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*RESEARCH ARTICLE*

# Electrolyte Abnormalities in Neonates with Septicaemia: A Hospital-Based Study

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## ABSTRACT

**Introduction:** Despite the continuing struggle, Bangladesh's under-five mortality rate is still high. However, Bangladesh has achieved a significant reduction in childhood mortality from 173 per thousand. The high level of neonatal deaths in Bangladesh is a great concern among all health professionals. **Objective:** To determine the frequency and pattern of electrolytes imbalance in neonates with septicaemia and their impact on mortality and morbidity. **Methods:** All neonates suffering from septicaemia and admitted to BSMMU from 1st January 2011 to 15th September 2011 and fulfilled the inclusion criteria were evaluated. **Results:** During the study period total of 120 neonates were admitted with the diagnosis of septicaemia in the Department of Neonatology, BSMMU, Dhaka, Bangladesh. Among the neonates, mean age was 9.26±4.58 days, mean weight 2282.68±580.40 gm, mean gestational age 35.68±2.40 weeks, males were 66 (55%), and females were 54 (45%). Electrolyte abnormalities were found in 42 (35%) neonates with septicaemia. Among the electrolyte abnormalities, hyponatremia was found in 24 (20%) neonates, hypernatremia in 12 (10%), hypokalemia in 17 (14.2%), hyperkalemia in 19 (15.8%), and mixed abnormalities in 18 (15%) cases. Neonates with dyselectrolytemia were found significantly associated with prolonged hospital stay compared to those with normal electrolyte levels ($p< 0.05$). Hyponatremia, hypokalemia, and mixed electrolyte abnormalities were significantly associated with higher mortality ($p<0.05$). But hypernatremia and hyperkalemia were not significantly associated with higher mortality ($p> 0.05$). **Conclusion:** Electrolyte abnormalities are common in neonates with septicaemia. They contribute considerably to the higher mortality and prolonged hospital stay of neonates irrespective of the primary disease.

**KEYWORDS:** Neonates; Septicaemia; Electrolyte abnormalities.

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## INTRODUCTION

Despite the continuing struggle, Bangladesh's under-five mortality rate is still high. Though Bangladesh has achieved a significant reduction in childhood mortality from 173 per thousand in the early 80s to 65 per thousand in 2006, the country still ranks seventh among the 42 countries contributing to 90% of childhood deaths worldwide1. The infant mortality rate is 52 deaths per 1000 live births, and the child mortality rate is 14 per 1000 children2. During infancy, the risk of dying in the first month of life (37 per 1000) is nearly two and a half times greater than in the subsequent 11 months (15 per 1000) 2. It is estimated that 3.9 millions of the 10.8 million deaths in children annually worldwide occur in the first 28 days of life3. More than 96% of all neonatal deaths occur in developing countries3. The high level of neonatal deaths in Bangladesh is a significant concern among all health professionals. Although the rate has fallen from 52 to 372 per thousand live births during the last 15 years, it remains unacceptably and alarmingly high. Deaths in the neonatal period account for 57 percent of all under-five deaths2. Mortality of neonatal unit of Bangabandhu Sheikh Mujib Medical University (BSMMU) is 12.9%4 observed in a study done from January 2008 to December 2009, Dhaka Medical College Hospital (DMCH) is 20.92%5. One of the primary causes of neonatal death in these tertiary care hospitals is neonatal sepsis. Death from neonatal sepsis is 28.5%4 in BSMMU and 11.7%5 in DMCH. So, a good number of neonatal death occur from neonatal sepsis even though the infection has been addressed adequately with broad-spectrum antibiotics.

For this reason, attention is drawn to the fact that the issue of fluid and electrolyte balance has been largely ignored. Disorders of electrolytes are one of the commonest derangements encountered in critically ill neonates. They occur in various conditions and may remain unrecognized, leading to morbidity and mortality irrespective of the primary disease6. So, timely recognition, a high index of suspicion, and a thorough understanding of common electrolyte abnormalities are necessary to ensure their correction7. The neonatal kidney has a limited capacity to excrete and conserve sodium8. Hyponatremia is common in newborns in the neonatal intensive care unit. Surveys worldwide suggest that up to one-third of very low birth weight infants are hyponatremic in the first week after birth9.

