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The frequency of hypernatremia at presenting to the Emergency Department with acute bronchiolitis

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Abstract

Aim: Acute bronchiolitis is a common lower respiratory tract disease in children. In addition to its common clinical findings, it may also cause extrarenal water losses. Deficiency in total body water is a risk for hypernatremia. This study aimed to analyze the frequency of concomitant hypernatremia in children suffering from acute bronchiolitis.

Material and methods: This retrospective study was conducted with 1317 children who presented to the pediatric emergency department with acute bronchiolitis and whose sodium levels were measured from January 1, 2019, to March 1, 2020. The age, gender, and application season of the patients were recorded.

Results: Hypernatremia was detected in 193 (14.7%) patients, and hyponatremia was detected in 99 (7.5%). There was no statistical difference in age or gender between the hyponatremia, hypernatremia, and normonatremia groups ($p>0.05$). The frequency of hypernatremia was the highest in winter and spring ($p<0.05$).

Conclusion: Patients with acute bronchiolitis may be accompanied not only by hyponatremia but also by hypernatremia. To prevent dysnatremia in patients with acute bronchiolitis, each child's intravenous hydration regimen must be ordered to electrolyte levels.

Key words: hypernatremia, acute bronchiolitis, children, pediatric emergency

Introduction

Hypernatremia is defined as serum sodium (Na) concentration higher than 145 meq/ L [1]. It shows net water loss or excess sodium intake in the body. Hypernatremia is most often created by a loss of hypotonic fluids from renal or extrarenal [2]. When the plasma sodium level increases, thirst, and vasopressin release are important defense mechanisms against the development of hypernatremia. If water is available, it is possible to prevent hypernatremia by taking in water. However, in cases of inability to ask for water, such as infants, intubated patients, or patients with neurological deficits, hypernatremia will occur due to insufficient water intake [1-3].

Clinical findings such as fever, vomiting, hyperventilation, and sweating may cause hypernatremia secondary to extrarenal fluid loss [2,4]. Although these symptoms are common in acute bronchiolitis, there is a large literature on hyponatremia accompanying lower respiratory tract infections. It is generally accepted that this is caused by the release of non-osmotic antidiuretic hormone (ADH) in acute bronchiolitis patients [5-8].

However, we suspect that (I) an increase in extrarenal fluid loss in acute bronchiolitis symptoms, (II) immaturity of renal functions about the capacity to excrete excess sodium in infants, and (III) infancy inability to describe thirst, may predispose to hypernatremia in young children with acute bronchiolitis [1,3,4,9]. Since hypernatremia increases the risk of morbidity and mortality even at mild levels, it is important to recognize it in the early period and apply the essential treatment [3,10].

This study aimed to evaluate the frequency of hypernatremia in children under two who were diagnosed with acute bronchiolitis in the pediatric emergency department of a tertiary hospital.

Material and methods

This study was approved by the ethics committee of Ankara Research and Educational Hospital (No: E-20/ 371).

We retrospectively analyzed acute bronchiolitis patients who were admitted to the pediatric emergency department of Ankara Research and Educational Hospital from January 1, 2019, to March 1, 2020. Inclusion criteria were children under 2 years with a diagnosis of acute bronchiolitis and tested for sodium levels by the biochemical method. In addition, patients who applied to the emergency department for any reason in the last week were excluded from the study, due to the risk of receiving intravenous fluid therapy. To exclude patients who had electrolyte measurements after intravenous fluid intake, care was taken to allow a maximum of one hour between the acceptance of the examination and the laboratory acceptance of the examination. Sodium levels were analyzed using the indirect ISE method by the Roche Cobas 6000 analyzer (Roche Diagnostics, Barcelona, Spain).

The plasma sodium level of less than 135 mEq/L was considered hyponatremia. Hyponatremia patients were also divided into 3 subgroups according to their sodium levels mild (130-134 mEq/L), moderate (125-129 mEq/L), and severe (<125 mEq/L) [11]. Hypernatremia was defined as >145 mEq/L. They were also divided into 3 subgroups depending on sodium levels; mild (146-149 mEq/L), moderate (150-169 mEq/L), and severe (>169 mEq/L) [12]. Plasma potassium levels less than 3.5 mEq/L was noted hypokalemia (mild: 3-3.4 mEq/L; moderate: 2.5-2.9 mEq/L, and severe: <2.5 mEq/L) and higher than 5 mEq/L was noted hyperkalemia (mild: 5.1-6 mEq/L, moderate: 6.1-7 mEq/L, and severe : >7 mEq/L) [13].

