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Authors

Kagan, Igor

Sarmosyan, Kristine

Hwang, Michelle

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Visual Diagnosis Pearl

EKG Changes from Life-threatening Hyperkalemia

Igor Kagan¹, Kristine Sarmosyan¹, Michelle Hwang¹

¹ Medicine, University of California, Los Angeles

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A 66-year-old female with a past medical history of chronic kidney disease stage 4 (CKD), type 2 diabetes mellitus, heart failure with reduced ejection fraction (HFrEF), and pulmonary hypertension, presented to the Emergency Department (ED) after a fall in her bathroom. The patient reported new-onset weakness that started several days prior to presentation. A week prior to the presentation she had an episode of nausea resulting in decreased oral fluid intake. She attributed this to a new medication, sotatercept, a 45mg injection every 3 weeks prescribed for her pulmonary hypertension. Her other significant medications included linagliptin 5mg daily, metformin 1000mg twice daily, tadalafil 40mg daily, metolazone 2.5mg twice per week, torsemide 100mg twice daily, spironolactone 50mg daily, empagliflozin 25mg daily and 48 milliequivalents of potassium chloride twice a day to supplement her electrolytes based on her aggressive diuretic regimen.

Initial blood testing in the emergency department demonstrated profound hyperkalemia with a serum potassium of 9.2 mmol/L (N 3.5 to 5.2 millimoles per liter (mmol/L) and the electrocardiogram (EKG) showing ventricular tachycardia ([Figure 1](#)). The patient received emergent temporizing measures, which 2 grams of calcium gluconate, 10 units of intravenous (IV) regular insulin and magnesium sulfate 2 grams. This resulted in successful stabilization of the patient's cardiac rhythm. Repeat blood tests showing only partial improvement in the hyperkalemia, with the serum potassium decreasing to 8.3 mmol/L. After activating the nephrology consult team, the patient received hemodialysis for definitive management of persistent hyperkalemia in under three hours from arrival in the ED. The patient was dialyzed with a 2 meq/L potassium dialysate bath. Repeat serum potassium after dialysis decreased to 6.2 mmol/L. The patient was then started on continuous renal replacement therapy (CRRT) to help further normalize her potassium.

DISCUSSION

The etiology of our patient's hyperkalemic crisis was likely triggered by her transient decreased fluid intake resulting in a pre-renal state given the significant diuresis that the patient is also prescribed. In addition, the potassium supplements and ongoing intake of spironolactone which inhibits renal aldosterone specific mineralocorticoid receptors and decreases sodium and water reabsorption in exchange for retaining potassium.

This case illustrates the classic electrocardiographic (EKG) changes of severe hyperkalemia, the risk of rapid progression to life-threatening arrhythmias and the importance of immediate temporizing measures. EKG changes of hyperkalemia start with peaked T waves, followed by PR interval prolongation and P wave flattening with rising serum potassium levels. With serum potassium above 8 mmol/L there is pronounced peaking of T-wave, QRS widening and ST depression. This ultimately progresses to a sine wave pattern when the potassium level reaches 9 mmol/L.¹ One study showed that patients with hyperkalemia had 30.7% in-hospital mortality.² Temporizing measures are vital for immediate management of hyperkalemia. The Kidney Disease Improving Global Outcomes (KDIGO) program provides a framework for management of acute hyperkalemia which was followed in our case. Patients with hyperkalemia require continuous electrocardiographic (EKG) monitoring, and when EKG changes are noted. Intravenous calcium along with IV insulin are administered to stabilize the cardiac membranes and facilitate intracellular potassium redistribution. Additional management considerations include intravenous sodium bicarbonate, loop diuretics and potassium binders, as clinically indicated. If the repeat potassium after receiving immediate temporizing treatment continues to remain above 6 mmol/L then dialysis should be considered.³ It is important that stat dialysis protocols are available to dialyze patients in need. UCLA provides 24-hour, 7 days a week inpatient dialysis coverage with a stat response time of 2 hours for patients requiring emergent dialysis.

Our vignette clearly demonstrates the potentially lethal nature of severe hyperkalemia and the necessary pathways that are required to treat patients presenting with significant EKG changes due to hyperkalemia.



Figure 1. Hyperkalemia induced monomorphic ventricular tachycardia.



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