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IDEAS FOR THE FORMULATION OF A PLAN FOR THE CONTROL OF GASTRO-INTESTINAL DISEASES, INCLUDING ENVIRONMENTAL SANITATION MEASURES, EPIDEMIOLOGY, HEALTH EDUCATION, AND EARLY DIAGNOSIS AND TREATMENT

Diarrheal Disease and the Health Care Services in Latin America

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DIARRHEAL DISEASE AND THE HEALTH CARE SERVICES IN LATIN AMERICA

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"Diarrhea is conceived of as a disturbance of intestinal motility and absortion which, once and by whatever means initiated, may become self perpetuating as a disease through the production of dehydration and profound cellular disturbances, which in turn favor the continuing passage of liquid stools." (1)

Mortality ascribed to diarrheal disease is the most striking pathological characteristic of the middle and southern sections of the Americas. The mortality is essentially limited to children under five years of age who experience 90% of such deaths in these sections of the hemisphere. On the basis of available reports, it is estimated that diarrhea is recorded as the cause of death in almost a quarter of the million young children who die annually in countries of the middle and southern Americas. Ninety-eight per cent of these diarrheal deaths are in excess of the number expected if the diarrheal disease death rates of northern America were to prevail throughout the hemisphere.

The lethal episode in most of the million Latin American deaths under 5 years of age, however, often reflects a complex synergistic chain of pathological antecedent and coincident conditions which include nutritional deprivation and repeated bouts with infectious agents of disease. It is probable, therefore, that diarrhea contributes directly or indirectly to most of those deaths which occur after the immediate neonatal period.

The reduction of early childhood mortality will require efforts to improve the economy, the social structure and the nutrition and sanitation of the population which draw upon all the forces of positive cultural, educational and social change. This is a gradual process that will requiere many years for its fulfillment. It seems clear, however, that organized health care services can greatly reduce mortality in a relatively short period of time, even in the absence of economic improvement and the provision of better living and environmental sanitation. This document will limit itself to describing this role and to suggesting specific ways in which these services can be strengthened as part of the total planning process.

At the XVI Pan American Sanitary Conference in 1962, Dr. John Grant defined health care as a comprehensive integrated "program of services which promote health, prevent disease, restore health and alleviate disability ... closely related to environmental health services on the one hand, and social protection and educational services on the other." (2) This is the sense in which the term is used in this document.

Observations and comments upon the programs and practices of Latin American health care services are based upon visits to several Latin American countries by one or both of the authors. They are not intended to portray a comprehensive picture of the existing situation. They should be considered rather as a series of selected points chosen to represent successful experiences from which something can be learned or to raise questions which can lead to resolution through discussion or through applied trial.

The role of health care services in reducing the incidence of diarrheal disease in childhood is limited to measures to promote personal and household cleanliness and sanitary food handling. Shortages of personnel and supplies make it impossible, however, to reach a significant proportion of the Latin American population with a system of preventive personal child health supervision by professional personnel that can expect to achieve such difficult objectives within existing levels of living. Community wide educational measures of this type are more appropriately considered as part of a program of environmental sanitation.

On the other hand, health care services, when considered as a comprehensive whole, have unique and important contributions to make toward the reduction of preventable deaths from diarrheal disease. These contributions will be considered first in terms of the objectives of patient care and second in terms of the organization of services to meet these objectives. The emphasis on patient care is of the utmost importance because it forms the basis of the priorities around which services must be organized to achieve maximal effect with minimal resources.

PATIENT CARE

Diarrheal disease in Latin America is an affliction of the very young. It appears as an important clinical problem in the newborn period and attains enormous proportions during the ensuing few months. The course of its incidence thereafter appears to be related to weaning practices, with some countries showing a fall-off as early as the sixth month of life and others as late as the third year. It is a major cause of illness throughout childhood and generally leads the list of ailments for which children come to hospitals and health centers.

The age-specific mortality rates for diarrhea are highest during the first year of life. The heavy concentration of deaths which occur during the first few months of life was pointed out some years ago by Verhoestraete and Puffer (3). It is illustrated by more recent data from two countries in the Americas (Tables 1 and 2). In Venezuela almost half the deaths in children under 5 years of age occur during the first six months of life while in Colombia the proportion is almost one third. Differences between countries may be related to type and techniques of infant feeding.

Regardless of the cause of differences, the young infant is peculiarly susceptible to the metabolic disturbance of diarrheal dehydration, cannot readily make his feelings and needs known, and depends upon others to feed him. These factors pose special problems in treatment.

TABLE I

DISTRIBUTION OF DEATHS FROM DIARRHEA UNDER 5 YEARS OF AGE, BY AGE AT DEATH COLOMBIA, 1960*

Age	Number	Per cent in age group	Average per cent per month in age group
Under 28 days	1,187	6.0	6.0
1 - 5 months	4,932	24.8	5.0
6 -11 months	5,303	26.7	4.4
12-23 months	4,840	24.3	2.0
24-59 months	3,634	18.2	0.5
Total:	19,896	100	(3.32)

*Includes deaths from dysentery, gastro-enteritis and diarrhea of newborn. Diarrhea of newborn figures taken from data of 1961.

TABLE 2

DISTRIBUTION OF "DIAGNOSED DEATHS" FROM DIARRHEA*
UNDER 5 YEARS OF AGE, BY AGE AT DEATH
VENEZUELA, 1961

Age	Number	Per cent in age group	Average per cent per month in age group
Under 28 days	328	7.4	7.4
28 days - 2 months	385	15.5	7.7
3 - 5 months	1,063	24.1	8.0
6 - 8 months	802	18.2	6.1
9 -11 months	537	12.2	4.1
12-23 months	669	15.2	1.3
24-35 months	171	3.9	0.3
36-47 months	99	2.2	0.2
48-59 months	57	1.3	0.1
Total:	4,411	100	(0.74)

*Deaths certified by a physician as due to diarrhea (gastro-enteritis and diarrhea of the newborn)

As has been pointed out earlier, diarrhea in young children is frequently associated with other infections and with protein-calorie malnutrition. In Latin America as in all the developing areas of the world, multiple pathology in a single child is the rule rather than the exception. While immediate attention to measures of rehydration or prevention of dehydration takes first priority, complete appraisal of the child and the treatment and follow-up of associated conditions are integral features of good medical practice.

Limitation of resources and personnel may make it impossible to render comprehensive care of this sort to every child presented to health care services for treatment of a diarrheal episode. More careful diagnosis and follow-up are indicated especially in cases which do not respond to routine treatment and in cases of severe malnutrition.

Etiology and Chemotherapy

Most cases of diarrhea are considered to be of infectious origin and in parts of the world where this malady is frequent and causes many deaths a recognized causative agent can frequently be isolated. Shigella and Salmonella species have long been recognized as causative of diarrheal disease, and in the past decade enteropathogenic strains of Escherichia coli have become incriminated with frequency, particularly in the production of nosocomial epidemics in young infants. Escherichia coli may be recovered with some frequency in endemic diarrhea as well, particularly in children under one year of age; their prevalence appears to be considerably greater in some areas than others*.

Of particular interest in Venezuela has been the recent immigration of very large numbers of country dwellers into city slum areas. This population move has been associated with a considerable upsurge in numbers of cases of diarrhea. Shigella has assumed renewed importance and, most interestingly, Endamoeba histolytica has been recovered with frequency from cases of diarrhea with bloody stools, even in children under 2 years of age (9, 11).

