RISK FACTORS FOR FATAL CHILDHOOD DIARRHEA: A CASE-CONTROL STUDY FROM TWO REMOTE PANAMANIAN ISLANDS

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Between September 1979 and March 1980, distinguishing features between fatal and nonfatal cases of diarrhea caused by the same etiologic agents were sought in a case-control investigation of Cuna Indian children living on the San Blas Islands located off Panama's Caribbean coast. The eight fatal cases of diarrhea (four associated with rotavirus, one with Giardia lamblia, and three without identifiable pathogens), which occurred in a cohort of 186 children aged less than five years who were followed for seven months, were matched with 24 contemporaneously occurring nonfatal cases of diarrhea. Weight-for-length measurements falling below the 90th percentile of the reference standard, reliance on traditional rather than equally as available Western medicine, and failure to receive oral rehydration solution were significantly more common among fatal than nonfatal cases. Incorporating traditional medicine men with their long-standing village-wide authority into expanded community health education programs that emphasize the importance of early treatment of diarrhea with oral rehydration solution would probably reduce mortality associated with diarrheal illness in this population.

diarrhea, infantile; fluid therapy; mortality; rotavirus infections

Although young children in the developing world experience several episodes of

diarrhea each year, less than 1 per cent are fatal (1). The reasons why this proportion of children die due to diarrhea have not been well studied. Access to appropriate medical care, the severity of the illness, the pre-existing health status of the child and the degree of so-called "maternal technology" which the child's mother possesses are all important (2). In this case-control investigation we sought to identify factors in cases of acute diarrhea associated with a fatal outcome. By identifying these factors we hope that diarrheal disease control programs may be better able to prevent diarrhea-associated deaths.

MATERIALS AND METHODS

This investigation was carried out on two islands, Achutupo and Tupile, in the San Blas Archipelago, a remote area located off

Panama's Caribbean coast. Tupile, one mile (1.6 km) off shore, measured 1.0 km by 0.5 km and had approximately 1,500 inhabitants, all Cuna Indians, living in approximately 150 housing units made of local materials. Achutupo, 10 km from Tupile, was of similar size and population. Each island had its own government-supported health center staffed by a resident nursing auxiliary. Hospitalization, when needed, was available at Aligandi, a well-equipped facility equidistant between the two islands and staffed by a well-trained medical team headed by a Western-trained physician. All health services were free. Oral rehydration solution was readily available on each island. Neither island had indigenous fresh water sources although Tupile had recently installed a centralized water distribution system which provided unlimited amounts of high quality fresh water to each dwelling. Defecation on both islands took place primarily in "privies" located on small platforms above the ocean which had a tidal elevation of 0.6 meters.

Following an August 1979 census of both islands, a 50 per cent random sample of the 368 children less than five years of age who lived on the two islands was selected for inclusion in the project cohort. A nutritional assessment which included body weight (25 kg Salter Scale (Salter Export Trading Co., West Bromwich, Staffs, England)) measured to the nearest 50 g and recumbent body length was performed on each cohort child. Prior to the start of the surveillance activities, Cuna Indian epidemiology field technicians were taught how to identify and define a case of diarrhea (>3 loose stools/24 hours). From September 1979 through March 1980 these technicians conducted door-to-door surveillance six days a week for incident cases of acute diarrhea. Eight fatal cases of diarrhea were detected during this period: five cases from Achutupo and three cases from Tupile. Three additional diarrhea-associated deaths in children born prematurely were excluded from this investigation since it is

probable that they were not preventable given the level of care which could be expected from the health delivery system. Rotavirus was identified in premorbid stool samples from four case children, *Giardia lamblia* from one child, and no pathogen from the other three children. Our methods for detecting rotavirus, enterotoxigenic *Escherichia coli*, salmonellae, shigellae and *G. lamblia* have been previously described (3).

For each fatal case of diarrhea, three similarly aged (±2 months) nonfatal cases of diarrhea caused by the same pathogen (when one had been identified) were selected as controls among children from the same island. Controls for fatal cases in which no pathogen was identified were similarly-aged children with diarrhea and with no identifiable pathogen who had diarrhea during the two-month period prior to a fatal case having had diarrhea. To identify factors associated with a morbid outcome, a standard questionnaire was administered to the responsible guardian within two months of the child's death for fatal cases and within two months of the child's having had diarrhea for nonfatal cases.

