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ELECTROLYTES DERANGEMENTS IN FIRST WEEK OF LIFE IN NEONATES ADMITTED WITH BIRTH ASPHYXIA

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Abstract

Background: Birth asphyxia is a major cause of neonatal morbidity and mortality and is frequently associated with electrolyte disturbances resulting from hypoxic injury and multiorgan dysfunction.
Objective: To determine the frequency of electrolyte derangements during the first week of life in neonates admitted with birth asphyxia and to evaluate their association with clinical outcomes.
Methodology: This descriptive cross-sectional study was conducted in the Department of Pediatrics, Lady Reading Hospital, Peshawar, from March 2025 to August 2025. A total of 175 full-term neonates with birth asphyxia were enrolled using consecutive non-probability sampling. Demographic, clinical, and laboratory data were collected during the first week of life. Serum sodium, potassium, calcium, and magnesium levels were measured using standard laboratory techniques. Data were analyzed using IBM SPSS version 26.
Results: Among the 175 neonates, 110 (62.9%) were male and 65 (37.1%) were female. Hyponatremia was observed in 146 (83.4%) neonates, hypokalemia in 119 (68.0%), hypocalcemia in 169 (96.6%), and abnormal magnesium levels in 29 (16.6%). Calcium status showed a significant association with survival status ($p=0.002$) and clinical course ($p=0.014$), while magnesium status was significantly associated with clinical course ($p=0.010$). No significant associations were observed between sodium or potassium levels and survival or clinical course ($p>0.05$).
Conclusion: Electrolyte derangements were highly prevalent during the first week of life in neonates with birth asphyxia. Hypocalcemia, hyponatremia, and hypokalemia were the most common abnormalities.

Keywords: Birth asphyxia; Neonates; Electrolyte derangements; Hyponatremia; Hypocalcemia; Neonatal outcome.

Introduction

Birth asphyxia (also referred to as perinatal hypoxia-ischemia) is a severe medical event that occurs in a newborn infant resulting from lack of oxygen and blood supply in the crucial perinatal period [1]. This shortage of oxygen and blood supply often takes place around the time that a baby is being delivered, making birth asphyxia a common occurrence [2,3]. This disorder is one of the main causes of morbidity and mortality among newborns and severely affects the neurodevelopment of survivors.Therefore, it poses a daunting challenge to the world's health and poses a significant threat to the world's population [4]. Although immediate medical attention is crucial for resuscitation of hypoxic newborns, the longer term consequences of such an environment are poorly understood [5,6]. This can have long term consequences for the health and wellbeing of these vulnerable newborns [7]. Several conditions can cause this syndrome such as umbilical cord compression, placenta insufficiency, prolonged labor or other complications in the delivery process [8]. Even with the advances in obstetrics and neonatal care, birth asphyxia remains a major public health challenge, especially in low-resource countries where access to more modern medical procedures is limited [9]. It's the leading contributing factor for long-term neurological damage to survivors and contributes to a large proportion of the global burden of newborn deaths. Two recently developed therapies, which have been shown to reduce immediate effects of birth asphyxia and to improve the chances of infant survival, are infant resuscitation and therapeutic hypothermia [10]. There is no doubt these efforts have saved a lot of lives. But not limited to the peri-natal period, the long term consequences of birth asphyxia may be detrimental to a newborn infant's health and development. One important aspect that has been gaining interest in the previous few years is the long-term metabolic consequences of birth asphyxia [11]. Although newborns have a chance of surviving the first damage caused by hypoxia, they still have a chance of experiencing electrolytes derangements that may have long-term implications on their health [12]. Disturbances in glucose control, acid-base balance, electrolyte homeostasis, and oxidative stress responses are all examples of metabolic disorders that may be caused by these mutations13. The exact mechanisms responsible for these metabolic changes and how they lead to the outcomes of neonates are still not known [13]. A few studies have been related to infant mortality in the first week of delivery due to birth asphyxia. Especially in low and middle income countries. Birth asphyxia is associated with metabolic acidosis, hypoglycemia and kidney abnormalities in the newborn. Low blood sugar can last for the first several days and can be a problem in caring for the person. Prevention is indicated by term babies who are at high risk of birth hypoxia. Hypoglycemia and metabolic acidosis have to be diagnosed and treated promptly to prevent birth asphyxia problem and irreversible damage [14].

