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ORIGINAL ARTICLE

Common electrolyte imbalance in neonates presenting with acute kidney injury in NICU.

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ABSTRACT… Objective: To determine common electrolyte imbalance among neonates admitting in neonatal intensive care unit (NICU) with acute kidney injury (AKI). **Study Design:** Cross-sectional study. **Setting:** The NICU of National Institute of Child Health (NICH), Karachi, Pakistan. **Period:** 13th August 2024 to 30th January 2024. **Methods:** A total of 196 neonates of either gender and admitted in NICU with AKI were evaluated. At the time of enrollment, demographical and clinical information were noted. Neonate's blood was drawn upon their admission in NICU for laboratory investigation in which their electrolyte profile was investigated. Data was analyzed using IBM-SPSS Statistics, version 26.0. For all inferential statistics, $p<0.05$ was noted. **Results:** In a total of 196 neonates, 104 (53.1%) were boys and 92 (46.9%) girls. The mean age, and birth weight were 7.24 ± 6.08 days, and 2.35 ± 0.56 kg, respectively. Prematurity was noted in 69 (35.2%) cases. Sepsis, and respiratory distress were identified 108 (55.1%), and 80 (40.8%) neonates, respectively. Socio-economic status was low among 180 (91.8%) cases. Acute kidney stage was 1, 2, and 3 among 118 (60.2%), 37 (18.9%), and 41 (20.9%) neonates, respectively. Electrolyte imbalance was noted among 123 (62.8%) neonates. The most frequent electrolyte imbalance was dysnatremia, and dyskalemia, noted in 94(47.9%), and 37 (18.9%) neonates, respectively. Electrolyte imbalance was significantly associated with prematurity (49.6% vs. 11.0%, $p<0.001$), and higher stages of AKI ($p=0.012$). **Conclusion:** This study highlighted a high prevalence of electrolyte imbalances, particularly sodium and potassium disturbances, among neonates with AKI admitted to the NICU.

Key words: Acute Kidney Injury, Dyskalemia, Dysnatremia, Electrolyte Imbalance, Neonatal Intensive Care Unit.

INTRODUCTION

A reduction in glomerular filtration rate (GFR), which is conventionally measured by an increase in serum creatinine, is generally referred to as acute kidney injury (AKI). AKI is considered a frequent finding in neonatal intensive care units (NICUs).[1,2] The literature revelas the prevalence of AKI among neonates admitted in NICUs ranging from 18-70%.[3-6] It is crucial to identify newborns who may develop AKI in order to improve outcomes in these neonates.[4]

Neonates with AKI may experience electrolyte abnormalities, which need to be treated timely. These conditions can further result in major consequences as bone demineralization, muscle atrophy, vascular calcification, and even mortality.[7,8] National report in the UK claimed that if patients had improved electrolyte monitoring, awareness of risk factors, and quick therapy, one-fifth of the in-hospital AKI may have been prevented.[9] Previous research has shown a connection between certain electrolyte problems, such as hypernatremia, hyperchloremia, and hypomagnesemia, and AKI[10,11], however, most the studies have looked at how a single electrolyte, such as hyponatremia or hypomagnesemia, affected kidney damage. Instead of concentrating on a single electrolyte, the researchers should ideally focus on several electrolytes.

No such research on electrolyte imbalance in neonates admitted in NICU with AKI is on record from Pakistan. Clinicians can benefit from knowing how frequently newborns experience electrolyte imbalance because they can change

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the current practices to better care for their patients. This study was designed to determine common electrolyte imbalance among neonates admitting in NICU with AKI.

METHODS

This cross-sectional study was conducted at the NICU of National Institute of Child Health (NICH), Karachi, from 13th August 2024 to 30th January 2024. The study was commenced after obtaining approval from the Institutional Ethical Review Board (letter number: IERB-25/2024, dated: 12th August 2024). A sample size of 196 was calculated taking the proportion of electrolyte imbalance in AKI as 49.5%[12], with 95% confidence level and 7% margin of error. The inclusion criteria were neonates of either gender and admitted in NICU with AKI. Neonates with chromosomal abnormalities, congenital heart diseases, malformations incompatible with life, or those with major kidney malformations were excluded. Parents/guardians of neonates unwilling to be part of this study were also excluded. Non-probability consecutive sampling technique was adopted. Informed and written consents were obtained from parents/guardians of all neonates enrolled for this study.

