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COSTA RICA AND
CURRENT EFFORTS IN CONTROL, PREVENTION, AND RESEARCH

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EPIDEMIOLOGIC PERSPECTIVE OF DIARRHEAL
DISEASE IN COSTA RICA AND CURRENT
EFFORTS IN CONTROL, PREVENTION, AND RESEARCH

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Mortality due to diarrhea: 1900-1979

Like most developing nations, Costa Rica also had a very high mortality attributable to diarrheal disease at the beginning of the Century. The Capital City, San José, had an estimated 25.000 population at the turn of the Century, and the mortality for all causes, according to one of the oldest census, was 41 per 1000 population, only surpassed by that of Alexandria. The estimated diarrheal disease death rate for 1900 was 239 per 100.000 (codes 091 and 092) (Mata and Mohs, 1976). Clinical descriptions in hospital records of those days suggest that most fatal cases were due to dysentery-like and cholera-like illnesses.

Relatively good data on total population, mortality and cause of death became available around 1920. The diarrheal disease death rate for the country at that time was extremely high, of the order of 400 per 100.000, but thereafter it started to decline slowly, and more pronouncedly after 1940, Table 1. The high rates recorded in the quinquenium 1928-1932 are comparable to those observed in modern times in several Asian and African nations which are seriously affected by malnutrition and poverty.

Table 1

MORTALITY DUE TO DIARRHEA IN COSTA RICA, 1928-1977.
Codes 008, 009 and 561. Code 561 was excluded after 1967

Period	Mean yearly deaths in period	Range of yearly death rates per 100.000	Range of yearly % proportionate mortality
1928-32	1850	320-431	13.8-18.1
1933-37	2082	321-417	16.6-19.1
1938-42	2077	282-398	15.3-20.3
1943-47	1596	157-257	12.1-16.5
1948-52	1179	112-187	9.3-16.1
1953-57	1420	125-158	11.6-15.9
1958-62	1512	120-140	14.2-15.9
1963-67	1703	86-143	12.4-16.6
1968-78	1207	55-84	9.4-15.8
1973-77	516	12-45	2.8- 8.9

After Mata et al., 1980

Figure 1 depicting the decline in diarrheal disease death rate just mentioned, clearly shows the profound change that the country experimented over a short span. The first reduction coincided with the period 1940-48, characterized by the beginning of social and economic reforms. After stagnation during the following 15 years (a period marked by civil war, followed by population explosion) diarrhea deaths again declined steadily up to the present (Mata et al., 1980; Mata et al., 1979).