In neonatal sepsis, inappropriate antidiuretic hormone secretion (SIADH) syndrome is a common problem where severe hyponatremia can occur10. ADH is also released in response to several drugs (such as Barbiturates) and various stressful stimuli such as pain, anxiety, nausea, vomiting 11, 12. Gastrointestinal losses due to vomiting, diarrhoea, nasogastric suction, necrotizing enterocolitis, etc., also cause hyponatremia 13, 14, 15. Sepsis also causes acute tubular necrosis, renal failure, which predisposes to hyponatremia. Excessive use of sodium Bicarbonate, improper preparation of formula feeds, inappropriate I/V fluid, increased insensible water loss, especially in premature neonates kept under radiant warmers, can cause hypernatremia in newborn16. An assessment of body water metabolism and electrolyte balance plays an important role in the early medical management of preterm infants and sick term infants coming to neonatal intensive care unit17. If inappropriate fluid and electrolytes are given to newborns, serious morbidity and mortality can result from fluid and electrolytes imbalance18. Electrolyte abnormalities often mimic the clinical manifestations of various disorders and are very difficult to diagnose. So, routine measurement of serum electrolytes is the best way to monitor the body's electrolyte status and adequacy or excess of electrolyte intake. This is why- this study is carried out to see the frequency and pattern of electrolyte abnormalities in neonates with septicaemia and their impact on mortality and morbidity.

## MATERIALS AND METHODS

**Study design**: Cross-sectional study.

**Place of study**: Department of Neonatology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka, Bangladesh.

**Period of study**: 1st January 2011 to 15th September 2011.

**Sample size**: 120 patients.

**Inclusion criteria:**

- All neonates who were suffering from septicaemia and admitted to the Department of Neonatology, BSMMU, during the study period.
- Definite septicaemia of the newborn was diagnosed by positive blood culture, and probable septicaemia was diagnosed by a scoring system[19] developed by Tollner U and positive CRP.

**Exclusion criteria:**

- Neonates with gross congenital anomalies.
- Any neonate suffers from a disease other than septicaemia such as perinatal asphyxia, meconium aspiration syndrome, transient tachypnea of the newborn, respiratory distress syndrome, etc.

**Operational definitions:**

**Neonatal sepsis**: Neonatal sepsis can be defined in various ways- Neonatal sepsis (also called septicaemia) is defined as a clinical syndrome characterized by signs of systemic infection and documented by positive blood culture in the first four weeks of life[20]. Neonatal sepsis is a clinical syndrome of systemic illness accompanied by bacteremia occurring in the first month of life[13].

**Early-onset neonatal sepsis (EONS)** occurs from birth to 7 days of age[21]. Some authors[13] describe early-onset sepsis presents in the first 5-7 days of life and is usually a multisystem fulminant illness with prominent respiratory symptoms[13].In the present study, EONS is defined as sepsis from birth to 7 days of age.

**Late-onset neonatal sepsis (LONS):** Late-onset sepsis occurs after seven days of age. Some authors describe it may occur as early as five days of age[15]. In the present study, LONS is defined as sepsis that occurs from 8 days to 28 days of age.

**Hyponatremia:** Hyponatremia is defined as serum sodium level below 130 mEq/L [7,22,23,24.]

**Hypernatremia:** Hypernatremia is defined as serum sodium level above 150 mEq/L7,[14,22,25.]

**Hypokalemia:** Hypokalemia is defined as a serum potassium level below 3.5 mEq/L7,[22.]

**Hyperkalemia:** Hyperkalemia is defined as a serum potassium level above 5.5 mEq/L7,[13,22.]

**Mixed dyselectrolytaemia** means the simultaneous presence of two electrolyte abnormalities such as hyponatremia and hypokalemia, hypokalemia, and hypernatremia.

