

## RICE - BASED ORAL REHYDRATION SOLUTION SHOWN TO BE BETTER THAN GLUCOSE - ORS AS TREATMENT OF NON - DYSENTERIC DIARRHOEA IN CHILDREN IN RURAL BANGLADESH

A BARI, ASMM RAHMAN, AM MOLLA<sup>1</sup> AND WB GREENOUGH III<sup>2</sup>

International Centre for Diarrhoeal Disease Research, Bangladesh, GPO Box 128, Dhaka 1000,  
Bangladesh; <sup>1</sup>Professor and Chairman, Department of Paediatrics, Aga Khan University  
Hospital, P O Box 3500, Karachi, Pakistan; <sup>2</sup>Professor of Medicine, Division of  
Geriatric Medicine, Francis Scott Key Medical Centre, 4940 Eastern Avenue,  
Baltimore, Maryland 21224, USA

### Abstract

Mothers living in rural Bangladesh were provided with either rice-based oral rehydration solution (rice-ORS) (Group A) or glucose-ORS (Group B) for treating non-dysenteric diarrhoea in their children aged under 5. Mothers living in a third area (Group C) were advised to use locally available treatment facilities, mainly unregistered medical practitioners. The incidence and duration of diarrhoea was recorded in all children over a two-year period. The outcome of each episode was recorded either as a success if the mother reported her child had recovered or as a failure if the child died or was admitted to hospital. Mothers in Group A used rice-ORS as the only treatment for 71% of episodes of non-dysenteric diarrhoea, mothers in Group B used glucose-ORS as the sole treatment in 60% of episodes, while mothers in Group C used drugs alone in 55% of episodes. Almost all children recovered successfully but the duration of diarrhoea differed significantly between groups: in the group treated with rice-ORS, 60% of children recovered within 3 days and less than 1% had diarrhoea which lasted for more than 14 days. By the criteria of early recovery and low rate of prolongation of diarrhoea, rice-ORS was found to be better than glucose-ORS.

*Key words:* Oral rehydration solutions; Oral rehydration therapy; Diarrhoea; Diarrhoea, Infantile; Prospective studies; Cereals; Rice.

### Introduction

It is well known that a glucose-based oral rehydration solution (glucose-ORS) can significantly reduce mortality due to non-dysenteric diarrhoea. The search for

a cheaper, more effective and more easily used alternative to glucose-ORS has resulted in the development of sucrose-ORS, sugar-salt solution and laban-gur solution (1-4). Research has shown that patients with diarrhoea are able to digest cereals and absorb the liberated glucose (5,6). This has led to clinical studies which have shown that a powdered cereal, such as rice,

---

Correspondence and requests for reprints should be addressed to Dr A Bari.

when substituted for glucose in the standard WHO ORS, can reduce the duration of non-dysenteric diarrhoea and vomiting, and reduce stool output (7-9). A feasibility study in rural Bangladesh showed that a rice-based ORS was acceptable to mothers as a treatment for children with diarrhoea and could be made at home (10). The aim of the present study was to compare the efficacy of rice-ORS with the standard glucose-ORS for treating children aged under 5 with diarrhoea, and to study the relative use by mothers of the principal treatments for diarrhoea.

### Materials and methods

#### *General description of study area and population:*

The study was carried out over a two-year period from November 1983 to October 1985, in seven villages of Chandpur district, Bangladesh. The study area is in a deltaic plain, 70 km southeast of Dhaka,

the capital of Bangladesh, and 20 km south of the Matlab field station of the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B). The Comilla-Chandpur highway runs through the study area (Fig. 1).

The main occupation of the population is agriculture. Less than a third of them have at least one year of schooling. Almost all families use open latrines and only about 30% obtain drinking water from shallow tube-wells; the remainder collect surface water for household purposes from ponds, canals and rivers. Diarrhoea is endemic and occasionally epidemic in the area. Government health facilities are available at a distance of 15-20 km, but most people obtain primary health care by paying unregistered village practitioners (11).

