ORIGINAL ARTICLE

Prevalence of Electrolyte Disorders Among Cases of Diarrhea with Severe Dehydration and Correlation of Electrolyte Levels with Age of the Patients

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ABSTRACT

Objective: To find out the prevalence of electrolyte disorders among children with severe dehydration, and to study correlation between age and electrolyte, urea and creatinine levels.

Study Design: Prospective, analytical study.

Place and Duration of Study: Outdoor and indoor of Fazle-Omar Hospital, Rabwah, Pakistan, from January to December 2012.

Methodology: All patients from birth to 18 years age, presenting with diarrhea and severe dehydration were included in the study. Urea, creatinine and electrolyte levels of all patients included in the study were checked and recorded in the data form with name, age and outcome. The prevalence of electrolyte disorders were ascertained and correlation with age was determined by Pearson's coefficient.

Results: At total of 104 patients were included in the study. None of the patients died. Hyperchloremia was the commonest electrolyte disorder (53.8%), followed by hyperkalemia (26.9%) and hypernatremia (17.3%). Hyponatremia, hypokalemia and hypochloremia were present in 10.6%, 7.7%, and 10.6% cases, respectively. Weak negative correlation was found between age and chloride and potassium levels.

Conclusion: Different electrolyte disorders are common in children with diarrhea-related severe dehydration.

Key Words: *Diarrhea. Dehydration. Water-Electrolyte imbalance.*

INTRODUCTION

Diarrhea is still one of the leading causes of morbidity and mortality in children around the world.[1-6] Oral rehydration treatment has considerably reduced complications and mortality from diarrheal diseases. Still many children with diarrhea suffer from dehydration and electrolyte imbalance.[7]

Presence of different types of electrolyte disorders is associated with significant increase in mortality rates among children with diarrhea.[7] Electrolyte disorders may remain unrecognized and result in increased morbidity and mortality. Timely recognition, a high index of suspicion, and a thorough understanding of common electrolyte abnormalities is necessary to ensure their correction. Different studies have shown different incidences of electrolyte disorders among children with dehydration. The present study was undertaken to ascertain the frequency of different types of electrolyte disorders among children with diarrhea related severe dehydration, and to study the correlation of electrolyte, urea and creatinine levels with age of the patients. No study conducted previously had evaluated the correlation of electrolyte, urea, and creatinine levels with age of the patients. According to our research, none of these studies evaluated chloride levels in children of all age groups with dehydration. Previous studies evaluated chloride levels only among children below one year and among children with malnutrition. Parameters of this study included checking of chloride levels among pediatric patients with severe dehydration belonging to all nutritional statuses and age groups and we also studied correlation between levels of different electrolytes and renal function tests with age of the patients.

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METHODOLOGY

Appropriate sample size was calculated using World Health Organization (WHO) sample size calculator. The calculations of sample size were based on the given prevalence of 6.4% for hyponatremia among children with diarrhea in a study by Samadi *et al*.[6] At the prevalence of 6.4%, level of confidence 95%, at required precision of 5%, the sample size required was at least 93 cases.

All patients with acute watery diarrhea from birth to 18 years age, who presented in outdoor and emergency of Fazle-Omar Hospital, Rabwah, Paksitan, from January to December 2012 were assessed for the status of hydration by a doctor in emergency and in pediatric ward and intensive care unit. The patients with severe

dehydration were included in the study. WHO criteria was used to assess the status of hydration. Following signs were taken as signs of severe dehydration: (i) lethargy or loss of consciousness, (ii) sunken eyes, (iii) drinks poorly or not able to drink, (iv) After skin pinch, skin goes back very slowly. If at least 2 of these signs were present, it was labelled as severe dehydration. The patients who had other diagnoses besides acute watery diarrhea were included in the study. History was taken to assess whether the participants had taken oral rehydration salts (ORS) or not; and if it was taken, whether or not its volume given after each loose motion, since the commencement of diarrhea was according to WHO recommendations. The patients with blood in stools and those who were given intravenous fluids within 6 hours before presentation or before taking of blood samples were excluded from the study. Blood samples were collected before giving intravenous fluids. SPSS version 20 was used for data analysis. Urea, creatinine, sodium, potassium, and chloride levels were checked by ISE method (Prolyte machine). Name, age, urea, creatinine, electrolyte levels, and outcomes were recorded on a proforma and data sheet of SPSS version 20 by doctors conducting the study.

