HYPOCALCEMIA: TREATMENT GUIDELINES

1000 mg elemental calcium = 25 mmol Ca^{++} or 50 mEq Ca^{++}

Before treating hypocalcemia:

- Magnesium serum concentration should be checked in hypocalcemic patients because hypomagnesemia can induce hypocalcemia (due to end organ resistance to parathyroid hormone and possibly impaired PTH secretion).
- Phosphate serum concentration should be examined, as hyperphosphatemia can induce hypocalcemia due to metastatic calcification of calcium phosphate in the soft tissues and lungs (usually associated with renal disease).
- Arterial pH should be assessed because alkalemia can induce hypocalcemia due to increased protein binding of calcium.

ORAL CALCIUM REPLACEMENT

Formulary Oral Calcium Preparations

Calcium Salt	Elemental Calcium	mmol Calcium	mEq Calcium
Calcium carbonate 1250 mg tablets	500 mg Ca^{++} / tab	12.5 mmol Ca^{++} / tab	25 mEq Ca^{++} / tab
Calcium gluconolactate & calcium carbonate effervescent tablet (Calcium Sandoz Forte®)	500 mg Ca^{++} / tab	12.5 mmol Ca^{++} / tab	25 mEq Ca^{++} / tab
Calcium gluconate and glucoheptonate oral solution (Calcium Rougier®)	19.5 mg Ca^{++} / mL	0.49 mmol Ca^{++} / mL	0.98 mEq Ca^{++} / mL

Adult Oral Dosing

Initial Adult Dose: 500 mg Ca^{++} / dose PO tid to qid (=1250 mg calcium carbonate PO tid to qid)

Pediatric Oral Dosing

Pediatric Dose: 45-65 mg / kg / day Ca^{++} PO divided tid to qid

INTRAVENOUS CALCIUM REPLACEMENT

- Calcium gluconate is generally preferred over calcium chloride for peripheral venous administration because calcium gluconate causes less phlebitis.
- Calcium gluconate may cause a less predictable and slightly smaller increase in plasma calcium compared to an equivalent dose of calcium chloride
- Note that there is a poor correlation between the ionized serum calcium (free) and total serum calcium, particularly in states of low albumin or acid/base imbalances. If total serum calcium levels are measured in patients with low albumin, the corrected total serum calcium should be estimated as follows:

Corrected serum calcium = measured serum calcium + [(40 - serum albumin) X 0.02]
(mmol/L) (mmol/L) (g/L)

HYPOCALCEMIA: TREATMENT GUIDELINES (cont'd)

- If the total corrected serum calcium is outside the normal range, or if the patient is alkalemic, an ionized serum calcium level is recommended. Note that a minimum of 2 hours is required for the reporting of ionized calcium results.

Formulary Intravenous Calcium Preparations

Calcium Salt	Elemental Calcium	mmol Calcium	mEq Calcium
Calcium chloride 10% Injection (100 mg / mL)	27 mg Ca^{++} / mL	0.68 mmol Ca^{++} / mL	1.36 mEq Ca^{++} / mL
Calcium gluconate 10% Injection (100 mg / mL)	9 mg Ca^{++} / mL	0.23 mmol Ca^{++} / mL	0.45 mEq Ca^{++} / mL

Note: Each 90 mg Ca^{++} = 10 mL Calcium gluconate 10% = 3.3 mL Calcium chloride 10%

Adult Intravenous Dosing

Normal total serum calcium = 2.15 - 2.65 mmol / L
Normal ionized serum calcium = 1.19 - 1.31 mmol / L

Usual maximum total daily dose is 15 g calcium gluconate (= 1350 mg Ca^{++})
Dose may be administered as a continuous infusion or in divided doses

Ionized Calcium [1]	Phosphate < 2 mmol / L	Phosphate 2 - 3 mmol / L	Phosphate > 3 mmol / L
Mild (asymptomatic) 0.80-0.99 mmol/L	Consider oral supplementation	Correct phosphate and reassess calcium level	Correct phosphate and reassess calcium level
Mild (symptomatic [2]) 0.80-0.99 mmol/L	2 g calcium gluconate (= 180 mg Ca^{++})	Correct phosphate 1 g calcium gluconate (= 90 mg Ca^{++})	Correct phosphate
Moderate 0.60-0.79 mmol/L	3 g calcium gluconate (= 270 mg Ca^{++})	Correct phosphate 1 to 2 g calcium gluconate (= 90 to 180 mg Ca^{++})	Correct phosphate 1 g calcium gluconate (= 90 mg Ca^{++})
Severe < 0.59 mmol/L	4 g calcium gluconate (= 360 mg Ca^{++}) [Repeat until symptoms are controlled]	Correct phosphate 2 to 3 g calcium gluconate (= 180 to 270 mg Ca^{++})	Correct phosphate 1 to 2 g calcium gluconate (= 90 to 180 mg Ca^{++})

[1] Repeat ionized calcium level two hours after intermittent infusion of calcium to reassess need for further supplementation.

[2] Symptomatic hypocalcemia:

Neuromuscular Tetany
(paresthesias around the mouth and in the extremities, muscle spasms and cramp, carpopedal spasms, and rarely laryngospasm and brochospasm)

Cardiovascular manifestations
(ECG changes characterized by a prolonged QT interval and symptoms of decreased myocardial contractility often associated with congestive heart failure)

Chronic hypocalcemia may present with CNS (e.g. fatigue, irritability, confusion) and dermatologic symptoms

Pediatric Intravenous Dosing

Normal total serum calcium = 2.25 - 2.62 mmol / L
Normal ionized serum calcium = 1.14 - 1.29 mmol / L

Calcium gluconate 10% (100 mg/mL) injection

200-500 mg (2-5 mL) calcium gluconate 10% /kg/day

= 0.92 - 2.3 mEq Ca^{++}/ kg / day

= 0.46 - 1.15 mmol Ca^{++} / kg / day

Administer as a continuous infusion or in divided doses q6-8h.
[Maximum of 3 g calcium gluconate per dose]

Rate (Adult and Pediatric)

Intermittent infusion:

Doses up to 4 g calcium gluconate (= 360 mg Ca^{++}) may be infused over one hour.

Note that rapid administration in emergency situations requires cardiac monitoring. (Rapid administration may cause vasodilation, decreased blood pressure, cardiac arrhythmias, syncope, and cardiac arrest).

Continuous infusion:

Recommended rate for continuous infusions is 5.6 to 22 mg calcium gluconate/kg/hour initially (= 0.5 to 2 mg Ca^{++}/kg/hour). This may be decreased to 3.3 to 5.6 mg calcium gluconate/kg/hour (=0.3 to 0.5 mg Ca^{++} /kg/hour) for maintenance infusions.

Dilution (Adult and Pediatric)

Intermittent infusion:

Recommended dilution for peripheral intermittent infusion of doses up to 4 g calcium gluconate (= 360 mg Ca^{++}) is 100 to 250 mL NS, D5W or dextrose-saline solutions.

Continuous infusion:

The recommended maximum concentration for peripheral continuous infusions is 8 g calcium gluconate per liter (=720 mg Ca^{++} per liter). More concentrated solutions for continuous infusion should be infused via a central line. In urgent situations, more concentrated solutions may be run peripherally for a short period of time in patients without central IV access if discussed with physician.

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