

Bon Secours Richmond
Pharmacy and Therapeutics Committees
Guidelines for Calcium Use in Treatment of Hypocalcemia or Hyperkalemia in Adults
11/2005

Recommendations:

- Calcium gluconate will be used as the standard for intravenous supplementation.
- Calcium chloride will be restricted to use in emergent situations and is best infused via a central catheter due to the risk of extravasation and tissue necrosis when infused peripherally.
- Calcium chloride injection will be available in the Pyxis stations in the OR, PACU, and ED, and will remain in the code carts.

Dosing Information

- Intravenous supplementation calcium is used for severe and/or acute symptomatic hypocalcemia (serum calcium < 7.5mg/dL or ionized calcium < 0.9 mmol/L) when rapid correction is needed (see chart below).
- Calcium gluconate or chloride have been used for patients with serum potassium above 7 milliequivalents/liter (mEq/L) and electrocardiographic (ECG) evidence of severe hyperkalemia
 - 1 g of calcium gluconate (10 ml of 10% solution) over 2 to 3 minutes with continuous ECG monitoring
 - 300 to 400 milligrams of calcium chloride (3 to 4 milliliters of 10% solution) over 2 to 5 minutes with continuous ECG monitoring.
 - If the patient is receiving digoxin calcium should be used with extreme caution. In this case 1 g of calcium gluconate in 100 ml of D5W infused over 20-30 minutes is recommended.

Condition	Calcium Salt	Intermittent Dosage	Continuous Infusion Dosage
Mild to moderate hypocalcemia, asymptomatic and unable to take oral calcium	Gluconate	1-2 g (4.56-9.12 mEq) in 100 ml D5W or 0.9% NaCl over 30-60min; may repeat every 6 hrs prn	NA
Severe hypocalcemia, symptomatic	Gluconate (preferred) Or Chloride	3 g calcium gluconate Or 1 g calcium chloride (13.6 mEq) over 10 minutes; may repeat prn	NA
Severe hypocalcemia, symptomatic; refractory to intermittent bolus doses	Gluconate (preferred) Or Chloride	Not applicable	0.03-0.12 g per hour of <u>elemental</u> calcium calcium gluconate (0.336-1.32 g per hour) Or calcium chloride (0.112-0.441 g per hour)
Severe <u>hyperkalemia</u> with electrocardiographic evidence of severe hyperkalemia	Gluconate (preferred)		1 g of calcium gluconate (10 ml of 10% solution) over 2-3 minutes with continuous ECG monitoring If the patient is receiving digoxin calcium should be used with extreme caution. In this case 1 g of calcium gluconate in 100 ml of D5W infused over 20-30 minutes is recommended.

- Severe hypocalcemia is defined as total serum calcium < 7.5mg/dL or ionized calcium < 0.9mmol/L
- 1g calcium chloride = 13.6 mEq calcium; 1g calcium gluconate = 4.56 mEq calcium
- Maximum rate of injection should not exceed 0.8-1.5 mEq calcium per minute because of the potential risk for cardiac arrhythmias associated with rapid calcium infusion.
- Since an IV bolus may only be effective for 2 hours or less, severe hypocalcemia may not be corrected with intermittent boluses. A continuous infusion may be required. Calcium levels should be monitored at least every 6 hours during the infusion and infusion rate adjusted to avoid recurrent symptomatic hypocalcaemia. The underlying cause should be treated or long-term therapy started, and the IV infusion should be gradually tapered.
- Hypocalcemia due to citrated blood transfusion can be treated by administering 1.35 mEq of calcium for each 100ml of blood transfused (1 g of calcium gluconate or 4.56 mEq per unit of blood).
- Routine monitoring of serum calcium levels every 24-48 hours is recommended in the ICU setting.
- The calcium should be diluted in dextrose and water or saline, because concentrated calcium solutions are irritating to veins
- Concomitant hypomagnesemia must be corrected first in order to correct hypocalcemia.