#### *Experimental design and sample size:*

A census of all families in the seven study villages was performed and the area

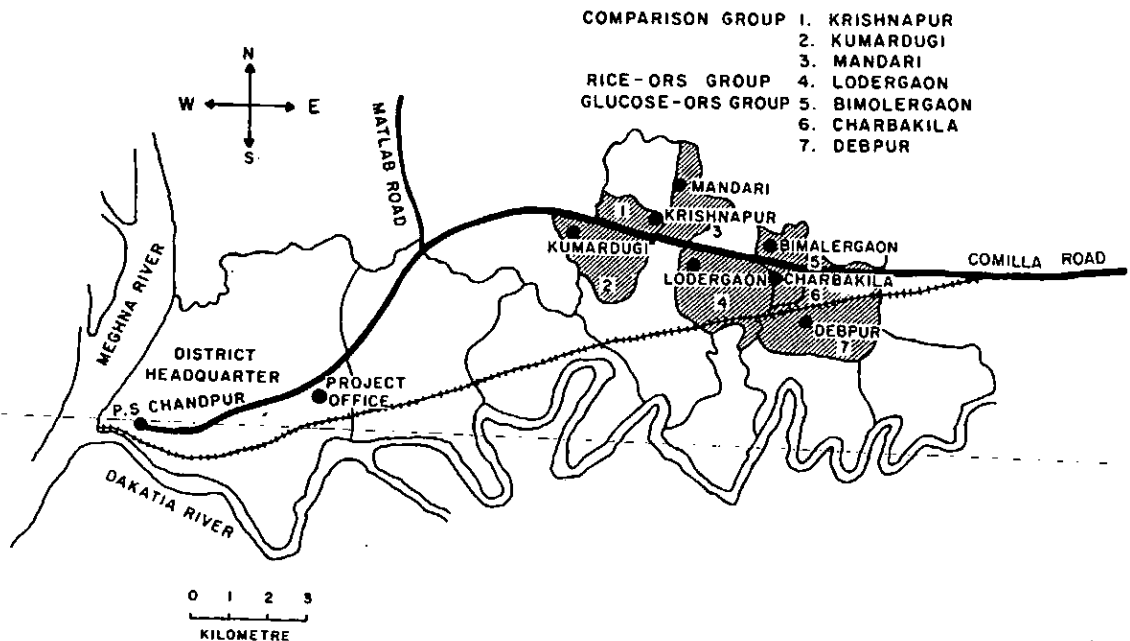


Fig. 1 - Map of Chandpur showing study villages.

in which they lived was divided into three sections (Fig. 1). The population of the villages was 10,450, of whom 1,961 were children aged under 5 (Table I). The weight and length of all children in this age group was measured and expressed as a percentage of NCHS standards (12).

Glucose-ORS, prepared according to the standard formula of the WHO Control of Diarrhoeal Diseases Programme\*, was provided to mothers in one section of the study area (Group A) as single packets making a 1/2 litre of solution. The mothers were shown how to make the solution by dissolving the contents of the packet in 0.5 l of water. Mothers in another part of the study area (Group B) were provided with rice-ORS in which the glucose in the WHO formula had been replaced with 40 g of powdered rice: the rice was provided in a packet separate from the salts. The mothers were shown how to make the solution by heating the rice powder with a little more than 0.5 l of water, to allow for evaporation, until it was boiled. This required cooking for 5 to 7 minutes. The salts were then added once the preparation had cooled.

Mothers in Groups A and B were advised to give ORS to their children from the onset of diarrhoea. Stores of ORS packets were given to 60 mothers to be distributed, when needed by each of them to 8-12 neighbouring families. No form of ORS was provided to mothers living in the remainder of the study area (Group C) and they were advised to use locally available facilities for treatment if their children developed diarrhoea. All mothers were advised to continue breast feeding and give other foods when their children had diarrhoea. They were also given advice about personal cleanliness.

Health workers visited all the families in each group once a week, between 9 am and 2 pm. The surveillance staff were rotated between groups. A mother's statement of diarrhoea was accepted for the purpose of surveillance and follow-up, and

health workers recorded the onset of diarrhoea, stool characteristics, major treatments used and the end of diarrhoea. If a mother reported that her child had diarrhoea, she was visited daily until her child's diarrhoea had ceased or for 7 days, whichever was earlier. If an episode of diarrhoea continued for more than 7 days the mother was then visited once a week. The end of an episode was recorded when the mother reported that her child had no stools or normal stools for two consecutive days, and was confirmed by subsequent daily visits. As health workers visited each area daily, they could be contacted by mothers to report episodes of diarrhoea.

