Nationwide Children's
When your child needs a hospital, everything matters.

Hyperkalemia

Emergency Department

Center for Clinical Excellence

***Risk Factors for Hyperkalemia**

- **Acidosis**
  - Diabetic ketoacidosis
  - Sepsis
- **Cell lysis**
  - Trauma, Burns
  - Hemolysis, Tumor lysis, Rhabdomyolysis
- **Medications**
  - β-blockers, Calcium channel blockers
  - Angiotensin blockers, K^+-sparing diuretics
  - Immunosuppressants
- **Kidney or adrenal dysfunction**

Any patient with hyperkalemia (even if hemolyzed)
< 90 days old: K^+ > 5.9 mmol/L
≥ 90 days old: K^+ ≥ 5.5 mmol/L

- ABCs, Cardiorespiratory monitoring
- Obtain EKG STAT
- Remove all sources of potassium intake (medications, fluids, nutrition)
- Consider **Risk Factors***

If high clinical suspicion for true hyperkalemia, do not delay treatment while waiting for confirmatory sample

Any of the following present?
- **EKG signs of hyperkalemia**
- **K^+ ≥ 7.0 mmol/L**
- **Acidosis**
- **Signs & Symptoms of hyperkalemia**

No →
- Repeat K^+ by venous blood draw
- Consider **Pseudohyperkalemia**
- Identify & treat underlying **Causes**

Confirmed hyperkalemia?
No → **Off Pathway**
Yes ↓

K^+ ≥ 7.0 mmol/L ?
Yes →
- **Defibrillator to bedside, Place 2nd IV**
- **IV Calcium *(FIRST PRIORITY)***
  - **Repeat every 10 minutes as needed to normalize EKG**
- **IV Sodium Bicarbonate** *(if pH < 7.4)*
- **Nebulized Albuterol**
- **IV Insulin bolus and Dextrose**

No ↓

- Repeat K^+ and glucose via POC blood gas every 30 minutes
- Identify & treat underlying **Causes**

Persistent hyperkalemia (K^+ ≥ 7.0 mmol/L)?
No →
- Seek expert consultation based on underlying cause
- Re-check K^+ every 2 hours

Yes ↓

Disposition per ED

Discuss with ICU
Continue treatment as above

Expected EKG changes by Potassium Level
(these do not always occur or may be late changes)

5.5-6.4 mmol/L
- Peaked T waves
- Normal or decreased QT
- Prolonged PR interval

6.5-8.0 mmol/L
- Widening of QRS complex
- Prolonged PR interval
- Broad, low amplitude P waves
- QT prolongation
- ST elevation or depression

>8 mmol/L
- P waves disappear
- Marked widening of QRS
- "Sine wave" pattern
- High risk of ventricular fibrillation or asystole

Adapted from Sood et al. 2007

Normal **PR** interval:
≤1 year old: < 160 msec
>1 year old: ≤ 200 msec
Normal **QRS** interval:
≤1 year old: ≤ 90 msec
>1 year old: ≤ 120 msec

Medications

First Line Medications		
Calcium gluconate ***(preferred if peripheral IV)***	60-100 mg/kg/dose IV (MAX 3000 mg) over 10 minutes	Repeat every 10 minutes as needed to normalize EKG
Calcium chloride ***(if central line)***	20 mg/kg/dose (MAX 1000 mg) over 10 minutes	Repeat every 10 minutes as needed to normalize EKG
Sodium bicarbonate ***(if pH < 7.4)***	1-2 mEq/kg/dose (MAX 50 mEq) over 5 minutes	Repeat doses may be necessary
Insulin regular + Dextrose	Insulin: 0.1 unit/kg/dose IV (MAX 10 units) over 1-2 minutes Dextrose: 0.5-1 g/kg IV (5-10 mL/kg if using D10%) over 30 minutes	Consider max dose of 5 units of insulin in children with chronic kidney disease
Albuterol	**< 15 kg:** 10 mg nebulized over 60 minutes	Repeat doses may be necessary
	≥ 15 kg: 15 mg nebulized over 60 minutes	Repeat doses may be necessary
Second Line Medications *use with consultation of ICU or Nephrology Only*		
Sodium Polystyrene Sulfonate (Kayexalate™)	1 g/kg/dose enterally (MAX 30 g)	Q6H PRN
Furosemide (Lasix™)	0.5-1 mg/kg/dose IV (MAX 40 mg)	Q6H PRN

