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Original Research Article

# Hospital Based Prospective Observational Study Evaluating Electrolyte Abnormalities in Patients with Perinatal Asphyxia

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**Abstract:**

**Aim:** The aim of the study was to assess the electrolyte abnormalities among asphyxiated neonates.

**Background:** In basic term birth asphyxia is delay in establishing spontaneous respiration upon delivery of a new-born. More precisely, birth asphyxia is defined as the presence of hypoxia, hypercapnia, and acidosis leading to systemic disturbances in the new-born probably electrolyte disturbance also. Knowledge of these electrolyte disturbances is very valuable as it can be an important parameter affecting perinatal morbidity, mortality and ongoing management.

**Material & Methods:** This prospective observational study was conducted in NICU, BMIMS, Pawapuri, Nalanda, Bihar, during a study period of one year from May 2022 to April 2023 among asphyxiated neonates admitted at this institute and a total of 100 cases were enrolled in the study. Serum Sodium level has been estimated. Informed consent was obtained from the legal guardians of each participant.

**Results:** The baseline characteristics of the participants in the study revealed that in 72% of instances, the mothers were primipara. Within the neonatal population, a majority of 60% consisted of males, while the remaining 40% were females. A mere 32% of the neonates under study had undergone consistent prenatal check-ups, while 58% had undergone sporadic check-ups, and 10% had not had any antenatal check-ups. Within the cohort of neonates under consideration, it was observed that 68% were delivered via the vaginal canal, while the remaining 32% were born by lower uterine segment cesarean section (LSCS). In 40% of instances, the domicile served as the location of delivery, while 24% of cases occurred at a clinic, and 36% took place at a hospital. Based on the classification of asphyxia, it was shown that 52% of infants exhibited moderate asphyxia, 20% had mild asphyxia, and 28% presented with severe asphyxia. Based on the analysis of blood sodium levels in newborns, it was observed that among the 20 mild instances, 15% exhibited hyponatremia, characterized by serum sodium levels below 130 mmol/l. Similarly, among the moderate asphyxia cases, 73.08% had hyponatremia, while 71.42% of the severe asphyxia cases exhibited the same condition. The sodium levels of the other subjects were within the usual range. Based on the assessment of blood potassium levels in newborns, it was shown that 15% of the 20 mild cases, 3.84% of the 52 intermediate cases, and 7.14% of the 28 severe cases had hypokalemia, characterized by a serum potassium level below 3.5 mmol/l. In contrast, it was observed that none of the 20 cases classified as mild, 9.62% of the 52 cases classified as moderate, and 28.58% of the 28 cases classified as severe had hyperkalemia or a blood potassium level over 6 mmol/l.

**Conclusion:** The research findings indicate that perinatal asphyxia patients frequently experience electrolyte abnormalities. Specifically, infants with perinatal asphyxia exhibit a higher incidence of hyponatremia and hyperkalemia. Additionally, there is a significant correlation between the severity of asphyxia and the observed increases in serum creatinine and blood urea levels.

**Keywords:** Asphyxia, Perinatal, Electrolyte, Hyponatremia, Hyperkalemia, Neonates.



## Introduction

Birth asphyxia, often referred to as perinatal asphyxia, is a significant worldwide health issue and is the leading cause of death among newborns in the early stages of life. Perinatal asphyxia, as defined by the World Health Organization, refers to the inability to start and maintain respiration during the birthing process. Annually, a significant number of neonates, ranging from four to nine million, are diagnosed with birth asphyxia on a global scale. In the context of India, the prevalence of perinatal asphyxia is estimated to be 5%, accounting for around 24.3% of newborn mortality

cases. [1] Perinatal asphyxia, a condition characterized by insufficient oxygen supply to the fetus or newborn during the perinatal period, stands as a prevalent and avoidable factor contributing to brain damage in infants. [2] This condition has been identified as a leading cause of neonatal death and morbidity, particularly in countries grappling with economic disadvantages. Despite notable advancements in monitoring technology, pregnancy awareness, and neonatal illness management, perinatal asphyxia continues to be a prominent contributor to mortality and acquired brain injury among babies on a global scale. In simple terms, birth asphyxia refers to the delay in the initiation of spontaneous breathing after the birth of a baby. [3] Birth asphyxia is specifically characterized by the occurrence of hypoxia, hypercapnia, and acidosis, which afterwards result in systemic disruptions in the neonate. [4]

