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A STUDY ON HYPONATREMIA IN CHILDREN ADMITTED IN OUR PEDIATRIC INTENSIVE CARE UNIT

KEYWORDS: PICU, Hyponatremia, Hypernatremia, Eunatremia.

Gowri Edagotti — Dept of Pediatrics, Siddhartha Medical College, Vijayawada, India

Murali Krishna.M — Dept of Pediatrics, Siddhartha Medical College, Vijayawada, India

Sridhar Mulaka — Dept of Pediatrics, Siddhartha Medical College, Vijayawada, India

Sreenivasa Chowdary.J — Dept of Radiology, Siddhartha Medical College, Vijayawada, India

ABSTRACT Hyponatremia is supposed to be the most common electrolyte abnormality in the paediatric intensive care unit (PICU), and is associated with increased morbidity and mortality. Critically ill children are at risk of developing hyponatremia, due to impaired renal free water excretion and exogenous sources of excess free water intake. Acute hyponatremia poses an immediate danger to the central nervous system. The rapid shift of fluids associated with this condition frequently results in brain edema.In our study, we have evaluated the frequency of hyponatremia in children who sought emergency care and required hospitalization. We also examined the relationship between electrolyte abnormalities and the primary illness and their impact on the morbidity.

INTRODUCTION

Electrolyte abnormalities are common in children who need intensive care. They occur in a variety of conditions, may remain unrecognized and result in morbidity and mortality irrespective of the primary problem[14.]

Hyponatremia in PICU has been linked to the syndrome of inappropriate secretion of antidiuretic hormone (SIADH)[19.] ADH excess results in water retention and volume expansion leading to fall in serum osmolality below the reference range. Hyponatremia does not develop unless the patient is ingesting or receiving some source of free water. Most children in PICU cannot maintain adequate fluid intake necessitating fluid therapy. Administration of hypotonic fluids may lead to development of acute hyponatremia which leads to a rapid shift of fluids into brain cells. The resultant cerebral edema is associated with high mortality. Hyponatremia has also been documented as a marker of severe illness and increases mortality.

It's therefore paramount for clinicians to understand common electrolyte abnormalities, have a high index of suspicion and timely recognize them. This will facilitate institution of appropriate treatment resulting in better outcomes.

METHODOLOGY

This is a Hospital based cross-sectional study a total of 248 paediatric children aged two months to twelve years old were studied that were admitted at Paediatric Intensive Care Unit (PICU) Old Government Genereal Hospital (OGGH), Sidhdhartha medical College,Vijayawada for over a period of February 2015 to July 2016. various investigations are done on the admitted cases. Serum electrolytes were evaluated for all PICU cases. Ethics committee approval was obtained prior to the study.

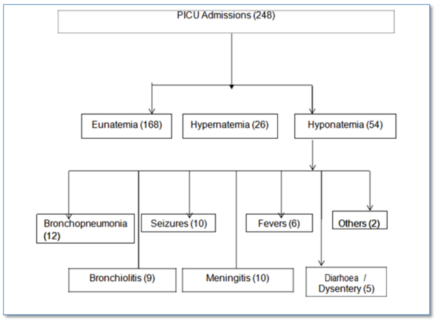
At PICU, complete history and physical examination were done. Those satisfying the inclusion criteria, informed consent was sought from the guardian or the parent after explaining to him or her about the study. Using aseptic technique, 2ml of blood was withdrawn from the antecubital fossa of each patient and put in a vacutainer. Samples were stored at 2-80 C. Samples were sent for serum electrolytes to The Department of Biochemistry, Siddhartha medical College, Vijayawada on the next morning.

EXCLUSION CRITERIA

- Children with known renal disease.
- Children with a known cardiac disease.
- Children already received intravenous fluids.
- Children on medication which affect electrolyte metabolism like diuretics.
- Children admitted in terminal stage.
- Children admitted with poisoning.
- Children left against medical advice.
- Children whose parent(s) or guardian(s) refused to give consent.

