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Original Article

Etiological Factors and Clinical Outcomes of Acute Hyperkalemia Among Hospitalized Patients at a Tertiary Care Hospital in Peshawar

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Abstract

Background: Acute hyperkalemia is a potentially life-threatening electrolyte imbalance frequently encountered among hospitalized patients, particularly those with renal dysfunction and multiple comorbidities. It is associated with serious cardiac complications and increased morbidity and mortality. Understanding the underlying etiological factors and clinical outcomes is essential for timely diagnosis, appropriate management, and improved patient care.

Objective: To determine the frequency, etiological factors, management strategies, and clinical outcomes of acute hyperkalemia among hospitalized patients at a tertiary care hospital in Peshawar.

Methodology: This descriptive cross-sectional study was conducted in the Department of Nephrology, Northwest General Hospital and Research Centre, Peshawar, Pakistan, from September 2020 to June 2024. A total of 142 hospitalized patients with serum potassium levels >5.0 mEq/L were included using non-probability consecutive sampling. Data on demographic characteristics, clinical presentation, comorbidities, medication history, laboratory parameters, treatment modalities, and clinical outcomes were collected using a structured proforma. Hyperkalemia was classified as mild, moderate, or severe.

Results: The median age of patients was 60 years (IQR = 19), with females comprising 54.9% of the cohort. Hypertension (59.9%), diabetes mellitus (48.6%), and chronic kidney disease (45.8%) were the most common comorbidities. Acute kidney injury was present in 49.3% of patients. Medications frequently associated with hyperkalemia included angiotensin-converting enzyme inhibitors (43.7%), diuretics (27.5%), and nonsteroidal anti-inflammatory drugs (23.9%). Severe hyperkalemia (>6.5 mEq/L) was observed in 47.2% of patients. Intravenous calcium (81%) and insulin-dextrose infusion (67.6%) were the most commonly used treatments. Potassium normalization was achieved in 41.5% of patients. Significant associations with potassium normalization were observed for nebulized salbutamol ($p = 0.043$) and intravenous bicarbonate ($p = 0.016$). Overall, 95.8% of patients were discharged in stable condition, while the in-hospital mortality rate was 4.2%.

Conclusion: Acute hyperkalemia among hospitalized patients was commonly associated with multiple comorbidities and the use of potassium-altering medications, particularly ACE inhibitors and NSAIDs. Despite standard management, potassium normalization was achieved in less than half of patients, highlighting the need for individualized treatment strategies, vigilant monitoring, and early intervention to improve clinical outcomes.

Keywords: Acute Hyperkalemia, Acute Kidney Injury, Clinical Outcomes, Electrolyte Imbalance, Potassium-Altering Medications.

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Introduction

Hyperkalemia, defined as a serum potassium concentration exceeding 5.0–5.5 mEq/L, is a common and potentially life-threatening electrolyte disturbance among hospitalized patients [1]. It represents a significant clinical concern, particularly in individuals with chronic kidney disease (CKD), heart failure, and those receiving medications that impair renal potassium excretion [2,3]. The reported incidence of hyperkalemia among hospitalized patients is approximately 85.7 per 1,000 admissions, with prevalence varying depending on diagnostic thresholds and patient populations [2].

Patients with heart failure, especially those with reduced ejection fraction, are at increased risk, with studies reporting hyperkalemia in nearly 39.6% of this population [3]. A large meta-analysis encompassing 542 observational studies estimated the overall prevalence of hyperkalemia among adults to be 6.3% [2]. Severe hyperkalemia, defined by serum potassium levels exceeding 6.5 mEq/L, is associated with a nearly fourfold increase in in-hospital mortality, underscoring its clinical significance [4].

Regional data from Pakistan further emphasize the burden of this condition. Studies have reported hyperkalemia prevalence rates of 39.6% among patients with heart failure[3] and 45.3% among non-dialysis-dependent CKD patients, with strong correlations observed between potassium levels, CKD stage, and disease duration [5]. Pharmacological agents such as angiotensin-converting enzyme inhibitors, beta-blockers, and other renin–angiotensin–aldosterone system inhibitors (RAASIs) further exacerbate hyperkalemia risk by reducing renal potassium excretion [6,7]. Early recognition is critical, as severe hyperkalemia can precipitate life-threatening cardiac arrhythmias, including peaked T waves, widened QRS complexes, and sine-wave patterns on electrocardiography [8].

