

Incidence and Outcome of Hyponatremia in Children with Acute Bronchiolitis: A Prospective Observational Study.

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Abstract.

Background:

Acute bronchiolitis is a leading cause of hospitalization in infants. Electrolyte disturbances, particularly hyponatremia, are increasingly recognized as markers of disease severity.

Objectives:

To determine the incidence of hyponatremia in children hospitalized with acute bronchiolitis and evaluate its association with disease severity and clinical outcomes.

Methods:

A hospital-based prospective observational cohort study was conducted in the Department of Pediatrics at Narayan Medical College and Hospital, Bihar, India, over one year. One hundred children aged 1 month to 2 years admitted with acute bronchiolitis were enrolled. Serum sodium was measured within 24 hours of admission. Hyponatremia was defined as serum sodium <135 mEq/L. Disease severity was assessed using the Bronchiolitis Clinical Score (BCS). Outcomes included duration of hospital stay, oxygen therapy, PICU admission, and mechanical ventilation.

Results:

Hyponatremia was observed in 32% of children. Most cases were mild (75%) and moderate (25%). Hyponatremia was significantly associated with higher BCS scores. Hyponatremic children had longer hospital stay (7.15 ± 1.4 vs. 4.92 ± 1.1 days; $p < 0.001$), prolonged oxygen therapy (52.8 ± 12.4 vs. 34.6 ± 9.2 hours; $p < 0.05$), higher PICU admission (15.6% vs. 4.4%; $p = 0.038$), and increased mechanical ventilation (9.3% vs. 1.4%; $p = 0.045$).

Conclusion:

Hyponatremia is common in hospitalized bronchiolitis and is associated with increased severity and adverse outcomes.

Recommendation:

Routine serum sodium monitoring, particularly in moderate to severe bronchiolitis, is recommended to aid early risk stratification and optimize fluid management.

Keywords: Acute bronchiolitis, Hyponatremia, Disease severity, Pediatric intensive care, Electrolyte imbalance

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Introduction

Acute bronchiolitis is one of the most common causes of hospitalization in infants and young children worldwide, particularly during seasonal viral epidemics [1,2]. It is characterized by upper respiratory tract symptoms followed by lower airway inflammation, edema, and mucus plugging, leading to wheeze, crackles, and respiratory distress [3]. Respiratory syncytial virus (RSV)

is the most frequently implicated etiological agent, although other viruses such as rhinovirus, parainfluenza, and human metapneumovirus also contribute significantly [4,5].

While bronchiolitis is primarily a respiratory illness and management is largely supportive, systemic complications are increasingly recognized in hospitalized children [6]. Among these, electrolyte disturbances,

particularly hyponatremia, are common and clinically relevant [7]. Hyponatremia, defined as a serum sodium concentration below 135 mEq/L, is the most frequent electrolyte abnormality observed in hospitalized pediatric patients and has been associated with increased morbidity and mortality [8,9].

The pathophysiology of hyponatremia in bronchiolitis is multifactorial. Non-osmotic release of antidiuretic hormone (ADH) secondary to pulmonary inflammation, stress, hypoxia, and intrathoracic pressure changes leads to water retention and dilutional hyponatremia, often described as the syndrome of inappropriate antidiuretic hormone secretion (SIADH) [10–12]. Inappropriate administration of hypotonic intravenous fluids may further exacerbate this imbalance [13].

Several studies have suggested that hyponatremia in bronchiolitis is not merely a biochemical abnormality but a marker of disease severity, correlating with increased respiratory distress, longer hospitalization, and higher need for intensive care [14–17]. However, routine electrolyte assessment in children with bronchiolitis remains controversial, particularly in mild to moderate disease [18]. There is limited prospective data from developing countries evaluating the incidence and outcome of hyponatremia in bronchiolitis. The present study was undertaken to determine the incidence of hyponatremia in children hospitalized with acute bronchiolitis and to assess its impact on disease severity and clinical outcomes.

