The Professional Medical Journal
www.theprofesional.com

ORIGINAL PROF-3333

DOI: 10.17957/TPMJ/17.3333

DYSNATREMIAS;

DYSNATREMIAS IN PEDIATRIC CRITICAL CARE, ETIOLOGY,EPIDEMIOLOGY AND EFFECT ON OUTCOMES

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Article received on:
12/03/2016
Accepted for publication:
18/03/2017
Received after proof reading:
03/07/2017

ABSTRACT… Dysnatremias (hyponatremia and hypernatremia) are common electrolyte disorders encountered in pediatric critical care patients. The spectrum of both hypo- and hypernatremia varies from mild to severe, being life threatening occasionally. We carried out a study to determine the etiology, epidemiology and effect of dysnatremias on outcomes of pediatric critical care patients. **Objectives:** To determine the etiology, epidemiology and effect of dysnatremias on outcomes of pediatric critical care patients. **Study Design:** Prospective, observational study. **Setting:** Paediatric Intensive Care Unit (PICU) Services Hospital Lahore. **Period:** October 2014 to March 2015. **Results:** 185 patients were included. 19 (10.3%) patients had hyponatremia and 22 (11.9%) patients had hypernatremia. A weak but significant inverse relationship between presentation serum sodium and mortality was observed (r = - 0.39, n=185, p= <0.001, two-tailed). **Conclusions:** Presentation serum sodium may influence the outcomes of the patients admitted to the pediatric intensive care unit.

Key words: Dysnatremia, Hypernatremia, Hyponatremia, Pediatrics, Critical care.

Article Citation: Omer R, Masood MK, Asghar S, Jawad M, Afzal A, Khan HI. Dysnatremias; Dysnatremias in pediatric critical care, etiology,epidemiology and effect on outcomes. Professional Med J 2017;24(7):1076-1080.
DOI: 10.17957/TPMJ/17.3333

INTRODUCTION

Dysnatremia is an umbrella term to describe hypo or hypernatremia. Hyponatremia (serum sodium concentration <135 meq/L) and hypernatremia (serum sodium concentration >135mEq/L) both primarily are manifestations of imbalance of body water homeostasis which is dependent upon salt and water intake, insensible losses and urinary concentration or dilution (in most circumstances mediated by vasopressin).[1,2]

Hyponatremia can be divided into euvolemic, hypovolemic and hypervolemic types denoting the presence of decreased, normal or increased total body water. It has been shown that hyponatremia may lead to worse outcomes in a variety of illnesses necessitating admissions to pediatric critical care.[3,4] Its presence seems to increase the mortality in critical patients.[5] It has also been repeatedly shown that hyponatremia.[4,6] as well as its treatment[7,8] can lead to neurologic sequelae.

Hypernatremia almost always means dehydration or decrease in total body water. Uncommonly, however, gain in total body salt may explain increased sodium levels.[9] As with hyponatremia, studies have shown poor outcomes in children having hypernatremia.[10,11]

There is a dearth of local data regarding epidemiology of dysnatremias and its consequences in critical care settings. We performed a cross sectional study to elucidate

the epidemiology of dysnatremias and their role in predicting outcomes in paediatric patients hospitalized in a tertiary critical care setup.

MATERIALS AND METHODS

This was a prospective observational study carried out on patients admitted in Paediatric Intensive Care Unit (PICU) Services Hospital Lahore from October 2014 to March 2015. A total of 2523 patients were admitted in Paediatric Unit during this period. 185 (7.3%) patients were admitted in PICU. At the time of admission basic demographic data (age, gender) was noted and routine labs were sent. Pseudo-hyponatremia was ruled out by checking blood sugar levels and lipid profile in patients with serum sodium concentration of <135 mEq/L. Patients clinical course were noted till the time of discharge or death. Each patient was treated according to individual clinical condition and standard recommendations.

Data analysis was carried out using SPSS version 22. Frequencies and percentages were calculated for gender, final diagnosis, need for ventilation and outcome. Means and standard deviation were calculated for age and serum sodium at presentation. Pearson's correlation was calculated to examine the relationship between presentation serum sodium and outcomes.

RESULTS

The study included 185 patients. Basic demographic data is presented in Table-I. Causes of hyponatremia are given in Table-II. Outcomes according to presentation serum sodium are given in Table-III. A Pearson correlation coefficient was computed to assess the relationship between presentation serum sodium and outcomes. There was a weak but significant inverse relationship between these variables ($r = -0.39$, $n=185$, $p=<0.001$, two-tailed).

DISCUSSION

Our study aimed to describe relationship between presentation serum sodium and outcomes of patients admitted to a pediatric ICU. To our knowledge this is the first local study attempting to examine this relationship in setting of critical care.

Total number of patients included (n)	185
Mean Age (months) ≤ 1 year 1 – 12 years ≥ 12 years	36.63 + 45.61 (range: 1 – 146) 93 (50.3%) 88 (47.6%) 4 (2.2%)
Gender	M: 97 (52.4%), F: 88 (47.6%)
Final Diagnosis CNS Infections RTI Cardiac Disease Sepsis Malnutrition Others	 55 (29.7%) 41 (22.2%) 22 (11.9%) 18 (9.7%) 13 (7.0%) 36 (19.45%)
Need for Ventilation	41 (22.2%)
Mean Serum Sodium at presentation (mEq/L) <135 135 – 145 > 145	136.62 + 7.49 (Range: 113 – 151) 19 (10.3%) 144 (77.8%) 22 (11.9%)

Table-I. Group Characteristics.
CNS: Central Nervous System RTI: Respiratory Tract Infection