Management of hospital-acquired hyperkalemia is multifactorial and depends on the severity and underlying etiology. Acute treatment strategies include insulin-dextrose infusion, intravenous calcium, beta-agonists, bicarbonate therapy, diuretics, and dialysis in refractory cases [9,10]. While insulin-dextrose therapy is effective, it carries a substantial risk of hypoglycemia, necessitating close monitoring [9]. Mild cases may resolve without aggressive intervention, whereas recurrent or severe hyperkalemia significantly increases healthcare utilization and costs due to prolonged hospital stays and intensive care admissions [11–13].

Despite its high prevalence and serious clinical implications, there remains a paucity of region-specific data exploring the etiological factors of acute hyperkalemia among hospitalized patients in Peshawar. Addressing this gap is essential for optimizing preventive strategies, refining treatment protocols, and improving patient outcomes. Therefore, this study aims to investigate the etiological factors, clinical characteristics, management approaches, and outcomes of acute hyperkalemia among hospitalized patients at a tertiary care hospital in Peshawar.

Methodology

Study Design

This study employed a descriptive cross-sectional design to evaluate the etiological factors associated with acute hyperkalemia among hospitalized patients. The design was chosen to systematically capture demographic characteristics, clinical profiles, comorbid conditions, medication exposure, and management strategies in patients presenting with elevated serum potassium levels during hospitalization.

Ethics

Ethical approval was obtained from the Institutional Review Board and Ethical Committee of Northwest General Hospital and Research Centre (NWGH&RC), Peshawar, under reference number IRB&EC/2020-GH/0179, dated 08-12-2020. Written informed consent was obtained from all participants or their legal guardians prior to enrollment. Confidentiality of patient information was strictly maintained, and the study adhered to the principles outlined in the Declaration of Helsinki.

Setting

The study was conducted in the Department of Nephrology and Dialysis at Northwest General Hospital and Research Centre, a tertiary care teaching hospital in Peshawar, Pakistan. Data collection spanned from September 2020 to June 2024, covering both general ward and intensive care unit (ICU) admissions.

Participants

A total of 142 hospitalized patients were enrolled using a non-probability consecutive sampling technique. Eligible participants included patients of either gender, aged ≥5 years, with documented serum potassium levels >5.0 mEq/L at admission or during hospitalization. Patients with non-dialysis-dependent chronic kidney disease (CKD stages 1–5), heart failure (particularly HFrEF), and those receiving medications known to influence potassium homeostasis were included. Exclusion criteria comprised dialysis-

dependent patients, outpatients with hyperkalemia, and patients with acute kidney injury without prior CKD.

Variables
The primary variables included serum potassium levels and etiological factors contributing to hyperkalemia. Secondary variables comprised demographic characteristics (age, gender, smoking status), clinical features (presenting symptoms, renal function, ECG findings), comorbidities (hypertension, diabetes mellitus, CKD, coronary artery disease), medication history (ACE inhibitors, ARBs, NSAIDs, diuretics, potassium-sparing agents), treatment modalities, and in-hospital outcomes including potassium normalization, discharge status, and mortality.

Data Sources/Measurement
Data were collected using a structured proforma designed specifically for the study. Serum potassium levels were measured through standard hospital laboratory methods. Hyperkalemia severity was classified as mild (5.0–5.5 mEq/L), moderate (5.5–6.5 mEq/L), and severe (>6.5 mEq/L). ECG findings were documented at presentation and post-treatment. Potassium normalization was defined as a serum potassium level between 3.5–5.0 mEq/L within 24 hours of initiating therapy.

Treatment regimens included IV calcium, insulin-dextrose infusion, nebulized salbutamol, sodium bicarbonate, sodium or calcium resins, and dialysis when indicated.

Bias
Selection bias was minimized by enrolling consecutive eligible patients during the study period. Information bias was reduced through standardized data collection tools and uniform laboratory measurements. However, as a single-center observational study, residual confounding related to unmeasured variables such as dietary potassium intake and long-term medication adherence could not be entirely excluded.