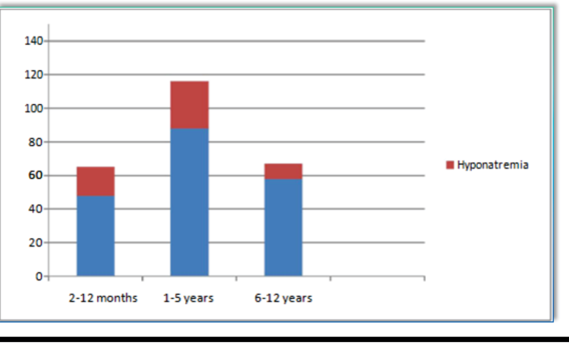
RESULTS

Table 1: Incidence Of Hyponatremia, Hypernatremia and Eunatremia



Out of 248 PICU admissions included, 54(21.77%) were hyponatremic, 26 (10.48%) were hypernatremic and rest 168 (67.74%) were eunatremic.

Fig 1 : Bar diagram showing Age Distribution



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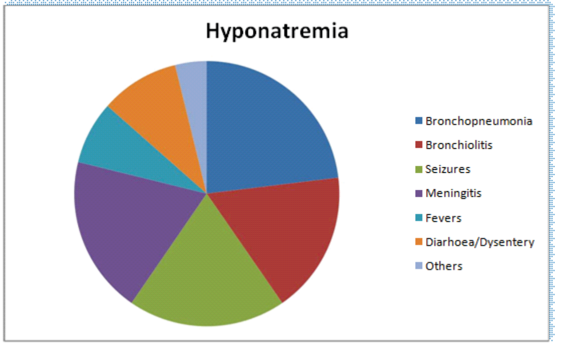
Out of 248 PICU admissions included, 65 children were between 2 – 12 months, out of these 17 (26.15%) were hyponatremic; 116 children were between 1 – 5 years, out of these 28 (24.14%) were hyponatremic; 67 children were between 6 – 12 years, out of these 9 (13.43%) were hyponatremic. Out of 248 PICU admissions included in this study, 53 children were suffering from bronchopneumonia, 32 children were suffering from bronchiolitis, 58 children were suffering from seizures, 17 children were suffering from meningitis, 49 children were suffering from fevers, 17 children were suffering from Diarrhoea/ Dysentery and 22 children were suffering from other diseases.

Table 2: Incidence of hyponatremia in different diseases

Disease	Total	Hyponatrema	%
Bronchopneumonia	53	12	22.64
Bronchiolitis	32	9	28.13
Seizures	58	10	17.24
Meningitis	17	10	58.82
Fevers	49	6	13.95
Diarrhoea /Dysentery	17	5	29.41
Others	22	2	09.09

In this study incidence of hyponatremia in bronchopneumonia was 12 (22.64%). Incidence of hyponatremia in bronchiolitis was 9 (28.13%). Incidence of hyponatremia in seizures was 10 (17.24%). Incidence of hyponatremia in meningitis was 10 (58.82%). Incidence of hyponatremia in fevers was 6 (13.95%). Incidence of hyponatremia in Diarrhoea /Dysentery was 5 (29.41%). Incidence of hyponatremia in other diseases was 2 (09.09%).

Fig 2: Pie diagram showing Distribution of hyponatremia in different diseases.



Distribution of hyponatremia: Out of 54 cases of hyponatremia,12 (22.22%) children were suffering from bronchopneumonia; 9 (16.67%) children were suffering from bronchiolitis; 10 (18.51%) children were suffering from seizures; 10 (18.51%) children were suffering from meningitis; 6 (11.11%) children were suffering from fevers; 5 (9.26%) children were suffering from Diarrhoea /Dysentery; 2 (3.7%) children were suffering from other diseases.

Table 3: Duration of hospital stay

	n	Total days	Per head (days)
Hyponatremia	54	514	9.52
Total	248	1991	8.03

The average duration of hospital stay in the present study was 8.03 days/head; while with hyponatremia was 9.52 days/head.