We used specially designed computer subroutines to compare the anthropometric data with the reference population from the National Center for Health Statistics Nutrition Survey (4). Previous studies have validated the use of this reference standard to measure the nutritional status in developing world children (5). Because an accurate date of birth was not available for all cohort children, only the weight-for-length ratio of each child in the September measurement expressed as a percentage of the reference mean was calculated.

RESULTS

Fatal and nonfatal cases were similar in respect to age, facility where they were born, age they first received supplementation other than breast milk, and number of people in the household with some income (table 1). Fatal and nonfatal case families

TABLE 3

General characteristics of cases of acute diarrhea among Cuna Indian children aged <5 years, San Blas Islands, September 1979–March 1980

Characteristic	Fatal cases (n = 8)	Nonfatal cases (n = 24)
Mean age	11.3 months	11.9 months
Male/female	5/3	12/12
Breast fed (first 4 months)		
Never	2 (25%)	0
Intermittent	1 (13%)	0
Exclusively	5 (62%)	24 (100%)
Place of birth		
Home	5 (63%)	15 (63%)
Health center	2 (25%)	6 (25%)
Hospital	1 (13%)	3 (13%)
Age began to receive supplementary foods		
≤4 months	2 (25%)	8 (33%)
>4–≤6 months	2 (25%)	11 (46%)
>6 months	2 (25%)	3 (13%)
Never	2 (25%)	2 (8%)
Other recent (<2 years) deaths in family	2 (25%)	0
Monthly income ($ US)/household		
<20.00	4 (50%)	9 (38%)
20.00–≤50.00	2 (25%)	6 (25%)
>50.00	1 (13%)	6 (25%)
Unknown	1 (13%)	3 (13%)
Mean	$20	$48
Language facility		
Everyone in household speaking/writing only local dialect	100%	38%
≥1 person in household speaking/writing Spanish	0	62%*
School attendance (no. of children/household in school)		
0	2 (25%)	6 (25%)
≤2	5 (62%)	14 (58%)
2+	1 (13%)	4 (17%)

* $p < 0.05$. One-tailed p values calculated by the method of Mantel and Haenszel (8).

had similar low monthly incomes although the mean income of nonfatal case families ($48.00 US) was more than double that of fatal case families ($20.00 US) ($p > 0.05$). None of the fatal case families but 62 per cent of nonfatal case families ($p < 0.05$, Fisher's exact test) were able to communicate in Spanish (the others could speak only the local language).

At the start of the surveillance period fatal cases were significantly more likely than nonfatal cases to fall below the 90th percentile of weight-for-length reference standard ($p < 0.05$) (table 2). Fatal cases tended to have had more protracted courses of diarrhea than nonfatal cases but this

difference was not significant. Fatal cases were also more likely than nonfatal cases to have had a respiratory illness concurrently with diarrhea. Skin infections were equally as common in both fatal and nonfatal cases.

We could not demonstrate significant differences between the places where fatal and nonfatal cases were brought for treatment following onset of diarrhea (tables 3 and 4). Fatal cases tended to use sources of traditional medicine more than nonfatal cases. All parents, nevertheless, appreciated the need for their children to receive some form of treatment since all cases (fatal and nonfatal) were brought to either the

TABLE 2

Health characteristics of cases of acute diarrhea among Cuna Indian children aged <5 years, San Blas Islands, September 1979–March 1980

Characteristic	% with characteristic		Risk ratio[*]	p value[*]
	Fatal cases (n = 8)	Nonfatal cases (n = 24)		
<90th percentile weight/length in August 1979	50	4	23.0 (2.0–262.6)[†]	0.01
Diarrhea lasting ≥10 days before dying (cases) or termination (controls)	50	25	3.0 (0.6–15.9)	NS[‡]
Had respiratory infection concurrently with diarrhea	50	21	3.8 (0.4–36.6)	NS
Had skin infection concurrently with diarrhea	38	29	1.5 (0.3–8.0)	NS

* Risk ratios and one-tailed p values calculated by method of Mantel and Haenszel (8).
† 95% confidence interval in parentheses calculated by method of Woolf (9).
‡ NS, not significant.

TABLE 3

Sources and type of health care for cases of acute diarrhea among Cuna Indian children aged <5 years, San Blas Islands, September 1979–March 1980

Source of health care	Fatal cases (n = 8)	Nonfatal cases (n = 24)
During first 2 days of diarrheal illness		
None	3 (38%)	14 (58%)
Traditional medicine	5 (63%)	10 (42%)
Health center	0	0
Hospital	0	0
Unknown	0	0
During second 2 days of diarrheal illness		
None	0	0
Traditional medicine	3 (38%)	8 (33%)
Health center	4 (50%)	16 (67%)
Hospital	0	0
Unknown	1 (12%)	0
Received oral rehydration solution at least once	0	11 (46%)[*]

* p = 0.02 (Mantel and Haenszel method (8)).

health center or the traditional medicine man. Eleven (46 per cent) of 24 nonfatal cases and none of eight fatal cases received oral rehydration solution on at least one occasion ($p < 0.05$).

