

Original Research Article

Clinical profile, etiology, management and outcome of serum sodium disturbances in children admitted in PICU

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ABSTRACT

Background: Sodium disorders are common in children who need intensive care, they occur in variety of conditions, may remain unrecognized if not suspected and monitored and result in morbidity and mortality irrespective of primary problem. The aim of the study is to know etiology, management and outcome of sodium disturbances in sick children admitted to pediatric intensive care unit to Institute of Social Pediatrics Stanley Medical College.

Methods: This is a hospital based cross sectional study. Two hundred and twenty-seven children in the age group of 1month to 12 years admitted in PICU over the period of 8 months were included in the study. Venous blood sampling is obtained from each patient enrolled in the study and is sent for estimation of electrolytes, blood urea, glucose levels. Serum osmolality (calculated), urine osmolality, urine spot sodium were done in selected patients.

Results: Among the 227 children studied, 85 children had sodium disturbances that included both hyponatremia (80 children) and hypernatremia (5 children) The most common cause of hyponatremia is CNS disorder 25 patients (31.25%) followed by poisoning 17.

Conclusions: Hyponatremia occurs frequently and should be looked for in all sick children. It is of hypotonic-euvolemic type in almost all the acute infections except diarrhea and should be managed accordingly. They contribute significantly to the mortality and morbidity.

Keywords: Hyponatremia, Hypernatremia, Hypotonic-euvolemic, Sodium disorders

INTRODUCTION

Sodium disorders are common in children who need intensive care, they occur in variety of conditions, may remain unrecognized if not suspected and monitored and result in morbidity and mortality irrespective of primary problem. Early recognition, a high index of suspicion and a thorough understanding of common electrolyte abnormalities is necessary to ensure their correction. Hyponatremia is particularly common in sick hospitalized children. It is many a times associated with hypo-osmolality and normal hydration and is attributed to SIADH.² Acute hyponatremia poses an immediate danger to central nervous system.

Hypernatremia occurs less frequently than hyponatremia on other hand, patients debilitated enough to develop hypernatremia carry a high mortality risk.⁴

The development of many electrolyte disturbances in PICU can be prevented by attention to use of intravenous fluids and nutrition. The objective of the study is to know etiology, management and outcome of sodium disturbances in sick children admitted to pediatric intensive care unit to Institute of Social Pediatrics, Stanley medical college. To study the outcome pattern amongst the critically ill children seeking emergency care with sodium abnormalities with respect to underlying co-morbid conditions.

METHODS

This is a hospital based cross sectional study done at the Pediatric Intensive Care Unit of Institute of Social Pediatrics, Government Stanley Medical College Chennai, India. Duration of study is eight months from January to August 2015. Two hundred and twenty-seven children in the age group of 1 month to 12 years admitted in PICU over the period of 8 months were included in the study. Children whose parents did not give consent and post resuscitated children were excluded from the study.

Sample Size was calculated as 222, with frequency in a population (for finite population correction factor or fpc) (N): 500, hypothesized % frequency of outcome factor in the population (p): 50%±5, confidence limits as % of 100 (absolute±%) (d): 5%, design effect (for cluster surveys-DEFF): 1. Sample size taking 10% as nonresponse is 222 (CDC Atlanta).

Ours is a tertiary care referral hospital attached to a medical college in North Chennai. This hospital caters to the medical needs of a population, the majority of whom belong to a lower socio-economic status. Being a referral institute with numerous feeding hospitals in the surrounding locality, the patient turnover in the PICU is very rapid. Hence it is only the very sick children who get admitted to the PICU. Ethical clearance for the study was obtained from the Institutional Ethics Committee. Informed written consent was obtained from the parent of the child included in the study. Detailed history and clinical examination of all the patients taken up for the study were done at the time of admission to the PICU as shown in the Proforma. Routine laboratory investigations done.

At the time of admission, the patients clinical picture is recorded in prefixed proforma. Venous blood sampling is obtained from each patient enrolled in the study and is sent for estimation of electrolytes, blood urea, glucose levels. Serum osmolality (calculated), urine osmolality, urine spot sodium, were done in selected patients. Imaging studies as relevant to the admission diagnosis were done.

Serum sodium was measured by a process known as potentiometry. This method measures the voltage that develops between the inner and outer surfaces of an ion selective electrode. The electrode (membrane) is made of a material that is selectively permeable to the ion being measured. Here sodium electrodes are made from a special glass formula that selectively binds sodium ions. The inside of the electrode is filled with a fluid containing sodium ions, and the outside of the glass membrane is immersed in the sample.

