Hyperkalemia

Inpatient

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

Center for Clinical Excellence

Verify patient is appropriate for the pathway, including age ≥ 90 days

Orderset: IP Hyperkalemia Clinical Pathway

If hemolyzed sample, **confirm non-hemolyzed hyperkalemia** by venous blood draw or K^+ priority sample.

- Address any reversible causes of hyperkalemia, including **medications and fluids that increase K^+**
- Assess for **symptoms**

Symptoms of hyperkalemia

Expected EKG changes by potassium level

Medications/fluids that increase potassium

Medication Risk vs. Benefits

Doses of medication to treat hyperkalemia

Initial non-hemolyzed potassium ≥ 6mmol/L?

No

Mild Hyperkalemia
5.5 – 5.9mmol/L

- Recheck **every 4-6 hours** until normalized
- Follow pathway to right if K^+ increases to > 6mmol/L

Yes

- Obtain STAT EKG
- Place IV if not in place
- Consider NS IV bolus if urine output < 1mL/kg/hr
- Assess renal function with BUN/Cre if not already obtained
- Discontinue or modify K^+ containing fluids, including TPN; maintain glucose infusion rate when applicable
- Hold **medications that increase K^+** unless risk outweigh benefit. Obtain guidance from managing provider regarding immunosuppressants.

Initial non-hemolyzed potassium ≥ 7mmol/L or EKG changes?

No

Moderate Hyperkalemia
6 – 6.9mmol/L

- Recheck potassium in 2 hours; can space repeat checks to every 4 hours if potassium stable or decreasing
- Consider more frequent checks if potassium rapidly increasing
- Follow appropriate pathway (mild, moderate or severe) based on recheck

Yes

Severe Hyperkalemia
≥ 7mmol/L OR Evidence of EKG changes

- Start cardiac monitoring (standard cardiac monitoring or telemetry if available)
- Give **IV calcium** for cardiac stabilization
- Give **albuterol aerosol(s)**
- Start **IV Insulin + Dextrose** with **blood glucose checks Q1H**
- Monitor for **Signs of Deterioration**
- ACT based on clinical judgement
- Notify team fellow/attending if not already done
- **Check K^+ level Q1H while in severe range or evidence of EKG changes**

Deterioration and Escalation of Care

Repeat non-hemolyzed potassium ≥ 7mmol/L or EKG changes?

No

- If **< 5.5mmol/L**, Off Pathway
- If **5.5-5.9mmol/L**, recheck K^+ level in 4hrs
- If **6-6.9mmol/L**, recheck K^+ level in 2 hours

Follow appropriate pathway (**Mild, Moderate,** or **Severe**) based on recheck level

Yes

Severe Hyperkalemia
Treatment Round 2

- Call ACT (or perform ACT follow up)
- Consult Nephrology
- Consider **IV K^+-Cocktail**
- Consider **IV furosemide**
- Consider **oral sodium polystyrene sulfonate (Kayexalate)**; only under Nephrology advisement
- **OFF Pathway – Individualized Management**

Pre-Pathway Validation

Is this Hyperkalemia?

Hyperkalemia is an elevated plasma or serum potassium level. Diagnosis is based on $K^+ \geq 5.5$mmol/L on a non-hemolyzed specimen. Please note reference range is for patients ≥ 90 days of age; a level up to 5.9mmol/L can be normal in infants.

Disease Severity

Mild hyperkalemia: 5.5-5.9mmol/L
Moderate: 6-6.9mmol/L
Severe: ≥ 7mmol/L

Common diagnoses associated with hyperkalemia

- Iatrogenic potassium supplementation (fluids or medications)
- Acute kidney injury
- Chronic kidney disease
- Decreased effective arterial volume (dehydration)
- Tubular dysfunction
- Hemolysis
- Malignancy
- Infection
- Sickle cell disease
- Metabolic acidosis

Pathway Inclusion Criteria

- Patients ≥ 90 days with potassium ≥ 5.5mmol/L on non-hemolyzed sample.

Pathway Exclusion Criteria

- Neonates < 90 days
- Pt in NICU, PICU, or CTICU
- Renal disease requiring dialysis
- Tumor lysis syndrome
- Diabetic Ketoacidosis

Always stop potassium containing fluids in children with moderate to severe hyperkalemia. Also hold medications that could increase potassium, unless risk outweigh benefit.

Differential Diagnosis

- Pseudohyperkalemia i.e. 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
- Always ensure specimen is not hemolyzed prior to proceeding to treatment

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Expected EKG Changes by Potassium Level

Changes may not progress in a stepwise or predictable fashion

5.5-6.4mmol/L

- Peaked T waves
- Normal or decreased QT
- Prolonged PR interval

6.5-8.0mmol/L

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

> 8mmol/L

- P waves disappear
- Marked widening of QRS
- “Sine wave” pattern
- High risk of ventricular fibrillation or asystole

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Adapted from Sood et al. 2007

Symptoms of Hyperkalemia

Symptoms are rare, even in severe hyperkalemia

- Palpitations
- Nausea
- Muscle pain
- Parethesias

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Medications & Fluids That Can Increase Potassium

- IV fluids that contain K^+ (including TPN, LR, and IV potassium replacement)
- Oral potassium supplements (KCL, KPhos, K iodide, KAce, KBicarb etc.)
- Penicillin K^+
- Potassium sparing diuretics (spironolactone, amiloride)
- Calcium channel blockers (amlodipine, nifedipine)
- Angiotensin-converting enzyme (ACE) inhibitors (lisinopril) and Angiotensin II Receptor Blockers (ARBs)
- NSAIDs
- Heparin
- Pentamidine
- Trimethoprim
- Propranolol
- **Immunosuppressants - decision to hold immunosuppression should be carefully evaluated with guidance from appropriate/managing provider**
  - **Cyclosporine**
  - **Tacrolimus**

