

UNIVERSITY HOSPITALS OF CLEVELAND ADULT ELECTROLYTE REPLACEMENT GUIDELINES

The purpose of this guideline is to standardize the replacement of electrolytes within UHC. The suggested electrolyte replacement doses may not be appropriate in all patients. Consider the patient's comorbidities, organ dysfunction, and concurrent drug therapy before ordering electrolyte supplementation.

CALCIUM

Normal range: Total calcium: 8.4-10.2 mg/dL / Ionized calcium: 1.1-1.32 mmol/L

Oral Replacement: May use for asymptomatic hypocalcemia
 Calcium Carbonate tablet 1250–2500 mg (500–1000 mg elemental calcium) PO TID–QID
 Recheck serum calcium or ionized serum calcium daily

Oral Product Information: (UHC available products)
 Calcium Carbonate tablet 1250 mg = 500 mg elemental calcium
 Calcium Carbonate oral solution 1250 mg/5 mL = 500 mg elemental calcium
 Calcium Citrate tablet 950 mg = 200 mg elemental calcium
 Calcium Glubionate syrup 5 mL = 115 mg elemental calcium (23mg/1mL)
 Calcium Gluconate tablet 500 mg = 45 mg elemental calcium

Parenteral Replacement:

Serum Level (mmol/L)	Calcium GLUCONATE
0.85 – 1	2 grams Calcium Gluconate IV in 100 mL of D5W or NS over 1 hour
< 0.85	3 grams Calcium Gluconate IV in 100 mL of D5W or NS over 2 hours

May repeat serum level 2 hours after the infusion complete. Repeat replacement boluses as needed.

Intravenous Product Information: (UHC available products)
 Calcium Gluconate injection 10 mL = 1 gram = 90 mg elemental calcium (4.6 mEq)
 Calcium Chloride injection 10 mL = 1 gram = 272 mg elemental calcium (13.6 mEq)

Note: Calcium chloride is used only for urgent correction of hypocalcemia.

Note:

- **Maximum infusion rate: Calcium Gluconate 200 mg/min; Calcium Chloride 100 mg/min (in emergency situations)**
- **Maximum concentration: No maximum concentration; may be given undiluted in emergency situations**
- Rapid calcium infusions may cause vasodilation, hypotension, bradycardia, cardiac arrhythmias, syncope, and cardiac arrest.
- Extravasation of calcium can cause serious tissue irritation and necrosis. Immediately discontinue administration if observed.
- Calcium chloride is three times more potent than calcium gluconate.
- Do not infuse calcium in the same IV line as phosphate-containing solutions due to precipitation.
- If hypocalcemia and hypomagnesemia coexist, magnesium should be corrected to avoid accumulation of calcium in muscle cells.
- Hyperphosphatemia should also be corrected prior to administering calcium.
- In the absence of measured ionized calcium, a corrected calcium level can be determined: observed calcium + 0.8(4 – observed albumin) = Corrected calcium level.

MAGNESIUM

Normal range: 1.5 – 2.5 mg/dL

Oral Replacement: May use for asymptomatic hypomagnesemia

Magnesium Oxide tablet 400–800 mg PO BID–TID

Recheck serum magnesium levels daily

Oral Product Information: (UHC available products)

Magnesium Oxide tablet 400 mg = 242 mg elemental magnesium (20 mEq)

Milk of Magnesium (magnesium hydroxide) 24% concentrate suspension 10 mL = 1001 mg of elemental magnesium (82 mEq)

Parenteral Replacement:

Serum Level (mg/dL)	Magnesium Sulfate
1 – 1.5	2 gm Magnesium Sulfate IV in 100 mL of D5W or NS over 2 hours
< 1	4 gm Magnesium Sulfate IV in 250 mL of D5W or NS over 4 hours
*** In patients with renal insufficiency (creatinine clearance < 50 mL/min) use 50% or less of the suggested dose.	

May repeat serum level 2 hours after the infusion is completed. Repeat replacement boluses as needed.

Intravenous Product Information: (UHC available products)

Magnesium Sulfate injection 1gm = 98.6 mg elemental magnesium (8.1 mEq)

Note:

- **Maximum infusion rate: 2 gm/hr**
- **Maximum concentration: 200 mg/mL**
- Rapid magnesium infusions may cause hypotension or asystole.
- Administer at reduced dosages and with caution to patients with renal impairment.
- Oral therapy is not usually adequate to replace moderate magnesium deficiency (serum magnesium levels <1.5 mg/dL). Treatment of hypomagnesemia may take 2-3 days of therapy.
- Serum magnesium concentrations may be elevated for 1-2 days following an infusion, because it can take up to 48 hours for the magnesium to fully redistribute into body tissues.
- Note that magnesium serum levels correlate poorly with total body stores.

