ANNOTATED
BIBLIOGRAPHY ON
COMPOSITION OF
ORAL REHYDRATION
SOLUTIONS
SPECIALIZED BIBLIOGRAPHY SERIES

No. 1 Annotated Bibliography on Nutrient Absorption and Diarrhoea - Malnutrition Cycle

No. 2 Annotated Bibliography on Oral Rehydration Therapy

No. 3 Annotated Bibliography on Composition of Oral Rehydration Solutions
Specialized Bibliography Series No. 3

COMPOSITION OF ORAL REHYDRATION SOLUTIONS

INTERNATIONAL CENTRE FOR DIARRHOEAL DISEASE RESEARCH, BANGLADESH
DHAKA, BANGLADESH

March 1985
EDITOR-IN-CHIEF: Dr A M Molla

ABBESTOR: Iftekharul Islam

SCIENTIFIC EDITOR: Naomi Rock Novak, Arifuzzaman Khan

MANAGING EDITOR: M S I Khan

COMPILATION AND DOCUMENTATION: M S I Khan, Iftekharul Islam, M A Matin and M A Chowdhury

PRODUCTION: Cover design: A Ansari Publication and printing: H S Ahmed and M N Huda

Manuscript typing: M M Hassan

SUBSCRIPTION INFORMATION

Subscriptions to the Specialized Bibliography Series are for 3 issues only, and include surface mail postage (book post). For airmail add 20% (Asian countries) or 30% (other countries) to the total cost.

Institution: Developed countries US $ 50.00 Developing countries US $ 40.00 Bangladesh Tk 75.00

Personal: Developed countries US $ 40.00 Developing countries US $ 30.00 Bangladesh Tk 60.00

Single copy: Developed countries US $ 17.00; Developing countries US $ 13.00; Bangladesh Tk 25.00

DISC members may subscribe directly at 50% discount. Subscription orders may be placed through an agent (agency commission 10%) or directly with the International Centre for Diarrhoeal Disease Research, Bangladesh, G P O Box 128, Dhaka 2, Bangladesh. All payments must be made in favour of "International Centre for Diarrhoeal Disease Research, Bangladesh". All correspondence regarding subscriptions should be addressed to: Managing Editor, Specialized Bibliography Series.

Copyright © 1985

International Centre for Diarrhoeal Disease Research, Bangladesh
G P O Box 128, Dhaka 2, Bangladesh

Cable: Cholera Dhaka; Telex: 65612 ICOD BJ
Telephone: 600171-600178 (PABX)

Printed by Printwell (Pvt.) Limited in Dhaka, Bangladesh
The Specialized Bibliography Series is part of the larger effort to establish an
information exchange network in the field of diarrhoeal diseases research—an
effort being carried out by the International Diarrhoeal Disease Information Ser-
vice and Documentation Centre (DISC), run by the ICDDR,B. The first bibliography
of the Series was on nutrient absorption and diarrhoea-malnutrition cycle, and
the second one on oral rehydration therapy. The present issue, the third of the
Series, includes 93 papers (54 abstracted) on composition of oral rehydration
solutions. Attempts were made to cover the major controversies regarding electro-
lyte composition and the carrier media used in ORS. This is a subject of current
importance, and the reason for selecting the topic is explained in the Introduction
by Dr A M Molla, an ICDDR,B scientist. A number of bibliographies under this
Series, covering other currently important topics within the field of diarrhoeal
diseases, are under preparation; and will be published shortly.

This is not an exhaustive bibliography on the topic. The bibliography was compiled
from our limited resources, and inadvertent omissions may have occurred.

We believe this bibliography will contribute towards generating greater interest
and awareness in this field, and will facilitate user access to knowledge of the
problems. Copies of articles abstracted here are available from DISC to interested
persons/organizations. We will consider this attempt successful if the bibliogra-
phy helps diarrhoeal disease researchers and practitioners. Suggestions for
improvement of a future edition will be appreciated.

K M S Aziz, PhD
CONTENTS

Introduction       i
User's guide       iii
Bibliography       1
Subject Section
  Electrolytes    1
  Carrier Molecules  4
Author Section    8
INTRODUCTION

The direct and immediate effect of acute diarrhoea is loss of water and electrolytes through stool, causing dehydration. Treatment of dehydration is simple; it involves the replacement of the loss with adequate amount of fluid in appropriate composition. In the beginning this was done by intravenous fluid, the discovery of which took many years of research endeavor by scientists. Further research has made this replacement therapy simpler by discovering an oral rehydration solution (ORS). Scientific merit of this simple therapy has made it important in the management of diarrhoea. Controversy, however, remains; and research therefore continues, with the objective of improving the ORS further. The objective of this bibliography is to surface the major controversies and highlight their importance in the management of diarrhoea.

The major ORS controversies are on electrolyte composition and the carrier media or substrate for carrying sodium and water from the intestinal lumen into the blood stream. The primary point of dispute is the level of sodium per liter of ORS. WHO/UNICEF recommends 90 mmol sodium per liter. Pediatricians in the developed countries as well as some of those of the developing countries apprehend this to be too high, particularly in young healthy infants who suffer from non-cholera diarrhoea where sodium loss is not as high as that amount. Some have used 60 mmol of sodium per liter and others even less, claiming equally effective rehydration without complications. Besides, an immature kidney may fail to get rid of the extra load of sodium quickly enough, giving rise to hypernatremia.

Stool potassium loss, on the contrary, in children with diarrhoea of any etiology is higher than 20 mmol/L as contained in the WHO/UNICEF ORS. Malnourished children in the developing countries are severely potassium depleted. Hypokalemia can influence nutrient intake during and after recovery from diarrhoea. Therefore, further research is needed in regard to optimum concentration of both sodium and potassium in the ORS.

Sodibicarb in the ORS packets, caramelizes after being in ambient temperature for a few months, thus limiting the shelf life. Sodium citrate, on the other hand, is equally effective in correcting acidosis, and has a longer shelf life. WHO has already recommended this. Some investigators have claimed reduction in stool output by using citrate while others could not prove this conclusively. Further research is needed to study the role of citrate specially in the management of dehydration in acute cholera.

One of the major areas of interest and scientific controversy is the substrate or carrier molecule of the ORS. Glucose has been replaced by sucrose without losing ORS efficacy. This has reduced cost and brought ORS closer to communities and households. Use of molasses with common salt further simplified ORS with minimum loss of efficacy. The main advantage of having a simple substrate in ORS is to bring diarrhoea treatment to the doorstep of the target population, the mother and the child in rural areas. Substantial achievement in this respect is the introduction of cereal (rice) in the ORS as a substitute of glucose. It is readily available, acceptable, inexpensive and more effective. Technology for its preparation is simple and it brings diarrhoea therapy to the home of the mother.
However, one must see these controversies from the planners point of view. It will be impossible for the health delivery agencies to advocate or deliver ORS packets of different kinds. But at the same time it is also true that until now only about 10% of the total diarrhoea episodes in the world have been covered by packets. It is highly unlikely that any of the developing countries can produce and distribute adequate number of packets to cover all diarrhoeal episodes. Home-made ORS prepared with the ingredients available in the kitchen of the mother must receive attention and this will in no way hinder the progress and preparation of the standard ORS packets.

Therefore, further research is needed to ensure that child mortality due to diarrhoeal diseases is reduced to an absolute minimum. This bibliography will be considered a success if it helps the scientists assess the present knowledge on ORT and plan research priorities in the desired direction.

A M Molla, PhD
The Specialized Bibliography Series includes papers and publications -- current as well as back materials -- from sources worldwide.

The bibliography is divided into subject and author sections. In the subject section, citations are arranged alphabetically by first author under two headings. The sequential number in the subject section sometimes is followed by a sign ($$), indicating that an abstract of the cited paper appears in the author section.

The author section contains citations arranged alphabetically by first author and then by paper title. Co-authors' names also appear in alphabetical order along with a cross-reference to the first author (e.g. Agarwal SK see Chatterjee A). This will facilitate a search by co-authors' names.

Efforts have been made to present abstracts with all available information regarding the study's nature and objective, methods used, and major findings and conclusions.

The bibliography is in English. A title in parentheses indicates that the paper is in another language.
COMPOSITION OF ORAL REHYDRATION SOLUTIONS

ELECTROLYTES


§ indicates an abstract appears with the citation in the author section.
Composition of ORS


022 § Islam MR, Bardhan PK, Rahman MM. A comparison of oral replacement solutions containing sodium in concentrations of 120 m mols/L and 60 m mols/L in pediatric diarrhoea. Indian J Pediatr 1982 May-Jun;49(398):349-55


Composition of ORS


034 Nalin DR, Cash RA, Rahman M. Oral (or nasogastric) maintenance therapy for cholera patients in all age-groups. Bull WHO 1970;43(3):361-3


037 Pichaiapat V, Yangkratok S, Varavithya W. Oral rehydration with three different electrolyte solutions. Siriraj Hosp Gaz 1979;31:1413


040 Recommendations on the composition of oral rehydration solution (of the)


Composition of ORS


047 Wendland BE, Arbus GS. Oral fluid therapy: sodium and potassium content and osmolality of some commercial "clear" soups, juices and beverages. Can Med Assoc J 1979 Sep 8;121(5):564-71


CARRIER MOLECULES


053 Bywater TJ, Woode GN. Oral fluid replacement by a glucose glycine electrolyte formulation in E. coli and rotavirus diarrhoea in pigs. Vet Rec 1980; 106:75-7


Composition of ORS


065 § Mahalanabis D, Patra FC. In search of a super oral rehydration solution: can optimum use of organic solute-mediated sodium absorption lead to the development of an absorption promoting drug? J Diar Dis Res 1983 Jun;1(2):76-81


Composition of ORS


073 § Nalin DR, Cash RA, Rahman M, Yunus M. Effect of glycine and glucose on sodium and water absorption in patients with cholera. Gut 1970 Sep;11(9):768-72


082 § Rahilly PM, Shephard R, Challis D, Walker-Smith JA, Manly J. Clinical comparison between glucose and sucrose additions to a basic electrolyte mixture in the outpatient management of acute gastroenteritis in children. Arch Dis Child 1976 Feb;51(2):152-4
Composition of ORS


