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# Incidence and Etiological Profile of Hyponatremia in Children Admitted to Pediatric Intensive Care Unit of a Tertiary Care Hospital

**Jyoti Yadav[1]*, Smita Satapathy[2], Priyabhasini Chinmoyee Ray[2], Jayant Acharya[3]**

[1]Assistant Professor, Department of Pediatrics, Maharishi Chawan Medical College, Koriawas, Narnaul, Haryana, India
[2]Assistant Professor, Department of Pediatrics, IMS and SUM Hospital, Bhubaneswar, Odisha, India
[3]Director, Department of Pediatrics, Ispat General Hospital, Rourkela, Odisha, India

***Address for Correspondence:** Dr. Jyoti Yadav, Assistant Professor, Department of Pediatrics, Maharishi Chawan Medical College, Koriawas, Narnaul, Haryana-123001, India
**E-mail:** drjoytiyadav1990@gmail.com

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## ABSTRACT

**Background:** Hyponatremia is the most common electrolyte disorder encountered in hospitalized and critically ill children. Despite its clinical importance, data from Indian pediatric intensive care units (PICUs) remain limited. The aim is to determine the incidence, severity, etiology, and outcome of hyponatremia in children admitted to a tertiary care PICU.

**Methods:** A prospective observational study was conducted in the PICU of Ispat General Hospital, Rourkela, over one year. Children aged 1–14 years admitted to PICU were enrolled after consent. Patients on diuretics, mannitol, nephrotoxic drugs, with renal disorders, endocrine abnormalities, or non-hypotonic hyponatremia were excluded. Serum electrolytes and urine parameters were analyzed. Hyponatremia was classified as mild (125–134 mEq/L), moderate (115–124 mEq/L), and severe (<115 mEq/L). Outcomes assessed included hospital stay, ventilation, inotrope use, and mortality.

**Results:** Out of 238 enrolled children, 50 (21%) developed hyponatremia. Distribution was uniform across age groups, with a male preponderance (61%). Mild hyponatremia was most common (58%), followed by moderate (34%) and severe (8%). Primary CNS disorders were the leading cause (54%), with encephalitis (40.7%) most frequent, followed by cerebral malaria and tubercular meningitis. Mortality was significantly higher in hypervolemic hyponatremia (71.4%) compared to euvolemic (36.7%) and hypovolemic (15.4%) cases (p=0.045). Ventilator requirement was also significantly associated with hyponatremia (p=0.02).

**Conclusion:** Hyponatremia is a frequent electrolyte disturbance in children admitted to PICU, especially in those with CNS infections. Severity of hyponatremia correlated with worse outcomes, including higher ventilator use and mortality. Early recognition and appropriate management are crucial for improving prognosis.

**Key-words:** Hyponatremia, Pediatric intensive care, CNS disorders, Electrolyte imbalance, Encephalitis

## INTRODUCTION

The most prevalent electrolyte anomaly in all clinical practice areas is hyponatremia, which is defined as a serum sodium level of less than 135 mmol/L [1,2]. It affects about 29.8% of hospitalised children. Intensive care unit (ICU) patients, who are critically ill, frequently have several risk factors, making them vulnerable to hyponatraemia. Several pathological and drug-related diseases, frequent hypotonic fluid delivery, and impaired free water excretion are known to predispose critically sick individuals to hyponatraemia [3-5].

Due to the crucial role that the central nervous system plays in regulating water and sodium homeostasis, deficiencies in water and sodium balance are frequently observed in hospitalised patients, and they are particularly prevalent in neurological patients who are in critical condition [6]. An increase in mortality of 1 to 15% was linked to a 60% prevalence of hyponatraemia in a group of hospitalised patients, according to Arief [7].

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Additionally, the underlying illness states and related medical conditions influence the morbidity and mortality linked to hyponatraemia [8]. The first step in ensuring proper treatment for hyponatremia is to identify its etiology properly [9].

The clinical presentation has a wide spectrum, varying from asymptomatic patients to those having seizures and coma [10]. In children with sodium <130 mmol/L, the underlying etiology is sometimes evident from history and physical findings. Given that clinical assessment of fluid volume status is difficult in hyponatremia, further laboratory evaluation is often required in these patients [11].

The assessment of patients with hyponatraemia can pose a clinical challenge, and strategies for its management are often suboptimal. In recent years, expert guidance and recommendations have been published that provide an evidence-based approach to the diagnosis and treatment of hyponatremia [12,13]. However, it is worth noting that high-quality evidence is lacking for many aspects of hyponatremia management. Additionally, new therapies have emerged promising a more targeted approach to regulating body water and sodium balance in certain patients with hyponatraemia.