The relative importance of viruses in endemic diarrhea is at the moment disputable. Whatever their role, no antiviral chemotherapy is available at the moment.

Clinically there is little to distinguish between diarrheal infections due to viruses or bacteria. Perhaps 15 per cent of all cases of diarrheal disease are associated with the passage of bloody stools, though this percentage may rise to nearly fifty in Shigella infections (12).

The foregoing review of the infectious etiology of diarrheal disease is a necessary prelude to consideration of the use of sulfa drugs and antibiotics in treatment. Up to this moment, only Shigella and entero-pathogenic Escherichia coli have been shown to be effectively eliminated from the body with chemotherapy. The use of appropriate antibiotics has been an important feature of the therapy of newborn infants with Escherichia coli infections but the same antibacterial effectiveness of a variety of drugs against Shigella has not been attended with comparable clinical improvement of the patient, although from a statistical standpoint it is known that the duration of diarrhea may be somewhat shortened if Shigella can be eliminated. The majority of recent studies continue to show the ineffectiveness of antibiotics in altering the clinical picture of diarrheal disease. For example, in a double blind study in Caracas, of which a preliminary report has appeared (13) the effect of Chloramphenicol was indistinguishable from that of a placebo.

*Current and recent references include reports from Mexico (4,5), Brazil (6, 7, 8), and Venezuela (9, 10).

It is reasonable to conclude that the identification of an infectious agent and the chemotherapy of a case of diarrheal disease are of limited usefulness, with the exception of infections due to enteropathogenic Escherichia coli in nursery epidemics and to Endamoeba histolytica. Antibacterial agents are expensive as well as inneffective on the whole. Among the potentially harmful results of their use is the production of diarrhea or the possible invitation of enteric infection by resistant organisms such as Staphylococcus aureus. Mycotic infections and bone marrow depression have been reported.

The potential hazards associated with the routine use of chemotherapeutic agents very likely outweigh their possible benefits. Their widespread use is a heavy drain on limited budgets, particularly when more important aspects of therapy are not adequately provided for.

The compulsion to prescribe drugs may be a reflection of both popular and professional tradition which views all non-surgical treatment as synonymous with materia medica.

Fluid therapy

With the exception of certain rare complications, death from diarrhea is due to dehydration or its serious consequence, shock. Treatment of diarrheal disease thus resolves itself into averting or repairing dehydration through appropriate fluid therapy.

Prevention of Dehydration: Oral Fluid Therapy

It is uniformly accepted by pediatricians that severe dehydration due to diarrhea may be averted if oral administration of fluids is commenced early in the illness. The prevention of dehydration, as opposed to the prevention of diarreha itself, is a basic feature in all programs for the control of diarrheal disease. The important features of this therapy are: (1) provision by mouth of liquids which, at least theoretically, approximate in content and volume the aggregate of those fluids lost; (a) abnormally in the diarrheal stools and (b) normally via lungs, skin, and kidneys; and (2) suspension of all food intake for a brief period. Twelve hours usually suffice and may be more than adequate. Rarely should 24 hours be exceeded. The child's usual food does not cause diarrhea, but it may briefly aggravate it. Prolonged restriction of food can only enhance the frequently present malnutrition, without fundamentally benefiting the diarrheal process.

Vomiting associated with diarrheal disease is an infrequent problem early in the course of the illness, but makes it appearence in most children as dehydration becomes more severe. Early oral fluid therapy thus averts not only dehydration but also the vomiting which makes oral administration of fluids difficult or impossible. Vomiting can frequently be controlled by the administration of teaspoonful amounts of fluids at intervals of 5 or more minutes.

Solutions for oral administration used in Latin America appear in Appendix I. Most are dispensed as solid concentrates to be dissolve in boiled water at home by the mother. The choice of a proper concentrate rests more on empirical than on theoretical grounds. The concentration of diarrheal stolls is greater than the prescription recommended by PAHO/WHO (Appendix I). On the other hand, normal body losses of water and electrolytes are represented by a more dilute solution. As long as renal blood flow is adequate the kidney is able to make extensive adjustments in the interest of homeostasis of body fluids. This cannot long be possible, however, if a solution as concentrated as Ringer's is employed. In some locallities it is unfortunately possible to purchase without prescription "papelillos" of a powdered Ringer's concentrate.

In prescribing a concentrate the doctor is of course aware that the mother may confuse teaspoon with tablespoon or may dissolve the product in an inadequate amount of water and thus provide a solution which is more concentrated than is intended. If, as is usually recommended, the solution is boiled after dissolving the salts, there may be still further concentration. In some instances in the United States of America the inadvertment therapeutic use of solutions of high sodium content has been associated with the development of hypernatremia as patients became dehydrated due to the continued passage of liquid stools.

The effectivennes of programs to prevent diarrheal dehydration through early administration of fluids by mouth is probably considerable, but objective evaluation is difficult. An effective program depends upon the existence of a health organization which at the same time carries out other activities in sanitation, nutrition, medical care and health education which might also affect diarrheal disease deaths. For this reason the Mexican experience, to be described later, is of particular interest.

Oral fluid therapy is recommended unequivocally as the regimen of choice in early mild cases of diarrhea. It is indeed practiced widely and promptly through all facets of the health service in some countries in the hemisphere, notably Venezuela, but it is not relied upon everywhere to the extent that its promise dictates.

Fluid Therapy of Dehydration

Once dehydration has made its appearance fluid therapy becomes more complex in that deficits must be repaired--quite a different problem from simply giving fluids and electrolytes to replace those being lost from the body by normal and abnormal routes. In simplest terms the definition of dehydration is the loss of sodium chloride and water, with accompanying deficit of potassium.

The goals of rehydration are threefold and indissoluble: prevention or treatment of shock, restoration of effective renal function, and replenishment of deficient water and electrolytes. These are assured through restoration and maintenance of an adequate circulating blood volume. Rehydration

progresses in two phases: a rapid phase of repair of deficits of sodium chloride and water, and a more gradual phase of restoration of deficient potassium, adjustment of residual deficits and osmotic and acid-base disturbances, and return to normal alimentation. The requisite fluids for these two phases are different, as are their rates of administration.

Routes of administration of fluids are subcutaneous, oral, intragastric, and intravenous.

Subcutaneous fluids have been used successfully in South Africa, but with poor success in Poland (1). There is no knowledge of their routine use in Latin America in the treatment of dehydration. There exist considerable experience and facility in the use of other, physiologically more desirable routes, described in the following paragraphs.

Fluids have been given orally to as many as half or even more of the children coming to rehydration centers. Success is usually assured if the child is not vomiting. Vomiting is frequently readily controlled through the administration of teaspoonful amounts of the hydrating solution at intervals of 5 or more minutes. In unrelenting vomiting drugs including tranquillizing agentes in small dosage have been used with success.

Oral fluid therapy was successful in 90 per cent of 508 moderated and severely dehydrated young children treated by De la Torre and Larracilla Alegre (5). The success of this experience was attributed in large measure to careful home supervision and follow-up and constant availability of a physician for consultation. Hospital beds were saved, but there appears to have been no net saving in the time expenditure of medical and paramedical personnel. Intravenous therapy is probably more practical in cases of such severity.

