%Cl)
<3 rooms/house	38	7	4.3 (1.3-14.4)
<2 kitchens/house	49	19	p = 0.64 *
<2 bathrooms/house	26	5	2.85 (0.8-10.4)
Family size = > 5	54	16	p = 0.012 *
<3 persons/room	41	3	16.2 (3.9-90.4)

* Fisher's exact test.
** Data for 3 secondary cases were missing.

Table 5

Secondary attack rates of BD by age of the index case

Age group of index cases (in years)	Age group of secondary cases (in years) <1 N(AR%)	1-4 N(AR%)	5-9 N(AR%)	10-14 N(AR%)	>15 N(AR%)	Total N y (AR%)	No. of Families with index cases	No. of Families will secondary cases
<1	0(0)	3 (60.0)	1 (20.0)	0(0.0)	1 (20.0)	5 (3.2)	4	2
1-4	1 (2.9)	15 (44.1)	6 (17.6)	6 (17.6)	6 (17.6)	34 (22.1)	21	16
5-9	4 (6.8)	27 (45.8)	10 (16.9)	8 (13.6)	10 (16.9)	59 (38.3)	26	19
10-14	1 (3.6)	6 (21.4)	12 (42.9)	3 (10.7)	6 (21.4)	28 (18.2)	14	11
15+	2 (7.1)	8 (28.6)	6 (21.4)	10 (35.7)	2 (7.1)	28 (18.2)	14	9
Total	8 (5.2)	59 (38.3)	35 (22.7)	27 (17.5)	25 (16.2)	154 (100)	79	57

Risk factors influencing spread of diarrhoea within families included having two rooms per house or fewer, family size of five or more and presence of more than three persons per room (Table 3). There was no association between age or sex of the index cases and secondary attack rates within families (Table 4). However, if the index case was under 10 years of age, then most of the secondary cases occur in the age group one to five. Majority of secondary cases occurred in the age groups five to nine and 10 to 14 if the index case was 10 to 14 or 15 years and above, respectively (Table 4).

DISCUSSION

Person-to-person transmission of BD: This study demonstrated propagated person-to-person and village-to-village transmission of shigellosis. The high secondary attack rates within families could be attributed to the very low inocula (as few as 10 organisms) needed by *Shigella* spp to cause an infection(10). Emphasising personal hygiene was found to be an effective and practical method for interrupting shigellosis. It markedly reduced secondary infection and case rate except in cases of *Shigella dysenteriae* type 1; failure in S. *dysenteriae* type 1 was attributed to its greater virulence and smaller dose requirement for infection(9,14). This is because humans are the primary reservoir and the only effective source for *Shigella,* although *Shigellae* occasionally infect other primates(6-7).

Age-sex attack rates: There was no sex predilection as sex ratio for index cases was equal to 1. The median age of index cases at six years suggests that children acquired infection from their playmates, probably outside their homes, and then introduced it to their families. This could be because they have not acquired adequate hygienic habits, combined with a low ineffective dose, the frequency of mild illness, and the acquisition of antimicrobial resistance(15). Unhygienic practices of mothers may have played a role in spreading the infection to other family members, especially to children under two years of age. Environmental social and behavioural factors could explain why the secondary AR% in this study was slightly higher than what has been reported in two other studies(6,16-17). In another study that studied families of 47 index cases with diarrhoea due to *S. dysenteriae* type 1, 20% of family contacts of index cases were infected with *Shigella;* the proportion of infected family contacts was highest (31%) among children 0-4 years old(16). Similar results were reported by Wilson *et al*(17).

Risk factors and recommended interventions:
Crowding was a risk factor that amplified transmission of BD within families. Occurrence of BD cases only among Saudis and Yemenis probably relates to unidentified cultural practices since there were many other nationalities (some with their families) living in these villages. It is important to understand what motivates people to change their age-old customs(18). Special health education efforts to control outbreaks of shigellosis were reported to be effective(15). Interruption of *Shigella* transmission involves promotion of hand washing practices and use of soap after defecation, changing diapers and before eating. Other control measures to guard against propagated outbreaks of shigellosis include preventing school-age children with shigellosis from attending schools as long as they are sick. Health education should go hand in with other known interventions, for example, treatment with antibiotics to reduce the duration of symptoms and excretion of *Shigellae*(7). The surveillance system, including data about antibiotic resistance of isolated strains, needs to be strengthened. Doctors need to be informed continuously about emerging resistant strains. In the USA, strains of *S. sonnei* have developed antibiotic resistance during the course of prolonged outbreak(4).

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