

# Correlation of serum sodium levels and severity of acute lower respiratory infections in children

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## Abstract

**Objectives:** Hyponatremia is a common electrolyte disturbance occurring in hospitalized children, commonly occur in pneumonia patients on admission and they are known to have worse outcome. The objectives of our study is to correlate between sodium levels with severity and prognosis of acute lower respiratory infections. **Methods:** This was the hospital based prospective study including 150 children of age group 6 months to 5 years admitted with chest x ray confirmed acute lower respiratory infections. All clinical findings were documented and serum sodium levels were sent along with other investigations. The association of hyponatremia with other clinical and laboratory parameters were studied to assess their role in predicting severity and prognosis of the disease. **Results:** Our study revealed 72(48%) of the admitted children in the study group had hyponatremia at admission, among them 51(34%) had mild hyponatremia, 20(13.3%) had moderate hyponatremia. Most consistent symptom was cough (98%), 60% of study subjects had mild to moderate pneumonia and 40% found to have severe pneumonia. 71.4% of consolidation, 58.6% of bronchopneumonia and 100% of empyema cases had hyponatremia. Hyponatremia was associated with initial high temperature, tachycardia, leucocytosis, increased neutrophil count with significant p values. Majority of severe pneumonia cases being hyponatremic (60%) and hyponatremia was associated with prolonged length of hospital stay and requirement of mechanical ventilation (90.9%) and higher mortality. **Conclusion:** Our study suggests that severe pneumonia, bronchopneumonia, lobar pneumonia and empyema are at higher risk of developing hyponatremia. Hyponatremia in acute lower respiratory infections were associated with increased morbidity and mortality. Thus fluid management must be managed properly in children with acute lower respiratory infections.

**Key Words:** Hyponatremia; Pneumonia; Empyema.

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## INTRODUCTION

Acute respiratory tract infections are one of the most common infections occurring in children. Pneumonia, the severe form of ALRTI is one of the most important cause of morbidity and mortality in children especially from the developing nations. Pneumonia is associated inflammation of the lung parenchyma<sup>1</sup>. The word

pneumonia has its origin from the Greek word 'Pneumon'- the organ which moves air in and out of the body. The inflammation involving the pneumos is pneumonia. Pneumonia can occur due to both infectious and non-infectious causes. Pneumonia can present in many ways and can also lead to many complications. Pneumonias can be caused by both bacteria and viruses. Some of the causes of bacterial pneumonia are Streptococcus pneumonia (pneumococcus), Haemophilus influenza mostly type b (Hib), Staphylococcus aureus and group A Streptococci. Mycoplasma pneumonia and Chlamydia pneumonia cause atypical pneumonias. Hyponatremia often develops in acute inflammatory diseases such as meningitis, respiratory tract infections, febrile convulsions, and Kawasaki disease in children.<sup>2</sup> Patients with pneumonia and bronchiolitis, the most common diseases encountered in pediatric general practice, are at particular risk of developing hyponatremia due to antidiuretic hormone (ADH) over secretion.<sup>3</sup>

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Pneumonia is the leading infectious killer of under 5 children claiming more lives than any other diseases. The burden is more in the developing nations. Pneumonia is the single largest infectious cause of death in children worldwide. Pneumonia killed 808 694 children under the age of 5 in 2017, accounting for 15% of all deaths of children under five years old.<sup>4</sup> India and Nigeria are the two countries which contributed to majority of cases. The regions. With high prevalence of the disease are South Asia and sub Saharan Africa. Hyponatremia associated with pneumonia is mainly because of syndrome of inappropriate Anti Diuretic Hormone secretion despite of normal/increased plasma volume in response to increased arginine vasopressin release due to hyperinflation of lungs, osmotic stimuli like hyperglycemia or uremia, non-osmotic stimuli such as hypovolemia, hypercapnia, pain, and anxiety.<sup>5</sup> The aim of the study was to study the prognosis and outcome in acute lower respiratory infection in relation to hyponatremia on admission. We found that hyponatremia associated with acute lower respiratory infection on admission had poor outcome.

## MATERIAL AND METHOD

Hospital based comparative study conducted from December 2017 to July 2019 included were children between 6 months to 5 years admitted to indoor pediatric ward and satisfying the WHO definition of LRTI. Informed written consent was obtained from the parents of the study subjects. Routine blood investigations like Complete blood count, Renal function tests, Serum electrolytes, etc. were drawn from the patient and sent without any delay on the day of admission before commencing any treatment. Serum sodium was measured by ISE (ion selective electrode) method. Hyponatremia was graded according to the definition with the collected serum sodium values. Fluids were restricted to two third

of maintenance for all children with hyponatremia All the other parameters were compared to the severity of Pneumonia graded according to British Thoracic Society guidelines. Ethical clearance was obtained from institutional review board.

