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THE CONTROL AND PREVENTION OF DIARRHEAL DISEASES AT THE NATIONAL LEVEL

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INTRODUCTION

Dr. Rohde told us this morning that diarrhea and poor diet interact in a vicious circle leading to malnutrition and frequently maiming and killing infants and young children. It appears certain that diarrhea has deleterious effects on nutrition and health through reduced food consumption, altered digestion and impaired absorption, and metabolic alterations, all of which eventually interfere with growth and development (Mata, 1983a; Mata, 1985). Invasive diarrhea often results in chronic loss of nutrients and cells (a protein-losing enteropathy), increasing the risk of malnutrition and death. The risk is greater for infants and young preschool children, but persons of other ages may also be affected. Recurrent or chronic diarrhea often causes debilitation, wastage, and stunting. An episode of acute diarrhea may precipitate a child into severe protein-energy malnutrition, just as it occurs with other acute infections.

In some countries children experience only a few attacks of diarrhea per year (Snyder & Merson, 1982; WHO, 1983), but in others, as many as seven to nine episodes per child per year are observed (Mata, 1983b; Mata, 1985). This formidable force of infection sometimes accounts for 20 percent of the total span during the first three years of life, resulting in loss of time for stimulation and learning. Children with diarrhea may be described as smelly, irritable, fearful, and retarded. Such children may become detached from their families and can be the target for mistreatment and abuse by parents or attendants.

Those who have personally experienced severe diarrhea and dysentery can appreciate the misery and effects of such events. Untreated watery diarrhea with dehydration and invasive diarrhea with toxic manifestations often lead to death within hours or days of onset. In less developed countries, diarrhea is one of the main contributors to global mortality, particularly among infants. The correlation between diarrheal disease mortality and infant mortality is striking (regression coefficient = 0.95) since more than 80 percent of all diarrhea deaths occur among infants; a decrease in diarrhea deaths will inevitably be followed by a drastic reduction

in infant mortality (Mata, 1981). Therefore, the control and prevention of diarrheal diseases is one of the main priorities in the process of national development. Responsible scientists, politicians, and planners are rightly interested in bringing about the necessary interventions to attain such an aim.

UNDERSTANDING TRANSMISSION: NEED FOR INTERVENTION

It is now widely accepted that the majority of the diarrheas that occur in the general population are caused by a large variety of viruses, bacteria, and protozoa. Infectious enteric agents are transmitted by ingestion of food and water contaminated with feces or through contact of the mouth with fingers or utensils soiled with feces (Mata, 1983b; Mata, 1985).

All possible forms of transmission outlined in Table 1 are evident to the careful epidemiologist or anthropologist who works in rural settings (Mata, 1985). Transmission involves human-to-human, and less prominently, animal-to-human direct or indirect contact. *Campylobacter jejuni*, enterotoxigenic *Escherichia coli*, rotaviruses, and *Cryptosporidium sp.* are harbored by man and animals; animals may be important in rural settings because they may cohabitate with children. Transmission is favored by cultural, religious, social, and economic factors but a better understanding of the complex web of causal factors is fundamental to strengthen efforts to develop diarrheal disease control programs.

Current knowledge about transmission indicates that the empirical approach that has always been used to support and implement interventions to improve the sanitary environment was correct. Thus, building water supplies and sanitary facilities eventually led to significant control of disease, even though there was no proof in sight of its impact and cost/benefit. Actions were primarily triggered by a desire to improve the quality of life and were partly influenced by the germ theory of disease, as Pasteur's discoveries made the world deeply concerned about hygiene and sanitation. Governments began interventions to that end, and it is now evident that countries that successfully developed an infrastructure for water supply and sanitation eventually decreased their diarrhea morbidity and mortality rates through a process that lasted several decades.

Thus, the need to satisfy the basic human rights (food and water, housing, education, and health) and the influence of the germ theory of disease, which emphasized prevention of infection, have been the driving forces for improving the sanitary environment in the last 150 years. Interventions were implemented without waiting for scientific proof of whether they had an impact or whether they had a low cost/benefit. Recent analyses demonstrate that the empirical decision to intervene was justified as most interventions have a measurable impact. The analyses show that improving water supply and sanitary facilities, promoting personal and domestic hygiene, and improving weaning practices lead to significant reduction in diarrhea morbidity and mortality (Feachem, 1985). Also, actions that reduce the rate of low birth weight would also reduce some morbidity and mortality due to diarrhea (Ashworth & Feachem, 1985).