At the time of enrollment, demographics, and clinical characteristics of neonates were documented. Low birth weight was labeled as weight below 2.5 kg. Prematurity was defined as birth before 37th week of gestation. AKI was defined and staged based on "Kidney Disease: Improving Global Outcomes (KDIGO)" criteria.[13] Patients' blood was drawn upon their admission in NICU for laboratory investigation in which their electrolyte profile was investigated. Electrolyte imbalance was defined as any of these: sodium <135 or >145 mEq/L, potassium <3.5 or >5.5mEq/L, magnesium <1.5 to > 2.5 mg/dL, or chloride <96 or >106 mEq/L. A special proforma was designed to record all study data.

Data analysis was performed using IBM-SPSS Statistics, version 26.0. Numerical variables were presented as mean ± standard deviation (SD). Frequency and percentages were shown for categorical data. Comparison of categorical data with respect to the frequency of electrolyte abnormalities was done employing chi-square test. Independent sample t-test was used for the comparison of numeric data. For all inferential statistics, $p<0.05$ was considered statistically significant.

RESULTS

In a total of 196 neonates, 104 (53.1%) were boys and 92 (46.9%) girls. The mean age, and birth weight were 7.24±6.08 days, and 2.35±0.56 kg, respectively. Prematurity was noted in 69 (35.2%) cases. Sepsis, and respiratory distress were identified 108 (55.1%), and 80 (40.8%) neonates, respectively. Socio-economic status was low among 180 (91.8%) cases. Acute kidney stage was 1, 2, and 3 among 118 (60.2%), 37 (18.9%), and 41 (20.9%) neonates, respectively. Table-I is showing characteristics of neonates studied.

Characteristics		Frequency (%)
Gender	Boys	104 (53.1%)
	Girls	92 (46.9%)
Age groups (years)	≤7	139 (70.9%)
	>7	57 (29.1%)
Low birth weight (kg)	Yes	103 (52.6%)
	No	93 (47.4%)
Prematurity	Yes	69 (35.2%)
	No	127 (64.8%)
Co-existing conditions	Sepsis	108 (55.1%)
	Respiratory distress syndrome	80 (40.8%)
Socio-economic status	Low	180 (91.8%)
	Middle	16 (8.2%)
Acute kidney injury stages	1	118 (60.2%)
	2	37 (18.9%)
	3	41 (20.9%)

Table-I. Characteristics of neonates (n=196)

Electrolyte imbalance was noted among 123 (62.8%) neonates. The most frequent electrolyte imbalances were dysnatraemia, and dyskalemia, noted in 94(47.9%), and 37 (18.9%) neonates, respectively. The frequency of various electrolyte parameters is shown in Figure-1.

Electrolyte imbalance was significantly associated with prematurity (49.6% vs. 11.0%, $p<0.001$), and higher stages of AKI ($p=0.012$). Table-II is showing association of the frequency of electrolyte imbalance with the characteristics of neonates.

Characteristics		Electrolyte Imbalance		P-Value
		Yes (n=123)	No (n=73)	
Gender	Boys	59 (48.0%)	45 (61.6%)	0.064
	Girls	64 (52.0%)	28 (38.4%0	
Age groups (years)	≤7	91 (74.0%)	48 (65.8%)	0.220
	>7	32 (26.0%)	25 (34.2%)	
Low birth weight (kg)		66 (53.7%)	37 (50.7%)	0.687
Prematurity		61 (49.6%)	8 (11.0%)	<0.001
Co-existing conditions	Sepsis	56 (45.5%)	32 (43.8%)	0.818
	Respiratory distress syndrome	71 (57.7%)	45 (61.6%)	0.589
Socio-economic status	Low	111 (90.2%)	69 (94.5%)	0.290
	Middle	12 (9.8%)	4 (5.5%)	
Acute kidney injury stages	1	65 (52.8%)	53 (72.6%)	0.012
	2	25 (20.3%)	12 (16.4%)	
	3	33 (26.8%)	8 (11.0%)	

Table-II. Association of the frequency of electrolyte imbalance with respect to characteristics of neonates (N=196)

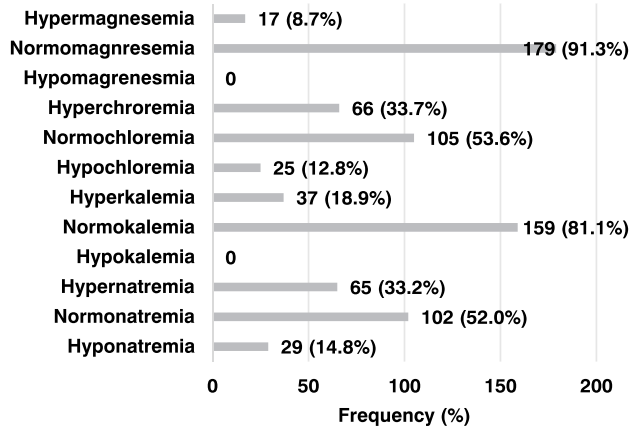

Figure-1. Frequency distribution of electrolyte levels (N=196)

