Chapter 1

Diarrhoeal Diseases

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Introduction

Diarrhoea remains a leading cause of morbidity and mortality in the world, predominantly affecting children in developing countries. Each child in the world experiences an average of one to three episodes of diarrhoea per year, with incidence rates as high as 10 per year for children in some areas (Bern et al. 1992b). During the 1990s diarrhoea was estimated to cause 20 to 25 per cent of mortality among children younger than 5 years in the developing world (Bern et al. 1992b). Effective interventions, including correct case management (oral rehydration therapy, continued feeding and antibiotics in cases of dysentery), promotion of breastfeeding, and better weaning practices, have the potential to reduce the burden of diarrhoeal disease substantially in the future.

This chapter reviews the global burden of morbidity and mortality from infectious diarrhoea, especially dysentery and persistent diarrhoea, as well as examining the issues involved in reducing that burden of disease through existing interventions.

Aetiology And Clinical Patterns

While non-infectious causes of diarrhoea may play a role, for example among the hospitalized elderly (Lew et al. 1991), the most important aetiological agents of diarrhoea are viral and bacterial, with rotavirus and enterotoxigenic *E. coli* generally identified most frequently among children in developing countries, and viral aetiologies playing a proportionately greater role in industrialized settings (Bern & Glass 1994, Huilan et al. 1991). Even among the elderly, infectious diarrhoea may be an important contributing cause of mortality (Lew et al. 1991).

Diarrhoea causes morbidity and mortality through several mechanisms. Acute watery diarrhoea can lead to dehydration severe enough to require hospitalization and to cause death. Rotavirus is the agent most frequently associated with acute dehydrating diarrhoea, and primarily affects children

younger than 2 years (Kapikian & Chanock 1990). *Vibrio cholerae* can cause epidemics of dehydrating diarrhoea affecting all age groups, and may lead to high case-fatality rates in the absence of rapid public health intervention, as in the recent epidemic among Rwandan refugees in Goma, Zaire (Goma Epidemiology Group 1995). Dysentery, most often associated with *Shigella* species, may cause death through bacteraemia or hypoglycaemia (Bennish 1991), but also is associated with a more marked effect on growth (Black, Brown & Becker 1984a). Dysentery may present a refractory problem in that case management depends upon treatment with antibiotics, and resistance is a widespread problem in areas with high rates of dysenteric morbidity and mortality (Salam & Bennish 1991).

Persistent diarrhoea, defined as diarrhoea lasting at least 14 days (World Health Organization 1988), has been recognized recently as an entity which carries a risk of both nutritional compromise and of mortality in excess of that for acute diarrhoea (Bhan et al. 1989, Victora et al. 1993). While enteroaggregative *E. coli* and *cryptosporidium* have been associated with persistent diarrhoea (Bhan et al. 1989, Baqui et al. 1992a, Henry et al. 1992), often no specific pathogen can be implicated (Lanata et al. 1992), and serial infection with different organisms may play a role (Baqui et al. 1992a).

Definitions and codes

Diarrhoea is a symptom complex defined by an increased number of stools of a looser consistency than usual per 24-hour period. In a comparison of the definitions commonly used in epidemiological studies, Baqui et al. (1991) reported that those with the best balance of sensitivity and specificity were 3 or more loose stools, or any number of stools containing blood, in a 24-hour period, while the optimal definition of the end of an episode was 3 diarrhoea-free days. The authors concluded that differences in definitions, especially of the end of the episode, made a substantial difference to the final estimate of diarrhoeal incidence, and that validation of the definition of diarrhoea was important to the overall validity of a study.

The ninth and tenth revisions of the International Classification of Diseases (ICD-9 and ICD-10) classify diarrhoea according to aetiological agent, rather than symptom complex. Because a number of agents may cause either watery or bloody diarrhoea, and because persistent diarrhoea is defined by duration of illness rather than aetiology, the ICD codes do not correspond neatly to the symptom complexes described in this chapter. An approximate mapping of symptom complexes and codes is, however, possible (Table 1.1). Persistent diarrhoea, which is discussed below, has been associated with a variety of aetiological agents which also cause acute watery diarrhoea and dysentery. Thus it is not included in the table, but may fall under any of several ICD classifications, depending on what agent, if any, is identified.