More recently many nations have been struggling to effect other interventions, such as promotion of breastfeeding, which prevents some diarrhea cases and averts some diarrhea deaths. Interventions resulting from recent scientific or technological achievement also have a measurable impact: measles immunizaton prevents some diarrhea cases and averts some diarrhea deaths (Feachem & Koblinsky, 1984); effective antibiotics avert most deaths due to severe invasive diarrhea (Mata et al., 1970); and the utilization of modern oral and intravenous salt solutions avert most deaths from acute watery diarrhea (Odio & Mohs, 1980; Mata, 1981).

The Rockefeller Foundation, the Pan American Health Organization (PAHO), the World Health Organization (WHO), the World Bank, and UNICEF have emphasized all along the need to implement the above-mentioned interventions. The role of PAHO has been outstanding in the Americas. The Conference of Punta del Este set specific goals for

TABLE 1
TRANSMISSION OF INFECTIOUS AGENTS THAT CAUSE DIARRHEA

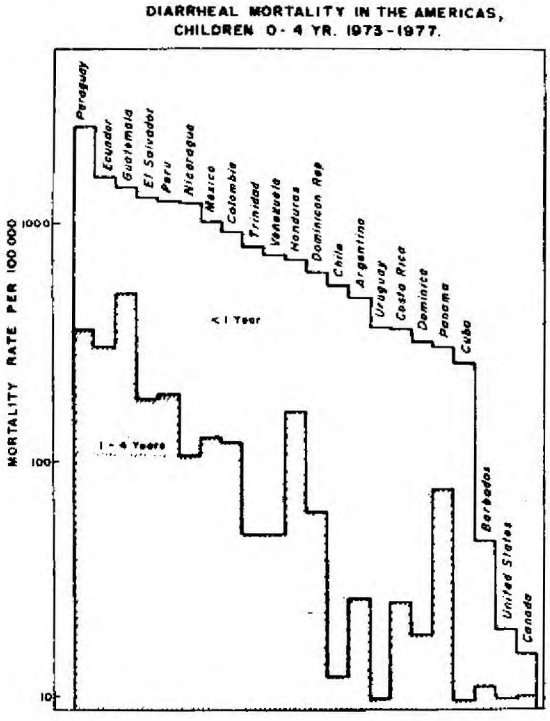
Human-to-Human
anus-fingers-mouth
feces-fingers-foods and drinking water-mouth
feces-fomites-fingers-mouth
feces-fomites-fingers-foods and drinking water-mouth
feces-soil to water-foods and drinking water-mouth
feces-soil-insects-foods-mouth
anus-mouth
Animal-to-human
anus-fingers-mouth
feces-fingers-foods and drinking water-mouth
feces-soil to water-foods and drinking water-mouth
feces-soil-insects-foods-mouth
anus-mouth

governments regarding expanding coverage of the population with basic services (for instance water supply and immunizations) in order to attain a reduction in childhood mortality. The accomplishments of this conference were reviewed a few years later in Santiago, Chile, and positive results were already visible in many countries. The important consideration, however, was the growing interest and concern of governments on health issues, the evident increase in responsibility, and the commitment to do something about prevailing deficiencies.

OBSERVABLE IMPROVEMENT IN DIARRHEA MORTALITY

Adequate data for calculation of diarrheal disease age-specific mortality rates are not available for many less developed countries, but they are available for most countries of the Americas (PAHO, 1980). Figure 1 shows diarrheal diseases mortality rates for infants and children 1 to 4 years old in the Americas for 1973-77. The varying status of nations with regard to mortality rates suggests differences in attainment of control of the diarrhea problem. Canada and the United States had the lowest rates, while Paraguay, Ecuador, Guatemala, El Salvador, Peru, and Nicaragua had rates greater than 1,000 infant diarrhea deaths per 100,000 live births in the period 1973-77. Since infant diarrhea deaths in New York and other North American cities were as high at the turn of the century as the highest rates seen today in Latin America, one must ponder the likelihood that some improvement will operate in the future in these nations as they evolve their sanitary infrastructure. In fact, significant additional progress has been noted in Costa Rica, Cuba, and Chile in the last few years, an omen that other countries will improve in the near future.

