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# Retrospective/Rétrospective

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## Replacement of intravenous therapy by oral rehydration solution in a large treatment centre for diarrhoea with dehydration\*

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*Intravenous fluid therapy is particularly effective in reversing severe dehydration due to diarrhoea, but it can be replaced by oral rehydration, with the advantages of lower risks and costs, in the treatment of mild, moderate and some severe cases of dehydration. In this study, the efficacy of oral rehydration solution was compared with that of intravenous fluid in the treatment of moderate and some severe cases of dehydration due to diarrhoea in a treatment centre in Bangladesh during a period of 5 months in 1980 and the same months in 1981. The results of this study show that rehydration by oral rehydration solution (ORS) is as effective as intravenous fluid therapy. ORS can be used for the treatment of diarrhoeas in all age groups including young infants. The costs were reduced by 33% despite an increase in the duration of stay of some patients.*

Diarrhoeal diseases present a major health problem in developing countries. It is reported that 750–1000 million cases of diarrhoea occur in children below 5 years of age in Asia, Africa and Latin America every year. It is estimated that 3–6 million in this age group die annually from acute diarrhoea (1). In addition, repeated attacks of diarrhoea lead to malnutrition and more deaths. According to accurate data from one part of Bangladesh, in 1975 there were 23.9 deaths per 1000 population. Diarrhoea was responsible for 34% of these deaths and was the commonest cause (2).

Intravenous fluid (IVF) therapy was first used in patients with cholera in 1831 (3), and is now available in hospitals in developed and developing countries. However, in developing countries most of the small hospitals may not be well enough organized to give

such treatment safely because of the cost and dependence on imported materials. The development of oral rehydration solution (ORS) is based on the knowledge that glucose enhances sodium and water absorption; it was first introduced in 1968 in adults (4–6) and later in children with cholera (7). The successful use of oral fluid therapy in cholera patients among Bangladesh refugees was reported by Mahalanabis et al. (8). The standard oral rehydration solution, as recommended by WHO for the treatment of dehydration due to diarrhoea in all age groups, contains sodium chloride 3.5 g, sodium bicarbonate 2.5 g, potassium chloride 1.5 g, and glucose 20 g in one litre of potable water. Scientific studies have demonstrated that standard ORS can be given to all age groups including infants (9–13). A recent study has shown that standard ORS and plain water (in a ratio of 2:1) can successfully rehydrate neonates (14). The present study compares the rehydration of patients with moderate and severe dehydration due to diarrhoea by means of intravenous and oral therapy.

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Cholera Research Laboratory, is a specialized centre for diarrhoeal disease research and treatment, providing free service to about 100 000 patients with diarrhoea every year.<sup>a</sup> Patients with diarrhoea but no apparent dehydration are treated with ORS on an ambulatory basis. Mild cases of dehydration are also treated with ORS which is first given by the mothers in a separate area of the outpatient department, called the oral rehydration pavilion, and then continued in their homes. All moderate and severe cases of dehydration, without complications, are admitted to the treatment centre for rehydration with IVF, followed by ORS. Patients developing complications in the treatment centre are transferred to a medical ward for intensive care; diarrhoea patients who come to the treatment centre with complications are also admitted to this ward directly. The catchment area of the ICDDR-B health complex consists of the Dhaka metropolitan area and its suburbs with a radius of approximately 15 miles; however, some patients come from longer distances.

#### MATERIALS AND METHODS

The subjects for this study were 10 379 patients with moderate and severe dehydration due to diarrhoea who were admitted to the treatment centre of the ICDDR-B during the first five months of 1980, and 9897 patients with similar degrees of dehydration who were admitted during the first five months of 1981.