Table 1.1 International Classification of Diseases (ICD) codes corresponding to watery diarrhoea and dysentery

Symptom complex	*Aetiological agent*	*ICD-8 and 9*	*ICD-10*
Watery diarrhoea	Cholera	001	A00
	Salmonella gastroenteritis	003	A02
	Bacterial food poisoning	005	A05
	Other bacteria	008.2–008.5	A04.0–A04.9
	Giardiasis	007.1	A07.1
	Viral gastroenteritis	008.6	A08
	Gastroenteritis, presumed infectious	009.1, 009.3	A09
Dysentery	Shigella	004	A03
	Campylobacter	008.43	A04.5
	Yersinia	008.44	A04.6
	Amoebiasis	006	A06
	Dysentery, aetiology unspecified	009.0, 009.2	A09

Methods for the measurement of diarrhoeal morbidity and mortality

Community longitudinal studies provide the most reliable data for diarrhoeal disease incidence and, if the study size is large enough, mortality estimates. Even for longitudinal studies, however, morbidity estimates can be shown to vary with the intensity of surveillance, with twice-weekly surveillance resulting in higher estimates than less frequent surveillance (Bern et al. 1992b). For example, in one study that made regional estimates for diarrhoeal morbidity, the reported number of episodes per child per year was consistently higher in studies in Latin America than in studies in India or Bangladesh, but the frequency of surveillance in the Latin American studies was also consistently higher (Bern et al. 1992b). However, in a more recent study conducted in India with home visits every 3 days, the incidence of diarrhoea was found to be similar to that in the most frequently surveyed Latin American communities (Bhandari, Bhan & Sazawal 1994). This suggests that among children in the poorest communities, diarrhoeal disease incidence is remarkably similar around the world, and that in studies with less frequent surveillance, the shorter or less severe episodes are likely to be missed. At the same time, several studies which monitored diarrhoeal morbidity among children from different socioeconomic strata in the same locality have demonstrated substantial variation in incidence rates, with poorer children experiencing from 2 to 6 times the number of annual episodes as more affluent children (Araya et al. 1986, Guerrant et al. 1983).

While longitudinal studies are best for measurement of incidence of disease, the number of individuals followed is generally too small to allow measurement of mortality. Hence active surveillance, survey data and vital registration are the principal methods used for mortality assessment. For developing countries, where nearly all mortality from diarrhoea occurs, vital registration is unreliable or incomplete, and a so-called "gold

standard" does not exist for its assessment. In addition, where vital registration is incomplete or absent, cause of death is ascertained on the basis of verbal autopsy methods, and the sensitivity and specificity of those methods for the diagnosis of diarrhoea and of dehydration have varied substantially in different evaluations (Snow et al. 1992, Kalter et al. 1990). In one study, verbal autopsy identified diarrhoeal deaths with a specificity greater than 80 per cent, but a sensitivity less than 50 per cent (Snow et al. 1992), while in another, the performance of verbal autopsy for the diagnosis of diarrhoea was adequate, but the identification of deaths from severe dehydration was problematic (Kalter et al. 1990). Nevertheless, estimates based on these methods reflect the best available data on the magnitude of diarrhoeal mortality, and are useful for comparison to the estimates published by the Global Burden of Disease Study (World Bank 1993, Murray & Lopez 1996).

Review of past attempts to quantify disease burden

Morbidity from diarrhoea disproportionately affects children younger than 5 years, and mortality from diarrhoea is overwhelmingly a problem of infants and young children in developing countries. Thus, most attempts to quantify disease burden from diarrhoea have focused on these age groups, and on developing countries. Three methods have been used to estimate global disease burden (Table 1.2).

Snyder & Merson (1982) developed estimates based primarily on longitudinal studies of children for morbidity, and included vital registration data for mortality estimates. These estimates were recently updated, using more recent longitudinal studies to estimate morbidity and including studies employing a wider range of methodologies, including vital registration and cross-sectional surveys, to estimate mortality (Bern et al. 1992b). For each of these studies, the empirical database was reviewed, and a median diarrhoeal incidence and mortality rate calculated for each region for which data were available, and for all developing countries excluding China. This

Table 1.2 Previous estimates of diarrhoeal disease burden for children younger than 5 years in developing countries

Authors (reference)	*Year*	*Deaths per year (millions)*	*Deaths per 1000 per year*	*Episodes per child per year*	*Methods*
Snyder & Merson (1982)	1982	4.6	13.6	2.2	Longitudinal cohorts and active surveillance
Bern et al. (1992b)	1992	3.3	7.6	2.6	Longitudinal cohorts and active surveillance
Institute of Medicine (1986)	1986	3.5	7.0	3.5	Estimated incidence plus case fatality rate
Martines et al. (1993)	1990	3.2	6.5	3.5	Data from surveys using WHO methods

method requires extrapolation from available longitudinal studies, which may not be entirely representative of the country or region.

The Institute of Medicine (1986), for the purpose of establishing priorities for vaccine development, published estimates of morbidity and mortality derived by a committee of expert researchers in the field. Based on a review of the literature and personal field experience, the committee made estimates of incidence by region and age group, which were combined with estimates of distribution of diarrhoeal episodes by severity (mild, moderate, severe, death), to yield figures for each of four regions of the developing world. This approach depends on the accuracy of estimates by a small group of experts, and is not derived directly from individual studies.

