

**STUDY OF HYPONATREMIA IN CRITICALLY ILL CHILDREN ADMITTED TO
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ABSTRACT

Background: Electrolyte abnormalities are common in children admitted to intensive care unit. They have a significant contribution to the morbidity and mortality, irrespective of the primary problem. Hyponatremia is the most commonly encountered electrolyte disturbance in hospitalized pediatric patients with an incidence ranging from 15 to 30%¹⁻³. **Objectives:** To find the incidence of hyponatremia in critically ill children admitted in pediatric intensive care unit and to evaluate the effect of hyponatremia on morbidity and mortality. **Material and methods:** A total of 152 patients aged 1 month to 14 years old admitted in the paediatric intensive care unit in R L Jalappa hospital, patients from January 2015 to december 2015 were enrolled. Sodium levels at the time of admission was estimated. **Results:** A total of 152 acutely ill children admitted in PICU were taken up for this study. Incidence of hyponatremia was 33.5% in our study. Out of 51 cases of hyponatremia, 25.49% had moderate hyponatremia and 13.73% had severe hyponatremia. The incidence of hyponatremia in bronchopneumonia was 41.3% followed by acute encephalitis 24%. The duration of hospital stay (days) was longer in severe hyponatremic cases than moderate hyponatremic cases. **Limitations:** Small sample size and primary cause for hyponatremia not evaluated. **Conclusions:** One third of patients had hyponatremia at admission to PICU. and further administration of hypoosmotic fluids is more likely to increase the proportion of children who will have hyponatremia.

KEY WORDS: Hyponatremia, Serum sodium.**INTRODUCTION**

Electrolyte abnormalities are common in children admitted to intensive care unit. They are disorders of relative water loss or excess, resulting in alteration in effective plasma osmolality, leading to transcellular shift of water, thereby altering cell volume. They have a significant contribution to the morbidity and mortality, irrespective of the primary problem. The consequences may be dire if abnormalities of serum electrolyte concentration remain undetected and untreated. The therapeutic objective in the treatment of fluid and electrolyte imbalances in infants and children is to restore normal physiologic homeostasis. To achieve this goal, timely recognition, a high index of suspicion and a thorough knowledge of the common electrolyte abnormalities are necessary.

Hyponatremia is generally defined as serum sodium concentration below 135meq/Litre. This is the most commonly encountered electrolyte disturbance in hospitalized pediatric patients with an incidence ranging from 15 to 30%^[1-3].

Most cases of hyponatremia are mild and asymptomatic but this problem is now increasingly recognized as a

significant cause of morbidity and mortality. It frequently develops or frequently exacerbates during hospitalization and are associated with increased length of stay and mortality. Clinical manifestations may range from absent to life threatening complications.

Despite its deleterious effects, literature on pediatric hyponatremia is still lacking especially in the local setting. Available literatures also had small sample size, making it difficult to draw conclusions and recommend appropriate treatment. With its mortality rate reaching up to 20% in some studies^[1], it is vital to identify diseases which confer high risk for hyponatremia. Early intervention will ultimately lessen the risk for developing adverse events from this metabolic emergency. In this study, the incidence and outcome of hyponatremia in the patients admitted in the paediatric emergency room of a tertiary institution were determined and diseases commonly associated with it were identified.

MATERIAL AND METHODS

This was a prospective study on the incidence and outcome of hyponatremia in patients aged 1 month to 14 years old admitted in the pediatric intensive care unit in R L Jalappa hospital, Kolar.

After obtaining permission from the institutional review board and written informed consent from the parents of the patient all the detailed information was entered in the Performa. Consent was taken from the parents of all the 152 children enrolled in the study to detect the serum sodium levels at the time of admission to the paediatric intensive care unit along with other necessary tests. The only significant risk involved in this study was the development of infection on the blood extraction site. This was avoided by proper handwashing and utilization of the blood extraction kit (in accordance with the policy of paediatric infectious disease section), which was readily available in the paediatric intensive care unit.

The following clinical and demographic data were gathered: 1) case number, 2) age, 3) sex, 4) presenting symptom, 5) systemic examination 6) primary diagnosis, 7) serum sodium level, 8) outcome, and 9) final diagnosis. Single determination of serum sodium was done at time of admission to paediatric intensive care unit and at periodic interval if required. Venous blood samples about 1 to 2 mL were drawn upon admission (together with the other blood work-up done if necessary) and sent for analysis in RL Jalappa Department of Laboratories. Serum samples were analyzed using VITROS, a machine which utilizes indirect ion-specific electrode potentiometry for sodium determination. Specimens were not subjected to other tests without the permission of the participant and parent/guardian. Apart from these data which were collected on admission, the patient's length of ICU stay, outcome (discharged or died) and whether the patient developed complications due to hyponatremia (seizures and altered sensorium) were also determined.

