Is oral rice electrolyte solution superior to glucose electrolyte solution in infantile diarrhoea?

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SUMMARY In a controlled trial of oral rehydration therapy, a rice-based electrolyte solution was evaluated in a group (n=26) of infants and young children aged between 3 months and 5 years with moderate to severe dehydration owing to acute diarrhoea, and the results were compared with a matched control group (n=26) receiving WHO recommended glucose electrolyte solution. The former was found to be more effective than the latter as shown by an appreciably lower rate of stool output, a shorter duration of diarrhoea, and a smaller intake of rehydration fluid.

Glucose mediated enhanced sodium absorption forms the basis of oral rehydration therapy in diarrhoea.¹ Glucose being expensive is not universally available so other carrier substances—such as sucrose—are used.² Rice on hydrolysis yields glucose, amino-acids, and oligopeptides which would enhance sodium absorption through independent carrier systems.³ This study describes a randomised trial of a rice-based oral electrolyte solution and compares it with the standard WHO recommended glucose electrolyte solution in infants and young children with dehydration caused by acute diarrhoea.

Patients and methods

Fifty-two children aged between 3 months and 5 years with acute watery diarrhoea and signs of moderate to severe dehydration⁴ were studied. The nature of the study was clearly explained to the parents, and written consent was obtained from them before the child was included in the study. Each child was weighed naked using a balance with a sensitivity of 1 g. The child was then randomly assigned to either of the two treatment groups by the use of sealed envelopes. The clinical features of the children were comparable (Table 1).

Children in the control group received an oral solution containing sodium 90 mmol/l, potassium 20 mmol/l, chloride 80 mmol/l, bicarbonate 30 mmol/l, and glucose 111 mmol/l; children in the study groups received an oral solution with an identical electrolyte composition, except that the glucose was replaced by 50 g/l of 'pop-rice' powder.

Pop rice is prepared by popping unhusked rice (paddy) on heated sand. It is a traditional rice snack universally consumed in the Indian subcontinent. It was procured from the market and made into a powder form and dissolved in the rehydration fluid before use. The rehydration solution was fed *ad libitum*.

Table 1 *Presenting features, nutritional status, and aetiological agents*

	Control group (n=26)	Study group (n=26)
Age median (months)	18	24
3 months-3 years	20	22
> 3 years-5 years	6	4
Duration of diarrhoea (hours) before admission (mean $\pm$ SE)	26.8 $\pm$ 5.8	27.4 $\pm$ 6.1
History of vomiting		
Number of patients	20	19
Mean duration (hours) $\pm$ SE	19.9 $\pm$ 5.3	16.8 $\pm$ 3.8
Weight on recovery for age as % of Harvard median		
$\geq$ 80%	2	5
70-79%	11	5
60-69%	9	9
< 60%	4	7
Pathogens isolated		
<i>Vibrio cholerae el tor</i>	8	7
<i>Shigella</i> sp.	1	0
Rotavirus	4	7
Enterotoxigenic <i>Escherichia coli</i>	3	2
Heat stable and heat labile	2	0
Heat stable	1	1
Heat labile	0	1
Combined infection		
Enterotoxigenic		
<i>E. coli</i> + <i>V. cholerae</i>	1	1
Enterotoxigenic		
<i>E. coli</i> + rotavirus	0	1
<i>V. cholerae</i> + rotavirus	0	1
Total positive (%)	14 (53.8%)	13 (50%)

by cup and spoon or directly from a cup. The volume ingested was recorded. Stool output was measured. Altogether 58% of the children in the control and 69% in the study group were breast fed. The feeding regimen has been described previously.⁵

Laboratory investigations

Blood chemistry and stool test for pathogens were carried out using methods which have been previously described.^{4,5} Protein content of rice was determined by the micro-Kjeldahl method. Statistical analysis was done using Student's *t* test.