Management of abnormalities in water homeostasis is frequently challenging. Because age-related changes and chronic diseases are often associated with impairment of water metabolism in critically ill children, it is essential to be aware of the pathophysiology of hyponatremia and hypernatremia in the pediatric population. The sensation of thirst, renal function, concentrating abilities and hormonal modulators of salt and water balance are often impaired in sick children, which makes patients highly susceptible to morbid and iatrogenic events involving salt and water. Unless addressed meticulously, the prognostic implications are grave and far-reaching [8].

Though hyponatremia has been reported as the commonest electrolyte abnormality in critically ill children, as well as an integral marker of the outcome of serious illness, the existing paucity of data in Indian literature has led to confusion in the interpretation and significance of the condition in Pediatric Intensive Care Units.

## MATERIALS AND METHODS

**Study Site and Design**- This prospective observational study was conducted over one year in the Pediatric Intensive Care Unit of the Department of Pediatrics at Ispat General Hospital, Rourkela, enrolling all consecutive patients admitted during the study period.

### Inclusion Criteria

- Patients aged 1 year to 14 years admitted to the PICU.
- Patients whose parents have given consent for being involved in the study.

### Exclusion Criteria

- Patients on drugs like diuretics, mannitol, glycerine, nephrotoxic drugs and steroids.
- Patients who are known cases of renal disorders like chronic renal failure, congenital renal disorders, Nephrotic syndrome, obstructive uropathy and Renal tubular acidosis, etc.
- Patients who were known cases of hypothyroidism and ACTH deficiency.
- Patients with hypernatremia, pseudohyponatremia and nonhypotonic hyponatremia.

**Methodology-** Over a period of one year, from 2nd January 2016 to 1st January 2017, all patients admitted to this hospital in the Pediatric Intensive Care Unit and those who gave consent were enrolled. Written informed consent was obtained from the patient's parents or guardian for the study. A detailed clinical history and physical examination were conducted in all enrolled patients, and they were categorized according to the predominant system involved and their volume status. The data thus obtained were documented in the predesigned proforma.

The blood samples of all enrolled patients were sent for assessment of metabolic profiles, including serum sodium, potassium, urea, creatinine, and random blood glucose. After the blood investigations, patients with hypernatremia, pseudohyponatremia and non-hypotonic hyponatremia were excluded from the study. The urine sample of patients with true hyponatremia was sent for evaluation of urine sodium, urea, and glucose to calculate urine osmolality. Patients with hyponatremia were further divided into three groups based on severity: mild (125-135 meq/L), moderate (115-124 meq/L) and severe (<115 meq/L). The outcome variables, including length of hospital stay, need for mechanical ventilation, inotropes, and mortality, were observed.

 

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**Statistical Analysis-** Data were analyzed using Microsoft Excel and SPSS. Continuous variables were expressed as mean±SD, and categorical variables as proportions. Associations were tested using the Chi-square test, with $p<0.05$ considered statistically significant.

## RESULTS

Two hundred thirty-eight children were enrolled in the study and divided into three groups based on age: 1-4 years (80), 5-9 years (78), and 10-14 years (80), with a mean age of 7.30±4.43 years. The majority of participants were male (61%). Hyponatremia was documented in 50 cases, accounting for 21% of the study population. Further analysis and interpretation have been grouped in the following sequence: demographic profile of the hyponatremic case population, Incidence and severity of Hyponatremia, Etiology and volume status of hyponatremic patients, and finally, the Outcome.

Out of 238 enrolled cases, the distribution of 50 (21%) hyponatraemic patients varied across three age groups, with proportions of 15 (18.8%) in the 1-4-year age group, 18 (23.1%) in the 5-9-year age group, and 17 (21.3%) in the 10-14-year age group.This implied that the incidence of true hyponatremia had no significant association with age groups ($p = 0.79$).

**Table 1:** Incidence of hyponatremia by age

| Age Group | Hyponatremia | | | | | | $\chi^2$, p |
|---|---|---|---|---|---|---|---|
| | Present | | Absent | Total | Present | | |
| | No. | % | No. | % | No. | % | |
| 1-4 | 15 | 18.8 | 65 | 81.2 | 80 | 33.6 | $\chi^2$= 0.45 p= 0.79 |
| 5-9 | 18 | 23.1 | 60 | 76.9 | 78 | 32.8 | |
| 10-14 | 17 | 21.3 | 63 | 78.7 | 80 | 33.6 | |
| Total | 50 | 21.0 | 188 | 79.0 | 238 | 100 | |
| Mean±SD | 7.78±4.52 | | 7.17±4.41 | | 7.30±4.43 | | P = 0.39 |

In each of the age groups, the distribution of hyponatremia according to severity was not significantly different ($p = 0.936$ The majority of cases in all age groups belonged to the mild category, 29 (58%), followed by the moderate category, 17 (34%), and the severe category, 4 (8%) (Table 2).