A potential difference develops across the glass membrane that is dependent upon the difference in sodium concentration (activity) on the inside and outside of the glass membrane.

This potential is measured by comparing it to the potential of a reference electrode. Since the potential of the reference electrode is held constant, the difference in voltage between the two electrodes is attributed to the concentration of sodium in the sample. Ion selective membranes can be made from materials other than glass.

Statistical analysis

The collected data were analysed with SPSS 16.0 version. To describe about the data, descriptive statistics, frequency analysis, percentage analysis were used for categorical variables and for continuous variables the mean and S.D were used. To find the significant difference between the bivariate samples in independent groups, the independent t test was used. To find the significance in categorical data, Chi-Square test was used. In all the above statistical tools, the probability value of <0.05 was considered as significant level.

P-Value - Highly significant at $P \leq 0.01$
P-Value - Significant at $P \leq 0.05$
P-value - No Significant at $P > 0.05$

RESULTS

Among the 227 children studied, 85 children had sodium disturbances that included both hyponatremia (80 children) and hypernatremia (5 children) depicted in the pie chart. This number accounts for 37.44% of the patients admitted to PICU.

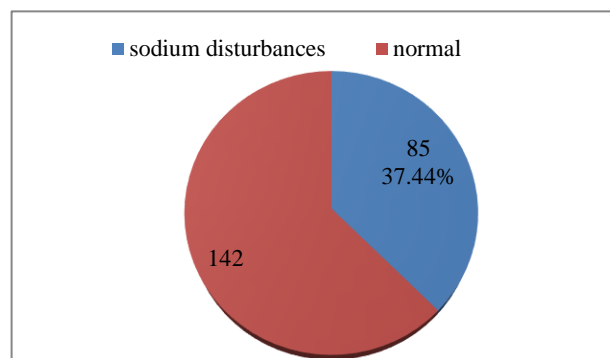


Figure 1: Sodium disturbances.

Of the children with sodium disturbances, distribution based on age were analysed and the corresponding chart is shown as below. Maximum number (27 children) of patients who developed sodium disturbances were in the age group of 1 month to 1 year and the mean age in years of the study population was calculated to be 1 month -2 years. Incidence of hyponatremia is more common among infants (about 27 cases). Among 5 cases of hypernatremia, it is more common among children aged >5 years. Incidence of hyponatremia is least among 1-2 years. On the contrary incidence of hypernatremia is least among age group of 2-5 years.

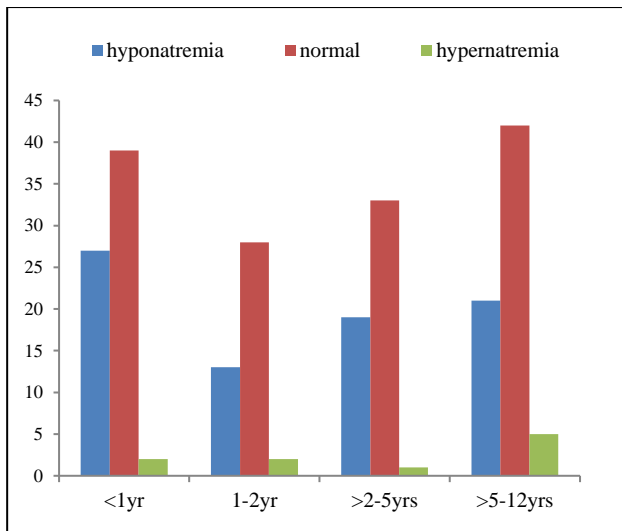


Figure 2: Age distribution of sodium disturbances.

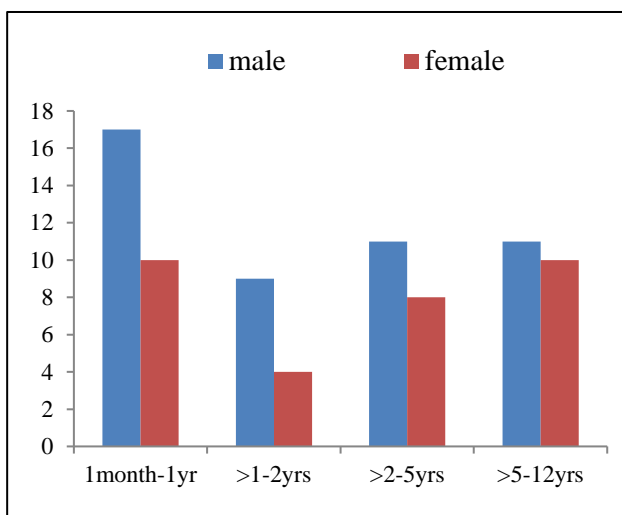


Figure 3: Age and sex wise distribution of hyponatremia.

