

Treating Acid Base Disturbances and Correcting Electrolyte Abnormalities

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Metabolic Acidosis

Sodium Bicarbonate:

- **Indication:** pH < 7.1 or severe acidosis with renal failure.
- Normal pH 7.35-7.45
- **Dose:** 1–2 mEq/kg IV bolus, or continuous infusion (150 mEq in 1L D5W at 100–200 mL/hr) titrated to effect (Kraut & Madias, 2010).
- Calculate the base deficit = $.3 \text{ (BE) } * \text{ (Ideal body wt) } / 50 \text{ meq per amp}$

Renal Replacement Therapy (RRT):

- **Indication:** Refractory acidosis or renal failure.
- **Mode:** CRRT or intermittent hemodialysis.



Metabolic Alkalosis

Normal Saline (0.9% NaCl):

- **Indication:** Chloride-responsive alkalosis (e.g., vomiting, diuretics).
- **Dose:** 1–2 L IV bolus followed by maintenance rate as needed.

Potassium Chloride (KCl):

- **Dose:** Oral 40–100 mEq/day or IV 10–20 mEq/hr, max 40 mEq/hr via central line with cardiac monitoring.

Acetazolamide:

- **Indication:** Volume overload with alkalosis.
- **Dose:** 250–500 mg IV or PO once or BID.



Respiratory Acidosis

Noninvasive Ventilation (BiPAP) or Intubation:

- Indicated based on mental status, respiratory effort, and gas exchange.
- $HP < 7.2$

Naloxone (if opioid-related):

- **Dose:** 0.04–0.4 mg IV, titrate to respiratory response.



Respiratory Alkalosis

Benzodiazepines (e.g., lorazepam):

- **Dose:** 1–2 mg IV/PO as needed for anxiety-induced hyperventilation.
- pH >7.45

Treat underlying cause
(e.g., antibiotics for sepsis).



pH Range and Associated Mortality Risk

pH Range	Clinical Interpretation	Associated Mortality Risk	Key Clinical Concerns
< 7.00	Severe Acidemia	> 80%	Cardiovascular collapse, arrhythmias, impaired contractility
7.00 – 7.19	Moderate to Severe Acidemia	50–60%	High lactate, shock, poor tissue perfusion
7.20 – 7.34	Mild Acidemia	20–30%	Often in sepsis, renal failure
7.35 – 7.45	Normal	< 5%	Optimal physiologic range
7.46 – 7.54	Mild Alkalemia	10–15%	May be asymptomatic or early compensatory response
7.55 – 7.59	Moderate Alkalemia	20–35%	Arrhythmias, hypokalemia, hypoventilation
≥ 7.60	Severe Alkalemia	> 45–50%	Cerebral vasoconstriction, seizures, decreased coronary perfusion



Sodium

Hyponatremia

3% Hypertonic Saline:

- **Indication:** Severe or symptomatic hyponatremia ($\text{Na}^+ < 120$ mEq/L with seizures or confusion).
- **Dose:** 100 mL IV over 10 min \times 3 doses PRN, then infusion 0.5–2 mL/kg/hr.
- **Correction goal:** ≤ 10 mEq/L per 24 hours (Sterns et al., 2022).

Tolvaptan (SIADH, euvolemic hyponatremia):

- **Dose:** 15 mg PO daily, titrate to 30–60 mg/day.



Sodium

Hypernatremia

D5W or 0.45% NaCl:

- **Dose:** Free water deficit = $0.6 \times \text{weight (kg)} \times [(\text{serum Na}^+ / 140) - 1]$; replace over 48–72 hours.



Potassium

Hypokalemia

Oral Potassium Chloride:

- **Dose:** 20–40 mEq PO BID-TID; max 100 mEq/day.

IV Potassium Chloride:

- **Dose:** 10–20 mEq/hr via peripheral line; up to 40 mEq/hr via central line with telemetry.

Magnesium Sulfate (if concurrent hypomagnesemia):

- **Dose:** 1–2 g IV over 1 hour, repeat as needed.



Potassium

Hyperkalemia

Calcium Gluconate 10%:

- **Dose:** 10 mL IV over 5–10 min; may repeat every 30–60 minutes.

Insulin + Dextrose:

- **Dose:** Regular insulin 10 units IV + 25–50 mL of D50W over 5 minutes.

Albuterol:

- **Dose:** 10–20 mg nebulized over 10 minutes.

Sodium Bicarbonate (if metabolic acidosis):

- **Dose:** 50–100 mEq IV over 5–10 minutes.



Potassium

Hyperkalemia (Cont.)

Furosemide:

- Dose: 20–40 mg IV; titrate for diuresis.

Sodium Polystyrene Sulfonate (Kayexalate):

- Dose: 15–30 g PO/PR; avoid in ileus or post-op.

Dialysis:

- Indicated in refractory or renal failure-associated hyperkalemia.



Calcium

Hypocalcemia

Calcium Gluconate:

- **Dose:** 1–2 g IV over 10–20 minutes; repeat PRN.

Calcium Chloride (for severe/symptomatic cases):

- **Dose:** 1 g IV over 10 minutes via central line only.

Vitamin D (Calcitriol):

- **Dose:** 0.25–1 mcg PO daily for chronic hypocalcemia or renal disease.



Calcium

Hypercalcemia

Normal Saline IV:

- **Dose:** 200–300 mL/hr for volume repletion.

Furosemide (after rehydration):

- **Dose:** 20–40 mg IV every 12 hours.

Calcitonin:

- **Dose:** 4 IU/kg SC or IM q12h; effect in 4–6 hours.

Zoledronic Acid (bisphosphonate):

- **Dose:** 4 mg IV over 15 minutes, single dose.



Magnesium

Hypomagnesemia

Magnesium Sulfate:

- **Mild (Mg^{2+} 1.2–1.7 mg/dL):**
1–2 g IV over 1–2 hours.
- **Severe (<1.2 mg/dL or seizures/arrhythmia):** 4–6 g IV over 4–12 hours.



Magnesium

Hypermagnesemia

Calcium Gluconate 10%:

- **Dose:** 1–2 g IV over 10 minutes to reverse cardiac/muscular effects.

Loop diuretics + IV fluids to enhance renal excretion.

Dialysis if anuric or severe toxicity.



Phosphate

Hypophosphatemia

Oral phosphate (Neutra-Phos):

- Dose: 250 mg PO BID-TID.

IV Sodium or Potassium Phosphate:

- Mild (2.0–2.5 mg/dL): 0.08–0.16 mmol/kg IV.
- Severe (<1.0 mg/dL): 0.32–0.64 mmol/kg IV over 4–6 hours.
- Kphos 10-30 mmol = (30-90 meqK+)



Phosphate

Hyperphosphatemia

Sevelamer (Renvela):

- **Dose:** 800–1600 mg PO TID with meals.

Calcium Acetate:

- **Dose:** 667 mg PO TID with meals.

Dialysis if refractory or ESRD.



Best Practice Recommendations

Use a **systematic approach**: Assess volume status, acid-base status, and electrolyte trends.

Correct coexisting abnormalities simultaneously (e.g., Mg and K).

Avoid overcorrection: Follow published correction limits to prevent iatrogenic harm.

Consider **consultation with nephrology or critical care** in complex cases.

Regular monitoring: Electrolytes, ABG, renal function every 4–6 hours in unstable patients.



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