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EXPERIENCE WITH ORAL REHYDRATION THERAPY IN MODERATELY DEHYDRATED CHILDREN DUE TO DIARRHEA*

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SUMMARY: Yurdakök K, Yalçın SS, Özmert E. (Department of Social Pediatrics, Hacettepe University Institute of Child Health, Ankara, Turkey). Experience with oral rehydration therapy in moderately dehydrated children due to diarrhea. Turk J Pediatr 1997; 39: 19-25.

Additional reports on oral rehydration therapy (ORT) in the management of moderately dehydrated patients may convince practitioners to convert from high-cost intravenous treatment to low-cost and efficient ORT in moderately dehydrated patients. Therefore, the failure rate and its association with admission serum sodium, potassium and bicarbonate levels of 162 moderately dehydrated children with diarrhea treated with ORT were analyzed retrospectively. The overall failure rate was found to be 17.6 percent. This rate did not differ significantly among normonatremic, hyponatremic and hypernatremic patients (16%, 25% and 28%, respectively; $p > 0.05$), nor did the rate differ among normokalemic, hypokalemic and hyperkalemic patients (16%, 33% and 25%, respectively; $p > 0.05$). Only moderately and severely acidotic patients had higher failure rates than non-acidotic and mildly acidotic cases (21%, 38%, 4% and 14% respectively; $p < 0.05$). Severely acidotic patients were also rehydrated over a longer time (10.4 ± 6.6 hours) than were nonacidotic patients (6.7 ± 2.3 hours, $p < 0.001$). Thus the degree of acidosis, which is closely related to the clinical severity of dehydration, was found to be much more predictive of ORT failure and the duration of rehydration than were other electrolyte disturbances. Besides correcting dehydration, ORT was safe and effective in treating various electrolyte disturbances. *Key words: G-ORS treatment, initial electrolyte levels, outcome.*

The Control of Diarrheal Diseases Programme was first established in 1986 in Turkey. Since then, WHO-recommended oral rehydration salts (ORS) have been distributed free-of-charge to all government health facilities. Despite the wide avalibility of ORS and intensive training programs, in-patient treatment of diarrheal cases does not correspond to the standard WHO management guidelines[1]. A survey reported in 1992 revealed a high rate of unneccesary hospitalizations for intravenous (IV) treatment in diarrheal cases[2]. Underuse of oral rehydration therapy (ORT) has also been reported from other countries. A recent study from the United States has shown that almost one-third of pediatric practitioners consider moderate dehydration to be a contraindication of ORT[3]. The presumption that moderately dehydrated children will have electrolyte and acid-base disturbances is one of the reasons for the preference of IV treatment in these cases.

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A second contributing factor to the underuse of ORT in moderate dehydration is the emphasis on IV treatment in fluid, electrolyte and acid-base disturbances in medical schools[4]. This results in a discrepancy between what is taught and what should be practiced. More reports on routine ORT experience in various electrolyte and acid-base disturbances may help to convince practitioners to change their practice from high-cost IV treatment to low-cost, highly efficient ORT. Therefore, we present the outcome of who were treated with standard WHO glucose oral rehydration solution (G-ORS) according to their initial serum electrolyte and acid-base levels.

Material and Methods

This study was done at Hacettepe University İhsan Doğramacı Children's Hospital Diarrhea Training and Treatment Center. Among 3,611 cases of diarrheal disease admitted to the center between September 1, 1992 and April 30, 1994, 162 cases of moderate dehydration were treated with G-ORS. The files of these cases were reviewed retrospectively and analyzed.