DISCUSSION

This investigation sought to identify premorbid risk factors associated with diar-

rhea. Several factors appear to be important but due to the small size of this study and its lack of statistical power, only a few reached statistical significance. For example, although not significant at the $p = 0.05$ level, 100 per cent of nonfatal cases were exclusively breast fed during their first four months of life compared with only 62 per cent of fatal cases. Our finding that children undernourished before they developed

TABLE 4

Frequency of visiting various health care providers by cases of acute diarrhea among Cuna Indian children aged <5 years, San Blas Islands, September 1979–March 1980

Source of health care no. of times visited during entire illness	Fatal cases (n = 8)	Nonfatal cases (n = 24)
Traditional medicine man*		
0	1 (13%)	14 (58%)
1–2	2 (25%)	3 (12%)
2+	5 (62%)	5 (21%)
Unknown	0	2 (8%)
Mean	2.5	1.2
Health center*		
0	3 (38%)	6 (25%)
1–2	2 (25%)	11 (46%)
2+	3 (38%)	6 (25%)
Unknown	0	1 (4%)
Mean	0.6	1.7
Hospital*		
0	5 (63%)	21 (87%)
≥1	3 (37%)	3 (13%)

* No significant differences between fatal and nonfatal cases.

diarrhea were at increased risk of dying confirms earlier work from Bangladesh (6). Significantly ($p < 0.05$) more household members of fatal cases spoke only the local language compared with the household members of nonfatal cases. Lack of any ability to communicate in Spanish suggests a more traditional approach to life which is documented by the greater reliance of fatal compared with nonfatal case families on traditional medicine sources rather than on the equally as available Western sources. Reluctance to use Western medicine is also demonstrated by the pattern of care which fatal case families sought compared with nonfatal case families. Nonfatal case families were less likely than fatal case families to seek any outside help during the first two days of their child's illness. Fatal case families were likely to seek help from the traditional medicine sources early in their child's illness while nonfatal case families kept the child under observation at home. However, when the illness persisted for more than two days, more nonfatal case families compared with fatal case families circumvented the traditional medicine

sources and brought their child directly to the health center. Reliance upon traditional medicine sources by some parents suggests that efforts to incorporate/educate a village's traditional medicine man into the primary health care program might be helpful. This approach has been used with success in primary health care programs in Swaziland, Africa (7).

Access to health care was not an important outcome predictor in this study. Both islands had health centers. Fatal cases were more likely than nonfatal cases to end up in the hospital. This finding suggests that fatal cases were sicker than nonfatal cases but also emphasizes that inability to get to the hospital was not an important risk factor for fatal cases of diarrhea. Nonfatal cases were more likely to have received oral rehydration solution than fatal cases. Greater use of oral rehydration solution in the nonfatal cases may have been important in controlling a child's illness early in his clinical course and preventing it from becoming life threatening. This increased use also reflects a greater reliance on Western medicine among parents of nonfatal cases.

Rotavirus infection, although a common cause of pediatric diarrhea throughout the world, has generally not been associated with a high case fatality rate (2). The high rate in this study (four of 50 children with diarrhea and rotavirus in their stools died) probably reflects the generally poor nutritional status of the children in these islands (13 per cent of all Achutupo children aged less than five years and 16 per cent of similarly aged Tupile children fell below the 90th percentile National Center for Health Statistics reference nutritional standard). The relative lack of widespread use of oral rehydration solution on these islands may also have contributed to the high rate.

In conclusion, families of fatal cases of diarrhea tended to be more traditional in their life styles and relied more heavily on non-Western sources for health care than

nonfatal case families. Fatal cases were more likely to have concurrent infections and be chronically undernourished than nonfatal cases. Nonfatal cases compared with fatal cases were much more likely to have received oral rehydration solution. These findings emphasize the importance of health education in rural settings. Early treatment of diarrhea with oral rehydration solution, emphasis on seeking appropriate medical care early in the course of the illness and targeted nutritional intervention in poorly nourished children will help reduce mortality associated with diarrheal disease.

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