

# Strategies for Electrolyte Replacement

Lauren N. Kuykendall MSN, RN, AGACNP-BC, CCRN

# Objectives

- Identify when electrolyte replacement is needed and underlying cause
  - Potassium, Magnesium, Calcium, Phosphorous
- Understand different formulations, route, dosage and adverse effects of replacement
- Identify when goal replacement has been achieved
- Identify when maintenance therapy may be required

# Hypokalemia

- Usually secondary to:
  - GI loss (vomiting, diarrhea)
  - Urinary losses (diuretics, RTA)

Also think about : co-existing electrolyte abnormality (hypomagnesemia), hyperaldosteronism, insulin therapy, albuterol, alkalosis)

- Indications for replacement:
  - Evidence of potassium loss
  - Significant deficit in body potassium
  - Acute therapy in redistributive disorders (periodic paralysis, thyrotoxicosis)

# Hypokalemia

- Symptoms: usually manifest when serum K <3.0
  - Muscle weakness (K <2.5), cramps, rhabdomyolysis
  - Respiratory muscle weakness
  - GI symptoms: anorexia, nausea, vomiting
  - Cardiac arrhythmias: atrial tachycardia, junctional tachycardia, AV block, ventricular tachycardia or fibrillation
  - EKG abnormalities: PAC, PVC, sinus bradycardia, ST segment depression, decreased amplitude of T-wave, increased amplitude of U-wave (mostly in V4-V6)
  - If prolonged hypokalemia: functional changes in the kidney and glucose intolerance

# Therapy

- Calculate potassium deficit (if normal distribution is present- do NOT use in DKA or HONK)
  - **Acute:** .27meq/L decrease in serum K+ for every 100meq reduction in total potassium stores
  - **Chronic:** 1meq/L decrease in serum K+ for every 200-400meq reduction in total potassium stores

## Simplified:

$$\frac{\text{Goal K} - \text{Serum K}}{\text{serum Cr}} \times 100 = \text{total meq K required}$$

10meq of KCL will raise the serum K by ~.1meq/L

# Formulations

- **Potassium Chloride : PREFERRED AGENT**
  - Most patients with hypokalemia and acidosis are also chloride depleted
  - Raises serum potassium at a faster rate
  - Available as salt substitute, liquid, slow release tablet or capsule, and IV
- **Potassium Bicarbonate/Citrate/Acetate:**
  - can be used in patients with hypokalemia and metabolic acidosis
- **Potassium Phosphate:**
  - Rarely used (Fanconi syndrome with phosphate wasting)

# Ongoing Losses

- In general, use oral therapy
- KCL with normal or elevated serum bicarb
- Potassium citrate/acetate/bicarbonate in presence of acidosis (diarrhea, RTA)
- no need for continued supplementation with chronic renal potassium wasting (potassium sparing diuretic is more effective):
  - Chronic diuretic therapy
  - Primary aldosteronism
  - Gitelman's, Bartter's syndrome

# Adverse Effects

- Hyperkalemia
- Potassium is osmotically active- can increase tonicity of IV fluids
- Oral therapy- pills are large, can be difficult to swallow
- Peripheral IV Therapy:
  - Pain
  - Phlebitis

Make sure to recheck serum potassium 2-4 hours later to assess response to therapy



# Goal of Therapy

- Prevent life threatening complications
- Urgency of replacement depends on severity, rate of decline and co-morbid conditions
  - Elderly
  - underlying heart disease
  - on digoxin or anti-arrhythmic drugs

# Example

- 72 year old female admitted for weakness and dehydration due to acute gastroenteritis. She is having up to 6 BM/day. Her serum K on admission is 2.5 meq and serum Cr is 2.0. EKG reveals u-waves.

1. How much potassium do you order?

$$\frac{4-2.5}{2} \times 100 = 75\text{meq}$$

2

2. What formulation do you choose?

KCL; if bicarb is low then consider potassium bicarb or acetate

3. What route should the potassium be administered? 40meq (initial) oral and 40meq IV; (re-assess 2-4 hours later and give more orally if needed and tolerating po)

4. Serum potassium remains low, what else could be contributing?

Low magnesium, ongoing diarrhea

# Hypomagnesemia

- Average daily intake: 360mg
- Presence of low magnesium (nearly 12% of hospitalized patients) suspected in following cases:
  - Chronic diarrhea
  - Hypocalcemia
  - Refractory hypokalemia
  - Ventricular arrhythmias
- Symptoms/Signs :
  - Tetany (seizures in children/neonates)
  - Hypokalemia
  - Hypoparathyroidism → hypocalcemia (<1.2mg/dL)
  - Vitamin D deficiency (due to low calcitriol)
  - EKG changes: widened QRS, peaked T-waves, → diminition, PR interval prolongation,
  - Ventricular arrhythmias (especially during ischemia or bypass), think TORSADES