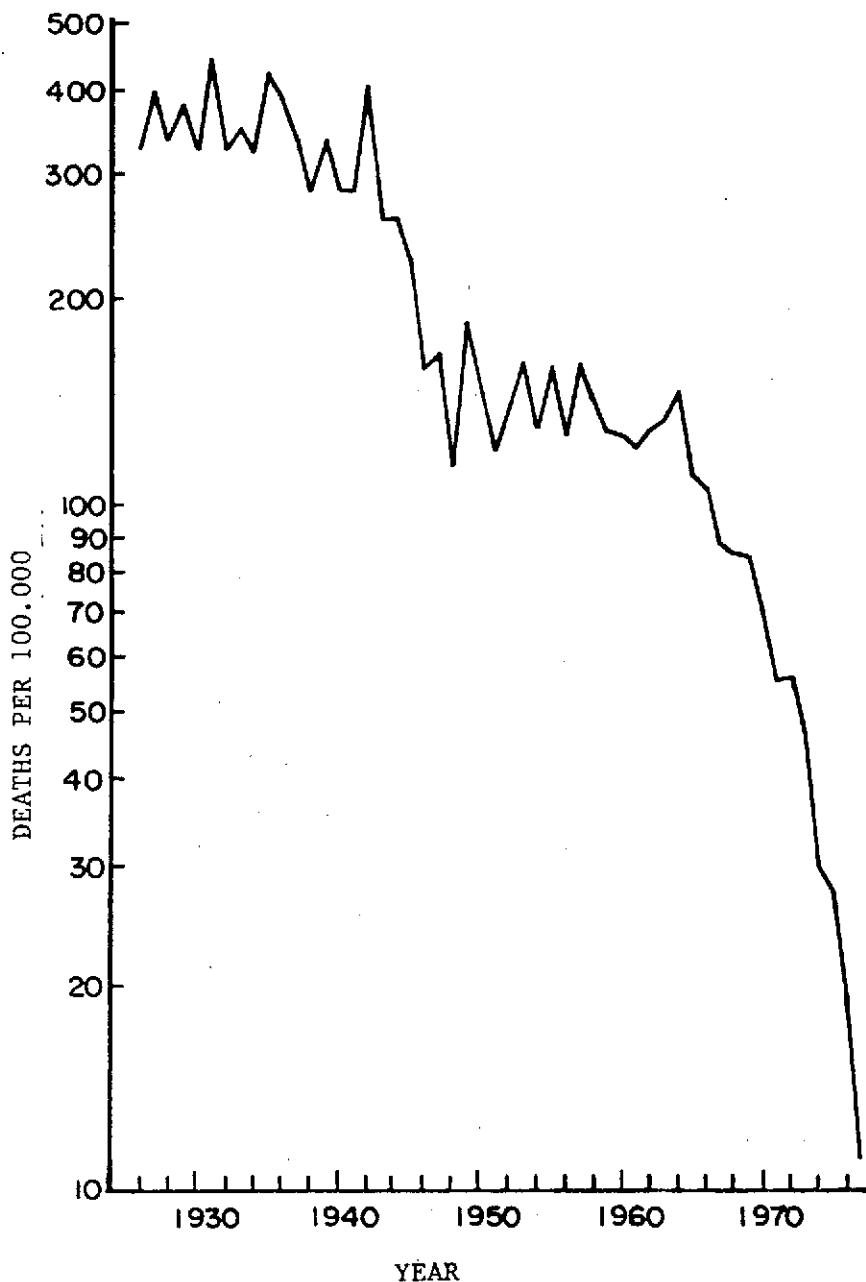


Figure 1. Diarrheal disease death rates in Costa Rica, 1928-1977. The first decline occurred after the depression, coincidental with significant social and economic reforms (1940-48). A revolution, social disruption and demographic explosion marked a span of stagnation (1948-1964) of the previously observed trend. Stability, and social and economic development coincided with the last decline (1965 to now).

As showed in Table 1, diarrhea deaths accounted for as much as 18% of all deaths in the country from the 1920's throughout the 30's. In the following three decades, diarrhea accounted for 10 to 16% of all deaths, while in the last decade the figure decreased to 2 to 3%. The change has been notorious for all age groups (excepting persons 15 to 44 years) but was more striking for children under 5 years, and less for older children, Figure 2.