According to the characteristics of the stools described by the mother, diarrhoea was classified as simple, watery, or dysenteric and defined as follows: loose or semi-liquid stools without blood or mucus was termed simple diarrhoea; liquid or watery stools with no blood or mucus was termed watery diarrhoea; loose or semi-liquid stools with blood and/or mucus was termed dysenteric diarrhoea. For the purposes of the present report, simple and watery diarrhoea were grouped together and termed non-dysenteric diarrhoea. Diarrhoea which lasted for 14 days or more was termed persistent diarrhoea.

The outcome of an episode of diarrhoea was assessed as a success if the mother reported a full recovery or as a failure if the child died or was admitted to hospital.

## Results

Table I shows the number of episodes of diarrhoea recorded during the study and the incidence rate of non-dysenteric diarrhoea. About two-thirds of all episodes of diarrhoea were non-dysenteric. There were significant differences between groups in the incidence rates of non-dysenteric diarrhoea.

Table II shows that mothers in Group A, who used rice-ORS, were more likely to use ORS to treat non-dysenteric diarrhoea when it was used as the only means of treatment than the mothers in Group B, who were provided with\* glucose-ORS

\*Glucose: 10 g; NaCl: 1.75 g; KCl: 0.75 g;  
NaHCO<sub>3</sub>: 1.25 g.

TABLE I - CHARACTERISTICS OF POPULATIONS IN GROUPS A, B AND C AND EPISODES OF DIARRHOEA AND NON-DYSENTERIC DIARRHOEA IN CHILDREN AGED UNDER 5

	Group A Rice - ORS	Group B Glucose - ORS	Group C Control
Total population	3261	3450	3739
* Density of population people/km <sup>2</sup>	951	959	963
* 0-4 yr children (% of population)	579 (17.7)	661 (19.2)	721 (19.3)
* Mothers of 0-4 yr children (% of population)	358 (11.0)	402 (11.6)	418 (11.0)
* Average family size (people/family)	5.9	6.2	6.0
+ Nutritional status: wt. for age. Mean (SD) of the % of median value of NCHS standards	69.5 (11.9)	69.4 (11.6)	69.2 (12.3)
Total episodes of diarrhoea	3871	3740	4883
Incidence/child/year	(3.34)	(2.83)	(3.39)
** Number of episodes of non-dysenteric diarrhoea (% of total episodes)	2399 <sup>a</sup> (62.0)	2405 <sup>b</sup> (64.3)	3326 <sup>c</sup> (68.1)
Incidence/child/year	2.07	1.82	2.31

\* Differences between the test and comparison areas were not statistically significant by Chi-square tests.

+ Differences between the nutritional values of the children in each group were not significant using two-tailed t test.

\*\* Chi-square test: a vs b :  $p < 0.05$   
b vs c :  $p < 0.001$   
a vs c :  $p < 0.001$

( $p < 0.001$ ). Table II also shows that drugs were the main treatment given to children by mothers in Group C, although nearly 30% of episodes received no treatment.

Table III shows that most episodes of diarrhoea ended in recovery irrespective of the treatment used. There were 8 failures in Group B compared with 2 in Group A ( $p < 0.05$ ); all other differences were not

significant.

Table IV shows that there were significant differences in the median duration of diarrhoea between groups.

Fig. 2 shows the cumulative rate of recovery from non-dysenteric diarrhoea in each group at days 3, 7, 14 and 21. In the group given rice-ORS, more than 60% of children had recovered within 3 days and

TABLE II - TREATMENTS USED BY MOTHERS FOR CHILDREN WITH NON-DYSENTERIC DIARRHOEA

Treatment	Group A Rice-ORS (n = 2399)	Group B Glucose-ORS (n = 2405)	Group C Control (n = 3326)
Only ORS	1700 <sup>a</sup> (70.9)	1446 <sup>b</sup> (60.1)	187 (5.6) <sup>*</sup>
Drugs alone <sup>+</sup>	89 <sup>c</sup> (2.9)	181 <sup>d</sup> (7.5)	1833 (55.1)
ORS plus drugs <sup>+</sup>	448 <sup>e</sup> (18.7)	595 <sup>f</sup> (24.7)	336 (10.1) <sup>*</sup>
No treatment	98 <sup>g</sup> (4.1)	178 <sup>h</sup> (7.4)	953 (28.6)
Others <sup>**</sup>	64 (2.7)	5 (0.2)	17 (0.5)

(Figures in parentheses indicate percentage)

- \* ORS from non-study source.
- + Drugs from non-study source.
- \*\* Combinations of homeopathic, herbal, and allopathic medicines.

