

ORIGINAL ARTICLE

Acid-base and Electrolyte Disturbances in Children Presenting with Acute Watery Diarrhoea in Emergency Observation and Referral Unit of Dhaka Shishu (Children) Hospital

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Abstract

Background: Acute watery diarrhoea (AWD) is a leading cause of illness and death amongst children in developing countries. Electrolyte and acid-base disturbances play an important role in the associated morbidity and mortality.

Objectives: To observe the acid-base and electrolyte changes in moderate and severe dehydration in AWD in children.

Methods: This cross sectional study was carried out in the Observation and Referral Unit of Dhaka Shishu (Children) Hospital from July 2018 to December 2018. Children below five years of age who came with acute diarrhoea with moderate to severe dehydration were included in the study. After admission 2ml of whole blood was collected with all aseptic measures at the time of insertion of intravenous cannula before giving intravenous fluids to measure serum levels of Na and K while arterial blood was also taken for analysis. The data was analyzed by using SPSS version 20.

Results: Total 125 AWD cases were admitted among them 98(78.4%) had moderate dehydration whereas 27(21.6%) had severe dehydration. Hyponatremic dehydration was present in 41(32.8%) cases. Among them 30(30.6%) had moderate dehydration and 11(40.4%) had severe dehydration, hypernatremic dehydration was present in 11.11% cases, hypokalemia was present in 54(43.2%) cases. Among them 42(42.86%) had moderate dehydration and 12(44.44%) had severe dehydration. Metabolic acidosis was present in 38(30.4%) cases [28(28.57%) in moderate dehydration and 10(37.04%) in severe dehydration]. The comparison of mean serum sodium and potassium value of the children with moderate and severe degrees of dehydration did not attain statistical significance, but there was a significant difference in bicarbonate concentration among moderate and severe dehydration cases ($p=0.02$).

Conclusion: Hyponatremia and hypokalemia was the commonest electrolyte abnormality among moderate to severe dehydration with AWD. Mean serum sodium and potassium of the children with moderate and severe degrees of dehydration did not attain statistical significance, but bicarbonate concentration was significantly low among severe dehydration cases.

Keywords: Acute watery diarrhea, electrolyte and acid-base disturbances.

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Introduction

Acute Watery Diarrhoea (AWD) is a public health problem in many regions of the world, especially where poverty prevails. It is defined as sudden onset of excessively loose stools of >10 mL/kg/day in infants and >200 g/24 hr in older children which lasts <14 days.¹ According to World Health Organization (WHO) the definition of diarrhoea is three or more loose stools per day, or as having extra stools than normal for that person.² It is a leading cause of illness and death in children of developing countries.³⁻⁵ Worldwide, an estimated 1.7 billion cases of acute diarrhoea and nearly 700,000 deaths occur each year in children under 5 years.⁶

In early childhood, the clinical problem of diarrhea arises from the loss of water and electrolytes in the stool in excess of their intake. The main cause of death in acute diarrhea is dehydration, which results from the loss of fluid and electrolytes in diarrheal stools. The clinical manifestations of acute diarrhea are related to the severity of water deficit and the type of electrolyte disturbances. Often laboratory facilities are not available or, even if available, there is a considerable time lag in obtaining the results. Consequently, clinical recognition of water and electrolyte disturbances becomes important, particularly Hyponatremic dehydration, due to its serious neurological consequences. Electrolytes are ionized molecules found in the blood as well as in various tissues and cells of the body. The main serum electrolytes are sodium, potassium, and bicarbonate with varying distribution and functions.⁷ In the extracellular fluid, sodium and chloride are the dominant cation and anion, respectively. Potassium is the most abundant cation in the intracellular fluid and contributes to the maintenance of intracellular tonicity and the resting cell membrane potential. These molecules which are either positive or negative ionic charge conduct an electric current and help to balance pH and acid-base levels in the body. Bicarbonate is the main anion in the extracellular fluid and helps to regulate blood acidity (pH). The increase or decrease in bicarbonate concentration results in acid-base disorder.⁷ Since extracellular fluid osmolality and volume are determined by sodium content, this ion plays a key role in water and electrolyte regulation. In this regard, the biochemical derangement in children with dehydration may be hyponatraemic, isonatraemic or hypernatraemic.⁸ Other biochemical disturbances

