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Frequency of Hyponatremia in Children with Severe Pneumonia under the age of 5 Years

Huma Shahzadi[1], Khola Binet Mansoor[1]

[1]Paediatric Medicine Unit 2, King Edward Medical University/ Mayo Hospital, Lahore, Punjab, Pakistan.

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Correspondence to: Huma Shahzadi, Paediatric Medicine Unit 2, King Edward Medical University/ Mayo Hospital, Lahore, Punjab, Pakistan.
Email: humashahzadi1144@gmail.com

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ABSTRACT

Background: Pneumonia remains one of the leading causes of morbidity and mortality in children under five years of age, particularly in low- and middle-income countries. Electrolyte disturbances such as hyponatremia are common in severe pneumonia and may contribute to adverse outcomes, yet local data from Pakistan remain limited. **Objective:** To determine the frequency of hyponatremia in children under five years of age admitted with severe pneumonia. **Methods:** This descriptive cross-sectional study was conducted at the Paediatric ICU, Department of Pediatric Medicine Unit II, Mayo Hospital, Lahore, from 5th February 2025 to 6th June 2025. A total of 132 children aged 6 months to 5 years fulfilling inclusion criteria were enrolled through non-probability consecutive sampling. After informed consent, demographic and clinical data were collected. Serum sodium was measured at admission, 48 hours, and at discharge. Hyponatremia was defined as serum sodium <135 mmol/L. Data were analyzed using SPSS version 25.0, with stratification and chi-square testing for effect modifiers. A p-value <0.05 was considered significant. **Results:** The mean age of participants was 26.4 ± 14.8 months; 59.1% were male, and 62.1% belonged to rural areas. At admission, hyponatremia was present in 45 (34.1%) children, which decreased to 38 (28.8%) at 48 hours and 21 (15.9%) at discharge. Mild hyponatremia was most frequent (62.2%), followed by moderate (31.1%) and severe (6.7%). Hyponatremia was significantly more common in children under 2 years of age (44.6% vs. 23.9%, p=0.01), in rural populations (41.5% vs. 22.0%, p=0.02), and in those with symptom duration >5 days (47.8% vs. 26.7%, p=0.01). The mean hospital stay was longer in children with hyponatremia (7.1 ± 2.8 days) compared to those with normal sodium levels (5.4 ± 2.2 days, p=0.004). **Conclusion:** Hyponatremia is a common finding in children under five years with severe pneumonia, particularly among younger patients, those from rural areas, and those with delayed presentation. Its presence is associated with prolonged hospital stay, highlighting the importance of routine serum sodium monitoring for timely detection and management to improve outcomes.

INTRODUCTION

Pneumonia in children under 5 years of age is the leading cause of death worldwide. Advances in the medicine sector, improved antibiotics and vaccines have decreased the incidence in developing countries of lower respiratory tract infection [1][2]. Pneumonia is, however, at present the leading cause of infant death in the developing countries and contributes to approximately 20 percent of infant deaths. Pneumonia is a common cause of hospitalization among the children and several complications are known as a result of pneumonia [3]. The WHO publishing data on 2020 reveals that in Pakistan influenza and pneumonia mortality constituted 5.72% of total mortality. Adjusted death rate is at 37.37 per 100000 of population that places Pakistan at position 72 in the entire world [4]. Hypoatremia is one of the most widespread and frequent electrolyte abnormalities encountered in any hospitalized and critically ill child. Hypotonic hyponatremia is common among pneumonia patients in hospitals with the frequency reaching 32.4%. In one study in children with pneumonia hyponatremia was revealed in 21 percent children [5]. A study done locally depicted hyponatremia in 38.89 percent children with pneumonia. Studies in support of the importance of hyponatremia as a prognostic factor in the definition of the severity of lower respiratory tract infection is reported by studies [6]. The mean stay in hospital was also significantly longer (p<0.05) in the group with hyponatremia i.e. 8.2+/-4.5days vs. 7.3+/-1.7 days in the group with normonatremia [7]. Adult pneumonia in such an early age can become fatal due to considerable complications. In addition to the direct effects on respiratory system, system, multi-organ failure, and metabolic/electrolyte imbalances are also frequently observed. Hypo natremia is