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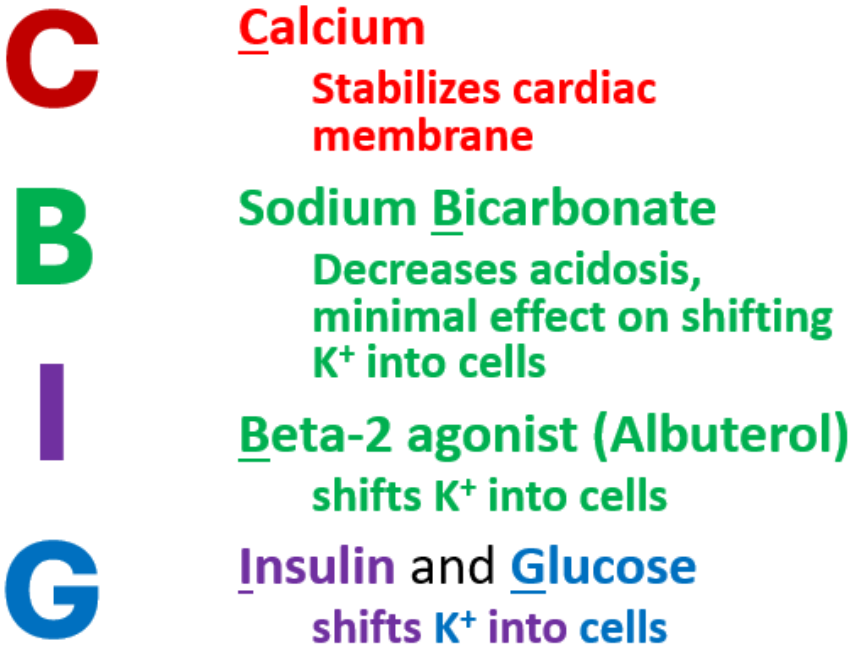
Potassium Pearls

- Potassium is mostly an intracellular cation, predominantly found in the myocytes.
- Small shifts from intracellular → extracellular potassium concentration can alter the cell resting membrane potential, and dramatically impact the function of the muscle (smooth and skeletal) cells and nerve function.
- **The most important clinical implication of hyperkalemia involves cardiac cell conduction,** which can manifest as life-threatening arrhythmias or cardiac arrest
- **Rapid increase of potassium is associated with higher risk of arrhythmia**
- Remember the mnemonic **"CBIG" for C**alcium**, B**icarbonate/**B**eta-2 agonist, **I**nsulin, and **G**lucose, in this order, when treating clinically significant hyperkalemia
- Management involves:
  - Stabilization of the myocardium (Calcium)
  - Correction of acidosis (Sodium Bicarbonate)
  - Shifting potassium intracellularly (Beta-2 agonist, Insulin, and Dextrose)
  - Elimination of potassium from the body (Furosemide, Sodium Polystyrene Sulfonate, Hemodialysis)



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Signs & Symptoms

Most patients are asymptomatic, even with severe hyperkalemia

Signs of hyperkalemia

- Bradycardia
- Hypotension
- Weakened pulse
- Arrhythmia
- Cardiac arrest or peri-arrest state

Symptoms of hyperkalemia

- Fatigue
- Muscle weakness
- Myalgias
- Palpitations
- Paresthesias

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Risk Factors for Hyperkalemia

Risk Factors for Hyperkalemia:

- **Acidosis** (e.g. diabetic ketoacidosis, sepsis, respiratory failure)
- **Cell lysis**
  - Trauma
  - Burns
  - Hemolysis
  - Tumor lysis
  - Rhabdomyolysis
- **Medications**
  - K^+ supplements
  - Angiotensin blockers
  - NSAIDs
  - K^+-sparing diuretics (spironolactone, amiloride)
  - β-blockers
  - Calcium channel blockers (amlodipine, nifedipine)
  - Trimethoprim
  - Immunosuppressants (e.g. Cyclosporine, Tacrolimus)
- **Kidney or adrenal dysfunction**

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Pseudohyperkalemia

- **If the initial potassium level is elevated and hyperkalemia is likely based on clinical scenario, do not assume pseudohyperkalemia, and initiate treatment while waiting for a confirmatory sample. Have a high clinical suspicion for true hyperkalemia in patients with risk factors.**

- Pseudohyperkalemia refers to a high serum potassium level that does not reflect the true in vivo level.

