

## Simulation Patient Design (May, 2022) Case of Hyperkalemia in Pregnancy

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### Introduction

Hyperkalemia in pregnancy is a rare condition and is associated with an increased risk of both short-term and long-term morbidity and mortality.<sup>1</sup> In particular, acute changes in the extracellular plasma potassium concentration can be fatal for the mother and subsequently for the fetus.<sup>2</sup>

### Major causes

Etiologies of hyperkalemia are broad and can be categorized into excess potassium influx versus poor potassium clearance, and while these pathways are not mutually exclusive, they often complicate one another. Pregnancy adds an extra layer of complexity given the impact from normal physiologic changes of pregnancy (such as relative tachypnea, tachycardia, and mild respiratory alkalosis) or pregnancy-specific disease states (such as preeclampsia, pregnancy loss and major hemorrhage).<sup>3,4,5</sup> Resuscitation with large volumes of red blood cells leads to hyperkalemia which may increase morbidity and mortality if not rapidly identified and treated.<sup>6</sup>

### Clinical manifestations

Hyperkalemia affects the cardiac, gastrointestinal, and central nervous systems. On physical examination, the patient will often present with tachypnea, tachycardia, and abdominal discomfort. Electrocardiogram changes can manifest as sinus tachycardia and peaked T-waves, which are hallmarks of this physiologic disturbance. Nausea and vomiting, with possible diarrhea are often reported. If untreated, the patient can progress to altered mental status, ventricular tachycardia or ventricular fibrillation, and ultimately death.<sup>7</sup>

### Treatment pathways and goals

The goal of acute treatment is to remove the source of the inflowing potassium and reduce circulating potassium either by forcing cell influx or through excretion. Both of these strategies can be overwhelmed in the perioperative setting especially if excretion organs are dysfunctional or the amount of potassium influx is extreme.

Treatment options in the perioperative setting include:

- Calcium chloride 1000 mg IV or calcium gluconate 1000 mg IV, over 2-3 minutes
- Regular insulin 10 u and dextrose 25 g IV, over 15 min
- Sodium bicarbonate 8.4% solution 1 mL/kg IV
- Albuterol 10-20 mg inhaled
- Furosemide IV 40-80 mg
- Hyperventilation (if being ventilated)
- Emergent dialysis

**Educational Rationale:** To teach team skills in managing hyperkalemia

**Target Audiences:** Nursing, OB, Anesthesiology

**Learning Objectives:** As per Accreditation Council for Graduate Medical Education (ACGME) Core Competencies. Upon completion of this simulation (including the debrief) learners will be able to:

- *Medical knowledge:* Identify causes of hyperkalemia as it relates to pregnancy. Identify clinical manifestations of hyperkalemia. Describe the balance between intracellular and extracellular potassium hemostasis and how treatments options affects each compartment.
- *Patient care:* Manage acute life-threatening hyperkalemia in a team setting. Describe management of hyperkalemia including medications (e.g. calcium, albuterol, insulin with dextrose etc.), maneuvers (e.g. hyperventilation, cardioversion) or other treatments (e.g. dialysis.).
- *Practice-based learning and improvement:* Adapt to a changing clinical picture. Call for medications and equipment that may not be readily available in the operating room (e.g. defibrillator).
- *Interpersonal and communication skills:* Demonstrate closed-loop communication, clear sign-outs of critical values and identify other team members to help with management.
- *Professionalism:* Communicate effectively to team members, even while under pressure.
- *Systems-based practice:* Identify rate-limiting steps for identifying and treating hyperkalemia.

**Questions to ask after the scenario:**

- Identify any specific lapses in communication and where they could be improved
- Was this complication preventable or inevitable?
- Once the diagnosis was established, were there challenges in providing emergent treatments?
- How did pregnancy affect this patient's care?
- What system-based initiatives could have prevented this outcome?
- This patient presented at 11 weeks gestation, how would your management plan change if her gestational age was 25 weeks - would you offer fetal heart rate monitoring and/or emergency delivery panning?

**Assessment Instruments:**

1. Learner Knowledge Assessment form (Appendix 1)
2. Simulation Activity Evaluation form (Appendix 2)

**Equipment Needed and Set-up:**

**In-situ set-up**

ASA standard monitors including ECG, BP, SPO<sub>2</sub> and ETCO<sub>2</sub>

Point-of-care testing for blood gas and electrolyte evaluation

Defibrillator

12-lead EKG machine

POCUS ultrasound machine

## Simulation Scenario Set-up:

### The case

A 41-year-old patient (G2P1) at 11 weeks gestational age presents for placement of a tunneled dialysis line. She has a 6-year history of focal segmental glomerulosclerosis (FSGS) with end-stage renal disease and has dialysis on Mondays, Wednesdays, and Fridays.

