

Severe Hypokalemia

A 68-year-old female is brought to the emergency department because of weakness, vomiting, and diarrhea for the past day. She has a history of hypertension treated with metoprolol, liver cirrhosis, and vaginal cancer. She drinks 3 whiskeys and smokes 1 pack per day and denies illicit drug use. Physical exam shows mild scleral icterus, irregular rhythm with tachycardia, hypotension, and a soft, nondistended, nontender abdomen.

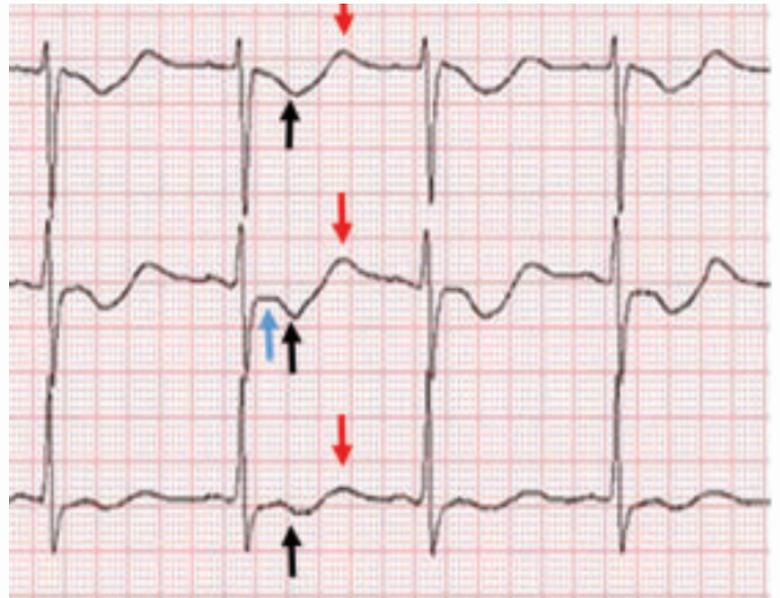
Initial labs were significant for hemoglobin 6.1, potassium 1.2, magnesium 1.3, creatinine 6.2, BUN 26, chloride 112, bicarbonate 16, calcium 7.4, troponin 1.66.

Initial ECG is significant for tachycardia, rate 126, irregular rhythm with occasional P waves, and ST segment abnormalities.

2 units of packed red blood cells are ordered and IV and oral repletion of potassium is started. What additional management can help avoid refractory hypokalemia?

- A. Albumin infusion
- B. Magnesium repletion
- C. IV regular insulin
- D. Calcium gluconate
- E. Dextrose

Figure 1. ECG changes in the setting of severe hypokalemia. Leads V2-V4 are significant for ST depression (blue arrow), T wave inversion (black arrow), U waves (red arrow).^{1,2}



The correct answer is B. Decreased levels of magnesium can hinder potassium repletion. A serum magnesium level should be ordered and repleted if necessary, particularly in patients with alcohol use disorder, in the setting of hypokalemia.

Although potassium and albumin have a positive correlation, albumin infusion is not indicated in the treatment of hypokalemia (Option A). Option D is indicated in patients with hyperkalemia as cardioprotective agent. Options C and E would both worsen hypokalemia by promoting intracellular uptake of potassium.

Discussion

Hypokalemia is defined as $<3.5\text{mEq/L}$. Severe hypokalemia is defined as $<2.5\text{mEq/L}$. Signs and symptoms usually occur in the setting of rapid changes or severe deficits. Commonly, patients with hypokalemia have an asymptomatic presentation but can also present with muscle cramping, constipation, respiratory distress, and ECG changes.³

All patients with hypokalemia should be evaluated in the emergency department with an ECG. Hypokalemia can cause life threatening arrhythmias such as atrial fibrillation, ventricular fibrillation, or ventricular tachycardia.²

Diagnosis is made with serum measurement of potassium. If there is no obvious etiology, additional testing can be performed including an arterial blood gas to evaluate for acid-base disorder or urinary electrolyte levels in the case of suspected renal loss.¹

Several etiologies of hypokalemia include gastrointestinal loss, renal loss, transcellular shifts, decreased intake, and cutaneous loss. Some of the more commonly encountered causes are related to diarrhea, vomiting, and diuretic use.³

Our patient's differentials for hypokalemia include gastrointestinal loss, hypomagnesemia, alcohol use, adverse effect of metoprolol, malnutrition, or renal loss.

