

Predictors of Outcome in Patients Presenting with Moderate to Severe Hyperkalemia

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Abstract

Introduction: One of the most common electrolyte imbalance observed in Emergency Departments (ED) is hyperkalemia [Potassium (K) level >5.5 mEq/dL]. Moderate to severe hyperkalemia (K level >6.0 mEq/dL) may cause serious arrhythmias therefore it is important to correct hyperkalemia promptly and treat the underlying cause.

Objective: The aim of this study is to assess patients with moderate to severe hyperkalemia presenting in the emergency department. Also, we will be considering patient mortality and factors associated with hyperkalemia.

Methods: The study was conducted in Aga Khan University Hospital Department of Emergency Medicine during November 2008-October 2009. All adult patients (age \geq 16) who visited ED with moderate to severe hyperkalemia were included. Complete medical charts of all the eligible patients were reviewed and relevant information was collected in the data collection tool. Data was analyzed using SPSS v16, along with the calculation of frequencies and proportions of categorical data. 2x2 tables were used to assess the association between hyperkalemia vs. age, sex, co morbidities, presenting complaints, presence of hypotension and chronic kidney disease. Statistically significant variables were entered into a multiple logistic regression model to determine the strength of association.

Results: There were a total 247 eligible patients, out of whom 51.8% were males and rest were females. 45% patients were between 46-65 years of age while 43% were above 65 years of age with only 12.3% patients between 15-45 years. 29% patients had 1-2 Comorbid conditions, whereas 69% of patients had \geq 3 comorbid. Survival data was available for 213 patients; out of whom 186 (87.3%) patients survived till discharge. Of expired, 89% patients had K level 6.0-7.0 mEq/dL and only 11% had K level of >7.0 mEq/dL. Age, coronary artery disease, high anion gap and moderate hyperkalemia were negatively associated with survival.

Conclusion: In patients presenting with hyperkalemia, increasing age, high anion gap metabolic acidosis and moderate hyperkalemia (K level 6.0-7.0 mEq/dL) are chief predictors of mortality.

Keywords: Hyperkalemia; Acidosis; Mortality; Predictors; Emergency department

Introduction

In previous literature, hyperkalemia is defined as serum potassium (K+) concentration greater than 5.5 mEq/dL which is very common in patients visiting Emergency rooms, and mostly associated with adverse clinical outcomes [1-4]. Its prevalence and clinical impact in critically ill Emergency Department (ED) patients is not fully discovered yet but it is thought to occur in 1-10% of patients admitted to the hospital [5]. Majority of the patients have underlying end-stage renal disease, which causes decreased excretion of dietary potassium, chronic asymptomatic, hyperkalemia, or metabolic acidosis induced extracellular shift of potassium leading to acute hyperkalemia [6-8]. Although the condition is associated with a variety of clinical presentations, EKG manifestations of hyperkalemia are generally progressive and proportional to the serum K+ and ventricular arrhythmias may be the first EKG finding of hyperkalemia. Sometimes, however, normal EKG may be seen even with very high serum potassium levels [1-3,9]. The management of hyperkalemia also depends on an understanding of the underlying physiology, cause of hyperkalemia and plasma potassium levels. Treatment is aimed at restoring normal potassium balance, preventing life threatening complications and treating the underlying causes [8,10,11]. Generally authorities consider that serum K+ concentration of greater than 6.0mEq/dL with ECG changes, or greater than 6.5 mEq/dL regardless of the ECG, represents severe hyperkalemia that warrants urgent treatment [11,12]. Despite many patients presenting to EDs in critical condition, predictors of clinical outcomes such as in-hospital mortality have not been well studied [12]. We therefore introduce this study to identify common factors associated with moderate to severe hyperkalemia and to analyze the relationship between serum K+ levels and clinical outcomes, including in-hospital mortality.

Materials and Methods

The study was conducted in Aga Khan University Department of Emergency Medicine (ED) during November 2008 till October 2009. All adult patients (age \geq 16) who presented to ED with moderate to severe hyperkalemia were included. For the purpose of study, the serum K+ level was classified as moderate hyperkalemia (K+: 6.0-7.0 mEq/dL) and severe hyperkalemia (K+: >7.0 mEq/dL). The medical charts of all eligible patients were reviewed and relevant clinical information was collected. Data was collected for demographic characteristics, underlying co-morbid conditions, presenting complaints, current medications, vitals at the time of ED presentation, management including medical treatment, hemodialysis, need for cardiac pacing and outcome at the time of hospital discharge. The patients were divided into two groups according to the serum potassium level i.e. Group 1: K 6.0-6.9 mEq/dl, and Group 2: K \geq 7 mEq/dl, to observe the difference in survival. Data was analyzed using SPSS v16, along with the calculation of frequencies and proportions of categorical data. 2x2 tables were used to assess the association between hyperkalemia vs. age, sex, co morbidities, presenting complaints, presence of shock and

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chronic kidney disease. Statistically significant variables were entered into a multiple logistic regression model to determine the strength of association.