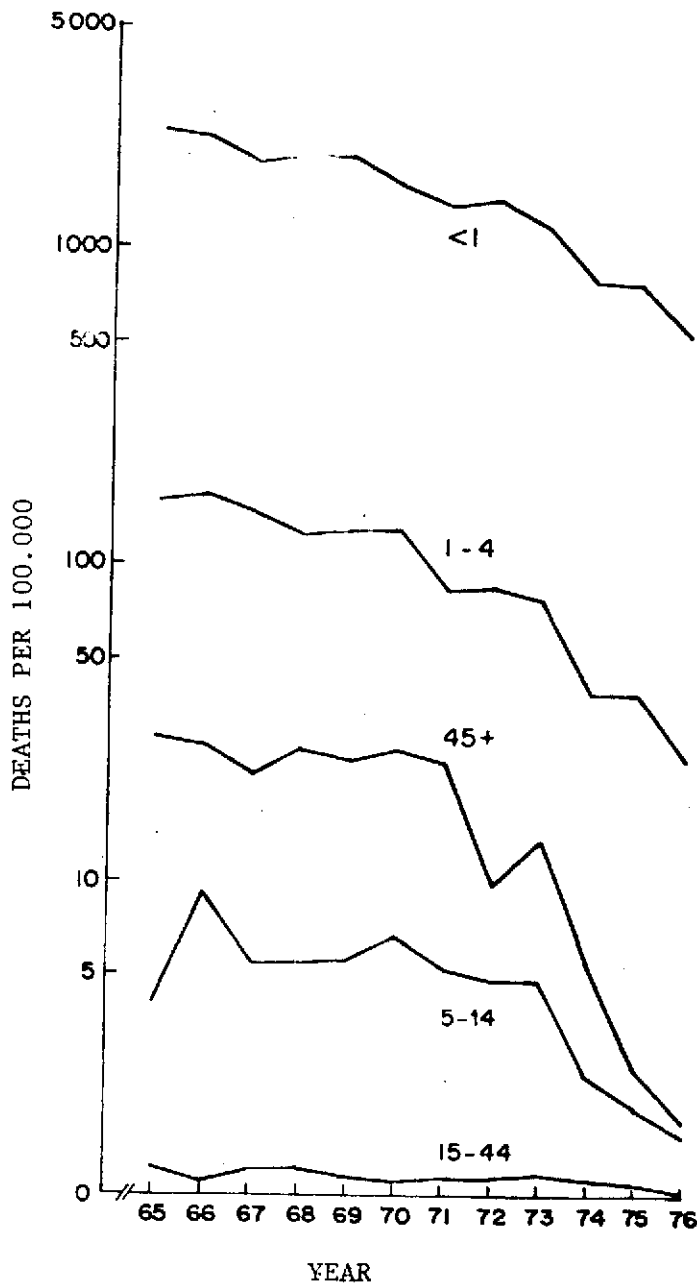


Figure 2. Diarrheal disease death rates per 100.000 population in Costa Rica, 1965-1976. The most distinct absolute change occurred among infants and children 1 to 4 years old. The greatest relative decline corresponded to older adults.

It is difficult to assess the individual contribution of several factors in the phenomenon described. Probably the main determinant was the rapid change in living conditions in Costa Rica resulting from an emphasis of most governments on social development. Over the last 20 years, there has been a significant increase in per capita income, and personal hygiene has markedly improved as evidenced by sales of clothing, soap, and toothpaste. Water supply, a political weapon in Costa Rica, has been used by candidates and Presidents alike, resulting in sustained programs of aqueducts. At present, 98% of the urban population has piped water in the home, and 70% of the rural population enjoys a similar service. Striking improvements in the availability of letrines and toilets have been recorded.

Concomitantly, education has improved steadily and the present rate of illiteracy is about 12%. Teaching emphasizes the concept of disease transmission and the role of hygiene in preventing disease, including diarrhea and intestinal parasitism. Collateral with this, hospital and health services coverage is, at present, virtually universal. Furthermore, greater availability of roads and transport, coupled with more aggressiveness and collaboration by physicians and the public, and the adoption of good methods for rehydration, has resulted in a drastic decrease of diarrhea deaths in the last few years.

Diarrhea, malnutrition and infant death.

There is a strong correlation between diarrheal disease and malnutrition and between diarrheal disease and infant mortality (Mata et al., 1980). The contribution of diarrhea to wasting, and eventually stunting has been shown by prospective field studies (Mata, 1978a; Mata, 1979). Anorexia, nutrient loss, wastage and retarded growth, were all demonstrated in the field. The correlation of diarrheal disease deaths with infant mortality (Nichols and Soriano, 1977) was

demonstrated for Costa Rica, Figure 3.

Even in recent years, more than 90% of all diarrhea deaths in the country occur in infants. Thus, it is expected that the decline in diarrheal disease mortality be reflected in the marked decrease in

