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ELECTROLYTES AND RENAL PROFILE IN CHILDREN SUFFERING FROM ACUTE GASTROENTERITIS: A COMPREHENSIVE ANALYSIS

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ABSTRACT

BACKGROUND: Acute gastroenteritis (AGE) is a leading cause of morbidity and mortality in children, characterized by diarrhea, vomiting, fever, and abdominal pain, which can lead to severe dehydration and electrolyte imbalances. Electrolyte disturbances such as hyponatremia, and hypokalemia are commonly observed in AGE and are linked to increased risk of complications, including acute kidney injury (AKI).

OBJECTIVE The primary objective of this study was to analyze the effects of acute gastroenteritis on electrolyte levels and renal function in children. Specific objectives included assessing changes in sodium, potassium, and chloride levels, exploring the relationship between electrolyte imbalances and the severity of gastroenteritis, and examining the link between renal dysfunction and dehydration.

METHODOLOGY This prospective observational study involved 150 pediatric patients, aged 6 months to 10 years, diagnosed with acute gastroenteritis, presented at Khalifa Gul Nawaz teaching Hospital, Bannu, Pakistan, from September 20, 2024 to December 20, 2024. Simple random technique was employed to ensure equal selection chances. Data collection included clinical assessments, laboratory investigations for electrolyte levels and renal function, and clinical severity scores. Electrolyte imbalances were defined as hyponatremia (<135 mEq/L), hypokalemia (<3.5 mEq/L), and hypochloremia (<98 mEq/L). Renal dysfunction was indicated by serum creatinine levels >0.7 mg/dL and BUN levels >20 mg/dL. Statistical analysis was conducted using SPSS version 25, with Pearson correlation, linear regression analyses, and multivariate regression analysis were performed.

RESULTS : The mean age of participants was 3.8 ± 2.5 years, with a slight male predominance. Diarrhea was present in all patients, with vomiting in 85%, abdominal pain in 70%, and fever in 60%. Clinical severity scores indicated moderate to severe symptoms in a substantial proportion of patients. Dehydration was categorized as mild (50%), moderate (35%), or severe (15%). Electrolyte imbalances were prevalent, with hyponatremia in 28%, hypochloremia in 20% and hypokalemia in 30%. Renal dysfunction was observed in 12% of patients based on elevated serum creatinine and in 15% based on elevated BUN levels. ORS (low osmolar) was administered to 95% of patients, with 72% showing symptom improvement and 58% showing improvement in renal function. Significant correlations were found between the severity of gastroenteritis and electrolyte imbalances ($r = 0.61$, $p < 0.01$), as well as between dehydration and renal dysfunction ($r = 0.64$, $p < 0.01$). Higher clinical severity scores were predictive of greater electrolyte imbalances ($\beta = 0.45$, $p < 0.01$) and increased renal dysfunction risk ($\beta = 0.39$, $p < 0.01$).

CONCLUSION: This study emphasizes the critical impact of acute gastroenteritis on electrolyte imbalances and renal function in children, highlighting the need for early recognition, targeted interventions, and continuous monitoring to prevent severe complications.

KEYWORDS : Acute Gastroenteritis, Electrolyte imbalance, Renal dysfunction, Children

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INTRODUCTION

Acute gastroenteritis (AGE) is a major public health issue, particularly among children, where it remains a leading cause of morbidity and mortality worldwide.[1] AGE is characterized by the sudden onset of diarrhea, often accompanied by vomiting, fever, and abdominal pain, leading to significant dehydration and electrolyte imbalances.[2] According to recent estimates, AGE is responsible for approximately 1.7 billion cases globally each year, with a significant proportion of these cases occurring in children under five years old.[3] The associated mortality, primarily due to dehydration, underscores the critical need for effective management strategies.[4]

Electrolyte imbalances such as hyponatremia, hypokalemia, and hypochloremia are frequently observed in children with AGE and are closely associated with the severity of dehydration.[5] These disturbances can lead to severe complications, including seizures, cardiac arrhythmias, and acute kidney injury (AKI), exacerbating the child's condition and increasing the risk of mortality.[6] The renal involvement in AGE, particularly in the form of dehydration-induced AKI, is an emerging concern and has been identified as a significant factor contributing to morbidity in affected children.[7]

The pathophysiology of AKI in the context of AGE is multifactorial, involving prerenal, intrinsic renal, and postrenal mechanisms.[8] These mechanisms are often exacerbated by electrolyte disturbances and the degree of dehydration, making the early identification and management of these conditions crucial for

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improving outcomes.[9] Recent studies have highlighted the importance of prompt and effective treatment of electrolyte imbalances to prevent the progression to severe AKI and other life-threatening complications.[10]

However, managing electrolyte disturbances and renal dysfunction in children with AGE remains particularly challenging in resource-limited settings, where access to advanced diagnostic tools and treatment options is often restricted.[11] This study aims to provide a comprehensive analysis of the electrolyte and renal profiles in children suffering from AGE, with the goal of identifying key predictors of poor outcomes and informing evidence-based management strategies.