FIGURE 1



The wide range of variation of diarrheal mortality rates for infants (top graph) and preschool children (bottom graph) indicates varying stages in control of diarrheal diseases in countries of the Americas. Source of data: Pan American Health Organization (1980).

Data on diarrheal diseases death rates corresponding to two separate years permit assessment of a possible decline as a function of time. The figures released for the Americas for the period 1970-78 (WHO, 1982) were used to calculate changes in a decade, as shown in Table 2. Countries were grouped in categories according to the current level of infant mortality. The nations in the "high infant mortality rate" group also had the highest diarrhea mortality rates (both in infants and preschool children) and also had the least pronounced variation in diarrhea mortality with time. It has been already mentioned that more than 80 percent of all the diarrhea deaths occur in infants and a very strong correlation exists between diarrheal disease and infant mortality rates (Mata, 1981). Three countries with high infant mortality, namely, Nicaragua, Ecuador, and Honduras, actually had an increase in diarrhea mortality during the observation period. The nations in the group of "middle infant mortality" showed a marked decline, excepting Uruguay where an increase in infant deaths was observed.

The most striking changes were in Chile, Costa Rica, and Cuba. The last two countries have been classified in the last few years in the category of nations with "low infant mortality rate," and it should be pointed out that the infant mortality rate in Chile in 1983 was quite close to that reported for Cuba and Costa Rica a few years earlier. The rates attained in these advanced less developed countries are so low now that the study of all diarrhea deaths at the national level to determine risk factors might be considered as part of the national surveillance program.

The most important consideration, however, is that most Latin American nations are experiencing a steady decline in diarrhea and infant mortalities in all probability due to the sustained efforts to improve the quality of life.

TABLE 2
EVOLUTION OF DIARRHEAL DISEASE DEATH RATES (PER 100,000) AND INFANT MORTALITY RATES (PER 1,000 LIVE BIRTHS) IN THE AMERICAS, 1970-78

Country	1970	1978	% Change	IMR c1980
High Infant Mortality				
Peru	1037	752	−27	100
Nicaragua	1225	1409	+15	90
Ecuador	969	1144	+18	80
Honduras	793	873	+10	80
El Salvador	1458	1345	−8	70
Guatemala	1818	1311	−28	70
Dominican Republic	1178	539	−54	60
Middle Infant Mortality				
Mexico	1802	1259	−30	50
Venezuela	875	601	−31	39
Uruguay	479	521	+9	38
Argentina	880	463	−48	36
Chile	1418	265	−81	32
Panama	589	306	−48	27
Low Infant Mortality				
Costa Rica	1509	195	−87	21
Cuba	565	123	−78	21

Source: *WHO Wkly. Epidem. Rec.* 57:353-355 (1982)

NATIONAL CONTROL OF DIARRHEA: THE CASE OF COSTA RICA

Despite the fact that Costa Rica is a small nation in area and population, it thrived relatively well with the inherited poverty and overt underdevelopment still prevailing in the early 1960's, by emphasizing education, health, and democracy (Mata & Rosero, 1986). The oldest data on per capita expenditures corresponding to the 1930's already revealed substantial investment in education and health as opposed to the military. In fact, during the period 1940-48 there was a virtual dismantling of the army, which in 1948 consisted of just a few hundred underpaid "soldiers." The army was abolished one year after a brief civil war in 1948 by unanimous Congressional vote, and the budget for health and education eventually reached the high record of 50 to 60 U.S. dollars per capita in the 1970's, much in excess of expenditure in police and security.

It is not surprising that interventions were commenced, developed, and eventually completed in Costa Rica between 1930 and 1970 (see Table 3). While most interventions were begun in the 1930's and 1940's, the greatest accomplishments oc-

TABLE 3
INTERVENTIONS AGAINST DIARRHEAL DISEASES EFFECTED IN COSTA RICA

	Decade of Intervention*		
Intervention	commenced	developed	80% completed
Water and Sanitation	late 1930's	1940	late 1969 & 1970
Personal and Home Hygiene	1930	1940 & 1950	1960 & 1970
Weaning practices	late 1940's	1960	1970
Breastfeeding	late 1960's	late 1960's	1980
Chemotherapy	1960	1970	late 1970's
Rehydration, intravenous	1960	1970	late 1970's
Measles immunization	late 1960's	1970	1980
Rehydration, oral	late 1970's	late 1970's	1980

*estimates from historical records (Mata & Rosero, 1986)

curred in the 1960's and 1970's (water supply, sanitation, personal and domestic hygiene, weaning practices, immunization, and breastfeeding). Interventions that led to an improved maternal nutrition and health (adequate growth in childhood and adolescence, maternal education and hygiene, child spacing, prenatal care, detection and care of the high-risk pregnancy, and improvement of delivery conditions) were also implemented; the rate of low birth weight infants was about 7.5 percent in 1975, a very low figure (Mata et al., 1978; Mata, 1983c).

