Oral rehydration therapy: A global perspective

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Diarrhea is the leading cause of morbidity and death in developing countries.[1-3] Even in developed countries such as the United States, approximately 500 diarrheal deaths occur each year, and approximately 200,000 persons are hospitalized each year for diarrheal illnesses.[4] Thus diarrheal diseases are a considerable disease burden and cause economic loss in both developed and developing countries.

HISTORY OF FLUID THERAPY

The physiologic disturbances that occur in diarrhea were not documented in the scientific literature until about 1830,[5,6] although many forms of therapy have been used for diarrhea throughout human history. In fact, the word "dehydration," meaning deficiency of water, did not appear in the scientific literature until the beginning of this century. When applied to the state seen after loss of body fluid in diarrhea, the term implies deficiency of both water and solutes. This distinction is important historically because effective solutions to treat diarrhea were developed only after the precise losses of fluid and electrolytes in diarrheal stools had been described. Intravenous fluids were initially used by Latta[7] in 1832 to treat patients with diarrhea during an epidemic of cholera. Unfortunately, the danger of microbes and the need for sterilization were not known, and many complications resulted from intravenous therapy. Thus this treatment did not become popular. It was not until the twentieth century that the routine use of intravenous fluid therapy took its current prominent place in modern medicine.

Because of mistakes in the measurement of the composition of cholera stool at one point, the initial solution developed was a hypertonic saline solution; it became the standard cholera intravenous replacement solution and was used for many years.[8] This solution, however, did reduce the total mortality rate for clinical cholera from more than 60% of those attacked to about 30%. When sodium bicarbonate was added to cholera treatment solutions, the death rate declined further.[9] In 1958, intravenous solutions based on accurate measurements of the composition of the stools of patients with cholera were used to treat all cases successfully.[10] A standard formula solution applied on a mass scale in a timely fashion in Dhaka, Bangladesh, between 1962 and 1967 saved virtually all patients treated, even with adverse field conditions. Simultaneously, investigators in India, in collaboration with U.S. scientists, developed effective intravenous replacement therapy and further described the physiologic derangements produced by cholera.[11]

ORS	Oral rehydration solution(s)
ORT	Oral rehydration therapy

The first field testing of an oral rehydration solution to use in the treatment of patients with cholera was successfully conducted in a rural area in Bangladesh known as Matlab Bazaar.[12] In 1971, when an epidemic of cholera broke out among Bangladesh refugees who had fled to refugee camps in Calcutta, ORS was shown to reduce death rates from more than 50%, when no treatment was given, to less than 5%. When oral rehydration therapy was coupled with initial intravenous rehydration, even with such adverse field conditions the mortality rate was less than 1%.[13]

Physiologic basis for the use of ORS. The key to the effective composition of the ORS and its optimal use rests on physiologic studies undertaken shortly after World War II in the United Kingdom. At Oxford University, it was observed that adding glucose to solutions of sodium chloride resulted in an acceleration of movement of fluid across the intestinal mucosa of rabbits.[14] In the early 1960s an expla-

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Table I. Mean stool sodium and potassium concentrations (mmol/L) according to duration of diarrhea before admission

Duration (hr)	Cholera		ETEC		Rotavirus	
	Na^+	K^+	Na^+	K^+	Na^+	K^+
0-12	97.9 ± 23.1[a]	28.5 ± 10.9	67.2 ± 34.1	37.4 ± 19.4	52.7 ± 26.3	45.6 ± 20.5
13-24	83.3 ± 31.7	37.0 ± 18.4	54.7 ± 19.9	38.6 ± 20.2	41.8 ± 15.5	42.4 ± 17.1
25-48	63.4 ± 27.9[b]	28.3 ± 13.3	44.0 ± 27.2	26.9 ± 26.9	32.6 ± 22.5	28.6 ± 7.4
49+	46	65	43.8 ± 21.9	37.4 ± 24.6	34.4 ± 11.6	43.8 ± 21.9

From Molla AM, Rahaman M, Sarker SA, Sack DA, Molla A. J PEDIATR 1981;98:835-8.
Significance: $p < 0.05$ (a versus b).