Materials and Methods

Study Setting

The study was conducted in the Department of Pediatrics at Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India. It is a tertiary care teaching hospital serving an estimated population of approximately 15–20 lakh from Rohtas and adjoining districts. The pediatric department includes general pediatric wards, a 12-bed Pediatric Intensive Care Unit (PICU), neonatal services, and emergency services. Commonly managed conditions include acute respiratory infections, diarrheal diseases, neonatal disorders, and infectious diseases.

Study Duration

The study was conducted from January 2024 to December 2024. Recruitment and data collection were carried out during this period.

Inclusion Criteria

- Age between 1 month and 2 years

- Clinical diagnosis of acute bronchiolitis
- Requirement of hospitalization

Exclusion Criteria

- Pre-existing renal, cardiac, hepatic, or metabolic disorders
- Known endocrine disorders affecting sodium balance
- Prior diuretic therapy

Study Size

The sample size was calculated using the formula:

$$n = Z^2 \times p \times (1 - p) / d^2$$

Assuming a prevalence (p) of hyponatremia as 30% based on previous literature, 95% confidence level (Z = 1.96), and 10% absolute precision, the minimum calculated sample size was approximately 81. Considering possible dropouts, 100 children were enrolled.

Data Collection

Demographic details, feeding history, and clinical findings were recorded at admission. Disease severity was assessed using the Bronchiolitis Clinical Score (BCS) [19]. Serum sodium levels were measured within the first 24 hours of admission. Hyponatremia was classified as mild (130–134 mEq/L), moderate (125–129 mEq/L), or severe (<125 mEq/L).

Outcome Measures

Primary outcomes included duration of hospital stay and duration of oxygen therapy. Secondary outcomes included the need for PICU admission and mechanical ventilation.

Bias

To minimize selection bias, all consecutive eligible children admitted during the study period were enrolled. Measurement bias was reduced by using standardized laboratory methods for serum sodium estimation and a validated Bronchiolitis Clinical Score. Outcome assessment was performed uniformly for all participants.

Statistical Analysis

Data were analyzed using descriptive and inferential statistics. Continuous variables were expressed as mean \pm standard deviation and compared using Student's t-test. Categorical variables were expressed as frequencies and

percentages. A p-value <0.05 was considered statistically significant.

Results. Participants Flow

A total of 112 children were assessed for eligibility. Twelve were excluded (6 did not meet the inclusion criteria, 4 had comorbidities, 2 declined consent). Finally, 100 children were enrolled and analyzed. No participants were lost to follow-up during hospitalization.

A total of 100 children aged 1 month to 24 months admitted with a clinical diagnosis of acute bronchiolitis were included in the study and analyzed.

1. Demographic Characteristics of the Study Population.

Of the 100 enrolled children, 62 (62%) were males, and 38 (38%) were females, showing a clear male predominance. The majority of patients were infants, with 56% belonging to the 1–6 months age group, followed by 28% aged 7–12 months and 16% aged 13–24 months.

Table 1 summarizes the age and gender distribution of the study population.

Table 1. Age and Gender Distribution of the Study Population

Age Group	Male (n)	Female (n)	Total (n)	Percentage
1–6 months	34	22	56	56%
7–12 months	18	10	28	28%
13–24 months	10	6	16	16%
Total	62	38	100	100%

This distribution highlights that acute bronchiolitis predominantly affects younger infants.

2. Prevalence and Severity of Hyponatremia at Admission

Serum sodium estimation at admission revealed that 32 children (32%) had hyponatremia at presentation, indicating a prevalence of 32% among hospitalized cases. Serum sodium estimation at admission revealed that 32 children (32%) were hyponatraemic, while 68 children (68%) had normal sodium levels. Among the hyponatremic group, 24 children (75%) had mild

hyponatremia (130–134 mEq/L) and 8 children (25%) had moderate hyponatremia (125–129 mEq/L). No child had severe hyponatremia (<125 mEq/L).