The third approach to estimating disease burden (Martines et al. 1993) is based on data from 276 surveys of diarrhoeal morbidity and mortality in 60 countries conducted between 1981 and 1986. From these data, a median and range were calculated for each region. The methodology for these surveys involved two-stage cluster sampling, and a standardized questionnaire to ascertain two-week prevalence and deaths from diarrhoea among children younger than 5 years (World Health Organization 1989) (Table 1.3). These studies represent the source of data with the broadest available coverage. The reliability of some national survey results have, however, been questioned, in part because of the inadequate training or supervision of field staff. In addition, the method used to estimate mortality, a one-year recall by the household head, is thought to result in underestimates (Martines et al. 1993). Thus, estimates made by these methods include an inherent uncertainty.

Table 1.3 Diarrhoeal morbidity and mortality in 276 surveys in children younger than 5 years, using WHO methodology, 1981–1986

Region	*Number of surveys*	*Number of countries*	*Episodes/child/year*		*Deaths per 1000 children per year*		*Diarrhoeal deaths as a percentage of total (median)*
			Median	*Range*	*Median*	*Range*	
Latin America and Caribbean	12	8	4.9	0.8–10.4	4.2	1.2–9.2	35
Sub-Saharan Africa	67	22	4.4	1.6–9.9	10.6	3.1–54.9	38
Middle East and North Africa	47	10	2.7	2.1–10.8	5.8	1.0–25.3	39
Asia and the Pacific	150	20	2.6	1.1–5.7	3.2	0.0–17.2	29
India	—	1	2.7	—	3.2	—	—
China	—	1	1.2	—	0.0	—	—
Other	—	18	2.6	—	3.3	—	—
All regions	276	60	3.5	0.8–10.8	6.5	0.0–54.9	36

Source: Martines 1993

Review of empirical databases

Children in developing countries

Because community-based studies of morbidity require intensive surveillance, the number of persons studied is generally insufficient to allow mortality measurements. Thus, the groups of empirical studies which examine morbidity (Table 1.4) and mortality (Table 1.5) are different. With two exceptions for which surveillance was monthly (Yang et al. 1990, Chen et al. 1991), the diarrhoeal morbidity studies presented in these tables are all longitudinal, community-based studies of children in developing countries, in which follow-up was at least one year, and surveillance occurred at least every two weeks.

Mortality data from studies employing active surveillance or cross-sectional ascertainment are sparse, especially for Latin America, but vital registration data support the observation that diarrhoeal mortality rates have declined substantially in Latin America (World Health Organization 1982, Pan American Health Organization 1991) (Table 1.6).

Many of the more recent studies presented here for Africa and Asia were studies of interventions for acute respiratory disease (Bang et al. 1990, Pandey et al. 1989, Roesin et al. 1990, de Francisco et al. 1993, Khan et al. 1990) or vitamin A deficiency (Daulaire et al. 1992, West et al. 1991, Herrera et al. 1992), which included longitudinal surveillance for cause-specific mortality. For these studies, as well as for diarrhoeal case management intervention studies, the rates shown are for the non-intervention group or area.

Older age groups

The Institute of Medicine (1986) has estimated that 60 per cent of overall morbidity and 90 per cent of mortality occur among children younger than 5 years. The few studies that have directly measured incidence of diarrhoea demonstrate that older children and adults experience about 0.1 to 0.5 episodes per year, and that the incidence rises to approximately 1 episode per year among the elderly. The results of some of these studies are seen in Table 1.7. Mortality rates for older children and adults are substantially lower than for children younger than 5 years (Table 1.8).

Morbidity and mortality by type of diarrhoea

Recently, persistent diarrhoea has been identified as the cause of a substantial proportion of diarrhoeal mortality (Table 1.9), although the percentage differs by location, with a range from 23 to 70 per cent. Differences in prevalent pathogens are likely to contribute to the variation in morbidity and mortality by type of diarrhoea. In addition, Victora et al. (1993) suggest that the differences in mortality may in part be attributable to differential access to oral rehydration therapy. When properly applied, oral rehydration therapy is highly effective in treating acute watery diarrhoea (Duggan,

Table 1.4 Review of empirical databases on morbidity from diarrhoea: longitudinal studies measuring incidence

		Episodes of diarrhoea per person per year							
		Age group (months)		*Age group (years)*					
Location	*Period*	*0–5*	*6–11*	*1*	*2*	*3*	*4*	*0–4*	*All ages*
India									
Rural Uttar Pradesh (Bhan et al. 1989)	1985–86	1.6	1.3	0.8	0.6	0.6	0.4	0.7	
Urban Calcutta (Sircar et al. 1984)	1985–86	1.7		2.0	0.8	0.5	0.4	1.1	
Rural Andhra Pradesh (Mathur et al. 1985)	early 1980s		3.1			1.6		1.6	
Rural Northern India (Kumar, Kumar & Datta 1987)	early 1980s	1.8		2.7	2.4	2.0	1.7	2.2	
Urban Uttar Pradesh (Bhandari, Bhan & Sazawal 1994)	1993					9.9			
China									
Hebei (Yang et al. 1990)	1986–87	4.2		3.8	2.3	1.6	1.7	2.5	
Fujian (Chen et al. 1991)	1986-87							2.3	0.73
Other Asia and Islands									
Bangladesh (Huttly et al. 1989)	1984–87	2.4	4.4	5.0	4.3				
Bangladesh (Black et al. 1982a, 1982b, Black, Brown & Becker 1984a)	1978–79	7.0		6.0	5.5	4.5	4.5	5.6	
Bangladesh (Chen et al. 1981)	1978–79				4.1			4.1	

continued

Table 1.4 Review of empirical databases on morbidity from diarrhoea: longitudinal studies measuring incidence *(continued)*