The administration of fluids by gastroclysis appears today to be enjoying less extensive use, due in large part to increasing skill of doctors and nurses in intravenous techniques. In two states in Venezuela dehydrated children are being treated exclusively with gastroclysis, in order that comparison may be made with the intravenous therapy used elsewhere in that country. Although results are not yet available, a value judgement seems already to have been made, in that a particularly ill child, instead of being treated by gastroclysis in a rural hydration center, is likely to be referred to a hospital rehydration center for intravenous therapy. In the hands of many persons, including some who make use of this route of administration frequently, achievement of a steady rate of flow through the nasogastric tube is difficult, tending to change abruptly with change in position of the child. This difficulty is overcome in one of two ways, each of which is set up as a routine in certain centers: quieting of the child with a tranquilizing drug, or immobilization of the child with restraining sheets.

In severe dehydration, intravenous therapy is mandatory. It is carried out by a variety of routes with rare resort to cut-down and even rarer use of bone marrow infusion for brief periods in emergencies. By and large puncture of superficial veins is a skill developed to a high degree in medical centers in Latin America among certain nurses and even auxiliares --indeed more than among pediatricians--. In certain parts of Brazil extensive use is made of subclavicular vein puncture as described by Aubaniac (14, 15). It is carried out with ease by physicians with requisite skill, and complications such as hemothorax or pneumothorax are so rare as to be virtually inconsequential in trained hands. It is possible that the full extent of complications is not known, since autopsies are not usually carried out on children who die.

In the practice of intravenous therapy fluids are administered rapidly until the patients voids, at which time the infusion is slowed and potassium is added. The choice of the initial infusion fluid is guided by the therapist's appraisal of the patient, usually in terms reflecting current awareness of differences in osmolarity of body fluids in dehydrated subjects. Dehydration in a well nourished or but mildly undernourished child is characterized as "hypertonic"; that in an undernourished child is "hypotonic". The implied relationship is however not borne out by current laboratory observations (Table 3) which show that most dehydrated children are "isotonic". The assumed osmotic disturbance as well as an estimation of "acidosis" (inferred from degree of clinical illness and extent of hyperventilation) is a guide to the choice of composition of the initial hydrating solutions. Several investigators have reached the conclusion that this choice bears little relevance to therapeutic success, as long as the solution is hypotonic (1/3 to 1/2 or perhaps 2/3 isotonic). As this point of view becomes more widespread, therapy will probably be carried out for virtually all patients with a solution of uniform composition. The therapist may then once again focus on the dehydrated patient instead of his assumed biochemical abnormality, and thought can be brought to bear on what is probably a more urgent question, that of <u>rate</u> of infusion.

Hospital Care of Dehydrated Children

While mortality due to diarrhea is falling because of the prevention of severe dehydration through better nutrition, health education, and early recognition and fluid therapy of affliected children, the mortality rate of dehydrated children admitted to hospital and dehydration centers remains for the most part well over 10 per cent. One to two-thirds of deaths occur before 48 hours --a large fraction of these in the first 12 or 24. Limited evidence, direct and influential, suggest that some of these deaths may be due to dehydration or shock. If so, a critical review of the effectiveness of present early therapy of dehydration might well lead to alterations resulting in the saving of more lives.

TABLE 3

INCIDENCE OF TYPES OF DEHYDRATION ACCORDING TO NUTRITIONAL STATUS IN CHILDREN WITH DIARREA AT THE HOSPITAL UNIVERSITARIO DE CARACAS (16)

Type of dehydration*	All cases	Normal nutrition	Malnutrition
"Hypotonic"	17	9	8
"Isotonic"	101	65	36
"Hypertonic"	41	29	12
Total:	159	103	56

* Isotonic: serum Na 131-149 mEg/l

Normal nutrition: Eutróficos

First however, it is necessary to define better the causes of death in hospitalized children, and to attempt to categorize with greater precision the roles played by infection, malnutrition and dehydration.

The factor of infection, most commonly respiratory infection, is usually easily documented and, when adequate post-mortem examination can be carried out, can be thoroughly substantiated.

The degree of malnutrition is conventionally related to percentage deviation from the weight of a normal, hydrated, well nourished child of the same age. While this is an objective technique, it tends to include weight loss due to dehydration and reference is to an ideal weight rather than to the patient's own potential. Furthermore, the same criteria for degrees of malnutrition are not used by all persons in all countries.

Objective criteria for measurement of degree of dehydration are urgently needed. All appraisals of the moment are based on clinical impression none enjoy widespread acceptance or use.

Definitive proposals for the quasi-objective measurement of malnutrition and dehydration appear in an Appendix. Also appended are suggestions for review and possible alteration of currently practiced regimes of rehydration.

The quality of continuing personal responsibility for the care of patients may also be reflected in mortality statistics.

The need for a close doctor-patient relationship is as integral a feature of good patient care during short periods of acute illness in hospital or emergency treatment center as in the long-term health care and supervision of the child. At the moment, however, treatment of the acutely ill person in many hospitals and health centers is fragmented by the frequent passage of responsibility for patient care through a succession of physicians who serve for but a few hours each. In some hospitals no physician is in attendance during large segments of the day, particularly at night, when nursing coverage too may be scanty. Some existing residency programs make no provision for night-time medical supervision except on an emergency basis, so that care for the critically ill patient again may pass through a succession of doctors who have no continuing awareness of the patient's changing needs. These shortcomings come sharply into focus in considering the care of dehydrated, undernourished children, half of whom die at the present time during their first day or two in the hospital.

In the hospitals the road to improved patient supervision lies chiefly in extension and improvement of internship and residency training programs, whereever possible under the supervision of a well-trained senior staff with full-time responsibility for patient care and residency training.

These considerations also apply to rehydration centers only during day-time hours. The interruption of close medical supervision and suspension of supervised fluid therapy of dehydrated children at the end of the day, making necessary their transfer home for further care while still critically ill, cannot help but result in fatalities that the presence of a qualified attendant might prevent. With serious limitations on number of doctors and registered nurses it may be necessary to develop auxiliary personnel specifically trained to staff such centers during night-time hours.

THE ORGANIZATION OF SERVICES

The key to the success of health care programs in reducing the mortality from diarrheal disease in recent years has lain most importantly in measures to reduce dehydration from diarrhea through early case finding and appropriate early oral fluid therapy. Backing this crucial phase of the program, are emergency hydration centers in hospital out-patient departments or health units. The degree of success of these last in carrying out more vigorous rehydration measures rests to a considerable extent on the referral of those patients in whom earlier simple attempts to prevent dehydration, while not successful, have none the less minimized fluid loss.

An indication of the way these features operate within an organized health program is given in the country examples which follow. These examples have been selected only because the authors are familiar with them and because they represent efforts deliberately planned at a national level and executed locally over large areas of the country. These are no reflections upon many excellent programs of more limited local coverage nor upon the countries with whose efforts the authors are not familiar.