The incidence and severity distribution of hyponatremia are shown in Table 2 and graphically represented in Figure 1.

Table 2. Incidence and Severity of Hyponatremia

Category	Sodium Range (mEq/L)	Number (n)	Percentage
Normonatremia	≥135	68	68%
Hyponatremia	<135	32	32%
Mild hyponatremia	130–134	24	24%
Moderate hyponatremia	125–129	8	8%
Severe hyponatremia	<125	0	0%

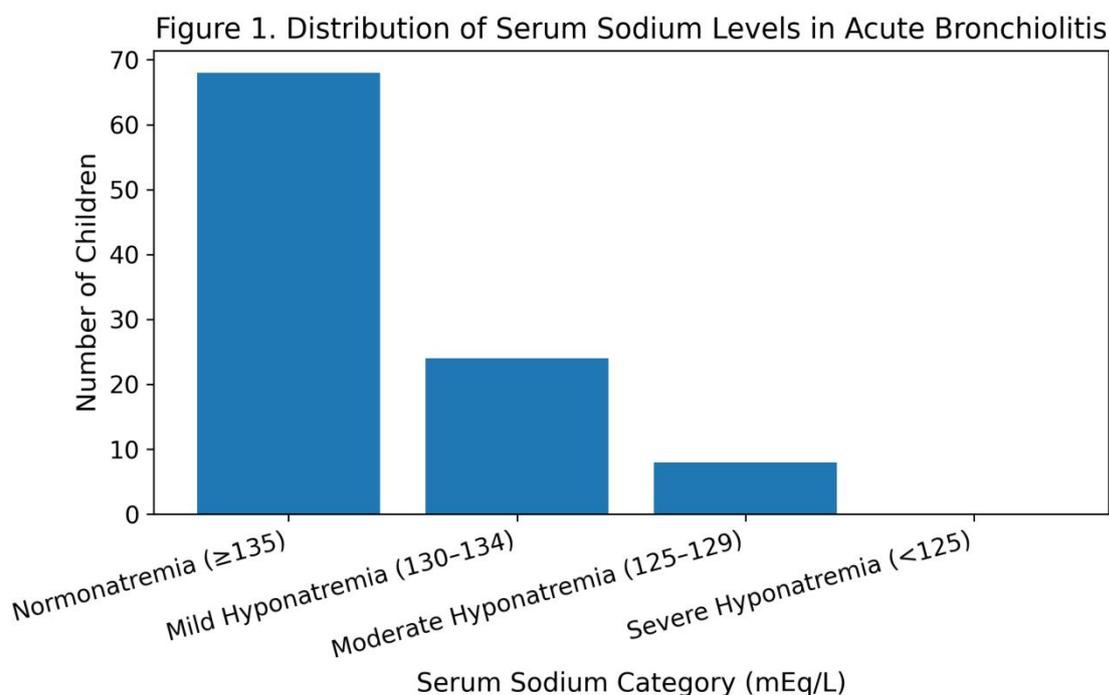


Figure 1. Distribution of serum sodium levels among children with acute bronchiolitis

3. Association Between Serum Sodium Levels and Disease Severity

Disease severity was assessed using the **Bronchiolitis Clinical Score (BCS)** at admission. A strong association was observed between hyponatremia and the increasing severity of bronchiolitis.

Among children with **severe bronchiolitis (BCS 9–12)**, **71.4% (10 out of 14)** were hyponatremic. In contrast, hyponatremia was observed in only **9.5% (4 out of 42)** of children with mild bronchiolitis. This relationship is detailed in **Table 3** and illustrated in **Figure 2**.