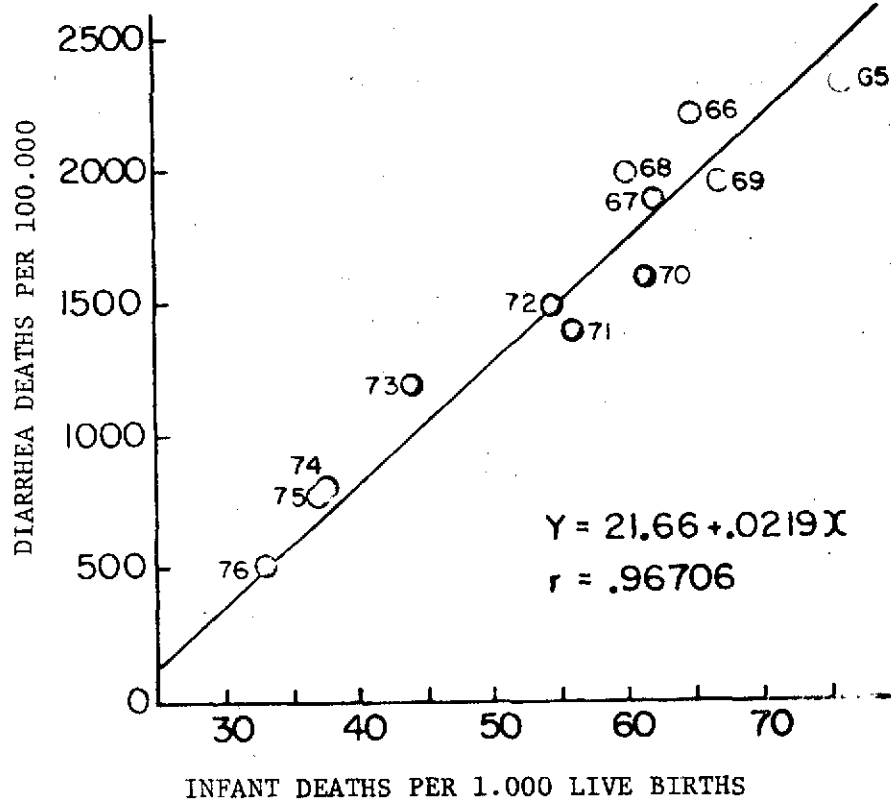


Figure 3. Correlation between infant mortality and diarrheal disease death rates in Costa Rica, 1965-1976. Numbers next to dots indicate the year of the correlated indices (i.e. 76=1976). The correlations exist also for the years 1977 through 1979.

infant mortality, Table 2. Furthermore, mortality due to severe malnutrition decreased by 65% from 1970 to 1976 (Sittenfeld et al., 1980). It is not surprising that the hospital ward for malnourished children had to be closed two years ago due to a reduction in the number of cases.

One may conclude that further gains in infant survival are expected from a sustained emphasis in control and prevention; attack should be at the national level, targetting on marginal populations and on those living in remote rural areas.

Table 2

EVOLUTION OF INFANT MORTALITY AND DIARRHEAL DISEASE DEATH RATES, COSTA RICA, 1965-1978

Year	Infant mortality per 1000 l.b.			Diarrheal disease deaths per 100.000 (008,009,561)
	Neonatal	Postneonatal	Total	
1965	27.2	48.9	76.1	109.3
1966	25.6	39.5	65.1	104.4
1967	24.3	38.0	62.3	86.1
1968	23.1	36.6	59.7	84.3
1969	25.4	41.7	67.1	82.8
1970	25.2	36.3	56.5	69.6
1971	28.7	27.8	56.5	55.4
1972	22.8	31.7	54.5	55.9
1973	20.8	24.0	44.8	43.9
1974	17.7	19.8	37.5	29.4
1975	17.7	19.3	37.0	27.2
1976	17.5	15.8	33.3	18.2
1977	14.7	12.8	27.5	12.3
1978	13.1	9.2	22.3	11.8

Diarrhea morbidity

Only limited data on diarrheal disease morbidity is available for Costa Rica. Studies conducted in 1959-60 in Barva, a "rural" population, showed a relatively high incidence of diarrhea among preschool children (Moore et al., 1965). At that time, the diarrheal disease death rate was about 120 per 100.000 population, and those deaths accounted for 15% of all deaths in the country. More recent studies carried out in 1966-67 in rural and urban communities of the

Highland Central Plateau, again showed a relatively high diarrhea morbidity (James, 1972). While the methods used in both investigations differed, the results were similar, although in no case the incidence was as high as that shown in other parts of the world, for instance, in Guatemala (Mata, 1978a).

Nevertheless, diarrhea still is one of the main illnesses diagnosed in clinics throughout the country. Thus, many cases are still treated every day at the National Children's Hospital, in San José. The profile over the last few years, Figure 4, reveals two distinct peaks of excess frequency per year. In recent years the peaks clearly appeared at the beginning of the rainy season (May-June) and at the onset of the dry and cooler months (November-February).