Venezuela

Venezuela presents an example of an integrated program at the national level, carried out by the Division of Maternal and Child Health of the Ministerio de Sanidad y Asistencia Social. During 27 years of growth of the Division health centers and rural medical centers have been established throughout the Republic. Since 1941 particular emphasis has been focused on diarrheal disease and since the end of 1958 rehydration centers have been created in rapidly increasing numbers of health centers, as part of a national campaign against the diarrheas. The plan for control of diarreha is the same throughout the country. All physicians assigned to any unit of the health care services which deals with children attend refresher-orientation courses which include practical experience in applying rehydration techniques. These are published as written norms of service. Efforts by nurses and auxiliaries, fortified with educational materials also furnished as part of the program, are aimed at early casefinding an early administration of an electrolyte solution prepared from pills which are distributed throughout the country.

In practice children may be treated on an ambulatory basis or detained at the center for intravenous therapy if home treatment is thought likely by the physician to prove inadequate. Therapy in the center may last from a few hours to a few days if necessary. Health centers, where also health care of mothers and children is carried out and ill persons of all ages are cared for, are open for emergency care such, as rehydration of a child with diarrhea, twenty four hours a day. When an infant is detained at the center for intravenous fluid therapy, the mother stays with him, not only to act as attendant but to learn more about the prevention and management of diarrhea. The integrated unit provides a structure for continuity of care and follow-up of any associated nutritional disease.

In Caracas rehydration centers have also been established, not only in the central hospitals but also in sectors of the city. The effectiveness of this program in reducing deaths due to diarrheal disease is shown in the progressive fall in mortality rate since 1939 with acceleration of the decline in more recent years as the specific attack against dehydration intensified (Table 4). The fall in Caracas is all the more remarkable in view of the huge influx of country dwellers into congested slum areas and the change in diarrhea etiology to which attention is called elsewhere in this report.

The reduction in mortality from diarrhea in Venezuela also has been attended with a remarkable reduction in case fatality in children admitted to rehydration centers. In 1959, with only 20 centers, the case fatality was 7.3 per cent. In 1962, with 107 centers, it was 3.2 per cent. The reduction in case fatality is ascribed to the opportunity of carrying out hydration measures on children before dehydration has become severe. In this period of three years there are said to have been no appreciable changes in socio-economic status, diarrhea morbidity, numbers of children reporting for treatment, or plan of hydration therapy.

Chile

Chile represents a country in which an organized national program to prevent diarrheal disease deaths has functioned within the structure of a comprehensive health care service. Of particular interest is the operation of services within the city and suburbs of Santiago. This zone is divided into five major areas, each responsible for 500,000 or more persons. Responsible for the health of children and central to each area is a children's hospital or children's division in a general hospital with personnel who supervise and deliver the health care in outlying consultorios. After hours emergency medical care is available in a centrally located posta from which major problems may be referred to the hospital if necessary. Although the organization of Santiago area services varies somewhat, staff organization in some areas is such that a health team headed by a physician is responsible for its own individual group of patients in the consultorio and can establish a close relationship between themselves and the patients they serve. Exchange of information between hospitals and consultorio is prompt and physicians have opportunities to work also in the hospital. Follow-up of hospital discharge is through the appropriate consultorio.

Perhaps the fall in overall diarrheal mortality in Chile from 5,774 in 1955 to 4,661 in 1961 in children under five years of age, despite a rising population and a rising or stationary infant mortality rate during that period, reflects the effectiveness of this program. In the Area Sur of Santiago the age-specific mortality due to diarrhea in children under 2 years of age fell from 1,010 per 100,000 in the summer of 1960 to 490 in the summer of 1963. The experience of the Hospital Arriarán provides other evidence of the effectiveness of the program in reducing death in diarrheal disease. In 1955, when 1,849 children with diarrheal dehydration had to be turned away from the hospital for lack of beds, an out-patient hydration

TABLE 4

GASTROENTERITIS* MORTALITY RATES PER 100,000 POPULATION

VENEZUELA AND CARACAS, 1939-1962 (17)

Time period	Venezuela		Caracas	
	Rate	% decline in time period	Rate	% decline in time period
1939-43	296.1	-	195.2	-
1944-48	220.6	25.6	180.7	7.4
1949-53	165.0	25.2	99.8	44.8
1954-58	162.4	1.5	78.4	21.4
1959-61	108.6	33.1	44.1	43.7
(1962)**	75.2	30.7	34.3	22.2

* Excludes diarrhea of newborn.
** Provisional figures.

center was established. By 1960, however, the population for which this hospital was chiefly responsible was supplying relatively few cases, and the decision was made to move the hydration center into a consultorio serving the suburban area from which most of the cases were coming. The cases of dehydration requiring treatment since then have been so relatively few that it has not been found desirable to operate the consultorio in this way, the few cases needing hydration being admitted to the hospital. It is the universal impression that diarrheal morbidity has changed but little during this time while the reduction of severe illness and fall in mortality has been striking.

Mexico

The Mexican campaign against the diarrheas is of special interest because it represents a direct approach to the community, mobilizing the people themselves to help solve their own problems and combining educational and early treatment efforts. It is significant that the most successful efforts to date have been in areas without ready access to health care services.

The technique of organization is simple enough. After a prior consultation with the Coordinator of Medical Services, local physicians and nurses, and community leaders in the central village of each municipio to be organized, an open meeting is held with citizens of the community. The hazards of diarrheal disease are discussed and a plan for prevention of dehydration is presented, based on early recognition of diarrhea by the parents themselves and administration of a sugar-electrolyte mixture dispensed in a "sobrecito".

Community members are designated as responsible for segments of the town or village population. After further indoctrination these "jefes de manzana" carry on educational work in their sector on a family-to-family basis, focussing on the importance of prompt treatment especially in young children. They themselves are the source of such treatment and distribute the "sobrecitos" when diarrheal disease occurs in a family, instructing the parents in proper usage and following the case carefully so that if response is not satisfactory, distant medical assitance will be sought. Major efforts are timed to coincide with the peak of the diarrheal disease season which is rather sharply limited to 4-5 months.

Cooperation of rural communities in this campaign has been impressive. Preliminary data which need further refinement suggest that a reduction of diarrheal disease deaths on the order of 50 per cent has occurred in those communities with organized programs as compared to the experience of other communities. There is indication that severe diarrheal dehydration is being reduced, while no effect on diarrhea morbidity has been observed.

In addition to the need for validating and expanding this approach to the problem, the Mexican experience raises a number of questions for

further exploration and study. How important is the electrolyte-sugar "packet" itself (regardless of its contents) as a tangible force which impels the "jefe de manzana" to his educational zeal and motivates the mother to increase the fluid intake of her child? Can this approach to communities be carried out by less highly trained professionals with the same dedication and effect? How much of the success depends upon community forces and drives peculiar to the areas of Mexico in which the campaign has functioned? It would be a mistake to think that identical techniques can be applied successfully elsewhere. A receptive community, responsive to its leadership, approached through the right channels by dedicated professionals sensitive to the nuances of the group must be important ingredients of success. These ingredients will differ from country to country and from community to community.

IMPLICATIONS FOR PLANNING

1. The Integration of Services

This document has focused upon the prevention of deaths from diarrheal disease rather than the prevention of diarrheal morbidity. The programs cited in Venezuela, Chile and Mexico have in common the combination of educational and therapeutic approaches to this objective.