Table 3. Correlation Between Serum Sodium Status and Bronchiolitis Clinical Score

BCS Severity	Hyponatremic (n=32)	Normonatremic (n=68)	Total
Mild (0–3)	4	38	42
Moderate (4–8)	18	26	44
Severe (9–12)	10	4	14

Figure 2. Association Between Bronchiolitis Severity and Hyponatremia

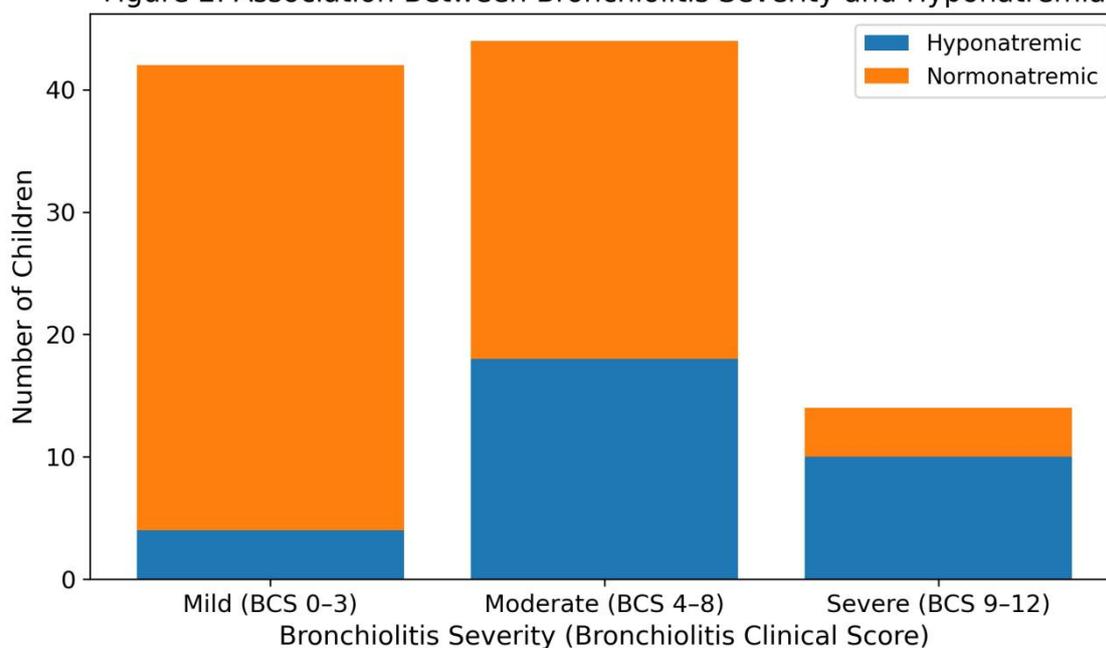


Figure 2. Relationship between bronchiolitis severity and hyponatremia

4. Comparison of Clinical Outcomes Based on Sodium Status

Clinical outcomes were significantly worse in children with hyponatremia. The mean duration of hospital stay was significantly longer in hyponatremic children (7.15 ± 1.4 days) compared to normonatremic children (4.92 ± 1.1 days; $p < 0.001$). Similarly, the mean duration of oxygen therapy was significantly prolonged in the

hyponatremic group (52.8 ± 12.4 hours vs. 34.6 ± 9.2 hours; $p < 0.05$).

Furthermore, PICU admission was required in 15.6% of hyponatremic children compared to 4.4% of normonatremic children. The need for mechanical ventilation was also higher in the hyponatremic group (9.3% vs. 1.4%). These findings are summarized in Table 4 and depicted in Figure 3.

Table 4. Comparison of Clinical Outcomes by Sodium Status

Outcome	Hyponatremic (Mean \pm SD / n %)	Normonatremic (Mean \pm SD / n %)	p-value
Hospital stay (days)	7.15 ± 1.4	4.92 ± 1.1	<0.001
Oxygen therapy (hours)	52.8 ± 12.4	34.6 ± 9.2	<0.05
PICU admission	5 (15.6%)	3 (4.4%)	0.038
Mechanical ventilation	3 (9.3%)	1 (1.4%)	0.045