Objectives

The main aim of this study is to remove the birth asphyxia neonates admitted in the first week of life with electrolyte derangements.

Methodology

This Descriptive Study was carried out in Department of Pediatrics, Lady Reading Hospital, Peshawar between March 2025 and August 2025. The sample size was determined by OpenEpi Sample Size Calculation. The reported frequency of neonatal asphyxia with hypomagnesemia was assumed as 13% and the level of confidence was 95% along with 5% margin of error. The number of neonates calculated was 174. A consecutive non-probability sampling technique was used to recruit eligible neonates. Neonates were included in the study who were admitted in the first week of life with the diagnosis of birth asphyxia. Congenital metabolic disorders, genetic syndromes, and congenital cardiac, liver, kidney, lung, brain and musculoskeletal anomalies were excluded. The final analysis excluded neonates with incomplete clinical and/or laboratory data.

Data Collection

The study was started upon approval from the institutional ethical review committee. After obtaining informed consent from the parents/legal guardian, eligible neonates admitted to the Department of Pediatrics, Lady Reading Hospital, Peshawar were enrolled. A structured data collection form was used to collect data. Demographic and perinatal data consisted of age at birth, gender, birth weight, gestational age and mode of delivery. The clinical information taken included neonatal resuscitation, severity and clinical course of birth asphyxia, treatment received, and clinical outcome during the first week of life. Blood samples from the veins were obtained in an aseptic manner in the first week of life. Serum sodium (Na), potassium (K), calcium (Ca) and magnesium (Mg) levels were determined by the standard hospital laboratory techniques. Electrolyte derangements were determined by the reference ranges used in the institution's laboratory. Medical records were also accessed where appropriate to get relevant clinical and laboratory information for the patients.

Data Analysis

The data were entered and analyzed by using IBM SPSS Statistics version 26.0. The categorical data such as gender, mode of delivery, electrolyte disturbances, resuscitation, and clinical outcomes were expressed in frequency and percentage. All continuous variables were checked for normality and are presented as mean and SD for those that are normally distributed and median and IQR for those that are not. Associations between categorical variables such as the relationship between electrolyte derangements and clinical outcomes were assessed using the chi-square test. When the expected frequencies in the cells were <5, Fisher's exact test was used. The statistical significance was set at a p value of < 0.05.

Results

Demographic and perinatal characteristics of 175 neonates with birth asphyxia are shown in Table 1. The majority of the participants were male (110; 62.9%), and female (65; 37.1%). A large majority, 162 (92.6%), had a birth weight below 2500 g, whereas 13 (7.4%) weighed between 2500 and 2999 g. Most neonates, 173 (98.9%), had a gestational age below 37 weeks, and only 2 (1.1%) were between 37 and 38 weeks. In 167 cases (95.4%) vaginal delivery was achieved, in 8 cases (4.6%) caesarean section was performed.

Table 1. Demographic and perinatal characteristics of neonates with birth asphyxia (n=175)

Characteristics	**n (%)**
Gender	
Male	110 (62.9)
Female	65 (37.1)
Birth weight	
<2500 g	162 (92.6)
2500–2999 g	13 (7.4)
3000–3499 g	0 (0.0)
≥3500 g	0 (0.0)
Gestational age	
<37 weeks	173 (98.9)
37–38 weeks	2 (1.1)
39–40 weeks	0 (0.0)
>40 weeks	0 (0.0)
Mode of delivery	
Vaginal delivery	167 (95.4)
Caesarean delivery	8 (4.6)
Neonatal resuscitation	
Yes	13 (7.4)
No	162 (92.6)

Among the 175 neonates, 87 (49.7%) remained clinically stable, while 88 (50.3%) required intensive care. No neonate was recorded as having developed complications under the separate complication category. Overall, 64 (36.6%) neonates survived, whereas 111 (63.4%) died. Most neonates, 141 (80.6%), remained hospitalized for seven days or less, while 34 (19.4%) had a hospital stay of 8–14 days. None remained hospitalized for more than 14 days (Table 2).

