

Importance of etiologic factors and electrocardiographic findings for diagnosis of emergency hyperkalemic patients

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ABSTRACT

Background: Hyperkalemia is the life-threatening problem. Early diagnosis and treatment of patients with the possibility of hyperkalemia should be performed in emergency department. Comorbid diseases used medications and electrocardiography (ECG) findings can be important clues for the possibility of hyperkalemic states. **Objectives:** In our study, we aimed to identify causes of hyperkalemia in patients who admitted to emergency department and to evaluate the importance of the relationship between hyperkalemia and ECG. **Materials and Methods:** Our study design was prospective. The patients who admitted to emergency department which has annual turnover of 70,000 patients between June 01, 2012, and June 01, 2014, were investigated. Total 100 patients aged 18 years and above who had hyperkalemia were included in the study. Patients were divided into three groups according to the level of potassium (1-mild: 5-5.9 mEq/L, 2-moderate: 6-7 mEq/L, 3-severe: >7 meq/L) and ECG finding of these hyperkalemic patients were evaluated. Patients were categorized according to etiology of hyperkalemia in four groups. They are chronic renal failure (CRF), acute renal failure (ARF), (angiotensin-converting-enzyme inhibitor /angiotensin-receptor blocker (ACEI/ARB) use and spironolactone use. **Results:** In our study, we included 100 patients with hyperkalemia. Potassium value of patients was maximum 8.1 mEq/L and mean value was 6.12 ± 0.66 mEq/L. There was no significant correlation between the ECG and potassium level ($P = 0.107$). In our study, we found that the most contributing cause was CRF, the second was ARF and the third was ACEI/ARB +/- spironolactone. **Conclusions:** According to our study, it should be kept in mind that even if the ECG findings are normal, hyperkalemia may occur in patients with ARF, CRF, spironolactone, and ACEI/ARB drug users.


KEY WORDS: Hyperkalemia; Electrocardiography; Emergency Department

INTRODUCTION

Potassium (K⁺) is an important electrolyte for human life. It is essential positive cation in cells. It plays a role in muscle contraction and nerve conduction, maintaining fluid, and electrolyte balance in the body. Potassium levels

are 150-160 mEq/L in intracellular and 3.5-5.0 mEq/L in extracellular compartment. Insulin, catecholamines, and acid-base balance affect to move potassium into the cells. 90% of the potassium is excreted from the kidney. Therefore, renal function is important in ensuring the potassium balance.^[1-4]

Hyperkalemia is defined as a serum potassium concentration above 5.0 mmol/l.^[4] Potassium ≥ 10 mEq/L is often fatal.^[5] Clinical findings of hyperkalemia depend on electrophysiological distortion. In hyperkalemic state, cardiac effects of potassium occur due to the cell membrane depolarization. Hyperkalemia slows the ventricular neurotransmission.^[1,2,6]

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Hyperkalemia is the life-threatening problem. Early diagnosis and treatment of patients with the possibility of hyperkalemia should be performed in emergency department. Comorbid diseases used medications and electrocardiography (ECG) findings can be important clues for the possibility of hyperkalemic states. In our study, we aim to identify causes of hyperkalemia in patients who admitted to emergency department and to evaluate the importance of the relationship between hyperkalemia and ECG. Typical ECG findings in hyperkalemia are shown in Table 1.^[7] Etiologies of hyperkalemia are summarized in Table 2.^[8]

MATERIALS AND METHODS

Our study desing was prospective. Patients who were above 18 years old and who admitted to emergency department of Cukurova University between June 1, 2012, and June 1, 2014, were investigated. Patients who had with hyperkalemia in their blood samples which were taken for any reason were evaluated. When hyperkalemia was detected, potassium for example was taken again from back of the hand without tourniquet. Thus, false hyperkalemia results were detected.