DISCUSSION

The present study aimed to identify the prevalence of electrolyte imbalances in neonates admitted to the NICU with AKI, revealing a significant electrolyte disturbance rate of 62.8%. Sodium disturbances were the most frequent electrolyte abnormalities (47.9%), followed by potassium (18.9%), chloride (12.8%), and magnesium (4.1%) imbalances. This distribution highlights the prominence of dysnatremia and dyskalemia as critical electrolyte disturbances in neonatal AKI. In systematic review by Erfurt et al., the correlation between sodium disturbances and AKI prognosis was emphasized, noting hypernatremia as independently predictive of in-hospital mortality, albeit without association with AKI onset.[14] Our study also found a significant occurrence of dysnatremia. In a retrospective cohort of ICU patients by Lee et al.[15], hyponatremia was shown to predict both AKI onset and in-hospital mortality, aligning with our findings that hyponatremia was the most frequent electrolyte disturbance, implicating a possible prognostic role of sodium levels in neonatal AKI as well. Gao et al.[16], further supported this, identifying both hypo- and hypernatremia as predictors of mortality in adult ICU patients with AKI, albeit without an indication for dialysis. Potassium imbalances were the second most common electrolyte disturbance in our cohort (18.9%). Hyperkalemia, a critical concern in AKI due to its potential for life-threatening arrhythmias, has been documented as a common complication in AKI across various age groups. The study by Lombardi et al.[17], indicated that serum potassium variability and hyperkalemia were associated with AKI onset in adults, a finding resonant with our data where potassium disturbance appeared notably prevalent among neonates with advanced AKI stages. This raises the possibility that potassium disturbances may have a predictive role in AKI progression in neonates, warranting continuous monitoring for early intervention. However, unlike adults, neonates may have varied potassium physiology influenced by rapid cellular turnover and different fluid management practices, adding complexity to potassium management in this population.

Chloride imbalance, noted in 12.8% of our cohort, underscores another dimension of neonatal AKI pathophysiology. While specific literature on chloride's impact in neonatal AKI is limited, adult studies have identified dyschloremia as a risk factor for poor outcomes in critical illness.[18] Our study's findings contribute to an emerging understanding that chloride, an often-overlooked electrolyte, might have relevance in neonatal AKI outcomes. Further studies could clarify whether chloride serves merely as an indicator of acid-base status or if it actively contributes to AKI pathophysiology. Magnesium disturbance was comparatively infrequent in our study (4.1%). This aligns with Chintala et al.[19], who observed a 69% prevalence of hypomagnesemia in AKI patients on day one, which gradually decreased over the following days and was linked to non-recovery of renal function. Although magnesium disturbances were less prominent in our findings, neonatal AKI studies may benefit from future attention to magnesium's role, especially considering its potential impact on long-term renal recovery. Magnesium is essential for cellular stability and enzymatic activity, and hypomagnesemia in neonates could aggravate the fragile electrolyte balance, possibly influencing recovery trajectories, as seen in adult and pediatric populations.[20]

Electrolyte imbalances in the context of prematurity, which was significantly associated with higher electrolyte disturbances in our study, have been noted by Basalely et al.[21], who reported that dysnatremia in neonates could predict mortality without being associated with AKI onset. Our findings corroborate this, as prematurity-related electrolyte imbalances may contribute to heightened mortality risk, albeit the relationship with AKI onset remains unclear. This could indicate that prematurity itself may predispose neonates to electrolyte imbalances due to underdeveloped renal and physiological maturity, warranting special attention in this vulnerable subgroup.[22] The relationship between electrolyte imbalance and AKI severity was evident, with higher stages of AKI being significantly associated with a greater frequency of electrolyte disturbances ($p=0.012$). This association aligns with the findings from Chen et al.[23], where a retrospective study on hospitalized patients demonstrated that higher electrolyte variability correlated with severe AKI and associated mortality risk. This suggests that electrolyte disturbances may not only reflect but exacerbate AKI severity in neonates, further complicating the clinical course. Chen et al.[23], study also emphasized the predictive utility of electrolyte disturbances for severe AKI, suggesting that interventions targeting electrolyte stabilization may play a role in mitigating AKI progression.