Results

Total number of eligible patients was 247; out of which 51.8% were males (Table 1: Patient Characteristics). Majority of patients were elderly; 45% patients were between 46-65 years of age and 43% were above 65 years of age with only 12.3% patients between 15-45 years. Almost all of the patients had pre-existing medical conditions; 29% patients had 1-2 co-morbid, whereas 69% of patients had ≥ 3 co-morbid. Amongst these, hypertension, chronic kidney disease and diabetes were the most frequently observed pre-existing conditions (81%, 62% and 66% respectively) and more than one third of the patients had coronary artery disease. 70% of all the patients who presented with moderate to severe hyperkalemia had Serum Creatinine level between 2.1-9.9 mg/dl. Patients presented with a variety of nonspecific complaints including shortness of breath (n=90, 36%) diarrhea/vomiting (n=45, 18%), generalized weakness (n=45, 18%), fever (n=37, 15%). About 12% patients presented with signs of circulatory shock and required inotropic/vasopressor support. Most commonly patients were treated with medications such as Insulin/ dextrose solution to facilitate intracellular transport of extracellular potassium, Calcium gluconate, a membrane stabilizer, potassium binding raisins like Keyexalate and sodium bicarbonate, where indicated. In addition to medications, 31 (12.5%) patients needed hemodialysis. Although none of them presented with cardiac arrest, 8 patients required temporary pacemaker in Emergency Department due to symptomatic bradycardia/ arrhythmias. With respect to serum potassium level, majority of patients in group 1 were treated with medications alone (87%) whereas 9% required hemodialysis. 76% patients from Group 2 were also treated with medications but a larger proportion (19%) required hemodialysis (Figure 1: Treatment). Treatment details of three patients were not available.

Patient Characteristics		Potassium level	
	n (%)	6.0-6.9 mEq/dl	≥ 7 mEq/dl
n=247		162 (65.6)	85 (34.4)
Sex			
Male	128 (52)	92	36
Female	119 (48)	70	49
Age (Years)			
15-45	30 (12.3)	20	10
46-65	109 (44.6)	65	44
>65	105 (43)	76	29
Unknown	3 (1.2)		
Co-morbid conditions			
Hypertension	200 (81)	128	72
Diabetes	163 (66)	105	58
Coronary artery Disease	91 (36.8)	53	38
Chronic Kidney disease	153 (62)	100	53
Others	14 (5.7)	11	3
S. Creatinine level			
≤ 2 mg/dl	25(10.1)	16	9
2.1-9.9 mg/dl	173 (70.1)	114	59
≥ 10 mg/dl	46 (18.6)	30	16
Unknown	3 (1.2)		
Mortality	27 (10.9)	24	3

Table 1: Patient Characteristics.

Multi-logistic regression analysis for predictors of mortality				
Variables	Odds Ratio	95% Confidence Interval		P Value
Age	1.05	1.006	1.095	0.025*
Diabetes	0.983	0.33	2.933	0.976
Hypertension	0.251	0.068	0.932	0.039 [§]
Coronary Artery Disease	3.642	1.222	10.853	0.02*
Chronic Kidney Disease	1.024	0.349	3.009	0.965
Hypotension on presentation	3.928	0.58	26.582	0.162
K level 6-6.9 mEq/dl	1 (ref)			
K level ≥ 7 mEq/dl	0.113	0.026	0.498	0.004 [§]
Anion Gap ≤ 13	1 (ref)			
Anion Gap (13.1-16)	4.654	1.204	18.001	0.026*
Anion Gap (≥ 16.1)	5.005	1.321	18.97	0.018*

Table 2: Predictors of mortality in patients with moderate to severe hyperkalemia.

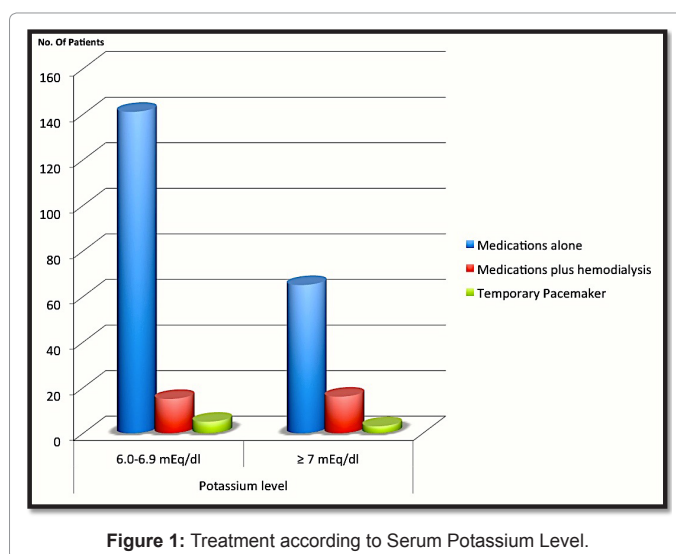


Figure 1: Treatment according to Serum Potassium Level.

