

A PROSPECTIVE STUDY ON HYPONATREMIA IN CHILDREN WITH THE LOWER RESPIRATORY TRACT INFECTIONS ADMITTED IN PICU

CHAPARALA SARISHMA, KAKARALA GESHMANJALI, BONELA SAIKUMAR, SESHAGIRI KORIPADU*

Department of Paediatrics, GITAM Institute of Medical Sciences and Research, Visakhapatnam, Andhra Pradesh, India.
Email: seshagiri_neo@yahoo.co.in

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ABSTRACT

Objective: The present study has been undertaken to study hyponatremia in children with lower respiratory tract infections. The other objectives of the study were to evaluate the clinical and laboratory characteristics of children with hyponatremia and explore the relationship between hyponatremia and outcome about the duration of hospital stay and recovery/death.

Methods: The study included children aged 2 months to 5 years who were referred to the PICU, GITAM Institute of Medical Sciences and Research, Visakhapatnam from October 2018 to September 2019 with the lower respiratory tract infections were included in the study. A thorough clinical examination and detailed history have been completed and recorded into a prestructured pro forma. Hematological investigations have been done in all cases. Chest X-ray has been done in all cases to delineate the radiological features of LRTI. A venous blood sample was collected and sent to the biochemistry lab to evaluate serum sodium and was estimated by the ion-selective electrode method analyzed by the radiometer.

Results: 872 children were admitted to the pediatric intensive care unit during the study period. Among them, 100 children in the age group of 2 months to 5 years suffering from the lower respiratory tract infection were included in the study. Out of 100 cases of the lower respiratory tract infections, 59 cases were Pneumonia, and 41 cases were severe Pneumonia. Out of 100 cases, 68 cases accounting for 68% have normal sodium levels, 32 cases accounting to 32% had hyponatremia, and none had hypernatremia. Thus, third of the cases suffering from the lower respiratory tract infections had hyponatremia. The mean CRP in children with hyponatremia was 7.38 mg/dl, higher than children with normal sodium levels, that is, 2.30 mg/dl; this was also statistically significant ($p < 0.001$). All 32 cases of hyponatremia and 68 cases of normonatremia recovered and were discharged. There was no mortality.

Conclusion: Children with hyponatremia had a longer duration of hospital stay. Serum sodium levels are an important biomarker and should be measured in all children hospitalized for the lower respiratory tract infections.

Keywords: Hyponatremia, Lower respiratory tract infection, Sodium levels, Children, Pneumonia, CRP.

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INTRODUCTION

Lower respiratory tract infections, such as pneumonia, atypical pneumonia, bronchitis, and bronchiolitis, threaten children's health worldwide, particularly in developing nations where inadequate nutrition and healthcare are scarce [1]. Acute lower respiratory tract infection is the most significant cause of morbidity in children under the age of five, with about 156 million new episodes each year globally, and the majority of which occur in India. The annual mortality rate is 1.9 million, with India accounting for roughly 400 thousand deaths [2]. Many acute illnesses, including Pneumonia, have been linked to electrolyte abnormalities, particularly hyponatremia [3]. Other electrolyte problems reported in Pneumonia are hypokalemia and hyperkalemia [4]. Impairment of the intrarenal mechanism of urine dilution due to extracellular fluid volume depletion and inappropriate antidiuretic hormone secretion has been offered as explanations for electrolyte abnormalities in pneumonia and bronchiolitis [5,6]. Hyponatremia is the most common electrolyte imbalance found in clinical practice and critically unwell children. Hyponatremia (HN) affects about 3% of hospitalized patients [7]. The most common mechanism of hyponatremia in respiratory tract infections has been identified as syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH) [3-5]. Electrolyte imbalances are frequently overlooked for an extended length of time. Regardless of the fundamental condition, they significantly impact morbidity and mortality. If variations in serum electrolyte concentration go unnoticed and ignored, the implications could be disastrous. The goal of treating fluid and electrolyte imbalances in infants and children is

to get them back to normal physiologic equilibrium. To do this, early detection, a high index of suspicion, and a detailed understanding of prevalent electrolyte imbalances are required. Thus, this study has been undertaken to study hyponatremia in children with the lower respiratory tract infections. The other objectives of the study were to evaluate the clinical and laboratory characteristics of children with hyponatremia and explore the relationship between hyponatremia and outcome about the duration of hospital stay and recovery/death.

METHODS

Place of study

Pediatric Intensive Care Unit (PICU), GITAM Institute of Medical Sciences and Research, Visakhapatnam.

Study period

October 2018 to September 2019.

Type of study

This was a prospective observational study.

Number of cases studied

100.

Inclusion criteria

All children between 2 months and 5 years suffering from the lower respiratory tract infections admitted to PICU fulfilling WHO criteria of ARI were included in the study.