Owing to the categorical development of organized health care services in Latin America and the predominant role of the healing tradition in medicine, preventive and educational methods and services particularly as they relate to mothers and children, have tended to be divorced from or viewed separately from treatment methods and services. This tendency is slowly changing. Where separation continues, however, it hampers the attainment of the objective. Education of the community must be accompanied by attention to the effectiveness and availability of treatment services or its results will be nullified. The successful treatment of diarrheal dehydration unaccompanied by educational efforts and follow-up of the underlying malnutrition may lead only to recurrence and death.

Fragmentation of care between hospital and health center services still continues in many areas of Latin America even when the health center delivers medical care. The structure of health care services must provide for the continuing flow of information and patients to and from the central hospital and health center or peripheral source, as in Venezuela and Chile, if effective patient care is to be delivered.

These examples serve to emphasize the importance of planning and developing health care services as a comprehensive whole.

2. The Quality of Services

There is need to plan programs which provide and maintain the quality of professional services by allocating time and support to the initial and continuing pediatric training of the personnel who will be dealing directly with diarrheal disease in children. Continuing technical supervision of both medical and nursing personnel, which stems from pediatric sources and provides for continuing consultation are additional means of maintaining quality. Medical centers in which well-trained pediatricians function exist in virtually all the countries of Latin America. However, their potential contributions to the national health care services are not always fully utilized. Their potential does not necessarily lie in the production of more pediatricians. It lies in the structuring of organized services which will permit pediatric influence to be more widely felt.

The need to provide for continuous individualized patient care and the importance of the personal relationship between the doctor-medical team and the patient and his family has been pointed out. It is recognized that shortages of professional personnel hinder the attainment of the ideal. However, much can be done to strengthen systems of hospital

residencies. This is important not only to the training of physicians but also as an integral feature of patient care in hospitals. Where residency programs can not be strenghtened the special training and assignment of paramedical personnel to work under medical supervision can be considered. In urban health centers, the assignment of a medical team to be responsible for health care of a group of families rather than to see patients indiscriminately in clinic can also be built into the planning.

Planning which takes account of the quality of the medical care delivered to children is not an end in itself. It is a means of reducing chilhood mortality and therefore must be incorporated into publich health programs.

3. The Selection of Priorities and The Relationships to Other Programs Of Child Health Care

The investment of scarce resources in developing any one aspect of child health care must be weighed against their investment in other aspects, their investment in other health programs and their investment in other sectors of national development. A program of health care which provides for the early and adequate treatment of diarrheal disease in young children can significantly reduce mortality in early chilhood. It should, therefore, receive a significant consideration in the planning process.

Such consideration should take into account the fact that personnel time in many Latin American child health care programs is deployed in routines of frequent clinic visits and home visiting for "health supervision" which could be reduced considerably so as to release personnel for the specific activities of parent education more immediately related to diarrheal disease and the malnutrition so frequently associated with it. One of the most important of these activities is follow-up and after-care, especially of the malnourished child.

Provision of convalescent resources for the severely malnourished child (who has been saved from death by dehydration) in the form of day-call centers and convalescent wards and institutions is an important, though generally neglected, aspect of both nutrition and diarrheal disease programs. Such facilities will reduce the need for hospital beds as well as deaths from recurrent disease.

This approach to child health care services does not disregard preventive measures but attempts to focus them as a matter of priority upon that portion of the population most vulnerable to risk during a period when they would be most receptive to counsel.

In considering the most economic and efficient means of implementing these concepts, attention should also be given to the often excessive use of expensive drugs, the over-complicated nature of some hospital rehydration routines and the successful application of nursing staff to intravenous therapy.

4. The Need for Studies

Throughout this document and in its appendices* allusion has been made to a number of subjects which deserve careful study. These are not subjects of academic interest only. The studies needed are those which will simplify and perfect the techniques which can be most efficiently applied by the health care services to save more lives. They represent combinations of the epidemiological and clinical approaches to diarrheal disease in children.

In a number of centers in Latin America competent investigators are exploring some of these areas of study. However, a common satisfactory language to define such terms as shock, dehydration and malnutrition is needed; hospital mortality rates are not being reported and analyzed comparably by times of death and age of patient. Other subjects for research such as the relationship between the rate of infusion of intravenous fluids and treatment results and the effects of different oral electrolyte fluids are not being investigated at all although current practices differ widely.

Thus there is need for a regional research planning conference which will define terms or suggest studies to arrive at satisfactory definitions. Such a conference could also spell out by common agreement the diarrheal disease study areas most significant to future health care service planning.

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*These appendices will be distributed at a latter date.

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APPENDICES TO DOCUMENT CD14/DT/1

Appendix I. Electrolyte Concentrates for Oral Administration

Solutions for oral therapy in general use in Latin America vary in their composition from boiled water and sweetened tea, which have essentially no electrolyte content, through one-third to one-half isotonic solutions, to the essentially isotonic Ringer's solution. "Isotonicity" is approximately 300 mOsm/L, the normal osmotic pressure of body fluids.

Useful electrolyte concentrates enjoying widespread use are listed in Table 5. In general they have been accepted by infants and children with eagerness. When reluctance has been encountered in Mexico, the addition of canela (cinnamon), manzanilla, or yerba buena to the soltion has made it acceptable.

The upper limits to the concentrations of sodium and total electrolytes, above which the ratic of electrolyte to water is too high, are not clearly defined, either on theoretical grounds or from experience in their use. The various soltuions described in Table 5 have been given to many patients with considerable success. Little is known, however, of their effect on the electrolyte economy of the body when treatment is unsuccessful. The amount of sodium in a popular United States concentrate, originally designed to provide 50 mEq/L of this ion, was reduced by half some years ago in the belief that occasional cases of hypernatremis encountered during its use were attributable to too high a sodium content. It is perhaps more likely that the hypernatremia in these cases expressed rather the biochemical lesion of prolonged, unremitting diarrhea with dehydration uncontrolled or uncontrollable with oral fluids. One awaits with interest the report of proposed Mexican observations of serum sodium in children referred for medical care after unsuccessful oral therapy with solutions prepared from "sobrecitos" and administered as recommended.

Table 5 - Some Useful Electrolyte and Sugar Concentrates Available in Latin America

Type of product and availability	Composition	Directions for solution	Concentration when dissolved as directed		
			Na (mEq/L)	K (mEq/L)	Total electrolytes (mOsm/L)
Materials available in homes	Table salt 1/2 teaspoonful Cane sugar up to 3 tablespoonfuls	Dissolve in 1 liter of water	50	9	89
Pill distributed by Ministerio de Sanidad y Asistencia Social, Venezuela	Sodium chloride 1.5 Gm Potassium chloride 0.5 Gm	Dissolve 2 pills in 1 liter of water (1 cognac bottle + 1/2 beer bottle) Add 2 teaspoonfuls of panela or raspadura de panelón	52	13	130
Packet ("sobrecito") distributed by Secretaria de Salubridad y Asistencia, Mexico	Sodium chloride 3.0 Gm Potassium chloride 1.5 Gm Sucrose 46 Gm	Dissolve contents of packet in 1 liter of water (4 1/2 glasses)	52	13	130
Proprietary pill (Hydrax ®, Johnson & Johnson) available in Brazilian Health Centers and pharmacies	Sodium chloride .214 Gm Potassium chloride .112 Gm Sodium citrate .262 Gm Excipient .63 Gm	Dispensary use: Dissolve 1 pill in 150 ml of water or 5% glucose solution Home use: Dissolve 3 pills in 2 glassfuls of water	42	12	109
Original formula of Dept. of Pediatrics, La. State Univ. School of Medicine recommended in 1956 by PAHO/WHO*	Sodium chloride 1.5 Gm Potassium chloride 2.0 Gm Sucrose 50 Gms	Dissolve in 1 liter of water	26	27	106

*Liquid concentrate is also described, prepared by dissolving salts in 15 ml of water, then adding 60 ml of syrup of raspberry in place of the sucrose.