Survival data was available for 213 patients; out of whom 186 (87.3%) patients survived till hospital discharge. Univariate analysis revealed that age, presence of diabetes, hypertension, coronary artery disease, and chronic kidney disease, presence of shock, serum potassium levels and high anion gap metabolic acidosis were predictive of poor survival. Serum Creatinine level, presenting complaint, type of treatment, including vasopressors had no association with the mortality. The variables that were found to be independently associated with mortality are listed in Table 2. Age (OR: 1.05, CI 1.006-1.095), coronary artery disease (OR: 3.642, CI 1.222-10.853) and high anion gap metabolic acidosis (OR: 4.654, CI 1.204-18.001) were positively associated with mortality, whereas diabetes, chronic kidney disease and hypertension were not associated with poor survival. Of note, among hypokalemic patients, there was a tendency toward a higher risk of mortality when the K⁺ level was between 6-6.9 mEq/dl. The patients with higher K⁺ levels were found to be associated with better survival (OR: 0.113, CI 0.026-0.498) when other variables were adjusted.

Discussion

Moderate to severe hyperkalemia is relatively a common presentation in acute care setting that requires urgent treatment to avoid fatal outcomes such as neuromuscular blockade, cardiac arrhythmias and sudden cardiac death [8,13]. Frequent causes of hyperkalemia include Renin-angiotensin-aldosterone inhibitors, potassium sparing diuretics and high dietary potassium intake relative to residual renal function. Acute conditions such as rhabdomyolysis, extensive burns and

extracellular shift of potassium caused by the metabolic acidosis of acute kidney injury may also cause sudden and severe rise in serum potassium level [5,6,14]. Patients with chronic kidney disease present a special problem because of frequent development of electrolyte imbalance and simultaneous presence of high anion gap acidosis and sometimes sepsis. Majority of these patients are older with other common pre-existing conditions such as hypertension, diabetes and coronary artery disease, thus multiple diagnosis and severity of underlying diseases also influence the overall outcome [14]. Our study verified that age was an independent predictor of mortality and odds of death increased by 5% for each year increase in age. Contrary to other studies [9,12,13,15], our findings suggested that presence of chronic kidney disease or level of creatinine did not predict survival independently, this may reflect that other indicators of worsening kidney function such as eGFR are better predictors of outcome than serum creatinine alone [13]. It was also important to note that the presence of shock or use of inotropic agents was not associated with increased risk of mortality in patients with hyperkalemia. However, age, severe metabolic acidosis and underlying coronary artery disease had a significant negative association with survival. Moreover, very high level of serum potassium seems to have less deleterious effect when compared to K level of 6.0-6.9 mEq/dl, One of the possible explanations in patients with chronic renal insufficiency is the compensatory response to chronic hyperkalemia, in which the body eventually develops a new steady state potassium level that is often higher than normal range. This observation has led to the practice of treatment of moderate hyperkalemia in the outpatient setting [6,11]. However, when acidosis causes potassium to shift into extracellular space, the treatment is directed to the correction of underlying cause and acid-base balance than just normalization of serum potassium level. In such instances, metabolic acidosis is associated with volume depletion, sepsis, blood loss in both acute and chronic kidney disease, which contribute to mortality significantly [12,15]. For this subset of patients, aggressive resuscitation, close monitoring and critical care support is needed regardless of serum potassium levels [12]. The negative association of severe hyperkalemia with mortality is poorly understood in this study and further in-depth studies on a larger population are needed to make sure that this finding is not merely by chance.

Limitations

Retrospective analyses such as this one have certain limitations that should be considered when interpreting the results. First, our study population was hospitalized and diagnosed with severe hyperkalemia; there was no control group. Therefore, it is possible that some patients with severe hyperkalemia, (K level ≥ 7 mEq/dl) never make it to hospital and others may be treated as outpatients. Second, the incidence of hyperkalemia is detected only at the time of ED admission and does not account for the occurrence of diagnosis at unobserved times. Third this is a single center study which may not be representative of a larger population.

Conclusion

Moderate to severe hyperkalemia is associated with higher risk of mortality when combined with high anion gap metabolic acidosis. Also, age, hypertension and coronary artery disease have negative relation with survival in patients with hyperkalemia.

Author's Contributions

AM wrote the manuscript whereas BA revised the final version. SK helped with data collection and entry. TKZ and SS helped in literature review. All authors read and approved the final manuscript.

Competing Interests

There are no competing interests.

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