notably of concern among these. Within resource-limited hospitals, annoyance with electrolyte abnormalities is a normal practice in the hustle and bustle of the clinical and laboratory practices, however, they can have significant impacts on prognosis and overall disease outcomes [8][9]. The most common electrolyte disorder in hospitalized patients, including children, is hyponatremia, which is defined as a serum sodium level of less than 135 mmol/L. In pediatric pneumonia, the etiology of hyponatremia is multifactorial [10]. The syndrome of inappropriate antidiuretic hormone secretion (SIADH) has been implicated as a major mechanism, where inflammatory mediators such as interleukin-6 stimulate non-osmotic release of antidiuretic hormone (ADH), resulting in impaired free water excretion. Additionally, hypoxemia and stress responses associated with severe lower respiratory tract infections further exacerbate ADH release. Inappropriate administration of hypotonic intravenous fluids, a common practice in many pediatric wards, may also contribute to dilutional hyponatremia [11]. In addition, especially in critically ill children, insensible fluid losses caused by tachypnea, fever, and inadequate oral intake may exacerbate the imbalance. The clinical significance of hyponatremia in severe pneumonia extends beyond biochemical abnormality. Mild hyponatremia may remain asymptomatic but moderate to severe hyponatremia can present with headache, irritability, nausea, vomiting, lethargy, and seizures. In children, where cerebral compliance is limited, rapid reductions in serum sodium may precipitate cerebral edema, increasing the risk of raised intracranial pressure and neurological complications [12]. Clinical diagnosis is even more difficult because these manifestations may overlap with or conceal the characteristics of severe pneumonia itself. Importantly, a number of studies have shown that children with pneumonia with hyponatremia have longer hospital stays, a higher risk of being admitted to intensive care, and a higher risk of dying. Global studies have reported variable frequencies of hyponatremia in children with pneumonia, ranging from 20% to over 40% [13]. For instance, electrolyte imbalances in hospitalized children were found to be significantly higher in studies conducted in South Asia and Africa, both of which have high rates of childhood pneumonia [14]. Variations in case definitions, disease severity, population nutrition, and hospital treatment protocols may be to blame for the disparities in reported prevalence. In Pakistan, where pneumonia remains one of the top causes of childhood mortality, there is a relative paucity of data addressing the frequency of hyponatremia and its implications in under-five children admitted with severe pneumonia. Most local hospitals often lack standardized protocols for routine electrolyte monitoring in children presenting with pneumonia, which may lead to under-recognition of this clinically relevant problem. Although the risk of overdosing on fluids and the significance of limiting fluid intake have been emphasized in meningitis, precise information regarding the amount of fluid restriction required in pneumonia is still lacking.

Objective

The aim of our study is to find the frequency of hyponatremia in pneumonia.

METHODOLOGY

This Descriptive cross-sectional was conducted at Paediatric ICU, Department of Pediatric Medicine unit 2, Mayo Hospital Lahore, from 5th February 2025 to 6th June 2025. A total of 132 patients were included. The sample size was calculated using a 95% confidence level, 8% margin of error, and taking the expected percentage of hyponatremia in pneumonia patients as 32.4%. Non-probability consecutive sampling was used to recruit participants meeting the inclusion criteria.

Inclusion Criteria

1. Children aged 6 months to 5 years presenting with severe pneumonia (as per operational definition).
2. Both male and female patients.

Exclusion Criteria

1. Children with known congenital or acquired heart disease (based on history and medical record).
2. Children with chronic lung disease or chronic renal disease (based on history and medical record).
3. Children with primary immunodeficiency disorders.
4. Children requiring mechanical ventilation due to respiratory failure.
5. Children with gastroenteritis.
6. Children with meningitis.
7. Children receiving medications that may alter serum electrolytes (e.g., diuretics, anticonvulsants).

Data Collection Procedure

Approval for the study was obtained from the Institutional Ethical Review Committee and the College of Physicians and Surgeons Pakistan (CPSP). A total of 132 patients fulfilling the inclusion criteria were recruited after obtaining informed written consent from the parents or guardians. For each participant, demographic information including age, gender, weight, duration of symptoms, and place of residence (rural/urban) was recorded. A 5 ml venous blood sample was collected at the time of admission, at 48 hours, and at discharge, and analyzed in the institutional pathology laboratory to determine serum sodium levels. The presence or absence of hyponatremia was noted. Patients were managed according to standard ward protocols and were followed by the researcher until discharge. Duration of hospital stay was documented in all cases. All collected information was recorded on a structured proforma (Annexure-I).

Data Analysis Procedure

Statistical analysis was performed using SPSS version 25.0. Normality of continuous data was assessed using the Shapiro-Wilk test. Quantitative variables such as age, weight, duration of symptoms, and serum sodium levels were expressed as mean ± standard deviation or median with interquartile range (IQR), as appropriate. Categorical variables including gender, place of residence (rural/urban), and hyponatremia status (present/absent) were presented as frequencies and percentages. Effect modifiers including age, gender, weight, duration of symptoms, and place of residence were controlled through stratification. Post-stratification chi-square test was applied to assess their association with hyponatremia. A p-value of < 0.05 was considered statistically significant.