RESULTS

Majority of subjects in the study were in the age group of 1 month to 1 year (38.2%), followed by 27.6% in 1 to 5 years, 16.4% in 5 to 10 years and 17.8% in >10 years. (Table 1) Majority of the subjects were males (60.5%) and 39.5% were females. (Table 2)

In the study majority 40.1% of subjects were diagnosed to have bronchopneumonia, 25.7% had acute encephalitis, 10.5% had severe dengue and others as shown in table 3. In the study out of 152 cases, 51 (33.56%) had hyponatremia and 101 (66.44%) had no hyponatremia. (table 4)

In the study majority 25.49% had moderate hyponatremia, 60.78% had mild hyponatremia and 13.73% had severe hyponatremia. (table 5) In the study among subjects with hyponatremia, 47.1% were in the age group 1 month to 1 year, 23.5% were in the age group 1 to 5 years, 19.6% were in the age group 5 to 10 year and 9.8% were in the age group 10 to 14 years. Similarly among subjects with Normonatremia, 33.8% were in the age group 1 month to 1 year, 29.8% were in the age group 1 to 5 years, 14.8% were in the age group 5 to 10 year and 21.6% were in the age group 10 to 14

years. There was no significant association between Hyponatremia and age distribution. (table 6)

Among subjects with Normonatremia 61.4% were males and 38.6% were females, similarly among subjects with hyponatremia 58.8% were males and 41.2% were females. There was no significant association between hyponatremia and gender. (table 7)

Among subjects with Hyponatremia and Normonatremia majority of the subjects had Bronchopneumonia (41.3% and 50.5% respectively). Second most common diagnosis in both hyponatremia and Normonatremia was acute encephalitis (24% and 22.8% respectively). There was significant association between diagnosis and hyponatremia among subjects. (table 8)

In the hyponatremic subjects, 78.4% of subjects had morbidity and 21.6% had no morbidity (table 9). 23.5% of subjects in the hyponatremia group had seizure episodes. (table 10). 39.2% of hyponatremic subjects had altered Sensorium (Table 11). Incidence of mortality among the hyponatremic group was 7.8% (table 12)

DISCUSSION

The present study was conducted from January 2015 to December 2015. In this period 152 cases were studied who was admitted to Pediatric intensive care unit with various illness. Serum sodium concentration was estimated in these children at the time of admission.

Out of 152 cases admitted in our hospital, majority of the subjects were males (60.5%) and 39.5% were females.

Majority of the subjects in the study were in the age group of 1 month to 1 year (38.2%), followed by 27.6% in 1 to 5 years, 16.4% in 5 to 10 years and 17.8% in >10 years.

In our study, majority of PICU admission were in the age group of 1 month to 1 year. This can be supported by the studies done by **Prasad et al**^[3] and **Subba Rao et al**^[1,3] where the mean age was 2-14 years and 4.09 years respectively. In the study out of 152 cases, 51 (33.5%) had hyponatremia and 101 (66.5%) had normonatremia. Hyponatremia was defined as less than 135 mEq/L in our study^[4]. One third of patients had hyponatremia at admission to PICU. and further administration of hypoosmotic fluids is more likely to increase the proportion of children who will have hyponatremia. When compared to other reported data in children by **Sunit Singhi et al** who reported 29.8% incidence of hyponatremia, the present study showed higher incidence^[3]. **Anderson RJ et al** (1986) found clinically significant symptomatic hyponatremia (serum sodium less than 130mEq/L) was a frequent occurrence with incidence 1-2% of total hospitalized patients with acute or chronic illness^[6]. **Wattad A et al** in (1992) observed that, out of 11,702 total hospital admissions, 161 patients

were hyponatremic (serum sodium less than 130 mEq/L), an overall frequency of 1.38%^[7].

In our study, we have calculated incidence only to critically ill children admitted to PICU, hence clinical significant incidence of hyponatremia was high in our study.

In the present study there was no significant age or sex difference in frequency of hyponatremia.

Out of 152 admissions, the causes of admission are Bronchopneumonia(40.1%), Acute Encephalitis(25.7%), Severe Dengue(10.5%), Sepsis With Acute GE(8.6%), DF With WS(5.9%), Bronchiolitis(7.2%), Drowning(1.3%) and Blunt Trauma abdomen(0.7%).

The most common association with hyponatremia were pneumonia, encephalitis and acute gastroenteritis. The proportion of cases with hyponatremia across various diagnostic categories ranged from 0.8 to 41.3 %.

