

Study of Serum Electrolytes and Calcium Changes in Children with Severe Pneumonia and its Outcome

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Abstract

Background: Electrolyte imbalance is one of the serious complications in hospitalized children with severe pneumonia. Monitoring of changes in electrolytes is very essential to prevent the complications leading to increased morbidity and mortality. **Aims and objectives:** To study serum electrolytes and calcium disturbances in patients with severe pneumonia. To identify relation of serum electrolytes with outcome of severe pneumonia. **Material and Methods:** After taking approval of ethics committee of our institute, we studied a total of hundred cases over a span of 24 months- August 2018 to December 2020. Study is carried out among cases of severe pneumonia and community acquired pneumonia (CAP) in age group of 2 months to 5 years admitted in pediatrics department of tertiary care centre in Maharashtra. Laboratory investigations of serum sodium, potassium, chloride and calcium levels were noted at admission and 24 hours after hospitalization. **Results:** This is observational cross study carried out in 100 children of severe pneumonia admitted in paediatric intensive care unit at Dr. Vasant Rao Pawar Medical College, Nashik to observe and study electrolyte changes in them. Most children were in age group of 2 months to 12 months (i.e., 72%) followed by 28% in age group of 13 months to 60 months. At admission most common abnormality was hypocalcemia 49% followed by hyponatremia 27%, hyperchloremia 7%, hyperkalemia 6%, hypernatremia 6%, hypokalemia 4%, hypochloremia 1%. After 24 hours of stabilization hyponatremia was most common 40%, followed by hypocalcemia 43%, hypokalemia 9%, hypernatremia 8%, hyperkalemia 4%, hyperchloremia 4%. **Conclusion:** Mortality was significantly higher in cases with chloride level abnormality than with normal chloride level. Cases with disturbances in electrolytes showed higher mortality than those without electrolyte disturbances. Hyponatremia and hypokalaemia were associated with adverse outcomes in pneumonia cases. Electrolyte disturbances are commonly seen in pneumonia cases, so we should monitor them properly while treating them to avoid complications. Hyponatremia in pneumonia occurs due to Syndrome of Inappropriate Anti Diuretic Hormone secretion (SIADH). Hyponatremia at admission significantly affect outcome in terms of prolonged duration of hospitalization and two fold increase in mortality.

Keywords: CAP - Community Acquired Pneumonia, SIADH - Syndrome of Inappropriate Anti-Diuretic Hormone Secretion Serum Electrolytes, Hypocalcemia, Hypokalemia, Hypernatremia, Hyperkalemia, Hyperchloremia

1. Introduction

The World Health Organization (WHO) defines pneumonia in children as presence of cough or difficulty in breathing associated with fast breathing or chest in drawing in children of 2-59 months of age. Pneumonia is the single largest infectious cause of death in children worldwide¹. India had under 5 mortality rates of 39.4

per 1000 live births in 2018². It is common in children especially under five age group and families everywhere, but is most prevalent in South Asia and sub-Saharan Africa³. It is more common in developing countries like India⁴. Community Acquired Pneumonia (CAP) is the most frequent cause of hospitalization, and is most common cause of admission to intensive care units^{5,6}. Electrolyte imbalance is one of the serious complications

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in hospitalized children with severe pneumonia⁷⁻¹¹. Hyponatremia is one of the most common electrolyte abnormalities in pneumonia⁷. Hypokalemia along with hyponatremia worsens the outcome⁷. Hyponatremia and hypokalemia were associated with adverse outcome in pneumonia cases⁷. Monitoring of changes in electrolytes is very essential to prevent the complications leading to increased morbidity and mortality. So it becomes necessary to study the electrolyte changes occurring in hospitalized children of severe pneumonia. This study is carried out to find out the changes in electrolytes in the cases of severe pneumonia. Sometimes hypokalemia is also seen in cases of children with severe pneumonia^{7,12}. Babies of asphyxia related pneumonia develop hyponatremia, hyperkalemia or Hypokalemia^{7,12-14}. During the active infection in lobar pneumonia, there was a decrease in electrolytes in the serum⁷. Fall in serum concentration of chloride and fixed base with the minister osmolality are described in lobar pneumonia⁸⁻¹¹. Low levels of serum calcium are seen in some cases of pneumonia¹⁵. Present study is an observational cross-sectional study carried out among the severe pneumonia patients of 2 months to 5 years of age admitted in paediatric ICU of Dr. Vasantrao Pawar Medical College, Nashik, Maharashtra.