Findings:

- The normal range for total serum calcium is 8.6-10.2 mg/dL.
- 99% of total body calcium is found in bone, with less than 1% in the serum.
- 40-50% of calcium in the blood is bound to plasma proteins, primary albumin. Hypoalbuminemia can cause a decrease in total serum calcium levels and this can be corrected for using the following equation:
Corrected serum calcium conc.= serum calcium_{mg/dl} + (0.8 [4 - serum albumin_{g/dl}])
Asymptomatic hypocalcemia due to hypoalbuminemia requires no therapy.
- Ionized or unbound calcium is the biologically active form of calcium and accounts for about 50% of calcium in the blood. Normal range for ionized calcium is 1.12-1.3 mmol/L.
- Equal amounts of ionized calcium are rapidly released from calcium gluconate and calcium chloride when equivalent doses are administered (1 g calcium gluconate= 0.333 g calcium chloride).
- Alkalosis augments calcium binding to albumin and increases the severity of symptoms.
- Hypocalcemia is primarily due to hypoalbuminemia. Other causes include: hypomagnesemia, hyperphosphatemia, sepsis, pancreatitis, renal insufficiency, hypoparathyroidism, and administration of blood preserved with citrate.
- The hallmark sign of severe hypocalcemia is tetany. Other symptoms include: altered mental status, cardiac arrhythmias, and neuromuscular deficits. Chronic hypocalcemia may cause skin manifestations such as brittle and grooved nails, hair loss, dermatitis, and eczema.
- Chronic or asymptomatic hypocalcemia can be treated with oral calcium supplements and vitamin D

Oral Calcium Supplements		
Calcium Preparation	Calcium Content per dose	Dose Size
Calcium carbonate	250 mg	650 mg
Calcium gluconate	90 mg	1000 mg
Calcium citrate	200 mg	950 mg
Calcium lactate	60 mg	300 mg

Calcium carbonate is well absorbed when taken with food, even in patients with achlorhydria.

- Compatibilities with other drugs:
 - The calcium intravenous solution should not contain bicarbonate or phosphate, which can form insoluble calcium salts. If these anions are needed, another intravenous line should be used.
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 - Other agents that are physically incompatible with calcium preparations include: amphotericin, tetracyclines, fat emulsions, propofol, dobutamine, methylprednisolone, metoclopramide, and fluconazole.

Micro Medex Information

1.3.1.A.2.a. Advanced cardiac life support

1. Advanced Cardiac Life Support

a. Calcium should be utilized only when hyperkalemia, hypocalcemia, or calcium channel block toxicity is present. The recommended dose of CALCIUM CHLORIDE in these conditions is 2 to 4 milligrams/kilogram of a 10% solution, repeated at 10-minute intervals as necessary. CALCIUM GLUCEPTATE can be given in a dose of 5 to 7 milliliters and CALCIUM GLUCONATE in a dose of 5 to 8 milliliters (Anon, 2000).

b. Patients with PULSELESS ELECTRICAL ACTIVITY (PEA) secondary to hyperkalemia should be treated with calcium chloride followed by insulin, glucose, sodium bicarbonate, nebulized albuterol, and diuresis (Anon, 2000).

1.3.1.A.2.b. Hyperkalemia

1. The recommendation for patients with serum potassium above 7 milliequivalents/liter (mEq/L) and electrocardiographic (ECG) evidence of severe hyperkalemia is 500 to 1000 milligrams of calcium chloride (5 to 10 milliliters of 10% solution) over 2 to 5 minutes with continuous ECG monitoring (Anon, 2000).

1.3.1.A.2.c. Hypocalcemia

1. CALCIUM GLUCONATE

a. Calcium gluconate is indicated to treat conditions arising from calcium deficiency including hypocalcemic TETANY, hypocalcemia related to HYPOPARATHYROIDISM, and hypocalcemia related to RAPID GROWTH or PREGNANCY. It may also be used to relieve muscle cramping caused by BLACK WIDOW SPIDER BITES and as adjunctive treatment for RICKETS, OSTEOMALACIA, LEAD COLIC, and MAGNESIUM SULFATE OVERDOSE. Calcium may decrease capillary permeability in ALLERGIC CONDITIONS, NONTHROMBOCYTOPENIC PURPURA, and EXUDATIVE DERMATOSES. The dose should be determined by requirements of the individual patient. Usual adult dosage is 0.5 to 2

grams (5 to 20 milliliters) administered slowly. Calcium gluconate should be injected through a small needle into a large vein at a rate of approximately 1.5 mL per minute (Prod Info Calcium gluconate, 1999).

References:

1. Ariyan CE, Sosa JA. Assessment and management of patients with abnormal calcium. *Crit Care Med.* 2004;32[suppl.]:S146-154.
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4. Trissel LA. *Handbook of injectable drugs.* 13th edition. 2004. pp191-205.
5. Ford. *Clinical Toxicology.* 1st edition.
6. Brenner & Rector's *The Kidney.* 7th edition.