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Appendix II. Pathological Physiology of Diarrheal Dehydration

As diarrheal dehydration progresses successive biochemical abnormalities make their appearance. Diarrheal stools consist of ileal fluid which fails to be reabsorbed and is altered in its electrolyte structure as it passes more or less rapidly through the colon. Physiologically and therefore therapeutically important constituents of these stools are water, sodium, potassium, and chloride. The typical diarrheal stool is alkaline and hypotonic. The kidney attempts to conserve body water and maintain normal acid-base balance by excreting concentrated, acid urine. Progressive depletion of body water leads however to reduced renal blood flow, renal function becomes impaired, and metabolic acidosis makes its appearance. The body responds to the hydrogen ion excess by reducing carbonic acid through increased alveolar ventilation. The kidney continues its attempt to maintain normal osmotic relationships but eventually the need to conserve body water takes precedence and output of urine becomes negligible. Severe dehydration is consequently associated with elevated osmolarity of body fluids. The theoretical biochemical end-point of severe diarrheal disease is thus (1) loss of body fluids (dehydration), (2) relative loss of water in excess of electrolytes (hyperosmolarity, hypernatremia), (3) reduced circulating blood volume (hypovolemia, anhydremia, hemoconcentration), (4) metabolic acidosis (lowered pH and bicarbonate), and (5) reduced blood carbonic acid (lowered blood P_{CO_2}).

The clinical features of dehydration are well known. Attempted respiratory compensation for the metabolic acidosis is recognized in hyperventilation. As dehydration progresses the patient may become stuporous, comatose, and "toxic". Shock, with pallor, cyanosis, and weak, thready pulse is a serious feature of severe dehydration and when fully developed may be irreversible.

The theoretical picture may be altered by sweating, vomiting, and therapy with water and electrolytes. Most cases do not progress to the point of severe hyperosmolarity. Absence of overbreathing in the child with severe dehydration due to diarrhea is an ominous sign since it bespeaks a breakdown in an important defense mechanism of the body and warns that vascular collapse or shock is present or impending.

The presence of severe malnutrition in children 1 to 4 years of age is associated with extracellular hypotonicity and expansion of the intracellular fluid phase (18, 19). Dehydration due to diarrhea in these children characteristically presents with hypo- rather than hyperosmolarity.

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Appendix III. Historical Aspects of Fluid Therapy for Diarrheal Dehydration

In a current review of diarrheal diseases Oropeza and Sahagun Torres (17) describe four "stages" of medical thinking: the organicist stage (introduction of the diagnostic terms "gastroenteritis," "colitis," etc.), the nutritional stage (concern over quantitive and qualitative features of the diet), the microbiological stage (still dominating much of our thinking, as shown by the widespread and indiscriminate use of antibacterial drugs), and the biochemical stage. In each stage there is a great tendency to focus on one aspect of the total disorder rather than on the treatment of the afflicted child.

The "biochemical stage" may be said to have begun before 1920 at the Johns Hopkins Hospital, when it was discovered that diarrheal dehydration is associated with depression of blood bicarbonate, which could be brought back to normal through parenteral administration of sodium bicarbonate. The irrelevance of this observation to proper therapeutic management was well expressed by Powers (20): "...You probably know what to do for acidosis, but do you know what to do for the babies? They used to live seven hours but they last only four now."

Approximately 20 years later concern over the low CO_2 still tended to dominate therapeutic considerations in diarrheal dehydration, as illustrated by a report of 51 per cent mortality in children who, thanks to therapy with sodium lactate, were "completely relieved of acidosis" before death (21).

Even today alkali treatment of children believed to be "acidotic" is recommended in many centers.

The large amounts of sodium used in the correction of low serum bicarbonate are probably primarily responsible for the development of the syndrome referred to two decades ago as "post-acidotic hypocalcemia", a biochemical abnormality now thought rather to be a more or less constant concomitant of hypernatremia. While hypernatremia represents the theoretical end-point of severe and usually prolonged dehydration, its appearance may be hastened and its extent aggravated by inappropriate therapy with excessive amounts of sodium. Hypernatremia indicates considerable suppression of renal function, which is in general perhaps better measured by the level of blood urea.

The recognition of loss of body potassium has led to an important contribution to the therapy of dehydration in the last 20 years, through provision of this ion once adequate urinary output has become re-established. There is a tendency in some clinics to confuse serum potassium with the total body potassium, most of which resides in the cells. Serum potassium levels, at best a crude reflection of total potassium, are not useful in therapeutic planning. It is enough to know that body potassium is depleted in diarrheal dehydration and should be restored as part of the therapeutic program.

Recognition in recent years of individual differences in osmolarity in diarrheal dehydration has led to recommendations of a variety of therapeutic regimens whose practical superiority in the management of the particular osmotic disturbances for which they are designed has not been demonstrated and which direct the therapist's attention from the dehydrated child, which he can see and evaluate, to interesting biochemical concomitants, which usually he cannot. Theoretical preoccupations are particularly evident in regimens designed to treat "hypertonic" dehydration. Some of these regimens are mutually contradictory

in that they seek either to bring the serum sodium quickly to normal, or, on the other hand, to prevent it from returning to normal too rapidly. Since retarding the return of sodium to normal can be achieved only by measures which perpetuate some degree of dehydration, any such regimen ignores the patient's basic problem through focusing on one isolated parameter. Equally incompatible of course is the simultaneous treatment of acidosis and hypernatremia with solutions of sodium bicarbonate or its equivalent.

Current Mexican descriptions of renal tubular necrosis in a variety of conditions have led to the use of peritoneal dialysis in selected cases of infantile diarrhea. Up to this moment, it has not been possible early in the therapy of diarrheal dehydration to distinguish between this serious anatomical complication and functional suppression of glomerular filtration; the latter responds rapidly to the rapid intravenous administration of fluids.

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Appendix IV. Theory and Practice of Parenteral Fluid Therapy

There is virtually uniform agreement among therapists (1) that the initial infusion of the dehydrated child should be rapid and (2) that the fluids should contain potassium once adequate urinary output has been established. There are, however, various interpretations of "rapid." Uniformity of opinion as to the appropriate composition and concentration of the initial hydrating fluid is also wanting.

While all systems of fluid therapy are based on the replenishment of losses which are known for the average dehydrated patient, in the treatment of the individual patient it is important to define the termination of the initial place of rapid repair, that of the replacement of most of the sodium cloride and water deficit, in terms of his own requirements, which may of course be more or less than the assumed average. This approach implies (1) consideration of the initial phase of repair as something quite separate from the subsequent period of maintenance therapy and gradual repair of the potassium deficit. It also implies (2) the desirability of a readily recognizable physiological end-point by which to recognize the completion of the initial phase of rapid repair.