2. Aims and Objectives

- To study the serum electrolytes and calcium disturbances in patients with severe pneumonia.
- To identify relation of individual serum electrolyte with outcome of severe pneumonia.

3. Materials and Methods

3.1 Study Setting

This study is carried out among the cases of severe pneumonia in the age group of 2 months to 5 years, admitted in a paediatric Department of a tertiary care centre in Maharashtra.

- Age: Age is recorded in completed months and years end root using a variety of age categories depending on the purpose of table.
- Hyponatremia: Hyponatremia is defined as a sodium level less than 135 millimoles per litre in children. Hyponatremia was further classified into either having mild, moderate or severe hyponatremia in the following fashion⁶.

- Mild hyponatremia-sodium levels of 130 to 134 millimoles per litre.
- Moderate hyponatremia-sodium levels of 125 to 129 millimoles per litre.
- Severe hyponatremia-sodium levels of less than 125 millimoles per litre⁶
- Hypernatremia: Hypernatremia is defined as plasma sodium concentration more than 145 millimoles per litre.
- Hypokalemia: Hypokalemia is defined as plasma potassium concentration less than 3.5 millimoles per litre.
- Hyperkalemia: Hyperkalemia is defined as a plasma potassium concentration more than 5.5 millimoles per litre.
- Hypocalcemia: Hypocalcemia is defined as serum calcium level less than 9mg/dl.
- Hypercalcemia: Hypercalcemia is defined as serum calcium level more than 11mg/dl.
- Hypochloridemia: It is defined as serum chloride level less than 90 meq/l.
- Hyperchloridemia: It is defined as serum chloride level more than 110 meq/l.

3.2 IEC Approval and Consent

- Permission for carrying out the study was obtained from the institutional ethical committee by submitting the study protocol.
- Informed consent in written was obtained separately from the lawful legally acceptable representative of the subject individually.

3.3 Type of Study

This is an observational cross-sectional study.

3.4 Duration of Study

The study was undertaken over 2 years - August 2018 to December 2020.

3.5 Study Participants

The present study was carried out among the patients of severe pneumonia in the age group of 2 months to 5 years admitted in the paediatric Department in a tertiary care centre.

3.6 Inclusion Criteria

- The cases of severe pneumonia in the age group of 2 months to 5 years admitted in paediatric Department.
- Those whose informant was willing to participate in the study.

3.7 Exclusion Criteria

- The cases below the age of 2 months and above the age of 5 years were excluded.
- Children with renal disorders.
- Children with associated central nervous system infections.
- Children with gastroenteritis.
- Children on drugs which can cause electrolyte imbalance such as Diuretics.

3.8 Sample Size Calculation

The following formula provided the required sample size.

$$N > z^2 \frac{p \cdot q}{L^2}$$

- $Z = 1.96$
- $l = 10\%$ margin of error
- P prevalence 49%
- $q = 100 - p = 51\%$
- $n > 96$

3.9 Sampling Technique

All the eligible cases that fulfilled the inclusion and exclusion criteria were included in the study after obtaining informed written consent from the lawful legally acceptable representative.

3.10 Data Collection

Study tools

Pre-designed, pre tested, and semi structured questionnaire was used which consisted of following sections

- General information of demographic data.
- Clinical findings.
- Laboratory investigations of serum sodium, potassium, chloride and calcium levels were noted at admission and 24 hours after hospitalization.

4.3 Data Collection Process

- Informants of all the eligible study subjects were willing to participate in the study as the confidentiality was assured to all of them.

- An informed written consent was obtained from all.
- All the required information was collected and noted by the researcher.
- All the physical examinations were done as per the standard procedures.

3.11 Statistical Analysis

Descriptive statistics were used to describe the prevalence of electrolytes and calcium changes. To test the significance Z test and chi square test was employed whenever necessary.

The value of less than 0.05 was considered as statistically significant and less than 0.001 was taken highly significant

4. Results

This is an observational cross sectional study. Total 100 cases of severe pneumonia were included in this study from the paediatric department at a tertiary care centre in Maharashtra.

Table 1. Demographic profile of cases of severe pneumonia

Age In months	Gender		Total
	Number of males (%)	Number of females (%)	
2 to12	43 (59.72)	29 (40.28)	72%
13 to 60	18 (64.28)	10 (37.71)	28%
Total	61	39	100%

Table 1 shows that, Majority were males (61%). Most of them were infants (72%). Age ranges from 2months to 60 months with mean age of 16.575 months.