**Study procedure and data collection:** A detailed history was obtained from the mother or other caregiver and recorded in a questionnaire form for each baby. Maternal history included antenatal care, duration of labour, prolonged rupture of the membrane, mode of delivery, place of delivery, maternal illness during pregnancy. The admission weight of the baby was recorded. Gestational age was determined from maternal records and by using the Modified Ballard Scoring System, also recorded when first crying or breathing after birth, apnoea, cyanosis, convulsion, respiratory distress, prelacteal feeding, breastfeeding, reluctance to feed, and bleeding manifestations. Each case was thoroughly examined and followed up. Heart rate, respiratory rate, temperature, color, activity, abnormalities in head, fontanelles, any congenital anomalies, primitive reflexes, level of consciousness, muscle tone were recorded. The venous blood sample was sent from neonates with septicaemia to estimate serum electrolytes (Sodium and Potassium). The researcher's Blood was drawn himself (sometimes by duty doctors) on the admission of patients with septicaemia or during the hospital stay in case of nosocomial infection.

**Other investigations**: Other relevant investigations for the diagnosis and follow-up of the patients included- complete blood count, peripheral blood film, blood culture, CRP, blood urea, serum creatinine, random blood sugar, blood grouping, chest x-ray, serum bilirubin, arterial blood gas analysis.

**Data analysis:** The collected data were analyzed thoroughly by the SPSS program, version- 12. In addition to descriptive statistics such as frequency tabulation, mean and standard deviation, statistical tests such as the chi-square test and t-test were applied accordingly to determine statistically significant differences and or to adjust for pertinent variables as necessary.

## RESULTS

**Table I**: Distribution of baseline characteristics among the neonates with septicaemia (n= 120).

| Baseline characteristics | Mean | ±SD |
|---|---|---|
| **Age (days)** | 9.26 | 4.58 |
| **Weight (gm)** | 2282.68 | 580.4 |
| **Gestation (weeks)** | 35.68 | 2.4 |
| **Sex** | | |
| **Male** | 66 | 55% |
| **female** | 54 | 45% |
| **Septicaemia** | | |
| **Early onset sepsis** | 57 | 47.5 |
| **Late onset sepsis** | 63 | 52.5 |
| **Electrolyte abnormality** | | |
| **Electrolyte abnormality was present** | 42 | 35% |
| **Electrolyte abnormality was absent** | 78 | 65% |

Among the neonates with septicaemia, males were 66 (55%), females were 54 (45%), and the male to female ratio was 1.2:1 (Figure- 2). Among 120 cases of septicaemia, 57 (47.5%) were early-onset, and 63 (52.5%) were diagnosed as late-onset neonatal sepsis (Table- II). Among the 120 neonates with septicaemia, electrolyte abnormality was present in 42 (35%) cases and absent in 78 (65%) cases (Figure- 3). Among the electrolyte abnormalities, hyponatremia was present in 24 (20%) neonates, hypernatremia in 12 (10%), hypokalemia in 17 (14.2%), hyperkalemia in 19 (15.8%), and mixed abnormality in 18 (15%) cases (Figure 1).

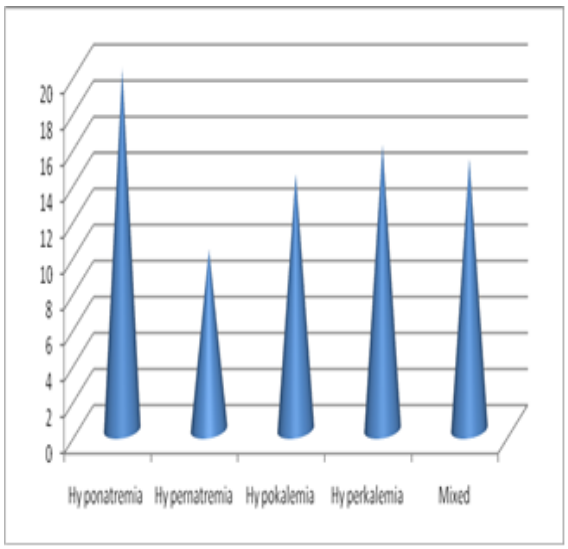


**Figure 1**: Pattern of electrolyte abnormality among the neonates with septicaemia (Multiple responses).

Neonates with dyselectrolytemia were found significantly associated with a prolonged hospital stay compared to those with normal electrolytes levels ($p<0.05$). Hyponatremia, Hypokalemia, Hypernatremia, and mixed electrolyte abnormalities were significantly associated with prolonged hospital stay ($P< 0.05$), but hyperkalemia was not found significantly associated with prolonged hospital stay ($p>0.05$) (Table- II).