nation of this finding was worked out by members of the Harvard University Department of Biophysics[15] and by investigators at a research laboratory of the U.S. Air Force.[16] In these classic studies, it was shown that when one molecule of glucose was absorbed, one ion of sodium traveled with it in an obligatory, linked fashion.[11] This was an active process, operating across the brush border of the intestinal epithelium.[16] When it was also shown that amino acids could transport sodium in a similarly linked fashion, the phenomenon of cotransport was firmly established.[17] At the same time that these observations were being made in the United States, investigators in Thailand, at the Cholera Research Laboratory in Dhaka, and at the Johns Hopkins International Centers for Medical Research and Training Unit in Calcutta were observing cholera patients at the bedside.[11] In 1965, it was shown in Dhaka that perfusion of glucose in patients with cholera changed the transepithelial membrane potential of the intestine in a way consistent with an active cotransport process.[18] Soon after these observations, investigators in both Dhaka and Calcutta found that the addition of glucose to sodium-containing solutions resulted in the net movement of salt and water from the lumen into the bloodstream of patients with severe cholera.[19] This finding confirmed and extended earlier observations made by Wallace and Phillips[11] of the U.S. Naval Medical Research Unit. Optimal compositions were soon worked out, and safe, practical solutions were devised.[20]

Studies of cholera and cholera-like diseases have provided much of the basis for fluid and electrolyte replacement. In severe cholera, as the loss of fluid approaches a maximum, the composition of the diarrheal stool approaches that of an ultrafiltrate of plasma; it is enriched with potassium and bicarbonate by colonic modulation of the effluent stool. Stools of cholera patients are lower in potassium and higher in sodium concentrations than those of patients with rotavirus or enterotoxigenic *Escherichia coli*[21] (Table I). When the fluid loss is small, the concentration of potassium is high, dropping toward a low of about 15 mEq/L at the highest purging rates. Sodium concentration is reciprocal to that of potassium, being lower when stool output is low and approaching the concentration of plasma sodium at the highest rates.[22] Thus, when fluid volume loss is high and the threat to the circulation is greatest, the need for sodium in the replacement fluids is increased. In more chronic and indolent diarrhea, sodium losses may be met easily by allowing fluids normally consumed to be taken as desired, but potassium losses may supersede sodium losses in importance.

If no fluids are given to the child with diarrhea, depletion of body fluids proceeds isotonically. However, if the child drinks, the effect on the circulating blood composition will depend on the difference between the composition of what is lost and the composition of what has been taken in. Thus, if a child has diarrhea with a high volume loss and drinks water only, the serum sodium concentration will be diluted rapidly and the child will have convulsions and water intoxication. If, however, a concentrated salt solution is used along with cotransporting glucose or amino acids, hypernatremia may ensue, with catastrophic consequences. In fact, epidemics of hypernatremia were seen at a time when feeding formulas contained high concentrations of sugars. Osmotic diarrhea occurs after the use of a concentrated, osmotically active solution of salts and sugars or amino acids that exceeds the threshold of intestinal absorptive capacity. The result is a greater loss of water than of solutes, leading to hypernatremic states.

Thus it is critically important to ensure that solutions taken during diarrhea match in volume and composition the losses sustained by the patient and to ensure that total solutes do not exceed the osmolarity of plasma. The solution recommended by the World Health Organization (WHO) and UNICEF[23] represents a compromise between the optimal sodium concentration desired for rapidly purging patients with cholera and the lesser sodium concentration needed by the more gradual fluid losses of a patient with rotavirus infection (Table II). At present, most commercial diarrhea replacement solutions have raised sodium concentrations into the desired range, although few match the amount suggested by WHO and UNICEF.

Table II. Oral rehydration solutions available in the United States

Component of solution	Solution (manufacturer)†					
	WHO*	Resol*,‡ (Wyeth)	Pedialyte* (Ross)	Rehydralyte (Ross)	Ricelyte (Mead Johnson)	Infalyte* (Pennwalt)
Sodium (mEq/L)	90	50	45	75	50	50
Potassium (mEq/L)	20	20	20	20	25	20
Chloride (mEq/L)	80	50	35	65	45	40
Bicarbonate (mEq/L)						30
Citrate (mEq/L)	30	34§	30	30	34	
Glucose (gm/L)	20	20	25	25		20
Sucrose (gm/L)						
Rice syrup solids (gm/L)					30	

Modified from Santosham M, Brown KH, Sack RB. Pediatr Rev 1987;8:273, reproduced by permission of Pediatrics.
*WHO and Infalyte are dispensed in packets; Resol and Pedialyte are dispensed in 240 ml (8 oz) bottles. Composition of solutions was taken from package inserts.
†Manufacturers: Wyeth-Ayerst Laboratories, Philadelphia, Pa.; Ross Laboratories., Columbus, Ohio; Mead Johnson Nutritionals, Evansville, Ind.; Pennwalt Corp., Rochester, NY.
‡Also contains magnesium, 4 mmol/L; calcium 4, mmol/L; and phosphate, 5 mmol/L.
§11 mmol/L was added as citric acid.

