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NEONATAL BLOOD GASES AND OUTCOMES FOLLOWING PERINATAL ASPHYXIA

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Abstract

Background: *Perinatal asphyxia presents a significant challenge in neonatology, contributing to high morbidity and mortality rates among neonates. Arterial blood gas (ABG) analysis is vital for assessing the condition, providing insights into oxygenation, ventilation, and acid-base balance.*

Objective: *This study aimed to analyze ABG parameters in neonates diagnosed with perinatal asphyxia, evaluate their clinical outcomes, and investigate the relationship between ABG findings and neonatal health outcomes.*

Methodology: *A cross-sectional descriptive study was conducted at the Nursery Unit of Bacha Khan Medical Complex, Swabi, Pakistan, from April 21, 2023, to October 21, 2023. The study included 163 neonates diagnosed with perinatal asphyxia. Demographic, clinical, and ABG data were collected using a structured proforma, and data analysis was performed using SPSS version 27.*

Results: *Among the study population, 54.6% were female. The mean gestational age was 37.56 weeks, and the average birth weight was 2.967 kg. The mean APGAR scores at 1 minute and 5 minutes were 4.09 and 6.33, respectively. ABG analysis revealed a mean pH of 7.106, PO2 of 123.64 mmHg, PCO2 of 39.15 mmHg, and HCO3 of 11.84. Hypoxic-ischemic encephalopathy (HIE) was diagnosed in 76.7% of cases, with 62% experiencing neurological sequelae. A significant correlation was found between HIE and neonatal outcomes ($p = 0.03$).*

Conclusion: *The study underscores the importance of ABG parameters in evaluating neonates with perinatal asphyxia and their association with clinical outcomes. Understanding the relationship between ABG findings and neonatal health can guide targeted interventions, ultimately improving patient care in neonatology.*

Keywords: *Arterial blood gas, Nenatal outcomes, Perinatal asphyxia*

INTRODUCTION

Neonatal asphyxia poses a significant challenge in neonatology, profoundly affecting neonatal survival and long-term health outcomes (1). Asphyxia neonatorum occurs when a newborn fails to initiate and maintain respiration at birth, leading to impaired gas exchange. If left untreated, this condition can result in escalating hypoxia, increased carbon dioxide levels, and metabolic acidosis. Early detection and timely intervention are crucial for enhancing neonatal outcomes and preventing long-term complications (2, 3).

Arterial blood gas (ABG) analysis plays a pivotal role in managing neonates with birth asphyxia. ABG measurements provide essential information regarding the neonate's oxygenation, ventilation, and acid-base status (4). Timely interpretation of these parameters facilitates targeted interventions that can significantly enhance clinical outcomes. Abnormal ABG values are consistently linked to poorer neonatal outcomes, particularly in cases of hypoxic-ischemic encephalopathy (HIE) (5).

Numerous studies have underscored the importance of ABG abnormalities in predicting neonatal outcomes following perinatal asphyxia. Research conducted in Nepal (6) and India (7) demonstrates that neonates experiencing moderate to severe birth asphyxia frequently develop varying degrees of HIE, with more pronounced metabolic acidosis and lower pH levels correlating with higher mortality rates. Furthermore, studies indicate that abnormal umbilical cord blood pH (<7.2) and electrolyte imbalances, such as hyponatremia and elevated creatinine levels, serve as predictors of adverse outcomes, including increased mortality and the progression of HIE (8, 9).

For instance, neonates presenting with severe base deficits or low pH levels are at an elevated risk for poor outcomes, including death and significant neurological impairment. Research from Bangladesh, the United States, and the West Indies highlights the global burden of perinatal asphyxia and its substantial contribution to neonatal morbidity and mortality (10-12).

While these studies provide valuable insights into the relationship between ABG abnormalities and neonatal outcomes, there remains a gap in thoroughly investigating the predictive value of ABG findings in determining the clinical outcomes in neonates with perinatal asphyxia. The present study aims to address this gap by analyzing ABG parameters in neonates diagnosed with perinatal asphyxia and exploring their correlation with clinical outcomes.

MATERIALS AND METHODS

STUDY DESIGN

This study utilized a descriptive cross-sectional design to evaluate the clinical and laboratory parameters of neonates diagnosed with perinatal asphyxia.

STUDY SETTING AND DURATION

The research was conducted at the Neonatal Unit of Bacha Khan Medical Complex, Swabi, Pakistan, from April 21, 2023, to October 21, 2023.