Total number of hyponatremia was 80 children.

Incidence of hyponatremia is more common among male child about 48 cases, most common age group being 1month-1year (17cases). Out of the 80 patients who developed hyponatremia 48 patients were male (60%) and 32 patients were females (40%) with male: female ratio of 1.5:1.

Poisoning includes kerosene poisoning, liquid detergent poison, camphor and insecticide poisoning. Endocrine /metabolic causes include diabetic ketoacidosis, metabolic liver disease, hepatic encephalopathy, neuronal ceroid lipofuscinosis.

CNS causes include seizure disorder, acute CNS infection. CVS causes include cyanotic/acyanotic heart diseases, cardiomyopathy, arrhythmias. Respiratory causes include bronchopneumonia, bronchiolitis,

aspiration pneumonia, acute severe asthma. Hematological causes include sickle cell anemia, malignancies, hemolytic anemia.

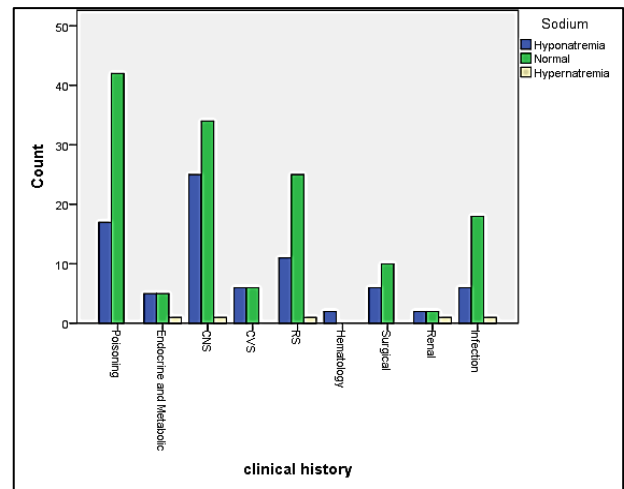


Figure 4: Etiological factors of sodium disturbances.

Surgical causes include post VP shunt, head injury, hepatoma, extrahepatic biliary atresia, thoracotomy. Endocrine, CNS disorders, Respiratory system, renal, infection each contributing 1 case for hypernatremia. Analysis of sodium disturbances with relation to IV fluids shows hyponatremia is more common among patients receiving hypotonic rather than isotonic fluids.

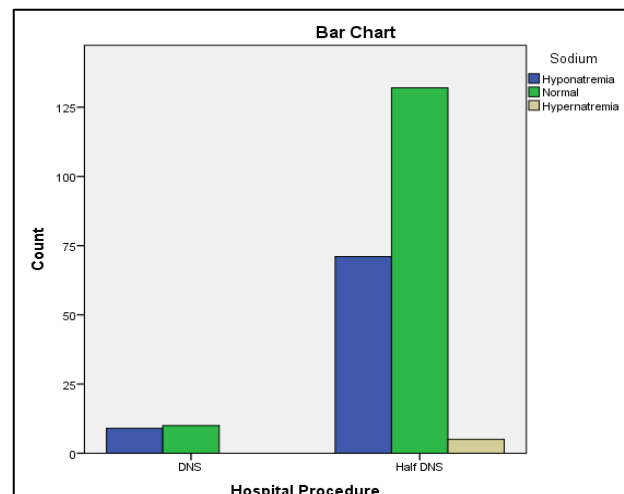


Figure 5: Graphical view of maintenance fluid and sodium disturbances

Among patients with hyponatremia, 88.75% (71 patients) were receiving 0.45% DNS whereas 11.25% (9 patients) were receiving 0.9% DNS. The patients were grouped on the basis of serum sodium concentration into normonatremic (serum sodium 135-145 mEq/L) and hyponatremic (serum sodium <135 mEq/L). Serum sodium concentration of 125 mEq/L or less was classified as severe hyponatremia. Hyponatremia was further categorized into five types: euvoletic (normal hydration,

plasma osm <280 mOsm/kg) hypovolemic (with dehydration), edematous (with edema), due to renal failure and hyperglycemic (fictitious) hyponatremia.