CLINICAL STUDIES

Hospital-based studies. From the late 1960s to the late 1970s, numerous clinical studies were conducted in developing countries to evaluate the safety and efficacy of various ORS for the treatment of acute diarrhea.[23] Initially, the solutions tested contained 100 to 120 mmol/L of sodium, but later the sodium content was reduced to 90 mmol/L. When the latter product was tested, it was shown to be safe and efficacious in treating first adults and then infants with cholera. Subsequently, in developing countries, it was also shown to be efficacious and safe in treating dehydration secondary to noncholera diarrheas, including rotavirus diarrhea in all age groups, even newborn infants.[24, 25] The results of all these studies consistently demonstrated that oral rehydration therapy was as efficacious as intravenous therapy for dehydration in 85% to 95% of cases and that it could be used in situations where intravenous therapy could not.

On the basis of these studies, WHO recommended the use of this solution to treat diarrhea in children and adults of all ages, regardless of cause. In recent years the bicarbonate content of the WHO ORS has been replaced by citrate because the latter compound is more stable than bicarbonate and because citrate-containing ORS have been shown to be as efficacious as bicarbonate-containing ORS in treating diarrhea.[26]

In developed countries the first clinical trials to evaluate the use of ORT for acute diarrhea were conducted on the Apache Indian Reservation in Arizona in the early 1970s.[27, 28] Although these studies confirmed previous findings in developing countries, the general public in the United States and other developed countries was reluctant to accept the use of ORS. It was thought that the findings among Apache infants might not be applicable to the general U.S. population or other developed countries, and pediatricians continued to be concerned that ORS might induce hypernatremia.

Therefore, in the early 1980s, a randomized, controlled clinical trial was conducted among hospitalized infants in a general U.S. population to evaluate the safety and efficacy of two different ORS for the treatment of diarrhea.[29] One solution was the WHO ORS, and the other was identical in composition to the WHO ORS except for its reduced sodium (50 mmol/L) and chloride (30 mmol/L) content. Infants in both ORS groups were hydrated successfully. Moreover, as shown in developing countries, all infants with hypernatremia, isonatremia, or hyponatremia were successfully treated with ORS; no evidence was seen that ORS induced hypernatremia in these infants.

This study confirmed previous findings in developing countries and established the safety and efficacy of using ORT for hospitalized infants in the general U.S. population. Recently another clinical study[30] was conducted in a large urban medical center in the United States among well-nourished hospitalized infants to compare the use of ORS with intravenous therapy for diarrhea. This study also confirmed the safety and efficacy of using ORS to treat diarrhea in U.S. children.

Clinic-based studies. Relatively few randomized, controlled studies have evaluated the ORS to treat mild diarrhea in outpatients who do not require hospitalization. In a recent U.S. study,[31] four different ORS formulations were evaluated in infants who were brought to three different outpatient clinics without clinical signs of dehydration. Two

solutions contained 30 mmol/L of sodium each, and the other two contained 50 and 90 mmol/L of sodium, respectively. The four solutions also varied in the content and concentration of carbohydrate and base (bicarbonate or citrate). All four solutions were found to be equally safe and efficacious for the treatment of mild diarrhea. Another group of investigators[32] demonstrated in a U.S. hospital emergency department that the use of ORT instead of intravenous therapy in infants with diarrhea resulted in substantial cost savings.

On the basis of results of the studies conducted in the United States, the American Academy of Pediatrics (AAP) recently recommended the use of ORS to treat dehydration caused by diarrhea in developed countries.[33] The ORS used should contain 75 to 90 mmol/L sodium, 20 mmol/L potassium, 20% to 30% of anions as base (acetate, citrate, lactate, or bicarbonate), and the remainder as chloride and glucose 2% to 2.5% (110 to 140 mmol/L). For prevention of dehydration and the maintenance of hydration after dehydration treatment, the AAP recommended a solution similar in composition except for a reduced sodium content (40 to 60 mmol/L). In addition, the WHO ORS or other ORS used to treat acute dehydration may be used during maintenance by alternating the solution with a no-sodium or low-sodium fluid such as water, low-carbohydrate juices, or human milk.