The patient was admitted one week ago after a fall and was found to have fever and chills. The team noticed erythema and edema around her tunneled dialysis catheter so it was removed and she was started on antibiotics. Her last dialysis was 48 hours ago. The patient was added to the OR schedule for line placement but it has been delayed due to emergent cases. The surgical resident has asked the OR team to bring the patient to the OR as they saw an anesthetic pre-operative assessment in the medical record from 2 days ago and thought the patient was 'cleared' for the procedure.

### Simulation Pre-Brief

- Read the scenario and instruct team members on their role during the simulation
- The learners take their places

### Scenario

Trigger	Patient Condition	Action	Done	Time	Comments
The patient is on the OR table without any monitors	Awake + alert though not answering questions appropriately	<input type="checkbox"/> Complete pre-operative evaluation <input type="checkbox"/> Verify NPO status <input type="checkbox"/> Review labs <input type="checkbox"/> Review baseline EKG <input type="checkbox"/> Confirm perioperative fetal monitoring			
	BP 110/65 mm Hg HR 105 bpm Sat 98% (air) Resp 18/min  EKG: Mildly elevated T waves	<input type="checkbox"/> Check IV access <input type="checkbox"/> Ensure fluid restriction <input type="checkbox"/> Send labs + perform point-of-care (POC) test			
The surgeon requests deep sedation	No clinical change  POC potassium = 5.2 mmol/L	<input type="checkbox"/> Discuss the risks/benefits/alternatives for light sedation vs. deep sedation vs. general anesthesia <input type="checkbox"/> Discuss alternative option for urgent dialysis, such as a new temporary dialysis catheter			
Patient is positioned	Patient becomes combative	<input type="checkbox"/> Start sedation <input type="checkbox"/> Perform left uterine displacement			

Sedation in progress	BP 105/60 mm Hg HR 110 bpm Sat 92% (with audible airway obstruction) Resp 6/min	<input type="checkbox"/> Manage airway <ul style="list-style-type: none"> <li>○ Chin lift/jaw thrust</li> <li>○ Apply facemask</li> <li>○ Lower or stop sedation if infusion is present</li> </ul>			
Good air flow noted	Patient calms down  BP 100/60 mm Hg HR 110 bpm Sat 95% Resp 8/min  EKG: Peaked T waves	<input type="checkbox"/> Consider hyperkalemia <input type="checkbox"/> Draw POC potassium <input type="checkbox"/> Call for help <input type="checkbox"/> Discuss concern with operative team + discuss plans <input type="checkbox"/> Discuss pausing, aborting, or changing procedure plan to a non-tunneled dialysis catheter <input type="checkbox"/> Hyperventilate with face mask			
Cardioversion	Patient is arousable with sternal rub only  BP 78/45 mm Hg HR 138 bpm Sat 88% (FiO <sub>2</sub> 1.0) Resp 8/min  EKG: Wide QRS complexes  POC potassium = 7.0 mmol/L	<input type="checkbox"/> Ask RN to bring code cart to OR <input type="checkbox"/> Stop all anesthetics/sedatives <input type="checkbox"/> Administer calcium (either calcium chloride 1000 mg IV or calcium gluconate 1000 mg IV, over 2-3 minutes) <ul style="list-style-type: none"> <li>○ Correct dose administered?</li> </ul> <input type="checkbox"/> Administer insulin + dextrose (25 g dextrose mixed with 10 U regular insulin IV, over 15 min) <ul style="list-style-type: none"> <li>○ Correct dose administered?</li> </ul> <input type="checkbox"/> Administer sodium bicarbonate 8.4% solution (boluses of 1 mL/kg) <ul style="list-style-type: none"> <li>○ Correct dose administered?</li> </ul> <input type="checkbox"/> Administer albuterol inhaled (10-20 mg) <ul style="list-style-type: none"> <li>○ Correct dose administered?</li> </ul> <input type="checkbox"/> Consider administering diuretic medication (furosemide 40-80 mg IV with or without thiazide) <ul style="list-style-type: none"> <li>○ Correct dose administered?</li> </ul>			

		<ul style="list-style-type: none"> <li>○ If not administered, why not? (Answer: decreased renal function at baseline is relative contraindication to loop and thiazide diuretics)</li> <li><input type="checkbox"/> Hyperventilate via facemask or secured airway</li> <li><input type="checkbox"/> Apply defibrillation pads, confirm synchronization + capture</li> <li><input type="checkbox"/> Perform cardioversion (under short-lasting sedation)</li> <li><input type="checkbox"/> Call for emergent dialysis to be brought to the OR or PACU</li> </ul>			
	<p>Pt is arousable to voice</p> <p>BP 95/48 mm Hg HR 100 bpm Sat 98% Resp 16/min</p> <p>EKG: Normal QRS complexes</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Ask surgeon for temporary dialysis catheter</li> <li><input type="checkbox"/> Initiate emergent dialysis</li> <li><input type="checkbox"/> Discuss disposition: PACU vs. ICU</li> <li><input type="checkbox"/> Recheck POC potassium</li> <li><input type="checkbox"/> Update patient + family</li> </ul>			
Transfer to ICU	<p>Patient is drowsy</p> <p>BP 98/52 mm Hg HR 92 bpm Sat 98% Resp 14/min</p> <p>Potassium = 5.5 mmol/L</p> <p>FHT = 138/min</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Sign-out events to MD team</li> <li><input type="checkbox"/> Plan for scheduled potassium checks</li> <li><input type="checkbox"/> Establish plan should the patient become hyperkalemic prior to dialysis</li> <li><input type="checkbox"/> Check fetal heart rate</li> </ul>			