Table 2. Clinical course and outcomes of neonates with birth asphyxia (n=175)

Clinical characteristic	n (%)
Clinical course	
Stable	87 (49.7)
Required intensive care	88 (50.3)
Developed complications	0 (0.0)
Survival status	
Survived	64 (36.6)
Deceased	111 (63.4)
Duration of hospital stay	
≤7 days	141 (80.6)
8–14 days	34 (19.4)
>14 days	0 (0.0)

Hyponatremia, defined as a serum sodium level below 135 mEq/L, was present in 146 (83.4%) neonates, while 29 (16.6%) had normal sodium levels. Hypokalemia was observed in 119 (68.0%) neonates, 48 (27.4%) had normal potassium levels, and 8 (4.6%) had hyperkalemia.

Table 3. Distribution of electrolyte levels during the first week of life (n=175)

Electrolyte level	**n (%)**
Serum sodium	

<135 mEq/L	146 (83.4)
135–145 mEq/L	29 (16.6)
>145 mEq/L	0 (0.0)
Serum potassium	
<3.5 mEq/L	119 (68.0)
3.5–5.0 mEq/L	48 (27.4)
>5.0 mEq/L	8 (4.6)
Serum calcium	
<8 mg/dL	169 (96.6)
8–10 mg/dL	6 (3.4)
>10 mg/dL	0 (0.0)
Serum magnesium	
Code 0—not defined	26 (14.9)
Low	146 (83.4)
Normal	3 (1.7)
High	0 (0.0)

Hypokalemia was more frequent among deceased neonates than survivors, occurring in 82 (73.9%) and 37 (57.8%), respectively. However, the association between potassium level and survival was not statistically significant (p=0.090). Low magnesium levels were present in 54 (84.4%) survivors and 92 (82.9%) deceased neonates, with no significant association with survival status (p=0.411). In contrast, serum calcium level was significantly associated with survival (p=0.002).

Table 4. Association of electrolyte levels with survival status (n=175)

Electrolyte level	Survived, n (%)	Deceased, n (%)	p-value
Serum potassium			
<3.5 mEq/L	37 (57.8)	82 (73.9)	0.090
3.5–5.0 mEq/L	23 (35.9)	25 (22.5)	
>5.0 mEq/L	4 (6.3)	4 (3.6)	
Serum magnesium			
High	10 (15.6)	16 (14.4)	0.411
Low	54 (84.4)	92 (82.9)	
Normal	0 (0.0)	3 (2.7)	
Serum calcium			
<8 mg/dL	58 (90.6)	111 (100.0)	0.002*
8–10 mg/dL	6 (9.4)	0 (0.0)	

