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**LOBON-GUR (COMMON SALT AND BROWN SUGAR) ORAL REHYDRATION
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Dacca, Bangladesh

April 1980

Scientific Report No. 36

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PREFACE

The International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) is an autonomous, international, philanthropic and non-profit centre for research, education and training as well as clinical service. The Centre is derived from the Cholera Research Laboratory (CRL). The activities of the institution are to undertake and promote study, research and dissemination of knowledge in diarrhoeal diseases and directly related subjects of nutrition and fertility with a view to develop improved methods of health care and for the prevention and control of diarrhoeal diseases and improvement of public health programmes with special relevance to developing countries. ICDDR,B issues two types of papers: scientific reports and working papers which demonstrate the type of research activity currently in progress at ICDDR,B. The views expressed in these papers are those of authors and do not necessarily represent views of International Centre for Diarrhoeal Disease Research, Bangladesh. They should not be quoted without the permission of the authors.

ABSTRACT

A clinical trial to examine the efficiency of oral fluid made with salt (lobon) and molasses (gur) were carried out in Dacca on 50 adult patients with moderate dehydration due to diarrhoea of various etiology. Failure was defined as not correcting initial dehydration, not maintaining hydration or developing an electrolyte imbalance at any time during the study period. Volume loss was corrected in less than 8 hours with the lobon-gur solution. Acidosis (CO_2 less than 20 mEq/L) could not be corrected in 20% of patients even after 48 hours of therapy. The severity and persistence of acidosis was significantly correlated with the stool volume. Adult patients, with diarrhoea and dehydration are readily rehydrated, if they drink a simple salt-sugar solution. When fluid losses exceed 50 ml/kg/24 hours acidosis will not be corrected for several days. The failure to correct acidosis promptly may not be of clinical importance in adults with mild diarrhoea, and in such cases sodium bicarbonate would not be needed. Sustained acidosis may have serious consequences in children and severely affected adults. This requires further evaluation.

INTRODUCTION

Death or disability from watery diarrhoea is generally due to loss of fluid and salts from the blood and extracellular spaces. The treatment is replacement of the deficit, and matching further losses. This can be accomplished with intravenous fluids, but not available in many areas where diarrhoea is common and frequent. Recently, replacement of lost fluids and salts with a oral solution containing glucose and electrolytes (Na, K, Cl and bicarbonate) has proved successful, obviating intravenous fluid therapy (1).

The relative efficacy of glucose-electrolyte as compared to sucrose-electrolyte solutions has been defined in the treatment of diarrhoeal diseases (2-6). Since there is little difference between sucrose and glucose-based replacement solutions, the ICDDR,B now uses inexpensive, local products instead of imported glucose for the treatment of diarrhoea. Several workers have advocated use of table salt and sugar only to make oral replacement solutions (7-9). A recent editorial has reviewed this issue(10). This study reports the efficacy of oral rehydration solution made from salt and molasses in the diarrhoea of adults. These are cheap and easily available in Bangladesh.

PATIENTS AND METHODS

Patients:

Patients aged between 16 to 50 years, with moderate dehydration due to diarrhoea, (an average of 13 hours duration) who had not received any antibiotics during the preceding week, were included in the study. The first four patients to the clinical research unit of the ICDDR,B in Dacca fulfilling these requirements were selected.

Clinical Information:

Each patient underwent a physical examination on vital signs, weight at admission, estimation of dehydration, and assessment for complications and other diseases. Blood was drawn on admission, after 8 hours, 24 hours, 48 hours and at discharge for measuring electrolytes, specific gravity and creatinine.

Rectal swabs were taken for cultures of *V.cholerae*, *Salmonella* and *Shigella*. No tests were done for enterotoxigenic *E.coli* and rotavirus.

Oral replacement solution was prepared by ICDDR,B nurses from locally produced sea salt (lobon) and molasses (gur). The composition of the solution is shown in table 1.

