Hyponatremia as a Prognostic Marker in Children with Severe Lower Respiratory Tract Infections

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ABSTRACT

Introduction: Lower Respiratory Tract Infection is inflammation of airways below the level of larynx. It requires hospitalization in children below 5 years and accounts for 30% of global deaths annually. Various complications including electrolyte imbalances can be seen in such children. Hyponatremia is the most common electrolyte abnormality. Hyponatremia in pediatric pneumonia is mainly due to syndrome of inappropriate antidiuretic hormone secretion, whereas in bronchiolitis, is due to hyperinflation of lungs which reduces right atrial blood flow and stimulates vasopressin release leading to dilutional hyponatremia. **Aims:** To find the association of hyponatremia with severe lower respiratory tract infection. **Methods:** This cross-sectional study was conducted in 110 children, aged 2 months-14 years, with cough for less than 3 weeks, fast breathing, chest indrawing and Pediatric Respiratory Severity Score of 4-5. Serum sodium level was sent during admission. Monitoring was done for, need of oxygen support, any complications, duration of oxygen supplementation, total duration of hospital stay and final outcome of patient. Data were analyzedusing SPSS version 25.Chi-square test and Fisher exact test were used. **Results:** Hyponatremia was detected in 38.18% children, of which 61.90% had mild hyponatremia, 33.33% had moderate and 4.76% had severe hyponatremia. Association of severity of hyponatremia with need of non-rebreathing face mask, mechanical ventilator, duration of hospital stay and final outcome was statistically significant (p-value<0.05). Mean duration of oxygen requirement was longer in hyponatremic children (5.8±1.2 days) than with normal sodium (2.7±0.8 days). **Conclusion:** Hyponatremia was commonly seen in children with severe lower respiratory tract infections. It could adversely affect the morbidity in terms of need of oxygen supplement, duration of hospitalization, duration of oxygen requirement and mortality. Thus, monitoring of serum sodium and timely correction, if abnormal, is warranted to prevent complications, and improve outcomes in such children.

Keywords: Hyponatremia; Hypoxia; Lower Respiratory Tract Infection; Mechanical ventilator

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INTRODUCTION

Lower Respiratory Tract Infection (LRTI) is inflammation of airways, below the level of larynx,due to viral, bacterial or fungal infection. It includes bronchiolitis, pneumonia and empyema.[1] LRTI is serious illness requiring hospitalization in children under-5 years of age and accounts for 30% of deaths annually worldwide, mostly due to pneumonia as a leading cause.[2] Bronchiolitis, inflammation of the bronchial tubes, is caused by Respiratory Syncytial Virus. Pneumonia usually follows upper respiratory tract infection, which promote invasion of lower respiratory tract by virus, bacteria or other pathogens and causes alveoli to fill with fluid. Empyema is collection of pus in pleural cavity. Common pathogens are Streptococcus pneumonia, Staphylococcus aureus and Streptococcus pyogenes.[3,4] LRTI can lead to complications like lung abscess, pneumatocele, pneumothorax, apnea, hyperinflation, atelectasis, respiratory failure. Other complications include sepsis, meningitis, pericarditis, endocarditis, osteomyelitis, septic-arthritis, and electrolyte imbalance.[5] Hyponatremia (serum sodium<135mEq/L) is the most common electrolyte abnormality. Hyponatremia in pediatric pneumonia is mainly due to the syndrome of inappropriate antidiuretic hormone secretion (SIADH).[6] Hypona-

tremia in bronchiolitis is due to hyperinflation of lungs which reduces right atrial blood flow and stimulates vasopressin release from posterior pituitary leading to dilutional hyponatremia.[7] Few studies have shown inflammatory cytokines(IL-1β, IL-6), stress, hypoxemia, in inflammatory conditions like pneumonia, meningitis, malaria, promote secretion of antidiuretic hormone(ADH), independent of plasma osmolality, leading to water retention and hyponatremia. This establishes a link between systemic inflammation and non-osmotic ADH driven hyponatremia.[8] This study aims to find the association of hyponatremia with severe LRTI.