Study Size
The sample size of 142 patients was calculated using OpenEpi software, based on a reported prevalence of hyperkalemia of 6.3%, a 95% confidence interval, and a 4% margin of error, ensuring adequate precision for descriptive analysis.

Quantitative Variables
Continuous variables such as age, serum potassium, creatinine, urea, sodium, and bicarbonate levels were expressed as mean ± standard deviation or median with interquartile range (IQR), depending on data distribution. Categorical variables were presented as frequencies and percentages.

Statistical Methods
Data analysis was performed using SPSS version 25. Normality of continuous variables was assessed using the Shapiro–Wilk test. Categorical variables were compared using the Chi-square test or Fisher's exact test where appropriate. For comparison of non-normally distributed continuous variables across hyperkalemia severity groups, the Kruskal–Wallis test was applied. A p-value <0.05 was considered statistically significant. Results were presented in tables and figures for clarity.

Results

Participants
A total of 142 hospitalized patients with documented hyperkalemia were included in the final analysis. The median age of the study population was 60 years (IQR = 19), with an age range spanning from 5 to 100 years. Most patients belonged to the 51–70 years age group (58.5%), reflecting a predominance of middle-aged to older adults. Female patients constituted a slightly higher proportion of the cohort (78; 54.9%) compared to males. The majority of patients (87; 61.3%) were managed in general wards, while a substantial proportion (51; 35.9%) required admission to the intensive care unit, indicating a significant burden of disease severity. Smoking history was uncommon and reported in only 6 (4.2%) patients.

Descriptive Data
Renal dysfunction was a prominent clinical feature among the study participants. Acute kidney injury (AKI) was observed in 70 (49.3%) patients, and oliguria was present in 56 (39.4%), underscoring impaired renal potassium excretion as a major contributing factor. Most patients presented with multiple comorbidities. Hypertension was the most prevalent condition (85; 59.9%), followed by diabetes mellitus (69; 48.6%) and chronic kidney disease (65; 45.8%). Coronary artery disease was present in 29 (20.4%) patients, while congestive cardiac failure affected 23 (16.2%) (Table 01).

Medication exposure potentially contributing to hyperkalemia was common. ACE inhibitors were used by 62 (43.7%) patients, diuretics by 39 (27.5%), and NSAIDs by 34 (23.9%). Herbal medication use was rare (1; 0.7%). On admission, nearly half of the patients had severe hyperkalemia (>6.5 mEq/L) (67; 47.2%), while an equal proportion had moderate hyperkalemia, and only a small fraction presented with mild disease (8; 5.6%) (Figure 01).

Patients frequently reported multiple presenting symptoms. The most common symptom was shortness of breath (40; 28%), followed by generalized body swelling (36; 25%) and drowsiness (28; 20%). Chest pain, gastrointestinal symptoms, and anorexia were also observed, reflecting multisystem involvement rather than isolated electrolyte disturbance (Table 02).

Outcome Data

Regarding management, intravenous calcium was the most frequently administered treatment (115; 81%), followed by IV insulin-dextrose infusion (96; 67.6%), sodium or calcium resins (74; 52.1%), nebulized salbutamol (59; 41.5%), dialysis (48; 33.8%), and IV bicarbonate (34; 23.9%). Following treatment, 59 (41.5%) patients achieved normalization of serum potassium levels, whereas 83 (58.5%) remained hyperkalemic during hospitalization. Overall clinical outcomes were favorable, with 136 (95.8%) patients discharged in stable condition. The in-hospital mortality rate was 4.2% (6 patients) (Table 03).

Main Results

Comparative analysis across hyperkalemia severity categories showed no statistically significant differences in age distribution or gender; however, severe hyperkalemia was more frequently observed among patients aged 31–70 years. Renal dysfunction, including AKI and oliguria, was more prevalent in patients with severe hyperkalemia, although these differences did not reach statistical significance. Among comorbidities, coronary artery disease demonstrated a significant association with hyperkalemia severity ($p < 0.001$). Laboratory evaluation revealed significantly higher serum creatinine levels in patients with severe hyperkalemia ($p = 0.015$), indicating worse renal impairment.

