

Hypokalemia: Student Handout

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Hypokalemia: A Student Guide to Low Potassium

Learning Objectives

- Define hypokalemia and recognize its prevalence in hospitalized patients
- Understand why cardiac patients need higher potassium targets
- Interpret ECG changes (U waves, QT prolongation)
- Recognize that hypokalemia often accompanies hypomagnesemia
- Manage hypokalemia safely with appropriate replacement strategies

Quick Definition

Hypokalemia = Serum potassium <3.5 mEq/L (normal: 3.5-5.0 mEq/L)

Key insight: While often underappreciated, hypokalemia is COMMON (up to 20% of hospitalized patients) and can be DEADLY in cardiac patients.

Why Hypokalemia Is Dangerous

Potassium controls resting membrane potential in cardiac cells. Low K⁺ causes: 1. **Membrane hyperpolarization** harder to trigger action potentials 2. **Prolonged repolarization** longer QT interval 3. **Delayed afterdepolarizations** premature beats, torsades de pointes 4. **Enhanced digoxin toxicity** (if patient on digoxin)

In plain English: Hypokalemia predisposes to life-threatening arrhythmias.

Severity and Risk Stratification

General Population (No Cardiac Disease)

K ⁺ Level	Risk	Symptoms	Treatment
3.0-3.5	Low	Usually none	Oral supplements or diet
2.5-3.0	Moderate	Weakness, cramping	Oral supplements
<2.5	High	Paralysis, arrhythmias	IV replacement

Cardiac Patients (Heart Failure, Recent MI, on Digoxin)

K+ Level	Risk	Recommendation
<3.0	VERY HIGH	Treat aggressively (IV)
3.0-4.0	HIGH	Maintain \geq 4.0 (higher targets)
4.0-5.0	ACCEPTABLE	Ideal range

Critical concept: Cardiac patients need HIGHER potassium targets (\geq 4.0 mEq/L) than general population (\geq 3.5 mEq/L) because arrhythmia risk is substantially greater.

The Magnesium Connection (Critical!)

~60% of hypokalemic patients ALSO have hypomagnesemia.

Why it matters: - Hypomagnesemia prevents renal potassium retention - You can't correct hypokalemia until hypomagnesemia is fixed - Many patients given "plenty" of potassium yet remain hypokalemic—they need magnesium!

Always check and replace Mg²⁺ simultaneously with K⁺ replacement.

ECG Changes by Severity

K+ Level	ECG Changes
3.0-3.5	U waves (after T wave), flattened T waves
2.5-3.0	U waves more prominent, ST depression, T wave flattening
<2.5	Prolonged QT interval, widened QRS, severe arrhythmias possible

U waves = characteristic finding (small deflection after T wave). Becomes more prominent as K⁺ drops.

Remember: ECG changes don't always correlate with K⁺ level. Some patients have no ECG changes despite significant hypokalemia, while others show changes at higher levels.

Common Causes

GI Losses (Most Common)

- Diarrhea
- Vomiting
- Ileostomy
- Laxative abuse

Renal Losses (Medication/Disease)

- **Diuretics** (loop and thiazides) - #1 medication cause
- **SSRIs, antidepressants**
- **Amphotericin B** (nephrotoxic)
- **Aminoglycosides**
- Primary hyperaldosteronism
- Renal tubular acidosis

Intracellular Shifts

- Beta-agonists (albuterol, epinephrine)
- Insulin administration
- Alkalosis (respiratory or metabolic)
- Thyroid hormone excess
- Refeeding syndrome

Clinical Assessment

History

- Diarrhea, vomiting frequency?
- Diuretic use and doses?
- Medications (SSRIs, beta-agonists)?
- Muscle weakness, palpitations?
- EKG changes (digoxin use)?

Physical Exam

- Vital signs (orthostasis from volume depletion?)
- Weakness, muscle tenderness?
- Reflexes (hypokalemia □ diminished)?
- Signs of underlying cause?