CRP levels were analyzed by immunonephelometric method (BN 100 system, Dade-Behring, Germany). 5 mg/L was accepted as the reference for the CRP level [14].

Statistical analysis

For categorical variables, numbers and percentages were given as descriptive variables. Continuous variables were presented as mean± standard deviation and median (minimum-maximum). The Chi-square test and Fisher exact test were used to assess categorical variables. The normality of distribution for continuous variables was confirmed with the Kolmogorov-Smirnov test. To evaluate the correlations between measurements, Spearman Rank Correlation Coefficient was used. Multinomial logistic regression analysis was performed to determine significant predictors of serum sodium levels. In univariate analysis, variables significant at the p<0.25 level were entered in logistic regression analysis. A p-value of <0.05 was considered statistically significant and statistical analysis was performed using SPSS version 28.0 software for Windows (IBM Corp; Armonk, NY: 2021). The graphics were drawn in the JASP program (www.jasp-stats.org).

Results

From January 2019 to March 2020, a total of 1317 children with acute bronchiolitis had their serum sodium measured shortly after admission to the pediatric emergency. The distribution of hospital admissions by month is given in Figure 1. There were 525 (39.9%) girls, and 792 (60.1%) boys in the population. The study consisted of 1063 (80.7%) patients under one year old and 254 (19.3%) patients between 1-2 years old. Hyponatremia was detected among 99 (7.5%) and hypernatremia 193 (14.7%) patients (Table 1).

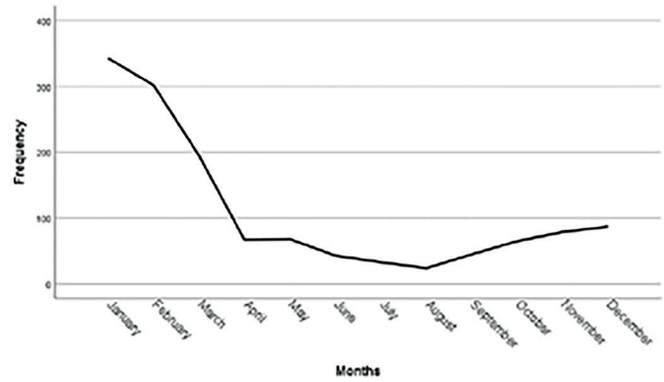

Figure 1 - Distribution of hospital admissions by months

When serum sodium levels were examined, 14.7% of the patients had hypernatremia and 7.5% had hyponatremia. Hyperkalemia was detected in 20.3% of the patients and hypokalemia was found in 8% of the patients. Hyperkalemia was detected in 22.3% (n=43) of the patients with hypernatremia. Hypokalemia was detected in 8.1% (n=8) of patients with hyponatremia. Both serum sodium and potassium levels were found to be normal in 71.4% of all patients. The sodium status of the patients was summarized according to age, gender, and seasonal variables (Table 2).

Table 1 Distribution of the variables

	n	%
Year (n=1351)		
2019	993	73.5%
2020	358	26.5%
Season (n=1351)		
Winter	732	54.2%
Spring	330	24.4%
Summer	100	7.4%
Autumn	189	14.0%
Sex (n=1351)		
Girl	537	39.7%
Boy	814	60.3%
Age (n=1351)		
0-1 years	1089	80.6%
1-2 years	262	19.4%
CRP (n=1324)		
≥5	708	53.5%
<5	616	46.5%
Sodium disorders (n=1317)		
normal	1025	77.8%
hyponatremia mild	96	7.3%
hyponatremia moderate	3	0.2%
hyponatremia severe	-	-
hypernatremia mild	90	6.8%
hypernatremia moderate	95	7.2%
hypernatremia severe	8	0.6%
Potassium disorders (n=1316)		
normal	944	71.7%
hypokalemia mild	97	7.4%
hypokalemia moderate	8	0.6%
hypokalemia severe	-	-
hyperkalemia mild	249	18.9%
hyperkalemia moderate	18	1.4%
hyperkalemia severe	-	-
Laboratory parameters	mean±SD	Median (min-max)
CRP (n=1324)	14.45±25.84	5.8 (0-338.1)
Chloride (n=780)	102.00±3.00	102 (92-114)
Sodium (n=1317)	140.00±7.00	139 (126-186)
Potassium (n=1316)	4.44±0.71	4.5 (2.7-6.4)