- Causes:
  - In vitro hemolysis
  - Fist clenching during phlebotomy
  - Undue delay in processing blood samples
  - Inappropriate storage temperature of blood samples
  - Potassium contamination of blood samples

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Causes of Hyperkalemia

Mechanism	Cause
Low glomerular filtration rate	• Acute kidney injury • Chronic kidney disease
Low effective arterial blood volume	• Dehydration • Nephrotic syndrome • Heart failure • Liver Failure
Tubular dysfunction	• Type 4 renal tubular acidosis • Pyelonephritis • Sickle cell disease
Medications	• K^+ supplements • Angiotensin blockers • NSAIDs • K^+-sparing diuretics • β-blockers • Immunosuppressants (e.g. Cyclosporine, Tacrolimus)

Shift of potassium out of cells into the bloodstream	• Acidosis (metabolic or respiratory)
	• Decreased insulin (diabetes mellitus/DKA)
	• Cell breakdown
	  ○ Hemolysis
	  ○ Tumor Lysis
	  ○ Rhabdomyolysis
	  ○ Trauma
	  ○ Burns

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Metrics

Pathway Goal

- Prompt recognition and management of life-threatening cardiac arrhythmias caused by hyperkalemia.

Quality Measures

Outcome Metric

- Mortality rate

Process Metrics

- Pathway Visualization
- Time from potassium result to EKG order
- Time from EKG completed to IV calcium administration

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References

1. Mahoney BA, Smith WA, Lo DS, Tsoi K, Tonelli M, Clase CM. Emergency interventions for hyperkalaemia. *Cochrane Database Syst Rev*. 2005;2005(2):CD003235. Published 2005 Apr 18. doi:10.1002/14651858.CD003235.pub2

2. Brown DH, Paloian NJ. Hypokalemia/Hyperkalemia and Hyponatremia/Hypernatremia. *Pediatr Rev*. 2023;44(7):349-362. doi:10.1542/pir.2021-005119

3. Weisberg LS. Management of severe hyperkalemia. *Crit Care Med*. 2008;36(12):3246-3251. doi:10.1097/CCM.0b013e31818f222b

4. Abuelo JG. Treatment of Severe Hyperkalemia: Confronting 4 Fallacies. *Kidney Int Rep*. 2017;3(1):47-55. Published 2017 Oct 7. doi:10.1016/j.ekir.2017.10.001

5. Masilamani K, van der Voort J. The management of acute hyperkalaemia in neonates and children. *Arch Dis Child*. 2012;97(4):376-380. doi:10.1136/archdischild-2011-300623

6. Long B, Warix JR, Koyfman A. Controversies in Management of Hyperkalemia. *J Emerg Med*. 2018;55(2):192-205. doi:10.1016/j.jemermed.2018.04.004

7. Rossignol P, Legrand M, Kosiborod M, et al. Emergency management of severe hyperkalemia: Guideline for best practice and opportunities for the future. *Pharmacol Res*. 2016;113(Pt A):585-591. doi:10.1016/j.phrs.2016.09.039

8. Durfey N, Lehnhof B, Bergeson A, et al. Severe Hyperkalemia: Can the Electrocardiogram Risk Stratify for Short-term Adverse Events?. *West J Emerg Med*. 2017;18(5):963-971. doi:10.5811/westjem.2017.6.33033

9. Singh BS, Sadiq HF, Noguchi A, Keenan WJ. Efficacy of albuterol inhalation in treatment of hyperkalemia in premature neonates. *J Pediatr*. 2002;141(1):16-20. doi:10.1067/mpd.2002.125229

10. Don BR, Sebastian A, Cheitlin M, Christiansen M, Schambelan M. Pseudohyperkalemia caused by fist clenching during phlebotomy. *N Engl J Med.* 1990;322(18):1290-1292. doi:10.1056/NEJM199005033221806

11. Sood MM, Sood AR, Richardson R. Emergency management and commonly encountered outpatient scenarios in patients with hyperkalemia. *Mayo Clin Proc.* 2007;82(12):1553-1561. doi:10.1016/S0025-6196(11)61102-6

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Clinical Pathway Development

This clinical pathway was developed using the process described in the NCH Clinical Pathway Development Manual Version 6, 2022. Clinical Pathways at Nationwide Children's Hospital (NCH) are standards which provide general guidance to clinicians. Patient choice, clinician judgment, and other relevant factors in diagnosing and treating patients remain central to the selection of diagnostic tests and therapy. The ordering provider assumes all risks associates with care decisions. NCH assumes no responsibility for any adverse consequences, errors, or omissions that may arise from the use or reliance on these guidelines. NCH's clinical pathways are reviewed periodically for consistency with new evidence; however, new developments may not be represented, and NCH makes no guarantees, representations, or warranties with respect to the information provided in this clinical pathway.

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