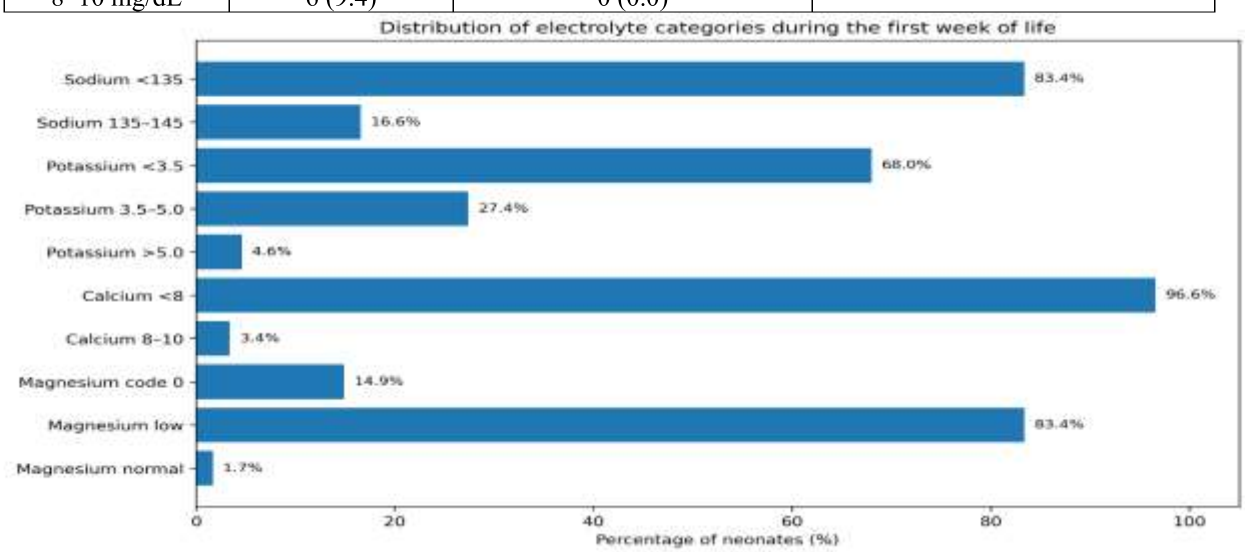

Figure 1: Distribution of electrolyte categories during the first week of life among neonates admitted with birth asphyxia (n=175).

Hyponatremia was observed in 71 (81.6%) stable neonates and 75 (85.2%) neonates requiring intensive care, with no significant association (p=0.520). Hypokalemia was more frequent among neonates requiring intensive care than stable neonates, occurring in 65 (73.9%) and 54 (62.1%), respectively, although this difference was not statistically significant (p=0.152). Magnesium level was significantly associated with clinical course (p=0.010), with low magnesium levels recorded in 66 (75.9%) stable neonates and 80 (90.9%) neonates requiring intensive care.

Table 5. Association of electrolyte levels with clinical course (n=175)

Electrolyte level	Stable, n (%)	Required intensive care, n (%)	p-value
Serum sodium			
<135 mEq/L	71 (81.6)	75 (85.2)	0.520
135–145 mEq/L	16 (18.4)	13 (14.8)	
Serum potassium			
<3.5 mEq/L	54 (62.1)	65 (73.9)	0.152
3.5–5.0 mEq/L	27 (31.0)	21 (23.9)	
>5.0 mEq/L	6 (6.9)	2 (2.3)	
Serum magnesium			
Code 0—not defined	20 (23.0)	6 (6.8)	0.010*
Low	66 (75.9)	80 (90.9)	
Normal	1 (1.1)	2 (2.3)	
Serum calcium			
<8 mg/dL	81 (93.1)	88 (100.0)	0.014*
8–10 mg/dL	6 (6.9)	0 (0.0)	

Among clinically stable neonates, 50 (57.5%) survived and 37 (42.5%) died. In contrast, only 14 (15.9%) neonates requiring intensive care survived, while 74 (84.1%) died. This association was statistically significant (p<0.001). Survival was also significantly associated with hospital stay (p<0.001). Among neonates hospitalized for seven days or less, 61 (43.3%) survived and 80 (56.7%) died, whereas only 3 (8.8%) of those hospitalized for 8–14 days survived and 31 (91.2%) died.

Table 6. Association of survival status with clinical course and duration of hospital stay (n=175)

Variable	Survived, n (%)	Deceased, n (%)	p-value
Clinical course			
Stable	50 (57.5)	37 (42.5)	<0.001*
Required intensive care	14 (15.9)	74 (84.1)	
Hospital stay			
≤7 days	61 (43.3)	80 (56.7)	<0.001*
8–14 days	3 (8.8)	31 (91.2)	

Data are presented as n (%). *Statistically significant at p<0.05.