Use of ORS in patients with vomiting. Vomiting is often an accompanying symptom in patients with diarrhea. In such patients, ORS should initially be given in small volumes (5 to 10 ml) every 5 minutes and gradually increased until the patient can drink normally. More than 90% of infants will tolerate an ORS if it is given gradually. If vomiting persists, ORS can be administered as a continuous drip by nasogastric intubation. Intravenous therapy is rarely required for patients with vomiting.

LIMITATIONS OF ORT

Oral rehydration solutions have limited usefulness in the situations described below.

Severe dehydration. In patients with severe dehydration, intravenous therapy should be used until the patient's blood pressure, pulse, state of consciousness, and ability to drink an ORS return to normal.

Glucose intolerance. Glucose intolerance for purposes of this discussion is defined as the presence of glucose or reducing substances in the stools, accompanied by a dramatic increase in stool output when ORS is administered. In patients with glucose intolerance, intravenous therapy should be used instead of ORT. However, the presence of glucose or reducing substances in the stools without other signs of glucose intolerance is not a contraindication for using ORS. In patients with a true glucose intolerance, the stool output is reduced immediately when ORT is replaced with intravenous therapy. The incidence of glucose intolerance during diarrheal episodes is approximately 1% in most populations. However, in one study from Peru[26] the incidence of glucose intolerance was 8%.

Vomiting. Although most patients who have vomiting as an initial symptom can successfully be treated with ORS, a few patients (less than 5%) have persistent vomiting in spite of the administration of ORS gradually by mouth or nasogastric drip. For these individual patients, intravenous fluids should be given until vomiting stops.

High stool output. An ORS can be used successfully in most infants if the stool output is less than 10 ml/kg per hour. The success rate is considerably lower if the rate of stool output is higher. In one study[34] the success rate was 15% when the stool output exceeded 15 ml/kg per hour, whereas it was more than 80% in patients whose stool output was less than 15 ml/kg per hour. In general, patients with a high stool output will be unable to maintain a positive fluid balance. When this occurs, intravenous fluids should be used until the stool output decreases and the patient is able to maintain a positive fluid balance with oral intake.

When intravenous fluid therapy is not available or possible, aggressive use of ORT can reduce deaths from 60% to less than 5% even in severe cholera. In diarrhea of lesser severity, early administration of ORT will be uniformly successful. It is always appropriate to begin ORT immediately in anyone with diarrhea regardless of severity.

PREPARATION, PACKAGING, AND DISTRIBUTION OF ORS

The advantage of distributing ORS premixed with water is that the solution will contain the intended concentration of electrolytes. In most developing countries, however, for financial and other logistic reasons, ORS is distributed in packets as a powder that must be mixed with an appropriate volume of water. In powdered form, ORS is relatively inexpensive, has a long shelf life, and is easier to transport than are premixed solutions. The major disadvantage of dispensing ORS in packets is the risk that the dry ingredients may be mixed with an inappropriate volume of water and that the ORS will therefore be too dilute or too concentrated.[35] Because such a solution could be dangerous when administered to infants, every effort should be made to ensure that the patients, parents, or guardians understand the instructions for preparing ORS.

To prepare ORS, one should use the cleanest available source of water. In areas where the water supply is usually contaminated, boiled, cooled water should be used. However, if the only available source of water is contaminated and cannot be boiled, the cleanest available water should be

Table III. Clinical assessment of the degree of dehydration

Degree	Clinical symptoms
Mild (5%-6%)	Watery diarrhea Increased thirst Slightly dry mucous membranes
Moderate (7%-9%)	Loss of skin turgor Sunken eyes Very dry mucous membranes Depressed anterior fontanelle
Severe (>9%)	Signs of moderate dehydration plus one or more of the following Rapid weak pulse Cold extremities Coma

used. Under no circumstances should ORT be withheld from an infant who is dehydrated and has ongoing diarrheal stool losses.

DEVELOPMENT OF A NEW ORS

The WHO-UNICEF solution presently agreed on is considered one of the most important medical advances of the twentieth century.[36] However, there are certain drawbacks. Most important, the solution in no way affects the duration or amount of diarrhea. For this reason, drugs are often used in place of ORS to reduce the severity and duration of disease. Previously it was recommended that neither food nor drink be given to victims of diarrhea to "rest the intestine."[37] Although diarrhea did, in fact, decrease as patients became even more dehydrated, this often led to vascular collapse and death. Thus the therapy cured the diarrhea but the patients died.