Chi-square test: a vs. b :  $p < 0.0001$   
 c vs. d :  $p < 0.0001$   
 e vs. f :  $p < 0.0001$   
 g vs. h :  $p < 0.0001$

TABLE III - OUTCOME OF TREATING NON-DYSENTERIC DIARRHOEA WITH THE MOST COMMONLY USED TREATMENT IN EACH GROUP

Outcome of treatment	Group A Rice-ORS (n = 1700)	Group B Glucose-ORS (n = 1446)	Group C Control (n = 1833)
Recovery	1685 <sup>a</sup> (99.1)	1425 <sup>b</sup> (98.5)	1822 <sup>c</sup> (99.4)
Failure of treatment <sup>*</sup>	2 <sup>d</sup> (0.1)	8 <sup>e</sup> (0.6)	5 <sup>f</sup> (0.3)
Outcome unknown	13 (0.8)	13 (0.9)	6 (0.3)

(Figures in parentheses are percentages)

Chi-square test: a vs. b : not significant  
 b vs. c : not significant  
 d vs. e :  $p < 0.05$   
 d vs. f : not significant

\* The criteria of failure of treatment are hospitalisation and/or death.

less than 1% episodes lasted longer than 14 days, a difference which was statistically significant when compared with the other two groups ( $p < 0.001$ ).

TABLE IV - DURATION OF EPISODES OF NON-DYSENTERIC DIARRHOEA

Groups	Major treatment used	n*	Duration of diarrhoea in days		
			Median	Mean (SD)	Inter-quartile range
A	Rice-ORS	1687	3 <sup>a</sup>	3.31 (2.17)	2 - 4
B	Glucose-ORS	1433	5 <sup>b</sup>	5.47 (3.50)	3 - 6
C	Drugs used, ORS not supplied	1827	7 <sup>c</sup>	8.86 (5.56)	5 - 10

Brown-Mood test for median: a vs. b :  $p < 0.0001$   
 b vs. c :  $p < 0.0001$

\* Episodes of diarrhoea in which the outcome of treatment could not be determined were excluded.

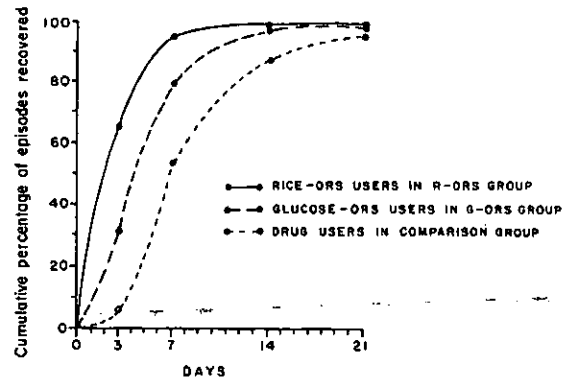


Fig. 2 - Cumulative rate\* of recovery from non-dysenteric diarrhoea using major treatment regimens in the three groups.

\* Episodes in which the outcome of treatment could not be determined were excluded.

Logrank test: Chi-square 1882; DF 2;  $p < 0.0001$ .

### Discussion

The effectiveness of ORS as a treatment for severe diarrhoea can be assessed by the cure rate or by a reduction in stool volume, and rice-ORS has been shown in clinical studies to be superior to glucose-ORS in these terms (7-9). But in field studies of mild diarrhoea, the effectiveness of ORS is better assessed in terms of the reduction in the duration of illness. In the present study, rice-ORS was more effective than glucose-ORS in reducing the duration of diarrhoea; also, the chances of the diarrhoea becoming persistent were lower.

The fact that mothers provided with rice-ORS were more likely to treat their children's diarrhoea with ORS than mothers given glucose-ORS may reflect its acceptability as a treatment: rice is a staple food in Bangladesh and preparations of rice are used traditionally to treat diarrhoea. This apparent preference for rice-ORS confirms a previous report from Bangladesh (10), but may not apply to other communities, particularly if rice is not a dietary staple.

Even though ORS was provided free and *ad libitum*, mothers in Groups A and B still sought treatment other than ORS for their children, though this was less common among mothers in Group A. This may again reflect the confidence of mothers in rice-ORS as an effective and adequate treatment for diarrhoea.

Although a few mothers in Group C used ORS obtained from another source to treat their children, about 65% used drugs alone or drugs and ORS, while nearly 30% gave no treatment at all. The lack of treatment may reflect the expensiveness of buying drugs from local practitioners. About 15% of all episodes of diarrhoea in children in Group C became persistent. This may be a consequence of inappropriate treatment with antibiotics.