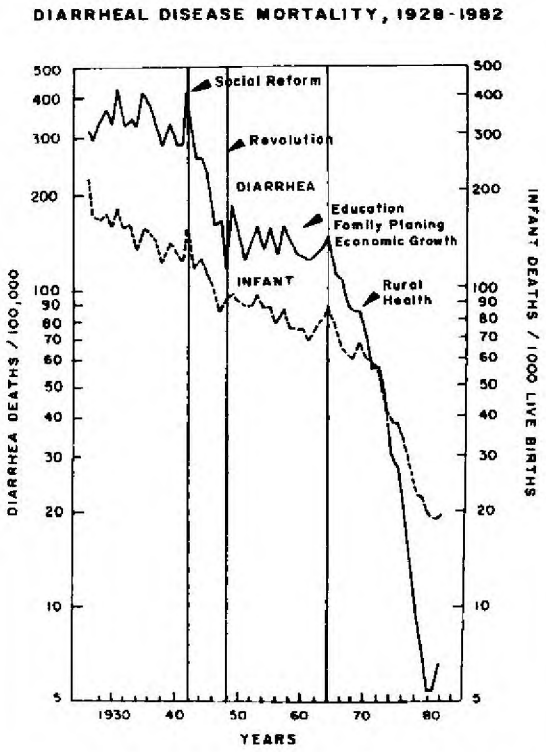
Each intervention or group of interventions probably accounted for some part of the rapid decrease in infant mortality and diarrheal disease mortality, particularly after the mid-1960's (Figure 2). But definitive data on the contribution of each intervention to the evolution of the mortalities in Costa Rica might never be obtained. Diarrhea and infant mortality were extremely high in the 1930's (about 250 per 100,000 population and more than 200 per 1,000 live births respectively) and were often greater than the highest rates recorded in contemporary times in countries with a serious diarrhea problem.

The period 1940 to 1948 was characterized by significant social, health, and educational achievement (labor legislation, minimum wages, paid vacations, social security, expanding of the grammar and high school system, founding of the University of Costa Rica, improving water supply and sanitation, expanding roads). This period witnessed the first striking reduction in infant and diarrheal mortalities, but the advancement was temporarily halted by the civil war of 1948, which was accompanied by social disruption. During this period there was migration from rural areas to cities, adoption of bottle-feeding with the upsurge of modern pediatrics, and excessive population growth (Costa Rica attained the fastest growth rate in the Americas during that period). While efforts to maintain and expand social, education, and health gains of the previous period continued, the diarrhea and infant mortality rates remained high and practically unaffected for 15 years.

By the mid-1960's, women in Costa Rica had attained almost the same level of education and political participation as men; moreover, this coincided with significant advances in family planning. The decline in fertility between 1960 and 1970 has been the fastest ever recorded in the Americas (Ortega, 1977). Undoubtedly, the reduction in fertility must have resulted in improvement in maternal nutrition and health, and consequently in a significant reduction in rates of prematurity and fetal growth retardation; this, in turn, must have determined part of the new decline in infant deaths from diarrhea and other causes in subsequent years (Mata et al., 1978).

The abrupt reduction in mortality that characterized the decade of 1970 (see Figure 2 again) coincided with ongoing interventions and with the establishment of the Rural Health Program (RHP), actually a primary health care intervention beginning in 1971 and expanding in 1973 to 1975 (Mohs, 1982). When malaria eradication was consolidated in the 1960's, health workers shifted to the care of about 600,000 rural people (30 percent of the then total population) living in scattered communities with less than 500 persons each. The duties of these workers were to reach the farthest points in the country to update the census, vaccinate (against poliomyelitis, diphtheria, tetanus, measles, smallpox and tuberculosis), survey and treat

FIGURE 2



Crude diarrheal disease death rate and infant mortality rate for Costa Rica during the period 1926–1982. Note that all peaks, depressions, and plateaus of both mortality curves coincide, indicating that the control of infant mortality must be preceded by the control of diarrheal disease mortality. The first decline in mortality coincided with the period of social reforms; the second with the implementation of the Rural Health Program that strengthened sanitation and health in rural areas. ORT, promotion of breastfeeding, and other interventions were effected in the second half of the 1970's.

malaria, treat intestinal helminthiasis, administer iron to pregnant women, educate in health and family planning, distribute contraceptives, do prenatal care, refer cases to regional health centers and hospitals, and organize health committees and promote community organizations. One of the main actions of the RHP was to build rural water supplies, sewers, and latrines.