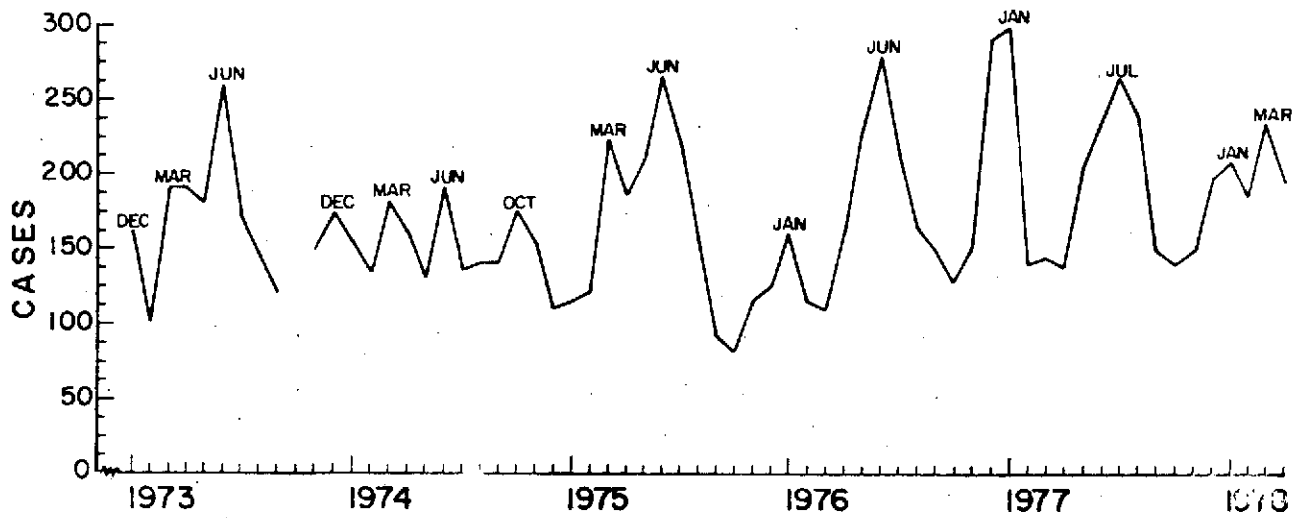


Figure 4. Cases of acute diarrheal disease attending the outpatient clinics, National Children's Hospital, Costa Rica, 1973-1978. The two yearly peaks became more evident after 1974.

Etiologic observations

Early investigations in 1959-1961 in the general population revealed the same agents found elsewhere, namely Shigella, Salmonella and enteropathogenic Escherichia coli. It became evident that Salmonella was more prevalent and Shigella less prevalent in Costa Rica than in Guatemala (Moore et al., 1966). Attempts to link enteroviruses with diarrhea were, as with other authors, futile. However, Coxsackie B viruses were found associated with some acute diarrheas (Pelon et al., 1966).

In 1969 an explosive regional epidemic of Shiga dysentery of high lethality, spread from Guatemala into the remaining Mesoamerican nations (Mata et al., 1970; Gangarosa et al., 1970). The epidemic reached Costa Rica, but probably due to better sanitary conditions in this country and to well coordinated preventive and treatment measures, it did not progress. Cases were much fewer than in the other countries, and lethality was significantly small. The epidemic became abated and did not reach Panama (Mohs et al., 1974).

With the characterization of enterotoxigenic Escherichia coli and the discovery of human rotaviruses, new studies began in Costa Rica. A long term study of acute cases seen at the outpatient clinics of the National Children's Hospital commenced in 1976 and continued for two years. By means of the enzyme-linked immunosorbent assay (ELISA) and electronmicroscopy, rotaviruses were found to be the commonest agents associated with diarrheal disease in Costa Rica (Mata et al., 1977). They were also detected among hospitalized neonates and chronically malnourished children (Hernández et al., 1977a). A large outbreak of diarrhea associated with rotaviruses occurred at the end of 1976 and the beginning of 1977 (Mata et al., 1977; Hernández et al., 1977b, Mata et al., 1978). In the peak months, as many as 70% of the cases were found shedding rotaviruses, Figure 5.