Analysis of treatment effectiveness demonstrated that the use of nebulized salbutamol ($p = 0.043$) and IV bicarbonate ($p = 0.016$) was significantly associated with potassium normalization. Other treatment modalities, including IV calcium, insulin-dextrose, sodium resins, and dialysis, did not show statistically significant associations with normalization.

Importantly, discharge rates and mortality did not differ significantly between patients who achieved potassium normalization and those who did not, suggesting that prompt inpatient management and close monitoring mitigated adverse short-term outcomes (Table 04).

Table 1: Clinical characteristics of patients.

Variables		N (%)
Renal status	AKI	70 (49.3%)
	Oliguria	56 (39.4%)
Comorbid status	DM	69 (48.6%)
	Hypertension	85 (59.9%)
	CAD	29 (20.4%)
	Congestive cardiac failure	23 (16.2%)
	Liver cirrhosis	2 (1.4%)
	COPD	3 (2.1%)
	CKD	65 (45.8%)
	Any other	31 (21.8%)
Medication History	Diuretics	39 (27.5%)
	NSAIDs	34 (23.9%)
	ACE inhibitor	62 (43.7%)
	ARBs	6 (4.2%)
	Herbal Med	1 (0.7%)
Hyperkalemia status on admission	Mild	8(5.6%)
	Moderate	67(47.2%)
	Severe	67(47.2%)

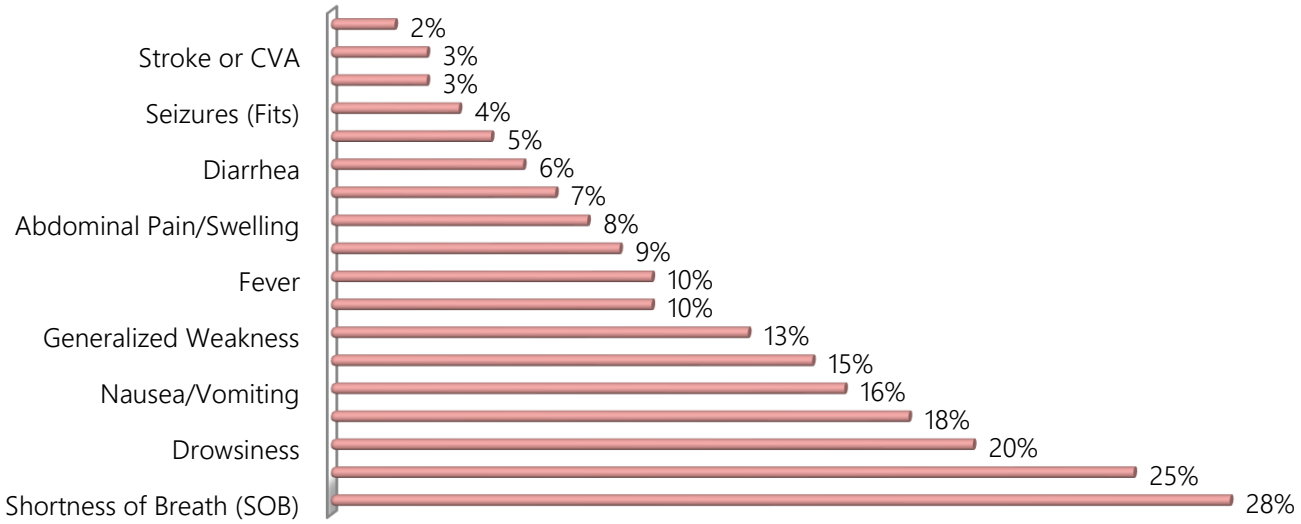


Figure 1: Presenting complication.

Table 2: Comparison of demographic and clinical characteristics among mild, moderate and sever hyperkalemia patients.