SAMPLE SIZE

The sample size was calculated using the WHO sample size calculation formula via the OpenEpi website. Based on a total population of 1,000,000 and an anticipated survival frequency of 88% in neonates with perinatal asphyxia, the required sample size was determined to be 163 neonates.

INCLUSION AND EXCLUSION CRITERIA

Neonates diagnosed with perinatal asphyxia were included based on clinical assessment and arterial blood gas (ABG) analysis. Neonates admitted to the neonatal unit during the study period were also included. Exclusion criteria comprised neonates with congenital anomalies affecting respiratory function, those with metabolic or genetic disorders unrelated to perinatal asphyxia, and neonates with incomplete clinical or ABG data.

DATA COLLECTION

Data were collected using a structured proforma designed to capture demographic, clinical, and ABG parameters. ABG measurements were performed within the first 6 hours of life to ensure timely assessment of the neonate's respiratory and metabolic status. Clinical outcomes, including recovery, morbidity, and mortality, were assessed during hospitalization and at discharge.

STATISTICAL ANALYSIS

Data analysis was performed using SPSS version 27. Descriptive statistics were employed to summarize demographic characteristics and ABG values. The correlation between ABG parameters and clinical outcomes was evaluated using chi-square tests for categorical variables and Pearson's correlation coefficients for continuous variables. A p-value of < 0.05 was considered statistically significant, indicating a meaningful relationship between the assessed variables.

RESULTS

Among the 163 neonates included in this study, 89 (54.6%) were female and 74 (45.4%) were male. The majority of the neonates, 114 (69.9%), were delivered via normal vaginal delivery, while 26 (16%) were born by cesarean section, and 23 (14.1%) underwent assisted delivery. At birth, 126 neonates (77.3%) presented with low APGAR scores, whereas 37 (22.7%) had satisfactory APGAR scores.

Descriptive statistics indicated that the gestational age of the neonates ranged from 34 to 39 weeks (mean: 37.56 ± 1.083 weeks), and their birth weights varied between 2.0 and 4.0 kg (mean: 2.967 ± 0.54 kg). The APGAR scores averaged 4.09 ± 1.609 at 1 minute and improved to 6.33 ± 1.512 at 5 minutes.

Arterial blood gas (ABG) analysis yielded the following average values: the mean pH was 7.106 ± 0.15, mean PO_2 was 123.643 ± 83.84 mmHg, mean PCO_2 was 39.148 ± 17.3 mmHg, and mean HCO_3^- was 11.842 ± 2.970. In terms of clinical signs, cyanosis was observed in 62.6% of neonates, hypotonicity in 22.7%, and respiratory distress in 55.8%, indicating the clinical complexity faced by these patients, as summarized in Table I.

Table I. Descriptive statistics of neonatal parameters

Parameter	Minimum	Maximum	Mean	Std. Deviation
Gestational age (weeks)	34	39	37.56	1.083
Birth weight (Kg)	2.0	4.0	2.967	.5492
APGAR score at 1 minute (/10)	0	7	4.09	1.609
APGAR score at 5 minutes (/10)	4	10	6.33	1.512
pH	6.85	7.29	7.1066	.15465
PO2	26.0	306.0	123.643	83.8437
PCO2	14.0	78.5	39.148	17.3749
HCO3	6.5	18.0	11.842	2.9704

Out of the 163 neonates, a considerable proportion experienced complications, with 76.7% diagnosed with hypoxic-ischemic encephalopathy (HIE) and 61.3% suffering from seizures. Additional complications included impaired renal function (14.7%), respiratory distress (7.4%), and hypocalcemia (7.4%). Ultimately, 62% of the neonates exhibited neurological sequelae, while 23.3% recovered and were discharged, and 14.7% did not survive during the study period.

The Chi-Square test demonstrated a significant association between neonatal outcomes and the presence of HIE, with a p-value of 0.03, underscoring the critical impact of HIE on clinical outcomes. Furthermore, Pearson's correlation analysis revealed a weak positive relationship between HCO_3^- levels and APGAR scores, with a correlation coefficient of 0.102, indicating a minimal association between acid-base balance and immediate neonatal health (Table II).