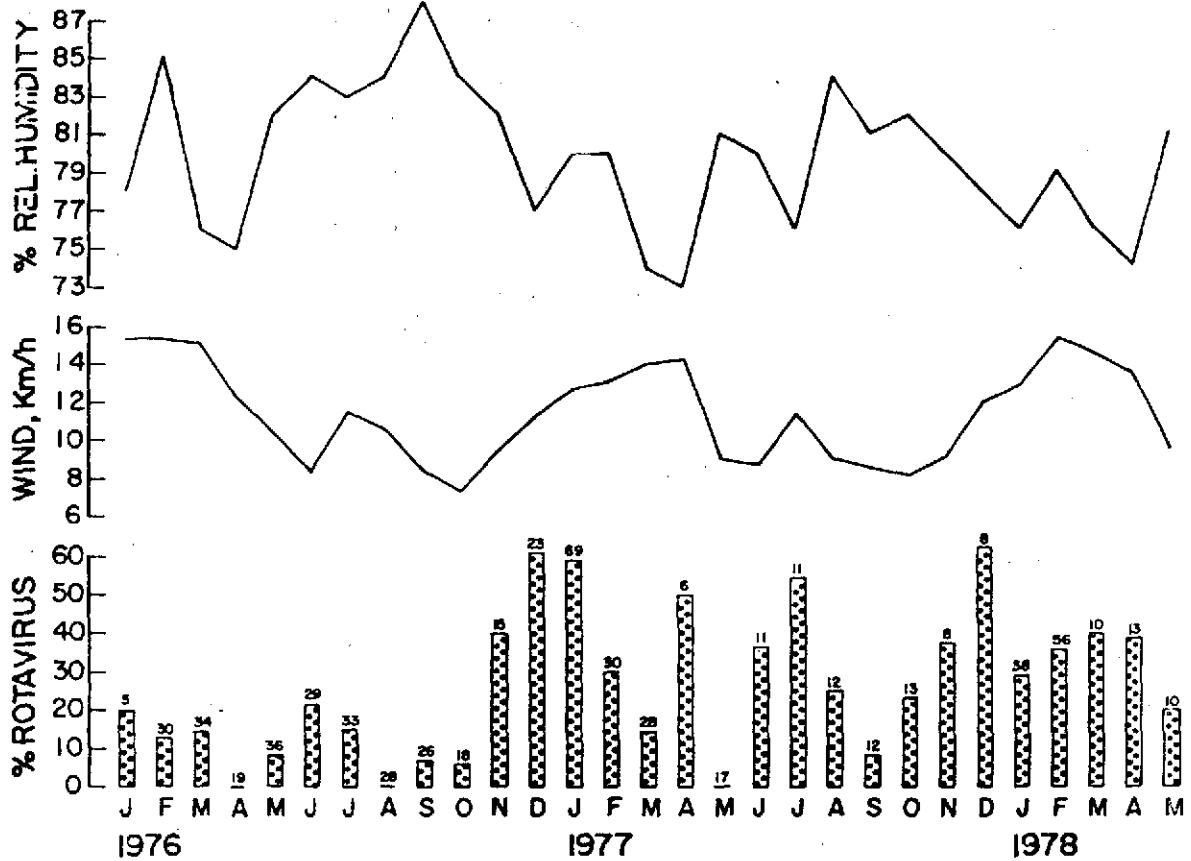


Figure 5. Prevalence of rotaviruses by the ELISA in infants and young preschool children, Costa Rica, 1976-1978. Peaks or greatest frequency corresponded to the dry and "cold" months of each year. No relationship was found with environmental temperature and relative humidity. An apparent inverse relationship was observed between prevalence of rotaviruses and wind velocity (Mata *et al.*, 1978).

Rotaviruses are ubiquitous in the country. Surveillance from 1976 through 1979 revealed their occurrence at all times of the year. The overall prevalence in diarrhea cases is about 30%, while in the non-diarrheic children of the same age is less than 5%. They are often found in greater frequency during the dry and "cold" months (November-February) but also in the rainy and warm season (April-July). Therefore, rotaviruses apparently explain the "winter" peaks depicted in Figure 4. Rotavirus diarrhea is mainly confined to infants and young preschool children. Its clinical features are basically those described by others. Onset is abrupt with watery diarrhea, vomiting and often severe dehydration. Red blood cells and leukocytes may be found in the stools of about 20% of the cases. Patients often have fever, but in general, the clinical course is less severe than that of shigellosis (Mata *et al.*, 1977).

