Pharmacy Friday

Brief pearls related to acute care pharmacology and evidence-based medicine
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Appropriate use of IV Calcium

Introduction

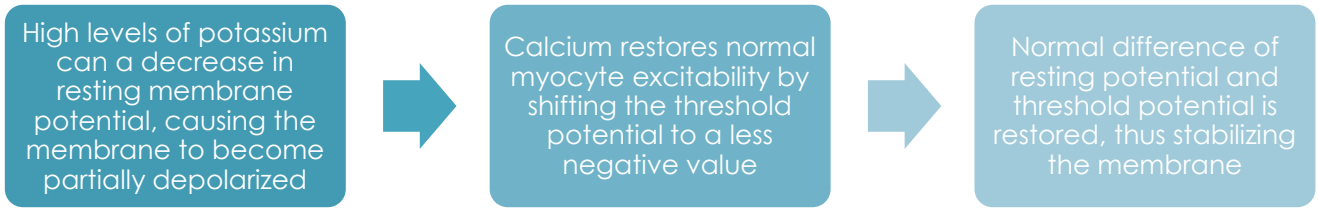
1. IV calcium is used in replacement and/or cardiac stabilization. Overuse can occur
   a. Patients with hyperkalemia and hypermagnesemia are commonly given calcium, but calcium is not a definitive treatment for hyperkalemia or hypermagnesemia
2. Ionized calcium versus serum calcium
   a. Serum (total) calcium represents all calcium in the body, both free and protein bound. This is affected by albumin stores in the body and can severely underestimate a patient's true calcium level
   b. Ionized (free) calcium represents active calcium in the body. Measuring ionized calcium should be considered prior to treating hypocalcemia, especially in non-emergent cases
3. IV calcium is currently on national drug shortage and consideration should be taken prior to ordering

Pharmacology		
	Calcium Chloride	**Calcium Gluconate**
Mechanisms	Normalizes myocyte excitability by shifting threshold potential Agonist at calcium channels to restore normal cardiac function in blockade	
Formulations	100 mg/mL (10%) contains 1.36 mEq EC/mL (3x higher than calcium gluconate)	100 mg/mL (10%) contain 0.465 mEq EC/mL.
Administration	IV push in emergent situations over 2-5 minutes. Central line administration recommended	Slow IV push administration over 2 -5 minutes May be given as continuous infusion for hypocalcemia
Adverse Effects	Arrythmias, bradycardia, cardiac arrest, syncope, tingling, **necrosis of tissue (chloride > gluconate)**	
Drug Interactions and warnings	Extravasation: Calcium is a vesicant, administration into tissue can cause necrosis Not to be used when patient is in ventricular fibrillation in cardiac resuscitation	
How supplied	Supplied at Grady as a 1 g/10 ml carpuject syringe or vial only in code carts due to drug shortage	Supplied at Grady as a 1g vial (100 mg/mL)
Clinical Pearls	Onset of action has been described as "immediate" but can take up to 5 minutes to start to have effects The duration of action of calcium is 30 – 60 minutes	

Indications for IV calcium			
Use	**Indications**	**Agents**	**Pearl**
Acute/symptomatic hypocalcemia	**Acute symptoms and/or ionized calcium < 3mg/dL** Moderate: Muscle twitching, spasms, tingling, numbness Severe: cardiac dysrhythmias, seizures Ionized calcium < 3mg/dL	**Calcium gluconate** Moderate: 1-4g IV (infusion preferred) Severe: 1-2g IV, over 10 minutes - may repeat every 60 minutes until symptoms resolve **Calcium Chloride** Moderate: 200mg-1g IV (infusion preferred) Severe: 1g IV, over 10 minutes, may repeat every 60 minutes until symptoms resolve	Chronic asymptomatic hypocalcemia should be treated with oral calcium

kmfifer@gmh.edu

Hyperkalemia	Potassium > 5.5mg/dL + EKG changes	**Calcium gluconate** 1.5-3g IVP over 2-5 minutes **Calcium chloride (cardiac arrest)** 1g IVP over 2-5 minutes, repeat as necessary	Calcium is used for heart membrane stabilization, NOT for potassium lowering effects. Additional therapy must be used in combination with calcium to lower potassium levels
Magnesium overload	**Severe cardiotoxicity/ cardiac arrest** Mild - moderate: nausea, diarrhea, urinary retention, lethargy, muscle weakness Severe: hypotension, cardiac abnormalities	**Calcium gluconate** 1.5-3g IVP over 2-5 minutes **Calcium chloride (cardiac arrest)** 1g IVP over 2-5 minutes, repeat as necessary	Hypermagnesemia can inhibit parathyroid hormone production leading to hypocalcium, as well as acting as a calcium channel blocking agent at high doses
Current ACLS guidelines recommend against routine use of calcium in the treatment cardiac dysrhythmias Calcium may be used off-label for calcium channel blocker or beta blocker overdoses on a case-by-case basis			



Review of Evidence			
Author, year	**Design**	**Intervention & Comparison**	**Assessment**
2004 Byrnes	Randomized, retrospective chart review	Over 38% of calcium levels were classified incorrectly with the corrected serum calcium based on albumin levels as the primary tool of measurement compared to ionized calcium levels.	Ionized calcium testing provides a high level of specificity compared to corrected calcium levels. As a result, it should be the primary lab used to assess calcium status in patients requiring management for calcium imbalance.
2018 Peacock	Multicenter, Prospective Observational Study	Patients aged 18 and older diagnosed with hyperkalemia were treated with multiple strategies. The most commonly used therapy employed was insulin/dextrose. IV calcium was used 55% of the time and only 4 of 203 cases employed it as a monotherapy option.	Observing major treatments and clinical decision making in multiple U.S. based trauma centers concerning acute hyperkalemia therapy options. **Most centers employed at least 3 to 4 combination therapies to treat hyperkalemia.** Calcium was almost never used as monotherapy due to its mechanism of action (not potassium lowering)

Conclusions

- Calcium does not directly lower potassium or magnesium. Additional therapies are needed to affect potassium levels in combination with calcium administration
- Routine use of calcium in cardiac dysrhythmias is not recommended
- Ionized and serum calcium are not equal; considerations need to be taken when considering a patients' true calcium level
- Oral replacement of calcium should be considered first line if patients are stable and/or chronic issue
- Calcium chloride has a higher risk of extravasation and use should be restricted to cardiac arrest unless a central line is established

References

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kmfifer@gmh.edu