Laboratory

1. **Serum K⁺ and Mg²⁺** (both essential!)
2. **Kidney function** (creatinine, eGFR)
3. **ECG** (any patient with K⁺ <3.0 or cardiac disease)
4. **Concurrent electrolytes** (calcium, phosphate)

Treatment by Severity

Mild Hypokalemia (3.0-3.5) Without Symptoms

- Oral replacement: 40-80 mEq/day of potassium
- Examples:
 - K-Dur tablets (20 mEq each)
 - Liquid formulations
 - Bananas, oranges, dried fruits

- Also correct hypomagnesemia if present
- Recheck K⁺ in 3-5 days

Moderate Hypokalemia (2.5-3.0) OR Symptomatic

- Oral replacement: 40-100 mEq/day in divided doses
- IV replacement if GI intolerance: 40 mEq in 200-500 mL saline over 2-4 hours (peripheral IV safe)
- Monitor K⁺ every 6-12 hours initially
- Also replace Mg²⁺
- ECG monitoring recommended

Severe Hypokalemia (<2.5) OR With Arrhythmias

- IV replacement mandatory: 10-40 mEq per 2-3 hours
- **Maximum rate:** 40 mEq/hour (peripheral can handle this if careful)
- **Never** give >20 mEq in 100 mL (too concentrated, damages veins)
- Continuous ECG monitoring
- Check K⁺ every 2-4 hours
- Central line preferred for faster replacement
- Replace Mg²⁺ simultaneously

Special Populations

Heart Failure Patients

- Maintain K⁺ ≥4.0 mEq/L (preferably 4.0-5.0)
- Avoid hypokalemia—mortality increases at levels <4.0
- May need K-sparing diuretics + RAAS inhibitors (helps retain K⁺)
- Monitor closely if on digoxin

Perioperative Patients

- Correct hypokalemia BEFORE elective surgery if K⁺ <3.0
- Even asymptomatic hypokalemia increases perioperative arrhythmia risk
- Magnesium also important for cardiac stability

Patients on Digoxin

- **Critical:** Even mild hypokalemia increases toxicity risk
- Maintain K⁺ ≥4.0 mEq/L ideally
- Hypomagnesemia also increases digoxin toxicity
- Check digoxin levels if available

Practical Replacement Guide

Oral Formulations

Form	K+ Content	Taste	Cost
K-Dur 20 tab	20 mEq	Bitter	Cheap
K-Dur liquid	20 mEq/15mL	Better	Higher
Potassium chloride solution	40 mEq/15mL	Terrible	Variable
Bananas	~0.4 mEq each	Great	Cheap

Tip: Mix liquid formulations with juice or water to improve palatability.

IV Formulations (Hospital Use)

- **10-20 mEq per hour:** Safe rate through peripheral IV
- **20-40 mEq per hour:** Maximum rate, but peripheral IV better tolerated than expected
- **>40 mEq per hour:** Requires central line
- Dilute in normal saline (never dextrose or glucose—increases intracellular shift)

Critical: Never give potassium as IV push!

Monitoring During Replacement

Duration	Checkpoint	Action
Initial	Baseline K+, Mg2+	Both must be documented
During IV therapy	Every 2-4 hours	Adjust rate based on trend
After first dose	4-6 hours	Check response
Stabilized	Daily during hospitalization	Ensure no overcorrection
Chronic therapy	Weekly initially, then monthly	Adjust doses based on response

Managing Concurrent Hypomagnesemia

Formula: 50% of hypokalemic patients have hypomagnesemia

Magnesium replacement: - Oral: Magnesium citrate or glycinate 400-800 mg daily - IV (severe): Magnesium sulfate 2-4g over 20 minutes, then continuous infusion - Always correct Mg2+ when correcting K+