### Inclusion criteria:

- Children between 6 months to 5 years age with LRTI as per WHO definition.

### Exclusion criteria:

- Children less than 6 months and more than 5 years.
- Those with clinical diagnosis of diarrhea, allergic diseases or asthma, CHD, tuberculosis and other comorbid states.
- Those with documented parenteral antibiotic intake prior to indoor admission for current illness.

Serum sodium level less than 135 mEq/L is taken as hyponatremia. The severity of hyponatremia is classified as MILD (131 to 134); MODERATE (126 TO 130); SEVERE (125 and less). Pneumonia was defined as the presence of infiltration on the chest X-ray.

### STATISTICAL ANALYSIS

Data was entered into Microsoft Excel (Windows 7; Version 2007) and analyses were done using the Statistical Package for Social Sciences (SPSS) for Windows software (version 22.0; SPSS Inc, Chicago). Descriptive statistics such as mean and standard deviation (SD) for continuous variables, frequencies and percentages were calculated for categorical Variables were determined. Association between Variables was analyzed by using Chi-Square test for categorical Variables. Bar charts and Pie charts were used for visual representation of the analyzed data. Level of significance was set at 0.05.

## RESULTS

**Table 1:** Association between Sodium and Gender (N = 150)

Gender	Sodium			
	Normal	Mild	Moderate	Severe
Male	50 (56.8)	31 (35.2)	6 (6.8)	1 (1.1)
Female	28 (45.2)	20 (32.3)	14 (22.6)	0

**Chi-Square Tables, P Value = 0.136, not Significant**

Sex related difference in distribution of hyponatremia is not statistically significant.

**Table 2:** Association between Sodium and severity of pneumonia (British Thoracic Society Classification) (N = 150)

BTS Classification	Sodium			
	Normal	Mild	Moderate	Severe
Mild to Moderate	55 (61.1)	27 (30.0)	8 (8.9)	0
Severe	23 (38.3)	24 (40.0)	12 (20.0)	1 (1.7)

**Chi-Square Tables, P Value = 0.024, Significant**

The table 2 shows that 61.1% of mild to moderate pneumonia had normal sodium levels, 30% has mild hyponatremia, 8.9% had moderate hyponatremia. 38.3% of severe pneumonia had normal sodium levels, 40% had mild hyponatremia,

20% had moderate hyponatremia and 1.7% had severe hyponatremia. Hyponatremia was associated with severe pneumonia in children.

**Table 3: Association between Sodium and Shock (N = 150)**

Shock	Sodium			
	Normal	Mild	Moderate	Severe
Present	5 (22.7)	8 (36.4)	8 (36.4)	1 (4.5)
Absent	73 (57.0)	43 (33.6)	12 (9.4)	0

**Chi-Square Tables, P Value <0.001, Significant**

The table 3 and diagram shows out of 22 cases of pneumonia with shock 5(22.7%) had normal sodium levels and 8(36.4%) had mild, 8(36.4%) had moderate and 1(4.5%) had severe hyponatremia.

**Table 4: Association between Sodium and Mechanical Ventilation (N = 150)**

Mechanical Ventilation	Sodium			
	Normal	Mild	Moderate	Severe
Yes	1 (9.1)	4 (36.4)	6 (54.5)	0
No	77 (55.4)	47 (33.8)	14 (10.1)	1 (0.7)

**Chi-Square Tables, P Value <0.001, Significant**

The table 4 and diagram shows out of 11 cases which needed mechanical ventilation 4(36.4%) had mild hyponatremia, 6(54.5%) had moderate hyponatremia.

**Table 5: Association between Sodium and Chest X Ray (N = 150)**

Chest X Ray	Sodium			
	Normal	Mild	Moderate	Severe
Pneumonitis	51 (67.1)	22 (28.9)	3 (3.9)	0
Bronchopneumonia	23 (39.7)	21 (36.2)	13 (22.4)	1 (1.7)
Consolidation	4 (28.6)	7 (50.0)	3 (21.4)	0
Empyema	0	1 (50.0)	1 (50.0)	0

**Chi-Square Tables, P Value = 0.008, Significant**

The table 5 shows out of 76 pneumonitis cases 51(67.1%) had normal sodium levels, 22(28.9%) had mild hyponatremia and 3(3.9%) had moderate hyponatremia. Out of 58 bronchopneumonia cases 23(39.7%) had normal sodium levels, 21(36.2%) had mild hyponatremia, 13(22.7%) had moderate and 1(1.7%) had severe hyponatremia. Out of 14 consolidation cases 4(28.6%) had normal sodium, 7(50%) had mild hyponatremia and 3(21.4%) had moderate hyponatremia. Out of 2 empyema cases 1(50%) had mild and 1(50%) had moderate hyponatremia. Hyponatremia was more commonly associated with consolidation and bronchopneumonia.