The clinical history and detailed physical examination were recorded in all cases. The diagnosis of moderate dehydration and management of the patients were based on standard WHO criteria[5]. Blood samples were obtained from all patients with moderate dehydration on admission for the assessment of serum electrolyte, pH and bicarbonate levels. G-ORS 100 ml/kg was administered to all cases for four to six hours. During this period the patients were observed closely for vital signs, vomiting, purging rate, abdominal distention and signs of dehydration. At the end of the first four to six hours, the patients were either re-administered G-ORS, hospitalized or discharged, depending on the clinical and laboratory assessments. Treatment failure was defined as deterioration in the clinical signs of dehydration after two hours of treatment, persistent frequent vomiting (more than 3/h), high purging rate (stool output exceeding 10 ml/kg/h during treatment) or no improvement in electrolyte and acid-base disturbance after two subsequent rehydration periods. Glucose malabsorption was considered to be present if the stool glucose strip test was positive (a color reaction corresponding to > 0.1 g/dl). in association with ORT failure related to a high purging rate. This test was performed in all patients with ORT failure and a high purging rate. Cases who had diarrhea for longer than 14 days were considered to have persistent diarhea. Patients hospitalized for associated diseases were not considered as treatment failures.

Patients were grouped according to their admission serum electrolyte and acid-base levels. Hyponatremic dehydration was defined by a serum sodium concentration of less than 130 mEq/L. Serum sodium levels greater than 150 mEq/L were considered as hypernatremia. Patients with serum potassium levels of less than 3 mEq/L and greater than 5.5 mEq/L were considered as hypokalemic and hyperkalemic, respectively. Patients were grouped according

to blood pH levels as normal (blood pH level of 7.35-7.40), midly acidotic (blood pH level of 7.30-7.34), moderately acidotic (blood pH level of 7.29-7.20) and severely acidotic (blood pH level less than 7.20).

Two outcome parameters, the hospitalization rate and the mean rehydration time of the patients, were analyzed accounting the patient groups according to their initial serum sodium, potassium and blood pH levels.

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 5.0. One way ANOVA, Chi-square and Student's t test were used to compare the groups.

Results

Among 3,611 diarrhea admissions, 162 patients (4.5%) had moderate dehydration and were treated with G-ORS. Selected characteristics of all patients are shown in Table I. The mean age of the patients was 10.4 ± 8.8 months. The mean duration

Table I: Characteristics of Moderately Dehydrated Patients

Number of patients	162
Mean age (months)	104 ± 8.8
Male / Female	102 / 60
Mean weight (kg)	7.8 ± 2.6
Mean days before admission	6.9 ± 10.1
Mean serum electrolytes (mEq/L)	
Na^+	143 ± 10
K^+	4.5 ± 0.9
Cl^-	109 ± 12
HCO_3^-	13.3 ± 3.7
Number (%) of patients with $Na^+ < 130$ mEq/L	8 (5)
$Na^+ > 150$ mEq/L	32 (20)
$K^+ < 3.5$ mEq/L	15 (9)
$K^+ > 5.5$ mEq/L	20 (12)
$HCO_3^- < 15$ mEq/L	113 (70)
Mean blood pH	7.27 ± 0.08
Number (%) of patients with blood pH	
7.30 - 7.735	37 (23)
7.20 - 7.29	80 (49)
< 7.20	21 (13)
Number (%) of patients with coexisting diseases	
Bronchopneumonia	1 (0.6)
Acute Otitis Media	6 (4)
Urinary Tract Infection	14 (9)
Sepsis	3 (2)
Mean rehydration time (hours)	8.4 ± 4.6

of diarrhea was 6.9 ± 10.1 days on admission, 89.5 percent of the cases having acute diarrhea and 10.5 percent persistent diarrhea. On admission 32 patients (20%) had hypernatremia, eight patients (5%) had hyponatremia and 15 patients (9%) had hypokalemia. Serum bicarbonate levels were less than 15 mmol/L in 113 (70%) patients. According to blood pH levels, 37 (20%) patients had mild, 80 (49%) patients had moderate 21 (13%) patients had severe acidosis. Overall 138 (85%) patients had some degree of acidosis. The mean blood pH of all cases was within the moderate acidosis range (7.27 ± 0.08).