Figure 3. Comparison of Critical Outcomes by Sodium Status

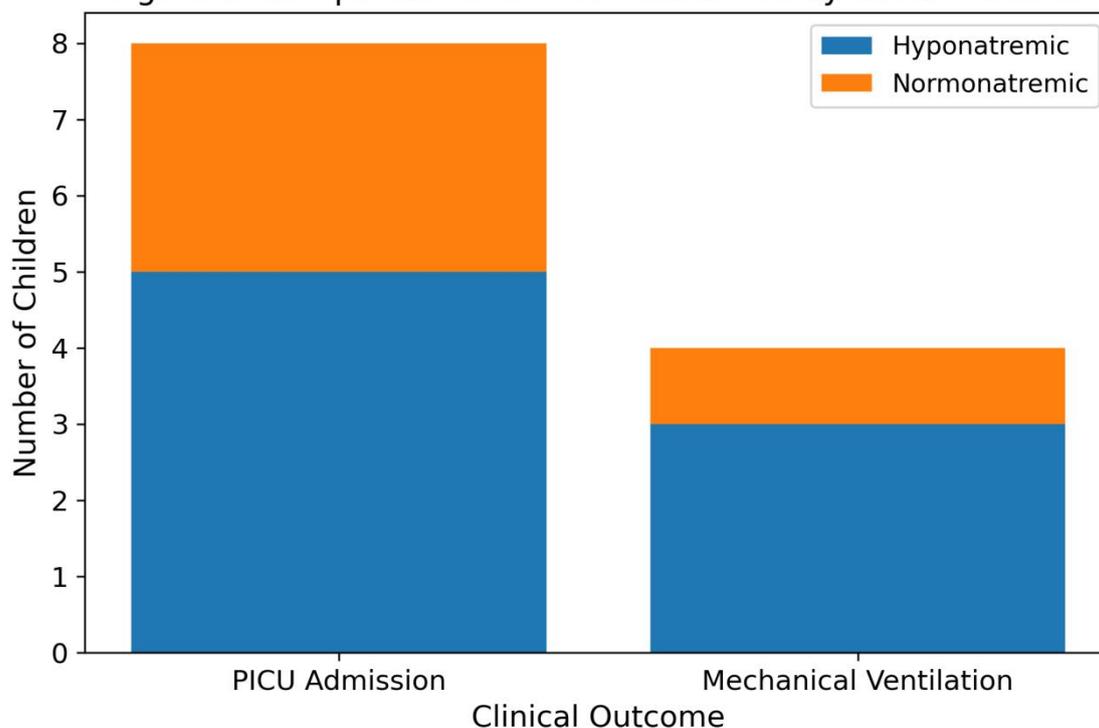


Figure 3. Comparison of clinical outcomes between hyponatremic and normonatremic children

5. Feeding Practices and Hyponatremia

Feeding practices were analyzed in relation to sodium status. Hyponatremia was more frequently observed among children receiving mixed feeding or top feeding compared to those on exclusive breastfeeding. The distribution of feeding practices is shown in Table 5.

Table 5. Feeding Practices and Hyponatremia

Feeding Type	Hyponatremic	Normonatremic	Total
Exclusive breastfeeding	12	40	52
Mixed feeding	14	22	36
Top feeding/cow's milk	6	6	12

Summary of Key Results

In summary, hyponatremia was observed in nearly one-third of children hospitalized with acute bronchiolitis and was significantly associated with greater disease severity, prolonged hospitalization, increased oxygen requirement, and higher need for intensive care and mechanical ventilation.

Generalizability

As this was a single-center tertiary hospital study, findings may be generalizable to similar tertiary care settings in developing countries but may not represent community-managed mild bronchiolitis.

Conclusion

Hyponatremia is a common and clinically significant finding in children hospitalized with acute bronchiolitis

and is associated with increased disease severity, prolonged hospitalization, and greater need for intensive care. Routine monitoring of serum sodium, particularly in moderate to severe bronchiolitis, may aid in early risk stratification and optimization of fluid management, thereby improving clinical outcomes.