The first principle is not adequately satisfied by the majority of currently recommended Latin American regimens, which lump together fluid needs for repair and subsequent maintenance into a single twenty-four hour package, arbitrarily defined as a total volume of fluid in the range of 130 to 200 ml per kilo of body weight per day. While amounts of fluid up to 4 per cent of the body weight are occasionally recommended in the initial period, in general smaller amounts are given. The initial period of "rapid infusion" may actually last several hours. Its duration is likely to vary considerably according to the size of the child. In the regimens employed by many if not most Latin American clinics the small child profits from the initial infusion more than the large, since these regimens are most frequently expressed in terms of a certain number of drops per minute regardless of the size of the child and therefore the small child receives more fluid per unit of body weight in the same unit of time.

The best index of completion of the early phase of rehydration—with the exception of the uncommon patient with renal tubular necrosis—is the passage of dilute urine. This implies not only the collection and measurement of all urine voided by the patient but determination of the specific gravity or osmolality. Insufficient attention has been paid to these simple and time-honored measures, because of inadequacy of nursing coverage, lack of familiarity with simple techniques of urine collection, and inability to determine specific gravity on small quantities of urine. Specific gravity is however easily measured on single drops of urine, using either a series of tubes of known specific gravity made up by the combining non-volatile liquids heavier and lighter than water in proper proportions, or directly and simply with the more expensive refractometer. Specific gravity, as opposed to osmolality, may be misleading if glucose is present. In urine of usual composition an osmolality of 300 mOsm/L corresponds to a specific gravity of approximately 1.010. A glucose solution of the same osmolality has a specific gravity of 1.023. It is therefore desirable, particularly if the 5 per cent glucose solutions widely recommended in Latin America are used in the initial hydration, to be prepared to determine by simple means whether high urinary specific gravity can be accounted for by the presence of glucose. The demonstration of an initially high specific gravity with progressive fall as fluids are administered is together with increasing urine volume important evidence that renal failure is not present.

There appears to be an increasing impression in Latin America, if not a documented awareness, that solutions with isotonic and nearly isotonic electrolyte contrations are less effective than hypotonic in initial hydration, and that among the adverse effects of the more concentrated solutions are the production of edema and perhaps sclerema—the latter to be sure perhaps in certain cases an inevitable feature of recovery from severe dehydration. In addition to restoration of salt and water, "free" water is needed for excretion of wastes and for osmotic and acid-base adjustments by the kidney. Except in the case of documented severe hyponatremia there would appear to be little indication for administration of a solution more concentrated than 150 mOsm/L. Indeed the effectiveness of even more dilute solutions appears to have been borne out in Venezuela, where although solutions of sodium chloride in 0.45 per cent (154 mOsm/L) and 0.3 per cent (103 mOsm/L) concentrations are recommended for assumed "hypotonic" and "hypertonic" dehydration respectively, in practice the more dilute solution has been successfully used to the virtual exclusion of the more concentrated in most parts of the country.

While a theoretical case can be made for the use of small amounts of alkaline solutions in the treatment of diarrheal acidosis, such therapy threatens to direct attention from the more urgent therapy of dehydration and, as employed in many clinics in the form of one-sixth molar sodium lactate, provides large quantities of sodium without adequate "free water." Further potential disadvantages of the administration of excessive amounts of sodium are referred to in Appendix III. Occasionally replacement of continuing stool losses is necessary in young infants. This is to be distinguised from repair of the acidosis, which can be carried out by the kidneys with solutions of sodium chloride, even when blood pH is 6.90 or lower, once satisfactory renal blood flow has been reestablished. Recent experience at the Hospital Infantil de Mexico is said to show that normalization of serum electrolytes occurs as rapidly with half isotonic solution of sodium chloride as with solutions of similar osmolarity containing some lactate or bicarbonate.

Once satisfactory output of urine is achieved, the rate of infusion is slowed and the infusion fluid should contain potassium and a higher concentration of glucose. A solution for maintenance and concomitant repair of the potassium deficit should have approximately equal amounts of sodium and potassium and be about one-third isotonic in electrolyte content, although solutions up to 150 mOsm/L are tolerated. It is virtually universal Latin Amiercan practice to add a potassium concentrate to a mixture of sodium chloride and glucose solutions. This technique has the dual disadvantages of possibility of error in calculation of the added potassium and of bringing the electrolyte concentration of the infusion solution to an undesirably high level. The maintenance solutions in general use in Latin America contain but 5 per cent glucose. A 10 per cent solution of glucose is preferable and is of particular importance for partial maintenance of nutrition in the undernourished children who are the typical victims of diarrheal disease.

Appropriate prepared maintenance solutions are listed in Table 6. Only one of these (26-27 solution), however, is provided with 10 per cent glucose as marketed in the United States.

In most clinics two solutions are thus used in the therapy of the dehydrated child: one for the initial rapid hydrating period, the other for the following phase of maintenance and repair of the potassium deficit.

The more complex solutions of Talbot (Table 6) and Meneghello et al. (22) have been suggested as single solutions useful both for initial rehydration and in the subsequent stage of maintenance and repair of potassium deficit. While the high potassium content of Talbot's solution is theoretically undesirable in the early stages of dehydration, from an empirical standpoint this solution has been used with success. Meneghello's solution is quite concentrated, is alkaline, and contains relatively little potassium in relation to sodium. The results of Meneghello et al. are not comparable with those of Talbot or the authors of this report, since the therapeutic techniques are different and the experiences are with children of vastly different risks and mortality.

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Table 6. Multi-electrolyte solutions for maintenance

	Electrolytes per liter				
	Cations (mEq)		Anions (mEq)		Total
	Na	K	Cl	Lactate	(mOsm)
25-20 solution (1) (Modified Butler's)	25	20	22	23	95
26-27 solution (Ordway's)	26	27	53		106
40-35 solution (2) (Talbot's)	40	35	40	20	143

(1) Contains also 3 mEq/L each of magnesium and phosphate
(2) Contains also 15 mEq/L of phosphate

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Appendix V. Cause of Death in Hospitalized Children with Diarrheal Dehydration

Reflection on the continued high mortality of children with diarrheal disease admitted to hospitals gives rise to the hope that current methods of treatment might be so altered as to reduce the mortality figures significantly. It is not at the moment clear what most hospital deaths are due to, a frequent expedient being to ascribe deaths to the complex of infection, malnutrition, and dehydration. If these parameters could be separately identified through objective measurements, it would be possible to recognize more precisely the cause of death in children who die from diarrheal disease.

The assessment of infection ordinarily presents no problem, as was pointed out in the main body of this report.

In view of the inaccuracies inherent in the use of average normal body weight for age as a reference point in assessing degree of malnutrition, the patient's crown-heel length is suggested as a more useful reference standard in that it is less likely than weight to be affected by malnutrition. The patient's weight in relation to his length-age would then be used as an index of malnutrition. The usual practice of relating weight to that of a hypothetical child of the same age measures undernutrition and genetically determined growth factors as well.

Length might well be expressed as percentage deviation from average length for age as well as in absolute units.

Percentage deviations from average weight for length are not known in relation to mild, moderate, and severe malnutrition as clinically appraised. As a first approximation pending more knowledgeable recommendations, first degree malnutrition might represent the range of 80-90% of average weight for length, second degree 70-80%, and third degree below 70%.