Results

Two patients in each group could not be rehydrated orally owing to excessive vomiting and diarrhoea that required intravenous therapy. They were excluded from analysis. The remaining patients responded well to oral therapy (Tables 2 and 3). Rice-based oral fluid was accepted well. All patients recovered by 72 hours as judged by passage of formed or semi-solid stool. The initial 24-hour and total stool output were significantly lower in the study group compared with the control (Table 2). The study group also consumed less rehydration fluid. Although the mean weight gain at 6, 24, and 48 hours was greater in the study group than in the control one the differences were not significant. Enteropathogens isolated were comparable in both groups (Table 1). Protein content of 'pop-rice' was 87 g/kg and on *in-vitro* acid hydro-

Table 3 Biochemical values (mean $\pm$ SE) during the study period

	Control group (n=24)	Study group (n=24)
Plasma specific gravity		
Admission (0 hours)	1.029 $\pm$ 0.001	1.028 $\pm$ 0.001
6 hours	1.026 $\pm$ 0.001	1.025 $\pm$ 0.001
Recovery	1.023 $\pm$ 0.001	1.022 $\pm$ 0.001
Haematocrit (%)		
Admission (0 hours)	40.3 $\pm$ 1.5	39.5 $\pm$ 1.1
6 hours	33.5 $\pm$ 1.7	32.5 $\pm$ 1.2
Recovery	31.2 $\pm$ 0.6	31.6 $\pm$ 0.5
Serum sodium (mmol/l)		
Admission	127.2 $\pm$ 1.5	126.7 $\pm$ 1.0
Recovery	129.6 $\pm$ 1.2	129.3 $\pm$ 1.3
Serum potassium (mmol/l)		
Admission	3.7 $\pm$ 0.2	4.0 $\pm$ 0.2
Recovery	4.0 $\pm$ 0.2	4.0 $\pm$ 0.1

lysis it liberated 700 g/kg of glucose. In the study group the mean ($\pm$ SE) calorie and protein intakes from rice-based solution alone were 40 ($\pm$ 5.3) cal and 1.02 ($\pm$ 0.13) g per kg body weight respectively during an average period of 30 hours.

Discussion

Rice is cheap, easily obtained (eaten by 60% of world population), simple to pack (salts alone need to be packaged), and safe (larger quantities if used are unlikely to produce osmotic diarrhoea). In this study 50 g of precooked rice used in place of 20 g of glucose in oral rehydration fluid for infants and small children with acute diarrhoea was found to be more effective than the WHO recommended glucose electrolyte solution as judged by stool output, amount of rehydration fluid consumed, and the duration of diarrhoea. Hence rice-based oral solution could be regarded as superior to the extensively tested glucose electrolyte solution, the latter being the most effective oral rehydration solution known so far. In the study group the larger quantity of carbohydrate and the protein content of rice-based solution provides an additional nutritional advantage over glucose electrolyte solution.

A recent study⁶ in adults and older children (>5 years) with cholera and enterotoxigenic *Escherichia coli* diarrhoea showed that oral electrolyte solution containing 30 g/l of cooked rice powder was as effective as a sucrose electrolyte solution.

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Table 2 Clinical course, weight gain, stool output, oral rehydration solution, plain water intake, and duration of diarrhoea during treatment

	Control group (n=24)	Study group (n=24)
Vomiting after admission		
Number vomited	15	10
Mean duration (hours) $\pm$ SE	5.0 $\pm$ 0.8	4.3 $\pm$ 0.6
First urine voided within 12 hours	100%	100%
Mean weight gain (% of recovery weight $\pm$ SE)		
6 hours	3.24 $\pm$ 0.6	4.34 $\pm$ 0.7
24 hours	4.62 $\pm$ 0.6	6.48 $\pm$ 0.7
48 hours	5.58 $\pm$ 0.7	6.48 $\pm$ 0.9
Recovery	7.23 $\pm$ 0.7	7.84 $\pm$ 0.9
Mean stool rate, ml/kg ($\pm$ SE)		
First 6 hours	60 $\pm$ 9.1	38 $\pm$ 5.0*
First 24 hours	166 $\pm$ 23.2	97 $\pm$ 16.0*
Total	253 $\pm$ 39.0	129 $\pm$ 27.0**
Mean oral rehydration solution intake, ml/kg ($\pm$ SE)		
First 6 hours	111 $\pm$ 12.3	96 $\pm$ 10.6
First 24 hours	268 $\pm$ 35.4	186 $\pm$ 20.0
Total	366 $\pm$ 54.2	234 $\pm$ 30.4*
Duration of diarrhoea (hours) (mean $\pm$ SE)	43 $\pm$ 4.5	30 $\pm$ 4.0*
Total plain water intake, ml/kg (mean $\pm$ SE)	95 $\pm$ 15.9	91.5 $\pm$ 16.4

P* < 0.05, *P* < 0.02.

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