# Therapy

- **Goal of therapy:**
  - maintain plasma magnesium concentration over 1.0mg/dL acutely in symptomatic patients
  - In cardiac patients, maintain Mg >1.7 (usually goal 2.0mg/dL) to avoid arrhythmias
  - Serum levels are poor reflection of actual body stores (mostly intracellular) so aim for high-normal serum level
- Avoid replacement in patients with reduced GFR
- Treat underlying disease (PPI, diuretics, alcohol, uncontrolled diabetes)
- **Adverse effects:**
  - Abrupt elevation of plasma Mg can remove the stimulus for Mg retention and lead to increased excretion
  - Diarrhea
  - Drug interactions
  - Magnesium intoxication, Aluminum intoxication

# Hypocalcemia

- Clinical Manifestations:
  - Acute: serum Ca <7.5mg/dL
    - Neurologic: tetany (from paresthesias to seizures and bronchospasm)
    - Cardiac: prolonged QT, hypotension, heart failure, arrhythmia
    - Papilledema
    - Psychiatric manifestations
  - Chronic:
    - EPS, dementia, cataracts, dry skin
- Etiology:
  - Vitamin D
  - PTH
  - Hypomagnesemia
  - Drugs

# Therapy

- Correct for albumin
  - Ca lower by .8mg/dL for every 1g/dL reduction in serum albumin
  - or check ionized calcium
- Level can be altered by acid/base disturbance
- Add Vitamin D in following cases:
  - **Hypoparathyroidism:** Vitamin D (Calcitriol .25-.5mcg bid)
  - **Vitamin D deficiency:** 50,000IU/week for 6-8 weeks then 800-1000IU daily
    - Ergocalciferol (D3)
    - Cholecalciferol (D2)

# Therapy

- **Goals of therapy:**
  - Treat and prevent manifestations of hypocalcemia
  - In hypoparathyroidism: to raise serum Ca to low-normal range (8.0-8.5mg/dL)
- **Adverse Effects:**
  - Rapid infusion- bradycardia, hypotension
  - Extravasation- tissue necrosis
  - Hypercalcemia
  - Hypercalciuria
  - Constipation
  - Hypophosphatemia
  - Milk-alkali syndrome

# Example

35 y/o male with hypoparathyroidism secondary to DiGeorge's presents with serum Ca of 6.2, albumin of 3.8, ionized Ca .77. Has some mild muscle cramps, otherwise asymptomatic.

1. How do you initially treat his hypocalcemia?
  - IV Calcium Gluconate 1g IV over 10-20min
2. Repeat serum Ca is 6.6, how do you proceed with treatment?
  - start Calcium gluconate 1mg/mL in D5W 50mL/hr infusion
2. After initial treatment, what maintenance regimen should you initiate?
  - Calcitriol (.5mcg bid, titrated up in this patient)
  - Calcium carbonate (1950mg po tid in this patient)



# Hypophosphatemia

- Due to:
  - Redistribution
  - Decreased intestinal absorption (small bowel)
  - Increased urinary excretion
- Common situations:
  - Chronic alcoholism
  - IV hyperalimentation w/o phosphate supplementation
  - Refeeding syndrome
  - “Hungry Bone” syndrome
  - Respiratory alkalosis (hyperventilation)
  - Chronic ingestion of antacids (containing aluminum or Mg)
  - Hyperparathyroidism (primary or secondary)
  - Vitamin D deficiency
  - Fanconi syndrome (associated with multiple myeloma in adults)

# Hypophosphatemia

- Signs/Symptoms:  $<2.0\text{mg/dL}$ , severe usually when serum  $\text{PO}_4 <1.0\text{mg/dL}$

## Acute:

- Metabolic encephalopathy- irritability, paresthesias → confusion, seizure, coma
- Respiratory failure due to weakened diaphragm
- Reduction in cardiac output leading to heart failure
- Proximal myopathy, dysphagia, ileus
- Elevated CPK, rhabdomyolysis
- Coagulopathy with thrombocytopenia

## Chronic:

- Hypercalciuria
- Increased bone resorption: Osteomalacia, Ricketts

# Treatment

- Usually aimed at treating the underlying cause (resolution of diarrhea, Vit D therapy, d/c antacid, etc.)
- If tx is needed, oral therapy is preferred
  - Asymptomatic, serum PO<sub>4</sub> <2.0mg/dL or symptomatic with serum PO<sub>4</sub> 1.0-1.9mg/dL
  - Available as tablet and powder/packets (sodium phosphate, potassium phosphate) 250-500mg tid-qid (w/ meals & HS) over 24 hours
  - Decrease dose by one-half in patients with reduced GFR
  - Increase dose in severely obese patients
  - Recheck after 12 hours to determine if additional/continued supplementation is required

# Treatment

- Goal of therapy: increase serum PO<sub>4</sub> to 2.0mg/dL
- Side effects of therapy:
  - Oral: Diarrhea, nausea, hyperkalemia (K-phos)
  - IV: Hyperphosphatemia → hypocalcemia, AKI, arrhythmia
- Maintenance therapy is not usually required