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Research Article

Hyponatremia in critically ill mechanically ventilated children

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ABSTRACT

Background: Hyponatremia is a serious adverse event in the paediatric critical care population is especially complex as many patients require multiple continuous infusion and excess fluid volumes due to hypovolemic shock or blood pressure instability. Acute hyponatremia poses an immediate danger to the central nervous system. Administration of hypotonic maintenance fluids may worsen this. Hyponatremia can eventually lead to seizure and death depending magnitude and severity of onset. Hyponatremia is a common electrolyte disturbance occurring in critically ill patients. Symptoms range from nausea and malaise, with mild reduction in the serum sodium, to lethargy, decreased level of consciousness, headache, seizures and coma. The treatment of hyponatremia depends on the duration of hyponatremia and volume status of the patients. There is serious neurologic sequel if hyponatremia is inappropriately treated.
Methods: The present retrospective observational study was conducted in the pediatric ICU ward of Department of Pediatrics at Dr. B.R.A.M. Hospital associated Pt. J.N.M. Medical College, Raipur (C.G.), India during study period from April 2015 to September 2015. The study was carried out hyponatremia in children between the age group of >1 months to 13 years presenting with critically illness need mechanical ventilation admitted in ICU were included in the study. Sample size was fixed at 84. The patient's clinical data were recorded in all the cases. Investigations were done on the day of admission in who were clinically critically ill and had an initial serum sodium value <135 mEq/L. Data was expressed as mean ± S.D. and percentage depending on distribution of data and as percentage.
Results: In the current study, maximum admitted subjects belonged to infancy (<1year) 31 subjects (35.7%), 17 of them were male and 14 were female. Out of total subjects 49 (58.3%) were male and 35 (41.7%) were females. Distribution of disease associated was studied in the subjects and maximum subjects were found to be suffering from septicemia (19 subjects, 22.6%). Frequency of hyonatremia is more (77.4%) in age group less than 1 year. Already admitted subjects showed significantly higher duration of illness (23.7±59.3 days) compared to newly admitted subjects (9.4±19.8 days). Incidence rate of mild hyponatremia is more (52%). Significant difference was noted in IV Fluids administered in study subjects who were previously admitted and newly admitted.
Conclusions: Current study denotes hyponatremia is a common finding in critically sick patients, it is more common in infants and patients with MODS &Meningoencephalitis diseased and so we need to be highly vigilant in these children.

Keywords: Hyponatremia, Critically ill, Children

INTRODUCTION

Hyponatremia is a serious adverse event in the paediatric critical care population is especially complex as many patients require multiple continuous infusion and excess fluid volumes due to hypovolemic shock or blood pressure instability. Hyponatremia, a very common electrolyte abnormality in hospitalized patients and is defined as a serum sodium level <135 mEq/L.[1] Both total body sodium and total body water determine the serum sodium concentration. 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. Administration of hypotonic maintenance fluids may worsen this edema. Hyponatremia can eventually lead to seizure and death depending magnitude and severity of onset.[2,3]

Hyponatremia can be classified on the basis of serum osmolality, volume status and urinary sodium into hypertonic, isotonic and hypotonic types. Hyponatremia may also be classified into hypervolemic, euvolemic and hypovolemic as follows:[4]

- *Hypovolemic hyponatremia:* Decreased total body sodium and decreased total body water. The sodium deficit exceeding water deficit.
- *Euvolemic hyponatremia:* Normal body sodium with increase in total body water.
- *Hypervolemic hyponatremia:* Increase in total body sodium with greater increase in total body water.

The treatment of hyponatremia depends on the duration of hyponatremia and volume status of the patients. There is serious neurologic sequel if hyponatremia is inappropriately treated. Limited data is available on whether the presence of hyponatremia on intensive care unit (ICU) admission is independently associated with excess mortality. This study was done to ascertain the frequency and etiology in terms of their diagnosis and management in critically ill patients admitted to the ICU with hyponatremia.

METHODS

The Present retrospective observational study was conducted in the Pediatric ICU ward of Department of Pediatrics at Dr. B.R.A.M. Hospital associated Pt. J.N.M. Medical College, Raipur (C.G.), India during study period from April 2015 to September 2015. Ethical clearance was taken from institutional ethics committee.

Inclusion criteria

All critically ill who were mechanically ventilated child. Age more than 1 month to 13 years.

Exclusion criteria

Age less than 1 month & more than 13 years.

The study was carried out hyponatremia in children between the age group of >1 months to 13 years presenting with critically illness need mechanical ventilation admitted in ICU were included in the study.

Calculation of sample size

It is calculated using formula- 4PQ/L2,

Where, P= prevalence of hyponatremia, Q=1-P, L=Level of error, Confidence level=95%.

Taking P=23%, L=5%, we see that minimum sample size =283. We have taken 33% that is 84. Sample size exceeded the sample size calculated for power of the study 0.8, α error to be 0.05 and population mean as seen in previous study.[5]

Predesigned proforma was used for the study. At the time of admission, one venous blood samples were collected & used for the estimation of serum sodium. The patient's clinical data including age, sex diagnosis were recorded in all the cases. Serum sodium concentration <135 mEq/L was considered as hyponatraemia. Serum sodium concentrations of 131-134 mEq/L represent mild hyponatremia, 126-130 mEq/L moderate hyponatremia and ≤125 mEq/L severe hyponatremia. Hypernatremia was defined as a serum sodium concentration >145 mEq/L.

