The 1982–1983 report by the United Nations Children's Fund (UNICEF) on the State of the World's Children recommended widespread implementation of oral rehydration as one of the four strategies projected to save the lives of 20,000 children each day.¹ In the developing countries, oral rehydration has been shown to be an effective, simple, and inexpensive therapy for dehydration caused by severe enteritis in infants.²⁻⁸ The modern concepts of oral fluid therapy for diarrheal diseases evolved in part from the clinical observation that orally administered glucose-electrolyte solutions can replace diarrheal fluid losses in cholera. Previous laboratory investigation had demonstrated the presence of a cotransport system of sodium with glucose or other actively transported small organic molecules in the small intestine in animals and in man. Clinical studies suggest that this sodium-glucose cotransport system remains intact not only when the pathophysiologic agent is an enterotoxin, such as that elaborated by Vibrio cholerae or enterotoxigenic strains of Escherichia coli, but also with inflammation such as that associated with rotavirus, Campylobacter jejuni, and Yersinia enterocolitica.⁴⁻⁸ These observations have provided a physiologic rationale for an appropriately efficient ratio of sodium to glucose in formulating solutions to be used in the developing countries for oral therapy in the treatment of infants with life-threatening diarrheal dehydration.

The question we address in this commentary is that of the appropriate implementation of oral hydration therapy in a developed country. Pediatricians and others concerned with the health of children in this country are not usually confronted with the problem of obtaining uncontaminated water nor with the management of large numbers of severely malnourished young infants with multiple health problems. Our usual problem is the management of mild, moderate, and (less frequently) severe diarrheal dehydration in an otherwise normal infant. The outstanding presenting complaints are often decreased intake of food and fluid and the presence of vomiting. The goal of our management is to support the infants (and their parents) over the two to three days of acute illness and avoid complications that might result from dehydration or from the measures to prevent dehydration. Pediatricians in this country are very sensitive to the possibility that the infants under their supervision might develop hypernatremic dehydration as a consequence of decreased fluid intake or as a result of the administration of inappropriate fluids.⁹⁻¹⁵ Pediatricians are also concerned with the cost of hospital care of infants and the potential complications of "hospitalization" and parenteral fluid therapy per se.

With the foregoing points in mind, the following recommendations for oral fluid therapy seem sound for a "developed" country. The recommendations are for patients of all ages, but in the older patient (those with weight greater than 10 kg), allowance should be made for lower maintenance water requirements per kilogram of body weight. The composition and the indications for use of two types of oral solutions are shown in the Table.

The World Health Organization's oral rehydration solution (WHO-ORS) is an exceedingly useful product, which has probably saved the lives of many thousands of children.¹⁶ The solution, containing 90 mEq/L of sodium, is appropriate for rapid rehydration of dehydrated infants—regardless of the initial osmolality of the infant's body fluids. However, this solution alone is not suitable for provision of water and solute for maintaining fluid balance
TABLE. Recommendations for Use of Oral Solutions in Treatment of Pediatric Patients with Gastrointestinal Fluid Losses

<table>
<thead>
<tr>
<th></th>
<th>Rehydration Solution</th>
<th>Maintenance Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indication for use</td>
<td>Treatment of acute dehydration (extracellular volume contraction)</td>
<td>Prevention of dehydration caused by diarrhea or maintenance of hydration after treatment of dehydration</td>
</tr>
<tr>
<td>Composition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>75–90 mEq/L</td>
<td>40–60 mEq/L</td>
</tr>
<tr>
<td>Potassium</td>
<td>20 mEq/L</td>
<td>20 mEq/L</td>
</tr>
<tr>
<td>Anions</td>
<td>20%–30% of anions as base (acetate, lactate, citrate, or bicarbonate); remainder as chloride</td>
<td>20%–30% of anions as base (acetate, lactate, citrate, or bicarbonate); remainder as chloride</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>Glucose: 2.0%–2.5% (110–140 mM/L)</td>
<td>Glucose: 2.0%–2.5% (110–140 mM/L)</td>
</tr>
<tr>
<td>Administration</td>
<td>Volume given to equal estimated fluid deficit; usually 40–50 mL/kg to be given over about 4 h; reevaluate clinical status and therapy after 3–4 h</td>
<td>Daily volume should not exceed 150 mL/kg/24 h; if additional fluid is needed to satisfy thirst, a low-solute fluid such as water or breast milk should be used</td>
</tr>
</tbody>
</table>

in the infant with ongoing losses of fluids from the gastrointestinal tract nor are other solutions with sodium concentrations of 75 to 90 mEq/L suitable alone for meeting maintenance water requirements.