The diagnostic criteria used in our study, based on KDIGO, were crucial for standardizing AKI classification and enhancing the comparability of our findings with other studies like those of Kumar et al.[10], and Chintala et al.[19] The use of standardized AKI criteria remains essential for establishing consistent associations between electrolyte disturbances and AKI progression. Nevertheless, pediatric-specific modifications in KDIGO criteria might further refine AKI diagnosis in neonates, considering their unique physiological profiles. Our study's design as a cross-sectional analysis allowed us to capture the prevalence of electrolyte imbalances upon admission, offering a snapshot of neonates' biochemical status in AKI. However, a limitation lies in the inability to track electrolyte variability over time. Longitudinal monitoring would enable the identification of trends in electrolyte fluctuations and their impact on AKI outcomes, presenting a potential area for future research. This could be particularly useful for understanding transient versus persistent disturbances and their respective clinical implications in neonates.

The limitations of this study included the lacke of a control group of neonates without AKI for comparison. Socioeconomic factors and resource constraints at the NICU may also have influenced the generalizability of the findings. The reliance on single-timepoint electrolyte measurements could miss transient abnormalities or fluctuations relevant to AKI progression and recovery.

CONCLUSION

This study highlighted a high prevalence of electrolyte imbalances, particularly sodium and

potassium disturbances, among neonates with AKI admitted to the NICU. Early identification and management of electrolyte disturbances in neonatal AKI could play a crucial role in improving outcomes, especially in resource-limited settings. Future longitudinal studies are recommended to better understand the dynamic role of electrolyte changes in AKI progression and recovery among neonates.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Coleman C, Tambay Perez A, Selewski DT, Steflik HJ. **Neonatal acute kidney injury.** Front Pediatr. 2022; 10:842544. doi: 10.3389/fped.2022.842544

2. Gul R, Anwar Z, Sheikh M, Salamat A, Iqbal S, Saleem F, et al. **Neonatal AKI profile using KDIGO guidelines: A cohort study in tertiary care hospital ICU of Lahore, Pakistan.** Front Pediatr. 2022; 10:1040077. doi: 10.3389/fped.2022.1040077

3. Jetton JG, Boohaker LJ, Sethi SK, Wazir S, Rohatgi S, Soranno DE, et al. **Incidence and outcomes of neonatal acute kidney injury (AWAKEN): A multicentre, multinational, observational cohort study.** Lancet Child Adolesc Health. 2017; 1(3):184-94. doi: 10.1016/S2352-4642(17)30069-X

4. Sethi SK, Agrawal G, Wazir S, Rohatgi S, Iyengar A, Chakraborty R, et al. **Neonatal acute kidney injury: A survey of perceptions and management strategies amongst pediatricians and neonatologists.** Front Pediatr. 2020; 7:553. doi: 10.3389/fped.2019.00553

5. Kirkley MJ, Boohaker L, Griffin R, Soranno DE, Gien J, Askenazi D, et al. **Acute kidney injury in neonatal encephalopathy: An evaluation of the AWAKEN database.** Pediatr Nephrol. 2019; 34(1):169-76. doi: 10.1007/s00467-018-4068-2. Erratum in: Pediatr Nephrol. 2019; 34(2):363. doi: 10.1007/s00467-018-4106-0

6. Stoops C, Boohaker L, Sims B, Griffin R, Selewski DT, Askenazi D, et al. **The association of intraventricular hemorrhage and acute kidney injury in premature infants from the Assessment of the Worldwide Acute Kidney Injury Epidemiology in Neonates (AWAKEN) Study. Neonatology.** 2019; 116(4):321-30. doi: 10.1159/000501708

7. Pandey V, Kumar D, Vijayaraghavan P, Chaturvedi T, Raina R. **Non-dialytic management of acute kidney injury in newborns. J** Renal Inj Prev. 2016; 6(1):1-11. doi: 10.15171/jrip.2017.01

8. Vega MRW, Cerminara D, Desloovere A, Paglialonga F, Renken-Terhaerdt J, Walle JV, et al. **Nutritional management of children with acute kidney injury-clinical practice recommendations from the Pediatric Renal Nutrition Taskforce.** Pediatr Nephrol. 2023; 38(11):3559-80. doi: 10.1007/s00467-023-05884-3

9. Mayor S. **UK report into acute kidney injury deaths recommends electrolyte checks in all emergency admissions.** BMJ 2009; 338:b2370. doi: 10.1136/bmj.f5302

