

# Oral solutions for infantile gastroenteritis—variations in composition

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**SUMMARY** Four different carbohydrate electrolyte solutions were provided for children under 18 months with acute gastroenteritis treated as outpatients. Osmolality and sodium content were measured in samples of solutions as given by the parents. All types of feed were made up with marked inaccuracy. Osmolality was sometimes unacceptably high in solutions containing glucose, while the highest osmolality for sucrose solutions hardly exceeded the correct value for glucose solutions. Most parents could use a sachet with reasonable accuracy although there were still wide extremes of error. The ideal preparation for use in developed countries may be a sachet containing sucrose and electrolyte, particularly if such sachets could be made generally available and not just for use in hospitals and clinics.

The successful treatment of gastroenteritis in children relies on the maintenance or restoration of adequate hydration and electrolyte balance. In most children this can be achieved by manipulation of the diet. A simple, effective, and accurate method suitable for use at home is difficult to achieve. There has been considerable success in developing countries with an oral rehydration solution promoted by WHO and distributed by UNICEF<sup>1</sup>, but in the UK a wide range of solutions is used.

The exact composition of oral fluids to be administered to infants with acute diarrhoea and vomiting is controversial but there is now general agreement that it should be a carbohydrate electrolyte solution. Controversy has centred upon whether the carbohydrate should be glucose or sucrose<sup>2–5</sup> and upon the appropriate level of sodium in the solution.<sup>6–10</sup> An important factor in deciding a suitable composition concerns the potential risk if inaccurately prepared; this in turn will be related to the mode of preparation of the solution as well as to its composition. We report the composition of four solutions currently used and prepared by mothers of infants with acute gastroenteritis in the UK. We also assess the implications of these findings.

## Methods

This study was performed in two parts. The first study was undertaken in 1976 and some aspects were reported<sup>11</sup>; the second study was undertaken in 1978.

In the first study, parents diluted a concentrated outpatient electrolyte mixture (OPEM) and then added either glucose or sucrose. 18 samples of glucose electrolyte solution and 25 samples of sucrose electrolyte solution had their osmolality and sodium measured.

In the second study, parents used either a sachet,<sup>12</sup> now marketed as Dioralyte (Armour Pharmaceuticals, Eastbourne, Sussex) and based on sodium chloride and dextrose compound powder BPC, to which water was added, or an already diluted electrolyte solution to which sucrose was added. 25 samples of glucose sachet solution and 23 of sucrose electrolyte solution were measured. All children treated were under 18 months of age. Each solution was made up at home by the parents and brought to the hospital for testing. The sucrose electrolyte solution was also prepared by pharmacists and dispensed complete, and the composition compared with that prepared by mothers. The correct composition of these solutions is shown in Table 1, and their constituents in the Appendix.

## Results

The osmolality of each solution as prepared by the parents is shown in the Figure, with the theoretically correct values for each one. The mean and the range of osmolality and sodium content for each solution is shown in Table 2. There was a wide range of osmolality of all types of solutions prepared by mothers. Although in sachet form as Dioralyte most

solutions had an osmolality close to the correct value, some samples were widely inaccurate. The range for solutions prepared and dispensed by pharmacy staff was much narrower. On two occasions osmolality approached a level of 600

Table 1 Correct composition of oral solutions

Constituents	Diluted OPEM	Electrolyte mixture	Dioralyte (1 sachet in 200 ml)
Sodium (mmol/l)	23	24	35
Potassium (mmol/l)	28	28	20
Chloride (mmol/l)	25	24	37
Base (mmol/l)	Phosphate 5 Citrate 7	Phosphate 5 Citrate 10	Bicarbonate 18
Sugar (mmol/l)	Sucrose 166 Glucose 266	Sucrose 120	200
Others (mmol/l)		Calcium 2 Magnesium 2	
Total osmolality (mmol/kg)	With sucrose 216 With glucose 315	215	310

OPEM = outpatient electrolyte mixture.