**Table 2:** Distribution of severity of hyponatremia with age

| Age Group | Severity | | | | | | | | $\chi^2$, p |
|---|---|---|---|---|---|---|---|---|---|
| | Mild (125-134 mEq/L) | | Moderate (115-124 mEq/L) | | Severe (<115 mEq/L) | | Total | | |
| | No. | % | No. | % | No. | % | No. | % | |
| 1-4 | 8 | 53.3 | 6 | 40 | 1 | 6.7 | 15 | 100 | $\chi^2$= 0.82 p= 0.93 |
| 5-9 | 10 | 55.6 | 6 | 33.3 | 2 | 11.1 | 18 | 100 | |
| 10-14 | 11 | 64.7 | 5 | 29.4 | 1 | 5.9 | 17 | 100 | |
| Total | 29 | 58 | 17 | 34 | 4 | 8 | 50 | 100 | |

Table 3 observed that among all types of hyponatremia, from mild to severe, Primary CNS disorders were most common at admission: mild, 13 (44.8%); moderate, 11 (64.8%); and severe, 3 (75%), indicating a significant association between CNS involvement and the severity of hyponatremia ($p<0.001$).

 

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**Table 3:** Etiological distribution of hyponatremia according to severity

| Severity | Hyponatremia | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CNS | | CVS | | Respiratory | | GI | | MODS | | Poisoning | | Total | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % | $\chi^2$, p |
| Mild | 13 | 44.8 | 3 | 10.3 | 5 | 17.2 | 3 | 10.3 | 2 | 6.9 | 3 | 10.3 | 29 | 100 | |
| Moderate | 11 | 64.7 | 1 | 5.9 | 1 | 5.9 | 1 | 5.9 | 3 | 17.6 | 0 | 0.0 | 17 | 100 | $\chi^2$= 18.76 p= 0.001 |
| Severe | 3 | 75.0 | 1 | 25.0 | 0 | 0.0 | 0 | 0 | 0 | 0.0 | 0 | 0.0 | 4 | 100 | |
| Total | 27 | 54.0 | 5 | 10.0 | 6 | 12.0 | 4 | 8.0 | 5 | 10.0 | 3 | 6.0 | 50 | 100 | |

Table 4 shows that among hyponatremic patients with primary CNS disorders, infections are more prevalent, with encephalitis (40.7%) being the most common infection, followed by cerebral malaria and TBM, etc.

**Table 4:** Primary CNS disorders contributing to hyponatremia

| Diagnosis | No. | % |
|---|---|---|
| Encephlitis | 11 | 40.7 |
| Cerebral Malaria | 5 | 18.5 |
| C.P with SZ dis. | 4 | 14.8 |
| Meningitis | 2 | 7.4 |
| Seizure disorder | 2 | 7.4 |
| TBM | 3 | 11.2 |
| Total | 27 | 100 |

Table 5 shows that mortality was found to be highest in hypervolemic hyponatremia (71.4%), followed by euvolemic (36.7%) and lowest in hypovolemic hyponatremia(15.4%); (p=0.04).

**Table 5:** Outcome of Hyponatremia with volume status

| | Volume status | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Euvoleumia | | Hypervolemia | | Hypovolemia | | Total | | $\chi^2$, p |
| | No. | % | No. | % | No. | % | No. | % | |
| Outcome | | | | | | | | | |
| Discharge | 19 | 59.4 | 2 | 6.3 | 11 | 34.4 | 32 | 100 | $\chi^2$= 6.21 p= 0.04 |
| Death | 11 | 61.1 | 5 | 27.8 | 2 | 11.1 | 18 | 100 | |
| Total | 30 | 60 | 7 | 14 | 13 | 26 | 50 | 100 | |
| Mech. ventilation | | | | | | | | | |
| Yes | 19 | 79.2 | 2 | 8.3 | 3 | 12.5 | 24 | 100 | $\chi^2$= 7.12 p= 0.02 |
| No | 11 | 42.3 | 5 | 19.2 | 10 | 38.5 | 26 | 100 | |
| Total | 30 | 60 | 7 | 14 | 13 | 26 | 50 | 100 | |
| Inotropes | | | | | | | | | |
| Yes | 3 | 30 | 3 | 30 | 4 | 40 | 10 | 100 | $\chi^2$= 5.10 p= 0.07 |
| No | 27 | 67.5 | 4 | 10 | 9 | 22.5 | 40 | 100 | |
| Total | 30 | 60 | 7 | 14 | 13 | 26 | 50 | 100 | |
| Length of hospital stay | | | | | | | | | |
| Mean±SD | 8.47±2.98 | | 7.14±1.46 | | 7.31±4.19 | | 7.98±3.19 | | p=0.42 |

 

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## DISCUSSION

The literature on paediatric hyponatraemia is still scarce, particularly in local settings, despite the harmful implications of hyponatraemia. Due to the tiny sample size of the available research, it was challenging to draw conclusions and suggest the best course of action. We therefore conducted this hospital-based observational study on 238 patients, ages 1 to 14, who were admitted to our hospital's PICU over the course of a year. The current study sample was typical of the age, sex, and illness categories of the sick children who were hospitalised to our hospital. Analysing the prevalence, aetiology, and result of hyponatraemia was the goal [1,6].