METHODOLOGY

This study employed a prospective observational design, at Khalifa Gulnawaz Teaching Hospital MTI, Bannu, an allied hospital of Bannu Medical College, Bannu, with effect from September 20, 2024 to December 20, 2024, capturing real-time data on pediatric patients diagnosed with acute gastroenteritis.

The primary objective of the study was to comprehensively analyze the impact of acute gastroenteritis on electrolyte balance and renal function in pediatric patients. The specific objectives were to assess alterations in sodium, potassium, and chloride levels in children suffering from AGE, to explore the association between electrolyte imbalances and the severity of gastroenteritis and to examine the relationship between renal dysfunction and dehydration in children with AGE.

A total of 150 pediatric patients was selected, using 95% confidence interval, 7.2% margin of error and a target proportion of 28.3% for hyponatremia in children with AGE.[12] A power analysis, with 80% power was conducted to ensure statistical adequacy and the chosen sample was deemed meaningful for the study objectives. Simple random technique was employed for sampling to ensure equal selection chances, reduce selection bias, enhance representation, and improve generalizability of these findings.

Pediatric patients aged 6 months to 10 years diagnosed with AGE based on clinical symptoms such as diarrhea and vomiting were included in the study. Exclusion criteria encompassed patients with comorbid conditions such as malnutrition, metabolic disorders, Immunocompromised states, chronic renal diseases, or pre-existing electrolytes imbalances; those who had used medications affecting electrolyte balance within the past two weeks; patients with severe gastroenteritis requiring emergency intervention (e.g., shock or sepsis); and those with a history of gastrointestinal surgery.

Electrolyte imbalances included hyponatremia (sodium <135 mEq/L), hypokalemia (potassium <3.5 mEq/L), hypochloremia (chloride < mEq/L), without further categorization into severity levels due to the study observational design. Renal dysfunction is defined by serum creatinine > 0.1mg/dL. BUN > 20 mg/dL or reduced urine output (<0.5mL/kg/hr for 6-12 hours).[25]

An informed written consent was obtained from the parents of all the children included in the study. Strict measures were implemented to ensure the confidentiality and privacy of patient data in accordance with the Declaration of Helsinki guidelines. Data was collected through detail history and clinical examination on a pre-designed proforma. Clinical severity scores were assigned based on the intensity of symptoms, and dehydration was categorized based on clinical signs. For laboratory investigation, 3cc blood was collected for electrolyte analysis (sodium, potassium, chloride) and renal profile assessment (serum creatinine, blood urea nitrogen) and was sent to the hospital laboratory. A repeat sample was obtained after 8 hours of rehydration to check for progression or resolution of abnormalities. All the tests were done on Chemistry Analyzemodel Roche Cobas 6000 (c501), its accuracy and reliability is ensured through robust internal audit (daily calibration, control materials and precision checks) and external audits by proficiency checking. An experienced hematologist with over 5 years' experience analyzed the samples.

Data obtained was statistically analyzed using SPSS version 25. A p-value <0.05 was considered significant**.** Descriptive statistics was utilized for summarizing demographic characteristics, clinical symptoms, and baseline electrolyte levels. In the line with the study objectives, the primary outcome, which was the severity of the electrolyte imbalances and renal dysfunction, were evaluated for their correlation with the severity of AGE (secondary outcome). Pearson correlation coefficients ware calculated to assess the relationship between electrolyte imbalances, gastroenteritis severity, and renal dysfunction**.** Linear regression analysis was conducted to explore the predictive relationship between clinical severity scores and electrolyte imbalances. Multivariate regression analysis was performed to adjust for confounding factors and examine the simultaneous effects of multiple predictors (clinical severity scores[26] and dehydration severity[27]) on the outcomes (electrolyte imbalances and renal dysfunction).

Ethical approval with reference number 35/DiR&MJ/BMC/2024 was obtained from the Institutional Ethical Committee of Bannu Medical College, MTI Bannu, affiliated with Khalifa Gulnawaz Teaching Hospital, Bannu on 19/09/24.

RESULTS

In this study, a total of 150 pediatric patients diagnosed with acute gastroenteritis (AGE) were included, with age ranging from 6 months to 10 years (mean age: 3.8 ± 2.5 years). The gender distribution was slightly skewed, with 88 males (58.7%) and 62 females (41.3%). The majority of the patients came from middle-income families and rural areas as shown in Table 1.