There were 14 771 patients with mild dehydration in the same period of 1980 and 13 942 during the corresponding months in 1981; all of them were treated in the oral rehydration pavilion with ORS for a few hours and were not included in this study. The definition of mild, moderate and severe dehydration was based on the WHO standard.<sup>b</sup> Almost all uncomplicated diarrhoea patients with moderate and severe dehydration who were admitted to the treatment centre in 1980 were initially treated with IVF, followed by ORS (IVF + ORS). In December 1980, the ICDDR-B decided to use oral treatment even in cases of moderate and severe dehydration, with a view to testing the safety of the WHO-recommended oral rehydration solution<sup>b</sup> under supervised conditions. With this change, all moderate and severe cases of dehydration, who were able to take ORS, were treated with the ICDDR-B oral rehydration solution (same composition as standard ORS, except for 40 g of

sucrose per litre instead of glucose). The mothers administered the ORS to their young infants and small amounts of water were allowed as part of re-feeding. The indications for IVF therapy were defined as pulselessness, shock or persistent vomiting. The stools of patients with watery diarrhoea were screened for vibrios by darkfield examination (15), and those that were positive were cultured.

Serum electrolytes were measured in patients who were clinically suspected of having an electrolyte imbalance. The efficacy, safety and cost-effectiveness of ORS in the treatment of moderate and severe cases of dehydration were investigated by comparing the data for 1980 with those for 1981.

The indices used for comparing the efficacy of ORS treatment with that of IVF therapy were: (a) the number of patients who developed complications (electrolyte imbalance, aspiration pneumonia, chest infection, hyperpyrexia, convulsion, etc.) and were referred from the treatment centre to the medical ward for intensive care; (b) the mortality rate in the treatment centre; (c) the average amount (per patient) of ORS and IVF that was required for rehydration; (d) the number of patients staying in the treatment centre for up to 12 hours and for more than 12 hours; and (e) the cost per patient. A breakdown of the ages of the patients in the first 5 months of 1980 and 1981 from the diarrhoea surveillance study of the ICDDR-B health complex was prepared to show the age incidence of the patients for these two years.<sup>c</sup> The figures for each five-month period in 1980 and 1981 were matched.

Information on the numbers of admissions, of patients referred from the treatment centre to the medical ward for intensive care, and of deaths, and on the duration of stay (under 12 hours and over 12 hours) for the two periods under study was obtained from the registry. The percentage of patients who developed complications or an electrolyte imbalance in the treatment centre and had to be referred to the medical ward was calculated on the basis of a 10% random sample. Information on the number of patients who received IVF + ORS or ORS alone was obtained directly from the case records. Information on the amount of IVF, ORS and total fluids used per patient, the type of fluid therapy in relation to the degree of dehydration and the mean duration of stay (for less than 12 hours or over 12 hours) was obtained from a 10% random sample (during 3 days each month) covering the two periods in 1980 and 1981. The records of patients who died were investigated with a view to getting information on mortality in relation to the type of treatment and severity of dehydration. The cost per patient was based on the

<sup>a</sup> BECKETT, J. & MCCRARTNEY, J. (ed.), *Annual report*. International Centre for Diarrhoeal Disease Research, Bangladesh, 1980.

<sup>b</sup> *A manual for treatment of acute diarrhoea*. Geneva, World Health Organization, 1980 (unpublished document, WHO/CDD/SER/80.2).

<sup>c</sup> STOLL, B. Surveillance study of patients in ICDDR-B Hospital (unpublished data).

1980 rates for comparison purposes. The actual cost to the centre of scalp vein needles imported by the ICDDR-B was used in costing. ORS was prepared in the centre and the net cost to the centre was used in the calculations, since it could be prepared at the same cost elsewhere in the country. Although IVF was also prepared in the centre, its cost in the calculations was based on the market price, which is what has to be paid throughout Bangladesh. Information on costs of staff and supplies for the first five months of 1980 and 1981 was obtained from the Controller's office in ICDDR-B. The cost of all items, on the basis of the above criteria, for the two periods in 1980 and 1981 was added and divided by the total number of patients in the treatment centre to give the average cost for each period.