		Episodes of diarrhoea per person per year							
		Age group (months)		*Age group (years)*					
Location	*Period*	*0–5*	*6–11*	*1*	*2*	*3*	*4*	*0–4*	*All ages*
Sub-Saharan Africa									
Gambia (Rowland et al. 1985)	1981–84	7.3							
Nigeria (Oyejide & Fagbami 1988a, 1988b)		2.2	4.0	1.7					
Nigeria (Huttly et al. 1990, Blum et al. 1990)	1982–86	2.7	5.0	5.0	3.8	3.0	2.8	3.7	
Zaire (Manun'ebo et al. 1994)	1987–88							6.3	
Ghana (Biritwum et al. 1986)	1982–85	2.7	3.3	2.4	1.6	0.7	0.6	1.3	
Middle Eastern Crescent									
Egypt (El Alamy et al. 1986)	1982–84	5.3	5.9	2.1				3.1	1.0
Latin America and the Caribbean									
Peru (Lanata et al. 1989)	1984–86	10.6							
Peru (Lopez de Romana et al. 1989, Black et al. 1989)	1982–84	9.3	10.3						
Mexico (Cravioto et al. 1988)	1982–85	3.0		3.0					
Mexico (Cravioto et al. 1990)	1985–87	4.0							
Brazil (Giugliano et al. 1986)	1978–79	3.2	1.8	1.9	1.1				
Brazil (Guerrant et al. 1983)	1978–80	7.6	9.6	7.7	5.3[a]			6.4	
		4.5	7.3	6.4	4.0[b]			4.9	
		0.5	1.5	1.3	1.2[c]			1.2	

Brazil (Linhares et al. 1989)	1982–86	2.6						
Brazil (Schorling et al. 1990)	1984–86	9.4	14.1	15.1	12.2	8.7	7.2	11.3
Costa Rica (Simhon et al. 1985)	1981–84	0.7	0.8	0.6				
Chile (Ferreccio et al. 1991)	1986–89	2.3		2.1	1.5	1.3	0.9	1.5
Chile (Araya et al. 1986)	1983						0.4[c]	
							0.8[b]	
Argentina (Grinstein et al. 1989)	1983–86	2.0	5.6	3.0	4.0	4.0	3.9	3.7

a. Poor rural children.
b. Poor urban children.
c. More affluent urban children.

Santosham & Glass 1992), but has limited impact on persistent or dysenteric diarrhoea.

Developed countries

Diarrhoeal disease continues to cause substantial morbidity among children in developed countries, with an estimated incidence of 1.3 to 2.3 episodes per year for children younger than 5 years (Glass et al. 1991), an estimate based on a review of the only four longitudinal studies which provide relevant data (Gurwirth & Williams 1977, Dingle, Badger & Jordan 1964, Hughes et al. 1978, Rodriguez et al. 1987). It is estimated that perhaps 10 per cent of diarrhoeal episodes in the United States entail a physician visit, and 1 per cent a hospital admission (Glass et al. 1991).

Lew et al. (1991) examined diarrhoeal mortality using vital registration data from the United States. Mortality rates ranged from <0.1 per 100 000 for persons 5–24 years, to 2 per 100 000 for children younger than 5 years, and 14 per 100 000 for persons 75 years or older. The only age group in the United States for which the diarrhoeal mortality rate increased from 1978 to 1987 were males 25–54 years old, and this increase appeared to be associated with acquired immunodeficiency syndrome (AIDS). These estimates were based on finding one of the ICD-9 codes for diarrhoea in the underlying cause (45 per cent) or in one of the top three positions (55 per cent) in the death certificate. However, 51 per cent of childhood deaths and 86 per cent of those among the elderly were coded using the ICD-9 code 558 (diarrhoea, presumed non-infectious), despite indirect evidence based on the seasonality of deaths that a substantial proportion were attributable to an infectious agent. This suggests that even good vital registration data may underestimate the contribution of infectious diarrhoea to mortality, because in most cases no aetiological agent is identified before death.