DISCUSSION

The study sample was fairly representative of the type of sick children admitted to our service with respect to their age, sex and the disease entities. The selection was unbiased. The data may therefore, be generalized on a population of sick children seeking emergency care. Out of 248 PICU admissions included in our study, there were 54 hyponatremic patients (21.77%). In a study done by S.V.S.S. Prasad et al[1] at PGI Chandigarh found Hyponatremia in 29.8% and was more frequent in summer (36%; 123/341) than in winter (24%; 94/386) ($p<0.001$).When compared to reported data in adult population, the frequency of hyponatremia is much higher in hospitalized sick children. The frequency was unaffected by the sex of the children. In this study 17 children were suffering from meningitis / meningoencephalitis, out of these 10 (58.82%) were hyponatremic. Study done by Prasad et al2 hyponatremia in meningitis/encephalitis was 33.3%. Study done by SubbaRao et al1 hyponatremia in central nervous system disorders was 41.4%. Apparently, hyponatremia occurs frequently without any major alterations in extracellular fluid volume in children with infectious diseases requiring hospitalisation, and should therefore be looked for actively in children with these diagnostic entities, and managed appropriately.

In this study 17 children were suffering from Diarrhoea/Dysentery, out of these 5 (29.41%) were hyponatremic. Prasad et al[1] found 34% of children with acute diarrhoea had hyponatremia. Samadiet al[2] found hyponatremia in 20.8% of 1330 Bangladeshi children below 3 years of age with diarrhoea. Hyponatremia in diarrhoea is hypovolemic type caused by excessive sodium loss in gastro-intestinal secretions, intake of salt free drinks and increased loss of salt through sweating in our climate might have contributed. In this study 32 children were suffering from bronchiolitis, out of these 9 (28.13%) were hyponatremic. A specific association between respiratory illnesses such as bronchiolitis and asthma and increased circulating levels of ADH(Antidiuretic Hormone) has been well documented. Hyperinflation of the lungs, a hallmark of this illness, stimulates the release of ADH from the posterior pituitary,[3-4] when under the influence of ADH and presented with a high urine flow rate, the distal nephron extracts free water and excretes the majority of the salt load in the urine, thereby returning[5] hypotonic fluid to the circulation and generating hyponatremia.

In this study 53 children were suffering from bronchopneumonia, out of these 12 (22.64%) were hyponatremic. Study conducted by Singhi S et al hyponatremia was found in 27% of pneumonia cases[5]. It's been postulated that hyponatremia in pneumonia is related to syndrome of inappropriate secretion of ADH(SIADH) which results in retention of fluid despite normal plasma osmolarity[4,6]. ADH secretion increases in proportion with the extent of lung parenchymal involvement. In addition, severe infections are associated with release of inflammatory cells e.g. Interleukin 6 (IL-6) which stimulates ADH production. Inflammatory markers also stimulate thermoregulatory centre resulting in reset of the thermostat hence the high temperatures.[7,8] Moreover, fever stimulates non-osmotic release of ADH. These observations compares to a study done by Don M Valerio et.al that found hyponatremia to be associated with significantly higher mean white blood cell countneutrophils, creactive protein and initial temperature in children with pneumonia.[9] Studies have also demonstrated that, respiratory compromise is a co-morbid factor in patients with hyponatremia markedly increasing the risk of death from pneumonia.[10] The underlying mechanism is probably hypoxia, a major risk factor for the development of hyponatremic encephalopathy.[11] Studies of hyponatremic animals have revealed that hypoxia impairs volume regulation of brain cells, decreases cerebral perfusion, and increases the probability of developing neuronal lesions.[12] Adaptation of the brain to hyponatremia largely depends on extrusion of sodium from the intracellular space via sodium–potassium ATPase pumps. This energy-dependent process is impaired under hypoxic conditions. The combination of systemic hypoxia and hyponatremia is more deleterious than is either condition alone, because hypoxia impairs the ability of the brain to adapt to hyponatremia, worsening hyponatremic encephalopathy.[13] In this study 58 children were suffering from seizure disorder, atypical febrile seizures, out of these 10 (17.24%) were hyponatremic. Study done by SubbaRao et al states hyponatremia in central nervous system disorders was 41.4%[14] In this study 49 children were suffering from fevers like dengue, rickettsial, enteric and other viral fevers out of these 6 (13.95%) were hyponatremic. Study done by SubbaRao et al