The study described here is essentially a drug trial comparing rice-ORS and glucose-ORS with each other, and with a control of no ORS. The treatments were given to people living in three different areas. Although a basic tenet of a drug trial is that there should be no significant

differences between groups receiving different treatments, the fact that there were differences between groups in the incidence rates of diarrhoea during the study does not influence its conclusions, because the effectiveness of treatments was assessed in terms of the duration of diarrhoea of individual episodes. Differences in the incidence rates would not be expected to affect the duration of diarrhoea providing the nutritional status of children and clinical severity of episodes were not significantly different. So although the incidence rate of non-dysenteric diarrhoea among children in Group B was lower than the incidence rate among children in Group A (1.82 vs 2.07 episodes/child/year) the median duration of the illness was longer (5.47 vs 3.31 days).

In summary, the use of either rice-ORS or glucose-ORS to treat non-dysenteric diarrhoea in children aged under 5 reduces the duration of illness and reduces the likelihood that acute diarrhoea will become persistent. Rice-ORS was found to be more effective in these terms than glucose-ORS and, because it is more nutritious, its use may help to prevent growth faltering in children with diarrhoea. These findings may have useful implications for the primary health care programmes of developing countries.

### Acknowledgements

This study was supported by the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B), UNICEF and the Aga Khan Foundation. Current major donors giving assistance to the ICDDR,B are: Arab Gulf Fund, Australia, Bangladesh, Belgium, Canada (Canadian International Development Agency, the International Development Research Centre and World University Service of Canada), the Ford Foundation, Japan, Norwegian Agency for International Development, Saudi Arabia, Swedish Agency for Research Co-operation with Developing Countries, Switzerland, United Kingdom, United Nations Children's Fund, United Nations Development Programme, United States Agency for International Development, and World Bank.

### References

1. Nalin DR. Sucrose in oral therapy for cholera and related diarrhoeas. *Lancet* 1975;1:1400-2.

2. Sack DA, Chowdhury AMAK, Eusof A, et al. Oral hydration in rotavirus diarrhoea: a double blind comparison of sucrose with glucose electrolyte solution. *Lancet* 1978;2:280-3.
3. Islam MR, Greenough WB, III, Rahaman MM, Choudhury AK, Sack DA. Laban-gur (common salt and brown sugar) oral rehydration solution in the treatment of diarrhoea in adults. *J Trop Med Hyg* 1980; 83:41-5.
4. Nalin DR, Cash RA, Rahman M, Yunus M. Effect of glycine and glucose on sodium and water absorption in patients with cholera. *Gut* 1970;11:768-72.
5. Chung AW. Effect of oral feeding at different levels on absorption of food-stuffs in infantile diarrhea. *J Pediatr* 1948;33:1-13.
6. Molla A, Molla AM, Rahim A, Sarker SA, Mozaffar Z, Rahaman M. Intake and absorption of nutrients in children with cholera and rotavirus infection during acute diarrhoea and after recovery. *Nutr Res* 1982;2:233-42.
7. Patra FC, Mahalanabis D, Jalan KN, SEN A, Banerjee P. Is oral rice electrolyte solution superior to glucose electrolyte solution in infantile diarrhoea? *Arch Dis Child* 1982;57:910-2.
8. Molla AM, Ahmed SM, Greenough WB, III. Rice-based oral rehydration solution decreases the stool volume in acute diarrhoea. *Bull WHO* 1985;63:751-6.
9. Molla AM, Sarker SA, Hossain M, Molla A, Greenough WB, III. Rice-powder electrolyte solution as oral therapy in diarrhoea due to *Vibrio cholerae* and *Escherichia coli*. *Lancet* 1982;1:1317-9.
10. Rahman ASMM, Bari A, Molla AM, Greenough WB, III. Mothers can prepare and use rice-salt oral rehydration solution in rural Bangladesh. *Lancet* 1985;2:539-40.
11. Rahman ASMM. Village practitioners of Bangladesh: their characteristics and role in an oral rehydration program. (M.Sc. dissertation). London: London School of Hygiene and Tropical Medicine, University of London, 1980. 84 p.
12. NCHS growth curves for children birth-18 years, United States. Rockville, MD: National Center for Health Statistics, 1977. (Vital and health statistics, series 11, no. 165; DHEW).