Table 1.5 Review of empirical databases on mortality from diarrhoea: studies measuring annual deaths per 1000 children

	Study characteristics			*Diarrhoeal deaths per 1000 by age group (years)*			*Diarrhoeal deaths as percentage of total 0–4 year mortality*
Location	*Period*	*Population*	*Type of study*	*< 1*	*1–4*	*0–4*	
India							
Eight states (Tandon et al. 1987)	1984–85	5 350	Active surveillance	9.2			
Haryana (Bhandari, Bhan & Sazawal 1992)	1982–84	1 467	Active surveillance			16.0	
Maharashtra (Bang et al. 1990)	1987	6 176	Active surveillance			8.4	20
Tamil Nadu (Rahmathullah et al. 1990)	1989	7 655	Active surveillance			4.3	41
Other Asia and Islands							
Matlab, Bangladesh (Chen, Rahman & Sarder 1980)	1975–77	42 000	Active surveillance	19.6	15.1	16.0	27
Matlab, Bangladesh (Shaikh et al. 1990)	1978–87	28 000	Active surveillance	5.7	10.4	9.5	
Jumla, Nepal (Daulaire et al. 1992)	1989	3 411	Active surveillance			97.5	77
Katmandu Valley, Nepal (Pandey et al. 1989)	1984–85	1 019	Active surveillance	70.0	12.0	23.0	39
Terai, Nepal (West et al. 1991)	1990	12 264	Active surveillance			4.6	28
Sumatra, Indonesia (Nazir, Pardede & Ismail 1985)	1983	974	National survey	18.8	9.2	11.3	22
Kediri, Indonesia (Roesin et al. 1990)	1986–87	8 624	Active surveillance			9.9	23

Sub-Saharan Africa							
Central African Republic (Georges et al. 1987)	1983	6 584	One-time cluster survey			5.6	19
Tanzania (Mtango & Neuvians 1986)	1984	9 915	Active surveillance			6.8	14.4
Gambia (Greenwood et al. 1990)	1982–83	1 064	Active surveillance			11.4	19
	1984–86	3 146				15.9	31
Kenya (Omondi-Odhiambo, van Ginaeken & Voorhoeve 1990)	1975–78	29 000 (total population)	Active surveillance	11.2	0.9	3.0	20
Ethiopia (Shamebo et al. 1991)	1986–88	5 067	Active surveillance	7.6	3.1	4.0	9
Nigeria (Jinadu et al. 1991)	1987	1 928	Retrospective survey (1 year recall)			20.0	33
Sudan (Herrera et al. 1992)	1988–90	14 149	6-monthly surveys			3.5[a]	44
Guinea-Bissau (Molbak et al. 1992)	1987–90	1 426	Active surveillance			18.9	34
Gambia (de Francisco et al. 1993)	1988–89	25 000	Active surveillance	11.0	4.5	5.8	17
Middle Eastern Crescent							
Yemen (Bagenholm and Nasher 1989)	1982–84	2 071	6-monthly ascertainment	27.7	0.8 (1–2 years)		21
Egypt (National Control of Diarrheal Diseases Project 1988)	1980	10 418	Local registration			15.3	85
	1986	12 156				4.6	71
Egypt (El-Rafie et al. 1990)	1984	10 739	Nationwide cluster surveys	10.9 (0–2 years)			62

continued

Table 1.5 Review of empirical databases on mortality from diarrhoea: studies measuring annual deaths per 1000 children *(continued)*

	Study characteristics			Diarrhoeal deaths per 1000 by age group (years)			Diarrhoeal deaths as percentage of total 0–4 year mortality
Location	*Period*	*Population*	*Type of study*	*< 1*	*1–4*	*0–4*	
	1986	8 704		5.5 (0–2 years)			50
Egypt (El Alamy et al. 1986)	1980–81	2 556	Family cohort study with active surveillance	27.5	4.4	11.2	
Pakistan (Khan et al. 1990)	1986	1 194	Active surveillance			9.0	22
Latin America and the Caribbean							
Nicaragua (Profamilia & Centers for Disease Control 1993)	1982–93	Children of 7 150 women	National demographic survey (retrospective ascertainment)	12.0	15.0	14.4	31
El Salvador (Salvadoran Demographic Association & Centers for Disease Control and Prevention 1994)	1988–93	Children of 5 752 women	National demographic survey (retrospective ascertainment)	7.0	3.0	3.8	20
Ecuador (Ministry of Health, Ecuador & Centers for Disease Control and Prevention 1992)	1979–89	Children of 7 961 women	National demographic survey (retrospective ascertainment)	7.0	5.0	5.4	23
Pelotas, Brazil (Barros et al. 1987, Victora et al. 1987)	1983	5 914	Birth cohort with one-time ascertainment	4.5			
Ceará, Brazil (Bailey et al. 1990)	1985	1 677	Birth cohort with 6-monthly ascertainment	21.8			

a. 9–72 months. Overall mortality unexpectedly low.