Birth asphyxia causes 29% of all neonatal deaths worldwide. [5] In India, the incidence of perinatal asphyxia is 5% and constitutes for 24.3% of neonatal deaths. [1] As per AAP (American Academy of Pediatrics) and ACOG (American College of Obstetrics and Gynecology), all the following must be present for designation of asphyxia such as, profound metabolic or mixed acidemia (pH < 7) in cord, Persistence of APGAR scores 0–3 for longer than 5 min, neonatal neurological sequel (eg: seizures, coma, hypotonia) and multiple organ involvement (kidney, lungs, liver, heart, intestine). [6] The factors, such as time taken to first breath, heart rate at 90 s, duration of resuscitation, and Apgar score at 5 min of life, define the outcome of birth asphyxia. [7] The early outcome of birth asphyxia is either neonatal death or presence of hypoxic-ischemic encephalopathy (HIE).

Typically, hypernatremia is anticipated during the initial neonatal phase due to the contraction of extracellular fluid caused by renal water excretion and high insensible water loss. However, neonates with perinatal asphyxia may exhibit hyponatremia due to heightened secretion of anti-diuretic hormone (ADH), resulting in increased water retention and subsequent dilutional hyponatremia. [8] Another aspect that contributes to hyponatremia is the presence of partial resistance to aldosterone. [9] The syndrome of inappropriate antidiuretic hormone secretion (SIADH) is a commonly seen disorder in paediatric populations, resulting in the development of hyponatremia and hypocalcemia. [10] In contrast, hyperkalemia may occur in these newborns as a result of renal insufficiency caused by the ischemic shock. [11] Perinatal hypoxia is a prevalent condition linked to aberrant electrolyte levels in ill newborns, including various solo or combination electrolyte disorders. [12] In newborns, the presence of electrolyte abnormalities often presents with symptoms that overlap with those of underlying hypoxic ischemic encephalopathy (HIE). In these cases, the administration of fluid and electrolytes might contribute to the prolongation of morbidity and death. [11] Organ damage is prevalent in patients who have ischemic insult during newborn hypoxia, in addition to hypoxic-ischemic encephalopathy (HIE). [12] Hence, it is important to possess a comprehensive comprehension of prevalent electrolyte abnormalities in order to effectively rectify them and enhance newborn outcomes.

Hence, the present research was conducted to assess the electrolyte status in neonates who had hypoxia immediately after delivery, with the aim of possibly identifying, managing, and reducing the death rate among this population.

## Material & Methods

This prospective observational study was conducted in the Department of Pediatrics, BMIMS, Pawapuri, Nalanda, Bihar, India during a study period of one year from May 2022 to April 2023 in asphyxiated new-borns admitted at this institute and a total of 100 cases were enrolled in the study. Informed consent was obtained from the legal guardians of each participant, Study participants were selected through purposive sampling following the inclusion and exclusion criteria.

### Inclusion Criteria

Term newborns approriate for gestational age with Birth asphyxia as per WHO Definition –"failure to initiate and sustain breathing at birth" and based on APGAR score <7 at 5 min of life even after receiving resuscitation according to Neonatal Resuscitation Program (NRP) guidelines were included in the study.

**Exclusion Criteria:** Preterm and IUGR babies, neonates with gross congenital anomalies ,suspected metabolic disease, babies born of high-risk mothers like diabetes mellitus, heart disease, mothers on anti – epileptic drugs, etc. were excluded from the study.

### Methodology

This was a hospital based prospective observational study. Consecutive sampling method was used for collection of samples. Apgar score at 1 and 5 min was taken after birth and cases were selected applying inclusion and exclusion criteria. Detailed antenatal, natal and postnatal history and clinical examination was done and findings were recorded on predesigned pro forma after informed assent obtained from parents. Relevant investigation were sent example- Complete Blood Count (CBC), Haematocrit, electrolytes (sodium, potassium, calcium), urea, creatinine, septic screen.

**Electrolyte estimation:** Serum electrolytes (sodium, potassium and calcium) was analyzed using ion selective electrode by automated machine.