Molasses made from sugarcane are readily available and cheap, so that was used for the ORS. Since the whole sugarcane is crushed to make gur, considerable amount of potassium is present which was an unknown advantage.

Treatment:

Every patient was treated with lobon-gur (L-G) oral solution. Patients who could not tolerate oral fluid due to persistent vomiting received intravenous fluid initially, thereafter, hydration was maintained with oral fluid alone. Oral fluid was continued until diarrhoea stopped. There was no restriction on food but plain water was not allowed during the study period. This is a departure from our usual practice which permits and encourages drinking plain water during treatment of diarrhoea. Since these patients were under close observation and blood was examined for electrolyte contents regularly, we restricted replacement only to the test solutions to assess any unforeseen risks such as hypernatraemia. To discourage vomiting, small amounts of fluid (30-50 ml) was given frequently (every 5 minutes). Failure of therapy was defined as either inability to rehydrate, maintain hydration or maintain electrolyte balance.

Comparison Group:

A group of 24 patients, with the same criteria of selection but treated with sucrose-based oral replacement solution containing bicarbonate were used for comparison. These patients were studied during a previous diarrhoea season in the same year (1978).

RESULTS

The characteristics of the patients studied are shown in table 2; oral fluid therapy was successful in 41 out of the 50 cases. The remaining 9 cases required intravenous fluid for

TABLE 1

COMPOSITION OF THE LOBON-GUR (SALT-BROWN SUGAR) AND THE WHO
RECOMMENDED ORAL REPLACEMENT SOLUTIONS FOR DIARRHOEA

| | Millimoles/Liter | | | | |
|--------------------------------------|------------------|-----------------|----------------|-----------------|-------------------------------|
| | Sucrose | Na ⁺ | K ⁺ | Cl ⁻ | HCO ₃ ⁻ |
| Lobon-gur (LG) (salt-brown sugar) | -- | 85±10.5* | 7.6±2.5 | 80±11.7 | 1.8±1.2 |
| WHO recommended solution | 111 | 90 | 20 | 80 | 30 |

* Means ± 1 standard deviation as mixed by ICDDR,B nursing staff.

TABLE 2

CHARACTERISTICS OF PATIENTS REHYDRATED WITH
LOBON-GUR ORAL REPLACEMENT SOLUTION

| | |
|---|--------------------|
| Weight (median) | 43.5 \pm 6.1* |
| Age (median) | 30 \pm 1.4 |
| Sex males/females | 35/15 |
| Hours of Diarrhoea (mean) Before admission | 13 \pm 1.3 |
| Admission Plasma specific gravity | 1.029 \pm 0.0007 |
| Admission Plasma CO ₂ in milliequivalents/liter | 20.9 \pm 0.5 |
| Number receiving intravenous fluid/total | 9/50 |

* Mean \pm SEM

initial hydration on admission only. Subsequently they were managed with oral fluid alone. All cases were moderately dehydrated (blood specific gravity less than 1.036) and with a palpable radial pulse. The oral solution was well absorbed, normal hydration attained within 8 hours of start of therapy (table 3). Every patient gained weight, haemoconcentration was corrected and a good urinary output (33.9 ± 3.5 ml/kg) established in the first 24 hours. Patients liked lobon-gur solution and drank it very well, (103.7 ± 4.5 ml/kg in the first 24 hours).

Acidosis, however, was corrected slowly. There were 26 patients with a CO_2 of less than 20 mEq/L on admission. At 24 hours there were still 14 patients with values less than 20 mEq/L. At 48 hours 7 patients remained below 20 mEq/L and two were below 15 mEq/L. A comparison was made between the patients under study with patients of comparable severity from a previous study in which sucrose, salt and bicarbonate were used in the oral replacement solution of the composition that is listed in table 4 (11). There were significant differences between the groups with respect to CO_2 values from 8 hours of therapy onward, the patients receiving lobon-gur replacement failed to correct their plasma bicarbonate. Patients with heavy purging whose stool volume exceeded 50 ml/kg/24 hours failed to correct their plasma bicarbonate significantly more often (table 5) than did patients with less fluid loss. The degree of depression CO_2 values on admission did not correlate with continued depression of plasma bicarbonate.

