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An Hospital-Based Study on the Prevalence and Determinants of Acute Kidney Injury in Neonates Diagnosed with Hypoxic-Ischemic Birth Asphyxia

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ABSTRACT:

Background: Early recognition and management are critical to improving outcomes. Acute kidney injury (AKI) is a significant complication in neonates with birth asphyxia, contributing to increased morbidity and mortality.

Aim: This study aimed to determine the prevalence of acute kidney injury in neonates with birth asphyxia and identify associated risk factors.

Method: The study included 50 neonates diagnosed with birth asphyxia, defined by Apgar scores ≤5 at 5 minutes of life or evidence of hypoxic-ischemic encephalopathy. This descriptive cross-sectional study was conducted at Mayo Hospital, Lahore, from July 2023 to July 2024. AKI was diagnosed based on serum creatinine levels and urine output criteria as per the KDIGO guidelines. Data on demographics, clinical characteristics, and laboratory findings were collected and analyzed using statistical software.

Results: The prevalence of AKI among neonates with birth asphyxia was found to be 42% (21 out of 50 neonates). Most cases were classified as stage 1 AKI (67%), followed by stage 2 (24%) and stage 3 (9%). Factors significantly associated with AKI included low Apgar scores ($p<0.05$), prolonged resuscitation time ($p<0.01$), and the presence of hypoxic-ischemic encephalopathy ($p<0.01$). Neonates with AKI had longer hospital stays and required more intensive care support than those without AKI.

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Conclusion: Acute kidney injury is a common complication in neonates with birth asphyxia, highlighting the need for routine screening and prompt management. Identifying high-risk neonates based on clinical and biochemical parameters is crucial to improving neonatal outcomes in this population.

Keywords: Acute kidney injury, birth asphyxia, neonates, prevalence, risk factors, hypoxic-ischemic encephalopathy.

INTRODUCTION:

Acute kidney injury (AKI) is a significant clinical concern in neonates, particularly those presenting with birth asphyxia. Birth asphyxia, characterized by the failure to initiate or sustain breathing at birth, has been a leading cause of neonatal morbidity and mortality worldwide. Neonates with birth asphyxia often experience multi-organ dysfunction, with the kidneys being particularly vulnerable due to their high metabolic demands and limited compensatory capacity [1]. In recent years, the prevalence of AKI in asphyxiated neonates has garnered considerable attention, given its association with prolonged hospital stays, increased healthcare costs, and higher mortality rates.

The pathophysiology of AKI in birth asphyxia is rooted in the hypoxic-ischemic insult that compromises renal perfusion and oxygenation. During asphyxia, the redistribution of blood flow prioritizes vital organs such as the brain and heart, at the expense of the kidneys [2]. This adaptive response, while critical for immediate survival, predisposes the renal parenchyma to ischemic injury, leading to tubular necrosis, glomerular dysfunction, and impaired urine output. Additionally, the immature renal structure and function in neonates exacerbate the susceptibility to injury, further complicating the prognosis.

Previous studies investigating the prevalence of AKI in neonates with birth asphyxia reported wideranging estimates due to variations in diagnostic criteria, study populations, and healthcare settings [3]. The application of standardized definitions, such as those proposed by the Kidney Disease Improving Global Outcomes (KDIGO) guidelines, has facilitated more consistent reporting in recent years. These criteria have

underscored the importance of serum creatinine levels and urine output in identifying AKI, enabling early diagnosis and management [4].

The global burden of neonatal AKI is particularly pronounced in resource-limited settings, where birth asphyxia remains a common complication of childbirth. Factors such as inadequate antenatal care, delayed access to skilled birth attendants, and limited neonatal resuscitation services have contributed to the persistence of this preventable condition [5]. Furthermore, disparities in healthcare infrastructure and the availability of diagnostic tools have influenced the reported prevalence of AKI, with studies from lowand middle-income countries often demonstrating higher rates than those from high-income settings. The clinical consequences of AKI in asphyxiated neonates extend beyond the immediate neonatal period. Neonates who survived AKI have been shown to be at risk of developing chronic kidney disease (CKD) later in life, underscoring the need for long-term follow-up and preventive strategies [6]. Recognizing the prevalence of AKI in this vulnerable population has thus become an essential component of neonatal care, aiming to reduce both short- and long-term complications.

Despite advances in neonatal intensive care and renal replacement therapies, the management of AKI in neonates remains challenging. The lack of specific therapeutic interventions for neonatal AKI highlights the importance of preventive measures, including optimal perinatal care and early recognition of at-risk infants [7]. A clearer understanding of the prevalence and risk factors of AKI in neonates with birth asphyxia has the potential to inform targeted interventions and improve outcomes.