Can ORT be improved to reduce also the severity and duration of diarrhea? Observations on the simultaneous use of feeding with replacement fluids have indicated that patients fed immediately while being rehydrated have had less fluid loss and a shorter course of diarrhea.[38] It can be reasoned that if more carrier molecules could be introduced into the intestine without increasing the osmotic backward drag, absorption would be enhanced. Digestive enzymes, especially amylase and peptidase, are present in diarrhea, usually in excess.[39] Thus it would be expected that if glucose and proteins were provided as polymers, they could be degraded by amylase and proteases. Additional glucose and amino acids could be provided to the transporting sites on the intestinal epithelium without increasing luminal osmotic forces.[40] With this hypothesis in mind, studies[41, 42] were carried out in Dhaka and Calcutta with an ORS having the same electrolyte composition as the WHO-UNICEF solution but with glucose replaced by rice. These nutrient-based solutions markedly reduced vomiting, decreased diarrhea volume loss, and shortened the duration of disease.[41, 42] These observations have been replicated and enhanced by further studies of early feeding coupled with standard ORS.[43]

Cereals contain some protein, and the amino acids released during the digestive process may have enhanced the transport of sodium and intestinal fluids back into the circulation. In recent studies[44] both glycine, and to an even greater extent alanine, enhanced the performance of the perfusing solution. However, comparative studies of all possible amino acids and all possible independent cotransporting pathways have yet to be carried out. These will be necessary to define a protein or polypeptide of optimal amino acid composition for inclusion in an ORS. At present it is not possible to predict whether the current 40% to 50% improvement in duration and severity of diarrhea achieved by the cereal-based solutions can be further enhanced by the addition of proteins of an ideally tailored composition in an optimal amount. However, use of nutrients at an early stage, whether through feeding or through incorporation into ORS, seems strongly indicated in all instances of diarrhea studied.[45]

There are both advantages and disadvantages to the use of a cereal-based ORS. However, the advantages described above are important enough to warrant overcoming any disadvantages that may accrue from using food-based solutions. One disadvantage is that because cooking is required to prepare the solution, fuel, time, and effort on the part of the household or institution treating the patient are needed. In times of adversity, when fuel is often extremely scarce or unavailable, the use of cereal solutions would be virtually impossible. Another disadvantage is that the rich nutrient broth of an electrolyte cereal solution provides an ideal medium for the growth of bacteria. Hence the solution will become sour on contamination more rapidly than glucose solutions. On the other hand, an advantage is that since cooking and boiling are required, contaminated water would be purified by the cooking process.

Use of these solutions will be encouraged by making them palatable and by preparing them as a soup or a drink with a taste familiar to the patient. A disadvantage is that few people think of drinking several gallons of a homemade soup. Understanding the need for replacement of losses is as essential for food-based solutions as for glucose-based solutions. Each country has its own form of starchy foods, its own recipes for preparing them, and its own taste for saltiness in prepared dishes. Thus a great deal of heterogeneity exists, and each country or region needs to learn how

Table IV. Diarrhea treatment chart

Degree of dehydration	Signs*	Rehydration therapy (within 4 hr)	Replacement of stool losses	Maintenance therapy
Mild	Slightly dry buccal mucous membranes, increased thirst	ORS 50 ml/kg	10 ml/kg or ½ to 1 cup of ORS for each diarrheal stool	Human milk feeding, half-strength lactose containing milk or formula, undiluted lactose-free formula, juices
Moderate	Sunken eyes, sunken fontanelle, loss of skin turgor, dry buccal mucous membranes	ORS 100 ml/kg	Same as above	Same as above
Severe	Signs of moderate dehydration plus one of following: rapid thready pulse, cyanosis, rapid breathing, lethargy, coma	Intravenous fluids (Ringer lactate), 40 ml/kg/hr until pulse and state of consciousness return to normal; then 50 to 100 ml/kg of ORS	Same as above	Same as above

*If no signs of dehydration are present, rehydration therapy is not required. Proceed with maintenance therapy and replacement of stool losses. Infants and children who receive solid food may continue their usual diet.

to adapt food-based solutions from foods available in the household. Prepackaging nutrients with the correct quantity of salts has not yet been achieved commercially; however, there are many packaged dried-food products on the shelves of supermarkets in wealthy countries, and there would seem to be no major obstacles to manufacturing food-based ORS. The challenge is how to present the product and ensure that the correct amount of salts is added to the final solution.