**Table 6: Association between Sodium and Duration of Hospital Stay (N = 150)**

Duration of Hospital Stay (in Days)	Sodium			
	Normal	Mild	Moderate	Severe
<7	67 (85.9)	31 (60.8)	8 (40.0)	0
8-14	9 (11.5)	17 (33.3)	9 (45.0)	1 (100.0)
>14	2 (2.6)	3 (5.9)	3 (15.0)	0

**Chi-Square Tables, P Value <0.001, Significant**

The table 6 shows out of 78 cases with normal sodium levels 67(85.9%), 9(11.5%),2(2.6%) had less than 7, 8 to 14, more than 14 days of hospital stay respectively. Out of 51 cases with mild hyponatremia 31(60.8%), 17(33.3%), 3(5.9%) had less than 7, 8 to 14, more than 14 days of hospital stay respectively.

**Table 7: Association between Sodium and Outcome (N = 150)**

Outcome	Sodium			
	Normal	Mild	Moderate	Severe
Death	0	1 (2.0)	3 (15.0)	0
Improved	77 (98.7)	46 (90.2)	16 (80.0)	1 (100.0)
DAMA/Referred	1 (1.3)	4 (7.8)	1 (5.0)	0

**Chi-Square Tables, P Value = 0.007, Significant**

The table 7 and diagram shows out of 78 cases with normal sodium levels 77(98.7%) improved. Out of 58 cases with moderate hyponatremia 46(90.2%) improved and 1(2%) expired. Out of 20 cases with moderate hyponatremia 16(80%) improved and 3(15%) expired.

## DISCUSSION

Acute lower respiratory tract infections represents one of the most common infective illness in developing

countries like India. And is of great importance as a cause of preventable mortality in children. Hyponatremia is the most commonly encountered finding in children with respiratory tract infections, since Stormant and waterhouse first reported the association of hyponatremia with pneumonia in 1962. Age and sex had no correlation with severity of pneumonia and electrolyte imbalances in our study. This was comparable to study done by Don M *et al*<sup>6</sup> in age, gender distribution of pneumonia. Our study showed that cough (98%) is the most common symptom followed by hurried breathing (74.7%), feeding difficulties (69.3%) and fever (23%) which are comparable with the other studies and cough being the most common symptom followed by hurried breathing In this study 48% children had hyponatremia. However majority of the cases had only mild hyponatremia. The frequency (48%) of hyponatremia in this study is comparable with the above studies Chaitra km *et al*<sup>7</sup> 45% and Sakellaropoulou *et al*<sup>8</sup> 35.2% The present study showed that hyponatremia was a frequent finding in children with bronchopneumonia 44(58.6%). Fortunately in the majority of cases, hyponatremia was mild 36.2%, 22.4% had moderate and 1.7% had severe hyponatremia. Consolidation was next common respiratory infection in our study had hyponatremia in 71.4% cases. In our study it was found that almost all cases with empyema had hyponatremia (100%) is comparable with the studies Chaitra km *et al*<sup>7</sup>, the cause of hyponatremia in these cases might be due to prolonged course of the disease. Hyponatremia cases had longer duration of hospital stay compare to normonatremia cases. 85.9%, 11.5%, 2.6% of cases with normal sodium levels had less than 7, 8 to 14, more than 14 days of hospital stay respectively. 60.8%, 33.3%, 5.9% of cases with hyponatremia had less than 7, 8 to 14, more than 14 days of hospital stay respectively. 90.9% children who are mechanically ventilated had hyponatremia. In our study total 4 death all had hyponatremia and 17% of hyponatremia with acute lower respiratory infections died and is comparable with Partha *et al*<sup>9</sup> 33%, Hyponatremia associated with pneumonia is mainly because of syndrome of inappropriate Anti Diuretic Hormone secretion despite of normal/increased plasma volume in response to increased arginine vasopressin release due to hyperinflation of lungs, osmotic stimuli like hyperglycemia, non-osmotic stimuli like volume depletion, hypercapnia, severe pain, and anxiety

## CONCLUSION

Majority of cases of LRTI in our study were males. There was no gender preponderance with pneumonia cases. Cough being the most common symptom in our cases. Mild hyponatremia was common among our cases. Majority of LRTI cases had hyponatremia, more over hyponatremia was more associated with severe pneumonia groups than mild to moderate pneumonia. Hyponatremia was more commonly present with bronchopneumonia, lobar pneumonia and empyema. Hyponatremia in LRTI cases at admission were associated with increased morbidity and mortality like need of ventilator support and prolonged duration of hospital stay. Hospital acquired hyponatremia also common in clinical practice due to regular use of hypotonic fluid as maintenance and one should take precautions in managing a case of acute respiratory infections and fluids and electrolytes should be closely monitored.

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