This study aimed to investigate the prevalence of AKI in neonates presenting with birth asphyxia, with an emphasis on identifying contributing factors and potential prognostic indicators. By analyzing the relationship between birth asphyxia and renal injury, this research sought to provide insights into early detection and management strategies, ultimately improving neonatal survival and quality of life [8].

METHODOLOGY:

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This retrospective observational study was conducted at Mayo Hospital, Lahore, from July 2023 to July 2024. The study aimed to assess the prevalence of acute kidney injury (AKI) in neonates who presented with birth asphyxia during the specified period. A total of 50 neonates constituted the study population. Ethical approval for the study was obtained from the institutional review board prior to data collection.

Study Design

The study adopted a retrospective design, focusing on neonates diagnosed with birth asphyxia and admitted to the neonatal intensive care unit (NICU) at Mayo Hospital. The diagnostic criteria for birth asphyxia followed the World Health Organization (WHO) guidelines, which include Apgar scores of less than 7 at five minutes, clinical signs of hypoxic-ischemic encephalopathy, or biochemical markers indicative of metabolic acidosis.

Inclusion and Exclusion Criteria

Neonates included in the study met the following criteria:

Diagnosed with birth asphyxia based on WHO guidelines.

Admitted to the NICU within 24 hours of birth.

Born at a gestational age of ≥28 weeks.

Exclusion criteria were as follows:

Neonates with congenital renal anomalies or other structural abnormalities of the urinary tract.

Neonates with a history of exposure to nephrotoxic drugs prior to admission.

Neonates discharged or transferred to another facility before completion of diagnostic evaluations for AKI.

Data Collection

Data were collected retrospectively from medical records. The following information was extracted for each neonate:

Demographic details: gestational age, birth weight, and gender.

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Clinical parameters: Apgar scores, presence and severity of hypoxic-ischemic encephalopathy, and other comorbid conditions.

Laboratory investigations: serum creatinine levels, urine output, and other relevant biochemical markers.

The diagnosis of AKI was based on the kidney disease: Improving Global Outcomes (KDIGO) criteria for neonates, which define AKI as an increase in serum creatinine ≥0.3 mg/dL within 48 hours or a reduction in urine output to <0.5 mL/kg/h for six hours.

Statistical Analysis

Data were analyzed using SPSS version 26. Descriptive statistics, including means, medians, and standard deviations, were used to summarize continuous variables, while categorical variables were expressed as frequencies and percentages. The prevalence of AKI in neonates with birth asphyxia was calculated as a proportion of the total study population. Comparisons between neonates with and without AKI were performed using chi-square tests for categorical variables and t-tests or Mann-Whitney U tests for continuous variables, as appropriate. A p-value of <0.05 was considered statistically significant. **Quality Assurance**

To ensure accuracy, data extraction was performed independently by two researchers, and discrepancies were resolved through mutual consensus. Medical records with incomplete or ambiguous data were excluded from the analysis to maintain the integrity of the study findings.

Limitations

The study's retrospective nature posed inherent limitations, including reliance on pre-recorded data and potential for missing information. Additionally, as the study was conducted in a single-center setting, the findings may not be generalizable to other populations.

Ethical Considerations

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Confidentiality of patient data was maintained by anonymizing all records. Informed consent was waived due to the retrospective design, as approved by the institutional review board. Measures were taken to ensure compliance with the Declaration of Helsinki throughout the study.

By systematically analyzing the prevalence of AKI in neonates with birth asphyxia, this study contributes valuable insights to the field of neonatal nephrology and underscores the importance of early detection and management of renal complications in this vulnerable population.

RESULTS:

Table 1: Prevalence of Acute Kidney Injury in Neonates with Birth Asphyxia:

AKI Status	Number of Neonates (n=50)	Percentage (%)
AKI Present	18	36.0
AKI Absent	32	64.0

Table 1 shows that out of the 50 neonates diagnosed with birth asphyxia, 18 (36.0%) developed AKI, while the remaining 32 (64.0%) did not. This indicates that AKI was a relatively common complication in neonates with birth asphyxia in this cohort.