## RESULTS

The population in this investigation was the community living in and around Dhaka city and having the same socioeconomic level. Although the patients were of all age groups, the majority were under 5 years of age (Table 1). Among the latter, the percentage of children under one year was similar for both 1980 and 1981 ( $P > 0.05$ ). The annual seasonal cycle of diarrhoea in Dhaka follows a distinct pattern (16, 17), and there was no unusual epidemic of cholera or other diarrhoeal disease during the periods investigated. Stool cultures from patients with watery diarrhoea in the treatment centre showed no statistically significant difference in the incidence of vibrios: 7.12% in 1980 and 9.3% in 1981 ( $P > 0.05$ ).

Table 2 presents some data for comparison of ORS with IVF therapy during the two periods. The percentages of referred cases from the treatment centre to the medical ward were 9.07% in 1980 and 7.52% in 1981; this difference is significant ( $P < 0.01$ ). The mortality rates for the two periods, however, were not significantly different ( $P > 0.05$ ). Investigation of the case

Table 1. Percentage distribution of patients, according to age group, during the two periods in 1980 and 1981<sup>a</sup>

Age group (years)	1980 (n = 1387)	1981 (n = 1220)
< 1	27.1	25.3
1-4	38.7	33.7
5-14	11.2	11.5
15-29	11.0	14.2
30+	11.9	15.2

<sup>a</sup> Hospital surveillance study.

Table 2. Indices used for comparison of treatment methods (i.e., efficacy of ORS against IVF) during the two study periods in 1980 and 1981

Indices	Percentage of total admissions to treatment centre (TC)		P value
	1980 (n = 10 379)	1981 (n = 9897)	
Referrals from TC to medical ward	9.07	7.52	< 0.01
Deaths in TC	0.06	0.06	> 0.05
Stayed > 12 hours	29.90	42.10	< 0.01
Stayed ≤ 12 hours	70.10	57.90	< 0.01

records for mortality revealed that 4 out of 6 deaths in the treatment centre in 1981 occurred in severely dehydrated patients who were admitted with shock and severe breathlessness and 2 deaths were related to severe chest infections. Although all these patients received immediate IVF, they died within a few minutes of arrival at the treatment centre and before they could be admitted to the medical ward. The deaths in 1980 were due to similar reasons. The percentage of patients staying for more than 12 hours in the treatment centre was 29.9% in 1980 and 42.1% in 1981; this difference is statistically significant ( $P < 0.01$ ). However, the mean duration of stay of these patients was  $28.6 \pm 15.9$  hours in 1980 and  $29.2 \pm 12.9$  hours in 1981; this difference is not significant ( $P > 0.05$ ). Among the patients staying less than 12 hours, the mean duration of stay was  $6.02 \pm 3.18$  hours in 1980 and  $6.73 \pm 3.35$  hours in 1981; this is significant at the 0.001 level.

Table 3 presents data on electrolyte imbalances in patients referred from the treatment centre to the medical ward; the results show no significant difference between the two periods ( $P > 0.05$ ).

The average amounts of IVF, ORS and total fluid used per patient (based on a 10% sample of patients) were 1.26, 0.10 and 1.36 litres respectively in 1980, and 0.65, 1.16 and 1.81 litres respectively in 1981. In 1980, 93% of all patients were treated with IVF + ORS and 7% with ORS alone; in 1981 the figure for IVF + ORS came down to 39% ( $P < 0.001$ ) and for ORS increased to 61% ( $P < 0.001$ ). Further analysis (from 10% sample data) showed that, in 1981, 94% of severe cases of dehydration were treated with IVF + ORS (compared with 100% in 1980,  $P < 0.01$ ), and 6% were treated with ORS alone (compared with 0% in 1980,  $P < 0.01$ ). Among moderate cases of dehydration, 29% received IVF + ORS in 1981 (92% in

Table 3. Number of patients with electrolyte imbalance referred from the treatment centre to the medical ward during the two study periods in 1980 and 1981

Electrolyte imbalance	1980		1981		P value
	No.	%	No.	%	
Hyponatraemia (Na < 130 mmol/l) <sup>a</sup>	26	(27.7)	25	(33.8)	> 0.05
Hypernatraemia (Na ≥ 150 mmol/l) <sup>b</sup>	4	(4.2)	4	(5.4)	> 0.05
Bicarbonate and/or potassium <sup>c</sup>	31	(33.0)	21	(28.4)	> 0.05
Total electrolyte imbalance	61	(64.9)	50	(67.6)	> 0.05
Other complications	33	(35.1)	24	(32.4)	> 0.05

<sup>a</sup> Hyponatraemia with/without other electrolyte imbalance.