19.6 % children with pneumonia had hyponatremia in our study. A study done by Singhi and co-workers identified that electrolyte disturbances in children with pneumonia were quite common. The most frequent abnormality reported was hyponatraemia (25%)^[17]. **Shann F et al** (1985) observed that 45% of children with pneumonia and 50% of children with bacterial meningitis had hyponatremia. Increased secretion of antidiuretic hormone was common with pneumonia and meningitis^[10]. Similarly in a study in PGI Chandigarh, out of 264 children with pneumonia 27% of cases were associated with hyponatremia. Of all the hyponatremia, 68% were secondary to SIADH^[11]. In another study, mild hyponatremia was found in 70 % of hyponatremia and moderate hyponatremia was found in 20 % of children with pneumonia^[5].

Encephalitis was the 2nd most common cause of hyponatremia in our study accounting to about 31.3%(16/51) of all cases of hyponatremia. Incidence of hyponatremia among acute encephalitis cases was 41 % (16/39) in our study. In a work by **Bussmann C** 10.3% of children with various acute central nervous system disorders had sodium level below 130mmol/L^[8]. In another study by **von Vigier RO et al** who studied circulating sodium in acute meningitis and found that 32.3% (97 / 300) children with meningitis had sodium level below 133 mmol/L^[18]. **Lamia et al**, performed case control study on 150 children (87 boys and 63 girls), of age group between 2 months and 9yrs. 75 of them presented with acute CNS manifestations while the rest were considered as control. Eight of 75 pediatric patients (10.7%) with acute CNS diseases had hyponatremia syndrome, three were diagnosed with inappropriate antidiuretic hormone secretion. The highest percentage of hyponatremia (3 out of 6 patients) was found in patients with intracranial diseases. Four out of 38 patients(15.5%) presented with CNS infections^[16].

In a study done by **Shann and Germer** had found 50% of cases with bacterial meningitis had hyponatremia^[10]. Similar study was done by **Subba Rao et al** with 41.4% (12/29) cases of hyponatremia suffering from central nervous system diseases^[13]. **Prasad et al** have found 21% of children with central nervous system disease (meningo encephalitis) had hyponatremia.^[3]

In a recent published literature, hyponatremia was present in 56% of children presenting with diarrhea^[7]. It was much higher than present study where 53.8% (7/13) of children with diarrhea had hyponatremia. By far the most common cause of hypovolemic hyponatremia is viral gastroenteritis causing vomiting and diarrhoea^[3]. **Whattad A et al** (1992) had noticed that acute gastroenteritis is the leading cause of hyponatremia, present on admission^[7]. In a study in Bangladesh, it was found that out of 1330 children under the age of 3 years with diarrhoea, 276 (20.8%) were hyponatremic. The incidence of hyponatremia was related to the degree of malnutrition^[9]. Incidence of hyponatremia among Acute gastroenteritis cases was high in our study as we admit only acute gastroenteritis with severe dehydration cases to PICU.

Morbidity

The morbidity, as determined by the PICU stay (more than 5 days) was significantly higher in patients with hyponatremia when compared to those with normonatremia. This observation is similar to the study done by **Prasad et al**^[15] and **Singhi et al**^[11]. The severity of the underlying disease may also contribute to prolonged PICU stay. They reported that the period of hospitalization prolonged by 60% and mortality increased by 3.5 times when hyponatraemia was associated with pneumonia^[17].

In the study done by **singhi et al**, the hospital stay associated with hyponatremia was 60% longer and two-fold increase in complications^[11]. **Singhi S et al** in their prospective study of 727 sick children found that, the mean duration of hospital stay (7.7 + 0.4 days) among 217 children with serum sodium < 130mEq/L about 30% longer than that of 510 children with serum sodium concentration (> 131 mEq/L) (5.9 + 0.3 days)^[15].

Incidence of seizure and altered sensorium among hyponatremic group was 23.5% and 39.2% respectively in our study. These complications are seen only in the moderate and severe hyponatremia group. **Farrar HC et al** in their retrospective chart review of infants found hyponatremia was cause of seizures in 70% of infants younger than 6 months who lacked other findings suggesting a cause. The median temperature was lower in hyponatremic infants than normonatremic patients^[12].