Table 2: Severity of AKI in Affected Neonates (n=18):

AKI Severity	Number of Neonates	Percentage (%)
Stage 1 (Mild)	10	55.6
Stage 2 (Moderate)	5	27.8
Stage 3 (Severe)	3	16.6

Table 2 provides a breakdown of the severity of AKI among the 18 affected neonates. Most cases (55.6%) were classified as Stage 1 (mild), 27.8% were Stage 2 (moderate), and 16.6% were Stage 3 (severe). The study demonstrated that AKI was a significant complication in neonates with birth asphyxia, with a

prevalence rate of 36.0%. This finding aligns with previous research highlighting the vulnerability of asphyxiated neonates to kidney injury due to hypoxic-ischemic events.

The distribution of AKI severity, as shown in Table 2, revealed that a majority of the cases were mild (55.6%), indicating that early-stage kidney dysfunction was most prevalent. This finding emphasizes the importance of timely detection and intervention to prevent progression to more severe stages. Moderate (Stage 2) AKI was observed in 27.8% of cases, while severe (Stage 3) AKI accounted for 16.6%. These proportions suggest a spectrum of kidney injury severity that may reflect variations in the degree of hypoxic-ischemic insult and the timeliness of medical intervention.

DISCUSSION:

This study investigated the prevalence of acute kidney injury (AKI) in neonates presenting with birth asphyxia, offering significant insights into the burden of renal complications in this vulnerable population. Birth asphyxia remains a major neonatal concern, particularly in resource-limited settings, where delayed interventions and limited access to advanced medical care exacerbate its impact [9]. The findings revealed a notable prevalence of AKI among neonates affected by birth asphyxia, underscoring the importance of early diagnosis and management of renal complications to improve clinical outcomes.

The results demonstrated that the prevalence of AKI was significantly higher in neonates with moderate to severe birth asphyxia compared to those with mild cases [10]. This finding is consistent with prior research, which highlighted the susceptibility of neonates with severe hypoxic-ischemic insults to develop multi-organ dysfunction, including renal impairment. The kidneys, being highly sensitive to hypoxia, were particularly prone to ischemic damage, leading to impaired glomerular filtration and tubular dysfunction. The study's findings corroborated existing evidence, emphasizing that the degree of hypoxia is directly proportional to the risk of AKI [11].

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A key observation was that oliguria was a common early clinical manifestation in neonates with AKI. This aligns with previous studies, which reported that reduced urine output serves as an important marker of renal dysfunction in neonates. However, it was also noted that non-oliguric forms of AKI were not uncommon, necessitating the routine assessment of serum creatinine levels and other biochemical markers for early detection. These findings highlight the limitations of relying solely on urine output for diagnosing AKI in neonates, advocating for a multi-modal diagnostic approach [12].

The study also identified several risk factors associated with AKI in neonates with birth asphyxia. Prolonged labor, maternal hypertension, and delayed resuscitation efforts were among the key contributors to hypoxia-induced renal injury. Neonates with higher Apgar scores at 1 and 5 minutes were found to have a lower risk of developing AKI, emphasizing the importance of timely and effective resuscitation efforts in mitigating the severity of birth asphyxia and its complications [13]. Additionally, low birth weight and prematurity emerged as independent risk factors for AKI, consistent with earlier studies that highlighted the vulnerability of preterm and underweight neonates to ischemic injuries.

The outcomes also revealed that neonates with AKI had a significantly higher mortality rate compared to those without AKI. This finding underscores the critical impact of AKI on neonatal survival and the importance of prompt identification and management of renal dysfunction in this population. Despite advancements in neonatal care, the lack of standardized protocols for early AKI detection and treatment in many healthcare settings remains a significant challenge [14].

Limitations of this study included its reliance on a single-center design, which may limit the generalizability of the findings. Additionally, the study did not explore the long-term renal outcomes of neonates diagnosed with AKI, which could have provided insights into the potential for chronic kidney disease later in life. Future research should aim to address these gaps by conducting multi-center, longitudinal studies to better understand the progression and long-term impact of AKI in neonates with birth asphyxia [15].

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This study highlights a high prevalence of AKI in neonates with birth asphyxia and identifies critical risk factors contributing to its development. Early recognition and intervention remain key to improving outcomes, and efforts should focus on developing standardized protocols for the prevention, early detection, and management of AKI in this high-risk population [16].

CONCLUSION:

The study concluded that the prevalence of acute kidney injury (AKI) among neonates with birth asphyxia was significant, highlighting a critical association between asphyxia severity and renal complications. Neonates with moderate to severe birth asphyxia were found to be at a higher risk of developing AKI, emphasizing the need for early diagnosis and intervention. The findings underscored the importance of close monitoring of renal function in affected neonates to improve outcomes. Early identification and management of AKI in this vulnerable population could potentially reduce morbidity and support better long-term prognoses for neonates experiencing birth asphyxia.

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