085 Sandhu BK, Jones BJ, Brook CG, Silk DB. Oral rehydration in acute infantile diarrhoea with a glucose-polymer electrolyte solution. Arch Dis Child 1982 Feb;57(2):152-4


Composition of ORS

AUTHOR SECTION


Agarwal SK see Chatterjee A

Ahmed SM see Islam MR

Akierman A see Nalin DR

Aleman E see Clements ML

Ali A see Islam MR

Ali MA see Sack DA

Antoine M see Nalin DR

Arbus GS see Wendland BE

Arora NK see Deorari AK

Assaee M see Saberi MS

Bachtin M see Moenginah PA

Bagchi DK see Chatterjee A

Banerjee P see Patra FC

Bardhan PK see Islam MR


Berry RJ see Dibley M

Bhan MK see Deorari AK

A controlled, randomized study was conducted in 65 male infants aged under 3 months, hospitalized with acute noncholera dehydrating diarrhoea. The study compared the efficacy and safety of standard WHO-ORS containing 90 mmol/L Na (group A: 22 infants) with that of an ORS containing 60 mmol/L Na (group B: 22 infants) and with standard I.V. therapy (group C: 21 infants). None of the 44 infants in groups A and B required I.V. Dehydration, acidosis, and initial hyponatremia or hypokalemia were corrected with equal efficacy in all 3 groups. In the critical first 8 h, mean Na absorption was significantly higher (p<0.01) in group A. This resulted in hypernatremia (50%), periorbital edema (50%), mild pedal edema (27%), excessive irritability, and convulsions (4.5%). Mean serum sodium levels at 0, 24, and even 48 h were significantly higher (p<0.05) than those in groups B and C. The urinary output was similar in all the groups, while the urinary Na excretion in group A was significantly higher (p<0.05) than that in groups B and C. The study demonstrated that ORS with 60 mmol/L Na is as safe and effective as I.V. for the management of mild to moderate dehydration due to non-cholera diarrhoea in neonates and infants aged below 3 months.


In a double-blind sequential trial of 784 children with rotavirus-associated diarrhoea treated in the Matlab Treatment Centre of the International Centre for Diarrhoeal Disease Research, Bangladesh the use of oral rehydration solutions containing essential electrolytes with either glucose (GORS) or sucrose (SORS) of equal osmolality was compared. The GORS and SORS groups were equally matched by age, sex, frequency of vomiting, duration of diarrhoea and vomiting before hospitalization, admission specific gravity, frequency of other pathogens in their stools, and nutritional status. The oral fluid failure rate was 11.5% for the SORS and 7.3% for the GORS group (a non-significant difference). Vomiting was a significantly more common cause of failure for the SORS group (1 in GORS and 12 in SORS group) and was associated with an increased rate of intake of the sweeter SORS. There was no difference in the purging rate of the 2 groups. The oral fluid failure rates for children in the most underweight category (60% of expected weight for age) were not different from those for other groups, although as assessed by purging rate and initial dehydration, the stool losses of members of this group constituted a greater proportion of body weight. It was indicated that sucrose can be substituted for glucose in oral rehydration treatment solution with only a minimum loss of efficacy. On the basis of some factors, including cost and availability of ingredients and comparative efficacy, it was suggested that although glucose is preferred, sucrose can as well be used in an oral solution which is safe and effective for the treatment of diarrhoea.


Black RE see Clements ML

Black RE see Levine MM

Black RE see Sack DA

Composition of ORS

The composition of ORS is reevaluated in the light of recently published data, and a single multipurpose ORS formula is recommended. The article also summarizes the rationale for oral rehydration therapy, some practical aspects of administration, and the likely future role of this form of management of acute diarrhoea.

Brook CG see Sandhu BK
Brook KH see Sack DA
Bywater RJ, Woode GN. Oral fluid replacement by a glucose glycine electrolyte formulation in E. coli and rotavirus diarrhoea in pigs. Vet Rec 1980;106:75-7

Caceres M see Clements ML
Candy DCA see Tripp JH
Carrera E see Santosham M

Since the maximum effective glucose concentration in ORS appears to be 110-160 mmol/L, other ingredients were looked for which might be used as an additional ORS substrate. This study determines whether glycine -- an inexpensive, widely available amino acid -- would be absorbed and enhance sodium and water absorption in cholera. Patients hospitalized in Dhaka, Bangladesh were divided into different study groups, to receive ORS with glucose (110 mmol/L) or glycine (110 mmol/L), or both. Two control groups received I.V. alone or a plain ORS without glucose or glycine. All groups were comparable in age, sex, weight and disease severity. Patients treated with ORS containing either glucose, glycine, or a combination of the two had an equally effective response, and required substantially (70%-80%) less I.V. compared to the I.V. group. The plain ORS group failed to absorb much fluid, and required more I.V. Glycine absorption was evidenced by a sharp rise in blood urea nitrogen after the start of ORT in all patients receiving glycine. This elevated blood urea nitrogen did not occur in patients who received plain ORS. The stooling duration was shortest in the combined glucose-glycine ORS group. This may indicate greater absorption of the combined solution.

Cash RA see Hirschhorn N
Cash RA see Nalin DR
Challis D see Rahilly PM


The efficacy of a sucrose-based ORS in treating children with severe to moderate
Composition of ORS

dehydration due to acute diarrhoea was studied. The study also analyzed the effect of a temporary sucrose depression in small bowel mucosa during acute diarrhoea in the undernourished. Stool examinations of 20 consecutive children (10 male) aged 3 months to 4 years showed non-enteropathogenic Escherichia coli (9), Klebsiella (5), Vibrio cholerae El Tor (1) and non-agglutinable vibrio (2). The remaining 3 showed usual mixed fecal flora. Malnutrition was severe in 5, moderate in 6 and mild in another 6. The sucrose-ORS brought about complete hydration in 19 children. One child did not respond and needed I.V. Vomiting, abdominal distension, and appearance of sugar in stools during oral rehydration did not interfere with its success. A satisfactory response was shown by weight gain (mean ± S.E. = 9.2 ± 0.6%), restoration of plasma-bicarbonate to normal levels, fall in hematocrit values and in plasma-specific gravity, and complete clinical recovery. Jejunal mucosa biopsy specimens in the acute phase showed reduced lactase in 75% and reduced sucrase in 18%; maltase levels were adequate. Except for the child who did not respond, all showed a satisfactory rise in blood sugar after sucrose and glucose tolerance tests. Thus, a sucrose-based ORS is as effective as one with glucose. Since sucrose is cheap and easily available, its use instead of glucose in ORS would be a con-
siderable gain.


The paper describes the controlled trial of an oral glucose-electrolyte solution designed on the basis of optimum pathophysiological needs for rehydration in infantile diarrhoea. Infants and children aged 4 months to 4 years hospitalized with acute diarrhoea and moderate to severe dehydration were studied. The solution (50 mmol/L sodium) was tried in a group of 20 infants, which was compared with a matched group of 19 infants, predominantly under age 2, taking a standard WHO/ UNICEF oral solution with 90 mmol/L sodium. The solutions were given by intraga-
stric drip initially, after gastric aspiration. All children in both groups were successfully hydrated and none required intravenous therapy. The group treated with high sodium standard solution showed a trend towards developing hypernatremia and/or periorbital edema more frequently than did the other group, although the difference was not significant. In addition, the low sodium solution eliminated the need for additional free water orally, thus rendering treatment much easier. The authors suggest caution in using high sodium oral hydration solutions in infants under age 2.

Cherchit L see Varavithya W

Chintu C see Raghu MB

Choudhury AK see Islam MR

Chowdhury AKMA see Sack DA

Cleary KR see Cleary TG


ORS conforming to the WHO formula was used in hypernatremic dehydration in a con-

11
Composition of ORS

trolled setting -- to determine the risk of hypernatremia during unsupervised ORS use, and to look for a relationship between etiologic agents and hypernatremia. In June 1980, 100 infants (54 males) aged below 1 year were hospitalized in Cairo, Egypt, with dehydration secondary to diarrhoea. On admission, 17% were hypernatremic (serum Na⁺ > 150 mEq/L), 27% were hyponatremic (serum Na⁺ < 130 mEq/L), and 56% were isonatremic. Hypernatremic infants were more dehydrated (9.6 ± 2.5%) than were either isonatremic (7.1 ± 3.7%, p<0.02), or hyponatremic (6.4 ± 3.6%, p<0.05) infants. Most hypernatremic (94%) and fewer hyponatremic (57%) and isonatremic (76%) infants were well-nourished (p<0.05 by x² analysis). Relative frequency of potential pathogens was unrelated to initial serum sodium. More hypernatremic (24%) than non-hypernatremic (5%) infants had taken ORS (p=0.03 by Fisher exact test). Of the 17 hypernatremic infants, 16 completed the ORS course, and of these 16, one developed a brief focal seizure after 24 h therapy. This infant and all others appeared neurologically normal on discharge. Ten (63%) hypernatremic infants had normal serum sodium by 6 h of therapy, and 15 (94%) by h. Fifteen infants, therefore, were discharged after 24 h therapy, and the remaining one required 48 h oral therapy to become normal. Fluid intake was most brisk during the first hour, with a decline during the second and third hours, and a plateau thereafter. The results were identical to those in rabbits in an earlier study. Homeostatic mechanisms are more efficient and safe, than when fluids are given intravenously at an arbitrarily-chosen rate.

Cleaves F see Levine MM


Clements ML see Levine MM


Commenting on an earlier paper on use of ORS in diarrhoea, the letter states that even in developing countries, hypernatremic dehydration can occur, even in the absence of overt fluid loss in artificially-fed infants among emerging urban elites.

The authors say it is unwise to extrapolate to infants and to non-cholera diarrhoea patients in general ORS results based mainly on studies in adults with cholera. They conclude that it is unacceptable to use a single high sodium formula ORS for pediatric patients; and that a low osmolar solution, containing 60-70 mmol/L sodium, should be used to treat non-cholera diarrhoea in children, until further studies are done on the optimal electrolyte concentration(s) of ORS.