Table 2. Electrolyte disturbances in severe pneumonia cases in children. N=100

Electrolyte disturbances	At admission	After 24 hrs of hospitalization
Hyponatremia	27	47
Hypernatremia	6	8
Hypokalemia	4	9
Hyperkalemia	6	4

Hypocalcemia	49	43
Hypercalcemia	0	0
Hypochloremia	1	1
Hyperchloremia	7	4

Table 2 shows that, At admission, most common electrolyte disturbance was hypocalcemia (49%) followed by hyponatremia (27%), hyperchloremia (7%), hyperkalemia (6%), hypernatremia (6%), Hypokalemia (4%) and hypochloremia (1%). After 24 hours of hospitalization, hyponatremia (47%) was the most common electrolyte disturbance followed by hypocalcemia (43%), hypokalemia (9%), hypernatremia (8%), hyperkalemia (4%), hyperchloremia (4%) and hypochloremia (1%). Hypercalcemia was not seen in any patient, neither at admission nor after 24 hours of hospitalization.

Table 3 shows that, most of the hyponatremia cases were in mild hyponatremia 21 (77.78%) followed by moderate hyponatremia 5 (18.51%) and only one case

(3.71%) was in severe hyponatremia. Outcome of the cases with hyponatremia at admission was as follows: 88.89% had recovered and 11.11% died.

The difference is not significant between hyponatremic and nonhyponatremic groups for age (P is 0.6895), gender (P is 0.4899) and outcome (P is 0.9289) as p value is more than 0.05.

Table 4 shows that, 47% cases were hyponatremic after 24 hours of hospitalization. 40 of 47 (85.11%) were in mild hyponatremia followed by 6 were in moderate hyponatremia. Majority were males i.e. 29 (61.70%), and infants 34 (72.34%). Mortality was more in cases with sodium changes, potassium changes and chloride changes as compared to the cases with normal sodium, potassium and chloride levels. However, mortality was more in normocalcemic cases than non normocalcemic cases. There is no significant difference between the outcome for sodium, potassium and calcium levels. But there is a significant difference in outcome of cases between normal and abnormal chloride level.

Table 3. Distribution of cases of hyponatremia (n= 27) at admission

Age in months	Mild hyponatremia	Moderate hyponatremia	Severe hyponatremia	Total
2 to 12	17 (80.95)	3 (14.29)	1 (4.76)	21 (77.78)
13 to 60	4 (71.43)	2 (28.57)	0 (0.0)	6 (22.22)
Gender	Mild hyponatremia	Moderate hyponatremia	Severe hyponatremia	Total
Males	11 (78.57)	2 (14.29)	1 (7.14)	14 (51.85)
Females	10 (76.92)	3 (23.07)	0 (0.0)	13 (48.15)
Outcome	Mild hyponatremia	Moderate hyponatremia	Severe hyponatremia	Total
Recovery	19 (79.17)	5 (20.83)	0 (0.0)	24 (88.89)
Death	2 (66.67)	0 (0.0)	1 (33.33)	3 (11.11)
Total	21 (77.78)	5 (18.51)	1 (3.71)	27

Table 4. Distribution of the cases of hyponatremia after 24 hours of hospitalization

Age in months	Mild hyponatremia	Moderate hyponatremia	Severe hyponatremia	Total
2 to 12	28 (82.35)	5 (14.71)	1 (2.94)	34 (72.34)
13 to 60	12 (92.31)	1 (7.69)	0 (0.0)	13 (27.66)
Gender	Mild hyponatremia	Moderate hyponatremia	Severe hyponatremia	Total
Males	26 (89.66)	2 (6.90)	1 (3.45)	29 (61.70)
Females	14 (77.78)	4 (22.22)	0 (0.0)	18 (38.30)
Outcome	Mild hyponatremia	Moderate hyponatremia	Severe hyponatremia	Total
Recovery	38 (86.36)	5 (11.36)	1 (2.27)	44 (93.61)
Death	2 (66.67)	1 (33.33)	0	3 (6.39)
Total	40 (85.11)	6 (12.77)	1 (2.13)	47

