ASSESSING THE CAUSE OF IN-PATIENTS PEDIATRIC DIARRHEAL DEATHS: AN ANALYSIS OF HOSPITAL RECORDS

P. Dutta
U. Mitra
R. Rasaily
S.K. Bhattacharya
M.K. Bhattacharya
B. Manna
A- Gupta
B. Kundu

ABSTRACT

Records of all the diarrheal patients up to the age of 5 years who were admitted to and died in Dr. B.C. Roy Memorial Hospital for Children, Calcutta, between January and December 1990 were analyzed. The records were reviewed to assess the relative importance of three clinical types of diarrhea (acute watery diarrhea, acute dysentery and persistent diarrhea) as the causes of mortality. Annual hospital death rates of children suffering from acute watery diarrhea, dysentery and persistent diarrhea were 13.6%, 18.2% and 25.9%, respectively. Overall death rates in dysentery ($p = 0.03$) and persistent diarrhea groups ($p < .00001$) were significantly higher than watery diarrhea group. Maximum deaths occurred among children aged between 7 and 36 months in all categories of diarrhea. Shigella infected children had higher case fatality rate. In acute watery diarrhea, 30.9% cases were assigned to associated causes of death whereas the same could be assigned to 92.6% and 93.2% cases in dysentery and persistent diarrhea group, respectively. Deaths occurred in most of the cases who had bronchopneumonia as underlying cause, septicemia as immediate cause and protein calorie malnutrition as associated cause and these were most frequently associated in patients suffering from dysentery and persistent diarrhea. Only 2.0% children suffering from acute watery diarrhea had dehydration at the time of death. Significantly, a high percentage of deaths occurred among malnourished children who suffered from dysentery (54.4%) and persistent diarrhea. These data suggest that Diarrheal Disease Control Programme should also give emphasis on management of non watery, non-dehydrating type of diarrhea with complications.

Key words: *Mortality, Diarrhea.*

Diarrhea is the major cause of childhood death in developing countries(l). It has been estimated that 4 million children under 5 years of age die annually from diarrhea(2). The World Health Organization (WHO) has initiated the Programme for Control of Diarrheal Diseases with the specific objective of reducing diarrhea related mortality(3). The programme has focussed on oral rehydration therapy (ORT) in the treatment of childhood diarrhea. It is sure that majority of the diarrheal deaths could be avoided by ORT if dehydration due to diarrhea is the primary cause of death(3). However, the pediatricians in developing countries recognize that diarrhea cases are frequently accompanied with other severe illness like meningitis, protein calorie malnutrition and

From the Division of Clinical Medicine, National Institute of Cholera and Enteric Diseases and Department of Medicine, Dr. B.C. Roy Memorial Hospital for Children, Calcutta.

Reprint requests: Dr. P. Dutta, Assistant Director, National Institute of Cholera and Enteric Diseases, P-33, C.I.T. Road, Scheme XM, Beliaghata, Calcutta 700 010.

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bronchopneumonia. In these cases treatment of dehydration only would have little impact. These diarrhea cases associated with other complications resulted in considerable mortality among under 5 children even after adequate rehydration. We have retrospectively analyzed the data from hospital records to find out the cause of death in diarrhea.

Patients and Methods

Assessment of the Patients and Definitions

On admission, detailed clinical history was obtained and thorough physical examination performed. Severity of watery diarrhea was assessed by clinical signs and symptoms of dehydration(3). Acute watery diarrhea was defined as passage of three or more watery stools during the preceding 24 hours. Dysentery cases were assessed by frequency of stools per day together with associated symptoms like fever and tenesmus(4). Dysentery was defined as passage of three or more loose stools mixed with blood and mucus. Persistent diarrhea subjects were also assessed for dehydration accordingly(3). Persistent diarrhea was defined as diarrhea lasting for more than 14 days during which there was not more than 3 days without symptoms^). Diarrhea cases who were admitted to the hospital for the treatment of acute epidose but lasted for 14 days or more during hospital stay were also considered as persistent diarrhea(6). Patients were weighed to the nearest 100 g. Children of all categories of diarrhea were followed up daily until discharge or death. Patients were also evaluated for major complications like septicemia, meningitis and associated diagnosis like pneumonia and protein calorie malnutrition and they were treated according to the treatment schedule of the hospital. Chest roentgenograms were taken of those patients who had tachypnea or pulmonary rales. Septicemia and meningitis were diagnosed clinically and supported by standard laboratory investigations. Septicemia was considered in those fatal patients who had terminal clinical courses suggestive of septicemia by presence of fever, hypothermia or shock. Causes of death were categorized into: (*i*) underlying, *(ii)* immediate, *(iii)* associated and *(iv)* combined causes. The underlying cause of death was the primary disease that initiated the events leading to the patient's death and without this the subject would have survived. Immediate causes of death were usually the complications such as septicemia and meningitis. Nutritional conditions were considered as associated causes of death.