Hyponatremia	N (%)	Hypernatremia	N (%)
CNS Infections	4 (21%)	CNS infections	10 (5.4%)
RTI	4 (21%)	Cardiac Disease	5 (2.7%)
CLD	3 (15.8%)	RTI	3 (1.6%%)
Malnutrition	2 (10.5%)	Kidney Disease	1 (0.54%)
DKA	2 (10.5%)	Malnutrition	1 (0.54%)
Cardiac Disease	2 (10.5%)	DKA	1 (0.54%)
Sepsis	1 (5.3%)	Sepsis	1 (0.54%)
Poisoning	1 (5.3%)		

Table-II. Causes of Hyponatremia (N=19) and Hypernatremia (N=22).
RTI: Respiratory Tract Infection CLD: Chronic Liver Disease DKA: Diabetic Ketoacidosis

Presentation Serum Sodium	Total Number of Patients	Survived	Expired
<135	19	2	17
135 – 145	144	104	40
> 145	22	20	2

Table-III. Outcomes according to serum sodium concentration at presentation

Presentation hyponatremia was seen in 19 of 185 (10.3%) patients. This is similar to that reported by Fatima B et al[12] in their cross sectional analysis of dehydration for non-malnourished subjects however our study was conducted in critical care population and included patients who were generally more sick.

Central Nervous System (CNS) infections (n=4, 21%) and Respiratory Tract infections (RTI) (n=4, 21%) were the most common final diagnoses in patients with hyponatremia. Both of these entities can cause hyponatremia by multiple mechanisms. Proposed mechanisms of hyponatremia in CNS infections and RTI are: hypo-volemic state (vomiting, decreased oral intake, high insensible losses secondary to fever) and Syndrome of Inappropriate ADH secretion (SIADH). In addition, CNS infections can cause hyponatremia by causing a urinary salt wasting state known as Cerebral Salt Wasting syndrome (CSW Syndrome). However our study cohort did not undergo detailed investigations (especially urinary chemistries and calculations of fractional excretion for sodium, uric acid and other salts) for differentiation of these different entities considering the non-affordability of our patients. Multiple studies have noted worse outcomes in patients developing hyponatremia with CNS infections and RTIs.[3,4] Patients were treated according to their clinical condition primarily taking into consideration their volume status.
Chronic Liver Disease (CLD) causes hyponatremia by a complex interplay of decreased effective blood volume, secondary aldosteronism, and in some patients concurrently developing renal insufficiency and is considered a poor prognostic factor. This was also seen as a major cause of hyponatremia in our cohort (n= 3, 15.8%). These patients usually respond well to salt restriction and diuretics.

Malnutrition (n=2, 10.5%), Diabetic Ketoacidosis (n=2, 10.5%) and Cardiac disease (n=2, 10.5%) (VSD n=1, Myocarditis n=1) were the next most common diagnoses in patients with presentation hyponatremia. Malnutrition usually presents with either hypovolemic hyponatremia or dilutional hyponatremia secondary to decreased serum albumin. There is an increased incidence of infections in these patients. Treatment requires cautious supervised feeding (to prevent re-feeding syndrome) and balanced salt solutions. Diabetic Ketoacidosis also figured in our cohort. It usually causes hypovolemic hyponatremia (osmotic diuresis secondary to high blood glucose, volume loss because of fever and vomiting). This is a potentially life threatening complication of insulin dependent diabetes mellitus and require emergent resuscitation and careful fluid balance monitoring. Cardiac patients develop hyponatremia secondary to hypervolemia. Two

of our patients (Chronic VSD and Myocarditis) presented with pulmonary edema. Hyponatremia in these patients respond well to salt restriction and diuresis as did in our patients.

Sepsis (N=1, 5.3%) and unknown poisoning (N=1, 5.3%) were the least common diagnoses in children with presentation hyponatremia. Sepsis may cause hyponatremia through mechanisms involving IL-1 and ADH[13,14] Hyponatremia is significantly correlated with the degree of inflammation in children with febrile UTIs[15] and it has been suggested that hyponatremia may be a potential marker of severe inflammation in general.[15]

Hypernatremia (Serum sodium >145 mEq/L) was seen in 20 (11.9%) patients. The final diagnoses in these patients are given in Table-II. As shown the most common diagnosis is CNS infections. The possible causes of hypernatremia in patients with CNS infections can be volume loss due to vomiting or decreased oral intake, increased insensible losses due to high grade fever or development of central diabetes insipid us. General management includes volume repletion and treatment of infection. However none of the patients with hypernatremia secondary to CNS infection expired.

Cardiac Diseases may sometime present with hypernatremia. This is usually due to over diuresis. Cautious volume repletion generally with hypotonic fluids reverses the metabolic abnormality. One of our patients with hypernatremia and cardiac disease failed to survive.

RTI may sometimes present with dehydration especially in infants and young children. Three (1.6%) of our patients with RTI had high serum sodium at presentation. One of these patients expired.

CONCLUSION

Our study suggests that presentation serum sodium in patients admitted to pediatric critical care unit may influence outcomes.

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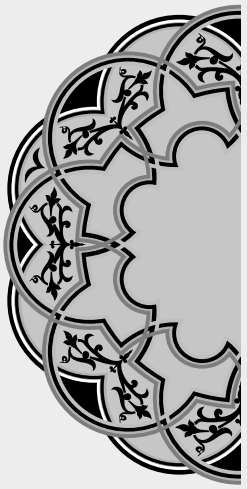

"Dig the well before you are thirsty."

Chinese Proverb

AUTHORSHIP AND CONTRIBUTION DECLARATION

Sr. #	Author-s Full Name	Contribution to the paper	Author=s Signature
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4	Muhammad Jawad	Data collection	
5	Amir Afzal	Data collection	
6	Humayun Iqbal Khan	Final approval	