Variables		Mild Hyperkalemia	Moderate Hyperkalemia	Severe Hyperkalemia	p-value	Effect size
Age	≤15 years	0 (0.0%)	4 (80.0%)	1 (20.0%)	0.304	0.185
	16–30 years	0 (0.0%)	3 (30.0%)	7 (70.0%)		
	31–50 years	1 (4.2%)	9 (37.5%)	14 (58.3%)		
	51–70 years	4 (4.8%)	42 (50.6%)	37 (44.6%)		
	>70 years	3 (15.0%)	9 (45.0%)	8 (40.0%)		
Gender	Male	6 (9.4%)	26 (40.6%)	32 (50.0%)	0.125	0.171
	Female	2 (2.6%)	41 (52.6%)	35 (44.9%)		
Renal function	AKI	2 (2.9%)	30 (42.9%)	38 (54.3%)	0.141	0.166
	Oliguria	4 (7.1%)	23 (41.1%)	29 (51.8%)	0.467	0.103
Comorbid	DM	5 (7.2%)	34 (49.3%)	30 (43.5%)	0.567	0.089
	Hypertension	6 (7.1%)	38 (44.7%)	41 (48.2%)	0.58	0.088
	CAD	6 (20.7%)	12 (41.4%)	11 (37.9%)	<0.001	0.331
	CKD	2 (3.1%)	29 (44.6%)	34 (52.3%)	0.329	0.125
Medication	Diuretics	2 (5.1%)	19 (48.7%)	18 (46.2%)	0.969	0.021
	NSAIDs	1 (2.9%)	16 (47.1%)	17 (50.0%)	0.722	0.068
	ACE Inhibitors	3 (4.8%)	32 (51.6%)	27 (43.5%)	0.641	0.079
	ARBs	0 (0.0%)	3 (50.0%)	3 (50.0%)	0.829	0.051
	Herbal	0 (0.0%)	0 (0.0%)	1 (100.0%)	0.569	--
Labs; Median(IQR)	Urea	118.5(179)	157(101)	169(157)	0.399	0.006
	Creatinine	3.71(3.74)	3.70(2.67)	5.28(5.88)	0.015	0.045
	Sodium	138(5.8)	136(10)	134(11)	0.197	0.017
	Bicarbonate	15(6.65)	17.60(5.30)	16.50(7.10)	0.306	0.009

Note: Chi square test or Fisher Exact test (for cell count<5) is used to calculate p value. For comparing lab investigation Kruskal Wallis test was used

Table 3: Hyperkalemia Treatment Regime in Hospitalized patients and outcomes.

Variables		N (%)
Treatment	IV Calcium	115(81%)
	IV Insulin-dextrose	96(67.6%)
	Nebulized Salbutamol	59(41.5%)
	IV Bicarbonate	34(23.9%)
	Sodium Resins	74(52.1%)
	Dialysis	48(33.8%)
Hyperkalemia status after treatment	Normalized Potassium	59(41.5%)
	Hyperkalemia	83(58.5%)
Outcome	Death	6(4.2%)
	Stable and discharged home	136(95.8%)

Table 4: Hyperkalemia status after treatments and its relation with different treatment types and discharge status.

Variables		Normalized Potassium (n=59)	Hyperkalemia (n=83)	p-value	Effect size
Medication	IV Calcium	44(38%)	71(62%)	0.078	0.197
	IV Insulin-dextrose	41(43%)	55(57%)	0.413	0.117
	Neb. Salbutamol	30(51%)	29(42%)	0.043*	0.263
	IV Bicarbonate	20(59%)	4(14%)	0.016*	0.206
	Sodium Resins	29(39%)	45(61%)	0.335	0.067
	Dialysis	17(35%)	31(65%)	0.190	0.209
Outcome	Discharged	57(96.6%)	79(95.5%)	0.512	0.073
	Death	2(3.4%)	4(4.8%)		

*p<0.05 is considered statistically significant.

Discussion

The present study provides a comprehensive descriptive evaluation of acute hyperkalemia among hospitalized patients at a tertiary care center in Peshawar, highlighting the interplay between demographic factors, comorbid conditions, medication exposure, treatment strategies, and short-term clinical outcomes. The findings reinforce the multifactorial nature of hyperkalemia and emphasize the central role of renal dysfunction, cardiovascular disease, and pharmacological agents in its pathogenesis.