Laboratory Procedures for Stool Samples

Fecal samples were collected from a representative samples of diarrheal children who were admitted to the wards between 10 A.M. and 1 P.M. during first four days a week and examined microscopically for presence of RBCs, mucus, cyst, ova and parasites. Samples were also cultured or tested for presence of bacterial and viral enteropathogens using standard techniques(7).

Sources of Data

Data from the history sheets of all the diarrheal children upto the age of 5 years who were admitted to the hospital and who died during the period

between January and December 1990 were analyzed. We recorded the age, body weight, type of diarrhea, degree of dehydration at the time of admission and death, presence of complications, associated diagnosis, laboratory findings and enteropathogens detected (representative samples). Care was taken to obtain the comparable data of all the history sheets. Nutritional status of the children were assessed by allocating the admission weight (after adjustment of loss due to dehydration) to different weight for age nutritional groups according the Indian Academy of Pediatrics using Harvard standard weight(8). Children having body weight less than 80% of Harvard standard weight for age were diagnosed as malnourished. Clinically, protein energy malnutrition (PEM) was diagnosed in those patients who had severe wasting.

Statistical Analysis

Statistical analysis was done by using Epi-info software package. For comparison between the groups, Chi-square test was used except when cell frequency was zero. Relative risk (RR) and 95% confidence interval (95% CI) were also calculated by using the same software package. Tests of proportions were used wherever applicable. During statistical analysis, acute watery diarrhea and dysentery cases were clubbed together and termed as non persistent diarrhea (non PD) group.

Results

Hospital records showed that during one year period, a total of 1889 children aged upto 5 years, suffering from three clinical categories of diarrhea (acute watery diarrhea, acute dysentery and persistent diarrhea) were treated as in-patients. Amongst them 323 (17.1%) children died at the hospital. Diarrhea cases were admitted most frequently during the months between April and August. Diarrhea associated deaths also occurred at large during these months. These were hot summer and monsoon months of the year. Annual hospital death rates of the children suffering from acute watery diarrhea, dysentery and persistent diarrhea were 152/1119 (13.6%), 68/373 (18.2%) and 103/397 (25.9%), respectively. The risk of death in children of dysentery group was 34% higher than that of the children of watery diarrhea group (Relative Risk (RR)-1.34; 95% Confidence interval (CI)-1.03-1.74; $p = 0.03$). Similarly the risk of death among the children of persistent diarrhea group was about 2 fold higher (RR-1.91; 95% CI-1.53-2.39; p <0.0p001) when compared to that of watery diarrhea group. Risk of death among children of persistent diarrhea group was also 42% and 76% higher than that of the children of dysentery group (RR-1.42; 95% CI-1.08-1.87, $p = 0.01$) and non PD group (RR 1.76; 95% CI-1.43-2.16; $p < 0.00001$), respectively.

Deaths among the hospitalized children of 7-36 months age group having normal nutritional status in watery diarrhea and dysentery groups were 50/175 (28.6%) and 5/38 (13.1%), respectively. The same parameters amongst the malnourished children of same age group were 72/557 (12.9%), 44/213 (20.6%), 95/337 (28.2%) in watery diarrhea, dysentery and persistent diarrhea groups, respectively. However, the admissions and deaths of the children of normal

nutritional status of other age groups were 97/24 (24.7%) and 57/14 (24.6%) in watery diarrhea and dysentery groups, respectively. These parameters of malnourished children of the same age group were observed in 6/290 (2.1%), 5/65 *(7.7%),* 8/60 (13.3%) cases in watery diarrhea, dysentery and persistent diarrhea, respectively. No child of normal nutritional status was admitted in persistent diarrhea group. Overall death rates were significantly higher ($p < 0.00001$) among malnourished children 257/1321 (19.4%) when compared to the children of normal nutritional status 66/568 (11.6%). Deaths 266/1320 (20.6%) . were significantly higher among the children aged between 7 and 36 months age group when compared to that of the children 57/569 (10.0%) of other age groups ($p < 0.00001$). However, differences of death rates of malnourished children 211/1107 (19.1%) and the children of normal nutritional status 55/213 (25.8%) of 7-36 months age group were not significant ($p > 0.05$). When death rates were compared in children according to the nutritional status in individual category of diarrhea, it was observed that the children of normal nutritional status having watery diarrhea had higher death rates ($p < 0.00001$) irrespective of age groups. It was also observed that there were no differences ($p = 0.14$) in death rates among the children of different nutritional status aged between 7-36 months in dysentery group. Death rates of the children of normal nutritional status of other than 7-36 months age groups were significantly higher in those who had dysentery ($p < 0.005$).