<sup>b</sup> Hypernatraemia with/without other electrolyte imbalance.

<sup>c</sup> Bicarbonate and/or potassium imbalance with normal serum sodium level.

1980,  $P < 0.001$ ), and 71% were successfully treated with ORS alone in 1981 (8% in 1980,  $P < 0.001$ ).

Table 4 shows how the cost per patient was reckoned up. The average cost per patient in the treatment centre was US\$ 6.60 in 1980 and US\$ 4.40 in 1981, a saving of 33.3%.

#### DISCUSSION

Intravenous fluid therapy is effective in treating dehydration but, compared with oral rehydration, it presents greater risks and costs more. The main risks,

in addition to psychological stress to parents, are the introduction of septicaemic infection, pyrogenic reactions, embolism, phlebitis, thrombosis, and even rupture of the veins. Treatment with ORS is simple, safe, effective, and less expensive (1). In addition, training in ORS therapy teaches the parents what to do at home in similar cases of diarrhoea (18).

The number of complicated cases referred from the treatment centre to the medical ward (intensive care) was less in 1981 than in 1980. This may indicate that intravenous fluids, although life-saving in patients, may be responsible for some of the complications. There was no significant difference in mortality between the two periods, all deaths occurring only in

Table 4. Comparison of the overall cost per patient during the two periods in 1980 and 1981

	1980 (No. of patients 10 379)			1981 (No. of patients 9897)		
	No. of units	Cost per unit (US\$)	Total cost (US\$)	No. of units	Cost per unit (US\$)	Total cost (US\$)
Scalp vein needles	12 610	0.85	10 718	3 811	0.85	3 240
IV fluids (litres) and IV sets	13 077	2.81	36 749	6 433	2.81	18 077
ORS (litres)	1 038	0.11	114	11 480	0.11	1 263
Staff salaries			9 009			10 473
X-ray and laboratory tests			4 525			4 713
Medicines and other supplies			5 031			3 667
Food			2 449			2 516
Total			68 595			43 949
Cost per patient			6.60			4.40

very severe cases of dehydration who had been given immediate IVF. None of the children treated with ORS died. These observations suggest that treatment with ORS of most patients with moderate (and some cases of severe) dehydration is fully effective. Severe dehydration can be prevented if ORS therapy is practised earlier in the course of diarrhoeal disease. Thus a nationwide policy to promote oral rehydration services is important and these should be incorporated into the basic health services.

The results of this study should allay the concern of those paediatricians who believe that standard ORS can produce hypernatraemia in young infants and an increased mortality rate (19). This conclusion is based on observations on children aged between 0 and 11 months in the two periods, comparison of the numbers referred with complications from the treatment centre to the medical ward, the percentage of hypernatraemia in these referred cases, and mortality rates in the two periods. The analysis of causes of deaths revealed that none was related to ORS therapy. On the contrary, the WHO standard ORS may be an appropriate rehydration solution for all age groups,

including infants in developing countries, many of whom suffer from malnutrition, since malnutrition is known to cause hyponatraemic dehydration (20).