observed include hypokalaemia and metabolic acidosis. Electrolyte disturbances are established risk factors for diarrhea-related deaths.⁹ Serum electrolyte measurement is usually unnecessary in children with mild to moderate dehydration. However, laboratory measurements of serum electrolytes are recommended in patients with severe dehydration.¹⁰ Electrolytes also facilitate the passage of fluid between and within cells and play a part in regulating the function of the neuromuscular, endocrine and excretory systems. Abnormal electrolytes with acute diarrhoea are common, it may be unrecognized and results in morbidity and mortality. Presence of different types of electrolyte disorders is associated with significant increase in mortality rates among children with diarrhea.¹¹ A study conducted in 2010 in Dhaka Shishu (Children) Hospital showed that electrolyte disturbances in AWD was associated with increased morbidity, with hyponatremic dehydration in 15% cases.¹² 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.¹³

No recent studies from this hospital exist regarding the electrolyte and acid-base disturbances occurring in a child suffering from AWD with moderate to severe dehydration. The present study was undertaken to ascertain the frequency of different types of electrolyte and acid-base disorders among the children with diarrhea having moderate and severe dehydration.

Materials and Methods

This cross sectional study was carried out in Observation and Referral Unit of Dhaka Shishu (Children) Hospital from June 2018 to December 2018. Children below five years of age who came with acute diarrhoea having history of loose motion at least three episodes in 24 hours of less than 14 days were included in the study after their parent's consent. Those children who have diarrhoea lasting more than 14 days and those having associated other diseases such as protein energy malnutrition were excluded. Each child with acute diarrhoea was then assessed by taking history from mother/caregiver, performing physical and systemic examination.

Dehydration status was assessed and moderate and severe dehydration was included in the study. After admission, 2ml of whole blood was collected after aseptic measures at the time of insertion of cannula before giving intravenous fluids. Electrolyte analyzer using ion selective electrodes were used to measure serum levels of Na and K while arterial blood was also taken for blood gas analysis. The data was analyzed statistically through SPSS version 20.0.

Results

Total 125 cases of AWD with moderate to severe dehydration was analyzed and among them 35.2% were below 1 year of age, 44.8% were 1-2 years of age and 20% were 3-5 years of age (Table I).

Age (in years)	Number	Percentage
<1	44	35.2
1-2	56	44.8
3-5	25	20

Among the AWD cases 98(78.4%) had moderate dehydration whereas 27(21.6%) had severe dehydration. Hyponatremic dehydration was present in 41(32.8%) cases among them 30.6% in moderate dehydration and 40.4% in severe dehydration cases. Hypokalemia was present in 54(43.2%) cases among them 42.86% in moderate dehydration and 44.44% in severe dehydration cases. Metabolic acidosis was present in 38(30.4%) cases among them 28.57% in moderate dehydration and 37.04% in severe dehydration cases (Table II).

Mean serum sodium in moderate dehydration was 135.22 ± 7.51 and 132.86 ± 4.26 in severe dehydration. Mean serum potassium was 3.52 ± 0.47 in some dehydration and 3.36 ± 1.15 in severe dehydration. The comparison of mean serum sodium and potassium of the children with moderate and severe degrees of dehydration did not attain statistical significance, $p=0.38$ and $p=0.57$, respectively. However, there was a significant difference in bicarbonate concentration among moderate and severe dehydration cases ($p=0.02$) (Table III).