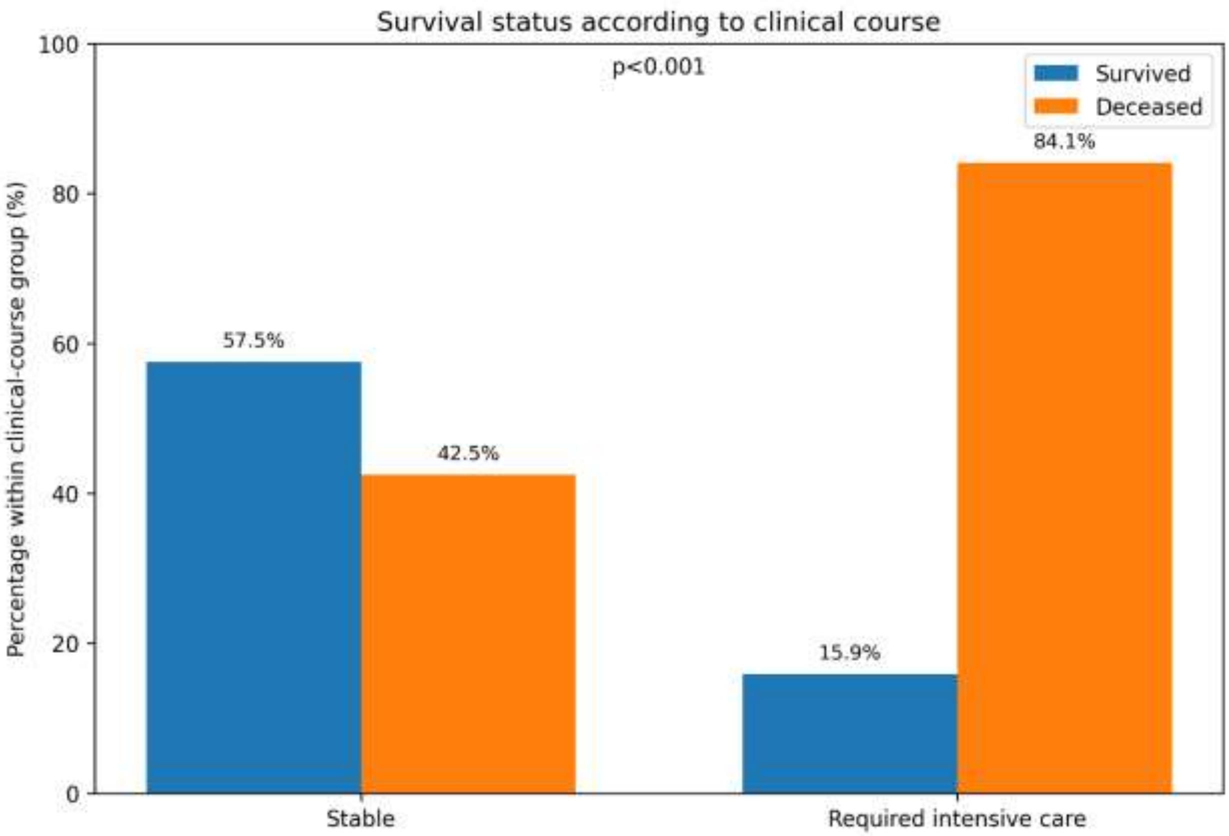

Figure 2: Survival status according to clinical course among neonates with birth asphyxia (n=175).

Discussion

In the present study, electrolyte derangements were noted in neonates with birth asphyxia who were admitted to the hospital during the first week of life and were of high burden. Sixty-eight percent had hypokalemia, 83.4% had hyponatremia, and 96.6% had hypocalcemia, with 4.6% experiencing hyperkalemia. These results suggest that sodium, potassium, calcium and magnesium imbalance is prevalent after hypoxic injury and routine electrolyte monitoring is important for affected neonates. As noted previously, the incidence of hyponatremia seen in the present study was similar to that reported in other studies of neonates who had suffered perinatal asphyxia. Previous studies have also shown that there is a correlation between the severity of birth asphyxia and hypoxic-ischaemic encephalopathy (HIE) and the degree of hyponatremia. Following birth asphyxia, hyponatremia can be caused by renal hypoperfusion, inability to excrete free water, acute kidney injury, and inappropriate secretion of antidiuretic hormone. Lowering the sodium concentration may also present additional risk of cerebral oedema and neurological impairment, and therefore fluid and sodium replacement should be done individually [15].

68.0% of neonates had hypokalemia which was defined as having a potassium level below 5.0 mEq/L, while 4.6% had blood potassium levels greater than 5.0 mEq/L. Previous studies have reported hyperkalemia as a more typical disturbance after severe asphyxia, but other studies reported mean levels within the normal range of potassium, but higher levels in the asphyxiated neonates than in controls. Variations in the results of the different studies may be partly explained by the different timing of blood sampling, the level of hypoxic injury, renal function, the fluid therapy administered, feeding status and treatment before the electrolyte measurements were made. In the current study, potassium was not significantly linked to the survival (p=0.090), clinical course (p=0.152), or hospital stay (p=0.860).