The characteristics and outcome of patients according to their initial serum sodium levels are shown in Table II. The age of patients with hypernatremia was significantly younger than that of normonatremic and hyponatremic patients (6.3 ± 3.2 months, 11.4 ± 9.6 months, respectively, $p < 0.05$). As shown in Table II,

Table II: Characteristics and Outcome of Patients According to Serum Sodium Levels on Admission

	Normonatremic	Hyponatremic	Hypernatremic
No. of patients (%)	122 (75)	8 (5)	32 (20)
Age (months)	11.4 ± 9.6*	13.5 ± 10.2	6.3 ± 3.2*
Body weight on admission (kg)	7.9 ± 2.7	7.8 ± 3.0	7.0 ± 1.6
Mean pH	7.28 ± 0.07	7.29 ± 0.10	7.26 ± 0.07
Serum electrolytes (mEq/L)			
Na^+	141 ± 5.0[a]	124 ± 7.1[a]	157 ± 6.7[a]
K^+	4.4 ± 0.7[b]	4.0 ± 0.8[c]	5.1 ± 0.7[b,c]
HCO_3^-	13.5 ± 3.7	13.0 ± 3.5	12.3 ± 2.7
Mean rehydration time (hours)	8.0 ± 4.0	8.3 ± 6.9	10.3 ± 5.6
No. of hospitalized patients (%)	20 (16)	2 (25)	9 (28)

Values are mean ± SD

*: $p < 0.05$

a, b, c: For all comparisons $p < 0.001$

the mean rehydration time and the rate of hospitalization were not significantly different among groups. Hyperkalemic patients were younger than hypokalemic patients (6.6 ± 3.9 months, 15.8 ± 9.6 months, respectively, $p < 0.05$, Table III). Neither the rehydration time nor the hospitalization rate varied significantly among the patients with different initial serum potassium levels.

Table III: Characteristics and Outcome of Patients According to Serum Potassium Levels on Admission

	Normakalemic	Hypokalemic	Hyperkalemic
No. of patients (%)	127 (78)	15 (9)	20 (12)
Age (months)	10.5 ± 9.2	15.8 ± 9.6*	6.6 ± 3.9*
Body weight on admission (kg)	7.9 ± 2.6	8.4 ± 2.7	6.7 ± 2.0
Mean pH	7.28 ± 0.07	7.29 ± 0.7	7.27 ± 0.08
Serum electrolytes (mEq/L)			
Na^+	143 ± 9.0[a, b]	135 ± 6.2[a, c]	149 ± 9.1[b, c]
K^+	4.5 ± 0.5[d]	3.1 ± 0.4[d]	6.0 ± 0.5[d]
HCO_3^-	13.2 ± 3.6	13.1 ± 3.5	13.4 ± 3.4
Mean rehydration time (hours)	8.3 ± 4.3	8.5 ± 5.7	8.3 ± 6.4
No. of hospitalized patients (%)	21 (16)	5 (33)	5 (25)

Values are mean ± SD
*: $p < 0.05$
a, b, c: For all comparisons $p < 0.001$

Children with moderate acidosis on admission had a longer rehydration time than non-acidotic or mildly acidotic children (9.6 ± 4.7, 6.7 ± 2.3, 6.2 ± 2.7 hours, respectively; $p < 0.001$; Table IV). Children with severe acidosis on admission had a longer rehydration time compared with nonacidotic and mildly acidotic children (10.4 ± 6.6, 6.7 ± 2.3, 6.2 ± 2.7 hours, respectively; $p < 0.001$; Table IV).

Table IV: Characteristics and Outcome of Patients According to Blood pH Levels on Admission

	Normal	Milld Acidosis	Moderate Acidosis	Severe Acidosis
No. of patients (%)	24 (15)	37 (23)	80 (49)	21 (13)
Age (months)	9.5 ± 6.4	12.9 ± 9.1	10.6 ± 8.1	6.6 ± 4.8
Body weight on admission (kg)	7.3 ± 1.8	8.4 ± 3.1	7.6 ± 2.2	6.7 ± 2.9
Mean pH	7.40 ± 0.04*	7.32 ± 0.01*	7.25 ± 0.3*	7.16 ± 0.02*
Serum electrolytes (mEq/L)				
Na^+	141 ± 8.9	142 ± 6.9	144 ± 8.9	145 ± 12.8
K^+	4.5 ± 0.7	4.5 ± 0.8	4.5 ± 0.8	4.7 ± 1.0
HCO_3^-	17.2 ± 3.9*	15.0 ± 3.5*	12.2 ± 2.2*	10.0 ± 2.2*
Mean rehydration time (hours)	6.7 ± 2.3[a, b]	6.2 ± 2.7[c, d]	9.6 ± 4.7[a, c]	10.4 ± 6.6[b, d]
No. of hospitalized patients (%)	1 (4)[e, f]	5 (14)[g]	17 (21)[e]	8 (38)[f, g]