In the current cohort, the median age of affected patients was 60 years, which is slightly lower than that reported in several outpatient and geriatric inpatient studies, where mean ages often exceed 65 years [14-16]. This difference likely reflects the hospital-based nature of the study and inclusion of patients with acute medical presentations. Although a modest female predominance was observed, previous studies have reported a higher prevalence of hyperkalemia among male patients [3,17]. Such variations may be attributable to regional differences in healthcare access, disease patterns, and medication use.

Comorbidities were highly prevalent among the study population, with hypertension, diabetes mellitus, and chronic kidney disease being the most common. These findings are consistent with prior studies demonstrating that impaired renal potassium excretion, particularly in CKD, substantially increases susceptibility to hyperkalemia [18–20]. Nearly half of the patients in this study had acute kidney injury, further reinforcing the critical role of renal dysfunction in precipitating hyperkalemia. Similar observations have been reported in critically ill populations, where hyperkalemia has been identified as an independent predictor of adverse outcomes [21,22].

Medication exposure emerged as an important contributing factor. A significant proportion of patients were receiving ACE inhibitors, diuretics, or NSAIDs—agents well known to disrupt renal potassium handling [23–26].

These findings align with existing literature emphasizing the need for close potassium monitoring in patients receiving renin–angiotensin–aldosterone system inhibitors, particularly in the presence of renal impairment or advanced age [23]. The frequent use of these medications reflects their essential role in managing cardiovascular and renal diseases, but also underscores the delicate balance required to minimize electrolyte disturbances.

The clinical presentation of hyperkalemia in this study was heterogeneous and often multisystemic. Symptoms such as shortness of breath, body swelling, and drowsiness were common but likely reflected underlying cardiac or renal pathology rather than isolated hyperkalemia itself [27]. This highlights the importance of considering hyperkalemia within the broader clinical context, where electrolyte imbalance often coexists with complex systemic illness.

Regarding management, intravenous calcium and insulin-dextrose infusion were the most frequently employed treatments, consistent with standard emergency management protocols [28–31]. Despite aggressive therapy, potassium normalization was achieved in only 41.5% of patients, indicating the challenges of managing hyperkalemia in individuals with significant comorbidities and ongoing renal dysfunction [32]. Notably, nebulized salbutamol and intravenous bicarbonate demonstrated significant associations with potassium normalization, supporting previous evidence regarding their effectiveness in facilitating intracellular potassium shifts, particularly in patients with metabolic acidosis [33–35].

Although normalization of serum potassium was achieved in less than half of the cohort, overall clinical outcomes were favorable, with high discharge rates and low in-hospital mortality. This suggests that timely intervention, close monitoring, and supportive care can mitigate short-term mortality even in patients with persistent hyperkalemia. However, persistent elevations may have implications for long-term outcomes, which were beyond the scope of this study.

Limitations

This study has several limitations that should be acknowledged. First, its single-center design may limit generalizability to other populations or healthcare settings. Second, the descriptive cross-sectional nature of the study precludes establishment of causal relationships between identified risk factors and hyperkalemia. Third, the sample size may not have been sufficient to detect less common etiological factors or treatment effects. Additionally, variables such as dietary potassium intake, medication adherence, and long-term follow-up outcomes were not assessed. Future research should focus on multicenter, prospective, and interventional studies with extended follow-up to better elucidate causal pathways and long-term outcomes of hyperkalemia.

Conclusion

This study highlights the significant burden of acute hyperkalemia among hospitalized patients, particularly those with underlying comorbidities such as hypertension, diabetes mellitus, and chronic kidney disease. Medications including ACE inhibitors, diuretics, and NSAIDs played a substantial role in exacerbating hyperkalemia. Despite adherence to standard treatment protocols, potassium normalization was achieved in fewer than half of the patients, underscoring the complexity of management in high-risk populations. The findings emphasize the importance of individualized treatment strategies, vigilant monitoring, and proactive risk mitigation to improve patient outcomes. In resource-limited settings such as Peshawar, early recognition and tailored management of hyperkalemia remain critical for reducing morbidity and mortality.

Authors' Contributions:

All authors meet the ICMJE criteria for authorship.

Author 1: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 2: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 3: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Author 4: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.
Author 5: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.

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