Potassium levels below 3.5 mmol/l and above 5 mmol/l were categorized as hypokalemia and hyperkalemia, respectively. Sodium levels below 130 mmol/l and above 150 mmol/l were taken as hyponatremia and hypernatremia, respectively. Chloride level below 98 mmol/l and above 108 mmol/l were categorized as hypochloremia and hyperchloremia, respectively. Urea and creatinine levels higher than 6.7 mmol/l and 125 ummol/l, were considered higher than normal.

Table I: Prevalence of electrolyte abnormalities among pediatric cases of severe dehydration.

Electrolyte	Low	Normal	High	Total
Sodium	11 (10.6%)	75 (72.1%)	18 (17.3%)	104
Potassium	8 (7.7%)	68 (65.4%)	28 (26.9%)	104
Chloride	11 (10.6%)	37 (35.6%)	56 (53.8%)	104

Table II: Correlation of age with electrolyte levels and renal function tests.

Variables	Spearman's coefficient (rs)	p-value
Sodium	-.080	.422
Potassium	-.304	.002
Chloride	-.304	.002
Urea	-.291	.003
Creatinine	-.049	.620

Patients were divided in to 4 groups according to age (i) below 1 month, (ii) 1 month to 11 months, (iii) 1 year to 4 years 11 months, (iv) above 5 years. All cases were admitted and rehydrated with Ringer's Lactate and other appropriate treatments.

Ethical Committee of Fazle-Omar Hospital approved the study.

RESULTS

A total of 104 patients were included in the study. None of the patients died. According to age, 11 (10.6%) patients were below one month, 48 (46.1%) were between 1 month and 11 months, 32 (30.8%) were between 1 year and 4 years and 11 months, and 13 (12.5%) were ≥ 5 years. Eighteen (17.1%) patients had taken ORS. None of them took quantity of ORS after loose motions, according to WHO recommendations.

Urea level was high in 88 (84.6%) patients. Creatinine level was high in 36 (34.6%) patients. Hyperchloremia was the commonest electrolyte abnormality (53.8%), followed by hyperkalemia (26.9%) and hypernatremia (17.3%) [Table I].

Minimum and maximum sodium levels were 124 mmol/l and 190 mmol/l, respectively. Median value was 142 mmol/l. Minimum and maximum potassium levels were 2.19 mmol/l and 6.8 mmol/l, respectively. Median value was 4.78 mmol/l. Minimum and maximum chloride levels were 85 mmol/l and 150 mmol/l, respectively. Median level was 107 mmol/l. Correlation of the electrolyte, urea and creatinine levels with age of the patients were checked. Urea, potassium, and chloride levels had weak negative correlation with age of the patients (Table II).

Median sodium levels of patients with age < 1 month, 1 month to 11 months, 1 year to 60 months, and > 5 years were 146 mmol/l, 142 mmol/l, 140 mmol/l, and 143 mmol/l, respectively. Median chloride levels in these 4 age groups were 112 mmol/l, 108.5 mmol/l, 103.5 mmol/l, and 106 mmol/l, respectively. Median potassium levels in these age groups were, 4.3 mmol/l, 5.150 mmol/l, 4.40 mmol/l, and 4.20 mmol/l, respectively. Table III shows mean ranks of electrolytes in different groups according to age, along with pairwise comparisons.