With a mean age of 7.30±4.43 years, the majority of patients admitted to the PICU during our study period were evenly distributed across age groups of 1-4 and 10-14 years (33.6% each), followed by the 5-9 year age group at 32.8%. The male preponderance in our study was 61.3%, which is comparable to the findings of studies by Sterns [14] and Pokharel and Block [15]. 21% of the 238 individuals, who were enrolled in our trial had hypotension. Recent Indian investigations conducted in the PICU by Greenbaum [16] (21.7%), Edwards [17] (33.5%), and BrainKart.com [19] (29.8%) were comparable to this. In contrast, Borque [20] and Robinson and Verbalis [21] showed a lower incidence of hyponatremia in adults (11.2% and 16.4%, respectively) compared to children.

In the present study, it was observed that the frequency of hyponatremia and its severity were uniformly distributed in all age groups. This can be explained on the basis that total body water plays a vital role in the pathophysiology of hyponatremia. During the first year of life, total body water decreases gradually to 60% of body weight, and this remains constant until puberty.

In previous studies by Robinson and Verbalis [21], Argent *et al.* [22], Robertson [23], and Argent *et al.* [24], the incidence of mild hyponatremia was 31%, 42.6%, 51.6%, and 27%, respectively. A similar trend was also observed in our study, with the majority of hyponatremic cases being mild (58%), followed by moderate (34%) and severe (8%). Out of 50 hyponatremic cases on admission, the most common associated etiologies were belonging to CNS (54%), respiratory (12%), CVS and MODS(10%) each.

Out of 94 CNS cases enrolled in our study, 28.7% cases had hyponatremia, with encephalitis being the most common CNS disease, accounting for 40.7% followed by cerebral malaria, tubercular meningitis, cerebral palsy with seizure disorder and others. Since this area is endemic for viral encephalitis and cerebral malaria, a larger number of these cases were enrolled in the study population. As reported by Robertson [23], 10.3% of children with acute CNS disorders had hyponatremia, which is lower than the present study, because tropical infections are less prevalent in the Western world. Argent *et al.* [24] reported a 27% incidence of hyponatremia in a recent prospective study of acute encephalitis syndrome. In comparison, KavyaDeepu and Sekar [25] reported 38.7% in tubercular meningitis, which had similarities to our research.

## CONCLUSIONS

Hyponatremia remains a major bane for the intensivist. Not only is it the most frequently encountered electrolyte disorder, but it is also increasingly recognised as a harbinger of poor outcomes in various conditions. There was a high incidence of hyponatremia in children admitted to the PICU with equal distribution in all age groups. Hyponatremia was found to be more predominant in those with Primary CNS disorders on admission, like encephalitis, cerebral malaria and TBM, followed by those with respiratory disorders, like pneumonia and bronchiolitis, CVS like CHD with CCF, GI like AGE with severe dehydration, etc. Euvolemic hyponatremia was observed in the majority of hyponatremic cases, with SIADH being the most common cause. Even among those with primary CNS disorders, SIADH was the most common cause of hyponatremia, followed by CSW. Morbidity in terms of mean hospital stay and ventilator requirement was substantially high in all patients who had hyponatremia. The overall mortality among hyponatremic patients was significantly high and directly related to the severity of hyponatremia.

## CONTRIBUTION OF AUTHORS

**Research concept-** Jyoti Yadav, Jayant Acharya
**Research design-** Jyoti Yadav, Smita Satapathy
**Supervision-** Jayant Acharya
**Materials-** Smita Satapathy, Priyabhasini Chinmoyee Ray
**Data collection-** Jyoti Yadav, Priyabhasini Chinmoyee Ray
**Data analysis and interpretation-** Jyoti Yadav, Smita Satapathy

 

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**Literature search-** Smita Satapathy, Priyabhasini Chinmoyee Ray
**Writing article-** Jyoti Yadav, Smita Satapathy
**Critical review-** Jayant Acharya
**Article editing-** Priyabhasini Chinmoyee Ray
**Final approval-** Jyoti Yadav, Smita Satapathy, Priyabhasini Chinmoyee Ray, Jayant Acharya

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