ORAL REHYDRATION SOLUTIONS

Oral rehydration solutions with sodium concentrations ranging from 75 to 90 mEq/L and other components are shown in the Table. It is preferable to use a prepared solution containing 40 to 60 mEq/L of sodium for the prevention of dehydration in the infant with ongoing gastrointestinal losses (the infant may or may not have required initial rehydration). The WHO-ORS preparation or other oral rehydration solutions used to treat acute dehydration may be used for this second phase of rehydration by giving the solution alternately on a 1:1 basis with a no-sodium or low-sodium fluid such as water, low-carbohydrate juices, or breast milk. ORS (oral rehydration solution) or similar fluids should not be used as the sole fluid intake. If breast milk is used with an oral rehydrating solution, breast-feeding may be given ad libitum to satisfy thirst and for hunger. The oral rehydration solution may be alternated with breast milk or given after two or more periods of breast-feeding. The volume of the 75 to 90 mEq/L rehydrating solution ingested should not exceed 75 mL/kg/24 h. The same caveat concerning carbohydrate concentration of the early phase applies in the recovery period as well.

PACKAGING

To ensure proper composition of the final solution, a premixed oral solution is preferred to a powder that must be diluted by the person caring for the child. Home mixing is fraught with hazards of inaccurate dilution, variation in sodium content because of the use of various methods of water softening, and, in some areas, contamination. However, the powder form has the advantages of longer shelf-life, reduced bulk for shipping and storage, convenience, and inherently lower cost. Therefore, although the prediluted electrolyte solution is preferable to the powder form, the latter is acceptable if distributed with a container of the appropriate
volume and if the physician is confident that the powder will be properly diluted.

REINTRODUCTION TO FOOD

The predominant teaching in this country has admonished a delay in the reintroduction of usual feedings in an infant recovering from acute gastroenteritis. In hospitalized patients receiving intravenous hydration, the infant's bowel has often been permitted to "remain at rest" for 24 to 48 hours, and suboptimal nutrition or actual starvation has been permitted to continue for several more days because of the persistence or recurrence of loose stools. Recognition of the deleterious effects of starvation, especially in the poorly nourished infant, has led some to urge the early introduction of parenteral nutritional support. Many pediatricians in this country now question the value of withholding usual feedings for any significant period once acute dehydration has been corrected.

There are many opinions but few data on which to base recommendations for reintroduction of food in the diet of infants recovering from acute diarrhea. There is no doubt that the ingestion of food increases fecal volume during the recovery period. The question is whether the infant benefits with a net nutritional gain in spite of increases in the losses. There are actually two separate issues here; the replacement of fluid and electrolytes so dehydration and the associated complications do not recur, and the provision of adequate nutrition.

There is general agreement that usual foods, including milk and formula, should be withheld if there is significant dehydration, severe vomiting, or marked gastric or intestinal distension. Clinical experience suggests that breast milk is often well tolerated when other foods are not, although the reason for this is not clear. There are two areas of concern with the early reintroduction of cow's milk or formula feeding, other than increased vomiting and stool losses. The first relates to observations showing that the absorption of macromolecules and whole protein may be great in the infant recovering from acute enteritis. The immunologic and clinical significance of this is not known. The second area of concern centers on the occurrence of carbohydrate intolerance after acute enteritis. The incidence and clinical significance of transient disaccharide intolerance after diarrhea is not known. When clinically evident as a problem for a specific patient, the offending carbohydrate should be avoided. The current data do not suggest that lactose should be "routinely eliminated" from the diet of infants recovering from diarrhea, although some experienced clinicians do make this recommendation.

Here, as in most areas in which quality health care is the goal, individualized management of the patient is the key. Attention should be focused on the clinical state of hydration and on nutrition once acute dehydration is corrected. "Stool watching" per se should not guide management. A reasonable approach to the reintroduction of food is that in the absence of a specific contraindication, the reintroduction of feeding should not be delayed more than 24 hours in the infant with acute diarrhea. Human milk may be introduced as such, but formula or milk feeding should be reintroduced gradually by starting with dilute mixtures. The older infant or child might be offered rice cereal, bananas, potatoes, or other nonlactose carbohydrate-rich food shortly after successful rehydration. Regardless, the infants must be followed closely in order to detect dehydration since this appears to impair the tolerance for food and may contribute to the development of a chronic illness.

ACKNOWLEDGMENTS

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REFERENCES

ANNOUNCEMENT OF THE 1985 PEDIATRIC CARDIOLOGY IN-TRAINING EXAMINATION

The Sub-Board of Pediatric Cardiology of the American Board of Pediatrics will offer an in-training examination to residents, fellows, and interested physicians on Wednesday, July 24, 1985. The purpose of this examination is to allow future candidates for the cardiology certifying examination to familiarize themselves with the general content and complexity of the questions used and, for those physicians in practice, to use this as a self-assessment exercise.

The examination will be offered only at those institutions in which the pediatric cardiology program director agrees to monitor the examination. The starting time of the examination will be at the program director’s discretion.

Residents and fellows should express their interest in taking this examination to their pediatric cardiology program director. Physicians in practice should contact the pediatric cardiology program director at the institution closest to them, or contact the Board office for information as to what institutions have agreed to administer the examination.

The registration period for this examination will begin May 1, 1985 and continue through June 15, 1985. The fee is $60 per candidate, to be submitted with the program director’s registration form. Checks should be made payable to the American Board of Pediatrics (US funds only).

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