PHOSPHORUS

Normal range: 2.5 – 4.5 mg/dL

Oral Replacement: May use for asymptomatic hypophosphatemia

- Neutraphos packet 1-2 PO TID–QID
- Recheck serum phosphorus levels daily

Oral Product Information: (UHC available products)

Neutraphos packet = sodium 164 mg (7.1 mEq), phosphorus 250mg (14 mEq or 8.1 mmol), potassium 278 mg (7.1 mEq)

Neutraphos-K packet = phosphorus 250 mg (14 mEq or 8.1 mmol), potassium 556 mg (14.2 mEq)

Parenteral Replacement:

Serum Level (mg/dL)	SODIUM or POTASSIUM Phosphate
2 – 2.5	15 mmol SODIUM Phosphate IV in 250 mL of NS or D5W over 4 hours or 15 mmol POTASSIUM Phosphate IV in 250 mL of D5W or NS over 4 hours
1 – 1.9	21 mmol SODIUM Phosphate IV in 250 mL of NS or D5W over 6 hours or 21 mmol POTASSIUM Phosphate IV in 250 mL of D5W or NS over 6 hours
< 1	30 mmol SODIUM Phosphate IV in 250 mL of NS or D5W over 8 hours or 30 mmol POTASSIUM Phosphate IV in 250 mL of D5W or NS over 8 hours
<p>*** If potassium < 4 mEq/L consider <u>POTASSIUM Phosphate</u> for replacement.</p> <p>*** In patients with renal insufficiency (creatinine clearance < 50 mL/min) use sodium phosphate and 50% or less of the suggested dose.</p>	

May repeat serum level 2 hours after the infusion is completed. Repeat replacement boluses as needed.

Intravenous Product Information: (UHC available products)

POTASSIUM Phosphate injection: Use if patient has serum potassium < 4 mEq/L

1 mL = 3 mmol phosphorus (93 mg) AND 4.4 mEq potassium (1.47 mEq of potassium for each mmol of phosphate)

SODIUM Phosphate injection: Use if patient has renal impairment or serum potassium > 4 mEq/L

1 mL = 3 mmol phosphorus (93 mg) AND 4 mEq sodium (1.33 mEq of sodium for each mmol of phosphate)

Note:

- **Maximum infusion rate: 7.5 mmol/hr.** POTASSIUM Phosphate will be further limited by the maximum rate for potassium (20 mEq/hr)
- **Maximum concentration: must be diluted before administration** (per package insert)
- Rapid infusion may cause phosphate, sodium, or potassium intoxication. Serum calcium may be reduced rapidly causing hypocalcemia tetany.
- Do not infuse phosphate in the same intravenous line with calcium-containing solutions.
- Use Sodium Phosphate with caution in renal impairment, cirrhosis, cardiac failure, or any edematous, sodium-retaining state.
- Use Potassium Phosphate with caution in renal impairment, cardiac disease, and digitalized patients.
- Note that phosphorus serum levels correlate poorly with total body stores.

POTASSIUM

Normal range: 3.5 – 5 mEq/L

Oral Replacement: May use for asymptomatic hypokalemia. Replace over several days.

Serum Level (mEq/L)	Potassium Chloride (sustained-release tablet, oral powder, or oral solution)
3.3 – 3.5	Potassium Chloride 20 mEq PO x1
3 – 3.2	Potassium Chloride 20 mEq PO Daily x2
2.5 – 2.9	Potassium Chloride 20 mEq PO Daily x3
*** In patients with renal insufficiency (creatinine clearance < 50 mL/min) use 50% or less of the suggested dose.	

May repeat serum level 4 hours after last dose. Repeat replacement boluses as needed.

Oral Product Information: (UHC available products)

Potassium Chloride sustained-release tablet 10 mEq or 20 mEq

Potassium Chloride oral solution 20 mEq

Potassium Chloride oral powder (Klorcon) 20 mEq

Parenteral Replacement:

Serum Level (mEq/L)	Potassium Chloride via PERIPHERAL line	Potassium Chloride via CENTRAL line
3.1 – 3.4	Potassium Chloride 20 mEq IV in 250 mL of NS or D5W over 1-2 hours x2	Potassium Chloride 40 mEq IV in 100 mL of SWFI (premix) or NS or D5W over 2-4 hours
2.6 – 3	Potassium Chloride 20 mEq IV in 250 mL of NS or D5W over 1-2 hours x3	Potassium Chloride 60 mEq IV in 150 mL of NS or D5W over 3-6 hours
< 2.5	Potassium Chloride 20 mEq IV in 250 mL of NS or D5W over 1-2 hours x4	Potassium Chloride 80 mEq IV in 250 mL of NS or D5W over 4-8 hours
*** In patients with renal insufficiency (creatinine clearance < 50 mL/min) use 50% or less of the suggested dose.		

May repeat serum level 2 hours after the infusion is completed. Repeat replacement boluses as needed.

Intravenous Product Information: (UHC available products)

Potassium Chloride injection 2 mEq/mL

Note:

- **Maximum infusion rate: 20 mEq/hr.** Continuous EKG monitoring is required if infusion rate >20 mEq/hr. In cases of life-threatening hypokalemia the infusion rate may be increased to 40 mEq/hr ONLY if the patient is on continuous EKG monitoring in an intensive care unit.
- **Maximum concentration: PERIPHERAL line = 0.08 mEq/mL; CENTRAL line = 0.4 mEq/mL**
- Rapid or excessive potassium infusions may result in myocardial conduction disturbances, manifested as arrhythmias or cardiac arrest.
- Pain at the injection site and phlebitis is dependent on infusion rate, solution concentration, vein size, and catheter position. Stop or slow infusion if patient complains of discomfort.
- If hypokalemia and hypomagnesemia both coexist, magnesium should be corrected simultaneously.

References:

1. Dickerson, RN. Guidelines for the Intravenous Management of Hypophosphatemia, Hypomagnesemia, Hypokalemia, and Hypocalcemia. *Hospital Pharmacy*. 2001;36(11):1201-1208.
2. Gahart, BL and Nazareno, AR. *2004 Intravenous Medications*, 20th Ed. St. Louis, Mosby, 2004.
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4. Lacy, CF, et al. *Drug Information Handbook*, 9th Ed. Hudson, Ohio, Lexi-Comp, 2003.