Table 1.6 Review of databases on mortality from diarrhoea: estimated from vital registration data in Latin America and the Caribbean

	1975–1979		*1980–1984*		*1985–90*		
Country	*Deaths per 1000 children 0–4 years*	*Diarrhoeal deaths as % of total for children 0–4 years*	*Deaths per 1000 children 0–4 years*	*Diarrhoeal deaths as % of total for children 0–4 years*	*Deaths per 1000 children 0–4 years*	*Diarrhoeal deaths as % of total for children 0–4 years*	*Diarrhoeal deaths as % of total for all ages*
Argentina	0.98	9.8	0.50	6.7	0.31	4.5	0.5
Belize	2.86	26.8	1.11	13.5	0.86	12.9	3.8
Brazil	4.82	26.6	3.02	20.7	1.94	17.2	3.8
Colombia	3.98	23.6	1.56	16.7	—	—	—
Costa Rica	1.16	13.7	0.37	7.3	0.27	6.1	1.5
Cuba	0.37	7.1	0.24	5.4	0.18	4.9	0.6
Chile	1.19	10.4	0.31	5.2	0.17	3.4	0.8
Dominican Republic	4.73	22.8	3.01	17.4	—	—	—
Ecuador	7.54	29.4	4.85	25.7	3.53	23.6	8.7
El Salvador	—	—	4.09	21.6	—	—	—
Guatemala	9.35	28.1	7.46	27.3	—	—	—
Honduras	8.57	38.4	6.56	36.1	—	—	—
Jamaica	1.99	26.1	1.32	28.5	—	—	—
Mexico	4.25	28.3	2.69	25.5	2.17	24.7	7.7
Nicaragua	9.83	44.6	—	—	—	—	—
Panama	1.45	14.3	0.70	9.5	0.66	9.4	2.8
Paraguay	4.50	32.3	2.95	24.4	2.35	23.0	7.0
Peru	7.80	24.6	5.50	19.9	—	—	—
Uruguay	1.03	10.0	0.61	8.4	0.31	5.2	0.6
Venezuela	2.27	20.1	1.55	17.2	1.08	13.6	3.5

Source: Pan American Health Organization 1991

Table 1.7 Review of empirical databases on morbidity from diarrhoea: morbidity in various age groups

	Age group (years) and morbidity			
China (Chen et al. 1991)	*0–4*			*all ages*
Episodes per person per year	2.3			0.73
Indonesia (El Alamy et al. 1986)	*0–4*	*5–12*	*>12*	
2 week prevalence (%)	35%	2%	2%	
Egypt (Nazir, Pardede & Ismail 1985)	*0–4*	*5–14*	*>14*	
Episodes per person per year	3.1	0.3	0.1	
United States (Rodriguez et al. 1985)	*0–4*	*5–14*	*>14*	
Episodes per person per year	1.0	0.4	0.4	

Disease Burden

Morbidity

Table 1.10 highlights the burden of diarrhoeal disease globally: 4 billion episodes of diarrhoea were estimated to occur each year (Murray & Lopez 1996). More than 90 per cent of the morbidity occurs in developing countries. Based on our review of empirical data, it seems likely that some of the regional figures in Table 1.10 are underestimates of the true scale of morbidity. For children in the poorest socioeconomic strata, it is likely that incidence rates are similar in India, Latin America and Africa, and that complete ascertainment of all episodes of diarrhoea would yield rates in the order of 8–14 episodes per year for children between 6 and 24 months, and 5–8 episodes per year for all children younger than 5 years. The overall incidence for a region would be dependent on its socioeconomic mix. It is therefore probable that morbidity is actually somewhat higher than presented in Table 1.10 for Africa, India, the Middle Eastern Crescent and Other Asia and Islands. In Africa, especially, the burden of diarrhoeal disease for adults is undoubtedly increasing because of the magnitude of the AIDS epidemic there.

Mortality

Table 1.11 presents summary estimates for mortality attributable to diarrhoea (Murray & Lopez 1996). Nearly 3 million people were estimated to die each year from diarrhoeal diseases. More than 99 per cent of the deaths occurred in developing countries and 84 per cent of all diarrhoeal deaths were among children under 5 years in developing countries. The highest diarrhoeal mortality rates on a regional basis were found in sub-Saharan Africa, followed by India, the Middle Eastern Crescent, and Other Asia and Islands. Latin America achieved an impressive decrease in diarrhoeal mortality rates over the past 20 years, a finding corroborated by both empirical and vital registration data.

Table 1.8 Review of empirical databases on mortality from diarrhoea: various age groups

	Age group (years) and mortality								
Bangladesh (Shaikh et al. 1990)	*0–4*	*5–9*	*> 9*						
Deaths per 1000 per year (Percentage of total mortality)		1.2 (27%)	1.7 (20%)						
Bangladesh (Fauveau et al. 1989) (Women only)				*15–24*	*25–34*	*35–44*			
Deaths per 1000 per year (Percentage of total mortality)				0.12 (5%)	0.4 (13%)	0.5 (14%)			
Kenya (Bradley & Gilles 1984)	*0–4*	*5–14*		*>14*					
Percentage of total mortality	25%	28%		21%					
Egypt (El Alamy et al. 1986)	*0–4*	*5–14*		*>14*					
Deaths per 1000 per year	11.2	1.3		0					
United States (Lew et al. 1991)	*0–4*	*5–24*			*25–54*		*55–74*	*> 74*	*all ages*
Deaths per 1000 per year	0.02	< 0.001			0.003		0.02	0.14	0.014