Epidemiologically, Costa Rican rotaviruses of outbreaks belong to type 2 (Volken *et al.*, 1978). Current studies using electronmicroscopy have revealed non-cultivable adenoviruses, coronaviruses and other virus-like particles in stool concentrates of diarrhea cases previously found negative for bacteria and rotaviruses.

Research on treatment of diarrhea

While prevention of diarrhea is the desired goal, much has been accomplished regarding treatment. This is evident from the sharp reduction of mortality, especially in hospitals. Studies were carried out in Costa Rica as a collaborative effort between scientists of the University of Maryland, the National Children's Hospital and the Instituto de Investigaciones en Salud (INISA) of the University of Costa Rica. The studies demonstrated that: (a) oral rehydration was almost 100% effective and safe under hospital conditions for rehydration of children with mild, moderate and often severe dehydration of rotavirus origin (Nalin *et al.*, 1979); (b) oral rehydration was equally effective for rotavirus diarrhea whether sucrose or glucose were used in the formula (Nalin *et al.*, 1978); and (c) oral rehydration was safe and effective to rehydrate neonates using the same procedure employed for older children (Pizarro *et al.*, 1979).

The studies of early 1978 resulted in the adoption of oral rehydration as the first choice for most cases of diarrhea at the Children's Hospital. Before the advent of oral rehydration, significant advances had been made regarding intravenous fluid therapy with important reduction in mortality. Adequate supplies of fluids and the necessary equipment were kept in hospitals and many rural health posts and centers, and this in all probability had an important effect in reducing deaths. On the other hand, the greater availability of roads and transport permitted referral of severe cases for proper treatment.

But the effect of oral rehydration, has been even more dramatic, as illustrated in Table 3. Lethality of diarrhea among children receiving oral rehydration dropped to 0.03% in 1978, a 900% reduction from the level recorded in the preceding year where oral rehydration had not yet being implemented in the Hospital (Odio et al., 1979).

Table 3

DIARRHEA DEATHS IN CHILDREN HOSPITALIZAD
AT THE NATIONAL CHILDREN'S HOSPITAL, COSTA RICA, 1965-1978

Year	Number of patients	Deaths	% Lethality	Rehydration route	% Reduction
1975	3839	32	0.83	venous	-
1976	3830	24	0.63	venous	32
1977	5974	18	0.30	venous	110
1978	6000	2	0.03	<u>oral</u>	900

Adapted from Odio et al. (1979)

National Program of Oral Rehydration (NAPOR). Research component

A joint decision was taken by the Ministry of Health and the Social Security System to use oral rehydration on a national basis and to eventually transfer the technology to the home, in order to prevent or correct most dehydrated children particularly in remote rural areas. Before such technology could be transferred it was necessary to test the capacity of mothers to learn the procedure of oral rehydration, first at the hospital outpatient, clinic, and then at the health post.

Transfer of technology to auxiliary health personnel was successful (Pizarro, 1979) as was at the health post level (Jiménez, 1980).

Two surveys were conducted simultaneously in different parts of the country, one by INISA and the other by the Social Security, and they revealed the absence of containers of one liter, while a wide range of "bottles" of various sizes was detected. Such finding precludes the use of the orthodox WHO pack of electrolytes. However, more than 98% of the homes had 8 oz bottles for formula feeding. A new pack was designed at INISA containing a corrected concentration of salts for the 8 oz bottles. At present, several million packs are being distributed by the Social Security, accompanied by: (a) manuals intended for physicians, (b) booklets designed for nurses and auxiliary personnel, and (c) leaflets directed to the mothers themselves, with clear instructions and drawings on the oral rehydration procedure. A "communication scheme for the education component" of NAPOR has been published (Mejía, 1979) and is being widely distributed among professionals.

The plan is to transfer technology to mothers within the next two years. Estimated costs of consultations and hospitalizations for diarrhea in the Hospital System during 1977 was 30 million colones (\$3.490.000). The cost of NAPOR is significantly less. For 250.000 preschool children in Costa Rica (1977), 500.000 cases of severe diarrhea are to be expected (2 attacks per child per year). These require 3 million packs of SUERORAL (6 packs per case of diarrhea with a cost of 1.5 million colones or \$174.400). The cost for audiovisual materials and training of personnel has been estimated in 500.000 colones (\$58.000) (Mejía, 1979).