Table 2 Comparison of serum sodium levels for age, sex, and seasonal groups.

	normonatremia	hyponatremia			hypernatremia			p1	p2
		mild	moderate	severe	mild	moderate	severe		
Age groups									
0-1 age	827 (80.7%)	72 (75.0%)	2 (66.7%)	NA	76 (84.4%)	79 (83.2%)	7 (87.5%)	0.101	0.579
1-2 age	198 (19.3%)	24 (25.0%)	1 (33.3%)	NA	14 (15.6%)	16 (16.8%)	1 (12.5%)		
Sex									
Female	421 (41.1%)	29 (30.2%)	1 (33.3%)	NA	35 (38.9%)	37 (38.9%)	2 (25.0%)	0.169	0.390
Male	604 (58.9%)	67 (69.8%)	2 (66.7%)	NA	55 (61.1%)	58 (61.1%)	6 (75.0%)		
Season									
Winter	535 (52.2%)	55 (57.3%)	1 (33.3%)	NA	55 (61.1%)	68 (71.6%)	3 (37.5%)		
Spring	247 (24.1%)	26 (27.1%)	2 (66.7%)	NA	26 (28.9%)	20 (21.1%)	2 (25.0%)	0.001*	0.002*
Summer	85 (8.3%)	3 (3.1%)	NA	NA	2 (2.2%)	2 (2.1%)	2 (25.0%)		
Autumn	158 (15.4%)	12 (12.5%)	NA	NA	7 (7.8%)	5 (5.3%)	1 (12.5%)		

NA: Not available, p_1: comparison of sodium levels, p_2: Comparison of the severity of sodium disorders.*:p<0.05

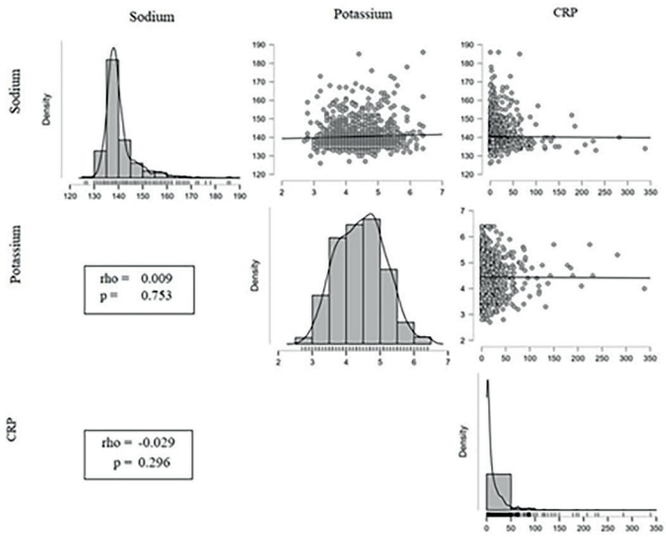

Figure 2 - Correlation between sodium and potassium

Although sodium disorders are seen more intensely in the 0-1 years group, the severity of sodium disorders does not show a statistically significant difference according to age groups (p=0.579). Although sodium disorders are more common in boys, the severity of sodium disorders does not differ significantly by gender (p=0.390). When sodium disorders are compared according to the seasons, sodium disorders are observed more frequently in winter and spring, and there is a significant relationship between the season and the severity of sodium disorders (p=0.002). While sodium disorders are more common in winter and spring, they are less common in summer and autumn.

We investigated the association between serum sodium levels and potassium, and CRP levels in children in a hospital in Ankara, Turkey. There was no significant correlation between serum sodium level and potassium and CRP levels (r=0.009; p=0.753 and r = -0.029; p=0.296 respectively) (Figure 2).