Table 1.9 Studies of persistent diarrhoea and distribution of mortality by type of diarrhoea

			Percentage of diarrhoeal deaths attributable to:			
Location (references)	*Type of study*	*Persistent diarrhoea (episodes per year)*	*Acute watery diarrhoea*	*Persistent diarrhoea*	*Dysentery*	*Other findings*
Bangladesh (Fauveau et al. 1992)	Case-control study of deaths			49		Peak mortality for persistent diarrhoea with malnutrition 24–35 months
Bangladesh (Baqui et al. 1992b)	Longitudinal N = 705	0.34 (age 0–4 years)				Risk factors for persistent diarrhoea: blood in stool, dehydration
Bangladesh (Baqui et al. 1993)	Same cohort as Baqui et al. 1992b					Malnutrition and immune deficiency independent risk factors for persistent diarrhoea
Bangladesh (Henry et al. 1992)	Retrospective N = 363	0.8 (age 6–11 months)				Risk factors for persistent diarrhoea: blood or mucus in stool
Bangladesh (Fauveau et al. 1989)	Population-based surveillance: women 15–44 years		24	59	17	10 per cent of mortality atrributable to diarrhoea; persistent diarrhoea may be important in adults
Bangladesh (Victora et al. 1993)	Population-based 236 deaths		34	23	42	
Brazil (Victora et al. 1992)	Population-based study of 227 infant deaths			62		99 per cent of children seen in health care facility during fatal illness
Brazil (Schorling et al. 1990)	Longitudinal N = 175	1.5 (age 0–4 years)				135 diarrhoea days per year for those with and 22 for those without persistent diarrhoea
Brazil (Lima et al. 1992)	Retrospective study of deaths			70		
Brazil (Victora et al. 1993)	Population-based 227 infant deaths		28	62	10	
Guinea Bissau (Molbak et al. 1992)	Longitudinal N = 1426		42[b]	58		

India (Bhan et al. 1986)	Longitudinal N = 1467		CFR[a] 0.7	CFR[a] 14		Risk factors for mortality: severe malnutrition, persistent diarrhoea
India (Bhan et al. 1989)	Longitudinal N = 963	0.31 (age < 1 year)				Risk factors for persistent diarrhoea: blood in stool, age 3–5 months
India (Victora et al. 1993)	Population-based 146 deaths		35	51	14	
Peru (Lanata et al. 1991)	Longitudinal N = 677	0.25 (age 0–3 years)				Risk factors for persistent diarrhoea: age < 6 months, ≥ 6 stools/day
Senegal (Victora et al. 1993)	Population-based 531 deaths		46	47	8	

a. Case-fatality rate.
b. Includes dysentery lasting < 14 days.

Disability calculations

In longitudinal studies of diarrhoeal morbidity, the median duration of watery diarrhoea has been observed to be 4 to 5 days, while dysentery lasts longer, 6 to 11 days (Baqui et al. 1991, Black et al. 1982a, Lopez de Romana et al. 1989, Black et al. 1989, Baqui et al. 1992b). Persistent diarrhoea, by definition, lasts at least 14 days (World Health Organization 1988).

For the purpose of calculating disability, the distribution of episodes by category (watery, persistent or dysenteric) was assumed to be constant for developing countries and was estimated by WHO based on an average derived from published sources (Bhan et al. 1989, Victora et al. 1993, Schorling et al. 1990, Bhan et al. 1986, Baqui et al. 1992b, Lanata et al. 1991, Henry 1991). Disability weights were assigned according to type of diarrhoea (Tables 1.12 and 1.13). As discussed above, the distribution of types of diarrhoea varies widely in the developing world. In addition, persistent diarrhoea may be a more important cause of mortality among adults than is reflected in the World Development Report disability estimates. Active surveillance data from Bangladesh suggest that diarrhoea may cause up to 10 per cent of mortality among women of child-bearing age, more than half of that mortality being attributable to persistent diarrhoea (Fauveau et al. 1989).

Diarrhoea, both persistent and acute, is associated with malnutrition. In particular, severe malnutrition is a significant risk factor for mortality from acute diarrhoea (Bern et al. 1992a) and, more strikingly, from persistent diarrhoea (Bhan et al. 1986, Baqui et al. 1993). Pre-existing malnutrition has also been shown to lead to increased duration (Black, Brown & Becker 1984b) and severity (Tomkins

Table 1.10 Regional summary estimates for morbidity from diarrhoeal disease

	Diarrhoeal episodes (millions)		*Episodes of diarrhoea per person per year*	
Region	*All ages*	*< 5 years*	*All ages*	*< 5 years*
Established Market Economies	167.2	92.6	0.21	1.8
Former Socialist Economies of Europe	93.8	61.9	0.27	2.3
India	787.9	524.1	0.93	4.5
China	1010.3	318.2	0.89	2.3
Other Asia and Islands	496.7	301.0	0.73	4.0
Sub-Saharan Africa	653.1	444.4	1.28	5.0
Latin America and the Caribbean	434.5	225.6	0.98	4.0
Middle Eastern Crescent	430.3	307.7	0.86	4.0
World	4073.9	2275.4	0.77	3.6

Source: Murray & Lopez 1996.