Treatment

Treatment of hypokalemia depends on the severity of the deficit as well as the cause. Typically, mild hypokalemia can be managed with oral potassium replacement, or discontinuation of the offending drug. In cases where the potassium is less than 2.5mEq/L or the patient is experiencing arrhythmias, IV replacement is indicated with potassium chloride. If magnesium is also low, it should be repleted to avoid refractory hypokalemia. This is an especially common presentation in patients with alcohol use disorder. Insulin, dextrose, or other glucose containing solutions should be avoided during correction to avoid transcellular shift of potassium.¹

Our patient's hypotension and tachycardia were initially managed with 1 liter bolus of lactated ringer. Abnormal electrolytes were managed with 80mg potassium chloride PO, 30mg potassium chloride IV and 1g magnesium sulfate IV. Repeat potassium and magnesium were 1.6 and 2.3 respectively. Her anemia was managed with 1 unit of packed red blood cells. Repeat CBC showed a hemoglobin of 7.4. Cardiac monitor after initial management revealed sinus rhythm.

How does hypokalemia cause U waves on ECG?

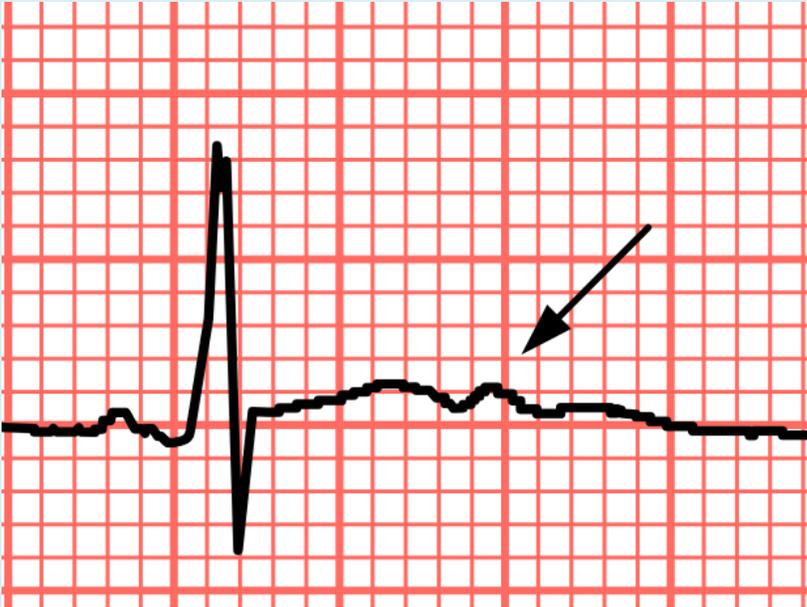


Figure 2.⁵ On ECG, a U wave is a continuation of the T wave and is due to delayed repolarization of the cell membrane related to a more electronegative resting potential.²

Take Home Points

- **Take a thorough medication and substance use history**
- **Always check magnesium in patients with hypokalemia and correct if necessary**
- **Cardiac monitoring is recommended**
- **During potassium correction, avoid insulin or dextrose**
- **Do not exceed an infusion rate greater than 20mEq per hour¹**



About the Author

This case was written by Samantha Dumala. Samantha is a 4th year medical student from FIU HWCOC. She completed her Emergency Medicine rotation at Broward Health Medical Center in June 2023 and plans on pursuing a career in Emergency Medicine.

References

1. Castro, H. C. (2005). *Emergency Medicine: A Comprehensive Study Guide*, 6th Edition: By Judith Tintinalli, Gabor Kelen, and J. Stapczynski. New York, NY: McGraw-Hill Professional, 2003, 2,016 pages, \$175.00 (hardcover). *Academic Emergency Medicine*, 12(6), 577-578. <https://doi.org/10.1197/j.aem.2005.03.024>
2. Wang, X., Han, D., & Li, G. (2020). Electrocardiographic manifestations in severe hypokalemia. *Journal of International Medical Research*, 48(1), 0300060518811058.
3. Kardalas E, Paschou SA, Anagnostis P, Muscogiuri G, Siasos G, Vryonidou A. Hypokalemia: a clinical update. *Endocr Connect*. 2018 Apr;7(4):R135-R146. doi: 10.1530/EC-18-0109. Epub 2018 Mar 14. PMID: 29540487; PMCID: PMC5881435.
4. Gerhard Malnic, Gerhard Giebisch, Shigeaki Muto, Wenhui Wang, Matthew A. Bailey, Lisa M. Satlin, Chapter 49 - Regulation of K⁺ Excretion, Editor(s): Robert J. Alpern, Orson W. Moe, Michael Caplan, Seldin and Giebisch's *The Kidney* (Fifth Edition), Academic Press, 2013, Pages 1659-1715, ISBN 9780123814623, <https://doi.org/10.1016/B978-0-12-381462-3.00049-5>(<https://www.sciencedirect.com/science/article/pii/B9780123814623000495>)
5. File:U wave.svg - Wikimedia Commons. (2012, October 15). https://commons.wikimedia.org/wiki/File:U_wave.svg