V. cholerae was not isolated. In three instances Shigella and in three non-cholera vibrios were isolated. In light of recent studies (11) the remainder were most likely due to enterotoxigenic *E. coli*.

DISCUSSION

The efficacy of oral fluid in treating diarrhoea is well established, but although the ingredients (glucose, sodium chloride, sodium bicarbonate and potassium chloride) are simple and inexpensive but may not be readily available in many areas. People from areas where diarrhoea and cholera are major hazards cannot obtain the appropriate mixture. In contrast cane sugar and salt, often unrefined, are virtually available in all countries however poor or remote.

Results of this study indicate that a replacement solution based on lobon-gur (common salt and mollasses) is very efficient in restoring fluid lost in diarrhoea, and is, in fact, accepted

TABLE 3

REHYDRATION AND FLUID BALANCE IN PATIENTS TREATED WITH
LOBON-GUR ORAL REPLACEMENT SOLUTION

| | 8 hours | 24 hours | Discharge |
|---|--------------------|--------------------|--------------------|
| Percent increase above Admission weight of 43.5±0.9 Kg. | 3.1* ± 0.3 | 2.9 ± 0.3 | 4.1 ± 0.4 |
| Decrease below admission specific gravity of 1.029 ± 0.0007 | 0.0030 ± 0.0004 | 0.0030 ± 0.0003 | 0.0040 ± 0.0003 |
| Cumulative stool volume ml/kg. | 11.4 ± 1.5 | 24.7 ± 3.1 | 39.9 ± 7.0 |
| Cumulative urine volume ml/kg. | 11.0 ± 1.8 | 33.9 ± 3.5 | 61.9 ± 5.9 |
| Cumulative intake ml/kg. | 59.7 ± 2.7 | 103.7 ± 4.5 | 158.7 ± 13.5 |

* All numbers are means ± one standard error of the means.

TABLE 4

COMPARISON OF CORRECTION OF PLASMA BICARBONATE IN-PATIENTS TREATED WITH LOBON-GUR ORAL REPLACEMENT SOLUTION AND A PREVIOUS GROUP TREATED WITH A REPLACEMENT SOLUTION CONTAINING BICARBONATE

| | Admission Values | Increase above admission values | | | |
|------------------------------------|------------------|---------------------------------|--------------|--------------|--------------|
| | | 8 hrs. | 24 hrs. | 48 hrs. | Discharge |
| Lobon-Gur N = 50 | 20.0* ± 0.6 | 0.7 ± 0.4 | 1.9 ± 0.5 | 2.7 ± 0.6 | 3.4 ± 0.6 |
| Sucrose salt-bicarbonate N = 24 | 19.1 ± 0.6 | 3.1 ± 0.7 | 7.7 ± 0.8 | 8.7 ± 0.8 | 8.1 ± 0.8 |

* Mean ± standard error of the mean

Insert Tables 3 and 4:

The lobon-gur; LG, group was compared with a previous study group (sucrose-salt-bicarbonate, SSB) using the complete WHO formulation (mEq/Liter) Na+90, K+20, HCO₃-30, Cl-80 with a sucrose base of 40 gms/Liter. The groups were comparable as to age (Lobon-gur 30.7±1.4, salt-bicarbonate sucrose 32.0±2.5), hours of diarrhoea before admission (LG 13.0±1.3, SSB 15±2.6); admission specific gravity (LG 1.029±0.0007, SSB 1.031±0.0007).

TABLE 5

STOOL OUTPUT TO PLASMA BICARBONATE IN PATIENTS AFTER 24 HOURS
TREATMENT WITH LOBON-GUR SOLUTION

| Stool volume ml/kg/24 hours | Plasma CO ₂ mEq/l after 24 hours | | |
|--------------------------------|---|----------------------------|-----------------------------|
| | > 20 Number of patients | < 20 Number of patients | Total Number of patients |
| < 50 | 33 | 8 | 41 |
| > 50 | 3 | 6 | 9 |
| TOTAL | 36 | 14 | 50 |

Fisher's exact Test. P = .01

with enthusiasm by Bangladeshis perhaps because its ingredients satisfy local taste preferences.

