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FREQUENCY OF HYPERNATREMIC DEHYDRATION IN CHILDREN WITH SOME AND SEVERE DEHYDRATION

Dr Saman Zahoor

Post Graduate Resident, Pediatrics Department, PAEC General Hospital Islamabad

ABSTRACT

Background: *Diarrhea and dehydration in children are often accompanied by electrolyte abnormalities, including hypernatremia, which can worsen clinical outcomes.* ***Objective:*** *To determine the frequency of hypernatremic dehydration in children with varying degrees of dehydration.* ***Methods:*** *A cross-sectional study was conducted at the Department of Pediatrics, PAEC General Hospital, Islamabad, enrolling children aged 6 to 60 months with diarrhea and dehydration through non-probability consecutive sampling. After ethical approval and informed parental consent, demographic data were collected. Venous blood samples were drawn under aseptic conditions to assess serum sodium levels, and hypernatremia was recorded. Data were analyzed using SPSS version 22.* ***Results:*** *A total of 201 children were included (mean age: 29.64±14.5 months), with 56.2% male and 43.8% female patients. Diarrhea duration averaged 4.84±2.1 days. Some dehydration was observed in 69.7% of cases, while 30.3% exhibited severe dehydration. Rotavirus vaccination was reported in 80.6% of participants. Mean serum sodium level was 142.67±6.9 mEq/L, and hypernatremia was present in 16.4% of patients. Hypernatremia was significantly more common in cases of severe dehydration (34.4%) than in cases of some dehydration (8.6%), with a p-value of 0.001.* ***Conclusion:*** *Hypernatremia is prevalent among children with diarrhea and dehydration, especially in those with severe dehydration, highlighting the need for prompt electrolyte management in these patients.*

Keywords: *Diarrhea, Dehydration, Hypernatremia.*

INTRODUCTION

Dehydration, particularly due to gastroenteritis, is a frequent pediatric emergency. Worldwide, diarrheal illness has an annual incidence of approximately 1.5 billion among children under five years, with an estimated 1.5 to 2.5 million deaths each year according to the Centers for Disease Control and Prevention (CDC) [1, 2]. In Pakistan, diarrhea and dehydration contributed to 33% of under-five childhood mortality in 2020 [3]. Various pathogens, including bacteria and viruses, can lead to diarrhea and dehydration, and regardless of the cause, rapid fluid loss can result in severe complications, hospitalization, or even fatal outcomes if not managed promptly [4]. Electrolyte imbalances, particularly hypernatremia, represent one of the most severe complications in dehydrated children, often leading to prolonged hospital stays, increased morbidity, and significant mortality risk if not identified in time [5, 6]. Hypernatremia, defined as a serum sodium level exceeding 145 mEq/L [7], is commonly observed in dehydrated children who may present with typical signs such as weight loss, decreased skin turgor, pale skin color, and dry mucous membranes. Neurological symptoms like irritability, restlessness, weakness, lethargy, and in infants, a high-pitched cry, may manifest depending on the degree and speed of sodium increase. Severe hypernatremia can induce brain shrinkage, tearing cerebral blood vessels and leading to potentially fatal cerebral hemorrhage, convulsions, or coma [8]. The occurrence of

hypernatremia varies with dehydration severity, with previous studies showing rates of 9.2% in patients with mild dehydration and 37.1% in those with severe dehydration [9]. This study aims to determine the prevalence of hypernatremia in children with diarrhea and dehydration. The findings will aid in understanding the disease burden within our population and guide the formulation of fluid rehydration protocols tailored to dehydration severity.

Objective

To determine the frequency of hypernatremic dehydration in children with varying degrees of dehydration.

Methods

A cross-sectional study was conducted at the Department of Pediatrics, PAEC General Hospital, Islamabad, enrolling children aged 6 to 60 months with diarrhea and dehydration through non-probability consecutive sampling. After ethical approval and informed parental consent, demographic data were collected. Data were collected through non-probability consecutive sampling was employed.

Sample Size:

The sample size was calculated using the WHO calculator, based on a 95% confidence interval, 4% absolute precision, and a 9.2% prevalence of hypernatremia in cases with some dehydration. This calculation yielded a required sample size of 201 patients.

Inclusion Criteria:

- Children aged 6 to 60 months.
- Both genders were included.
- Children presenting with acute gastroenteritis and displaying either some or severe dehydration as per the operational definition.

Exclusion Criteria:

- Patients with chronic diarrhea lasting more than 14 days.
- Patients who had already received intravenous fluids before presentation.
- Patients with hypovolemic shock, defined by feeble pulses and unrecordable blood pressure.

Data Collection Procedure:

Following approval from the hospital's ethical board, eligible patients were enrolled from the pediatric emergency department of PAEC General Hospital Islamabad. Informed written consent was obtained from parents after explaining the study's purpose. Demographic data, including age, gender, dehydration status, rotavirus vaccination status, and duration of acute gastroenteritis, were documented. A comprehensive history and physical examination were conducted. Under aseptic conditions, a 2cc venous blood sample was drawn and sent to the hospital laboratory for serum sodium analysis. Rehydration was provided based on the assessed degree of dehydration. The researcher personally collected the lab reports, noting the frequency of hypernatremia. Data was entered into a specifically designed proforma.