Table 1.11 Regional summary estimates for mortality from diarrhoeal disease

	Diarrhoeal deaths (thousands)		*Mortality rate from diarrhoea (deaths per 1000)*		*Diarrhoeal deaths as percentage of total mortality*	
Region	*All ages*	*< 5 years*	*All ages*	*< 5 years*	*All ages*	*< 5 years*
Established Market Economies	3	<1	0.003	0.007	<0.1	0.4
Former Socialist Economies of Europe	4	4	0.01	0.1	0.1	3.5
India	922	733	1.1	6.3	9.8	22.6
China	93	50	0.1	0.4	1.0	4.7
Other Asia and Islands	397	352	0.6	4.1	7.2	21.8
Sub-Saharan Africa	950	809	1.9	8.6	11.6	20.1
Latin America and the Caribbean	153	130	0.4	2.3	5.1	18.4
Middle Eastern Crescent	424	402	0.8	5.0	9.3	21.6
World	2946	2480	0.6	3.9	5.8	19.4

Source: Murray & Lopez 1996.

1981) of diarrhoea. Diarrhoeal disease can affect growth in the short term (Henry et al. 1987) and long term (Black, Brown & Becker 1984a, Guerrant et al. 1983). This may depend on the type of diarrhoea, with dysentery having a more marked effect on linear growth (Black, Brown & Becker 1984a). It has been shown that sustained nutritional supplementation can obviate the nutritional consequences of diarrhoea in young children (Lutter et al. 1989), but that without supplements, there may be lifelong consequences for growth (Rivera & Martorell 1988).

Table 1.12 Estimates for distribution of episodes by type of diarrhoea according to age

	Percentage of episodes attributable to			*Percentage of mortality attributable to*		
Age (years)	*Watery diarrhoea*	*Persistent diarrhoea*	*Dysentery*	*Watery diarrhoea*	*Persistent diarrhoea*	*Dysentery*
0–4	80	10	10	50	35	15
5–14	89	1	10	75	5	20
15–44	90	0	10	80	0	20
45–59	90	0	10	80	0	20
≥ 60	85	0	15	85	0	15

Source: WHO.

Table 1.13 Assignment of disability weights according to type of diarrhoea; classification used for calculation of disability-adjusted life years

	Percentage assigned to severity class[a]			
Type of diarrhoea	*I*	*II*	*III*	*IV*
Acute watery	70	20	10	
Persistent	50	40	10	
Dysentery		40	40	20

a. Severity classes based on limited ability to perform activities in the following areas: recreation, education, procreation or occupation. Class I denotes limited ability to perform at least one activity in one of these areas. Class II denotes limited ability to perform most activities in one area. Class III denotes limited ability to perform most activities in two or more areas. Class IV denotes limited ability to perform most activities in all areas.

Conclusion

Oral rehydration therapy (ORT) is the major intervention that has been promulgated globally for control of morbidity and mortality from diarrhoeal disease. ORT is not a primary intervention, in that it does not affect incidence of diarrhoeal disease, but it has been shown to be effective in reducing hospitalizations and mortality from diarrhoea in intensive studies (Oberle et al. 1980, Rahaman et al. 1979, Heymann et al. 1990). It has been more difficult to demonstrate an effect of ORT diarrhoeal control programmes on a larger scale (Santosham & Greenough 1991). Data from the Egyptian national programme have demonstrated a decrease in mortality over the 1970s and 1980s (National Control of Diarrheal Diseases Project 1988), but the decrease in mortality had begun before the programme was in place, suggesting that other changes, such as socioeconomic development with attendant improvements in nutrition, sanitation and water, may have been at least partly responsible.

WHO estimates suggest that increased global access to ORT coupled with methods to improve usage have the potential to decrease global mortality from diarrhoea (World Health Organization 1992). The extent to which this will be effective will depend upon the proportion of mortality resulting from acute watery diarrhoea in the locality in question (Victora

et al. 1993). Recent data on diarrhoeal mortality attributable to persistent diarrhoea and dysentery suggest that once ORT use is high, further reduction of diarrhoeal mortality will depend upon additional interventions such as improved case management, hygiene education, encouragement of breast-feeding, improved sanitation, and general socioeconomic development (Feachem, Hogan & Merson 1983, Esrey, Feachem & Hughes 1985, Feachem 1984, Ashworth & Feachem 1985, Feachem & Koblinsky 1984, Ronsmans et al. 1991), all of which are more difficult to implement. Thus, in areas where diarrhoeal mortality is very high and ORT access is low, such as sub-Saharan Africa, a large fraction of deaths may be preventable through improved ORT access and education, while areas such as Brazil may already be at the point where further reduction will require other interventions in addition to the maintenance of ORT promotion.

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