In our study, we invastigated 100 patients who had ECG with true hyperkalemia. Patients were divided into three groups according to the level of potassium; 1-mild: 5-5.9 mEq/L, 2-moderate: 6-7 mEq/L, and 3-severe: >7 meq/L. The demographic characteristics, complaints, comorbid diseases, used medications, biochemical parameters (urea, creatinine, sodium, potassium, and calcium levels), venous blood gase, ECG and ultrasonography findings, and control potassium levels of the patients were recorded. ECG findings shown in Table 1 were considered diagnostic for the electrocardiographic effects of hyperkalemia. Patients were categorized according to possible etiology into four groups; (1) chronic renal failure (CRF), (2) acute renal failure (ARF), and (3) angiotensin-converting-enzyme inhibito /angiotensin receptor bloker (ACEI/ARB) use, and (4) spironolactone use.

The statistical analysis of our data was performed using the "SPSS for Windows version 17.0" software. Mann–Whitney U test, Kruscal–Wallis test, and Chi-square test were employed in the analysis.

Ethics approval for this study was obtained from Cukurova University/Turkey.

RESULTS

There were 100 patients who were included in our study. 51 (51%) of patients were male, 49 (49%) of patients were female. The mean of age was 62.52 ± 17.290 (minimum 23, maximum. 92). Potassium value was maximum 8.1 mEq/L and mean value was 6.12 ± 0.66 mEq/L. 44 (44%) of patients had mild, 33 (33%) had moderate, and 23 (23%)

Table 1: ECG changes associated with the severity of hyperkalemia

Blood potassium level (mmol/l)	Major ECG changes
5.5-6.5 mmol/l	Tall, peaked (tented) T waves (T wave larger than R wave in more than 1 lead)
7.0 mmol/l	Prolonged PR interval
7.5 mmol/l	Flattened or absent P waves
>8.0 mmol/l	Widened QRS (>0.12 s) Sine wave pattern (S and T waves merging) Bradycardia Ventricular tachycardia

ECG: Electrocardiography, QRS: QRS complex

Table 2. Pathogenesis and causes of hyperkalemia

Pathogenesis of hyperkalemia	Causes of hyperkalemia
False Hyperkalemia	Hemolysis Tight turnstile Thrombocytosis Leukocytosis
Impaired elimination of potassium	ARF, CRF Pseudohypoaldosteronism, hypoaldosteronism, and congenital adrenal hyperplasia Medications (ACEI, ARB, NSAI) Mannitol Drugs interfering with renal potassium excretion (amiloride, spironolactone, and triamteren)
Increased shift of potassium from intra to extracellular space	Trauma Burn injury Rhabdomyolysis, tumorlysis, hemolysis, and after massive transfusion Acidosis Hyperkalemic periodic paralysis Hyperglisemia Succinylcholine
Excessive intake	

ARF: Acute renal failure, CRF: Chronic renal failure, ACEI: Anjiotensin-converting-enzyme inhibitor, ARB: Anjiotensin receptor bloker, NSAI: Non-steroidal anti-inflammatory

had severe hyperkalemia. 34 (34%) of the patients had electrocardiographic findings.

In our study, we found that 37 (37%) of patients had CRF, 30 (30%) had ARF, and 10 (10%) of patients were ACEI/ARB ± spironolactone users. According to our study, the most contributing cause was CRF, the second was ARF and the

third was ACEI/ARB ± spironolactone. 34% of the patients had electrocardiographic findings (Figure 1).

According to our study, there was no statistical relation between potassium level and sex ($P=0.578$), ARF ($P=0.830$), CRF ($P=0.870$), drug use ($P=0.749$), and age ($P=0.890$). In addition, we did not find any statistically significant relationship between ECG findings and sex ($P=0.780$), ARF ($P=0.407$), CRF ($P=0.774$), drug use ($P=0.865$), and age ($P=0.425$). There was no significant correlation between the ECG and potassium height ($P=0.107$).

DISCUSSION

Potassium imbalance is one of the common electrolyte disorders in clinical practice. Although it can be diagnosed incidentally in a asymptomatic patient, it can be a cause for life-threatening symptom. The demographic characteristics and comorbidities of patients, medications used are quite important in etiology of hyperkalemia. In this study, we examined the predisposing factors of hyperkalemia and relationship between ECG and hyperkalemia.