Investigations were done on the day of admission in who were clinically critically ill and had an initial serum sodium value <135 mEq/L.

Data was expressed as mean±SD. and percentage depending on distribution of data and as percentage. Kolmogorove-Smirnov analysis was used to check if data follows the normal distribution. Chi-square test was used to check the significance of difference between frequency distribution of data in different groups. P Value <0.05 was considered to be statistically significant.

RESULTS

Age and sex distribution of study group was assessed. It was noted that maximum admitted subjects belonged to infancy (<1 year) 31 subjects (35.7%), 17 of them were male and 14 were female. Nineteen subjects each belonged to toddler (1-3 years) and school going (5-12 years) age, 9 subjects belonged to preschool age (3-5 years) and 6 to teen age (>12). Out of total subjects 49 (58.3%) were male and 35 (41.7%) were females (Table 1).

Table 1: Age and sex distribution of study subjects.

Age (in years)	Male		Female		Total	
	N	%	N	%	N	%
<1	17	20.2	14	16.7	31	35.7
1-3	12	14.3	7	17.9	19	22.6
>3-5	5	6.0	4	4.8	9	10.7
>5-12	10	11.9	9	10.7	19	22.6
>12	5	6.0	1	1.2	6	7.1
Total	49	58.3	35	41.7	84	100

Distribution of disease associated was studied in the subjects and maximum subjects were found to be suffering from septicemia (19 subjects, 22.6%). Meningoencephalitis was found to be present in 16 (19.0%) subject. Congenital heart disease was present in 4 (4.8%) subjects while 8 (9.5%) subjects were

suffering from haematological malignancies. Hepatic encephalopathy was noted in 7 (8.3%) subjects and bronchopneumonia in 9 (10.7%) subjects (Table 2).

Table 2: Primary diagnosis in study subjects.

Disease associated	No. of subjects	Percent (%)
Septicemia	19	22.6
CHD	4	4.8
Meningoencephalitis	16	19.0
Hematological malignancies	8	9.5
Hepatic encephalopathy	7	8.3
Bronchopneumonia	9	10.7
Others	11	13.1
Total	84	100

Frequency of hyonatremia is more (77.4%) in age group less than 1 year (Table 3).

Table 3: Frequency of hyponatremia.

Frequency of hyponatremia	Percent (%)
>1 Month-1 year	77.4% (24/31)
>1 years-13 years	58.4% (31/53)

Study group was further divided based on if the subjects were previously admitted to other institute and then transferred to our institute or they were newly admitted. Bothe group were found to be age matched (Table 4).

Table 4: Comparison of age of study subjects.

Characteristics	Already admitted	Newly admitted	p value
Age (Years) (Mean ± S.D.)	3.8±3.6	4.03±4.32	>0.05

Already admitted and newly admitted groups were found to be sex matched (Table 5).

Already admitted subjects showed significantly higher duration of illness (23.7±59.3 days) compared to newly admitted subjects (9.4±19.8 days) (Table 6).

Table 5: Comparison of sex distribution in study groups.

Characteristics		Already admitted	Newly admitted	p value
Sex	Male	10	38	>0.05
	Female	9	27	

Table 6: Comparison in duration of illness between study groups.

Characteristics	Already admitted	Newly admitted	P-value
Duration of illness (days) (Mean ± S.D.)	23.7±59.3	9.4±19.8	<0.01 (Significant)

No significant difference was noted in study groups regarding serum sodium levels (Table 7).

Table 7: Comparison between S. Sodium levels in study groups.

Characteristics	Already admitted	Newly admitted	P-value
S. Sodium (mmol/l) (Mean±S.D.)	132.9± 6.9	133.6±9.04	>0.05

Incidence rate of mild hyponatremia is more (52%) (Table 8).

Table 8: Level of hyponatremia among patients.

Hyponatremia	No. of patients (n=55)
Mild	29
Moderate	18
Severe	8

Frequency of subjects with different systems involved was noted in both study groups. No significant difference was found between distributions of systems involved in study groups (Table 9).

Table 9: Comparison of various organ systems involved in study groups.

Characteristics		Already admitted	Newly admitted	P- value
Systems involved	CNS	9	17	>0.05
	Respiratory	3	8	
	Lymphoreticular	1	7	
	MODS	3	25	
	Others	3	8	

Significant difference was noted in IV Fluids administered in study subjects who were previously admitted and newly admitted. Frequency of DNS was notably higher and frequency of D10 was found to be lower in newly admitted subjects (Table 10).

Table 10: IV fluids used in previously admitted and newly admitted subjects.