The impact of the RHP has been assessed by a model of regressions that enter economic factors (food production, income, roads, growth, etc.), social variables (literacy, schooling, political participation, etc.), health variables (sanitation, water supply, nutritional status, child spacing, immunizations, diarrhea mortality, infant mortality, etc.), and several other variables (Rosero, 1985). The model (Figure 3) clearly showed that during the decade of 1970 most of the change in infant mortality can be explained by the interventions of the RHP (primary care), and, to a lesser extent, by treatment in health posts, health centers, and regional hospitals (secondary care). Economic development appeared to be less important than these two packages of interventions. Decreased fertility had a small contribution according to the model, but it is possible that this variable might have influenced infant mortality in preceding years.

A costly food distribution program was implemented in the late 1970's without apparent effect on the nutritional status and on infant mortality (Mata, 1983; Mata & Rosero, 1986). No changes were noted in calorie intake of families or individuals in urban and rural areas between 1966 and 1982 (Mata, 1983) but a dramatic reduction in the incidence of severe calorie-protein malnutrition was observed in the intervening period. In fact, kwashiorkor has virtually disappeared from the country.

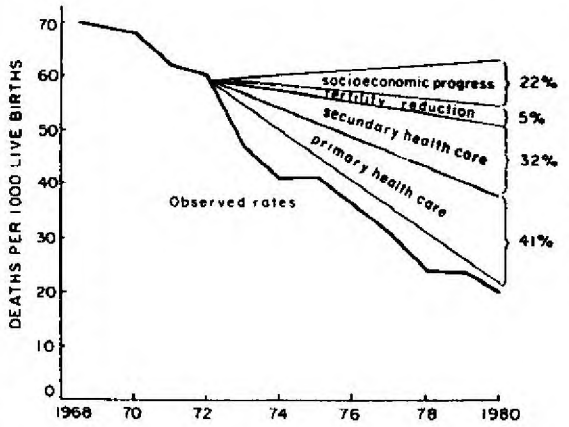
It is difficult, if not impossible, to determine at present the impact on diarrhea mortality of other interventions effected in Costa Rica in the late 1970's, namely, promotion of breastfeeding, chemotherapy, measles immunization, and rapid intravenous and oral rehydration therapy, all successfully implemented. For example, promotion of breastfeeding resulting from shifting from mother-infant separation and formula-feeding hospital practice to rooming-in, resulted in almost universal breastfeeding for at least one month, while more than 80 percent of infants nationwide were breastfed for at least three months. Furthermore, most infants who had to be separated from their mothers for medical reasons (hyaline membrane disease, congenital defects, and so forth) were given pooled colostrum and milk from donating mothers (Mata et al., 1984). A remarkable reduction was noted in hospital cases and deaths of early neonatal diarrhea, but the total impact on the overall diarrhea mortality is unknown.

A national program of distribution of oral rehydration packages was also started in the late 1950's that undoubtedly saved many lives (Mata, 1981; Lopez, 1982). Again, it is difficult to know the impact of such a program on the overall diarrhea mortality because the decline in diarrhea mortality was clearly in effect in the preceding period (see Figure 2 again). Regarding chemotherapy directed against properly diagnosed infectious diseases, Costa Rica has benefited from such an intervention since the late 1960's owing to the extensive urban and rural network of hospitals and health services. Bacterial diseases that respond to specific treatment with antimicrobials have been considerably controlled, for example, rheumatic and scarlet fevers, shigellosis, and chronic recurrent otitis media.