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hyponatremia in infections was 24.1%[14] In this study 22 children were suffering from other diseases, out of these 2 (09.09%) were hyponatremic. In a study done by S.V.S.S. Prasad at PGI Chandigarh found hyponatremia was predominantly of euvolemic (64%) and hypovolemic (27%) types. About 80% of cases of hyponatremia associated with acute respiratory illness, meningitis/encephalitis, septicemia, seizures and miscellaneous diseases were of euvolemic hypotonic (dilutional) type while in all children with hyponatremia associated with acute diarrheal illness it was of hypovolemic type[15] Treatment

Acute hyponatremia: The treatment of acutely developing hyponatremia depends on the cause, the rapidity of the fall, the severity of the hyponatremia and the presence or absence of symptoms. Serum sodium above 130 mEq/L is generally asymptomatic even when it develops acutely and does not require rapid correction. When serum sodium falls rapidly to less than 125 mEq/L cerebral edema is generally present. When CNS symptoms result, the serum sodium should be corrected rapidly with hypertonic saline to ameliorate the cerebral edema.

10 to 12 ml/kg of 3% NaCl should be given over a period of 2 to 4 hours. 1 ml of 3% NaCl =0.5 mEq of sodium. Once the acute symptoms have been taken care of, the serum sodium should be corrected more gradually over a period of 48 hours[16-17.]

In cases of **hypovolemic hyponatremia,** the sodium required is calculated as 0.6 x body weight x (135 – serum sodium). This should be given over 48 hours Serum sodium should be increased at a rate of 0.5 mEq/L per hour or not more than 12mEq/day. **Hypervolemic hyponatremia** occurs due to water gain and not due to sodium loss. In fact the total body sodium is high despite the low serum sodium. Administration of sodium would result in worsening of edema and more fluid overload. The treatment here would consist of fluid restriction Fluid administered in edematous hyponatremia should be less than the insensible water loss plus urine output. The fluid excess can be calculated as follows TBW x [1-measured sodium/ expected sodium].

Euvolemic hyponatremia as in SIADH
Restrict fluids to insensible water losses.
Give fluids as isotonic saline.
Do not administer hypotonic fluids.
Administer furosemide to improve free water clearance. If serum sodium is less than 120 mEq/L and is accompanied by CNS symptoms administration of 3% NaCl would be needed to counteract the cerebral edema[18.]

Chronic hyponatremia: In slowly developing hyponatremia the CNS has had time to adapt to the hypotonic milieu .The cells do so by extruding osmotically active particles and lowering intracellular osmolality. Rapidly correcting serum sodium to normal levels in such a situation will restore normal ECF tonicity, however as sodium cannot enter the cells, the ICF will be unable to increase its osmolality so rapidly. The osmotically challenged cells of the CNS undergo a characteristic change called osmotic demyelination that can lead to pseudo bulbar palsy, quadriparesis and terminate in death. These changes are seen as central pontine myelinolysis at autopsy or on magnetic resonance imaging (MRI). Therefore, all asymptomatic hyponatremia and slowly developing hyponatremia should be corrected gradually by not more than 12 mEq/L/day to prevent CNS damage secondary to treatment.

CONCLUSION

There is a high prevalence of hyponatremia in children admitted in PICU. Meningitis, Acute gastroenteritis / Acute diarrhoeal illness, Bronchopneumonia and Bronchiolitis patients were having hyponatremia in most of them. Routine estimation of serum electrolytes is mandatoryin all PICU admissions because clinical manifestations are subtle at beginning. Most of the clinical manifestations mimic central nervous system disorders. Hyponatremia is one of the indicators of severity of the illness. Early detection of hyponatremia is mandatory to start proper fluid management, otherwise further hyponatremia causes irreversible brain damage and death. Hyponatremia causes increased hospital stay.

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