RESULTS

The mean age of children with severe pneumonia was 26.4 ± 14.8 months, almost equally divided between those aged 6–24 months (49.2%) and 25–60 months (50.8%). Boys made up 59.1% of the cohort, while girls accounted for 40.9%. A majority lived in rural areas (62.1%) compared to urban settings (37.9%). The average duration of symptoms before admission was 4.6 ± 2.1 days, and the mean body weight was 10.8 ± 3.2 kg.

Table 1

Baseline Demographic and Clinical Characteristics of Children with Severe Pneumonia (n = 132)

Variable	Category	Frequency (n)	Percentage (%)
Age (months), mean ± SD	—	26.4 ± 14.8	—
Age groups	6–24 months	65	49.2
	25–60 months	67	50.8
Gender	Male	78	59.1
	Female	54	40.9
Place of Residence	Rural	82	62.1
	Urban	50	37.9
Duration of Symptoms (days), mean ± SD	—	4.6 ± 2.1	—
Weight (kg), mean ± SD	—	10.8 ± 3.2	—

At admission, 65.9% of children had normal sodium levels, while 34.1% showed hyponatremia, mostly mild (21.2%), followed by moderate (10.6%) and severe (2.3%). At 48 hours, the prevalence of hyponatremia reduced to 28.8%, with most cases being mild (18.2%) and fewer moderate (8.3%) or severe (2.3%). By discharge, only 15.9% still had hyponatremia, mostly mild (11.4%) and moderate (4.5%), with no severe cases.

Table 2

Frequency and Severity of Hyponatremia in Children with Severe Pneumonia

Time Point	Normal Sodium (≥135 mmol/L)	Mild (130–134 mmol/L)	Moderate (125–129 mmol/L)	Severe (<125 mmol/L)	Total Hyponatremia n (%)
At Admission	87 (65.9)	28 (21.2)	14 (10.6)	3 (2.3)	45 (34.1)
At 48 Hours	94 (71.2)	24 (18.2)	11 (8.3)	3 (2.3)	38 (28.8)
At Discharge	111 (84.1)	15 (11.4)	6 (4.5)	0 (0.0)	21 (15.9)

Hyponatremia was significantly higher in children under 2 years (44.6%) compared to those 2–5 years old (23.9%, p=0.01). Males had 38.5% with hyponatremia versus 27.8% in females, though this was not statistically significant (p=0.18). Children from rural areas were more affected (41.5%) compared to urban residents (22.0%, p=0.02). Longer symptom duration (>5 days) was strongly associated with hyponatremia (47.8% vs 26.7%, p=0.01).

Table 3

Association of Hyponatremia with Demographic and Clinical Variables (n = 132)

Variable	Hyponatremia Present n (%)	Hyponatremia Absent n (%)	p-value
Age <2 years	29 (44.6)	36 (55.4)	0.01
Age 2–5 years	16 (23.9)	51 (76.1)	
Gender (Male)	30 (38.5)	48 (61.5)	0.18
Gender (Female)	15 (27.8)	39 (72.2)	
Residence (Rural)	34 (41.5)	48 (58.5)	0.02
Residence (Urban)	11 (22.0)	39 (78.0)	
Duration of Symptoms >5 d	22 (47.8)	24 (52.2)	0.01
Duration of Symptoms ≤5 d	23 (26.7)	63 (73.3)	

In the 6–24 month age group, 44.6% developed hyponatremia, distributed as mild (27.7%), moderate (13.8%), and severe (3.1%). In the 25–60 month group, only 23.9% had hyponatremia, with 14.9% mild, 7.5% moderate, and 1.5% severe. This demonstrates that both frequency and severity of hyponatremia were higher among younger children.

Table 4

Distribution of Hyponatremia According to Severity and Age Groups

Age Group	Mild (130–134 mmol/L)	Moderate (125–129 mmol/L)	Severe (<125 mmol/L)	Total n (%)
6–24 months (n=65)	18 (27.7)	9 (13.8)	2 (3.1)	29 (44.6)
25–60 months (n=67)	10 (14.9)	5 (7.5)	1 (1.5)	16 (23.9)

The mean serum sodium concentration improved steadily during hospitalization. At admission, the average was 134.2 ± 4.6 mmol/L (range 121–142). At 48 hours, it increased to 135.6 ± 3.9 mmol/L (range 124–144), and by discharge it reached 137.1 ± 3.2 mmol/L (range 128–145). This shows a consistent correction trend across the hospital stay.

Table 5

Change in Serum Sodium Levels Over Time (n = 132)

Time Point	Mean Serum Sodium (mmol/L) ± SD	Minimum	Maximum
At Admission	134.2 ± 4.6	121	142
At 48 Hours	135.6 ± 3.9	124	144
At Discharge	137.1 ± 3.2	128	145

Children with hyponatremia stayed in the hospital significantly longer, with a mean of 7.1 ± 2.8 days and a median of 7 days (IQR 5–9). In contrast, those with normal sodium had a mean stay of 5.4 ± 2.2 days and a median of 5 days (IQR 4–7), with the difference being statistically significant (p=0.004).