In the study by Fordjour et al., CRF was found most common cause and ACEI and spironolactone used was found the second in hyperkalemic patients. They showed that 50% of patients had ECG findings.^[9] In the study by Acker et al., renal failure was found cause of hyperkalemia in 77% of patients, while drugs was found cause in 63% of hospitalized hyperkalemic patients.^[10] In our study, we have achieved similar result. According to our study, the most common contributing factors of hyperkalemia are renal failure, ACEI/ARB, and spironolactone used.

Hyperkalemia is a known complication of the use of ACEI. In the study by Ahuja et al., the rate of hyperkalemia in patients using ACE inhibitors was found 38% and the ratio of hyperkalemia was found 10% after 1-year drug use.

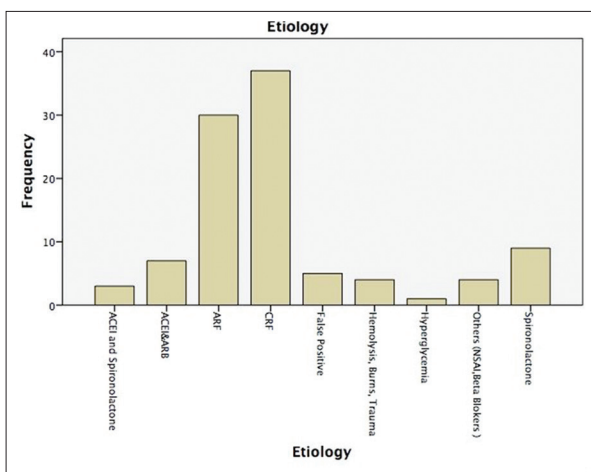


Figure 1: The etiology of hyperkalemia

The risk of developing hyperkalemia has been shown to be higher in diabetes and chronic kidney disease.^[11] Patients who have renal dysfunction and who use medications that renal angiotensin aldosterone bloker have a high risk of developing hyperkalemia. In the study by Reardon and Macpherson, ACE inhibitors was found to be an independent risk factor for hyperkalemia in patients with a creatinine value of >1.5 mg/dl.^[12]

In the study by Schepkens et al., it was shown that patients who had the creatinine value between 1.8 and 2.0 mg/dl with using high dose spironolactone were higher risk for hyperkalemia.^[13] In our study, we observed the use of spironolactone in 9%, ACEI or ARB in 8%, and spironolactone with ACEI/ARB combination in 8% of patients.

The ECG findings depend on the degree of hyperkalemia. In the literature, it has been observed that many cases with severe hyperkalemia have normal ECG results. In our study, we have similar results. A study by Acker et al., ECG abnormalities were shown in only 14% of 242 hyperkalemic patients.^[10] In the study by Aslam et al., ECG of 74 hemodialysis patients with hyperkalemia were compared. They did not identify any typical hyperkalemia findings on ECG.^[14] In the study by Cohen et al., they evaluated 309 patients and found no relationship between potassium elevation and ECG findings.^[15]

Although there is no significant correlation between ECG findings and hyperkalemia, ECG findings of hyperkalemia has been shown in the majority of patients who have potassium above 7 mmol/L.^[16] The appearance of typical ECG findings in hyperkalemia plays an important role in patient management. An ECG may be an important clue for the emergency physician in patients with hyperkalemia who may be overlooked because of the intensity of the emergency department. However, as shown in our study, we may not always be able to see ECG findings in hyperkalemia.

Limitations

We investigated the patients who were taken potassium for any reason in our study. ECG interpretation is made by a emergency specialist. The fact that interpreting is person-dependent creates a limitation in our work

CONCLUSIONS

According to our study, ECG should not be relied on for the diagnosis of hyperkalemia. ARF and ACEI/ARB, and spironolactone used were found most common contributing factors of hyperkalemia in emergency department. Patients with hyperkalemia should be specifically questioned for renal disease and potassium spironolactone and ACEI/ARB used. It should be kept in mind that even if the ECG findings

are normal, hypertension may occur in patients with ARF, CRF, spironolactone, and ACEI/ARB drug users.

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