**Statistical Analysis:**Descriptive statistics was used for representation of data. The statistical data analysis was done using SPSS version 20. Statistical comparison of mean values of different electrolytes with different severity of perinatal asphyxia was performed by ANOVA test for parametric data and significant data were further analyzed using post hoc test. Bivariate analysis was done to determine the correlation between Apgar score at 5 min and serum electrolytes. Pearson test was used to calculate the correlation coefficient. Box plot was used to show median and quartiles of serum electrolytes with respect to Apgar score at 5 min.

**Results**

**Table 1: Distribution of case group participants based on characteristics**

| Characteristics | N | % |
|---|---|---|
| **Parity** | | |
| Primipara | 72 | 72 |
| Multipara | 28 | 28 |
| **Babies Sex** | | |
| Male | 60 | 60 |
| Female | 40 | 40 |
| **Antenatal check-up** | | |
| Regular | 32 | 32 |
| Irregular | 58 | 58 |
| No ANC | 10 | 10 |
| **Place of delivery** | | |
| Home | 40 | 40 |
| Clinic | 24 | 24 |
| Hospital | 36 | 36 |
| **Mode of delivery** | | |
| Vaginal delivery | 68 | 68 |
| Lower segment caesarean section | 32 | 32 |
| **Neonates in different grading of asphyxia** | | |
| Mild | 20 | 20 |
| Moderate | 52 | 52 |
| Severe | 28 | 28 |

The baseline characteristics of the case participants showed that in 72% of cases, the mother was primipara. Among the neonates, 60% were male, and 40% were female. Only 32% of the case neonates had received regular antenatal check-ups, while 58% had irregular check-ups, and 10% had no antenatal check-up's. Among the case neonates, 68% had a normal vaginal delivery, and 32% had LSCS. The place of delivery was home for 40% of cases, the clinic for 24%, and the hospital for 36%. According to the grading's of asphyxia, 52% of neonates had moderate asphyxia, 20% had mild asphyxia, and 28% had severe asphyxia.

**Table 2: Distribution of case neonates based on grading of asphyxia, and serum sodium level**

| Serum. Sodium level | Grading of asphyxiated baby | | | | | | Total patients (n=100) | |
|---|---|---|---|---|---|---|---|---|
| | Mild (20) | | Moderate (52) | | Severe (28) | | | |
| | N | % | N | % | N | % | N | % |
| **Hyponatremia (<130 mmol/l)** | 3 | 15 | 38 | 73.08 | 20 | 71.42 | 61 | 61 |
| **Normal sodium level (134-146 mmol/l)** | 17 | 85 | 14 | 26.92 | 8 | 28.58 | 39 | 39 |

According to serum sodium levels of the case neonates, 15% of the 20 mild cases, 73.08% of the moderate asphyxia cases, and 71.42% of the severe asphyxia cases had hyponatremia, or serum sodium levels <130 mmol/l. The remaining participants had normal sodium levels.

**Table 3: Distribution of neonates based on grading of asphyxia, and serum potassium level**

| Serum potassium level | Grading of asphyxiated baby | | | | | | Total patients (n=100) | |
|---|---|---|---|---|---|---|---|---|
| | Mild (20) | | Moderate (52) | | Severe (28) | | | |
| | N | % | N | % | N | % | N | % |
| **Hypokalemia (S.K<3.5 mmol/l)** | 3 | 15 | 2 | 3.84 | 2 | 7.14 | 7 | 7 |
| **S.K. Normal (3.5-06 mmol/l)** | 17 | 85 | 45 | 86.54 | 18 | 64.28 | 80 | 80 |
| **Hyperkalemia (S.K>6 mmol/l)** | 0 | 0.0 | 5 | 9.62 | 8 | 28.58 | 13 | 13 |

According to the Serum potassium level of the case neonates, 15% of the 20 mild cases, 3.84% of the 52 moderate cases, and 7.14% of the 28 severe cases had hypokalemia or serum level below 3.5 mmol/l. On the other hand, none of the 20 mild cases, 9.62% of the 52 moderate cases, and 28.58% of the 28 severe cases had Hyperkalemia or serum potassium level above 6 mmol/l.