Limitations

- Single-center study
- Relatively small sample size
- Serum sodium is measured only at admission
- No long-term follow-up

Recommendation

- Routine serum sodium monitoring in moderate/severe bronchiolitis
- Avoidance of hypotonic IV fluids
- Larger multicenter studies are recommended

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List of Abbreviations

BCS – Bronchiolitis Clinical Score
PICU – Pediatric Intensive Care Unit
SIADH–Syndrome of Inappropriate Antidiuretic Hormone
RSV – Respiratory Syncytial Virus

Source of Funding

No external funding was received for this study.

Conflict of Interest

The authors declare no conflict of interest.

Availability of Data

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions

Neha Kumari – Concept, design, manuscript drafting
Richa Raj – Data collection, analysis
Om Prakash Singh – Supervision, critical revision
Mani Kant Kumar – Final approval, oversight

Author Biography

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The present prospective observational study evaluated the prevalence and clinical significance of hyponatremia among children hospitalized with acute bronchiolitis. We observed that 32% of patients had hyponatremia at admission, and its presence was significantly associated with increased disease severity, prolonged hospitalization, greater oxygen requirement, and higher need for intensive care support.

Prevalence of Hyponatremia

In our study, the prevalence of hyponatremia was 32% among hospitalized children. Although routine electrolyte testing is not universally recommended in mild bronchiolitis, the National Institute for Health and Care Excellence (NICE) guidelines emphasize careful monitoring in moderate to severe disease, particularly when intravenous fluids are required [18]. Our findings support the need for selective electrolyte evaluation in hospitalized patients.

The high prevalence observed in our cohort likely reflects the inclusion of moderate to severe cases requiring admission. Previous literature has also shown that electrolyte disturbances are more common in children with lower respiratory tract infections requiring inpatient care [20,24].

Association with Disease Severity

We found a strong association between hyponatremia and higher Bronchiolitis Clinical Scores at admission. This finding is clinically significant and aligns with earlier observations that hyponatremia may correlate with the severity of illness.

Singhi et al. demonstrated that hyponatremia in sick children can serve as a marker of disease severity and systemic involvement [21]. Similarly, inflammatory processes have been implicated in the pathogenesis of hyponatremia, with cytokine-mediated stimulation of antidiuretic hormone release contributing to dilutional sodium imbalance [22]. In bronchiolitis, pulmonary inflammation, hypoxia, and stress may stimulate non-

Original Article

osmotic ADH release, leading to water retention and subsequent hyponatremia.

These mechanisms provide a biological explanation for the higher prevalence of hyponatremia observed in children with severe bronchiolitis in our study.

Page | 8 **Impact on Clinical Outcomes**

Children with hyponatremia had significantly prolonged hospital stay and oxygen therapy duration compared to normonatremic children. Furthermore, PICU admission and mechanical ventilation were more frequent in the hyponatremic group.

These findings are consistent with broader epidemiological data demonstrating that hyponatremia is associated with increased morbidity and adverse clinical outcomes in hospitalized patients [23]. El-Radhy also reported that hyponatremia in pediatric respiratory diseases is associated with more severe clinical presentation and complicated course [24].

Importantly, neurological complications may occur if the sodium imbalance worsens or is corrected improperly. Moritz and Ayus highlighted the importance of preventing complications related to dysnatremias in children and emphasized careful fluid management strategies [25]. Therefore, early recognition of hyponatremia in bronchiolitis is essential to prevent iatrogenic worsening and optimize supportive care.

Clinical Implications

Our findings suggest that serum sodium estimation at admission may serve as a useful adjunct marker for identifying children at risk of severe bronchiolitis. While routine testing in all cases may not be necessary, selective monitoring in hospitalized and moderate-to-severe cases appears justified, in accordance with current clinical guidance [18].

Early identification of hyponatremia may help guide appropriate isotonic fluid therapy, prevent complications, and improve overall outcomes.

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Original Article

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