Cox DL see Erasmus PS


The pathophysiology of acute diarrhoea and dehydration, along with the practical application of ORT are discussed. The main danger of acute diarrhoea is the loss of body water and electrolytes. The scientific rationale for ORT depends on small
Composition of ORS

Bowel enterocytes' function. Recent studies have indicated that active secretion rather than a failure of absorption is the main mechanism for most acute cases. The linked absorption of sodium and a substrate (e.g. glucose) greatly enhances water and electrolyte uptake in the intestine. Sophisticated absorption/secretion balance studies, particularly in cholera patients, showed that the mechanisms for sodium and water absorption remain essentially intact. A suitable rehydration mixture depends on: the physiology of absorption mechanism, the chemical composition of fluid secreted in the particular type of diarrhoea, and on practical factors relating to cost and availability of ingredients. A single ORT formula is convenient and effective. The rewards of successful ORT application is likely to be great, because it counters two major problems: the malignant synergism of diarrhoea, and malnutrition. Thus, ORT is an appropriate primary health care technique for use in early acute diarrhoea.

Daral TS see Bhargava SK


This paper discusses briefly the development, composition, limitations and advantages of WHO-recommended ORS (3.5 g NaCl, 1.5 g KCl, 2.5 g NaHCO3 and 20 g glucose in 1 liter of water). This solution's sodium concentration was found ideal, for several reasons enumerated. The paper also describes the problems encountered during oral rehydration therapy and ways to solve them. The authors conclude that all but a small percentage of patients with dehydration and diarrhoea can be treated solely with ORS.

de Cespedes C see Nalin DR


The safety of two oral rehydration solutions containing respectively, 60 and 90 mEq/l of sodium, was evaluated in children with mild-to-moderate dehydration secondary to non-cholera diarrhoea. Fifty patients, (39 males and 11 females) aged below 5 years and hospitalized between March 1981 and June 1982, were divided into two groups. One patient (3.7%) in the high sodium group developed hypernatremia (serum sodium 155 mEq/l at 8 h, 160 mEq/l at 24 h, and 145 mEq/l at 36 h after initiation of therapy). However, the risk of hypernatremia and hyponatremia in the two groups did not differ significantly. Five (10.2%) patients, all malnourished, had hypokalemia (K+ < 3 mEq/l) prior to rehydration. While serum potassium became normal in these patients, three other patients (6.1%) showed hypokalemia 24 h after ORS was begun. It was concluded that, while ORS formulas containing both 90 mEq/l and 60 mEq/l of sodium are safe, an increase in potassium concentration needs to be considered, particularly in developing countries where malnutrition is common.

Desphande A see Raghu MB

Composition of ORS

The osmolalities and sodium, potassium and sugar contents of various commercial and home-made clear fluid preparations were analyzed to allow physicians to evaluate their therapeutic usefulness in diarrhoea treatment. Analysis of 91 commercial and home-made clear fluids, including carbonated beverages, cordials, powdered drinks, jellies, fruit juices, fruit juice drinks, syrups and soups showed a range of 0-175 mmol/L of Na, 0-52.1 mmol/L of K, 0-839 mmol/L of reducing sugars and an osmolality of 50-914 mmol/kg water. Home-made ORS prepared by groups of mothers and medical staff members also showed an unacceptably wide compositional range in terms of constituent proportions. The composition of products specifically indicated for diarrhoea treatment was also remarkably diverse with a range of 24-100 mmol/L of Na, 14.2-21.0 mmol/L of K, 45-326 mmol/L of glucose, and 170 to 460 mmol/kg water osmolality. The Na levels of the glucose-electrolyte solutions differed significantly from the sugar recipe solution ($X^2=15.1; p<0.005$). Based on current knowledge of water and electrolyte absorption, neither the commercial clear fluids nor the home-made solutions can be recommended for diarrhoea treatment. Of the therapeutic products, only the UNICEF-ORS had been subjected to clinical trials and found safe and effective. However, the formulation of "Dialyte" also appears appropriate for the treatment of mild diarrhoeal dehydration.

Dodge JA see Price HV
DuPont HL see Cleary TG
Dutta B see Chatterjee A

El-Malih GS see Cleary TG


To maximize water and electrolyte absorption in dehydrated children, an ORS Formula should approximate closely the WHO recommendations: (1 mmol/L) glucose 110 or sucrose 210, Na+ 90, K+ 20, Cl- 80 and HCO3 30. The study compares the composition of home-made salt-sugar solutions prepared by 44 Jamaican mothers according to current health training methods, and solutions prepared with a double-ended spoon. Solutions containing sucrose, syrup, dark sugar, glucose, or plain sugar and salt were popular. Several mothers had flavored solutions with lime or orange, and in most cases the solutions were prepared according to taste. Of the 13 mothers who used salt-sugar solutions, 6 had obtained their information from radio and 3 from a doctor. Analysis of 22 home-made samples showed that glucose solutions had a very high mean osmolality (mean 1,216 mosm/L), while sucrose solutions had a lower (mean 809). 5 of 7 salt-sugar solutions, Na+ exceeded 150 mmol/L and the solutions were hyperosmolar (mean 844 mosm/L). When the mothers used double-ended spoons, 6 samples had a satisfactory osmolality (less than 300 mmol/L), and only one was slightly raised. Four orange-flavored samples had K+ more than 10 mmol/L, whereas the lime/mint tea solutions had less than 5 mmol/L of K+. The mothers' estimate of fluid volume given in 24 h varied widely, from 2,280 ml (36 mmol Na) for a 13-year-old, to 176 ml (21 mmol Na) for an 8-year-old. The results confirm that home-made ORS often has a dangerous composition. The double-ended spoon is an effective method of improving precision. However, the type of sugar used is
Composition of ORS

important. For example, a single spoonful of semi-refined dark-sugar yields a concentration of only 1-2%, and to attain the desired sucrose concentration, 4 teaspoons of dark sugar were needed. Likewise, the osmolality of the glucose-water solution was especially high, because Jamaicans like things very sweet. Since glucose is not as sweet as sucrose, much larger amounts of glucose were used. Glucose provides double the amount of osmoles per unit weight. Thus extremely high osmolalities are produced when solutions are prepared to taste. It was concluded that short, concereted messages, giving a standard regimen for home treatment, may be effective. Also, double-ended spoons and cups can be provided cheaply by primary health clinics.

Eusof A see Sack DA


To prevent and treat dehydration associated with diarrhoea, the present focus is on oral rehydration instead of parenteral therapy. The role of the clinician-physiologist and the public health field worker is important, since conflicts have arisen concerning how to carry out an oral therapy regimen. Historical background of the treatment process for diarrhoea and dehydration, with a stress on the gradual change-over to the oral route, has been outlined. A range of ORS formulae, with varying sodium concentrations, is recommended for varying degrees of illness severity. The need for a rational formula for oral usage, and the possibilities of its industrial manufacture have been emphasized.

Finberg L see Bart KJ

Foote DP see Levine MM

Gangarosa R see Nalin DR

Ghai OP see Deorari AK

Ghavami F see Sharifi J


This editorial discusses the development of a 'Super ORT'. Considering the settings where the full ORS formulation with sterile drinking water is not available,
Composition of ORS

3 essential ORS components are identified: water, salt (NaCl) and a carrier substance (glucose). A simple sea salt/crude cane sugar ORS, used regularly in children was found to result in significantly improved nutrition. It is anticipated that nutrition can be enhanced even further, by using cereals and proteins as components for ORS. Thus, both fluid-electrolyte malnutrition and protein-energy malnutrition can be treated or prevented, by using the under-formulation super ORT solutions.

Greenough WB, III see Islam MR

Greenough WB, III see Molla AM

Gupta BD see Bhargava SK

Gutierrez C see Levine MM

Harland E see Nalin DR

Harland G see Erasmus PS

Harries JT see Booth IW


Hendrickse RG see Coulter JBS

Hirschhorn MA see Hirschhorn N


Children hospitalized with diarrhoea who were strong enough to drink generally were able to take sufficient amounts of a hypotonic glucose-electrolyte solution (GE-SOL) appropriate to their requirements for volume replacement and maintenance. Of the 47 study children (28 females; average age: 9 months), 21% had a recognized stool pathogen. Clinically apparent volume depletion was found in 48% and some degree of undernutrition in 62%. Children with 2° volume depletion differed significantly from children with 1° depletion: the former drank more GE-SOL, put out more stool, gained more weight, and had a larger fall in plasma protein concentration. Urine output and the unmeasured loss did not differ significantly. Nine of 11 children with 2° volume depletion and 4 of 6 in 1° group were adequately hydrated 3 to 6 h after admission. Moderate hypo- and hypernatremia and acidosis also were corrected. Children originally in shock should drink GE-SOL after rapid I.V. volume replacement. Ad libitum oral therapy is effective, comfortable and inexpensive, and may reduce morbidity and mortality rates of infantile diarrhoea, particularly in areas where the disease is endemic.

[The article is followed by an editorial comment from Dr William B Weil, Jr.]
Composition of ORS


Holmes R see Sandle GI

Hossain M see Molla AM

Hughes TP see Clements ML

Hughes TP see Levine MM


This paper on the second part of a study, reports the composition of 4 carbohydrate-electrolyte solutions currently used and prepared by mothers of infants under 18 months with acute gastroenteritis treated as out-patients in the UK. The implications also were assessed. Osmolality and sodium content were measured in sample solutions given by the parents. All types of feed were prepared with marked inaccuracy. Osmolality sometimes was unacceptably high in solutions containing glucose (range 192-590 mmol/kg), while the highest osmolality for sucrose solutions (range 145-360 mmol/kg) hardly exceeded the correct value for glucose solutions. Most parents were able to use a sachet with reasonable accuracy (mean 327 mmol/kg, while 310 was correct), although there were still wide extremes of error (121-580). There was a wide range, too, of sodium levels, but this range did not exceed 43 mmol/L. A unit pack, such as a sachet, containing sucrose and electrolyte, may be ideal for use in developed countries, particularly if such sachets could be made generally available and not just for hospital and clinic use.