**Table 4: Distribution of neonates based on comparison of serum sodium and potassium levels between cases, and controls**

| Serum sodium level | Case (100) | | Control (100) | | Total patients (200) | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Hyponatremia (<130 mmol/l) | 62 | 62 | 10 | 10 | 72 | 36 |
| Normal serum sodium (134-146 mmol/l) | 38 | 38 | 90 | 90 | 128 | 64 |
| Total | 100 | 100 | 100 | 100 | 200 | 100.0 |
| **Serum potassium level** | | | | | | |
| | N | % | N | % | N | % |
| Hypokalemia (3.5 mmol/l) | 7 | 7 | 20 | 20 | 27 | 13.5 |
| Normal Potassium (3.5-5.5 mmol/l) | 73 | 73 | 79 | 79 | 152 | 76 |
| Hyperkalemia (S.K>6 mmol/l) | 20 | 20 | 1 | 1 | 21 | 10.5 |
| Total | 100 | 100 | 100 | 100 | 200 | 100.0 |

Comparing both the case, and the control group participants by serum sodium levels, it was observed that 62% of the case participants had hyponatremia, while only 10% of the control group participants had hyponatremia. Comparing the serum potassium levels of both the case and the control group, it was observed that 7% of the case group had hypokalemia, as opposed to the 20% of the case group participants. 73% of the case and 79% of the control group participants had normal serum potassium levels, while 20% of the case group and only 1% of the control group participants had hyperkalemia or serum potassium over 6 mmol/l.

**Table 5: Comparison of blood urea and serum creatinine levels between case and controls**

| Parameter | Case (n=100) | Control (n=100) | P value |
|---|---|---|---|
| **Blood urea** | 64.56±32.48 SD | 38.62±07.03 SD | <0.001 |
| **Serum creatinine** | 1.16±0.70 SD | 0.86±0.24 SD | <0.001 |

The comparison of mean values between the case, and the control group showed that both blood urea, and serum creatinine levels were significantly higher among the case group participants, compared to control group values.

**Table 6: Mean values of serum electrolyte, and creatinine, urea in different grading of asphyxia**

| Serum electrolyte level | Mild asphyxia (mean) | Moderate asphyxia (mean) | Severe asphyxia (mean) | P value |
|---|---|---|---|---|
| **Serum sodium (mmol/l)** | 136.34 | 124.46 | 122.48 | <0.001 |
| **Serum potassium (mmol/l)** | 4.16 | 4.86 | 5.55 | <0.002 |
| **Serum creatinine (mg/dl)** | 0.74 | 1.00 | 1.86 | <0.001 |
| **Blood urea (mg/dl)** | 36.14 | 58.92 | 88.02 | <0.001 |

The mean serum sodium value in mild, moderate, and severe asphyxia was 136.34, 124.46, and 122.48 mmol/l respectively. Mean serum potassium values were 4.16, 4.86, and 5.5 mmol/l respectively. Mean serum creatinine was 0.74, 1.00, and 1.86 mg/dl respectively. Mean blood urea

levels were 36.14, 58.92, and 88.02 mg/dl respectively. A significant difference was observed between the mean values of serum electrolytes and patients' asphyxia grade.

## Discussion

In simple terms, birth asphyxia refers to the delay in the initiation of spontaneous breathing immediately after the birth of a child. [3] Birth asphyxia is specifically described as the occurrence of hypoxia, hypercapnia, and acidosis, which afterwards result in systemic disruptions in the baby. [4] According to the American Academy of Pediatrics (AAP) and the American College of Obstetrics and Gynecology (ACOG), the criteria for diagnosing asphyxia include the presence of profound metabolic or mixed acidemia (pH < 7) in the umbilical cord, the persistence of APGAR scores between 0 and 3 for more than 5 minutes, the occurrence of neonatal neurological sequelae such as seizures, coma, and hypotonia, and the involvement of multiple organs such as the kidneys, lungs, liver, heart, and intestines. [6] The aforementioned issue is a frequently seen phenomenon, with its occurrence ranging from 0.5% to 2% of live births. [13] The reported incidence ranges from 1 to 8 per 1000 live births. [14]