Table II. Pearson's Correlation analysis among APGAR scores and artificial blood gas parameters

Correlations		APGAR score at 5 minutes (/10)	pH	PO2	PCO2
APGAR score at 5 minutes (/10)	Pearson Correlation	1	.045	-.079	.089
	Sig. (2-tailed)		.564	.313	.257
pH	Pearson Correlation	.045	1	.463**	-.716**
	Sig. (2-tailed)	.564		.000	.000
PO2	Pearson Correlation	-.079	.463**	1	-.679**
	Sig. (2-tailed)	.313	.000		.000
PCO2	Pearson Correlation	.089	-.716**	-.679**	1
	Sig. (2-tailed)	.257	.000	.000	
HCO3	Pearson Correlation	.102	.602**	.027	-.047
	Sig. (2-tailed)	.197	.000	.731	.548

Likewise, the link between PH and APGAR scores is 0.05, suggesting a weak positive association. The correlation coefficient for APGAR Score and PO_2 is -0.0, alluding to a weak negative correlation with a significance level of 0.313. Meanwhile, the correlation coefficient for APGAR Score and PCO_2 is 0.089, indicating a weak positive association, with a significance level of 0.257, indicating no statistical significance (Table II).

DISCUSSION

Perinatal asphyxia is a critical condition characterized by insufficient oxygen supply to the fetus during the perinatal period, leading to significant morbidity and mortality in neonates. The immediate assessment of a newborn's condition is commonly evaluated using the APGAR scoring system, which measures heart rate, breathing effort, muscle tone, reflex response, and skin color. Low APGAR scores at 1 and 5 minutes after birth are associated with an increased risk of complications, including hypoxic-ischemic encephalopathy (HIE) and neurological impairments (13).

In our study, the mean APGAR score at 1 minute was 4.09 ± 1.61, which improved to 6.33 ± 1.51 by the 5-minute mark. This finding contrasts with the research conducted by Ghimire et al., which reported that only 56 (2.3%) of 2,423 neonates had an APGAR score of less than 7 at 5 minutes. The discrepancy suggests a higher incidence of low APGAR scores in our cohort, potentially attributable to variations in study populations, methodologies, or healthcare settings (14).

Our analysis revealed that 125 neonates (76.7%) were diagnosed with hypoxic-ischemic encephalopathy (HIE), and 100 (61.3%) experienced seizures. Additionally, 24 neonates (14.7%) developed impaired renal function, while 12 (7.4%) exhibited respiratory distress and another 12 (7.4%) had hypocalcemia. These findings align with those of Shah *et al.*, 2021 (15), who noted that among neonates with severe asphyxia (APGAR scores of 1–3), 20% were diagnosed with HIE, while 80% of those with moderate asphyxia (APGAR scores of 4–6) showed similar trends. Their study also highlighted that 30% of neonates with HIE exhibited neurological impairments, such as diminished reflexes, lethargy, convulsions, and abnormal pupil responses.

In our cohort of 163 neonates, neurological sequelae resulting from HIE emerged as the most common outcome, affecting 101 neonates (62%). In contrast, 38 neonates (23.3%) recovered and were discharged, while 24 (14.7%) unfortunately did not survive. These outcomes are consistent with findings from a comparative study in which 72 (9.7%) out of 740 live births presented with perinatal asphyxia, resulting in a case fatality rate of 20%.

Our study underscores the critical importance of early identification and management of perinatal asphyxia, particularly the association between abnormal APGAR scores and subsequent neurological sequelae such as HIE. The results highlight the necessity for continuous monitoring of neonates impacted by perinatal asphyxia and prompt intervention to prevent or mitigate adverse outcomes, including seizures, respiratory distress, and renal impairment.

The high incidence of neurological complications, particularly seizures and HIE, observed in our study is consistent with previous research and emphasizes the long-term risks faced by neonates with severe birth asphyxia (16). Given that HIE remains a significant contributor to morbidity and mortality in this population, early therapeutic interventions and intensive care are crucial for improving clinical outcomes and reducing the risk of permanent neurological damage. This reinforces the need for healthcare providers to prioritize the early detection and management of at-risk neonates to enhance survival and long-term health prospects.

CONCLUSION

In conclusion, this study highlights the critical role of arterial blood gas (ABG) analysis in the management of neonates with perinatal asphyxia. Our findings demonstrate significant correlations between ABG parameters and clinical outcomes, especially in relation to hypoxic-ischemic encephalopathy (HIE). Although the study found weak associations with APGAR scores, it emphasizes the necessity for early and targeted interventions, along with comprehensive assessments, to optimize neonatal care. The study also suggests the potential for improving prognostic tools to predict better outcomes in neonates suffering from perinatal asphyxia. Further research, particularly multi-center studies with larger sample sizes, is needed to confirm these findings and refine the understanding of the relationship between ABG values and long-term outcomes in neonatal asphyxia.

Conflict of Interest:

The authors have no conflict of interest.

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