## Appendix 1

### Learner Knowledge Assessment Labor and Delivery Multidisciplinary Team Simulation

Name of simulation: \_\_\_\_\_

Date: \_\_\_\_\_

OB Nursing Anes

Each item has two components. The “Before the simulation” column (left side) examines your perspective at the beginning of the simulation. The “End of Simulation” column (right side) is to evaluate your perspective at the completion of the simulation.

#### 1. How would you rate your knowledge of risk factors for hyperkalemia?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

#### 2. How would you rate your knowledge of differential diagnosis of hyperkalemia?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

#### 3. How would you rate your knowledge of signs and symptoms of hyperkalemia?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

#### 4. How would you rate your overall confidence if confronted with hyperkalemia?

BEFORE THE SIMULATION							END OF SIMULATION						
1	2	3	4	5	6	7	1	2	3	4	5	6	7
Little/none					Knowledgeable		Little/none					Knowledgeable	

## Appendix 2

### Simulation Activity Evaluation

DATE OF SIMULATION: \_\_\_\_\_

OCCUPATION: Consultant PG Yr 1 2 3 4    STUDENT    NURSE    MIDWIFE    OTHER

SPECIALTY: \_\_\_\_\_ YEARS IN PRACTICE: \_\_\_\_\_

Please rate the following aspects of this training program using the scale listed below:

1 = Poor      2 = Suboptimal      3 = Adequate      4 = Good      5 = Excellent

Use "N/A" if you did not experience or otherwise cannot rate an item

#### **INTRODUCTORY MATERIALS**

Orientation to the simulator	1	2	3	4	5	N/A
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#### **PHYSICAL SPACE**

Realism of the simulator space	1	2	3	4	5	N/A
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#### **EQUIPMENT**

Satisfaction with the mannequin	1	2	3	4	5	N/A
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#### **SCENARIOS**

Realism of the scenarios	1	2	3	4	5	N/A
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Ability of the scenarios to test technical skills	1	2	3	4	5	N/A
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Ability of the scenarios to test behavioral skills	1	2	3	4	5	N/A
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Overall quality of the debriefings	1	2	3	4	5	N/A
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#### **DID YOU FIND THIS USEFUL?**

To improve your clinical practice?	1	2	3	4	5	N/A
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To improve your teamwork skills?	1	2	3	4	5	N/A
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To improve your VERBAL communication?	1	2	3	4	5	N/A
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To improve your NONVERBAL communication?	1	2	3	4	5	N/A
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#### **FACULTY**

Quality of instructors	1	2	3	4	5	N/A
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Simulation as a teaching method	1	2	3	4	5	N/A
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#### **COMMENTS/SUGGESTIONS:**

## References:

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- <sup>1</sup> Wolak T, Shoham-Vardi I, Sergienko R, Sheiner E. High potassium level during pregnancy is associated with future cardiovascular morbidity. *J Matern Fetal Neonatal Med.* 2016;29:1021-4  
doi: 10.3109/14767058.2015.1032238
- <sup>2</sup> Zacchia M, Abategiovanni ML, Stratigis S, Capasso G. Potassium: From Physiology to Clinical Implications. *Kidney Dis (Basel).* 2016;2:72-79  
doi: 10.1159/000446268
- <sup>3</sup> Youn JH, McDonough AA. Recent advances in understanding integrative control of potassium homeostasis. *Annu Rev Physiol.* 2009;71:381-401  
doi:10.1146/annurev.physiol.010908.163241
- <sup>4</sup> Liang L, Alder M, Gorrindo P, Toledo P. Peripartum Hyperkalemia Caused by Magnesium Infusion in a Woman with End-Stage Renal Disease: A Case Report. *A Pract.* 2019;13:190-192  
doi: 10.1213/XAA.0000000000001031
- <sup>5</sup> Naderi AS, Palmer BF. An unusual case of acute hyperkalemia during pregnancy. *Am J Obstet Gynecol.* 2007;197:e7-8  
doi: 10.1016/j.ajog.2007.06.083
- <sup>6</sup> Aboudara MC, Hurst FP, Abbott KC, Perkins RM. Hyperkalemia after packed red blood cell transfusion in trauma patients. *J Trauma.* 2008;64(2 Suppl):S86-91; discussion S91  
doi: 10.1097/TA.0b013e318160c0b8
- <sup>7</sup> Mattu A, Brady WJ, Robinson DA. Electrocardiographic manifestations of hyperkalemia. *Am J Emerg Med.* 2000;18:721-729  
doi: 10.1053/ajem.2000.7344