**Table II** Relation between electrolyte abnormality and hospital stay

| Type of dyslectrolytemia | | Mean±SD | P value |
|---|---|---|---|
| **Dyselectrolytemia** | Present | 10.86±5.14 | 0.003 |
| | Absent | 8.37±3.74 | |
| **Hyponatremia** | Present | 12.38±4.74 | <0.001 |
| | Absent | 8.46±4.00 | |
| **Hypernatremia** | Present | 11.92±4.96 | 0.02 |
| | Absent | 8.94±4.23 | |
| **Hypokalemia** | Present | 12.71±3.68 | <0.001 |
| | Absent | 8.68±4.29 | |
| **Hyperkalemia** | Present | 9.00±5.01 | 0.79 |
| | Absent | 9.29±4.33 | |
| **Mixed** | Present | 13.56±3.98 | <0.001 |
| | Absent | 8.93±4.37 | |

T-tests were done to find out the p-value.

Among the 120 neonates with septicaemia, 37 (30.83%) died, and 83 (69.17%) survived (Figure- 2).

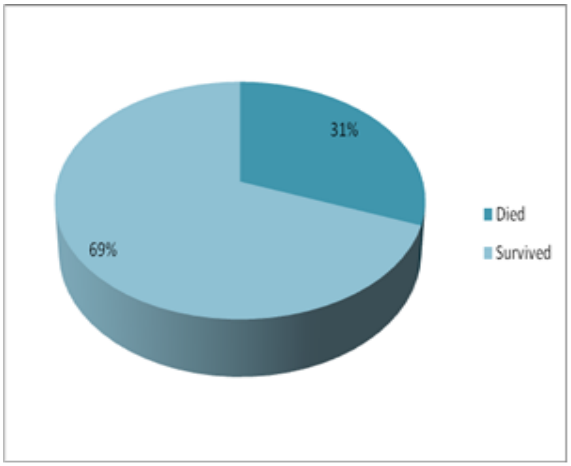


**Figure 2:** Outcome of neonates with septicemia.

Among the neonates with septicemia having electrolyte abnormality, 19 (45.23%) died, and for those who had no electrolyte abnormality, 18 (23.07%) died. A significant relation was found between septicaemic neonates with electrolyte abnormality ($p < 0.05$) (Table-III).

**Table III**: Outcome of septicaemic neonates having electrolyte abnormality.

| | | Survived | Died | P value |
|---|---|---|---|---|
| **Dyselectrolytemia** | Present (n= 42) | 23 (54.76%) | 19 (45.23%) | 0.01 |
| | Absent (n= 78) | 60 (76.92%) | 18 (23.07%) | |

X2 test was done

Hyponatremia, hypokalemia, and mixed electrolyte abnormalities were significantly associated with higher mortality (P<0.05). Hypernatremia and Hyperkalemia were not found significantly associated with higher mortality (P>0.05) (Table-IV).

**Table IV**: Outcome of neonates with septicaemia with different types of electrolyte abnormality.

| Type of dyselectrolytemia | | Survived | Died | P value |
|---|---|---|---|---|
| **Hyponatremia** | Present (n= 24) | 12 (50%) | 12 (50%) | 0.02 |
| | Absent (n= 96) | 71 (74%) | 25 (26%) | |
| **Hypernatremia** | Present (n= 12) | 10 (83.33%) | 2 (16.66%) | 0.21 |
| | Absent (n= 108) | 73 (67.60%) | 35 (32.40%) | |
| **Hypokalemia** | Present (n= 17) | 8 (47%) | 9 (53%) | 0.03 |
| | Absent (n= 103) | 75 (72.80%) | 28 (27.2%) | |
| **Hyperkalemia** | Present (n= 19) | 11 (57.89%) | 8 (42.11%) | 0.16 |
| | Absent (n= 101) | 72 (71.28%) | 29 (28.72%) | |
| **Mixed** | Present (n= 18) | 8 (44.44%) | 10 (55.56%) | 0.01 |
| | Absent (n= 102) | 75 (73.53%) | 27 (26.47%) | |
| **Dyselectrolytemia** | Present (n= 42) | 23 (54.76%) | 19 (45.24%) | 0.01 |
| | Absent (n= 78) | 60 (76.92%) | 18 (23.08%) | |