Idrus DA see Hendrata L

Indra S see Chatterjee A

Islam A see Sack DA

Islam AFMR see Palmer DL

Composition of ORS


The relative risk of "high" sodium (Na 120 mmol/L) and "low" sodium (60 mmol/L) ORS was studied in 65 children aged 6 months to 2 years, with acute watery diarrhoea and dehydration of comparable severity. Forty children were maintained with low sodium and 25 with high sodium ORS in two separate six-month periods, in the study ward of the International Centre for Diarrhoeal Disease Research, Bangladesh. While hydration and electrolyte balance could be maintained in all children, the mean serum sodium level was significantly higher after 24 h administration in the high sodium than in the low sodium group (p < 0.05). Two children developed hypernatremia after 24 h on high sodium ORS. Serum sodium rose from 146 to 161 mmol/L in one and from 146 to 152 mmol/L in the other. Children receiving high sodium ORS excreted significantly more sodium in urine and stool after 24 and 48 h of oral therapy. Sodium citrate combined with an equal amount of sodium bicarbonate was quite effective for acidosis correction. This study demonstrated a wide safety range for sodium concentration in ORS. Despite the presence of an effective homeostatic mechanism, high sodium ORS (120 mmol/L) was not recommended. Low sodium ORS was recommended for children suffering from non-cholera diarrhoea losing relatively less sodium in the stool. For general use in all types of diarrhoea including cholera, the WHO-recommended ORS with 90 mmol/L sodium was considered appropriate.


The efficacy and safety of ORS containing crude sodium chloride and molasses, with and without sodium bicarbonate, were prospectively compared as a maintenance solution after initial I.V. rehydration. Studied at the ICDDR,8 in a randomized double-blind trial were 101 children below 12 years (57 in salt-sugar and 44 in salt-sugar-soda groups), having less than 1 week's watery diarrhoea. On admission the groups were comparable in age, sex, body weight, diarrhoea duration, dehydration severity, serum electrolytes and amount of I.V. required for initial rehydration. ORS therapy was successful in 41 patients (72%) in the salt-sugar and 26 (60%) in the salt-sugar-soda groups. Among cholera patients, 19 of 33 in the salt-sugar and 10 of 25 in the salt-sugar-soda groups were successfully treated orally. Success rate differences between these groups were not statistically significant. Oral therapy failures occurred equally whether or not bicarbonate was present, and were correlated with a high stool output. Hypokalemia was a major problem in younger cholera patients with high purging rates. With adequate potassium supplementation, simple home-made ORS, containing crude sodium chloride and sugar without any base, may be recommended for most non-cholera diarrhoea patients. However, for actively purging cholera patients, WHO-recommended ORS, with sodium, potassium, chloride and bicarbonate, is necessary.


The efficacy of an ORS containing only common salt (labon) and unrefined brown sugar (gur) was studied in 50 adults (16-50 years) hospitalized in Dhaka, Bangladesh with moderate dehydration due to diarrhoea of varying etiology. The ingredients are cheap and readily available in Bangladesh. Twenty-four matched patients,
selected from a previous study but treated with a bicarbonate-sucrose ORS, were controls. Failure was defined as inability to rehydrate, to maintain hydration or to maintain electrolyte balance. Oral fluid alone succeeded in 41 cases. The remaining 9, on admission, required intravenous hydration. Subsequently they were managed with ORS alone. Volume loss was corrected by the labon-gur solution in less than 8 h, while acidosis (CO$_2$ less than 20 mEq/L) was corrected slowly. Even at 48 h, 7 patients remained below 20 mEq/L and 2 were below 15 mEq/L. Severity and persistence of acidosis was correlated significantly (p<0.01) with stool volume. The results indicate that adults, with diarrhoea and dehydration, are rehydrated readily with a simple salt-sugar solution. When fluid losses exceed 50 ml/kg/24 h, acidosis will not be corrected for several days. The failure to correct acidosis promptly may not be of great clinical importance in adults with mild diarrhoea; and in such cases, sodium bicarbonate may not be needed. Sustained acidosis may have more serious consequences in children and severely-affected adults. The cost of ingredients to make 100 L of ORS in Bangladesh was US $12.00 for glucose-electrolyte, US $7.42 for sucrose-electrolyte and US $1.80 for labon-gur. Additionally, gur contains enough potassium to yield a mean of 7.6 mEq/L K$^+$. Thus, if WHO-recommended ORS is unavailable, labon-gur seems to be the best-available substitute in Bangladesh.


The efficacy of ORS without bicarbonate was compared with the WHO-ORS in 98 children aged below 5, in a double blind, randomized clinical trial at the ICDDR,B. These children had varying degrees of dehydration and acidosis due to acute watery diarrhoea. The mean serum bicarbonate concentration on admission was 13.3 mmol/L in the group receiving ORS without bicarbonate and 13.1 mmol/L in the WHO-ORS group. All but 3 children who received the ORS without bicarbonate were successfully treated; 3 treatment failures were attributed to persistent vomiting and severe diarrhoea (greater than 10 ml/kg/h). The non-bicarbonate treated group consumed less ORS than the WHO-ORS group, and also passed less liquid stool, but this difference was not statistically significant. Among those who vomited (17 in non-bicarbonate and 15 in WHO-ORS group), the mean volume of vomitus/kg body weight was more (p<0.001) in the non-bicarbonate group (22 ml/kg) than that in the WHO-ORS group (12 ml/kg). Acidosis correction was slower among non-bicarbonate treated than those in the WHO-ORS group during the first 24 h of treatment (p<0.001). By 48 h, however, acidosis was corrected and mean bicarbonate had risen to 17.1 mmol/L compared to 18.9 mmol/L in the WHO-ORS group (p<0.05). Some failures due to sustained acidosis and persistent vomiting and diarrhoea could be expected. ORS without bicarbonate may be used where complete formula solution is not available.


The efficacy and acceptability of ORS containing sodium citrate was compared with that containing sodium bicarbonate in terms of self life and in the treatment of dehydration from diarrhoea and acidosis. At the ICDDR,B, 51 patients (children and adults) with moderate dehydration and acidosis due to acute watery diarrhoea were treated randomly with either WHO-ORS which included 2.5 g/L sodium bicarbonate or an ORS where the sodium bicarbonate was replaced by 2.94 g/L sodium citrate. Twenty-one of 28 cases (75%) in the citrate group and 19 of 23 (83%) in the bicarbonate group were successfully rehydrated (p>0.05). There were no significant dif-
Composition of ORS

ferences in intake, output, gain in body weight, fall in hematocrit and plasma specific gravity, and correction of acidosis between the two groups within 48 h of therapy initiation. Treatment failure was mostly due to inability to drink enough of either ORS because of excessive vomiting and purging. The citrate base solution was as effective, safe and acceptable as WHO-ORS for diarrhoeal rehydration and acidosis correction. In addition, the citrate-based salt is convenient for longer storage and also for tablet formulation.


Islam MR see Koster FT
Islam MR see Palmer DL
Islam S see Rahaman MM
Islam S see Sack DA
Iyngkaran N see Abidin Z

Jalan KN see Chatterjee A
Jalan KN see Patra FC
Johnson B see Nalin DR
Jones BJ see Sandhu BK

Kabir AKMI see Sack DA
Khatua SP see Chatterjee A
Khatun M see Molla AM


ORS with a low glucose (2%) and high sodium (about 90 mmol/L) contents are recommended for developing countries, while in developed countries, such solutions generally contain 4-5% glucose (or sucrose) and 25-35 mmol/L sodium. To determine the optimal glucose concentration in ORS for developed countries, 51 infants and children under age 4, hospitalized in Sweden for infectious diarrhoea of probable
Composition of ORS

viral etiology, were treated with ORS containing 4.6% glucose. Nearly half the patients had fecal glucose >0.3%. In most, fecal glucose was higher than 0.5%. Of 16 children treated with ORS containing 2.5% glucose, 6 had fecal glucose. Thus, children with "ordinary western" infectious diarrhoea often may be affected by temporary glucose malabsorption. The authors recommend decreasing the glucose concentration substantially for diarrhoea treatment in developed countries, especially since the glucose-enhanced sodium and water absorption appears to reach an optimal level at as low a glucose concentration as 1%.

Kordy MI see Cleary TG


Koster FT see Palmer DL

Kumar R see Deorari AK


In this letter answering Dr Mittal, the author maintains that, although there are variations in stool electrolyte losses with different types of diarrhoea; and although there exists the possibility of hypernatremia and over-hydration, which may be related to the sodium content of the WHO-ORS there are very strong reasons for accepting the WHO-recommended ORS, irrespective of patient age and diarrhoea etiology. The reasons: (1) There have been only rare failures and hardly any hypernatremia or over hydration in the overall widespread success of ORS with 90 mEq/L sodium around the world, in a variety of different settings; (2) Wide variation of sodium losses exists, even in acute diarrhoea; (3) The critical factor emphasized in various balance studies is not the total sodium quantity administered (which determines hypernatremia risk), but the availability of free water for excretion; (4) With 90 mEq/L sodium, it is possible to make up the sodium already lost to diarrhoea and to replace continuing losses; (5) For effective net sodium absorption to occur, sodium concentration should match glucose on a molar basis, and for this 75-100 mEq/L sodium would be needed; and (6) Under field conditions, it is impossible either to identify acute diarrhoeal etiology or to modify ORS composition from case-to-case. Thus, it is better to recommend one standard ORS. Moreover, since ORS is to be used mainly by the semi-literate or illiterate, it is better to concentrate on community education and health worker training, to ensure proper ORS use. Furthermore, compared to home-made salt-sugar solutions, with a sucrose base and variable compositions, the WHO-recommended standardized packet is a much better choice. Among other reasons, for sucrose mixes, a large amount of sucrose is needed, which increases the cost and makes the mix so sweet it often is vomited. Also the 25 g recommended by Dr Mittal is unphysiological and, therefore, unacceptable.