METHODS

The cross-sectional study was carried out in the department of Pediatrics at Nepalgunj Medical College from September 2025 to February 2026. Ethical clearance was obtained from the Institutional Review Committee, Nepalgunj Medical College and Teaching Hospital. The study included 110 children,aged 2 months to 14 years, admitted in Pediatric ward and Pediatric intensive care unit, with cough for less than 3 weeks, fast breathing, chest indrawing and with Pediatric Respiratory Severity Score (PRESS)[9] of 4-5. Selection of cases was done by the convenient sampling method. After taking consent with the parent, complete history taking and physical examination was done. Relevant laboratory investigations including serum sodium level and chest X-ray were done. Chest CT scan was done in doubtful cases. Severity of hyponatremia was defined as mild = serum sodium 131-135 mEq/L, moderate= 126-130 mEq/L, and severe= less than 125 mEq/L (the normal values for serum sodium at our institution are 135-145 mEq/L). Patients were monitored for, need of oxygen support, any complications, duration of oxygen supplement, total duration of hospital stay and final outcome. Data were collected in a predesigned proforma, which included demographic informations such as age, sex, address, sodium label, oxygen requirement and mode of oxygen supplement.

The results were tabulated and statistically analyzed using SPSS version 25. Descriptive statistics was used for determining frequency. Chi-square test and Fisher exact test were used to derive association between qualitative variables. P-value <0.05 was taken as significant.

RESULTS

During the study period, 110 children with severe LRTI were admitted. Among them, 73 (66.36%) were males and 37 (33.63%) were females, making male-to-female ratio of 1.9:1 (Figure 1). Majority of the children were infants (<1 years) (53.63%) followed by children of 1-6 years (29.09%) and rest 17.27% were of age group 6-14 years (Figure 2). Mean age was 3.2±4.1 years.

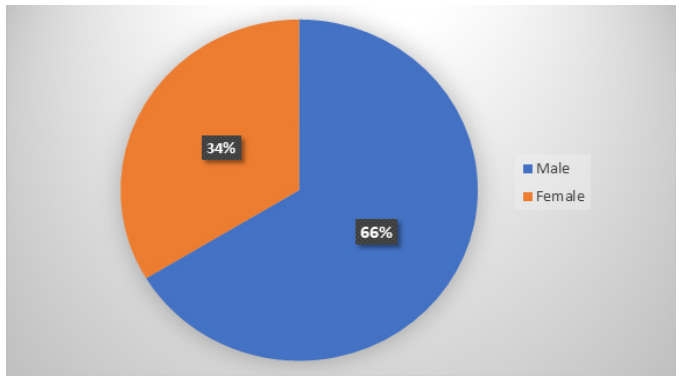

Figure 1: Sex distribution of the study population

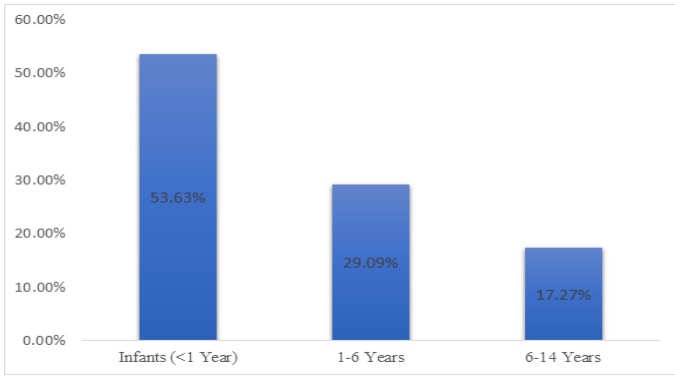

Figure 2: Age distribution of the study population

Hyponatremia was detected in 42 (38.18%) children, of which 26 (61.90%) had mild hyponatremia, 14 (33.33%) had moderate and 2 (4.76%) had severe hyponatremia. However, 68 (61.81%) had normal sodium concentration (Table I).