X2 test was done

## DISCUSSION

In this study, an attempt was made to find out the frequency and pattern of electrolyte abnormalities in neonates with septicaemia and their impact on morbidity and mortality of neonates. Electrolytes abnormality is a common complication in critically ill neonates. In the present study, among the 120 neonates with septicaemia, electrolytes abnormalities were observed in 42 (35%) of neonates, which correlated with the findings of Rao et al. (32.45%)7. But Hossain MM et al.6 observed electrolyte abnormalities in 65.6% of neonates. This difference was probably due to the inclusion of asphyxiated neonates in that study6. Hyponatremia was the commonest electrolyte abnormality found in the present study. It is found in 24 (20%) patients. These findings contrast to those by Hossain MM et al.6 and Rao et al.7, who found hyponatremia in 16.6% and 9.5% cases, respectively. They found that hyponatremia was the second most common electrolyte abnormality. In the present study, hyponatremia was found significantly associated with prolonged hospital stay compared to those with normal sodium levels (p<0.05). A significantly prolonged hospital stay was also observed by Hossain MM et al. 6 in neonates with hyponatremia compared to those with normal sodium levels. Prasad et al.15 and Rao et al.7 also observed the same result. In the present study, hyponatremia was also found significantly associated with higher mortality when compared to those with normal sodium levels (p<0.05). Of the 24 patients with hyponatremia, 12 patients died, and 12 survived. The death rate was 50%. In contrast, among the 96 patients with normal serum sodium levels, 25 patients died, and 71 patients survived. The death rate was 26%. So, the death rate is almost two times more in patients with hyponatremia than those with normal sodium levels. These findings correlate with Rao et al.7. They found that the risk of mortality is increased by 3-3.5 times in patients with hyponatremia compared to those with normal serum sodium levels.7 Hossain MM et al.6 found that the case fatality in hyponatremia is 59.6%. Prasad et al.15 also observed the same result. Hyperkalemia was the second most common electrolyte abnormality observed in the present study. It was found in 19 (15.8%) patients. But Hossain MM et al.6 and Rao et al.7 observed that hyperkalemia was the commonest electrolyte abnormality in their study. They observed hyperkalemia in 34.4%6 and 14.4%7 cases, respectively. Singhi et al17 observed hyperkalemia in 5.4% cases. This difference may be attributed to faulty techniques during blood collection. Some tissue fluid could have been mixed with the collected blood or blood drawn through a tiny needle or sometimes with difficulty by squeezing the tissue may cause haemolysis leading to falsely elevated potassium level. Besides these, some studies defined hyperkalemia as serum potassium level > 5.5 mEq/L7. Some studies defined it as serum potassium level > 6 mEq/L 6,17. In this study, hyperkalemia is defined as a serum potassium level of more than 5.5 mEq/L 7,13, and 22. In the present study, hyperkalemia was not found significantly associated with prolonged hospital stay and higher mortality when compared to those with normal potassium levels (p>0.05). Hossain MM et al.6 also found that case fatality (33.9%) in patients with hyperkalemia was lower than that in patients with normal electrolytes levels. This is in contrast to Brem AS26 and Rao et al.7 where it had been shown that hyperkalemia is associated with higher mortality. This finding may be attributed to spurious hyperkalemia in a patient with normal potassium levels. Their samples were drawn from peripheral veins and sometimes with difficulty by squeezing the tissue in the present study. Hypokalemia was also common in sick neonates with septicaemia. It was found in 17 (14.2%) cases in the present study. In contrast, Singhi et al.17 observed 13.9%, Marudkar et al.27 observed 14.8%, and Hossain MM et al.7 observed 9.3% of cases are hypokalemic in their study. But Rao et al.7 observed lower frequencies in their study. They found 3.6% of cases are hypokalemic. In the present study, hypokalemia was found significantly associated with higher mortality in comparison to those with normal electrolytes levels with similar underlying disease conditions. Among the 17 patients with hypokalemia, 9 patients died, and 8 patients survived. The death rate was 53%. In contrast, among the 103 patients with normal potassium levels, 28 patients died. The death rate is 27.2%. Hossain MM et al.6 also found that the risk of mortality is significantly higher in patients with hypokalemia than those with normal electrolyte values. The case fatality was 75%. Singhi et al.17 and Marudkar et al.27 also observed