It is of course important to measure length accurately. This can not be done with an ordinary measuring tape. The simplest practical way is for the patient to be supine on a flat surface with his head against a hard vertical surface such as the wall, against which one end of a rigid measuring device such as a meter stick is also placed. The meter stick lies in approximation with the patient's side, so that his length may be measured at the heel with the knee extended and the foot held in a position of 90-degree flexion.

The weight chosen for comparison with the average weight for length should whenever possible be that obtained immediately before the dehydration set in, or, failing that, at an arbitrary period of recovery from dehydration (see following paragraph). In the child who dies soon after admission, the weight would be that at death.

Objective measurement of the degree of dehydration is infrequently made but urgently needed. The most accurate appraisal and the one incidentally yielding the highest figure for percentage loss is derived from the difference between weight on admission and that immediately before the onset of dehydration. In the child who has had health supervision this can be assessed accurately through extrapolation of the recorded previous weights on a growth chart, or better still, if the child recovers, through interpolation of a line joining past and future

observations. The more expedient method would be to compare the weight on admission with that at an arbitrary later period. For the surviving child this might be at 5-7 days, when most children would have reestablished a normal feeding pattern. For the child that dies the subsequent weight would be at the time of death. Weight regained, as measured in this way, is considerably lower than that measured from the extrapolated or interpolated initial weight but is probably comparable with the same type of measurement in other patients. In either method the weight loss should be expressed as a percentage of the pre-dehydration or recovery weight, not of the admission weight.

The sort of analysis suggested in the foregoing will lead to better understanding of the pathological physiology of diarrheal dehydration and hopefully to more effective therapy of hospitalized patients. The following two hypotheses could be tested among others.

(1) It is likely that the great majority of malnourished children admitted to rehydration centers and hospitals for treatment of dehydration do not have severe dehydration per se although they are without any question quite ill. The malnourished child soon shows poor skin turgor and other signs of dehydration and these signs may persist for some time after clinical recovery is attested by the child's general behavior and the passage of satisfactory amounts of dilute urine. The well-nourished child on the other hand may have intensive dehydration without the usual clinical signs. Indeed the comment is recurrently made in treatment centers that shock seems to be more frequent in well-nourished children. The well-nourished child, although he has the reserve of good health not available to the malnourished, has in relation to his body weight a more limited water reserve, since a large fraction of his weight is made up of fat.

The likelihood that most malnourished children treated for diarrhea do not have severe dehydration is inferred from a variety of observations, though very limited published data: the prompt recovery from dehydration following infusion of relatively small amounts of fluids at relatively slow rates; the appearance within a few hours of admission of a satisfactory urine output of low specific gravity; values for plasma pH above - usually well above - 7.10, indicating metabolic acidosis of no more than moderate severity, good respiratory compensation, or generally both; in occasional cases for which data are available, little or no weight gain following recovery from dehydration.

(2) Some hospitalized children may be dying of dehydration or the effects of dehydration; the possibility of altered, perhaps more vigorous early therapy suggests itself as a means for reducing early mortality.

Although a few cases dehydration continues because of continuing diarrhea which progresses at a more rapid rate than the infusion, deaths from dehydration or its effects are likely to occur in the first few hours following admission -- namely in the initial period of 48 hours which many hospitals exclude from their mortality figures as being "no institucional." Statistics from various hospitals indicate that from one to two thirds of diarrhea deaths occur before 48 hours.

Few data are available to permit further breakdown of deaths in the initial 48 hours into the actual time of demise. In a recent report Meneghello et al (22) exclude from their mortality figures all cases dying in the first three hours. Of their 25 deaths, all of which are attributed to dehydration, twelve were between 3 and 24 hours of admission in children who had not been adequately rehydrated. In the rehydration center of Maracay, Venezuela, in the month of June, 1963, of 6 deaths occurring before 48 hours, four were within 24. Of 418 children admitted to the Centro de Rehidratacao Salles Neto in Rio de Janeiro during

the 6-month period, January - June 1963, 60 per cent of whom were admitted for treatment of dehydration (the others for malnutrition or infection), there were 48 deaths occurring at the following intervals after admission; less than one hour, 3; 1-3 hours, 8; 3-6 hours, 11; 6-12 hours, 7; 12-24 hours, 7; 24-48 hours, 9; 2 days and over, 3.

The possibility that many of these early deaths may be due to dehydration or shock is inferred on the basis of several considerations: that many physicians working in dehydration centers note a concentration of deaths in the first 12 hours, that deaths are more common in infants with "toxicosis", that infants who die in this period ordinarily do not void. The younger the infant, the more susceptible he may be to shock, and one reflects whether the uniformly high case mortality among young infants may not be in part due to shock resulting from dehydration. The recent recognition in Mexico City of acute renal tubular necrosis, determined by kidney biopsy or at postmortem in large numbers of infants with diarrheal dehydration, suggests that prolonged restriction of renal blood flow may have been operative. Again it is significant that most of the Mexican infants were under 6 months of age.

The treatment of prevention of shock is in its simplest form the rapid expansion and maintenance of adequate circulating blood volume. Disagreement over what exactly is meant by "rapid" has been noted. If, however, children indeed are dying of shock it would be worthwhile to know whether even more rapid initial infusion might reduce mortality. This observation would not be difficult to make on a controlled basis in many centers where large numbers of children are admitted for rehydration.

Maintenance of circulating blood volume implies not only continuing adequacy of fluid administration but very likely in some cases administration of whole blood, plasma, or perhaps other colloids. Blood and plasma are infrequently used in the treatment of the dehydrated child in Latin America, although they are administered in some instances for anemia or hypoproteinemia. In general, when blood is used in the treatment of shock, its administration is several hours after admission of the patient and only when clinical signs of shock have become quite evident. It may be that by this time the shock is irreversible.

The importance of early administration of blood was first emphasized by Powers in 1926 (23) - to be sure at a time when the understanding of fluid therapy was considerablyless sophisticated than it is now:

> "After the administration of fluids, patients with intestinal intoxication often show astonishing improvements within a period of less than two hours. This improvement is often temporary and misleading. It seldom persists in severe cases, even when adequate fluid intake in maintained. It is for this reason that that administration of fluid should be reinforced by a blood transfusion in practically all cases, regardless of an apparent initial improvement...
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> "It is impossible to state with exactness in just what manner transfusion helps these patients' both quantitative and qualitative changes in the blood are quickly brought about so that improvement in function of the circulatory renal and respiratory system - and thus of the cells throughout the organism - is made possible... Unmistakable indications for a transfusion may come too late for that treatment to be any longer effective. Having knowledge of these facts, therefore, we have felt that it is better to err in subjecting the patient to unnecessary transfusion rather than to withold a treatment which subsequent developments may show might have been a life saving measure. We believe that our general good

results in the treatment of this malady are due to the fact that we have found out that we cannot discriminate correctly, and foretell which patients are safe without transfusion."

For practical reasons blood or plasma may not be available in many centers, or the requisite time for cross-matching may cause so much delay that the assumed benefit of early administration may be lost. For these reasons the use of other colloids as dextran solution might well be explored on an experimental basis. These should however be viewed as a substitute for whole blood, which probably represents the best substance available for restoration and maintenance of integrity of the circulation.