Spearman's coefficient was used to check correlation between continuous variables. Spearman's coefficient (rs) of 0.0 - 0.19 was taken as very week, 0.20 - 0.39 as

Table III: Mean ranks of electrolytes in different groups according to age.

Electrolyte	< 1 month	1 - 11 months	1 - 5 years	> 5 years	p-value	Pairwise comparisons					
	a	b	c	d		ab	ac	ad	bc	bd	cd
Sodium	62.3	52.9	46.1	58.3	.379						
Chloride	64.4	60.2	39.8	45.3	.001	.70	.02	.10	.003	.12	.34
Potassium	48.9	62.8	44.8	36.7	.010	.30	.99	.64	.006	.005	.35

Kruskal-Wallis test was done to evaluate difference between different age groups. If Kruskal-Wallis test was significant Mann-Whitney U test was applied for pairwise comparison.

weak, 0.40 - 0.59 as moderate, 0.60 - 0.79 as strong, and 0.80 - 1.0 as very strong correlation.

Kruskal-Wallis test was used to assess significant difference on a continuous dependant variable by a grouping independent variable, if the groups were 3 or more. If the result of Kruskal-Wallis test was found to be significant, pairwise comparison was conducted by Mann-Whitney U test. P-value of 0.05 or less was taken as significant.

DISCUSSION

Majority of children with dehydration suffer from different electrolyte abnormalities.[7] As shown in Table I, hyperchloremia was the commonest electrolyte disorder in this study. Chloride ion is distributed exclusively within the extracellular fluid (ECF), which comprises the blood and the interstitial fluid compartments. It is the major anion associated with sodium in the ECF. Conditions causing elevation of the serum chloride concentration and a concomitant elevation of the serum sodium concentration result primarily from disorders associated with loss of hypotonic fluids. Causes of hypochloremia include loss of chloride ion from gastrointestinal tract by diarrhea, vomiting, and through nasogastric tube. Severe vomiting may lead to the most disproportionate loss of chloride compared to sodium since gastric chloride content is greater than 100 mEq/L and gastric sodium content is relatively low (20 - 30 mEq/L). Relatively few studies have analyzed chloride among cases of diarrhea. A study by Weizman *et al*. showed that among 74% cases of infants with some and severe dehydration presented with normal anion gap and hyperchloremia (115.8 ±4.2 mmol/L).[8] In this study, 53.8% cases had hyperchloremia.

Disorders of sodium levels among cases diarrhea related dehydration can constitute a medical emergency requiring a prompt and adequate diagnosis and management.[10] Different studies have shown different prevalences of hyponatremia and hypernatremia among children with dehydration. According to a study by Chouchane *et al*., hypernatremia was present in 11.51% cases of all kinds of dehydration.[11] A study by Samadi *et al*. included children admitted with diarrhea. This showed that hyponatremia and hypernatremia were present in 20.8% and 6.4% cases, respectively.[6] The study by Shah *et al*. showed that 56% of cases admitted with diarrhea and dehydration had hyponatremia, while hypernatremia was present in 10% cases.[7] Hypernatremic dehydration is also a serious problem in neonatal age. Neonates with weight loss are at increased risk of developing hypernatremia. Some of these cases suffer from long-term neurological consequences.[12-16]

Unlike the studies by Samadi *et al*. and Shah *et al*., this study showed that hypernatremia was more common than hyponatremia, and majority had normal sodium levels.

Different factors can alter the prevalence of electrolyte disorders among children with diarrhea. Malnutrition is one of these factors. It has been shown to be significant factor that alters the prevalence of electrolyte disorders among children with diarrhea. A study by Memon *et al*. showed that hyponatremia and hypokalemia were significantly more common in children with malnutrtition among children from age of 6 months to 5 years.[17] Another factor that can alter the amount of electrolyte loss in stools is the causative pathogen. Diarrhea due to different pathogens can lead to significantly different amount of electrolyte loss in the stool. It can also increase significantly because of electrolyte transport into fecal water due to exogenous substances and toxins, e.g. cholera toxin. A study by Molla *et al*., showed that the mean stool sodium concentration in cholera was 88.9 mmol/L, in enterotoxigenic *Eschericia coli* 53.7 mmol/L, and in rotavirus infection, 37.2 mmol/L.[18] These factors explain why different studies show different incidence of electrolyte abnormalities.