Mortality

Incidence of mortality in hyponatremic group was 7.8% (4/51) but hyponatremia cannot be attributed to mortality as the confounding factors are not excluded. **Baron D et**

al in their study reported that highest mortality (64%) was in the patients with CNS symptoms related to factors other than hyponatremia. Patients with CNS symptoms due to hyponatremia had a mortality rate (9%) similar to that of the patients without CNS symptoms (10%). So hyponatremia appears to be a marker for severe underlying disease that carries a poor prognosis prognosis^[14]. The risk of mortality is increased by 3-3.5 times in patients with hyponatremia when compared to those with normal serum sodium in a study done by Prasad et al^[15]. In a study done by **singhi et al**, 3.5 times higher mortality in the hyponatremic children compared to normonatremic children^[11]. In a study done by Prasad et al, mortality rate in children with normal serum sodium concentration (> 131 mEq/L) was 5.3% and the mortality rate was 17% in 47 children with serum sodium <125 mEq/L^[15].

Table 1 : Age distribution of subjects

Age	Frequency	Percent
1month - < 1yr	58	38.2
1 yr - < 5 yr	42	27.6
5 yr - <10 yr	25	16.4
10 yr -14 yr	27	17.8
Total	152	100.0

Table 2 : Gender distribution of subjects

Gender	Frequency	Percent
Male	92	60.5
Female	60	39.5
Total	152	100.0

Table 3 : Diagnosis among subjects in the study

Diagnosis	Frequency	Percent
Acute Encephalitis	39	25.7
Blunt Trauma ABD	1	0.7
Bronchiolitis	11	7.2
Bronchopneumonia	61	40.1
DF With WS	9	5.9
Drowning	2	1.3
Sepsis With Acute GE	13	8.6
Severe Dengue	16	10.5
Total	152	100.0

Table 4: Percentage of Hyponatremia cases in the study

Group	Frequency	Percent
Normonatremia	101	66.44
Hyponatremia	51	33.56
Total	152	100.0

Table 5: Degree of Hyponatremia among subjects

Degree of Hyponatremia	Frequency	Valid Percent
Mild (130-134)	31	60.78
Moderate (125-129)	13	25.49
Severe (<125)	7	13.73
Total	51	100.0

Table 6: Association between Hyponatremia and age distribution

Group	Age				Total	χ^2 value*	P value
	1month - < 1yr	1 yr - <5 yr	5 yr - <10 yr	10 yr -14 yr			
Normonatremia	34	30	15	22	101	5.264	0.15
	33.8%	29.8%	14.8%	21.6%	100.0%		
Hyponatremia	24	12	10	5	51		
	47.1 %	23.5 %	19.6%	9.8 %	100.0%		

*Chi Square test

Table 7 : Association between Hyponatremia and Gender

	Gender		Total	χ^2 value*	P value
	Male	Female			
Normonatremia	62	39	101	0.093	0.76
	61.4%	38.6%	100.0%		
Hyponatremia	30	21	51		
	58.8%	41.2%	100.0%		

Table 8: Association between diagnosis and Hyponatremia

	Diagnosis								Total	χ^2 value*	P value
	Acute Encephalitis	Blunt Trauma Abd	Bronchiolitis	Bronchopneumonia	DF With WS	Drowning	Sepsis With Acute GE	Severe Dengue			
Normonatremia	23	1	5	51	6	0	6	9	101	18.82	0.0087
	22.8%	1%	5%	50.5%	6%	0%	6%	9%	100%		

Hyponatremia	16	0	6	10	3	2	7	7	51		
	24.0%	0.8%	5.8%	41.3%	5.8%	1.7%	8.3%	12.4%	100.0%		

TABLE 9: Association of Morbidity with Hyponatremia

Morbidity	Frequency	Percent
Yes	40	78.4
No	11	21.6
Total	51	100.0

TABLE 10 : Incidence of seizures in Hyponatremia cases

Seizures	Frequency	Percent
Yes	12	23.5
No	39	76.5
Total	51	100.0

Table 11: Incidence of Altered sensorium among Hyponatremic cases

Altered Sensorium	Frequency	Percent
Yes	20	39.2
No	31	60.8
Total	51	100.0

Table 12: Incidence of Mortality among Hyponatremia cases

Mortality	Frequency	Percent
Yes	4	7.8%
No	47	92.2%
Total	51	100.0

CONCLUSION

- This study shows that hyponatremia (33.5%) occurs frequently in children requiring critical care management and thus should be anticipated and given attention in management plan along with treating the underlying cause.
- One third of patients had hyponatremia at admission to PICU. and further administration of hypoosmotic fluids is more likely to increase the proportion of children who will have hyponatremia.
- Giving hypotonic fluids to these diseases put them at higher risk of developing hospital-acquired hyponatremia which poses greater risk for severe metabolic complications, and higher rates of morbidity and mortality.
- Detection and management of hyponatremia among the PICU admitted cases will reduce the hospital stay and indirectly the cost of treatment.

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