The total cost of NAPOR is \$232.000, Table 4, which conservatively will reduce about 75% of hospitalizations and 50% of hospital admissions and consultations. Furthermore, there will be significant savings in terms of infant death, and benefits to the nutritional state of the child and wellbeing of the family, not only from the psychologic point of view but from the economic angle as well. NAPOR will be evaluated by INISA as a case of applied research.

Table 4

COST-BENEFIT OF THE NATIONAL PROGRAM OF
ORAL REHYDRATION (NAPOR), COSTA RICA

1. Hospital cost of diarrhea, 1977	\$3.500.000
2. Reduction of 80% hospitalization and 50% outpatients	2.190.000
3. Cost of NAPOR	232.000
Total savings related to NAPOR	1.960.476
Reduction in total cost = 56%	

Preventive measures. A research effort in promotion of breast-feeding.

Costa Rica has not diminished efforts to prevent diarrheal disease. The programs of water supply, letrines and education continued, now with television and radio programs, and promotion through posters and the press. The coverage of water supply has been extended to the sparse rural population by means of water pumps acquired with an AID loan to the Government, and which will cover 95% of that population by 1985.

One aspect that deserves special mention because of its immediate and long range significance for survival of children, is the situation of breast-feeding. Costa Rica in this regard is in a critical position since, according to two Nutrition Surveys conducted in 1975 and 1978 by the Ministry of Health, about 30% of infants are not put at the breast at all. By one month of age, more than 60% of

infants in rural areas had been placed in formula milk schedules, and by 5 months of age 95% already had been completely weaned (Díaz et al., 1975; Ministry of Health, 1979). The reasons for this sad situation probably are many (Mata, 1978b), but we postulate that it had to do mainly with the hospital practice of separation of mother and infants for varying periods post partum.

In a long term prospective study of maternal and child health and development in the area of Puriscal, INISA is recruiting all infants of the region born in the San Juan de Dios Hospital, under a protocol which emphasizes mother-infant stimulation at the hospital. Mothers and infants are visited upon return to the home in the more than 120 communities of the area. The growth of children, their feeding habits and the general state of health are periodically monitored by a team of field workers. Preliminary results obtained for all cohort mothers and infants recruited since September 1979, revealed the astonishing fact that most women are breast feeding their infants by 3 months, Table 5 (Mata et al., 1980b). While search for an adequate

Table 5

BREAST FEEDING, ABLACTATION AND
WEANING IN PURISCAL AND COSTA RICA

Age in months	Percent infants at the breast	
	Costa Rica*	Puriscal**
0	72	100
1	34	95
2	27	84
3	11	71
4		63
5	5	61

* National Nutrition Survey, Ministry of Health, 1978. Sparse rural population

** Long term prospective study of Puriscal, Sept 1979-March 1980, INISA. Rural sparse and concentrated population.

explanation of the phenomenon observed is sought, we propose that mother-infant stimulation after delivery and the insistence of our personnel in that mothers should provide the colostrum and milk to their infants, must have influenced the change. It is important to note that diarrheal disease has been minimal in these rural children during the first months of life, the attack rate being less than 0.5 episodes per child per semester.

Other research efforts

As part of the long term prospective field studies on maternal and child health and development, further investigations are conducted on the etiology of diarrheal disease. Search for the classical agents is complemented with investigation of rotaviruses by the ELISA (Simhon et al., 1979), enterotoxigenic Escherichia coli, Yersinia, Edwardsiella, and Campylobacter and other vibrios. Furthermore, specimens concentrated by ultracentrifugation from cases negative for the above mentioned agents are investigated by immunoelectronmicroscopy for virus-like particles other than rotaviruses and adenoviruses. Preliminary findings showed coronavirus-like, astrovirus-like and other particles in stools of diarrheic children. Furthermore, Campylobacter has been isolated in Puriscal. Etiological findings serve to determine the impact of specific diarrheas on nutrition and growth of children. Since oral rehydration is used to treat children in the field, unique data on its effectiveness for treatment of specific diarrheas are being collected.

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