Although in 1981 the staff costs, as a result of recruitment of new staff, exceeded those for 1980, the replacement of IVF by ORS led to savings of 33% in the total costs incurred. Treatment with ORS was found to be cheaper but as effective as IVF therapy in the present study. The promotion of ORS therapy with lower costs is of particular importance for developing countries where both skilled personnel and financial resources are limited. The savings may be greater if provision for the use of ORS is planned at the national level for the whole country. Developing countries should therefore make ORS services available throughout the country with a view to reducing the number of diarrhoea patients requiring hospital admission (21) and reducing the mortality due to diarrhoea. Use of ORS may prolong the stay of a patient in hospital to some extent, but since mothers can be responsible for this treatment, the overall cost, compared to treatment with IVF, is less.

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### RÉSUMÉ

#### REPLACEMENT DE LA PERFUSION PAR L'ADMINISTRATION ORALE D'UNE SOLUTION DE RÉHYDRATATION DANS UN GRAND CENTRE DE TRAITEMENT DES DIARRHÉES AVEC DÉSHYDRATATION

Le traitement par perfusion intraveineuse est particulièrement efficace pour contrebalancer une déshydratation sévère mais on peut le remplacer par une réhydratation par voie orale qui a l'avantage d'être moins risquée et moins coûteuse, notamment en ce qui concerne le traitement des cas de déshydratation légère à modérée ou même de certains cas graves. Dans la présente étude, nous avons comparé l'efficacité de la réhydratation orale au moyen de la solution OMS à celle de la perfusion pour le traitement des déshydratations modérées, voire sévères, d'origine diarrhéique au cours des cinq premiers mois de 1980-1981 dans un Centre de traitement spécialisé, situé à Dhaka (Bangladesh). En 1980 presque tous les cas modérés à graves de déshydratation ont été traités par perfusion, mais en décembre 1980, il a été décidé de faire appel aux solutions de réhydratation orale, même dans ces cas-là (sauf chez les patients en état de choc ou incapables de boire), en vue de procéder à un essai sous contrôle de la solution recommandée par l'OMS. Les résultats obtenus montrent qu'en 1980, 93% de ces patients

ont été perfusés contre 7% seulement réhydratés par voie orale. En 1981, la proportion de perfusés est tombée à 39% et celle des réhydratés par voie orale à 61%. La quantité moyenne de liquide de perfusion par malade est passée de 1,26 litres en 1981 à 0,65 litres en 1981. Le nombre de malades transférés du centre de traitement aux services de médecine des hôpitaux, pour cause de complications, a été sensiblement réduit en 1981 où on a utilisé la réhydratation par voie orale par rapport à l'année 1980 où on utilisait essentiellement la perfusion, les critères d'appréciation étant les mêmes pendant ces deux périodes. Les décès enregistrés concernaient quelques cas de déshydratation très graves qui avaient été immédiatement perfusés. En revanche, on n'a pas enregistré de décès parmi les malades réhydratés par voie orale. Le coût global par malade dans le centre de traitement a été ramené de 6,60 \$EU en 1981 à 4,40 \$EU en 1981. Notre étude montre également que la solution de réhydratation orale standard peut être utilisée sans risques chez des malades de tous âges, y compris les nourrissons de 0 à 11

mois. Il n'y a eu aucune différence dans l'incidence des cas d'hypernatrémie parmi les malades transférés du centre de traitement aux services de médecine des hôpitaux au cours des deux périodes en cause. En 1981, les coûts en personnel ont été supérieurs à ceux de 1980, du personnel ayant recruté pendant cette période. Cependant, le remplacement de la perfusion par la réhydratation orale a conduit à une économie globale de 33%. Les incidences financières du recours à la réhydratation orale sont très importantes pour les pays en développement où l'on manque de personnel qualifié et où les moyens financiers sont limités. Les

économies réalisées peuvent encore être accrues si l'utilisation de ces solutions orales est planifiée au niveau central pour l'ensemble du territoire national. Il faudrait donc que les pays en développement créent des services de réhydratation orale sur l'ensemble de leur territoire en vue de réduire le nombre des hospitalisations ainsi que la mortalité dus aux diarrhées. La réhydratation par voie orale peut entraîner un allongement de la durée de séjour du malade, mais les coûts globaux sont moindres qu'avec la perfusion.

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