Data Analysis Procedure:

Data were analyzed using SPSS v19. Mean and standard deviation were calculated. For categorical variables, including gender, dehydration severity, and presence of hypernatremia, frequency and percentage were determined. Hypernatremia frequency between some and severe dehydration groups was compared using the chi-square test, with a significance level of $p \leq 0.05$. Effect modifiers such as age, gender, rotavirus vaccination status, and disease duration were addressed through data stratification, followed by post-stratification application of the chi-square test. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

The study enrolled 201 children with a mean age of 29.64±14.5 months, including 56.2% males and 43.8% females, resulting in a male-to-female ratio of 1.2:1. The mean duration of diarrhea was 4.84±2.1 days. Of the participants, 69.7% had some dehydration, while 30.3% exhibited severe dehydration. Rotavirus vaccination was reported in 80.6% of cases. The mean serum sodium level was 142.67±6.9 mEq/L, with hypernatremia present in 16.4% of children, notably more common in severe dehydration cases (34.4%) compared to some dehydration cases (8.6%), yielding a significant p-value of 0.001.

Table 1: Age, Duration of Diarrhea, and Serum Sodium Level

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age (months)	201	6	60	29.64	14.589
Duration of disease (days)	201	1	9	4.84	2.120
Serum sodium level (mEq/L)	201	135	166	142.67	6.979

The study included 201 children, with a gender distribution of 56.2% male and 43.8% female. Dehydration severity varied, with 69.7% of children experiencing some dehydration and 30.3% classified as having severe dehydration. Most children (80.6%) had received rotavirus vaccination, while 19.4% had not. Hypernatremia was observed in 16.4% of participants, with a majority (83.6%) maintaining normal sodium levels.

Table 2: Clinical values of patients

Category	Frequency	Percent
Male	113	56.2
Female	88	43.8
Dehydration: Some dehydration	140	69.7
Severe dehydration	61	30.3
Vaccination: Yes No	 162 39	 80.6 19.4
Hypernatremia: Yes No	 33 168	 16.4 83.6

Hypernatremia prevalence differed significantly between dehydration levels. Among children with mild dehydration, 8.6% exhibited hypernatremia, while 91.4% did not. In contrast, children with severe dehydration showed a higher hypernatremia rate of 34.4%, with 65.6% maintaining normal sodium levels. This difference in hypernatremia prevalence between mild and severe dehydration groups was statistically significant (p-value = 0.001),

Table 3: Data stratification for frequency of hypernatremia and severity of dehydration

			Hypernatremia		Total
			Yes	No	
Dehydration	Mild	Count	12	128	140
		% within Dehydration	8.6%	91.4%	100.0%
	Severe	Count	21	40	61
		% within Dehydration	34.4%	65.6%	100.0%
p-value 0.001					

Among children aged 6-30 months, 16.1% had hypernatremia, compared to 16.9% in the 31-60 months age group. The majority in both age groups maintained normal sodium levels (83.9% and 83.1%, respectively). The difference in hypernatremia rates between the age groups was not statistically significant (p-value = 0.888), indicating that hypernatremia occurrence was consistent across these age ranges.

Table 4: Data stratification for frequency of hypernatremia and age group

			Hypernatremia		Total
			Yes	No	
Age groups	6-30 months	Count	20	104	124
		% within Age groups	16.1%	83.9%	100.0%
	31-60 months	Count	13	64	77
		% within Age groups	16.9%	83.1%	100.0%
p-value 0.888					

In this study, hypernatremia was more prevalent among male children, with 20.4% showing elevated sodium levels compared to 11.4% in females. Most children in both groups maintained normal sodium levels, with 79.6% of males and 88.6% of females in the non-hypernatremic range. The difference in hypernatremia prevalence between genders was not statistically significant (p-value = 0.088), suggesting no strong association between gender and hypernatremia in this sample.

Table 5: Data stratification for frequency of hypernatremia and gender

			Hypernatremia		Total
			Yes	No	
Gender	Male	Count	23	90	113
		% within Gender	20.4%	79.6%	100.0%
	Female	Count	10	78	88
		% within Gender	11.4%	88.6%	100.0%
p-value 0.088					

Discussion

Infants and young children are particularly vulnerable to diarrheal disease and dehydration due to higher metabolic rates, limited ability to express hydration needs, and increased insensible water losses [10,11]. Dehydration in this population may also result from reduced fluid intake coupled with ongoing fluid losses, often accompanied by electrolyte imbalances vary depending on the severity of dehydration, which is classified as mild (3-5%), moderate (6-10%), or severe (over 10%). In infants, total body water (TBW) content is 70-80% of body weight, compared to 60% in older children, making infants more susceptible to rapid fluid loss relative to their body weight [12]. Dehydranifest as hyponatremic, hypernatremic, or isonatremic. Hyponatremic dehydration is common when children consume free water during diarrheal episodes, diluting sodium levels [13]. Conversely, hypernatremic dehydration can occur when infants are given improperly mixed oral rehydration solutions with excess salt or in conditions involving substantial free water loss, such as diabetes insipidus. This study aimed he frequency of hypernatremic dehydration in children with diarrhea and varying dehydration levels [14]. Our findings align with existing studies. Of the 201 patients enrolled, with a mean age of 29.64±14.5 months, 56.2% were male and 43.8% female, resulting in a male-to-female ratio of 1.2:1 [15]. This is consistent with an Iranian study of 437 children, where the mean age was 20.5±25 months, and the male-to-female ratio was 1.04:1. Similarly, a Tunisian studychildren reported a slight male predominance (1.8:1 ratio). Another study in Pakistan found thatases involved children under five years of age [16,17].

Conclusion

Hypernatremia is relatively cildren presenting with diarrhea and dehydration. Selecting an appropriate rehydration fluid is essential to avoid further electrolyte imbalances and associated complications.

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