Hypocalcemia occurred in the highest number of animals, 96.6% of the study population. Previous studies also showed that the serum calcium level drops early following birth asphyxia, and that lower calcium levels are correlated with worsening hypoxic-ischaemic injury. Impaired calcium regulation, increased tissue-destructive phosphate load, renal dysfunction, decreased calcium intake and altered parathyroid hormone response may be involved in hypocalcemia in asphyxiated neonates [16,17]. The clinical significance of severe hypocalcemia is that it can be a cause for seizures, myocardial dysfunction, hypotension, and cardiac rhythm abnormalities [18].

The calcium status was significantly associated with the survival outcome in the present study (p=0.002). It was also significantly associated with clinical course (p=0.014) suggesting calcium disturbances may be an indicator of the severity of the systemic hypoxic injury. Similarly, previous studies have found lower calcium levels in more severely affected neonates (those with more severe HIE) and in non-survivors [19]. The direction of the association in the current data set, however, should be taken with caution as all six neonates with 8-10 mg/dL calcium survived. On the other hand, all neonates that were classified as deceased were noted in the calcium level below 8 mg/dL category. The size of these associations might have been inflated by the sparse cell frequencies. However, Magnesium status was significantly related to clinical course (p=0.010), but not to the survival status (p=0.411) or duration of hospitalization (p=0.113). A series of previous studies has shown that serum magnesium levels were significantly lower in asphyxiated than in healthy neonates and that it is associated with the degree of hypoxic injury [20]. Magnesium plays an important role in energy metabolism, stability of neuromusculature, in membrane function, and in the regulation of calcium. Disturbance of this can, therefore, worsen neurological symptoms and make it difficult to correct any associated hypocalcemia. However, the findings related to magnesium should be interpreted with caution because there was no clear coding scheme to identify the unknown "Other" category in the SPSS dataset [21].
The overall mortality rate in this study was 63.4% and 50.3% of neonates needed intensive care. The clinical course was significantly associated with survival (p<0.001), with the mortality rate significantly higher in the neonates who required intensive care than in those who were clinically stable (22). This is not surprising, as neonates with the need for intensive care services would be more severely hypoxic injured, and would have multiorgan dysfunction, seizures, respiratory failure, and/or haemodynamic instability. Recent studies have also revealed that electrolyte disturbances can be associated with poor early outcomes in term neonates with birth asphyxia, and that the non-survivors may have lower levels of sodium and calcium and higher levels of potassium. Additionally, hospital stay (p<0.001) was significantly associated with survival status. The mortality rates for neonates hospitalized for 7 days or less and 8-14 days were 56.7% and 91.2%, respectively. This could mean that the longer the hospital stays were due to more severe disease, ongoing complications or more gradual clinical improvement [23]. But length of stay is dependent on survival time as well as discharge practices, and therefore should not be used as an independent measure of prognosis unless the severity of the disease and the time of death are taken into consideration.

Limitations

There were several limitations in this study. Firstly, it was done in one tertiary care hospital thus may not be generalizable to other health care settings. Second, measurements of electrolytes were made only in the first week of life, and serial long-term follow-up to assess long-term electrolyte abnormalities or effects on neurodevelopmental outcome was not conducted. Third, other factors that could have confounded the results, like the severity of hypoxic-ischemic encephalopathy, therapeutic interventions, fluid management, renal function, and maternal characteristics, were not fully evaluated. Third, some variables had sparse categories and inconsistencies in coding, resulting in less consistency in multivariable regression analysis and less precision in the adjusted estimates. Multicenter prospective studies with standardized assessment of electrolytes and long-term follow-up are recommended to further clarify the prognostic role of electrolyte alterations in neonates with birth asphyxia.

Conclusion

Electrolyte derangements are very common in neonates admitted for birth asphyxia and hypocalcemia, hyponatremia, and hypokalemia are the most common electrolyte abnormalities. Calcium status was significantly associated with both survival and clinical course and the same applied to magnesium status and clinical course. However, no significant association was found between sodium and potassium abnormalities and clinical outcomes. The results in this study underline the need for routine electrolyte monitoring and early correction of electrolyte abnormalities as an integral part of the management of neonates with B.A. Electrolyte disturbances are frequently encountered and could be better managed if they are identified early and managed accordingly in this vulnerable population, which may help improve the clinical outcomes and lower the risk of complications.

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