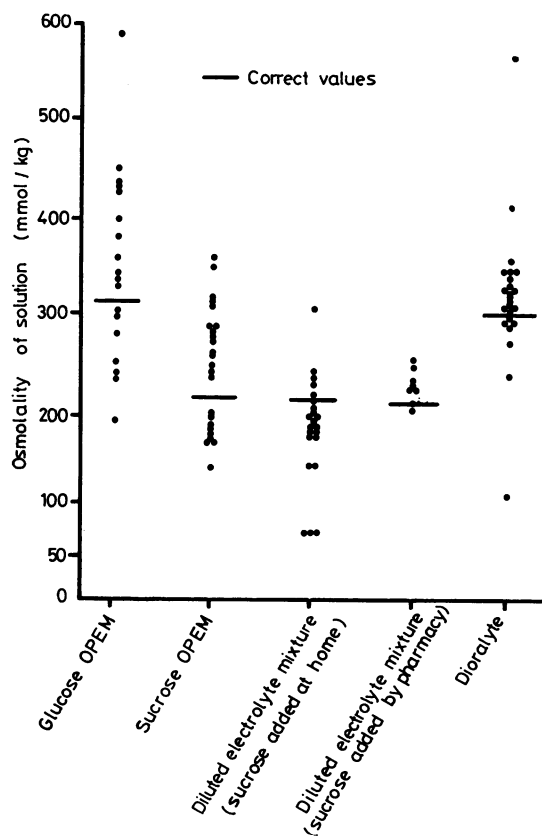


Figure Osmolality of samples of oral solutions provided by parents.

Table 2 Composition of oral solutions given by parents

	Glucose OPEM	Sucrose OPEM	Diluted electrolyte mixture		Dioralyte
			Sucrose added at home	Sucrose added by pharmacy	
Osmolality (mmol/kg)					
Range	192-590	145-360	81-314	201-259	121-580
Mean $\pm$ SD	351 $\pm$ 98	245 $\pm$ 63	189 $\pm$ 56	232 $\pm$ 19	327 $\pm$ 74
Correct composition	315	216		215	310
Sodium content (mmol/l)					
Range	16-27	5-28	2-28	23-29	5-43
Mean $\pm$ SD	22 $\pm$ 4	22 $\pm$ 5	23 $\pm$ 5	25 $\pm$ 2	36 $\pm$ 7
Correct composition		23		24	35

OPEM = outpatient electrolyte mixture.

mmol/kg, a value to which infants are potentially intolerant.<sup>13</sup> Indeed one of these children who received glucose OPEM had diarrhoea and required hospital admission, whereas the other child who received Dioralyte did not require admission.

There was a wide range, too, of sodium levels but this range did not exceed 43 mmol/l.

## Discussion

Two studies<sup>11 14</sup> from this hospital have shown that sucrose was at least as good as glucose in the outpatient management of acute gastroenteritis, and the usefulness of sucrose in other countries has been demonstrated.<sup>5 15</sup>

There are theoretical grounds now for believing that unlike the situation in the toxigenic diarrhoea of cholera, glucose has no particular merit for nontoxigenic gastroenteritis—for example rota virus gastroenteritis;<sup>16</sup> therefore there appear to be no advantages for a glucose solution in such children and it carries a risk of hyperosmolality if made up incorrectly. Indeed some years ago Ironside<sup>17</sup> pointed out the risk of hyperosmolar solutions if glucose is used orally for gastroenteritis; this study confirms this risk. The highest osmolality achieved when sucrose is added to electrolyte solution hardly exceeded the osmolality of the correctly formulated glucose solution. Inaccurate formulation of glucose solutions may achieve an unacceptably high osmolality, even if they are packed in a sealed sachet.

The sodium content of the Dioralyte sachet is higher at 35 mmol/l than that of solutions containing 24 mmol/l Na<sup>+</sup> which have been used at this hospital since 1952, during which period there have been few cases of hyponatraemia.<sup>18-19</sup> Although the range

for sodium was wide it was not as great as the range of osmolality. The highest sodium concentration was less than it would have been had any parent added two sachets to 200 ml, a fear expressed recently by Cutting,<sup>20</sup> and sodium probably never reached harmful levels.

The incidence, morbidity, and mortality of infantile gastroenteritis are fairly low in Britain. Any method of preparing oral carbohydrate electrolyte mixtures must be safe and morbidity due to their use is unacceptable. A sachet preparation has the advantages of compactness and convenience over an already made-up solution, although we have shown that it may occasionally be used with great inaccuracy. If glucose is used as the carbohydrate, hyperosmolar feeds may be prepared with the risk of promoting or prolonging diarrhoea. A unit pack, such as a sachet, containing sucrose as carbohydrate may be ideal for use in developed countries such as Britain. This would be particularly relevant if such sachets could be made generally available.<sup>21</sup>

## Appendix

### Concentrated outpatient electrolyte mixture

500 ml contains:

Sodium chloride	3.05 g
Potassium chloride	1.55 g
Sodium dihydrogen phosphate (2H <sub>2</sub> O)	2.35 g
Potassium citrate	6.75 g