		Moderate Dehydration (n=98) (%)	Severe Dehydration (n=27) (%)	Total (%)
Na	Normal	59(60.20)	13(48.15)	72(57.6)
	Hyponatremia (<135 mmol/L)	30(30.61)	11(40.74)	41(32.8)
	Hypernatremia (>145 mmol/L)	9(9.19)	3(11.11)	12(9.6)
K	Normal	54(55.10)	13(48.15)	67(53.6)
	Hypokalemia (<3.5 mmol/L)	42(42.86)	12(44.44)	54(43.2)
	Hyperkalemia (>5.5 mmol/L)	2(2.04)	2(7.41)	4(3.2)
Metabolic acidosis	Absent	70(71.43)	17(62.96)	87(69.6)
	Present	28(28.57)	10(37.04)	38(30.4)

Patient data	Total	Moderate dehydration n=98	Severe dehydration n=27	p value
Serum Sodium (mEq/l)	134.08 ± 5.88	135.22 ± 7.51	132.86 ± 4.26	0.38
Serum Potassium (mEq/l)	3.44 ± 0.81	3.52 ± 0.47	3.36 ± 1.15	0.57
Bi-carbonate (mEq/l)	16.3 ± 4.32	17.60 ± 4.12	15.06 ± 4.52	0.02

Data was expressed as Mean \pm SD; p value <0.05 is considered as significant

Discussion

This study included 125 patients for electrolyte and acid-base disturbances who presented with AWD with moderate to severe dehydration in less than five years of age. Most of the patients were below 24 months of age. Incidence of diarrhea is higher in this age group. Jotsna et al¹² also found higher incidence at age group of 6-11 months in Bangladesh. We found mean serum sodium 134.08 ± 5.88 mEq/l, while potassium was 3.44 ± 0.811 mEq/l. Nowrouzi et al¹⁴ found mean sodium 137 ± 10.3 mEq/l, while the mean serum potassium was 4.4 ± 1.2 mEq/l. Mean serum sodium in moderate dehydration was 135.22 ± 7.513 mEq/l and 132.86 ± 4.263 mEq/l in severe dehydration. Mean serum potassium was 3.52 ± 0.473 mEq/l in moderate dehydration and 3.36 ± 1.153 mEq/l in severe dehydration. Mean serum sodium and potassium of the children with moderate and severe degrees of dehydration did not attain statistical significance. Okposio et al¹⁵ also did not found statistical significant difference in serum sodium and potassium level among moderate and severe dehydration cases.

The common abnormality was hypokalemia in 42.86%, hyponatremia in 30.61% followed by hypernatremia in 9.6% and hyperkalemia in 2.04% cases. Babar et al¹⁶ found hypokalemia in 43.7%, hyponatremia in 5.7%, hyperkalemia in 4.6% and hypernatremia in 2.9%. Another study in Bangladesh reported frequency of hyponatremia and hypokalemia 27.8% and 47.5% respectfully.¹⁷ This is due to loss of sodium in diarrhoea while potassium loss due to bicarbonate loss in diarrhoea. Pizzoti et al¹⁸ found hyponatremia in 34% of admitted patients. The most common electrolyte abnormality in our study was hypokalemia which was present in 42.86% cases but Greenbaum et al¹⁹ in their study found only 14% case were hypokalemic.

Acid-base disturbances are also common findings in children with acute diarrhoea especially metabolic acidosis. The most common explanations for the occurrence of metabolic acidosis in acute diarrhoea include bicarbonate loss in stool, ketone production from starvation, and lactic acid production from decreased tissue perfusion in hypovolemia. Decreased renal perfusion also causes a decreased glomerular filtration rate, which, in turn, leads to decreased hydrogen (H^+) ion excretion.²⁰ This study found metabolic acidosis in 28.57% which is comparable with 27.6% metabolic acidosis found by Babar et al.¹⁶ Narchi et al²¹ found 59.5% metabolic

acidosis, and with increasing levels of dehydration, there was a concomitant reduction in serum bicarbonate concentration. The difference was more significant between moderate and severe but less so between mild and moderate. There was a significant difference in bicarbonate concentration among moderate and severe dehydration cases ($p=0.02$) in this study. Okposio et al¹⁵ found statistical significant difference in bicarbonate concentration among severe dehydration than moderate dehydration.

Conclusion

Hyponatremia and hypokalemia was the commonest electrolyte abnormality among moderate to severe dehydration with AWD. Mean serum sodium and potassium of the children with moderate and severe degrees of dehydration did not attain statistical significance, but bicarbonate concentration was significantly low in severe dehydration.

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