5. Discussion

In the study, most common Electrolyte disturbance was hypocalcemia 49%, followed by hyponatremia 27%, hypochloremia 7%, hyperkalemia 6%, hypernatremia 6%, hypokalemia 4% and hypochloremia 1%. Hyponatremia is considered to be one of the most common electrolyte abnormalities in hospitalized patients¹⁶. It complicates many conditions affecting respiratory, cardiovascular and central nervous system and is frequently encountered in children suffering with pneumonia. Studies report that it as a marker of severity of illness resulting in high mortality and morbidity. The overall incidence of hyponatremia in our study was 27% at admission and 47% at 24 hours of hospitalisation. Mild hyponatremia was the commonest in present study. Out of 27 cases of hyponatremia, 21 that is 77.78% were in mild hyponatremia, 5 (18.51%) were in moderate hyponatremia and 1 (3.71%) were in severe hyponatremia. Hypocalcemia was therein 49% cases of severe pneumonia at admission and 43% after 24 hours of hospitalization. Hypercalcemia was not seen in any patient, neither at admission nor after 24 hour of hospitalization. Hypokalemia is prevalent in patients with covid19 pneumonia which makes severe progression¹⁶. Our study also showed prevalence of hypokalemia as 4% at admission. 90% normokalemic and 6% were hyperkalemic. 9% were hypokalemic, 4% were hyperkalemic and 87% were normokalemic after 24 hours of hospitalisation. Hypokalemia can have deleterious effect on membrane potentials and affect the excitability of cardiac and smooth muscles¹³. Severe hypokalemia can lead to life threatening complications like cardiac arrhythmia and respiratory failure. Sudden deaths have been reported in complications associated with hypokalemia without any warning signals⁷. Hypokalemia along with hyponatremia worsens the outcome⁷.

Hyponatremia and hypokalemia were associated with adverse outcome in Pneumonia cases⁷.

Outcome of the cases showed higher mortality in the cases with disturbances in electrolytes than those without electrolyte disturbances. Mortality was significantly higher in cases with abnormalities in chloride levels than those with normal chloride levels. No significant differences in outcomes were seen between the cases with abnormal sodium levels and normal sodium levels. No significant differences in outcomes were seen between the cases with abnormal potassium levels and normal

potassium levels. No significant differences in outcomes were seen between the cases with abnormal calcium levels and normal calcium levels. Thus, in the present study, we didn't find significant difference in outcome of cases with electrolyte disturbances and without it, individually for sodium, potassium and calcium. However there was a significant difference in outcome of the cases with chloride level changes and cases with normal chloride levels. Thus we conclude that electrolyte disturbances are common in severe pneumonia cases. Hence we should look after this while treating the patients to avoid complications.

6. Conclusion

This is an observational cross sectional study carried out in 100 children of severe pneumonia admitted in a tertiary care hospital in Maharashtra to observe and study the electrolyte changes in them.

No. of males (61%) was more as compared to females (39%).

Most of the children were in the age group of 2 months to 12 months i.e., 72% followed by 28% in the age group of 13 months to 60 months.

At admission, most common electrolyte disturbance was hypocalcemia (49%) followed by hyponatremia (27%), hyperchloremia (7%), hyperkalemia (6%), hypernatremia (6%), Hypokalemia (4%) and hypochloremia (1%).

After 24 hours of hospitalisation, hyponatremia (47%) was the most common electrolyte disturbance followed by hypocalcemia (43%), hypokalemia (9%), hypernatremia (8%), hyperkalemia (4%), hyperchloremia (4%) and hypochloremia (1%).

Hypercalcemia was not seen in any patient, neither at admission nor after 24 hours of hospitalization.

Outcome of the cases showed higher mortality in the cases with disturbances in electrolytes than those without electrolyte disturbances.

Mortality was significantly higher in cases with abnormalities in chloride levels than those with normal chloride levels.

No significant differences in outcome were seen between the cases with abnormal sodium levels and normal sodium levels.

No significant differences in outcome were seen between the cases with abnormal potassium levels and normal potassium levels.

No significant differences in outcome were seen between the cases with abnormal calcium levels and normal calcium levels.

Most of the hyponatremia cases were in mild hyponatremia (21nos, 77.78%) followed by moderate hyponatremia (5nos, 18.51%) and only one case (3.71%) was in severe hyponatremia. Majority of the hyponatremia cases were infants (17nos, 80.95%). Majority of hyponatremia cases (14nos, 51.85%) were males followed by (13nos, 48.15%) females. Outcome of the cases with hyponatremia at admission showed 88.89% recovery and 11.11% death. The difference is not significant between hyponatremic and non hyponatremic groups for age (P is 0.5948), gender (P is 0.3629) and outcome (P is 0.2346) as p value is more than 0.05.

It is concluded that monitoring of electrolyte changes is necessary in severe pneumonia in order to manage the disease and to prevent the complications.

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