Nevertheless, Costa Rica might not be a good example to show the impact of these recent interventions, but serves as a model to demonstrate that holistic interventions aiming at interrupting transmission definitely result in monumental decreases in diarrheal disease mortality. Whatever doubt there was that such a decrease in mortality might have not been accompanied by a concomitant decrease in the incidence of diarrhea vanished after calculation of morbidity rates in a typical rural region (Puriscal); rates in this region were found to be exceedingly low, about 10 times less than the usual rates observed in traditional

FIGURE 3

EXPECTED EVOLUTION OF INFANT MORTALITY



Effect of different variables on the trend of infant mortality rate in Costa Rica according to Rosero's explanatory model. Primary and secondary health care had the greatest effect on the decline of infant mortality during the 1970's.

societies (Mata, 1982). Also, there are data on prevalence and intensity of infection with intestinal helminths for the years 1966 and 1982, at the national level, that clearly reveal a marked decline in prevalence and worm load, almost to the point of eradication (Mata et al., 1986).

The cost of interventions is high. Costa Rica is presently investing about 7 to 8 percent of its gross national product in health. The cost of interventions might be found too high by politicians, but it is certainly low when compared with the cost of weapons and even more so when weighed against the value of happiness and human life.

ORAL REHYDRATION THERAPY (ORT): IMPACT AND COST/BENEFIT

The value of ORT as a life-saving measure is unquestionable and was vividly demonstrated during cholera epidemics and civil strife in the Indian subcontinent. Experiments to document the impact of ORT, however, are difficult and time consuming and may fall in the fringe of the ethical issue. They are complicated by the lack of research capability in many countries where diarrhea is a priority problem deserving implementation of ORT and other suitable interventions.

Data collected in nine hospitals throughout the world showed, with one exception, a consistently large and significant reduction in the rate of hospital admissions due to diarrheal disease and in the diarrhea case-fatality rate after introduction of ORT (see Table 4)(WHO, 1984). The one exception (Matlab Treatment Center of ICDDR/B) might have been due to successful use of ORT in outpatients resulting in a significant reduction in admission of mild and moderate cases of diarrhea. This change likely resulted in a relative increase in admission of very severe cases in the post-ORT versus the pre-ORT period.

The dramatic effect of ORT was observed in the National Children's Hospital in Costa Rica, shortly after the adoption of ORT (Nalin et al., 1978). ORT was used in about 90 percent of the diarrhea cases with dehydration; the rest were treated with rapid intravenous fluids. Table 5 shows a 90 percent reduction in case fatality within a year of commencement of ORT. The case fatality has remained very low ever since (Odio & Mohs, 1980). An even more dramatic effect was recorded in a traditional rural population in Bangladesh where a relatively inexpensive distribution system for sachets of oral rehydration salts was followed by a marked decrease in diarrhea and child deaths (Rahaman et al., 1979).

Dr. Merson reviewed some WHO activities oriented towards development of diarrheal disease control programs in a large number of developing countries throughout the world (WHO, 1985). These programs include oral rehydration therapy (ORT) as one of their strong components. There is urgent need for data on impact and cost/benefit of ORT, to provide guidance on its values separate from that of other measures included in the primary health care package. Such information is required by international organizations such as WHO, UNICEF, and USAID, that are presently engaged in child survival programs. Unfortunately, there is scarce information on the subject due in part to the fact that treatment programs require the use of some intravenous fluid therapy; this makes it difficult to accurately estimate the impact and cost of ORT alone.

TABLE 4
IMPACT OF ORAL REHYDRATION THERAPY (ORT) ON DIARRHEA ADMISSION AND CASE-FATALITY RATES IN NINE HOSPITALS

Hospital	Percent Change	
	Admissions	Fatalities
Dhaka ICDDR, B, Bangladesh	−82	0
Matlab ICDDR, B, Bangladesh	+40	+11
National Children's, Costa Rica	−58	−45
Al Shatby Children's, Egypt	−71	−83
Bustamante Children's, Jamaica	−81	−75
Kanti Children's, Nepal	−70	−93
Port Moresby General, Papua New Guinea	−53	−12
National Children's, The Philippines	−37	−71
Children's, Thailand	−15	−50

Adapted from *WHO Wkly. Epidem. Rec.* 59:361-363 (1984)

TABLE 5
DIARRHEA CASE-FATALITY RATIO (CFR), NATIONAL CHILDREN'S HOSPITAL, COSTA RICA, BEFORE AND AFTER ORAL REHYDRATION THERAPY

Year	Rehydration method	Number of diarrhea cases	Number of deaths*	CFR per 1000
1977	slow IV	5974	18	3.0
1978	ORT (90%) +	6000	2	0.3**