The frequency distribution of serum sodium concentration in 227 study children was analysed. Hyponatremia serum sodium <135 mEq/L was present in 80 children (35.2%). While severe hyponatremia, serum sodium <125 mEq/L was found in 5 children (6.25%). Amongst those with severe hyponatremia all the 5 children had serum sodium ranged between 121-125 mEq/L, none of them had sodium value <121 mEq/L.

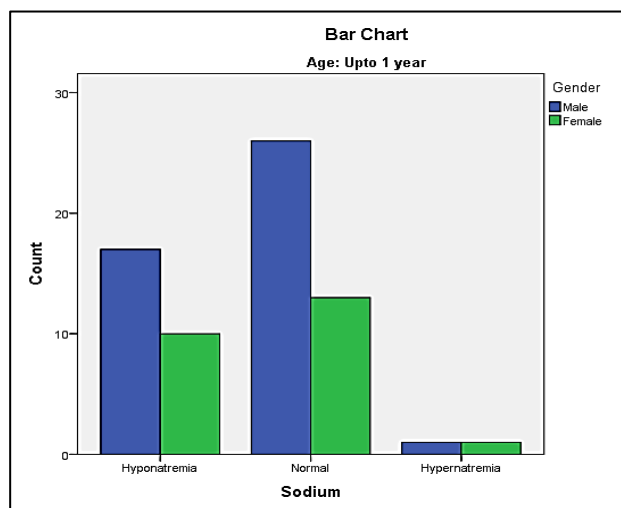


Figure 6: Gender distribution of sodium disturbances.

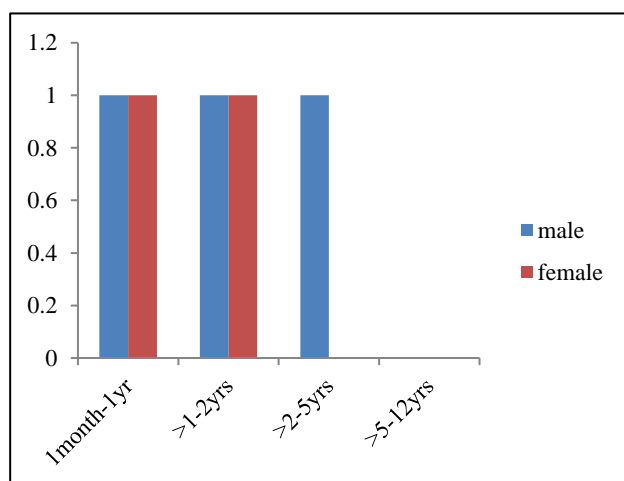


Figure 7: Frequency distribution of sodium disturbances.

Among patients with hyponatremia, symptomatic hyponatremia was found in 4 children. In children with seizures, around 18 patients in addition to those 4 patients who were symptomatic were given 3% NaCl correction. Similar observation was noted in Subbarao SD et al study on electrolyte disturbances.⁴ The commonest cause of hyponatremia is cerebral salt wasting and Syndrome of Inappropriate ADH secretion.

Among patients with hyponatremia, 9 patients (11.25%) received DNS and 71 patients (88.75%) received ½ DNS. This difference had no statistical significance. Among 25 patients with hyponatremia who died, 16 patients (64%) had seizures. 9 patients (36%) with seizures survived. similar observations were noted in another study by Subbarao SD et al and Thomas B et al. Studies on the mechanism of euvolemichyponatremia have emphasized a role of syndrome of inappropriate ADH secretion (SIADH) in these patients

Sex wise distribution of hypernatremia

Age = Upto 1 year

Sodium * Gender crosstabulationa

Among 5 cases of hypernatremia, 1 case occurred in both male and female between 1 month -1 year and >1-2 years. There were no case of hypernatremia over the age group of 5-12 years. out of 5 patients with hypernatremia, 3 patients were males, 2 patients were females with male to female ratio 1.5:1.

DISCUSSION

Study period from January 2015 to August 2015, out of 227 patients admitted in PICU of Government Stanley Medical College hospital, 85 patients developed sodium disturbances, this accounted for 37.4% incidence of sodium disturbances.