Table 6

Comparison of Hospital Stay Between Hyponatremia and Normal Sodium Groups

Sodium Status	Mean Hospital Stay (days) ± SD	Median (IQR)	p-value
Hyponatremia Present (n=45)	7.1 ± 2.8	7 (5–9)	0.004
Hyponatremia Absent (n=87)	5.4 ± 2.2	5 (4–7)	

DISCUSSION

In this study, hyponatremia was found to be a common electrolyte abnormality among children admitted with severe pneumonia under the age of five years, with an overall frequency of 34.1 percent at admission. Most cases were mild to moderate in severity, while severe hyponatremia was uncommon. These findings are consistent with previously published studies where the prevalence of hyponatremia in children with pneumonia has ranged between 20 and 40 percent depending on disease severity, population characteristics, and clinical settings [15]. Our findings are consistent with South Asian data in which a corresponding rate of hyponatremia in childhood pneumonia has been reported. The similar rates have been observed in India and Nepal where the syndrome of inappropriate antidiuretic hormone secretion as a result of pulmonary inflammation, hypoxemia, and systemic stress has often been cited as the cause of the pathophysiology of the phenomenon [16]. Besides, low-resource hospital practices in fluid management, especially, use of low-tonicity intravenous fluids may also cause the development of hyponatremia. The current study also illustrated that younger children especially those below two years had a marked rate of hyponatremia than older children. This finding is biologically reasonable since infants and toddlers do not possess much renal capacity to eliminate bare water and a more relative share of total body water, which puts them at risk of developing electrolyte disorders. Corresponding results were presented in local studies showing the susceptibility of this age group to sodium abnormalities in the context of a severe respiratory infection [17].

The next significant observation was that the incidence of hyponatremia was significantly high in pediatrics who had rural locations as compared with pediatrics who had urban location [18]. This could depict disparities in access to healthcare, nutrition status, and late presentation to the hospitals. Metabolic and electrolyte disturbances are known to be caused by malnutrition that is more prevalent within rural population. These findings stress the issue of early diagnosis and referral of children with pneumonia in rural communities.

Duration of illness also appeared to play a role, as children with symptoms lasting more than five days before admission were more likely to develop hyponatremia. Prolonged illness may lead to worsening systemic inflammation and more pronounced antidiuretic hormone release, along with inappropriate oral or parenteral fluid administration. Previous studies have similarly reported that delayed presentation is associated with increased risk of electrolyte imbalance and complications [19]. An important clinical implication of our findings was the longer hospital stay observed in children with hyponatremia. On average, these children required more than seven days of admission compared to five days in those with normal sodium levels. This observation is consistent with earlier reports linking hyponatremia to prolonged hospitalization, increased need for intensive care, and poorer overall outcomes [20]. Identifying hyponatremia early may therefore serve as a prognostic indicator for more complicated clinical courses in children with pneumonia.

No significant association was found between gender and the presence of hyponatremia, although it was slightly more frequent in male children. This trend may be explained by the higher proportion of male admissions, which often reflects healthcare-seeking patterns in South Asian societies, where boys are more likely to be brought for hospital care than girls. This study's findings emphasize the importance of regular electrolyte monitoring for children admitted with severe pneumonia. Given the relatively high frequency of hyponatremia and its association with prolonged hospital stay, serum sodium measurement should be considered an integral part of initial assessment, especially in younger children, rural populations, and those presenting late in the course of illness. Early detection and correction may reduce the risk of neurological complications and improve recovery outcomes. There are some limitations to this study. Being a single-center study, the results may not be generalizable to all populations in Pakistan. Children with comorbidities such as heart disease, chronic renal disease, or those requiring mechanical ventilation were excluded, which may have underestimated the true burden of hyponatremia in critically ill patients. In addition, the study did not assess outcomes such as seizures or mortality about hyponatremia, which could provide further insight into its clinical significance.

CONCLUSION

It is concluded that hyponatremia is a frequent electrolyte disturbance in children under five years of age admitted with severe pneumonia, with nearly one-third affected at admission. The condition was more common in younger children, those from rural areas, and in cases with prolonged symptoms. Hyponatremia was also associated with longer hospital stay, underscoring its clinical relevance in the management of pediatric pneumonia. Routine monitoring of serum sodium levels in children with severe pneumonia should therefore be emphasized to ensure timely detection and management of electrolyte imbalance, which may help reduce complications and improve overall outcomes.

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