*After 48 hours of internment
**A 90 percent reduction (significant)
Adapted from Odio & Mohs (1980)

Our own experience in a rural area of Costa Rica indicates that staffing a program of ORT is not necessary as the new activities can be readily absorbed by existing health personnel. Auxiliary nurses and other health workers can be effectively trained in the ORT procedures used in the hospital; mothers can use their own children with diarrhea as models for training; the knowledge can be effectively transferred to mothers and then from mother-to-mother (Jimenez et al., 1982). The pilot study in Puriscal was the base for adoption of sachets for eight-ounce bottles (Mata, 1981), and the ORT technique developed in the hospital, (Pizarro et al., 1979) for a successful national program (Lopez, 1982).

Limited information available indicates that ORT has a low cost, apparently the lowest of all interventions (excepting breastfeeding) known to avert deaths from dehydrating diarrhea (Table 6). The cost in the cholera treatment center in Dhaka, Bangladesh, was 11 U.S. dollars per capita and 94 U.S. dollars per death averted (Sack, 1985). In a treatment center in rural Matlab, Bangladesh, the cost was 40 U.S. cents per capita and 22 U.S. dollars per death averted (Samadi et al., 1983). It was 38 U.S. cents per capita and 16 U.S. dollars per death averted in a community-based distribution program in Teknaf, Bangladesh (Rahaman, 1985). Estimates for the treatment centers in Dhaka and Matlab include costs of treating approximately 90 percent of the diarrhea cases with ORT and about 10 percent (the most severe ones) with intravenous fluids.

Data for national programs are scarce. In two countries, Egypt and Zaire, the cost ranged from 50 U.S. dollars to 240 U.S. dollars per death averted (Hirschhorn, 1983; Kielmann, 1983; Shepard, 1983). The cost per capita of the national program in Egypt was close to that obtained in community-based studies in Bangladesh.

TABLE 6
COST OF REHYDRATION THERAPY (MAINLY ORAL) IN THE MANAGEMENT OF DIARRHEAL DISEASES

Setting (Source)	U.S. dollars per: capita	death averted
Treatment center		
Dhaka (Sack)	11.00	94.00
Rural program		
Matlab (Samadi et al.)	0.40	22.00
Teknaf (Rahaman)	0.38	16.00
National program		
Egypt (Hirschhorn)		50.00
Egypt (Kielmann)	0.57	73.00
Zaire (Shepard)		240.00

IS ORT THE END OF THE SEARCH?

While it has not been possible to determine the impact of ORT programs in most countries operating them, most agree that they are useful. Lack of impact or apparent negative effects of ORT are interpreted as due to environmental, cultural or managerial constraints that have interfered with proper delivery of the intervention. The various reports on the benefits of ORT are definitively encouraging. They pertain to countries as diverse as Bangladesh, Costa Rica, Egypt, Honduras, Papua New Guinea, the Philippines, and Tonga (Rahaman et al., 1979; Odio & Mohs, 1980; Mata, 1981; Lasch et al., 1983; USAID, 1983; Frankel & Lehmann, 1984; WHO, 1984; Clow, 1985; Gabr, 1985). However, some gross failures have been reported (Teckce, 1983; Williamson, 1983) and there might be other similar cases that went unreported for the reason that negative results usually are not published.

While most data support the rationale for ORT, serious consideration should be given to the fact that it is primarily a life-saving measure and not a means to prevent or correct basic deficiencies in the affected population. Most clinicians and field workers engaged in oral rehydration programs recognize that diarrhea persists in an important proportion of rehydrated children, perhaps as much as 5 to 19 percent. In fact, chronic diarrhea develops in about 1 to 5 percent of children after recovering from an attack of acute diarrhea; chronic diarrhea may eventually kill children through wasting and malnutrition. A recent study in Bangladesh showed that a considerable proportion of malnourished children with diarrhea who had been treated for dehydration in the treatment center died in their homes within three months of discharge either from diarrhea (chronic or acute) or from other infections (Roy et al., 1983). Mortality and malnutrition in these children were definitely in excess of rates seen in the general population, once corrected for age and other factors. This study suggests that ORT may spare death from a particular episode of acute diarrhea but not from a new diarrhea attack or another illness striking later on once the child has returned to his deprived environment. Obviously, malnutrition is an underlying factor enhancing the deleterious effects of infection.