IMPACT OF ORT ON MORTALITY RATES

Case fatality rates and hospital admission rates because of diarrhea can be reduced dramatically by the appropriate use of ORT. It has been much more difficult, however, to demonstrate the impact of ORT on reducing diarrhea-specific mortality rates in communitywide or countrywide diarrheal disease control programs. In a study from Bangladesh,[46] the diarrhea-specific mortality rate during a 2-year period in a village where ORS usage for diarrhea was high (80%) was compared with the mortality rate in a village where usage was low (38%). The diarrhea-specific mortality rate in the village with high ORS usage was 0.6% per 100,000 population, and the rate in the other village was 2.9 per 100,000 population. More recently, studies from Egypt[47, 48] have shown substantial reductions in mortality rates after diarrheal disease control programs based on ORT were introduced. Additional studies to evaluate the impact of introducing ORS in countrywide programs would be useful. Unfortunately, the surveillance systems available in many countries are not adequate to evaluate the impact of using ORT in national diarrheal disease programs.

RECOMMENDATIONS FOR MANAGEMENT OF ACUTE DIARRHEA

To treat patients with diarrhea appropriately, one must first clinically assess their degree of dehydration (Table III).

Fluid therapy for infants with signs of dehydration. The following three components should be included in fluid therapy: rehydration, maintenance, and replacement of ongoing stool losses (Table IV). During rehydration, the estimated fluid deficit should be clinically assessed and losses replaced. During the maintenance phase, the daily fluid requirements of the individual patient should be given. During the entire illness, ongoing diarrheal stool losses should be replaced. A solution similar in composition to the WHO ORS can be used during both the rehydration and maintenance phases. After rehydration, the ORS intake must be supplemented by water as desired or by a low-sodium fluid.

Rehydration phase. Patients who are mildly or moderately dehydrated should be given 50 ml/kg and 100 ml/kg, respectively, of ORS for a 4-hour period. If the patient is severely dehydrated, intravenous therapy (Ringer lactate or a similar solution) should be given at the rate of 40 ml/kg per hour until pulse, blood pressure, and state of consciousness return to normal. The patient should be reassessed for the degree of dehydration, and fluid therapy should be continued as in mild to moderate dehydration. The patient should be reassessed at the end of the rehydration period

(approximately 4 hours). If clinical signs of dehydration are still present, rehydration therapy should be repeated until dehydration is corrected.

Maintenance phase. For infants fed with human milk, demand feeding should be continued. For formula-fed infants, in countries where lactose-free infant formulas are available and affordable, 150 ml/kg per day of the formula should be given. In other countries, the milk consumed by the infant normally should be diluted 1:1 and administered in the same volume. For older children and adults, fluids normally consumed can be taken as desired.

Replacement of ongoing stool losses. Ongoing stool losses should be replaced on a 1:1 basis with ORS. If the stool output is not known, approximately 10 ml/kg or ½ to 1 cup of ORS should be given for each diarrheal stool.

Fluid therapy for infants with no clinical signs of dehydration. These infants do not need rehydration therapy. They should, however, receive the same fluids recommended for patients with signs of dehydration for the maintenance phase and for ongoing stool losses.

CONCLUSIONS

Although ORT is a powerful tool for combating diarrhea, death from diarrhea remains common in many countries. The major obstacle to the successful implementation of ORT programs in many developing countries is the lack of necessary resources and of an infrastructure to distribute the ORS. It is estimated by WHO that, among infants with diarrhea, only 60% have access to ORT and that ORT is used in fewer than 20% of episodes.

In the past 30 years the scientific community has made vast strides in developing powerful and simple forms of therapy for diarrhea. Government leaders and medical communities have implemented national diarrheal disease control programs for the prevention of diarrheal deaths and morbidity. However, our task has by no means been completed. Millions of infants die every year unnecessarily, and many more suffer adverse nutritional consequences because of diarrhea. The challenge for the future is to ensure that we in the medical community transfer our knowledge in practical, understandable terms to mothers of infants around the world. If the individual mother becomes an active partner with the health care system to ensure optimal care for her child, these unnecessary deaths will be averted.

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