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Table 1: Demographic profiles of children suffering from AGE. (n = 150)

Characteristics		Number (%)
Mean Age:	6months to 1year	54 (36%)
	>1years to 5years	69 (46%)
(3.8 ± 2.5 years)	>5years to 10years	27 (18%)
Gender	Male	88 (58.7%)
	Female	62 (41.3%)
Area of residence	Urban	46 (30.6%)
	Rural	104 (69.4%)
Socioeconomic status	Low income	39 (26%)
	Middle income	94 (62.6%)
	High income	17 (11.3%)

The mean duration of symptoms before presentation was 4.9 ± 2.1 days. Diarrhea was universally present (100%), followed by vomiting (85%), abdominal pain (70%), and fever (60%) as depicted in Table 2.

Table 2: Frequency of most common symptoms in children suffering from AGE. (n = 150)

Most common symptoms	Number (%)
Diarrhea	150 (100%)
Vomiting	128 (85.3%)
Abdominal pain	105 (70%)
Fever	90 (60%)
Lethargy	68 (45.3%)
Reluctant to feed	21(14%)
Irritability	66 (44%)
Abdominal distention	20(13.3%)
Sunken eyes	53(35.3%)
Respiratory distress	15 (10%)
Convulsions	7 (4.6%

Clinical severity was assessed based on the intensity of symptoms. It was found that 55% of patients experienced moderate diarrhea (4-6 loose stools/day), while 30% had severe diarrhea (>6 loose stools/day). Severe vomiting (>5 episodes/day) was noted in 35% of cases, and 50% of patients reported moderate abdominal pain that interfered with daily activities. Dehydration was categorized into mild, moderate and severe dehydration and their proportions are shown in Figure No 1.

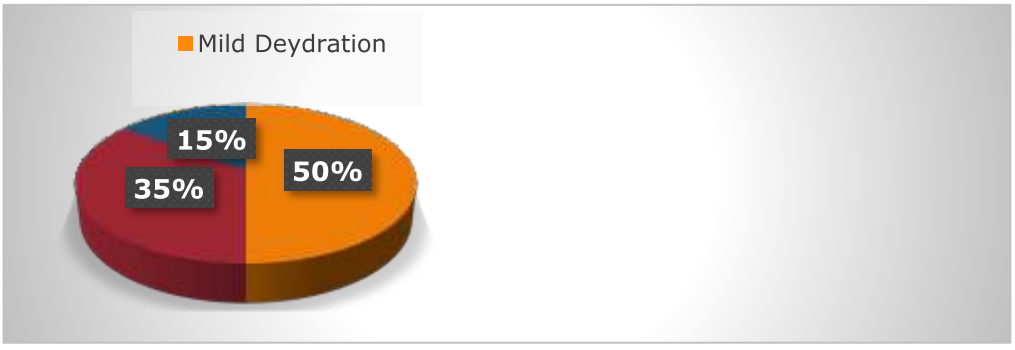

Figure 1: Frequency of Types of dehydration in children suffering from AGE. (n = 150)

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Additionally, 40% of the children had moderate fever (38.5-39.4°C). The average total clinical severity score was 7.6 ± 2.7 out of 12. The mean sodium level was 135.8 ± 3.9 mEq/L, with 28% patients exhibiting hyponatremia (Sodium <135mEq/L), reflecting a significant proportion of patients with low Sodium despite the near-normal mean, as mentioned in Table No 3.

Table 3: Electrolytes and Renal profile Pattern in children suffering from AGE (n = 150)

Biochemical Parameters	Values
Mean Sodium	135.8 ± 3.9 mEq/L
Hyponatremia (<135 mEq/L)	28%
Mean Potassium	3.5 ± 0.6 mEq/L
Hypokalemia (<3.5 mEq/L)	30%
Mean Chloride	97.2 ± 4.8 mEq/L
Hypochloremia (<98 mEq/L)	20%
Mean Creatinine level	0.68 ± 0.14 mg/dL
Raised Creatinine	12%
Mean Blood Urea Nitrogen level	19.1 ± 5.3 mg/dL
Raised Blood Urea Nitrogen	15%

Hospitalization was required for 40% of the patients, with an average hospital stay of 3.9 ± 1.2 days. Oral Rehydration Therapy (ORS) was administered to 95% of patients. At follow-up, 72% of patients showed improvement in clinical symptoms, 22% remained unchanged, and 6% worsened. Improvement in electrolyte levels was observed in 65% of patients, while 58% showed improvements in renal function.