Amongst 1889 hospitalized children, stool samples of 380 (20.1%) children were collected and processed for detection of enteropathogens. Deaths occurred in 65 (17.1%) of these children. Death rate in different groups of children could be compared only for those who were infected with *Shigella* species because mortality among the children infected with other enteropathogens were less frequent. It is evident from the *Table I* that *Shigella* infected children had significantly higher case fatality rate in comparison to the children infected with other organisms in dysentery group ($p < 0.01$) and non PD groups ($p < 0.0001$) but not in watery diarrhea ($p > 0.05$) and persistent diarrhea group ($p > 0.05$) when compared within the same category of diarrhea. Deaths due to *Shigella* infection were not statistically significant ($p > 0.05$) when compared between the different categories of diarrhea which indicated that chances of death due to *Shigella* infection was similar in all categories of diarrhea.

Table II shows the probable causes of deaths in three different categories of diarrhea. Each patient was assigned to either underlying, immediate, associated or combined causes of death. Septicemia was diagnosed clinically in 30 cases either as immediate or combined cause of death. Different organisms were isolated from 11 cases and they were *Escherichia coli, Saint, enteritidis, Shig. flexneri, Shig. dysenteriae* type 1 from two patients each and *Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Strep, pneumoniae* from 1 case each.

Table III shows the level of dehydration of the fatal patients at the time of admission. Dehydration was present in a significantly high percentage of fatal

TABLE I— *Enteropathogens Identified From 380 Patients Tested in Different Groups and Case Fatality Among Them (Percentage of Patients Tested and Deaths Given in Parentheses)*

Enteropathogens	Watery diarrhea[a]		Dysentery[b]		Persistent diarrhea[c]	
	Tested	Death	Tested	Death	Tested	Death
V. cholerae 01	38 (3.5)	2(5.3)	0	0	0	0
V. parahaemolyticus	4 (1.8)	0	0	0	0	0
Enterotoxigenic *E. coli*	20 (8.9)	2 (10.0)	0	0	2 (2.5)	0
Enteropathogenic *E. coli*	25 (11.1)	3 (12.0)	0	0	10 (12.5)	2 (20.0)
Rotavirus	40 (17.8)	4 (10.0)	0	0	5 (6.2)	1 (20.0)
Shigella species	10 (4.4)	4 (40.0)	25 (33.3)	10 (40.0)	18 (22.5)	8 (44.4)
Campylobacter jejuni	9 (4.0)	0	1 (1.3)	0	2 (2.5)	0
Salmonella species	1 (0.4)	0	8 (10.7)	1 (12.5)	6 (7.5)	2 (33.3)
Mixed enterpathogens	15 (6.7)	2 (13.7)	6 (8.0)	2 (33.3)	10 (12.5)	4 (40.0)
No enteropathogen	63 (28.0)	9 (14.3)	35 (46.7)	3 (8.5)	27 (33.7)	6 (22.2)
Total	225	26 (11.5)	75	16 (21.3)	80	23 (28.7)

Comparison of deaths amongst *Shigella* infected children and the children infected with other enteropathogens presented either as watery diarrhea or dysentery or persistent diarrhea a = p >0.05; b = p <0.01; c = p >0.05; a + b = p > 0.05.
Comparisons of deaths in *Shigella* infected patients between the categories of diarrhea were not statistically significant p >.05.

patients of acute watery diarrhea group in comparison to dysentery and persistent diarrhea groups at the time of admission. The 29.6% fatal cases in acute watery diarrhea group had no dehydration at the time of admission in comparison to 83.8% and 88.3% cases of dysentery and persistent diarrhea group, respectively. Differences of these percentages were highly significant ($p < 0.00001$) when compared to that of watery diarrhea group. However, only 3 (2.0%) cases of acute watery diarrhea group had dehydration at the time of death.

Discussion

Overall case fatality rate in our hospital is very high as admission of diarrhea cases are selective and complicated diarrhea cases are referred and admitted to this hospital frequently. Representativeness of this observation is, therefore, a problem. However, overall case fatality rate 17.1% of this hospital can be compared to that of 12.3% in a

TABLE II- *Causes of Death in* 323 *Cases of Fatal Diarrheal Illness (Percentage of Deaths Given in Parentheses)*

Causes of deaths	Watery diarrhea (n=152)	Dysentery (n=68)	Persistent (n=103)
None	105 (69.1)	5 (7.3)	7 (6.8)
Underlying cause			
Bronchopneumonia	5 (3.3)[a]	11 (16.2)[b]	16 (15.5)[c]
Associated cause			
PEM	19 (12.5)[d]	25 (36.8)[e]	35 (43.7)[f]
Immediate cause			
Septicemia"	8 (5.3)	8 (11.8)	10 (9.7)
Meningitis	0	1 (1.7)	1 (1.0)
Combined causes			
Bronchopneumonia + PEM	8 (5.3)[g]	12 (17.6)[h]	20 (19.4)[i]
Other combinations	7 (4.6)	6 (8.8)	4 (3.9)