IV Fluids	Previously admitted (N=19)	Newly admitted (N=65)	p value
Dextrose 10%	3	2	<0.01 (Significant)
DNS (dextrose normal saline)	3	41	
ISO-P	9	11	
Normal saline	2	3	
Others	2	8	

DISCUSSION

Hyponatremia is the most common electrolyte disorder in the hospitalized critically ill patients.[6] We studied consisted of 84 children, 31 (35.7%) were children in the age group of >1 month to 1 year and 53 (64.3%) children in the >1-13 years age group. It was noted that maximum admitted subjects belonged to infancy (<1 year) 31 subjects (35.7%), 17 of them were male and 14 were female. Out of total subjects 49 (58.3%) were male and 35 (41.7%) were females.

On admission, the patient's serum sodium concentration ranged from 96 mEq/L to 160 mEq/L. Hyponatremia was seen in 55 (65.4%). There were 29 (52.7%) cases of mild, 18 (32.7%) cases of moderate and 8 (14.5%) cases of severe hyponatremia respectively. Similar study done by Guruswamy et al found frequency of hyponatremia was 46.7%, whereas Don et al found 45.4%.[3,7]

The incidence of hyponatremia was higher in the study because only the very sick ventilated patients have been considered in the study.

The frequency of hyponatremia in children <1 year and 1-13 years was 77.4% (24/31) and 58.4% (31/53) respectively. Padhi R et al conducted a prospective study of series of ICU patient for 12 month period in total 730 patients and found the frequency of hyponatremia on ICU admission was 34.3%.[4] Alicia K. Au et al performed a retrospective analysis of postoperative admission to pediatric intensive care unit in total 145 children (116 received hypotonic and 29 received normotonic fluid) 11% were hyponatremic.[8] A study by Fenk et al involving 151486 adult patients from 77 ICU's over 10 years noted that severity of hyponatremis in ICU is associated with poor outcome in graded fashion.[9]

On study of distribution of diseases as the primary diagnosis of subjects the maximum subjects were found to be suffering from septicaemia (19 subjects, 22.6%). Meningoencephalitis was found to be present in 16 (19.0%) subject and bronchopneumonia in 9 (10.7%) subjects. This observation is similar to study done by Padhi R et al in which septicemia was the leading cause of hyponatremia in this study; no significant difference was noted in study groups regarding serum sodium levels.[4] Already admitted subjects showed significantly higher duration of illness (23.7±59.3 days) compared to newly admitted subjects (9.4±19.8 days) (p <0.01). Frequency of subjects with different systems involved was noted in both study groups. No significant difference was found between distributions of systems involved in study groups, both group had maximum subjects with MODS. There is significant difference (p <0.01) was noted in distribution of IV Fluids administered in study subjects who were already admitted and newly admitted, The frequency of DNS was notably higher and frequency of dextrose 10% was found to be lower in newly admitted subjects. On comparisons of study group who are already admitted to other hospital, received IV fluids and who are newly admitted to our hospital from other hospitals with their matched demographic data; there was no difference in the sodium status of the patients in the two groups, Similarly Singhi S has also reviewed and raised the question that conventional hypotonic maintenance fluid is not the main cause of hyponatremia in critically sick patients.[10] There are various debates regarding the tonicity and volume of fluid to be used.[11] On another review of 258 surgical patients aged 6 month to 16 years expected post-operative stay over 24 hours, had been randomly assigned to isotonic or hypotonic maintenance fluid for 48 hours and got hypotonic fluid significantly increase the risk of hyponatrmia 40% vs 20%. Isotonic fluid did not increase risk of hypernatremia.

Hyponatremia is common occurrence in hospitalized sick children.[6] The common causes are acute diarrhea, acute infectious disease, like pneumonia, meningitis, septicemia, heart failure, renal disease, and hepatic failure. Hyponatremia is a frequent finding in the critically ill; most of these patients are euvolumic. SIADH is the most common cause of hyponatremia in critically ill. Pneumonia being the leading cause of SIADH. Severe sepsis, trauma, surgery (elective more than emergency), thiazides and other drugs (SSRIs and Carbamazapine), renal failure, HF, liver cirrhosis, subarachnoid hemorrhage, hypothyroidism and hypocortisolism are other etiologic factors for hyponatremia. 36.25% of hyponatremic patients met the criteria of SIADH, (Padhi R et al).[4] Severe sepsis (sepsis with acute organ dysfunction) was the most common leading to hyponatremia probably due to SIADH, although the cause is not known but it may be related to dilution of extracellular space and retained exogenous fluid. Valentine SL et al on study of 168 children with

acute lung injury got positive fluid balance on day 3 is independent associated with fewer ventilator-free days and greater fluid load at initiation of continuous renal replacement therapy associated with higher mortality.[12]

Therefore, there cannot be a single fluid that can appropriately meet all the electrolyte demands of the critically sick patients and also liberal use of fluids should be restricted and the fluid therapy in the ICU should be goal oriented and adequately monitored.

CONCLUSION

Current Study denotes hyponatremia is a common finding in critically sick patients, it is more common in infants and patients with MODS and meningoencephalitis diseased, and so we need to be highly vigilant in these children. Altered serum sodium level (hyponatremia or hypernatremia) increases morbidity and mortality of children if not evaluated and treated appropriately.

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