Common Mistakes to Avoid

1. **Forgetting to check magnesium** K+ won't correct without Mg2+
2. **Giving too much K+ too fast** hyperkalemia risk (pendulum swings)
3. **Using dextrose IV** shifts K+ intracellularly, worsens hypokalemia
4. **Not checking ECG in symptomatic patient** missing arrhythmias
5. **Ignoring underlying cause** K+ keeps dropping after replacement
6. **Overaggressive replacement in CKD** hyperkalemia crisis
7. **Not monitoring post-IV replacement** rebound hyperkalemia possible

Practice Questions

Question 1: A 72-year-old on furosemide 80mg daily for heart failure has K⁺ 3.2, Mg²⁺ 1.4 (low), and denies symptoms. What's your approach?

Answer

This patient needs BOTH K⁺ and Mg²⁺ replacement despite no symptoms. As a cardiac patient on diuretics, maintain K⁺ ≥4.0. Give magnesium first (40 mEq oral), then start potassium 40 mEq daily. Check levels in 1 week. Consider adding K-sparing diuretic or adjusting current diuretic dose to prevent future losses.

Question 2: Patient receives 40 mEq IV potassium in 50mL over 30 minutes through peripheral line. What went wrong?

Answer

The concentration is too high (800 mEq/L) and rate too fast. This causes severe vein irritation/phlebitis and risk of extravasation. Correct approach: dilute in 200-500mL, give over 2-4 hours. Future: smaller volumes still work but go slower to protect the vein.

Question 3: A 58-year-old with recent MI develops K⁺ 2.8 and atrial fibrillation. After two hours of IV potassium 40 mEq/hour, K⁺ is now 5.2. What happened?

Answer

Overcorrection! The pendulum swung from too low to too high. The cardiac patient actually needs K⁺ around 4.0-4.5 (not 5.2). Stop potassium, recheck in 4 hours, and start digoxin/rate control for AFib. Hyperkalemia is now the problem—can't give calcium (increases digoxin effect), but can give insulin/glucose if K⁺ stays >6.0.

Key Takeaways for Exams

- **Hypokalemia is dangerous in cardiac patients** maintain ≥4.0 mEq/L
- **Always check magnesium** ~60% coexist with hypokalemia
- **U waves on ECG** = characteristic finding
- **Diuretics are #1 medication cause** in outpatients
- **Diarrhea is #1 cause overall**
- **IV K⁺ must be dilute and slow** use peripheral saline, avoid concentrated solutions
- **Correct hypomagnesemia first** K⁺ won't stay up without it
- **Digoxin toxicity risk increases** with hypokalemia (MAJOR point)
- **Never give K⁺ as IV push**
- **Monitor for overcorrection** can swing to dangerous hyperkalemia

Clinical Pearls

1. **Bananas and oranges are decent K⁺ sources** for chronic mild depletion
2. **Furosemide >80mg daily = high K⁺ loss** monitor closely
3. **Alkalosis worsens hypokalemia** correct acid-base status
4. **Weakness from hypokalemia is real** don't dismiss as "just tired"
5. **Refeeding syndrome = serious hypokalemia** go slow with nutrition
6. **Post-dialysis hypokalemia** common, requires monitoring and replacement

Study tip: Remember the U wave as the key ECG finding. When you see U waves on an EKG, think “Unusual (U = Unusual finding in hypokalemia)” to remember hypokalemia.

Clinical wisdom: In a cardiac patient with any reason for hypokalemia (diuretics, diarrhea, medications), proactively maintain $K^+ \geq 4.0$. Prevention beats treatment.

See Also

Related Student Handouts

- Hyperkalemia Management
- Acid-Base Disorders
- Diuretics
- RAAS Inhibitors and Renal Protection
- GDMT and Cardiac Medications

Clinical Content (01-Clinical-Medicine/Nephrology)

- Electrolyte Disorders Hub
- Essential Renal Laboratory Tests

Butler-COM Resources

- Butler COM - Nephrology Deep Dive