similar results. The mortality rate was 15% and 25.6%, respectively. Hypokalemia was also associated with prolonged hospital stay compared to those with normal electrolytes levels. Hossain MM et al.6, Rao et al.7, Singhi et al.17, and Marudkar et al.27 also observed similar results. Hypernatremia was the least common electrolyte abnormality observed in the present study. It is found in 12 (10%) patients. Hossain MM et al.6 observed in their study that 15.2% of cases were hypernatremic, which was the 3rd most common electrolyte abnormality. Rao et al.7 observed hypernatremia in 4.9% of the patient, the 3rd most common electrolyte abnormality. In the present study, hypernatremia was not found significantly associated with higher mortality ($p>0.05$). But Rao et al.7 observed that hypernatremia is significantly associated with higher mortality, and the mortality rate was 33.33% with $P<0.008$. Mandal et al.28 also observed similar results. In the present study, hypernatremia was found significantly associated with a prolonged hospital stay. Hossain MM et al.6, Rao et al.7, and Mandal et al.28 also observed similar results. Mixed electrolytes abnormalities were also commonly found in the present study. It is found in 18 (15%) patients. Rao et al.7 observed 7.9%, and Hossain MM et al.6 observed 9.9% cases were mixed electrolyte abnormalities. The present study observed that mortality rates in patients with mixed electrolyte abnormalities were significantly higher when compared to those with single electrolyte abnormality or normal electrolyte values. Of the 18 patients with mixed electrolyte abnormality, 10 patients died, and 8 survived. The death rate was 55.55%. Hossain MM et al.6 observed that case fatality was 50% in mixed dyselectrolytemia. The present study also observed that the mean duration of hospital stay was also prolonged in patients with mixed dyselectrolytemia compared to those with a single abnormality or normal electrolytes value. Similar observations were also made by Hossain MM et al.6 Rao et al.7 and Prasad et al.15 In the present study, among the 120 neonates with septicaemia, electrolytes abnormalities were observed in 42 (35%) cases. Among the electrolytes abnormalities, hyponatremia was seen in 24 (20%) cases, hypernatremia in 12 (10%), hypokalemia in 17 (14.2%), hyperkalemia in 19 (15.8%), and mixed abnormality in 18 (15%) cases. Of these 42 patients with electrolyte imbalance, 19 (45.23%) expired. Hossain MM et al.6 observed in their study that among the 225 patients with electrolyte imbalance, 105 (46.7%) died.

## CONCLUSION

Electrolyte abnormalities are common in neonates with septicaemia. They contribute significantly to the higher mortality and prolonged hospital stay of neonates irrespective of the primary disease.

## LIMITATIONS AND RECOMMENDATION

Limitations of the study included a small sample size, and the duration of the study was short. It is a single-center study. Timely recognition and appropriate correction of electrolytes abnormalities are important to reduce morbidity and mortality. Most often, the clinical manifestations of electrolytes abnormalities merge with the underlying disease and are very difficult to diagnose clinically in neonates. So, close monitoring, a high index of suspicion, and measurement of serum electrolytes is the best way to monitor the body's electrolytes status.

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**AUTHORS' CONTRIBUTIONS**

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

**COMPETING INTERESTS**

The authors declare no competing interests with this case.

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