The knowledge of prevalence of electrolyte disturbances in a hospital is the most essential and the foremost in planning appropriate preventive strategies in that particular hospital. This information also stays as a baseline value for future comparison of results following any interventions taken in this regard. Thus, the value of the effort taken for this part of the study is well acceptable.

Clinical evaluation and concurrent plasma and urinary osmolality and urine sodium suggested that hyponatremia associated with pneumonia, meningitis/encephalitis, septicemia, seizures and miscellaneous diseases was of euvolemic (dilutional) type in more than 80% patients. While in all children with acute diarrhea it was of hypovolemic type. The study has shown that hyponatremia occurs frequently in sick children requiring emergency care, and should receive appropriate attention in the management plan.

The most common cause of hyponatremia is CNS disorder 25 patients (31.25%) followed by poisoning 17 patients (21.25%). Other causes were bronchopneumonia (13.75%) septicemia (7.5%), cardiac (7.5%) and renal (2.5%). Pizzotti et al.⁵ showed that 10.8% of patients with hyponatremia had an under-lying neurologic disorder and hyponatremia persisted in 4.3% of them after treatment of the underlying disorder. This could be due to the

difference in the pattern of PICU admissions in these studies where only 10.3% were CNS diseases. Samadi et al found hyponatremia in 20.8% of 1330 Bangladeshi children below 3 years of age with diarrhoea.¹² Similar figures have been reported by other workers in tropics. In contrast to this the reported frequency of hyponatremic dehydration was only 10% in children with acute diarrhoea in the western countries.

Age distribution

As seen from the study, maximum number of patients who developed electrolyte disturbances in PICU were in the age group 29 patients developed sodium disturbances of which 27 developed hyponatremias 2 patients with hypernatremia the most common age group being 1month-1yr this accounted for 34.11% of sodium disturbances.² Incidence of hyponatremia is the most common electrolyte abnormality in our study. Another study by SVS Prasad from PGIMER Chandigarh showed similar observations.

Sex distribution

Out of the 80 patients who developed hyponatremia 48 patients were male that is 60% and 32 patients were females that is 40% were female with male: female ratio 1.5:1. Out 5 patients with hypernatremia, 3 patients were males, 2 patients were females that is 60% were males, 40% were females with male to female ratio 1.5:1. The sex distribution of the study population was then correlated with the clinical outcome and statistical analysis done for the same. Once again, the percentage of deaths or discharges among the male or female population has not been found to be statistically significant.

Out of 55 deaths reported over the period of study, 25 patients had hyponatremia. 5 cases died had received DNS fluid and 50 cases died received ½ DNS, these results were not statistically significant.

Morbidity

The morbidity, as determined by the PICU stay was significantly higher in patients with hyponatremia when compared to those with normonatremia. This observation is similar to the findings reported.^{8,9} The severity of the underlying disease may also contribute to prolonged PICU stay.

Mortality

The risk of mortality is increased by 3-3.5 times in patients with hyponatremia when compared to those with normal serum sodium.^{8,9} The predictive factors for mortality in hypernatremic patients are reported to include persistently elevated serum sodium levels in association with protracted hypotension.¹⁰ Similar observations were noted in a study by Michael et al

journal of critical care (2013), hypernatremia was independently associated with a 40% increase in risk for hospital mortality and 28% increase in PICU length of stay.³ Present study also had similar findings. Mortality rates in patients with mixed electrolyte abnormalities were higher when compared to those with single electrolyte abnormality. Similar observations were made by others.^{8,10}

CONCLUSION

Hyponatremia occurs frequently and should be looked for in all sick children. It is of hypotonic- euvoletic type in almost all the acute infections except diarrhea and should be managed accordingly. They contribute significantly to the mortality and morbidity. Since the specific symptoms of electrolyte abnormality often merge with the underlying disease, close monitoring and correction of electrolyte abnormalities is important to reduce morbidity and mortality. The causative mechanism and clinical significance of this disturbance in children awaits further studies.

Recommendations

Electrolyte abnormalities are not always associated with symptoms. Administration of routine maintenance fluids, which are generally hypotonic (such as N/5saline, in 5% glucose), may worsen this edema. On the other hand, ½ DNS associated with hyponatremia is not a common occurrence and is associated with much less incidence of hyponatremia compared to other hypotonic fluids.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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