Exclusion criteria

The following criteria were excluded from the study:

- Infants <2 months of age.
- Children > 5 years of age.
- Children with renal disorders.
- Children with associated CNS infections.
- Children with gastroenteritis.
- Children are on drugs that can cause electrolyte disturbances, such as diuretics anticonvulsants.

A case of the lower respiratory tract infection (LRTI) is defined as per the ARI control program presence of cough with fast breathing of:

- More than 60/min in <2 months of age,
- More than 50/min in 2 to 12 months of age and
- More than 40/min in 12 months to 5 years of age.

Method of collection of data

The study included children aged 2 months to 5 years who were referred to the PICU with lower respiratory tract infections during the study period. Informed consent has been obtained from either of the parents of children who meet the inclusion criteria. A thorough clinical examination and detailed history have been completed and recorded into a prestructured pro forma. The institutional ethical committee has given its approval. A complete history of symptoms such as fever, cough, breathlessness, chest retractions, rejection of feeds, irritability, and lethargy was taken. Parents were asked about their child's immunization history and the previous history of disease with similar symptoms, verified by looking at documentation when they were available. Each child had a thorough clinical evaluation. For 1 min, the heart rate and breathing rate were monitored. Each child's respiratory distress severity was determined using the WHO pneumonia criteria. Hematological investigations have been done in all cases. Chest X-ray has been done in all cases to delineate the radiological features of LRTI. A venous blood sample was collected and sent to the biochemistry lab to evaluate serum sodium and was estimated by ion-selective electrode method analyzed by the radiometer. Hyponatremia is defined as a sodium level <135 mEq/L in serum [8]. The serum concentration of 131-135 mEq/L means mild hyponatremia, 126-130 mEq/L means moderate hyponatremia, and <125 mEq/L means severe hyponatremia [8]. Hypernatremia is defined as serum sodium concentration >145 mEq/L. Cases of the lower respiratory tract infections were divided into two groups based on serum sodium levels, that is, hyponatremia and normonatremia. Total leukocyte count and CRP, two inflammatory indicators, were assessed and compared in the two groups. The length of hospital stay in hyponatremia and normalatremia was determined and compared. Other investigations were carried out as needed in individual instances, and all individuals were treated according to ordinary PICU policy. Complete blood picture, C-reactive protein, serum electrolytes, renal function tests, and a chest X-ray were all performed. Other tests, such as blood culture and arterial blood gas analysis, are performed as needed.

Statistical analysis

The data were entered into a computerized Microsoft Excel 2010 spreadsheet. Subsequently, it was analyzed using SPSS (Statistical Package for the Social Science) version 20.0. After entering the coded information into the computer, the data analysis was carried out, and the tables were generated. Mean±SD was calculated to summarize the data. Results were expressed in Mean±SD. Statistical comparison between the groups was made using student t-test with statistical significance as $p < 0.05$. Graphical presentations such as bar diagrams and pie charts were used where needed.

RESULTS

A total of 872 children were admitted to the pediatric intensive care unit during the study. Among them, 276 children were presented with the lower respiratory tract infections. 176 children with the lower respiratory tract infections were excluded from the study based on exclusion criteria. A total of 100 children in the age group of 2 months to 5 years suffering from the lower respiratory tract infection were included

in the study. Out of 100 cases of lower respiratory tract infections, 59 cases were Pneumonia, and 41 cases were severe Pneumonia.

Out of 100 cases, 58 children were in the age group of 2-12 months and 42 cases in the age group of >12-60 months. Thus, it appears that infants in the age group of 2-12 months are more prone to the lower respiratory tract infections compared to the children in the age group of > 12-60 months (Fig. 1). Among 100 cases, 61 cases were males, and the rest 39 cases accounting were females (Fig. 1). Out of 100 cases of the lower respiratory tract infections, they were divided into two groups depending on the severity of LRTI, that is, pneumonia and severe pneumonia. 59 cases accounting for 59% were pneumonia, and 41 cases accounting for 41% had severe pneumonia. Serum sodium estimation was done in 100 cases of the lower respiratory tract infections. They were divided into three groups, that is, cases with normal sodium levels, hyponatremia, and hypernatremia. 68 cases accounting for 68% have normal sodium levels, 32 cases accounting for 32% had hyponatremia, and none had hypernatremia. Thus third of the cases suffering from the lower respiratory tract infections had hyponatremia. 32 cases of hyponatremia with the lower respiratory tract infections were further divided into three groups, that is, mild, moderate, and severe hyponatremia severity. 28 cases accounting for 87.5% were of mild hyponatremia, four cases accounting for 12.5% were of moderate hyponatremia, and none of them had severe hyponatremia. The majority of cases with the lower respiratory tract infections had mild hyponatremia. Inflammatory markers such as total leukocyte count and C-reactive protein were measured in cases of hyponatremia, and they are compared with cases with normal sodium levels. Mean ±SD of total leukocyte count and CRP were taken. The mean TLC in children with hyponatremia was 17753.12 cells/mm³, which was high, compared to children with normal sodium levels, that is, 9989.70 cells/mm³; this was statistically significant ($p < 0.001$). The mean CRP in children with hyponatremia was 7.38 mg/dl, which was higher compared to children with normal sodium levels, that is, 2.30 mg/dl; this was also statistically significant ($p < 0.001$) (Table 1). Out of the 100 cases of the lower respiratory tract infections, 32 cases had hyponatremia. They were divided into two groups depending on the severity of the lower respiratory tract infections, that is, pneumonia and severe pneumonia. Out of 32 cases of LRTI with hyponatremia, 20 cases with severe pneumonia (62.5%) had hyponatremia, and