Timely detection and correction of electrolyte disorders is important. Various studies have shown that disorder in sodium levels leads to adverse effect on outcome. A study by Molat *et al*. showed that increasing severity of hypernatremia leads to increase in mortality rate and is associated with significant difference in Denver Developmental Screening II test results.[14] Similarly, study by Molaschi *et al*. conducted in elderly population showed that mortality was positively related to sodium levels.[19] A study by Corona *et al*. showed that among cases suffering from hyponatremia, correction of sodium level leads to improvement in mortality rate.[20] The study by Samadi *et al*., showed that among children under 3, with diarrhea and dehydration, the case fatality rates were 10.1% in hyponatremia, 3.8% in isonatremia, and 1.2% in hypernatremia.[12] As none of the case included in this study died, effect of sodium abnormality on mortality rate cannot be studied.

Many studies have been conducted in the past to study the prevalence of different electrolyte disorders among children. These studies show that disorders of sodium levels are common among children with severe dehydration. Studies from South Asia show that hyponatremia is more common as compared with hypernatremia in pediatric age group. This study shows that now among children with severe dehydration, hypernatremia is more common as compared to hyponatremia. Above mentioned information can help us decide the electrolyte constituents of the intravenous

and oral rehydration fluids used to correct severe dehydration.

Disorders of potassium levels are common among children with diarrhea and also among critically ill pediatric patients suffering from other ailments. Hypokalemia is a common complication among children admitted in intensive care. It can have profound effects on electrical activity in cardiac, skeletal and smooth muscle. If severe, these may result in life threatening conditions like cardiac arrhythmias, cardiac arrest, respiratory failure, muscular paralysis and paralytic ileus. A study by Singhi *et al*. showed that 14.8% cases in pediatric intensive care unit had hypokalemia, and mortality rate among these patients was significantly higher (25.6%) as compared with other patients admitted in the same unit (10.9%).[21] Hypokalemia is a common problem among children with diarrhea and dehydration. In the study by Shah *et al*., among the children with diarrhea and severe dehydration 46% cases had hypokalemia.[7]

Total body potassium is decreased as much as 25% in malnourished children, due to decreased intake and reduced muscle mass. Study by Odey *et al*. showed among children of protein energy malnutrition with diarrhea, hypokalemia was the commonest (23.4%) electrolyte disorder.[9]

In this study, the prevalence of hyperkalemia (26.9%) was higher as compared to the prevalence of hypokalemia (7.7%). One reason for higher prevalence of hyperkalemia in this study can be that only children with severe dehydration were included in this study. In severe dehydration, metabolic acidosis is present that causes intracellular potassium to shift to extracellular compartment.

We used Pearson's coefficient to study the strength of association between electrolyte levels, urea, creatinine, and age of the patient. There was weak negative correlation between age of the patients and urea, potassium, and chloride levels.

This study is the first study which has ascertained chloride levels in the pediatric patients of all age groups with severe dehydration, regardless of their nutritional status. And this shows that hyperchloremia is the commonest electrolyte disorder among these cases. No previous study had evaluated the correlation between age of the patients and levels of electrolytes, urea and creatinine.

CONCLUSION

Among patients with diarrhea-related severe dehydration, hyperchloremia, hypernatremia, and hyperkalemia are common electrolyte abnormalities. None of the patients with severe dehydration, included in this study, had taken ORS according to WHO recommendations. It is necessary to keep watch over signs and symptoms of electrolyte disorders among patients having severe dehydration. If such clinical manifestations are present, electrolyte levels should be checked. Proper use of ORS, according to WHO recommendations, should be promoted.

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