10. Kumar AB, Shi Y, Shotwell MS, Richards J, Ehrenfeld JM. **Hypernatremia is a significant risk factor for acute kidney injury after subarachnoid hemorrhage: A retrospective analysis.** Neurocrit Care. 2015; 22(2):184-91. doi: 10.1007/s12028-014-0067-8

11. Suetrong B, Pisitsak C, Boyd JH, Russell JA, Walley KR. **Hyperchloremia and moderate increase in serum chloride are associated with acute kidney injury in severe sepsis and septic shock patients.** Crit Care. 2016; 20(1):315. doi: 10.1186/s13054-016-1499-7

12. Fisher M, Neugarten J, Bellin E, Yunes M, Stahl L, Johns TS. **AKI in hospitalized patients with and without COVID-19: A comparison study.** J Am Soc Nephrol. 2020; 31(9):2145-57. doi: 10.1681/ASN.2020040509.

13. Lentine KL, Kasiske BL, Levey AS, Adams PL, Alberú J, Bakr MA, et al. **Summary of kidney disease: Improving Global Outcomes (KDIGO) clinical practice guideline on the evaluation and care of living kidney donors.** Transplantation. 2017; 101(8):1783-92. doi: 10.1097/TP.0000000000001770

14. Erfurt S, Lehmann R, Matyukhin I, Marahrens B, Patschan S, Patschan D. **Stratification of acute kidney injury risk, disease severity, and outcomes by electrolyte disturbances.** J Clin Med Res. 2023; 15(2):59-67. doi: 10.14740/jocmr4832

15. Lee SW, Baek SH, Ahn SY, Na KY, Chae DW, Chin HJ, et al. **The effects of pre-existing hyponatremia and subsequent-developing acute kidney injury on in-hospital mortality: A retrospective cohort study.** PLoS One. 2016; 11(9):e0162990. doi: 10.1371/journal.pone.0162990

16. Gao XP, Zheng CF, Liao MQ, He H, Liu YH, Jing CX, et al. **Admission serum sodium and potassium levels predict survival among critically ill patients with acute kidney injury: A cohort study.** BMC Nephrol. 2019; 20(1):311. doi: 10.1186/s12882-019-1505-9

17. Lombardi G, Gambaro G, Ferraro PM. **Serum potassium disorders predict subsequent kidney injury: A retrospective observational cohort study of hospitalized patients.** Kidney Blood Press Res. 2022; 47(4):270-76. doi: 10.1159/000521833

18. Shao M, Li G, Sarvottam K, Wang S, Thongprayoon C, Dong Y, et al. **Dyschloremia Is a Risk Factor for the Development of Acute Kidney Injury in Critically Ill Patients.** PLoS One. 2016; 11(8):e0160322. doi: 10.1371/journal.pone.0160322

19. Chintala V, Prabhu VM, Boyanagari M, Bhat AN. **Role of hypomagnesaemia in acute kidney injury.** J Clin Diagn Res. 2018; 12(13):OC08-OC10. doi: 10.7860/JCDR/2018/28073.11329

20. Fiorentini D, Cappadone C, Farruggia G, Prata C. **Magnesium: Biochemistry, nutrition, detection, and social impact of diseases linked to its deficiency.** Nutrients. 2021; 13(4):1136. doi: 10.3390/nu13041136

21. Basalely AM, Griffin R, Gist KM, Guillet R, Askenazi DJ, Charlton JR, et al. **Association of early dysnatremia with mortality in the neonatal intensive care unit: Results from the AWAKEN study.** J Perinatol. 2022; 42(10):1353-1360. doi: 10.1038/s41372-021-01260-x

22. Stritzke A, Thomas S, Amin H, Fusch C, Lodha A. **Renal consequences of preterm birth.** Mol Cell Pediatr. 2017; 4(1):2. doi: 10.1186/s40348-016-0068-0

23. Chen X, Xu J, Li Y, Xu X, Shen B, Zou Z, et al. **Risk scoring systems including electrolyte disorders for predicting the incidence of acute kidney injury in hospitalized patients.** Clin Epidemiol. 2021; 13:383-96. doi: 10.2147/CLEP.S311364

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2	**Murtaza Ali Gowa:** Study concept and design, proof reading, critical revisions.
3	**Sadaf Asim:** Study concept and design, proof reading, critical revisions.
4	**Syed Habib Ahmed:** Literature review, data analysis, proof reading.
5	**Hafsa Qazi:** Study concept and design, proof reading, critical revisions.
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