Lacapa A see Hirschhorn N
Composition of ORS

Langmuir AD see Cutting WAM

Lawrie B see Hutchins P


Carefully prepared simple sugar/salt solutions, accompanied by adequate potassium supplementation, may be used as an alternative to the preferred glucose/electrolyte ORS formula when the latter is unavailable. Many persons, particularly in developing countries' rural areas, do not have ready access to fixed health facilities. Mothers use ingredients readily-available at the village level (crude salt and sugar) mixed with reasonable accuracy to produce a safe, effective ORS. Improper mixing could result in hyperosmolar solutions, which could induce in infants hypernatremic dehydration accompanied by convulsions, intracerebral hemorrhage and high case fatality. This chapter provides data on i) the variability of 3 methods of preparing a simple sugar/salt ORS; ii) developing a practical and reliable method; and iii) the simple solution's efficacy in oral rehydration. There must be at least one person in a village who has been formally taught how to properly prepare the simple ORS, and who must be responsible for choosing correctly-sized utensils and for teaching/supervising ORS preparation by mothers.


Evaluated were three ways to prepare simple home-made ORS. Five nurses in Baltimore, USA and 14 Honduran mothers in a rural health center prepared ORS by two methods: (1) pinch and scoop, and (2) household teaspoon and glass, using locally available salt and sugar. The nurses also prepared a third set of ORS, using special double-ended plastic spoons. Among the nurses, double-ended spoons gave the most consistent results: whether used with exact or approximate volumes of water, the sodium and sucrose concentrations closely approached the intended values of 75 meq/L and 2.0 g/dl, respectively. Sodium concentrations ranged from 64 to 93 mEq/L. Using either method, 2 of the 5 nurses several times prepared hypernatremic solutions (>150 mEq/L of Na). The nurse-to-nurse variation in sodium values was highly significant (p<0.01). Five of 14 Honduran mothers also produced hypertonic solutions, using either method. The "teaspoons" were of variable volume: eight were standard (4 to 5 mL), four were big (15-20 mL), and two were demitasse (2.5 mL). The glasses too varied greatly, from 150-500 mL in volume. The inherent variability of the two methods is too great to be promoted in an ORS program without health worker supervision. The special double-ended spoon should be field evaluated, as it was found accurate under optimal circumstances.

Levine MM see Booth IW

Levine MM see Clements ML

Levine MM see Malin DR
Composition of ORS

Lindo F see Erasmus PS
Lizano C see Nalin DR
Lobley RW see Sandle GI
Loria AR see Nalin DR
Lyew M see Erasmus PS

McCarthy BJ see Hirschhorn N
McDonald J see Nalin DR
MacKenzie K see Nalin DR


A hypothesis is proposed that may lead to the development of a super ORS. Available literature was critically reviewed. Suggested were possible ways of further enhancing the absorption of sodium and water from the small intestine in acute diarrhoea, through water soluble organic solute-linked transport, without imposing an osmotic penalty due to unabsorbed organic compounds. These ways are use of: (i) suitable polymers, such as polysaccharides and proteins; (ii) mixtures of rapidly absorbed organic molecules, such as d-hexoses and amino acids; and (iii) complex and variable mixtures of polysaccharides, proteins, protein hydrolysates, oligo- and monosaccharides, di- and tri-peptides and amino acids. Based on these principles, optimum concentrations of organic compounds in ORS and use of compounds other than glucose (including sucrose, glucose polymer and rice powder) are discussed. Through clinical trials it already has been shown that addition of the amino acid glycine to standard glucose-ORS enhanced sodium and water absorption, without imposing an osmotic penalty. To explore the possibility of further enhancing of sodium absorption, clinical trials were conducted in infants and children, who had moderate-to-severe dehydration due to diarrhoea caused by rotavirus, Vibrio cholerae, enterotoxigenic Escherichia coli and other pathogens. The control group received the standard WHO-ORS with glucose, while one study group received the same solution with added glycine, and another received ORS in which 20 g glucose was replaced by 50 g of popped rice powder in each liter of fluid. Compared to the control groups, in the groups treated with rice ORS and glycine-glucose ORS, there was a reduction of stool output by 49% and 50%; mean duration of diarrhoea by 30% in each group; and volume of ORS needed to treat them by 36% and 43%, respectively. In addition to replacing diarrhoeal losses, these two study solutions led to reduced magnitude and duration of diarrhoea. Thus, the two solutions assumed the role of highly effective absorption-promoting drugs. The results were superior to the effects of antisecretory drugs so far being tested in human studies.

Mahalanabis D see Chatterjee A

Mahalanabis D see Patra FC
Composition of ORS

Mahoney TJ see Dibley M
Maitra TK see Chatterjee A
Majid MA see Rahaman MM
Majid N see Molla AM
Maniya V see Das AK
Manly J see Hutchins P
Manly J see Rahilly PM
Manly JAE see Hutchins P
Mata L see Nalin DR
Matheny S see Levine MN
Matthews THJ see Hutchins P


Merson MH see Black RE
Merson MH see Sack DA


Admitting that the advent of oral glucose electrolyte therapy has revolutionized home management of diarrhoeal disease, the author seriously disagrees in this letter with recommending the WHO formulation for all childhood gastroenteritis, as advocated by Dr Kumar. He says that since electrolyte loss levels vary among different diarrhoeal diseases (from a large amount in cholera to a much lower amount in rotavirus), the WHO formulations, with 90 mEq/L sodium are unsuitable for the majority of childhood diarrhoeas. The safety of the WHO formulation in children with mild vomiting and diarrhoea with little or no dehydration has not been proven. Also, younger infants have a decreased renal concentration capacity and, hence, are unable to withstand a large sodium load. Unfortunately, none of the recognized precautions necessary for using the WHO-recommended ORS in younger infants is mentioned on any of the commercially available formulations claiming to be similar to the WHO one. Thus, a solution with a sodium content of about 50 mEq/L would be more universally ideal, except for severe gastroenteritis or cholera. Moreover, sucrose, which fails in only rare cases, is almost as effective as glucose. Sucrose also is much cheaper. The value of non-sodium electrolytes in childhood diarrhoea with up to moderate dehydration is debatable, and only add to ORS's cost. Thus, an ordinary salt/sugar solution is a convenient alternative to ready-made packets. As to worries about the variability, and hence safety, of such home-made mixes used by illiterate people, countries such as India have large numbers of local health practitioners, who could be taught to prepare and dispense a standardized salt/sugar mix, which village mothers only would have to mix with water.
Composition of ORS


Glucose is not always available and its price is at least 5 times that of sucrose in rural Indonesia. The efficacy of a 2% sucrose ORS therefore was compared to that of a glucose-ORS, in 67 children aged 2-28 months, hospitalized in Yogyakarta, with mild or moderate diarrhoeal dehydration. In all cases, except the 7 failures, diarrhoea stopped within 24 h. The glucose group put out less stool, had a more positive net fluid balance and gained more weight, but the differences were not statistically significant. Reducing substances occurred more in the stools of the sucrose group: 15/34 compared 10/33. In the glucose group, 3/33 and in the sucrose group 4/34 were considered ORS failures. It was concluded that sucrose can be a substitute for glucose in ORS, as a therapy for mild and moderate dehydration in childhood diarrhoea.

Mohan M see Bhargava SK

Mohieldin MS see Cleary TG

Mohs E see Nalin DR

Molla A see Molla AM


To replace sucrose or glucose in a standard ORS rice powder was used in a case-control study to see whether a cereal-based electrolyte solution is effective as a rehydration medium in diarrhoea. Of the 124 patients admitted to the Treatment Centre of International Centre for Diarrhoeal Disease Research, Bangladesh, with acute diarrhoea due to Vibrio cholerae or Escherichia coli, 61 were treated with standard sucrose-electrolyte solution and 63 with an electrolyte solution containing 30 g rice powder per liter and electrolytes as recommended by the WHO (sodium 90 mmol/L; chloride 80 mmol/L; potassium 20 mmol/L; and bicarbonate 30 mmol/L). In vitro hydrolysis converts 80-86% of the rice powder into glucose. Therefore 30 g rice powder was given so that at least 20 g glucose would be liberated in the intestinal lumen. The treatments were compared by measuring the rate of purging, change in body weight, serum specific gravity, urine output and post-hydrolysis sugar content in the stool. The proportions of successfully treated patients in the rice powder group were 80% for cholera patients and 88% for E. coli patients, which was no different from the results in patients receiving the sucrose electrolyte solution. The results are also comparable to those of other oral replacement
Composition of ORS

solutions. Failure was due to rates of purging that exceeded the patients' ability to drink enough replacement solution. Several advantages of using rice powder in the ORS were seen. It was speculated that intraluminal digestion of rice powder liberated glucose gradually and slowly without causing the osmotic drag of fluid from the vascular space to the gut lumen resulting in osmotic diarrhoea, as is seen when sucrose or glucose exceeds the recommended amount in ORS. This study suggests that treatment with rice powder, or any other cereal appropriate for a specific geographical area, may permit simultaneous rehydration and nutritional rehabilitation in diarrhoea patients with nutritional compromise.


This letter intends to make clear the distinction between rice water ORS and rice powder ORS. Starchy water obtained by draining boiling rice is, with added salts, called rice water ORS. Analysis of rice water samples from 30 urban households showed considerable range of both carbohydrate and electrolyte concentration. Rice water alone is not an ideal and dependable solution, but may still be a useful home remedy for early or mild diarrhoea. Rice powder ORS, on the other hand, is made by boiling specified quantity of ground dry rice and then adding measured amounts of salts to it (3.5 g/L NaCl, 2.5 g/L NaHCO3 and 1.5 g/L KCl). This is effective both as a home and hospital rehydration solution. It replenishes important nutrients lost during diarrhoea, reduces stool output, and, with proper preparation through boiling, makes a safe solution regardless of water source.