Pearson correlation analysis demonstrated a significant correlation between the severity of gastroenteritis and the degree of electrolyte imbalance ($r = 0.61$, $p < 0.01$). A strong correlation was also found between the severity of dehydration and renal dysfunction ($r = 0.64$, $p < 0.01$). Likewise, linear regression analysis revealed that higher clinical severity scores were predictive of greater electrolyte imbalances ($\beta = 0.45$, $p < 0.01$) and an increased risk of renal dysfunction ($\beta = 0.39$, $p < 0.01$).

Multivariate regression analysis, adjusting for age, gender, and baseline dehydration status, revealed that clinical severity scores were positively correlated with electrolytes imbalances ($\beta = 0.45$, $p < 0.01$). Additionally, dehydration severity was an independent predictor of renal dysfunction ($\beta = 0.39$, $p < 0.01$), indicating that children with more severe dehydration were at a higher risk of developing renal dysfunction.

DISCUSSION

This study provides critical insights into the electrolyte imbalances and renal dysfunctions associated with acute gastroenteritis (AGE) in pediatric patients, a condition that continues to pose significant health challenges globally, particularly in resource-limited settings.

The demographic characteristics of the study population are consistent with global trends observed in pediatric AGE, with a slight male predominance and a majority of cases arising in children from middle-income families. This distribution aligns with recent studies that highlight the vulnerability of younger children, particularly those from socioeconomically disadvantaged backgrounds, to gastrointestinal infections.[12,13]

The average duration of symptoms prior to presentation (4.9 ± 2.1 days) and the prevalence of diarrhea, vomiting, abdominal pain, and fever are reflective of the typical clinical presentation of AGE, as reported in other contemporary studies.[12,14]

The severity of clinical symptoms observed in this cohort, particularly the high incidence of moderate to severe diarrhea and vomiting, correlates with the significant risk of dehydration, a common and dangerous complication of AGE. The study's findings that 85% of patients exhibited dry mucous membranes and 35.3% had sunken eyes are consistent with established markers of dehydration severity.[15] These findings are crucial as they emphasize the need for prompt and effective rehydration strategies to prevent the progression to severe dehydration and associated complications.

Electrolyte disturbances, particularly hyponatremia (28%) and hypokalemia (30%), were prominent in this study and are consistent with findings from other recent investigations into the biochemical impacts of AGE.[12] Hyponatremia, in particular, has been linked to the severity of diarrhea and vomiting, which lead to significant sodium loss.[16] Hypokalemia, often resulting from prolonged vomiting and diarrhea, further complicates the clinical management of these patients and increases the risk of severe outcomes if not promptly addressed.[17]

The renal profile of the patients indicated that 12% had elevated serum creatinine levels, and 15% had elevated BUN levels, suggesting a significant incidence of acute kidney injury (AKI) in the context of AGE. These findings are in line with recent studies

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that have reported similar rates of renal impairment among children with severe dehydration due to AGE.[18] AKI in this context is often prerenal, resulting from reduced kidney perfusion due to hypovolemia, and underscores the importance of early and aggressive fluid resuscitation.[19]

The administration of Oral Rehydration Therapy (ORS) to 95% of the patients in this study highlights its effectiveness as the cornerstone of AGE management, with 72% of patients showing clinical improvement at follow-up.[20] However, the 6% of patients who worsened despite treatment indicate that in some cases, ORS alone may be insufficient, necessitating the need for more intensive interventions.[21] The improvements in electrolyte levels and renal function observed in the majority of patients further underscore the effectiveness of timely intervention in preventing the complications associated with electrolyte disturbances and renal dysfunction.[22]

The significant correlations found between the severity of gastroenteritis, electrolyte imbalances, and renal dysfunction ($r = 0.61$, $p < 0.01$, and $r = 0.64$, $p < 0.01$, respectively) are consistent with findings from other studies that have identified these relationships as key predictors of poor outcomes in pediatric AGE.[23] The linear regression analysis further reinforces the role of clinical severity scores as predictive tools for identifying children at higher risk of adverse outcomes, which can guide clinical decision-making and resource allocation in both acute and preventive care settings.[24] This single-centred study lacks generalizability, and the lack of long-term renal functions monitoring prevents assessment of chronic outcome. Future multi-centre research should focus on refining predictive models and exploring the long-term renal outcomes of children.

CONCLUSION

This study highlights the critical need for early detection and management of electrolyte imbalances and renal dysfunction in children with AGE. The strong correlations between clinical severity, electrolyte disturbances, and renal outcomes suggest that routine monitoring and aggressive treatment of these parameters could significantly improve patient outcomes.

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