The baseline characteristics of the participants in the study revealed that in 72% of instances, the mothers were primipara, meaning they were giving birth for the first time. These results were also in line with previous studies conducted on neonatal hypoxia. [15,16] In the neonatal population, it was observed that 60% of the individuals were male, while 40% were female infants. These findings align with previous research conducted on the same matter. [17,18] A mere 32% of the neonates under study had undergone consistent prenatal check-ups, whilst 58% had gotten sporadic check-ups, and the other 10% had not had any antenatal check-ups. Within the cohort of neonates under consideration, it was observed that 68% were delivered via the vaginal canal, while the remaining 32% were born by lower uterine segment cesarean section (LUCS). Furthermore, this observation provides support for the concept that a reduced capacity for expansion of the birth canal plays a substantial role in the occurrence of infant hypoxia. The case group in our research exhibited a notable prevalence of vaginal births, a finding that aligns with the results of a comparable study. [19] The location of childbirth was reported as follows: 40% of instances occurred at home, 24% at a clinic, and 36% at a hospital. The aforementioned observation highlights a deficiency in societal knowledge about prenatal check-ups, resulting in a delay in the prompt diagnosis of high-risk pregnancies and subsequently contributing to the occurrence of birth asphyxia. Based on the classification of asphyxia, it is seen that 52% of newborns exhibited moderate asphyxia, while 20% had mild asphyxia, and the remaining 28% suffered from severe asphyxia. Both Gupta et al and Mangi et al observed a comparable proportion of instances with mild and moderate asphyxia. [17,18]

According to serum sodium levels of the case neonates, 15% of the 20 mild cases, 73.08% of the moderate asphyxia cases, and 71.42% of the severe asphyxia cases had hyponatremia, or serum sodium levels <130 mmol/l. The remaining participants had normal sodium levels. In the current investigation, hyponatremia was the most common electrolyte anomaly, which was consistent with the findings of Roy et al. [20] Hypernatremia is most common in extremely preterm infants due to high transepidermal water loss, which may be exacerbated by excessive sodium administration. According to the Serum potassium level of the case neonates, 15% of the 20 mild cases, 3.84% of the 52 moderate cases, and 7.14% of the 28 severe cases had hypokalemia or serum level below 3.5 mmol/l. On the other hand, none of the 20 mild cases, 9.62% of the 52 moderate cases, and 28.58% of the 28 severe cases had Hyperkalemia or serum potassium level above 6 mmol/l. Hyperkalemia is a more common and potentially fatal consequence of acute renal failure. Hyperkalemia was seen in 16.1% of moderate hypoxemic individuals and 35.3% of severely hypoxemic patients. This pattern of hyperkalemia among moderate and severe case group members matched earlier research findings. [20,21]

Comparing both the case, and the control group participants by serum sodium levels, it was observed that 62% of the case participants had hyponatremia, while only 10% of the control group participants had hyponatremia. Comparing the serum potassium levels of both the case and the control group, it was observed that 7% of the case group had hypokalemia, as opposed to the 20% of the case group participants. 73% of the case and 79% of the control group participants had normal serum potassium levels, while 20% of the case group and only 1% of the control group participants had hyperkalemia or serum potassium over 6 mmol/l. The comparison of mean values between the case, and the control group showed that both blood urea, and serum creatinine levels were significantly higher among the case group participants, compared to control group values. The mean serum sodium value in mild, moderate, and severe asphyxia was 136.34, 124.46, and 122.48 mmol/l respectively. Mean serum potassium values were 4.16, 4.86, and 5.5 mmol/l respectively. Mean serum creatinine was 0.74, 1.00, and 1.86 mg/dl respectively. Mean blood urea levels were 36.14, 58.92, and 88.02 mg/dl respectively. A significant difference was observed between the mean values of serum electrolytes and patients' asphyxia grade.

Basu et al [22] found increased severity of hyponatremia, hyperkalemia and hypocalcaemia with increased severity of birth asphyxia. The pattern of hyponatremia and hyperkalemia was similar to our study. Similarly in case control study by Jajoo et al [23], Rai et al [24] and Schedewie et al [25], showed that asphyxiated newborns had lower serum calcium level compared to their controls.

The treatment of hyponatremia in such condition is by fluid restriction rather increasing sodium load for reasons mentioned in background section. So fluid should be restricted in cases of birth asphyxia till normalization of serum sodium with close monitoring of weight and serum sodium. Serum potassium and Electrocardiography (ECG) monitoring should be done to avoid the deadly complications of hyperkalemia. Apart from other treatment measures, correction of acidosis and use of potassium free fluid are the most useful measures to correct hyperkalemia.

## Conclusion

The findings of the study indicate that perinatal asphyxia patients frequently experience electrolyte abnormalities. Specifically, infants with perinatal asphyxia exhibit a higher incidence of hyponatremia and hyperkalemia. Additionally, significant elevations in serum creatinine and blood urea levels were observed, with the severity of asphyxia being directly proportional to these changes.

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