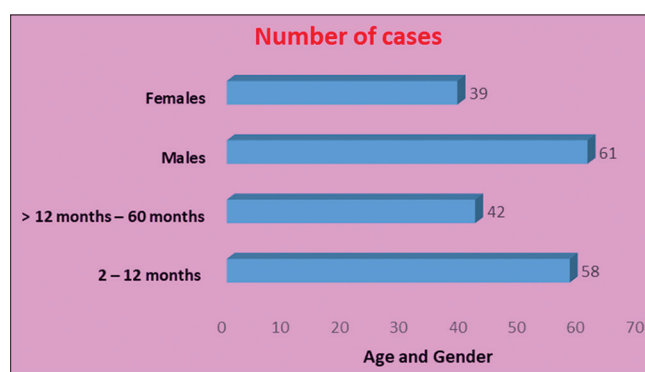


Fig. 1: Age and gender-wise distribution of cases

Table 1: Distribution of cases based on serum sodium levels about laboratory parameters in children with lower respiratory tract infections

Parameter	Mean±SD		p
	Hyponatremia (n=32)	Normonatremia (n=68)	
Total leucocyte count (cells/mm ³)	17753.12±1987.86	9989.70±3900.1	<0.001
CRP (mg/dl)	7.38±8.07	2.30±2.17	<0.001

CRP: C-reactive protein, SD: Standard deviation

12 cases of pneumonia (37.5%) showed hyponatremia, indicating that hyponatremia was predominantly seen in severe pneumonia (Fig. 2). A total of 100 cases of the lower respiratory tract infections were divided into two groups based on serum sodium levels, that is, hyponatremia and normonatremia. The mean duration of hospital stay was calculated for cases with hyponatremia and those with normal sodium levels, and both were compared. The mean duration of hospital stay in cases with hyponatremia was 7.18 days, which was higher compared to cases with normal sodium levels, that is, 5.6 days; this was statistically significant ($p < 0.001$) (Table 2). The outcome of cases with the lower respiratory tract infections was studied in the form of the duration of hospital stay, recovery, and death. They were divided into two groups based on serum sodium levels, that is, hyponatremia and normonatremia, and the outcome was assessed in terms of recovery/death. All 32 cases of hyponatremia and 68 cases of normonatremia recovered and were discharged. There was no mortality (Table 3).

DISCUSSION

The incidence of hyponatremia in children with the lower respiratory tract infections, laboratory characteristics, and the potential impact of hyponatremia on the clinical course of the lower respiratory tract infections in terms of hospital stay, recovery, and death were investigated in this prospective study. In the current study, 32 children out of 100 with the lower respiratory tract infections had hyponatremia, accounting for 32%. In a survey conducted by Duru *et al.* [9] in Turkey

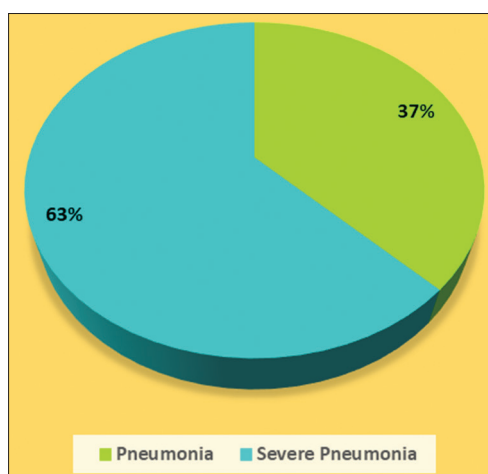


Fig. 2: Distribution of cases of hyponatremia about the severity of the lower respiratory tract infections

Table 2: Distribution of cases based on serum sodium levels about duration of hospital stay in children with lower respiratory tract infections

Serum sodium levels	Duration of hospital stay in days, mean \pm SD	p
Hyponatremia (n=32)	7.18 \pm 1.4	<0.001
Normonatremia (n=68)	5.6 \pm 1.09	

SD: Standard deviation

Table 3: Distribution of cases based on serum sodium levels about recovery/death in children with the lower respiratory tract infections

Outcome	Hyponatremia (n=32), n (%)	Normonatremia (n=68), n (%)
Recovered	32 (100)	68 (68)
Death	Nil	Nil
Total	32 (100)	68 (100)

in 2013, out of 91 cases of pneumonia, 31 cases had hyponatremia, with a hyponatremia rate of 33.6%, almost identical to the current study. In a comparable study conducted in Poland by Wrotek *et al.* [10] in 2013, the incidence of hyponatremia was 33.3 %, which was similar to the current research. However, the sample size was bigger (312 children compared to the present study's 100 cases).