To determine the risk factors, multinomial logistic regression analysis was performed with age, gender, and seasonal variables, which were found to be significant as a result of univariate analysis. When the results of the multinomial logistic regression analysis are examined, it is seen that only the season

Table 3 Comparison of serum sodium levels for age, sex, and seasonal groups

			OR (%95 Cl)	p
hypernatremia	Age groups	0-1 years	1.28 (0.84-1.94)	0.250
		1-2 years	Ref	
	Sex	Girl	0.87 (0.63-1.19)	0.378
		Boy	Ref	
	Season	Autumn	1.20 (0.44-3.27)	0.723
		Winter	3.44 (1.47-8.06)	0.004*
		Spring	2.80 (1.16-6.78)	0.022*
		Summer	Ref	
hyponatremia	Age groups	0-1 years	0.72 (0.44-1.16)	0.176
		1-2 years	Ref	
	Sex	Female	0.61 (0.39-0.95)	0.030*
		Male	Ref	
	Season	Autumn	2.24 (0.61-8.17)	0.223
		Winter	3.1 (0.94-10.14)	0.062
		Spring	3.32 (0.98-11.22)	0.053
		Summer	Ref	

*: p<0.05, ref: reference category

is a significant factor in the detection of hypernatremia, while only the gender is significant in the detection of hyponatremia. Patients were 2.8 times more likely to have hypernatremia in the spring than in the summer (95% CI: 1.16-6.78, p=0.022). Patients were 3.4 times more likely to have hypernatremia in winter than in summer (95% CI: 1.47-8.06, p=0.004). The probability of hyponatremia in women is lower than in men (OR=0.61, 95% CI=0.39-0.95) (Table 3).

Discussion

In the current study, a total of 1317 infants with acute bronchiolitis, aged below two, were subjected to analysis. Among the study population, 193 (14.7%) had hypernatremia, and 99 (7.5%) had hyponatremia. While the majority of the hypernatremic children were moderate (n: 95, 49.2%), the majority of the hyponatremic children were mild (n: 96, 96.9%). Although not statistically significant, both hypernatremia and hyponatremia were detected more frequently in patients younger than one-year-old.

The frequency of hypernatremia was almost twice that of hyponatremia. Contrary to our results, many studies have reported that hyponatremia is the most common electrolyte disorder in lower respiratory tract infections in the literature. To our knowledge, this is the first time that a high frequency of hypernatremia has been reported in patients with acute bronchiolitis. Considering that even mild and moderate hypernatremia increases mortality and morbidity [3,10,15,16], we believe that the frequency of hypernatremia detected in this study is critical in child health.

The literature reports that hypernatremia is associated with undesirable outcomes, such as neurological changes (from lethargy and weakness to coma), decreased cardiac function, and impaired hepatic lactate clearance [3,17]. In this study, we did not aim to analyze the physiopathology of hypernatremia in acute bronchiolitis. However, we suggest that it may be related to malnutrition and insufficient drinking accompanying extrarenal fluid loss.

Fever, sweating, vomiting, increased respiratory secretions, and hyperventilation may cause hypotonic fluid loss in acute bronchiolitis patients [16]. This stimulates thirst. In this condition, drinking enough water will prevent hypernatremia [4,16]. If the children too young to express their thirst are not perceived by their parents and sufficient water intake is not provided, this may cause hypernatremia [18]. In our analysis, 83.9% of patients with hypernatremia were under the age of one. We believe that this difference is because children under one year are incapable of expressing their thirst.

In this study, the frequency of hypernatremia was affected by seasons. It was most often detected in winter and spring. In studies, conducted with the general patient population in the adult age group, hypernatremia was detected most frequently in the winter season, and it was reported that this might be due to the lack of attention to hydration during the winter months [10,19]. In addition, we assume that parents dressing their children in thick clothes to protect them from the cold might increase sweating and lead to hypernatremia.

This study has several limitations. First, although we demonstrated the frequency of hypernatremia due to its retrospective design, we did not have sufficient data to explain the causality. Second, sodium levels were not corrected according to serum glucose levels. Third, although patients who applied to a different hospital during the same disease period were excluded from the study due to possible intravenous fluid intake, we cannot be sure that these patients were completely excluded because the study was retrospective.

Conclusion

In conclusion, hypernatremia may accompany children with acute bronchiolitis. Therefore, patients with acute bronchiolitis should be investigated for electrolyte imbalances to personalize their fluid therapy. Which factors contributed to the risk of hypernatremia in acute bronchiolitis should be evaluated in further studies.

What is already known? Acute bronchiolitis infections in children may often be accompanied by hyponatremia.
What does this study add? Children with acute bronchiolitis are at risk not only for hyponatremia but also for hypernatremia.

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