CEREAL-BASED ORS

The possiblity of doing more than merely correcting the electrolyte imbalance and fluid loss in diarrheal disease is the wish of every devoted practitioner. There has been much theoretical discussion about feeding during and after acute illness, but there is not enough information on the practicality and benefits of such prescription, nor on the feeding regimes and techniques that are more suitable for ill and convalescent children. One of the complicating issues is anorexia—very common in children with diarrhea—as it interferes with proper feeding even under adequate environmental conditions.

The Mollas in Bangladesh found that absorption of nutrients is impaired during and in the weeks following an attack of acute diarrhea, but considerable absorption occurs if children are fed properly (Molla et al., 1982a; Molla et al., 1983). This work was followed by demonstration that cereal-based oral rehydration solution had a similar therapeutic effect on the electrolyte imbalance as that of the standard ORS, while it shows several advantages (Molla et al., 1982b). Previous work by Nalin and co-workers had shown that ORS containing both glucose and glycine enhanced sodium and water absorption to a greater extent than solutions containing either glucose or glycine alone (Nalin et al., 1970), a finding that led to the concept of super-ORS, of potential significance for further improvement of oral rehydration (Merson, 1985).

Cereal-based ORS actually brings a prescription followed by millions of women throughout the world since ancient times to more accurate scientific description and recommendation. Cereal-based ORS is prepared by dissolving about 50 grams of rice powder in 1 liter of water with heating to produce a gruel; regular WHO oral rehydration salts without glucose are then added to the gruel, which is now ready to be used. Administration is by spoon or by cup involving the mother or attendants in the treatment. Molla has found that children prefer and readily accept rice-based ORS over glucose-based ORS (Molla, 1985). Furthermore, children receiving this ORS have less purging, gain more weight, and develop less chronic diarrhea than children given the standard ORS. Cereal-based ORS generally is less expensive than ORS, and it can be readily prepared and administered at home by very poor rural women (Rahman et al., 1985). There is a large variety of cereals in developing countries of potential use for this ORS. Such cereals could be prescribed according to prevalent dietary habits, removing the dependence on imported manufactured ORS or of raw materials for their preparation, but much more research is needed.

The possibility of improving the nutritional status of children concomitantly with the correction of

fluid and electrolyte imbalance is one of the most exciting developments of today's public health practice, particularly in view of the suspicion that ORT may not modify infant mortality in countries where malnutrition is rampant.

COMMENT

There is a genuine concern throughout the world about decreasing the burden of diarrhea in order to diminish suffering, malnutrition, and risk of death of children, especially in the less developed countries. This concern puts pressure on finding practical solutions for its control, and ORT was thought to be one of the measures that could have a rapid impact. However, it is evident from the evolution of health in industrial nations, and in a few transitional countries (Costa Rica, Cuba, Chile), that eventual control and prevention depend more on holistic and sustained interventions that alter the environment and interrupt transmission, than on a life-saving measure like ORT. Holistic interventions have a greater influence on the host and the quality of life because they act on the determinants of disease transmission and because they have a long-lasting effect.

Nevertheless, the importance of ORT among the constellation of existing measures should not be neglected as it has a dramatic effect in lowering mortality in severely dehydrated children, including infants and small neonates. Benefits extend not only to hospital and clinic patients but also to people living under very rustic conditions such as in rural sparse areas. While there is no doubt of the value of ORT for survival of children who are adequately nourished or who have mild or moderate malnutrition, its importance for severely malnourished children is less certain. Malnourished children and children with other handicaps may be spared from immediate death from diarrhea by the benefit of ORT, but they remain susceptible to new complications, malnutrition, and even death from a new episode of diarrhea, chronic diarrhea, or other infectious disease.

Yet, the effective implementation of ORT has added advantages, in addition to saving lives. ORT generates a new attitude among poor urbanites and villagers, especially women, regarding the feasibility and importance of preserving life, particularly of well-nourished children. Its impact on malnourished children may be less evident to poor women. But even under the worst of the situations, to spare death in what appears miraculous fashion has considerable meaning, especially for deprived slum and village people.

It must not be forgotten, however, that ORT can do little if anything to improve the environment that prompts the occurrence of diarrhea. Nevertheless, there is hope that through the infrastructure to deliver the intervention, mothers will acquire relevant information about interruption of disease transmission, feeding children during and after acute disease, family planning, and other facets of health education.

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