Diluted 1 part of concentrated OPEM to 5 parts boiled water. Sugar added as 25 g to 500 ml of diluted solution. This solution has not been dispensed since December 1977

### Electrolyte mixture

500 ml contains:

Sodium chloride	0.26 g
Sodium citrate	0.49 g
Potassium chloride	0.26 g
Potassium citrate	1.13 g
Magnesium chloride (6H <sub>2</sub> O)	0.2 g
Calcium chloride (6H <sub>2</sub> O)	0.147 g

### Dioralyte (Armour Pharmaceuticals)

Each sachet is dissolved in 200 ml of water and contains:

Sodium chloride	0.2 g
Potassium chloride	0.3 g
Sodium bicarbonate	0.3 g
Dextrose	8.0 g

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## References

- Rohde J E, Northrup R S. Taking science where the diarrhoea is. In: *Acute diarrhoea in childhood*. Ciba Foundation Symposium 42 (new series). Amsterdam: Elsevier Excerpta Medica, 1976: 339-65.
- Anonymous. Water with sugar and salt. *Lancet* 1978; ii: 300-1.

- Hirschhorn N, McCarthy B J, Ranney B, et al. *Ad libitum* oral glucose-electrolyte therapy for acute diarrhoea in Apache children. *J Pediatr* 1973; 83: 562-71.
- Nalin D R, Levine M M, Mata L, et al. Comparison of sucrose with glucose in oral therapy of infant diarrhoea. *Lancet* 1978; ii: 277-9.
- Sack D A, Chowdhury Amak, Eusof A, et al. Oral rehydration of rotavirus diarrhoea: a double blind comparison of sucrose with glucose electrolyte solution. *Lancet* 1978; ii: 280-3.
- Chatterjee A, Mahalanabis D, Jalan K N, et al. Oral rehydration in infantile diarrhoea. Controlled trial of a low sodium glucose electrolyte solution. *Arch Dis Child* 1978; 53: 284-9.
- Nichols B L, Soriano H A. A critique of oral therapy of dehydration due to diarrheal syndromes. *Am J Clin Nutr* 1978; 30: 1457-72.
- Hirschhorn N. Letter: Treatment of diarrheal dehydration. *Am J Clin Nutr* 1978; 31: 1967-8.
- Sperotto G. Letter: Treatment of diarrheal dehydration. *Am J Clin Nutr* 1978; 1968-9.
- Nicholls B L. Letter: Treatment of diarrheal dehydration. *Am J Clin Nutr* 1978; 1969-70.
- Hutchins P, Matthews T H J, Manly J E, Lawrie B, Walker-Smith J A. Comparison of oral sucrose and glucose electrolyte solutions in the out-patient management of acute gastroenteritis in infancy. *J Hyg (Camb)* 1979; 82: 15-9.
- Anonymous. Hydration in acute diarrhoea in childhood: use of Dioralyte. *Drug Ther Bull* 1979; 17: 51-2.
- Francis D E M. Treatment of multiple malabsorption syndrome of infancy. *J Hum Nutr* 1978; 32: 270-8.
- Rahilly P M, Shepherd R, Challis D, Walker-Smith J A, Manly J. Clinical comparison between glucose and sucrose additions to a basic electrolyte mixture in the out-patient management of acute gastroenteritis in children. *Arch Dis Child* 1976; 51: 152-4.
- Chatterjee A, Mahalanabis D, Jalan K N, et al. Evaluation of a sucrose electrolyte solution for oral rehydration in acute infantile diarrhoea. *Lancet* 1977; i: 1333-5.
- Davidson G P, Gall D G, Petri M, Butler D G, Hamilton J R. Human rotavirus enteritis induced in conventional piglets. Intestinal structure and transport. *J Clin Invest* 1977; 60: 1402-9.
- Ironsides A G. Gastroenteritis of infancy. *Br Med J* 1973; i: 284-6.
- Gribbin M, Walker-Smith J A, Wood C. A twelve month prospective survey of admissions to the gastroenteritis unit of a children's hospital. *Acta Paediatr Belg* 1976; 29: 69-77.
- Tripp J H, Wilmers M J, Wharton B A. Gastroenteritis: a continuing problem of child health in Britain. *Lancet* 1977; ii: 233-6.
- Cutting W. Oral treatment of diarrhoea in children. *J Mat Child Health* 1979; 4: 276-81.
- Whitney J D W. Letter: Standard rehydration fluids. *Lancet* 1977; ii: 191.

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