All children under study were under oxygen supplement. Among them, 89.09% were in nasal prongs, 69.09% required simple face mask, 16.36% needed non-rebreathing face mask, bubble CPAP was used in 9.09% and 3.63% children were kept under mechanical ventilator (Table II).

Mean duration of oxygen requirement was 5.8±1.2 days in hyponatremic children and in those with normal sodium concentration was 2.7±0.8 days.

SN	Sodium concentration	Number (n)	Percentage (%)
1.	Normal	68	61.81
2.	Hyponatremia	42	38.18
a.	Mild	26	61.90
b.	Moderate	14	33.33
c.	Severe	2	4.76
3.	Total	110	100

Table I: Prevalence of hyponatremia in the study population

Oxygen Support	Number (n)	Percentage (%)
Nasal Prongs	98	89.09
Simple face mask	76	69.09
Non-rebreathingface mask	18	16.36
CPAP	10	9.09
Mechanical ventilator	4	3.63

Table II: Modes of oxygen supplementation in study population

Among 110 children under study, 18 needed non-rebreathing face mask. 10 of them (55.55%) had mild hyponatremia, 4 (22.22%) were with moderate hyponatremia and 2 (11.11%) each had severe hyponatremia and normal sodium concentration. Severity of hyponatremia was significantly associated with need of non-rebreathing face mask (p<0.01).

Sodium concentration	Non-rebreathing face mask		Total	p-value
	No	Yes		
Mild hyponatremia	16	10	26	
Moderate hyponatremia	10	4	14	
Severe hyponatremia	0	2	2	
Normal Sodium	66	2	68	<0.01
Total	92	18	110	

Table III: Association of severity of hyponatremia with need of non-rebreathing face mask

Bubble CPAP was used in 10 children under study. Of which 3 (30%) had mild hyponatremia, 2 (20%) had moderate and 1(10%) had severe hyponatremia. 4 (40%) patients with normal sodium concentration also required CPAP. Severity of hyponatremia was not statistically significant with need of CPAP (p=0.14).

Sodium concentration	CPAP		Total	p-value
	No	Yes		
Mild hyponatremia	23	3	26	
Moderate hyponatremia	12	2	14	
Severe hyponatremia	1	1	2	
Normal Sodium	64	4	68	0.14
Total	100	10	110	

Table IV: Association of severity of hyponatremia with requirement of CPAP

Four children were kept under mechanical ventilator. Among them, 2 had mild hyponatremia, 1 each had moderate and severe hyponatremia. Severity of hyponatremia was statistically significant with need of mechanical ventilator (p<0.01).

Sodium concentration	Mechanical Ventilation		Total	p-value
	No	Yes		
Mild hyponatremia	24	2	26	
Moderate hyponatremia	13	1	14	
Severe hyponatremia	1	1	2	
Normal Sodium	68	0	68	<0.01
Total	106	4	110	

Table V: Association of severity of hyponatremia with mechanical ventilator support

Total 2 children expired during the study period. 1 had moderate hyponatremia and another had severe hyponatremia. Severity of hyponatremia with outcome was statistically significant (p<0.01).

Sodium concentration	Outcomes		Total	p-value
	Survived	Expired		
Mild hyponatremia	26	0	26	
Moderate hyponatremia	13	1	14	
Severe hyponatremia	1	1	2	
Normal Sodium	68	0	68	<0.01
Total	108	2	110	

Table VI: Association of severity of hyponatremia with outcomes

Severity of hyponatremia was statistically significant with duration of hospital stay (p=0.046)

Sodium concentration	Duration of hospital stay		Total	p-value
	<7 days	>7 days		
Mild hyponatremia	17	9	26	
Moderate hyponatremia	10	4	14	
Severe hyponatremia	0	2	2	
Normal Sodium	55	13	68	0.046
Total	82	28	110	