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Medications Risk vs. Benefit

		Benefit	Risk
First Line Medications	**Calcium Gluconate**	(1) Rapid onset of action to stabilize cardiac membrane and prevent cardiac arrhythmias (2) Can be administered via peripheral IV	(1) Does not decrease potassium serum concentration (2) Duration lasts 30-60 min, repeat doses may be necessary
	Calcium chloride (use only through central line)	(1) Rapid onset of action to stabilize cardiac membrane and prevent cardiac arrhythmias	(1) Does not decrease potassium serum concentration (2) Duration lasts 30-60 min, repeat doses may be necessary (3) Central line required for administration
	Albuterol	(1) Lowers serum potassium by shifting K^+ intracellularly (2) Available for rapid administration via inhalation (3) Onset of action within 30 min (4) Increases the efficacy of insulin in lowering potassium	(1) Effect lasts only 2 hours, repeat dosing is often necessary (2) Rebound hyperkalemia is common
	Insulin + Dextrose	(1) Lowers serum potassium by shifting K^+ intracellularly (2) Produces a reliable shift of potassium into cells within 15 minutes (peak 30-60 min) that lasts 2-6 hours (3) Works synergistically with albuterol	(1) Hypoglycemia may occur despite administration of dextrose; blood glucose should be monitored every hour while on insulin
	K^+-Cocktail	(1) Standard mixture of calcium gluconate, insulin, dextrose, and sodium acetate that reliably shifts K^+ intracellularly (2) Continuous infusion can maintain serum K^+ up to 2 mEq/L lower over 12-24 hours	(1) Central line is preferred administration route due to high glucose concentration (though it may be administered peripherally) (2) Rapid drop in potassium may result in hypokalemia
Second Line Medications	**Furosemide (Lasix)**	(1) Total body excretion of potassium	(1) Typically, several hours until notable effect makes it not ideal for acute treatment (2) Amount of potassium excreted is unpredictable (3) Patient must be producing urine for effect
	Sodium Polystyrene sulfonate (Kayexalate™)	(1) Binds potassium to remove via the gut	(1) Delayed and highly variable onset of action (2) Intestinal side effects are common (3) Can cause gut necrosis; should be avoided in infants and those with possible altered gut mobility

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Doses of Medications to Treat Hyperkalemia

First Line Medications		
Calcium gluconate ***(preferred)***	60-100mg/kg/dose IV (MAX 3000mg) over 10 minutes	Repeat doses may be necessary
Calcium chloride ***(if central line)***	20mg/kg/dose (MAX 1000mg) over 10 minutes	Repeat doses may be necessary
Insulin regular (bolus dose) + dextrose	Insulin: 0.1unit/kg/dose IV (MAX 10 units) over 1-2 minutes WITH Dextrose: 0.5-1g/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 • Bolus insulin dosing with dextrose may be safely used on med/surg units
Albuterol	**< 15kg:** 10mg, aerosol	Repeat Q2H PRN
	≥ 15kg: 15mg, aerosol	Repeat Q2H PRN
K^+-Cocktail (Calcium gluconate 3000 mg, Dextrose 27%, Insulin Regular 30 units, Sodium acetate 100 mEq)	2mL/kg/hr for the first hour followed by 0.5-1mL/kg/hr	Due to its hyperosmotic content, the K^+-Cocktail is best administered by central line, but it may be given peripherally temporarily for urgent treatment
Second Line Medications ***use with consultation of ICU or Nephrology Only***		
Sodium Polystyrene Sulfonate (Kayexalate™)	1g/kg/dose enterally (MAX 30g)	Q6H PRN
Furosemide (Lasix™)	0.5-1mg/kg/dose IV (MAX 40mg)	Q6H PRN

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Signs of Deterioration & Escalation of Care

Signs of deterioration:

- Tachycardia, arrhythmia
- Altered mental status
- Development of symptomatic hyperkalemia (nausea, palpitations, myalgias, paresthesias)
- A rise in potassium level despite treatment
- Sustained K^+ > 7mmol/L despite treatment
- Decreasing urine output or urine output < 1ml/kg/hr (excluding known anuric or oliguric patients)
- Progression of EKG changes (see “Expected EKG changes by potassium level”) regardless of potassium level

Escalation plan:

- Consult ACT team
- Consult Nephrology
- Ensure IV access
- Ensure full disclosure telemetry or serial EKG if not available
- Consider additional treatments: K^+-cocktail, IV fluid bolus, furosemide, Kayexalate™ under guidance of experts

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Quality Measures

Goals:

1. Prevent or counteract life-threatening cardiac conduction disturbances due to hyperkalemia.
2. Efficiently and safely lower potassium to normal level with the least amount of blood draws.

Metrics:

Process measures:

1. IP Order Set use
2. Rate of EKGs obtained for patients with a non-hemolyzed potassium of 6mmol/L or greater.
3. Rate of calcium gluconate or calcium chloride administration for patients with a non-hemolyzed potassium greater than 7mmol/L.

Outcome measures:

1. Time until potassium normalization (potassium less than 5.5mmol/L).
2. Rate of patients with a potassium greater than 8mmol/L.
3. Mortality rate

Balancing measure:

1. Rate of hypoglycemia (blood glucose < 60) for hyperkalemic patients treated with insulin.
2. Number of potassium lab draws per encounter.

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Team & Process

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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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