In comparison to the current study, a study conducted by Sitaram *et al.* [8] in India in 2013 found that out of 49 infants with pneumonia, 23 children had hyponatremia, accounting for 46.5%. In research conducted by Guruswamy *et al.* [11] in India in 2014, 28 children out of 60 instances of pneumonia had hyponatremia, accounting for 46.7%, similar to the current study. This difference of higher incidence of hyponatremia in the above three studies maybe because the cases included were suffering from severe pneumonia. In contrast, even mild cases of pneumonia were included in the present study. Mild hyponatremia was found in 35.2% of 105 children with the lower respiratory tract infections in a study by Kanai *et al.* [12], which was higher than the current study, which found mild hyponatremia in 28%. In a study conducted by Guruswamy *et al.* [11] in 2014, out of 60 cases of severe Pneumonia investigated, 11 instances (or 18.3%) had mild hyponatremia, which was lower than the current study because their study had more cases of moderate and severe hyponatremia. Moderate hyponatremia was seen in four children in this investigation, accounting for 4% of the cases of lower respiratory tract infections. In the study done by Duru *et al.* [9] in the year 2013 in turkey, out of 92 cases of lower respiratory tract infections, four patients accounting for 4.3% had moderate hyponatremia, which was similar to the present study. In the present study, out of 100 cases of lower respiratory tract infections, there was no case of severe hyponatremia, which was similar to the studies done by Duru *et al.* [9], Sakellaropoulou *et al.* [1], and Kanai *et al.* [12]. In the present study, the mean total leukocyte count in children with hyponatremia was 17753.12 cells/mm³, significantly higher than children with normal sodium levels, who had a value of 9989.7 cells/mm³. This was statistically significant ($p < 0.001$). The present study results were in concordance with those of Duru *et al.* [1] and Nair *et al.* [13]. The present study measured the mean CRP in children with hyponatremia and children with normal sodium levels, and both groups were compared. The mean CRP in children, who had hyponatremia, was 7.38 mg/dl, which was higher than in children with normal sodium levels, which was 2.30 mg/dl. This was statistically significant ($p < 0.001$). These findings in the present study were comparable to the studies done by Duru *et al.* [9] and Wrotek *et al.* [10]. The reason can be attributed to the severity of the LRTI cases studied, which could have raised the levels of non-specific inflammatory markers. In the present study, the mean duration of hospital stay of children suffering from the lower respiratory tract infections with hyponatremia was 7.18 days, which was high compared to children with normal sodium levels, who had a mean duration of 5.6 days. This was statistically significant ($p < 0.001$). In the study done by Singhi *et al.* [3], the mean duration of hospital stay in children with hyponatremia was 7.1 days, which was higher when compared to children with normal sodium levels. The duration of the hospital stay was 5.5 days. This was comparable to the present study. In the present study, all 32 cases of hyponatremia were recovered. In the study done by Patil *et al.* [14], out of 78 cases of hyponatremia, four children died, whereas in the present study, there was no death in cases of hyponatremia. In the study done by Guruswamy *et al.* [11], out of 28 cases of hyponatremia, three patients died, rest 25 recovered. This difference can be due to more cases of severe pneumonia with coexistent hyponatremia. In the present study, there was no mortality in all the 68 patients with normonatremia recovered. Similar findings were present in the studies done by Patil *et al.* [14] and Guruswamy *et al.* [11], where all the cases of normonatremia recovered.

CONCLUSION

Hyponatremia is seen in one-third of the cases among children suffering from the lower respiratory tract infections accounting for 32%. Among the cases of hyponatremia with the lower respiratory tract infections, mild hyponatremia is more common than moderate and severe hyponatremia. Hyponatremia is related to the severity of the lower respiratory tract infections. Children with hyponatremia had a longer

duration of hospital stay. Serum sodium levels should be measured in all children hospitalized for the lower respiratory tract infections.

AUTHORS' CONTRIBUTION

The first and second authors, CS and KG, had performed the work and wrote the first draft of the manuscript. The third author, BS, collected the literature, and performed the statistical analysis. The fourth author corrected the final draft of the manuscript.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

SOURCE(S) OF SUPPORT (IF ANY)

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