Electrolyte Imbalances

Na, K, Ca, Mg and phos: normals, ECG clues, safe replacement, hyperkalemia steps

NORMALS AND KEY SIGNS

Exam study summary, not a bedside tool. Doses are typical adult ranges; follow your institution's protocols.

Typical adult ranges (MedlinePlus; ionized Ca from Merck). Labs and exams vary: many review books use Ca 9.0–10.5 and Mg 1.3–2.1 mEq/L.

ION	NORMAL	LOW	HIGH
Na	135–145 mEq/L	Nausea, confusion, seizures	Thirst, confusion, seizures
K	3.5–5.0 mEq/L	Weakness; flat T, U wave, ST sag	Weakness; peaked T, wide QRS
Ca	8.8–10.3 mg/dL; ionized 4.7–5.2 mg/dL (1.17–1.30 mmol/L)	Tetany, Chvostek, Trousseau; long QT	Stones, constipation, confusion; short QT
Mg	1.7–2.2 mg/dL	Tremor, tetany; long QT, torsades	Lost reflexes, slow breathing, long PR
Phos	2.8–4.5 mg/dL	Weakness, failure to wean, hemolysis	Low-Ca signs (tetany, long QT)

EXAM TIP Low Mg keeps K and Ca low: if K will not correct, check and replace Mg.

HYPERKALEMIA: STABILIZE, SHIFT, REMOVE



Hyperkalemia: peaked T, flat P, wide QRS; can end in sine wave, VF or asystole.

1. Stabilize (ECG changes): calcium gluconate 10% 30 mL over 10 min; in arrest or peri-arrest, calcium chloride 10% 10 mL over 5 min (same calcium). Acts in about 3 min, lasts 30–60 min; repeat if changes persist.
2. Shift: regular insulin 10 units IV with dextrose 25–50 g. K falls within 15 min, lowest at 30–60 min.
3. Add-on shift: nebulized albuterol 10–20 mg, never alone. Bicarbonate mainly for metabolic acidosis.
4. Remove: binders (sodium zirconium cyclosilicate acts in about 1 h, patiromer 4–7 h), loop diuretic, dialysis (definitive).
5. Recheck K often; it rebounds as the shift wears off.

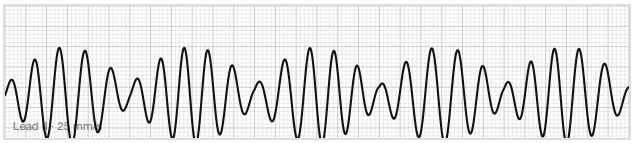
EXAM TIP Exams test the why: calcium protects the heart but does not lower K; insulin and albuterol shift K in; binders, diuretics and dialysis remove it.

SAFETY Insulin-glucose can cause hypoglycemia, usually 1–3 h later; check glucose often for 6 h. High K with a normal ECG may be hemolysis, but treat ECG changes now.

In cardiac arrest (AHA 2025), calcium, bicarbonate and insulin-glucose may be considered but are unproven; inhaled albuterol is not recommended.

POTASSIUM AND MAGNESIUM REPLACEMENT

- Check urine output and kidney function first.
- IV KCl: always diluted, always on a pump.
- Peripheral IV: usually no faster than 10 mEq/h.
- Central line, continuous ECG: often up to 20 mEq/h per policy; the label allows 40 only if K is under 2 with ECG changes or paralysis.
- DKA: if K is below 3.5, give K first and hold insulin (ADA 2024).
- Torsades (polymorphic VT with long QT): magnesium sulfate 1–2 g IV; defibrillate (unsynchronized) if pulseless or sustained. Mg is not advised for normal-QT polymorphic VT.
- Mg toxicity (preeclampsia drip): reflexes fade, then breathing slows. Stop the Mg; give IV calcium gluconate.



Torsades: polymorphic VT twisting around the baseline, set up by a long QT.

SAFETY Never give KCl IV push. Concentrated KCl can stop the heart.

CALCIUM: SALTS AND CORRECTED CALCIUM

FEATURE	GLUCONATE 10%	CHLORIDE 10%
Elemental Ca per 10 mL	About 93 mg	About 270 mg (3 times more)
Line	Peripheral OK (secure IV)	Central or deep vein; necrosis if it leaks

Corrected Ca = Ca + 0.8 × (4.0 – albumin g/dL). Example: Ca 7.6, albumin 2.0 → 9.2 mg/dL, not truly low.

EXAM TIP Low albumin lowers total Ca, not ionized Ca. Exams give the albumin to see if you correct first.

Low ionized Ca: alkalosis, massive transfusion (citrate), thyroid or parathyroid surgery, pancreatitis.

SAFETY In the ICU, measure ionized Ca; the formula often misses true hypocalcemia. Never mix calcium with bicarbonate, phosphate or ceftriaxone. Caution with digoxin.

High Ca: IV saline first. If severe (over 14 mg/dL), calcitonin (fast, fades in 48–72 h) plus an IV bisphosphonate or denosumab (slower, longer acting).

SODIUM: CORRECT SLOWLY

- Severe symptoms (seizures, coma): 3% saline 100–150 mL over 10–20 min, repeated to raise Na about 5 mEq/L.
- Chronic: raise Na no more than 8 mEq/L in any 24 h; guideline upper limits run 10–12.
- ODS risk: very low Na, alcohol use, malnutrition, liver disease, low K.
- ODS shows days later: dysarthria, dysphagia, paralysis.
- Overcorrected: stop saline; re-lower with D5W, desmopressin on expert advice.
- Hypernatremia: give free water; lower chronic cases slowly, over about 48 h.

SAFETY Too fast is the danger: raising low Na risks osmotic demyelination; dropping chronic high Na risks cerebral edema.

CAUSES, REFEEDING, PHOSPHATE

- High K: AKI or CKD, ACE inhibitors, ARBs, spironolactone, rhabdo or burns, acidosis, transfusion.
- Tumor lysis: high K, phos and uric acid; low Ca.
- Refeeding: phos, K and Mg fall within 5 days of restarting nutrition (ASPEN 2020).
- IV phosphate: slowly over hours, never with calcium in the same line.

Sources (24) are listed with links at icubasics.com/sheets/electrolytes.html. For education and exam preparation only. Not medical advice; follow current guidelines and your institution's protocols. ICU Basics is an independent study aid not affiliated with any certifying body.