Molla AM see Greenough WB, III


Clinical and biochemical effects of ORT in 2 different concentrations were studied in a double-blind trial in 50 under-5 children hospitalized in India for acute gastroenteritis, with or without mild-moderate dehydration. The concentrated formula contained (in mEq/L): Na 115, HCO3 48, Cl 62, K 25, Ca, Mg, SO4 and lactate all 4, and 3.68% dextrose. The dilute formula contained (in mEq/L): Na 60, Cl 35, HCO3 30, K 25 and 4.035% dextrose with other electrolytes as in the concentrated formula. Of the children, 84% were rehydrated completely with ORT alone. I.V. was necessary in 16%, who had persistent vomiting, severe acidosis, abdominal distension or paralytic ileus. One moderately dehydrated child given I.V. had acidosis and later developed paralytic ileus; but this child died the following day. ORT alone could not correct severe acidosis, but successfully treated mild and moderately acidic children. Concentrated formula led to slight hypernatremia after 48 h therapy. The dilute formula better maintained electrolyte levels within normal limits in mild and moderate dehydration. ORT is life-saving, economic and easily available, and, therefore, particularly significant for developing countries.


In acute watery diarrhoea, children lose less sodium and more potassium in stools than do adults, for whom the WHO-ORS (90 mEq/L Na and 20 mEq/L K) initially was
formulated. Thus, WHO-ORS may place small children at risk of hypernatremia and hypokalemia. This study compares ORS with "high" vs "low" Na or K in 84 infants aged 3-15 months with dehydration due to acute watery diarrhoea. In randomized double-blind trials, ORS contained (in mmol/L): glucose 110; HCO3 30; K 20; Na 60 (low; given to 33 infants) or 90 (high, given to 25); or, in the second trial, the high Na formula plus 20 (given to 14 infants) vs 50 mEq/L K (given to 11). ORS administration (2 bottles, 240 mL) was followed by plain water (1 bottle) in the 2:1 regimen. Net absorption was measured using a balance technique. ORS (240 mL/h, 37°C) was given until skin elasticity and other hydration signs were normal; then infants drank diluted milk formula. Serial weights, clinical signs, plasma proteins, electrolytes, ureas, and hematocrits confirmed rehydration. Of 84 infants, 83 needed no I.V. All groups' water absorption and mean fecal Na (54) and K (33 mEq/L) were similar. The critical first 6 h mean Na absorption was significantly lower (p<0.02) in the low Na group; and hyponatremia was more common lasting up to 1 week. Four high Na group infants, receiving no extra oral water, had transient mild asymptomatic hyponatremia (average Na 156.0 ± 1.6). Net K absorption at 24 h was more than twice as high in the high K group than in the low K group. No one on high K had hyper- or hypokalemia at 5 or 24 h. In contrast, 33% (p = 0.025) of the low K infants had hypokalemia. High Na ORS used in the 2:1 regimen with extra plain water causes no electrolyte abnormalities, yields better Na absorption and is usable in all diarrhoeas and all age groups. High K corrects K deficits better than does low K ORS. Thus, there is a need to consider the possibility of raising K concentration in the WHO-ORS. Some infants treated with the current formula can benefit from K-rich foods or K-supplements during and after convalescence.


No controlled trial of sucrose versus glucose had been reported previously in infants. In a randomized, double-blind trial in Costa Rica, 51 infants, aged 3-12 months with 5-10% dehydration due to acute watery diarrhoea, were rehydrated with ORS containing sucrose or glucose. The therapeutic progress was determined from balance data, and from serial changes in clinical signs, weights, hematocrits, plasma proteins and serum electrolytes. Oral rehydration and maintenance without intravenous fluids was successful in 100% and 92% of patients, respectively, in the glucose and sucrose groups. Compared with sucrose, the glucose solution corrected electrolyte abnormalities more rapidly (p=0.003) and fewer patients required oral therapy beyond 24 h (p=0.03). Where adequate knowledge and means of oral therapy exist, sucrose can substitute for glucose in many cases; where there is a choice, glucose is recommended.


This study sought to determine whether glycine, an amino acid that increases the lumen-to-plasma sodium flux, would promote net sodium and water absorption in cholera patients. Electrolyte solutions containing glucose, glycine, or a combination of the two were absorbed sufficiently well from the intestine to supply maintenance fluid and electrolytes required by 48 severely dehydrated cholera patients. The mean diarrhoea duration was 49 h in the plain electrolyte group, 46 h in the glucose group, and 27 h in the glucose-plus-glycine group. There were significant differences between the group taking the plain electrolyte solution and those on glucose
Composition of ORS

or glycine (p<0.05) and between those taking the plain electrolyte solution and glucose-plus-glycine (p<0.01). An additional field trial showed that diarrhoea duration in glucose-plus-glycine patients was 9 h less and the diarrhoea volume 8 L lower than for the glucose group. These differences were significant (p<0.05). The results showed that the glucose-plus-glycine solution provides more effective therapy than do solutions containing either glucose or glycine alone.

Nalin DR, Cash RA, Rahman M. Oral (or nasogastric) maintenance therapy for cholera patients in all age-groups. Bull WHO 1970;43(3):361-3

Oral or nasogastric maintenance therapy with a solution containing ions (in mEq/L) Na⁺120, K⁺25, CO₃⁻ 48, Cl⁻ 97 and glucose (110 mmol/L) was developed for treating cholera patients in all age-groups. Studied were 56 children and 50 adults with uncomplicated, severe cholera. All children were maintained in positive balance with oral or nasogastric solution, after correcting for shock by I.V. The safety of ORS containing 25 mEq/L K⁺ was studied in adults; it was found that plasma potassium levels remained normal. Total I.V. requirements were reduced by 70%-80%. Patients with milder infections, who are not in shock, can be treated with ORS alone. ORS ingredients are cheap, need not be sterile, and are widely available in endemic areas. Since ORS can be used in both children and adults, it is very convenient for use in large-scale epidemics.


Development of ORS for cholera therapy was described previously. This paper reports balance studies which determine whether a solution given orally or by nasogastric tube could maintain positive water and electrolyte balance in children. ORS containing ions (in mEq/L) Na⁺120, K⁺25, HCO₃⁻ 48, Cl⁻ 97; and glucose (110 mmol/L were given to 12 children (2-9-year-olds) with severe cholera. After oral or nasogastric treatment was started, 8 of the 12 patients required no I.V. to maintain a water and electrolyte balance. The remaining 4 required small amounts of I.V. during the first 8 h. After 8 h, no patient needed any I.V.; all were maintained on ORS. The children absorbed sufficient ORS from their intestinal tracts to maintain a positive fluid electrolyte balance. ORS reduced the I.V. requirement by 80%, thus reducing the treatment cost. ORS ingredients also are widely available in endemic cholera areas.


Sucrose was tested as a possible alternative to glucose in oral rehydration therapy for diarrhoea. Eighteen patients aged, 11-65 were given an oral sucrose-electrolyte maintenance solution ORS, after initial intravenous rehydration. ORS successfully maintained 15 patients while two cholera patients and one non-cholera patient developed massive increases in net water and electrolyte losses. In these three, plasma specific gravity increased more than 1.031, necessitating additional I.V. fluids. In three other patients, gross diarrhoea rates also increased strikingly (2-4-fold from pre-oral to first oral period). Reducing sugar was significant in stool samples of 12 patients examined. These findings for sucrose contrast with the rarity of treatment failures seen with glucose-ORS. Glucose, therefore, is preferable to sucrose for oral therapy of diarrhoeal diseases, and a sucrose solution should be used only when glucose is unavailable.

Nalin DR see Cash RA
Composition of ORS


This paper reviews some important literature on oral rehydration therapy for diarrhoea. It reveals that 4% sucrose effectively can replace 2% glucose in ORS, and that the standard (WHO-recommended) ORS can be used as well in rotavirus diarrhoea where Na losses are low. It was recommended that household availability of salt, sugar, some measuring spoons, and a plastic bag may help to combat infant diarrhoea. Though this practical solution lacks K⁺ and HCO₃⁻, it may well save many infants with diarrhoea who are out of reach of medical centers and I.V. therapy.

Palmer D see Koster FT


Sucrose-ORS and glucose-ORS was compared in terms of their effectiveness as fluid-replacement therapy in subjects aged 5 and above, hospitalized in Bangladesh, with severe diarrhoea due to V. cholerae or non-cholera diarrhoea. The ORS contained (in mEq/L) Na 96, K 25, Cl 72, HCO₃ 24 and citrate 25 with sucrose (40 g/L) or glucose (20 g/L). Of the 122 patients, 69 were given sucrose-ORS and 53 glucose-ORS. The total success rates for sucrose-ORS (86%) and glucose-ORS (87%) were identical (X²=0.04). When restricted only to cholera patients, there was also no significant difference between the success rates of sucrose (68%) and glucose (78%). Average diarrhoea rate was significantly higher (p<0.005) in failures. Most failures (13 of 17) occurred in patients with stool rates greater than 20 mL/kg/h. The results indicate that sucrose can effectively replace glucose in ORS for severe diarrhoea in patients aged 5 and above.


Most ORS consists of a single glucose-electrolyte combination. While sodium bicarbonate is a useful constituent for correcting acidosis, bicarbonate reacts with glucose to from furfural compounds, leading to discoloration and short shelf-life in pre-packaged ORS. As this is a serious constraint, an alternative must be found. In a double-blind trial, two groups of infants and young children, suffering from diarrhoeal dehydration and acidosis, were successfully treated with an acetate-and a bicarbonate-containing ORS. The former was found to be as effective as the latter, and was equally acceptable to patients.

Composition of ORS

In a double-blind trial at a Calcutta, (India) hospital, a glycine-fortified (111 mmol/L) oral rehydration solution (glucose-glycine ORS) was evaluated in 25 infants and children aged 3 months-to-5 years with moderate-to-severe dehydration due to acute diarrhoea. A matched control group of 26 received only the WHO-recommended glucose-ORS. Enteropathogens were isolated in about 65% of patients. Found, respectively, in control and study groups, were Vibrio cholerae in 8 and 5, enterotoxigenic Escherichia coli in 7 and 4 and rotavirus in 6 and 7. Shigella sp. was detected in one control patient, while 4 controls and 1 study patient had more than one pathogen isolated. The diarrhoea stool output, diarrhoea duration, and ORS volume required to achieve and maintain hydration were significantly lower in the group receiving glucose-glycine-ORS. Although mean weight gains at 6, 24 and 48 hours were consistently higher in the study group, the differences were not significant. The results support the concept that, when an organic molecule such as glycine with an independent absorption pathway is added to standard ORS, such a molecule significantly enhances sodium and water absorption without imposing an 'osmotic penalty'—and thus increases ORS's efficacy. Its optimum use could lead to the formulation of an ORS which would act as an absorption-promoting drug.