Table VII: Association of severity of hyponatremia with duration of hospital stay

DISCUSSION

Electrolyte abnormalities like hyponatremia, hypernatremia, hypokalemia, hyperkalemia are encountered in respiratory

tract infections. Hyponatremia is the most common dyselectrolytemia in both adults and children with respiratory tract infections. Stormont and Waterhouse first reported the association of hyponatremia with pneumonia in 1962.[10]

In the current study, males were greater in number than females, making male-to-female ratio of 1.9:1. Majority of the children were infants (53.63%) followed by children of 1-6 years (29.09%). Mean age was 3.2±4.1 years. Similar to the study by Chaitra KM et al[11] and Elliman MG et al[12] where number of male children was higher and most of them were infants.

Hyponatremia was detected in 38.18% children, of which 61.90% had mild hyponatremia, 33.33% had moderate and 4.76% had severe hyponatremia. Similar to the study by Chaitra KM et al[11] where prevalence of hyponatremia was 46.7%, of which 71% had mild, 21.4% had moderate and 7% had severe hyponatremia. The results of present study are also consistent with the study by Patil J et al.[13]

All children under study were under either noninvasive or invasive oxygen support. Nasal prongs, simple face mask, non-rebreathing face mask were noninvasive while bubble CPAP and mechanical ventilator were invasive oxygen support used in the current study. In 89.09% children oxygen was given via nasal prongs, 69.09% required simple face mask, 16.36% needed non-rebreathing face mask, bubble CPAP was used in 9.09% and 3.63% children were kept under mechanical ventilator. Mean duration of oxygen requirement was 5.8±1.2 days in hyponatremic children and in those with normal sodium concentration was 2.7±0.8 days. Association of severity of hyponatremia with need of non-rebreathing face mask and mechanical ventilator was statistically significant (p -value <0.01) but it was not statistically significant with need of bubble CPAP (p-value=0.14). This might be because of difficulty and non-feasibility of using bubble CPAP in older children.

These findings were consistent with Lamichhane et al[1], Ata Sobeih A et al[14] and Alwan AQ et al[15] who reported statistically significant association of severity of hyponatremia with need of non-rebreathing face mask and mechanical ventilator (p-value <0.01). And oxygen was required for longer duration in children with hyponatremia than in those with normal sodium concentration.

In the present study total 2 children expired. One had moderate hyponatremia and another had severe hyponatremia. None of the children with normal sodium concentration expired. Severity of hyponatremia was statistically significant with outcome (p-value<0.01). This is similar to the findings in the study by Luu R et al[16] and Hamid N et al[17] where mortality was higher in hyponatremic children and hyponatremia was statistically significant with mortality. Children with hyponatremia had longer duration of hospital stay as compared to those with normal sodium concentration. Mean duration of stay was 6.28±2.8 days for hyponatremic and 5.25±2.4 days for normal sodium values. Severity of hyponatremia was statistically significant with duration of hospital stay (p-value=0.046). This is in consistent with the study by Berhanu Y et al[18] and Thani KP et al[19] where duration of hospital stay in hyponatremic group was longer than children with normal sodium concentration. Association of severity hyponatremia was statistically significant with duration of hospital stay.

LIMITATIONS

Convenient sampling method and relatively small sample sizemight have led to selection bias, and altered the results. Hydration status of the child during admission might have also influenced serum sodium status, which was not taken into consideration in the study. It was not feasible to use bubble-CPAP in older children. This might have resulted in variability in modes and duration of oxygen supplementation, influencing the outcomes.

CONCLUSION

Hyponatremia is one of the common electrolyte imbalances in children with severe lower respiratory tract infections. It is associated with worse clinical outcomes, prolonged hospital stays as well as utilization of oxygen, in the form of either non-invasive or invasive. Hence regular monitoring of serum electrolytes is necessary which will guide appropriate fluid and electrolyte management and prevent complications, and ultimately improve outcomes in children with severe LRTI.

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