Values are mean ± SD
*: For all comparisons between groups $p < 0.001$
Comparisons for a, b, c, d: $p < 0.001$
Comparisons for e, f, g: $p < 0.05$

There was no significant difference between the mean rehydration time of moderately and severely acidotic patients. The hospitalization rate was significantly

higher among severely acidotic children than non-acidotic and mildly acidotic children (38%, 4% and 14%, respectively; $p < 0.05$). Moderately acidotic cases were also more likely to be hospitalized than were non-acidotic, moderately dehydrated children (21% and 4%, respectively, $p < 0.05$).

One hundred and thirty-one cases (82.4%) were treated successfully with G-ORS, the failure rate being 17.6 percent (28 cases Table V). The reasons for treatment failure are given in Table V. The main reasons for failure in order of decreasing frequency were high purging rate, persistent acidosis, glucose malabsorption, persistent vomiting, persistent hypernatremia, persistent hypokalemia and paralytic ileus with abdominal distention. Persistent acidosis constituted 25 percent and electrolyte disturbances constituted only 10.5 percent of the failures. Three patients were hospitalized due to sepsis.

Table V: Reasons for ORT Failure

	n	%
High purging rate	9	32
Persistent acidosis	7	25
Glucose malabsorption	5	18
Persistent vomiting	3	11
Electrolyte disturbances		
Persistent hypernatremia	2	7
Persistent hypokalemia	1	3.5
Abdominal distention, paralytic ileus	1	3.5
Total	28	100

Discussion

The overall ORT failure rate is reported by WHO to be five percent among all diarrheal dehydration cases[6]. An earlier report from Turkey has revealed a failure rate of 8.5 percent among moderately dehydrated cases, which is compatible with the literature[7]. In this study we found the failure rate to be 17.6 percent. Our failure rate seems to be higher than those reported earlier. This may be explained by the low initial blood pH levels and the long duration of diarrhea of our patients before admission, both of which criteria are correlated to the severity of dehydration. Although the WHO criteria were used for assessment of the degree of dehydration, we may have underestimated the degree of dehydration in some of our cases that were borderline severe dehydration.

Failure was mostly due to a high purging rate, persistent acidosis and glucose malabsorption. These are the major leading causes of ORT failure according to WHO. Initial serum sodium and potassium levels were not predictive of ORT

failure. On the contrary, the initial blood pH and bicarbonate levels could be significant in predicting ORT failure. The failure rate increased significantly with the degree of acidosis. In our study the overall failure rate in initially acidotic patients was 21 percent; the rate was five percent in mildly acidotic and 17 percent in moderately acidotic patients, and the rate increased significantly to 38 percent in severely acidotic patients. Thus, not only the presence but also the degree of acidosis is important in determining the final outcome.

The overall mean rehydration time was found to be longer than the four to six hours established by WHO[5]. Most of the patients admitted to our center required twice as much time as recommended by WHO for adequate rehydration. Although the time seems to have been prolonged in all cases, the only significant association with the mean rehydration time could be found in moderately and severely acidotic cases. Non-acidotic and mildly acidotic patients had a mean rehydration time of approximately six hours, which may be compatible with the WHO recommendations. The mean rehydration time did not change significantly with various initial serum sodium and potassium levels. Thus, the overall, prolonged, mean rehydration time may only be related to the moderate or severe acidosis present in most of our patients.

In conclusion, in this study it has been shown that the initial level of metabolic acidosis is the only parameter that determines ORT failure and the necessary duration of rehydration. Low-cost and highly efficient ORT can be used safely and successfully even in patients with severe acidosis and various electrolyte disturbances. However, the mean duration of rehydration should be longer for acidotic patients than nonacidotic patients.

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