In a controlled oral rehydration therapy trial, a rice-based electrolyte solution was evaluated in 26 infants and young children, aged 3 months to 5 years, with moderate to severe dehydration due to acute diarrhoea. The results were compared with a matched control group of 26 receiving WHO-recommended glucose electrolyte solution. The former was found to be more effective, as shown by an appreciably lower rate of stool output (129 ± 27 ml/kg vs. 253 ± 39 ml/kg; p<0.02), a shorter diarrhoea duration (30 ± 4.0 h vs. 43 ± 4.5; p<0.02), and a smaller rehydration fluid intake (234 ± 30.4 ml/kg vs. 366 ± 54.2 ml/kg; p<0.05).

Patra FC see Mahalanabis D

Phillips F see Dibley M

Pichaipat V, Yangkratok S, Varavithya W. Oral rehydration with three different electrolyte solutions. Siriraj Hosp Gaz 1979;31:1413


Aqueous bicarbonate solutions have been found to gradually decompose and form carbonate, and then react chemically with their glass containers. On heating, glucose solutions become discoloured and produce furfural and other deposits; bicarbonate accelerates these reactions, thereby making it difficult and expensive to produce sterilised preparations containing both bicarbonate and glucose. These stability problems were overcome in Cardiff (UK) by using a prepacked bicarbonate-free sterile ORS. Fifty boys and forty girls all aged under 5, hospitalized in UK for gastroenteritis were studied. Rehydration was carried out with a sterile ORS containing Na 34 mmol/L, K 30 mmol/L, Cl 54 mmol/L and glucose 183 mmol/L. Eighty-two children were treated with ORS alone, and 8 received I.V. within 2 h of admission. None of those managed with ORS required sodium bicarbonate supplements or I.V. fluids. Standard formulae or low lactose feed was resumed after rehydration. It is suggested that in Britain and other developed countries, childhood gastroenteritis can be treated advantageously with a prepacked, bicarbonate-free, sterile ORS.
Composition of ORS


The efficacy and safety of an ORS with 50 mmol/L versus 90 mmol/L sodium was compared, in 88 children aged 2-36 months, with mild to moderate dehydration due to acute gastroenteritis. Adequate hydration was mild in both groups, and no I.V. was used. Neither group received additional water or other fluid in the first 24 h. There was a significant rise in sodium concentration with both solutions (p<0.01), but no one developed hypernatremia. The children with clinical kwashiorkor, who all were rehydrated with the low sodium solution, showed no rise in sodium concentration, but a significant rise in potassium. There was no difference in recovery rate between the groups. The authors conclude that a low sodium ORS (50 mmol/L) is as effective as the standard ORS recommended by WHO/UNICEF, with high sodium (90 mmol/L).


Rahaman MM see Islam MR

Rahaman MM see Koster FT

Rahilly PM, Shepherd R, Challis D, Walker-Smith JA, Manly J. Clinical comparison between glucose and sucrose additions to a basic electrolyte mixture in the outpatient management of acute gastroenteritis in children. Arch Dis Child 1976 Feb;51(2):152-4

In a double-blind trial in 94 children in the outpatients, from 2 January to 21 February 1975, the value of glucose or sucrose added to a basic electrolyte mixture (ORS) for management of acute gastroenteritis was compared. Five (10%) of the 50 children in the sucrose-treated group and 12 (27%) of the 44 in the glucose-treated group were clinical failures (i.e. failed to recover and were hospitalized). The failures were chiefly in the younger age group, in whom dehydration is more important, but none required intravenous fluids and none had disaccharide intolerance. The number of failures in the glucose-treated group was significantly greater (p=0.05), but the recovery time difference between the groups was insignificant. Thus, despite theoretical advantages, there was no practical advantage in using glucose rather than sucrose. A 5% sucrose-electrolyte solution, with its relatively low osmolality, ready availability, and ease of preparation, is recommended as the treatment of choice in outpatient management of acute gastroenteritis in infancy.

Rahman ASMM see Palmer DL

Rahman M see Nalin DR

Rahaman MM see Islam MR
Composition of ORS

Ramlal A see Nalin DR
Ranney B see Hirschhorn N


Rohde J see Molla AM
Rohde JE see Hendrata L
Rohde JE see Moenginah PA
Ronge E see Kjellman B
Royan G see Abidin Z
Rust J see Clements ML


To compare the efficacy and safety of a low-sodium solution versus the WHO formula in oral therapy for dehydration in infantile diarrhoea, a study was carried out in Shiraj, Iran in May and June 1981. Divided into two groups, 51 infants and children (54.9% male) aged 2-to-20 months, with moderate-to-severe diarrhoeal dehydration, were randomly assigned to either sucrose high sodium (90 mEq/L) or sucrose low sodium (58 mEq/L) solution, in a double-blind manner. Rehydration was assessed on clinical grounds, and confirmed by serial determination of body weight, hematocrit, total serum protein and blood urea nitrogen. Successful rehydration with oral fluid therapy alone was achieved in 20 (80%) of 25 patients on sucrose high sodium solution, and in 20 (77%) of 26 patients on sucrose low sodium solution. Only the assigned sucrose-electrolyte solution was given during the average rehydration period for about 7 hours, when the serum electrolytes were remeasured. Mild, asymptomatic hypernatremia (serum sodium 146-150 mmol/L) developed in 3 patients on high sodium solution. Among patients on low sodium solution, 2 became hyponatremic (serum sodium 127 and 130 mmol/L) but had no apparent symptoms. The purging rate was the same among successfully treated patients of both groups, but it was significantly higher in those who failed (p<0.001). Study data suggest that, while there is no superiority of one formula over the other, the WHO oral rehydration solution can be used safely and effectively to treat acute infantile diarrhoeal dehydration of moderate-to-severe degree and of diverse causes. However, the need for intravenous fluids for those with a high purging rate is stressed, because a significant number fail to recover with either solution.

Sachdev HPS see Bhargava SK
Sack B see Koster FT
Composition of ORS


The efficacy of oral rehydration solution (ORS) specifically in rotavirus infection was studied for the first time, and sucrose was compared with glucose as the carbohydrate source in ORS (WHO formula). In a randomized double-blind trial, 57 Bangladeshi males, aged 5 months to 21 years hospitalized with rotavirus diarrhoea, were treated either with sucrose-ORS (28 infants) or with glucose-ORS (29). The groups were similar in age, nutritional status, diarrhoea duration before hospitalization, vomiting history and blood and stool laboratory values. All were rehydrated and remained so on ORS alone. A comparison of the groups showed no difference in rehydration rate as judged by time of first urination, rate of weight gain, or follow-up serum-specific gravity measurements. These patients were compared with 44 children, also with rotavirus, rehydrated only intravenously. The ORS versus I.V. groups did not differ clinically in the rate of rehydration, diarrhoea duration, and purging rate. Vomiting did not prevent administration of ORS during hospital admission. Bangladeshi children with rotavirus diarrhoea have a defect of carbohydrate digestion, but this does not prevent use of a sugar-electrolyte ORS. Thus, patients with rotavirus diarrhoea who are considerably dehydrated can be rehydrated and maintained on ORS, and both sucrose and glucose are effective.


Sucrose-ORS was compared with glucose-ORS, in a double-blind trial in 111 children (102 with bacteriologically-confirmed cholera) below age 5. Electrolyte composition of both solutions followed the WHO recommendation. Dehydration was severe in 89 and moderately severe in 22. Fifty-five children were randomly assigned to the sucrose-ORS and 56 to the glucose-ORS groups. The groups were well matched for age, sex, dehydration degree, pre-admission duration of diarrhoea and admission laboratory values. Success rates were similar; 73% and 77% of the sucrose and glucose groups, respectively, did not require any unscheduled I.V. therapy; and there was no difference in purging rates. The primary determinant of success for ORT, regardless of the sugar, was the purging rate. Sucrose malabsorption was responsible for oral therapy failure in one child. This sucrose intolerance was documented by a rising stool output with increasing oral fluid intake (while on sucrose-ORS) and high fecal post-hydrolysis reducing substances. Sucrose is an effective, readily-available, less expensive alternative to glucose for ORS, but either must be used in conjunction with I.V. solution when treating severe dehydration diarrhoea.

Sack DA see Black RE
Sack DA see Islam MR
Sack RB see Palmer DL
Sack RB see Santosham M
Samadi AR see Islam MR

Sandhu BK, Jones BJM, Brook CGD, Silke DBA. Oral rehydration in acute infantile diarrhoea with a glucose-polymer electrolyte solution. Arch Dis Child 1982 Feb; 57(2):152-4
Composition of ORS

The efficacy of a glucose-polymer electrolyte solution (G-PES) was assessed in 7 normally-nourished infants aged 3-34 months, with mild acute diarrhoeal dehydration. The G-PES supplies greater energy at no extra osmotic cost, compared to glucose- or sucrose-electrolyte solutions. Six infants were rehydrated successfully. Initial blood urea and bicarbonate showed significantly favorable changes (p<0.05 and p<0.02, respectively) after oral therapy. The solution's high sodium content (90 mmol/L), based on the WHO-UNICEF recommendations, was implicated as the cause of serum sodium increase in 4 infants, one of whom developed serious hypernatremia (serum sodium 162 mmol/L) associated with glucose-positive stools and a convulsion. Body weights only moderately increased in 5 successfully-treated infants, and decreased in 2, one of whom had diarrhoea persisting beyond 48 h. A solution with a lower sodium and glucose-polymer content might be of nutritional benefit in the oral rehydration of acute infantile diarrhoea.