Statistical comparison between the categories of diarrhea

a *vs* b - P <0.001	d *vs* e - p <0.00001	g *vs* h - p< 0.004
a *vs* c - p < 0.001	d *vs* f - P < 0.00001	g *vs* i - P < 0.004
b *vs* c - p > 0.05	e *vs* f - P > 0.05	h *vs* i - P > 0.05
a+b *vs* c - p < 0.04	d+e *vs* f - P < 0.001	g+h *vs* i - P < 0.01

*Statistical differences were not observed (p > 0.05) between the groups.

TABLE III- *Level of Dehydration of the Fatal Patients at the Time of Admission (Percentage of Deaths Given in Parentheses)*

Dehydration diarrhea status	Watery diarrhea (n=152)	Dysentery (n=68)	Persistent (n=103)
No dehydration	45 (29.6)[a]	57 (83.8)[b]	91 (88.3)[c]
Some dehyration	82 (53.9)[d]	9 (13.2)[e]	12 (11.7)[f]
Severe dehydration	25 (16.4)[g]	2 (2.9)[h]	0

Statistical comparison between the categories of diarrhea

a *vs* b - P <0.00001	d *vs* e - p <0.00001	g *vs* h - p< 0.01
a *vs* c - p < 0.00001	d *vs* f - P < 0.0001	
b *vs* c - p > 0.05	e *vs* f - P > 0.05	
a+b *vs* c - p < 0.00001	d+e *vs* f -p < 0.00001	

highly specialized hospital for diarrheal diseases in Dhaka, Bangladesh(9). Another hospital based study in Bangladesh showed that majority of the death occurred among young children, with 31% less than 1 year old, 43% between 1-4 years old(10). Community based study in Guinea Bissau also showed that persistent diarrhea and acute watery diarrhea were the two leading causes of childhood mortality, accounting for 16.3% and 14.4% of the deaths, respectively(ll). Several other community based studies from the Gambia(12), Bangladesh, north eastern Brazil, northern India and Nepal also showed that 36%-56% of all deaths related to diarrhea were associated with persistent diarrhea(13). In our hospital based study, death due to acute watery diarrhea and persistent diarrhea are 13.6% and 25.9%, respectively. After 1984 epidemic of acute bacillary dysentery in West Bengal(14), case fatality rate in dysentery patients of pediatric age group was increased(15,16) which also corroborates the findings of our present observation. High case fatality rate among dysentery patients of pediatric age group was also observed by other workers of developing countries(17,18).

Bacterial enteropathogens are mostly responsible for childhood diarrhea in this country. These usually occur during the months of April through August which are characteristically hot summer and monsoon months(19). Majority of the diarrheal deaths also occur during this period. The seasonality can be compared to that of our neighboring country Bangladesh(17) because the environmental and living conditions of the people of the state of West Bengal, India and Bangladesh are almost similar. In contrast, diarrheal admissions and deaths occur most frequently in winter months in the United States of America and other Western countries because rota viruses are responsible for hospitalization and deaths of childhood diarrheas in those countries(20,21).

Leading causes of death in children worldwide are acute respiratory infections and diarrhea(22). In diarrheal children, complications contributed to most of the deaths in this study. Amongst the causes of deaths, bronchopneumonia and septicemia were frequently associated. High proportion of fatal diarrheal illness with concomitant pneumonia suggests that diarrheal disease may predispose patients to lung infection. Alternatively, the pneumonia and diarrheal disease may occur together as a result of common predisposing factors(23). Septicemia was the most frequent cause of death in this observation which also corroborates the findings of other workers(10). It is postulated that enteroinvasive bacterial enteropathogens like *Shigella* and *Salmonella* may gain entry to the blood stream through ulcers in the colon and produce fever, shock and death. Ulcerative diseases of colon and small intestine produced by *Shigella* and *Salmonella* may predispose to death in large number of patients with dysentery and persistent diarrhea.

Although oral rehydration therapy has been considered to be the life saving therapy for dehydrating diarrhea, rehydration alone is not sufficient to prevent death when complication is present. The present hospital based observations show that majority of the

children, who die in the hospital, have complications. To reduce the diarrheal mortality in children, Diarrheal Diseases Control Programme should also give more emphasis to the management of non watery, non dehydrating type of diarrhea with complications. Persistent diarrhea is also a major cause of childhood mortality. Consequently, control and management of persistent diarrhea should also be a major priority of Diarrheal Diseases Control Programme.

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