The slow correction of acidosis relate to the fact that the adult human kidney has only a limited ability to excrete fixed acids. Even with optimal hydration and renal perfusion, acidosis can be corrected at a rate of somewhat less than 200 mEq per day until the excretion of ammonium ion can be brought into full play. This requires 5 to 7 days (12). The ability to excrete acid in childhood is less. Thus failure to correct acidosis during severe diarrhoea is a problem, especially among small children.

Sustained acidosis can be damaging and would manifest clinically in respiratory difficulty or death rather than as something ordinarily related to diarrhoea (13). On the other hand with adequate kidney function after hydration a small degree of acidosis will gradually be corrected and, as a rule, the gradual correction of electrolyte imbalance is preferable to a rapid correction. Thus the theoretical advantages of oral solutions with a more complex formula are perhaps more apparent than real in diarrhoea of mild to moderate severity. We have observed some patients develop carpopedal spasm due to alkalosis when they were hydrated with the standard WHO formulation containing bicarbonate. This has been especially the case in small children, and pregnant women, and indicates an uncomfortable but not serious side effect of bicarbonate containing solutions of the currently recommended composition.

In a village home the family would have to prepare the solution. In this study, the actual mixing was done by the nursing staff rather than in the laboratory or pharmacy to see how a well-trained individual who is not a pharmacist could make up the solutions. Thus for each patient common salt and brown sugar, purchased from local market, were mixed with one litre of tap water. The variation (seen in table 1) indicates that concentrations of solutes were always in a safe range but there was a considerable variation even when nurses prepared the solution. At present there is little published information on the accuracy of diarrhoea treatment solutions made in the home settings. There is evidence, however, that major inaccuracies can occur. Unpublished informations suggest dangerous variations can be avoided with proper instructions, the mothers can make appropriate solution.

In one study a decrease in death rates due to diarrhoea was observed following implementation of a programme employing a simple home made salt sugar solution (7). That study did not

report measurements of the accuracy of the solution, or complications such as hypernatraemia, and control groups were not available to insure that the decrease in mortality was not related to variables other than oral rehydration alone. The likelihood is, however, that even the simple home made salt-sugar solution may have a major impact on death and disability due to diarrhoea.

Advantage of using molasses (gur) was that there was, on an average 7.6 mEq per litre of potassium in the oral mixture (table 1). This obviates the need for additional potassium supplementation.

The production cost in Bangladesh of 100 liters of glucose electrolyte solution is about \$12.00. If glucose is replaced by sucrose, the cost comes down to \$7.42. The cost of the same amount of L-G (salt-molasses) oral solution is \$1.80; less than one sixth of the cost of same amount of the commercially produced packets. Taking into consideration the fact that oral replacement solution in litres has generally equalled the number of episodes of diarrhoea in the population, the yearly demand for ORS (oral replacement solution) in Bangladesh would be between 10-80 million litres. Commercial ORS packets alone would cost \$8 million a year, distribution costs would be additional.

The ingredients of lobon-gur solution are readily available in every area. We suggest that in view of immediate availability, lower cost, and greater simplicity of salt sucrose solutions, the penalties imposed by not having sodium bicarbonate in such preparations be carefully evaluated. Consideration must be given to strategies for treatment of diarrhoeal syndromes which will provide maximum coverage of those in need as well as to what best matches the ideal physiologic composition of any solution to be used.

Field studies are needed as well as carefully monitored hospital-based observations. If the WHO recommended formula for oral diarrhoea replacement solution is not available, everyone should be taught how to use the best available substitutes. For Bangladesh the best substitute seems to be a solution based on lobon and gur.

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