Few data are available on the use of WHO-ORS in well-nourished ambulatory children with minimal dehydration. In an outpatient clinic in Panama City, a randomized study evaluated the safety of ORS containing 90 mmol/L (WHO formula) or 50 mmol/L of sodium in diarrhoea management among 93 well-nourished ambulatory children aged 3 months to 2 years. Patients were randomized into three groups. Patients in Group A were given WHO-ORS; patients in Group B ORS containing 50 mmol/L sodium, and those in Group C a clear liquid diet, consisting of commonly-available aerated beverages, bananas, cereals and apple sauce. All 93 patients were hydrated successfully. Patients in both ORS groups gained significantly (p<0.05) more weight than did those in the control group by the 2-week follow-up visit. There were no complications of either ORS, and no one developed hypernatremia or hyponatremia during therapy. Thus, ORS containing both 90 and 50 mmol/L sodium is effective and safe, and can be recommended for undernourished and well-nourished ambulatory or hospitalized patients with minimal dehydration.

Sarker SA see Molla AM

Sen A see Patra FC

Shah PM see Naik NV


Shepherd R see Rahilly PM

Shoukry I see Cleary TG

Shukry S see Cleary TG

Siegel A see Levine MM

Silk DB see Sandhu BK

Simhon A see Nalin DR
Composition of ORS

Singh HP see Bhargava SK  
Smith W see Levine MM  
Soenarto J see Moenginah PA  
Stinzing G see Deorari AK  
Suprapto see Moenginah PA  
Sutaryo see Moenginah PA  
Sutrisno D see Moenginah PA  
Swaby D see Nalin DR

Tay JSH see Ho TF  
Taylor PR see Black RE  
Thomas MK see Price HV  
Tome FC see Clements ML  
Tome FC see Levine MM  

Vargas W see Nalin DR  


The usefulness of soymilk in the treatment of acute diarrhoea was compared with conventional oral electrolyte rehydration, followed by diluted breast milk or humanized milk formula. Moderately well nourished patients hospitalized in Thailand with mild to moderate diarrhoea were divided into group I (23 patients aged 3.5 - 22 mo.) and group II (23 patients aged 2-18 mo.). Group I received 200 mL/Kg/24 h of diluted soymilk: 100 mL soymilk + 100 ml ORS containing Na+ and Cl- (60 mEq/L each) and 5% sucrose. Group II received 200 mL/Kg of ORS only in the first 24 h. Diluted humanized milk and breast milk were given orally on the second and full-strength milk on the third day in group II. In this group, recovery period was significantly shortened (p<0.05) in the breast fed infants as compared to those on humanized milk formula. But there was no statistically significant difference between soymilk and breast milk or soymilk and humanized milk. Sugar malabsorption
Composition of ORS

was found in 27-30%. Only 5 patients had first degree malnutrition. Stool culture revealed 2 cases of Salmonella in group I and 3 cases of Shigella in group II. Serum electrolytes were within normal limits except total CO₂ content which was persistently low despite the patients' clinical improvement. Sampling error was the most likely explanation. Sucrose electrolyte ORS followed by breast milk would be the most appropriate treatment of diarrhoea in infants and children. Soymilk, given early, was well tolerated, but had no obvious advantage over others. It indicates that soymilk may not be necessary in acute diarrhoea.

Varavithya W see Pichaipat V
Vellayappan K see Ho TF
Verwey WF see Rahaman MM


Walker-Smith JA see Hutchins P
Walker-Smith JA see Rahilly PM


Wendland BE, Arbus GS. Oral fluid therapy: sodium and potassium content and osmolality of some commercial "clear" soups, juices and beverages. Can Med Assoc J 1979 Sep 8;121(5):564-71


Wilson C see Hutchins P


Rice water (RW) versus the standard WHO oralyte solution (WOS) were compared in the treatment of common types of infantile gastroenteritis (IGE), for 130 babies hospitalized in Singapore. WOS was given to 63 patients and RW to 67. The most important finding was that RW was at least as effective as WOS in controlling diarrhoea, for the two groups that were matched for age, sex, ethnicity, days of diarrhoea before admission, degree of dehydration, initial serum sodium, chloride, urea, potassium and bicarbonate. The RW group passed fewer stools per day and recovered faster than did the WOS group. It was concluded that in Singapore, where the dehydration...
Composition of ORS

degree usually is not too high, rice-water is a convenient, sterile, effective, free and readily available anti-diarrhoeal agent that can be used for 24 hours, followed on subsequent days by graduated milk feeds mixed with rice water.

Importantly, it was found that, though amounts of Na, K and Cl in RW were extremely low, use of RW for 24 hours and resumption of diluted milk feeding from day two, produced an extracellular fluid solute content similar to that seen in babies fed WOS, which contains more electrolytes. Several possibilities were postulated for this surprising finding. First, RW is absorbed better than WOS, as evidenced by fewer stools. The reason: evidence shows that in many patients after diarrhoea onset glucose is poorly absorbed. This may result from derangement of the glucose carrier status in the small intestinal epithelia. If glucose is not absorbed for this reason, the solutes in it, such as salt, will be wasted; and this may account for the greater number of stools in WOS-fed babies. Second, the osmolarity of WOS is high compared to RW babies, because there are far fewer molecular particles in the latter, as confirmed by osmolarity measurements of the two fluids. The deranged intestinal epithelial cell probably cannot tolerate high osmolar fluids, which may tend to increase intestinal cellular secretion into the lumen, resulting in increased stools. Low osmolarity RW prevents excessive secretory loss of fluids and electrolytes. Infants with ileostomies surgically constructed for intestinal obstruction often develop diarrhoea; and measurement of ileostomy fluids after feeding both groups demonstrated that less fluid was secreted via the ileostomy in RW-fed babies. Third, the main molecular particles in RW consist of starch, a polysaccharide; and possibly, compared to glucose, this type of polysaccharide is dealt with and absorbed much better by the intestinal epithelial. Finally, the authors reported working on a salt-added RW, that also could be used for the most severe forms of IGE, equivalent to those due to cholera.


A comparative study between rice water and WHO-recommended electrolyte solution was performed. Infants with gastroenteritis admitted to the Department of Paediatrics, National University of Singapore, were studied. Sixty-three patients received oral electrolyte solution and 67 rice water. Milk was withdrawn totally from all patients for 24 hours after admission. Intravenous glucose (3.75%) and saline (0.23%) were administered simultaneously to severely dehydrated patients. On day 2, quarter-strength powdered milk was given, followed by half-strength on day 3, three-quarter strength on day 4 and full-strength on day 5. For the electrolyte group, milk feeds were made up with water, while for the rice water group, milk feeds contained rice water. Both groups were comparable with respect to age, sex, race, number of days of diarrhoea before admission, severity of dehydration, serum sodium, chloride, urea, potassium and bicarbonate. Electrolyte and urea values were compared, both for "drip" versus "no-drip" for oral treatment patients, and between electrolyte solution and rice water groups. Rice water reduced the number of stools more effectively than did oral electrolyte solution. No patient died, and there was no pathological sequelae in any patient. It was concluded that rice water may be a more practicable alternative than oral electrolyte solution in developing countries -- since the latter is not always available and/or sterile, and boiled rice water meets both criteria. In severe cases, it might be possible to add measured quantities of table salt and rice gruel, to enhance electrolyte and caloric value. Rice water may be superior because its lower osmolality reduces the risk of increasing intestinal secretion, and because in infantile gastroenteritis, absorption of glucose (monosaccharide) is affected more than is absorp-
Composition of ORS

There is some evidence that polysaccharide absorption and breakdown is better than absorption of oral electrolyte solution, when oral electrolyte and rice water absorption tests were done and blood glucose was estimated over time (These latter results were unpublished).

Wongsaroj P see Varavithya W
Woode GN see Bywater RJ
Woodward ST see Hirschhorn N
Woodward WE see Cleary TG
Woodward WE see Hirschhorn N


Wyatt RG see Cleary TG

Yangkratok S see Pichaipat V
Yip WCL see Ho TF
Yolken RH see Black RE
Yunus M see Nalin DR
ICDDR,B PUBLICATIONS FOR SALE

Proceedings of the Conference on Experimental Cholera Vaccines
Edited by Shereen Rahman
November 1981. 155 pages
Special publication no. 15
Price: US$ 15.00

Proceedings of ICDDR,B Workshop: Medical Education on Diarrhoeal Diseases and Related Subjects
Edited by A R Samadi and K M S Aziz
September 1981. 33 pages
Special publication no. 14
Price: US$ 5.00

Proceedings of the National Workshop on Oral Rehydration
Edited by K M S Aziz and J L Beckett
October 1980. 23 pages
Special publication no. 9
Price: US$ 4.00

The Biken test for detection of enterotoxigenic Escherichia coli producing heat-labile enterotoxin (LT): a laboratory manual
By T Honda, Q Akhtar and R I Glass
November 1981. 13 pages
Special publication no. 16
Price: US$ 4.00

Beliefs and fertility in Bangladesh
By C Maloney, K M A Aziz and P C Sarker
December 1981. xv, 366 pages
Monograph no. 2
Price: US$ 30.00

Kinship in Bangladesh
By K M A Aziz
May 1979. xviii, 228 pages
Monograph no. 1
Price: US$ 10.00

For your copy/copies please send order along with the remittance to: Head, Library and Publication Branch, International Centre for Diarrhoeal Disease Research, Bangladesh, G P O Box 128, Dhaka 2, Bangladesh.
SHIGELLOSIS:  
A CONTINUING GLOBAL PROBLEM

Proceedings of an International Conference

Cox’s Bazaar, Bangladesh
June 15-20, 1981

Editors:
M. Mujibur Rahaman
William B. Greenough III
Naomi Rock Novak
Shereen Rahman

Price: US $15.00 (developed countries), US $10.00 (developing countries) and Tk. 150.00 (local), including surface mail (book post) cost. To get your copy/copies (258 pages) by AIR please add 10% (Asian countries) and 20% (other countries) with the total cost.

For your copy/copies please send order along with the remittance to: Head, Library and Publication Branch, International Centre for Diarrhoeal Disease Research, Bangladesh, G P O Box 128, Dhaka 2, Bangladesh.