TREATMENT OF HYPERKALEMIA

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Objectives

- Explain hyperkalemia and the signs and symptoms
- Identify the causes of hyperkalemia
- Review the treatment of hyperkalemia
- Discuss a patient who presented to the hospital with hyperkalemia

Background

- Normal plasma potassium concentration: 3.5-5 mEq/L
- Primary intracellular ion
- Potassium homeostasis modulated by:
  - Short-term (internal balance): insulin, catecholamines, and acid-base balance
  - Long-term (external balance): kidneys and intestines

Causes

- Increased intake
- Shift of potassium from intracellular to extracellular:
  - Acidosis
  - Insulin deficiency (i.e. DKA)
  - Beta adrenergic blockade
  - Digoxin overdose
  - Rewarming after hypothermia
  - Succinylcholine
- Reduced urinary excretion:
  - Kidney dysfunction
  - Intravascular volume depletion
  - Hypoaldosteronism
  - Medications

Signs and Symptoms

- Cardiac effects:
  - EKG changes:
    - Peaked T wave
    - Widening of the QRS complex
    - Loss of the P wave
    - "Sine wave" configuration
    - Ventricular fibrillation
    - Asystole
  - Enhanced by a variety of factors
  - EKG changes may be absent and should not delay treatment of severe hyperkalemia

Signs and Symptoms

Serum potassium	Typical ECG appearance	Possible ECG abnormalities
Mild (5.5-6.5 mEq/L)		Peaked T waves Prolonged PR segment
Moderate (6.5-8.0 mEq/L)		Loss of P wave Prolonged QRS complex ST-segment elevation Ectopic beats and escape rhythms
Severe (>8.0 mEq/L)		Progressive widening of QRS complex Sine wave Ventricular fibrillation Asystole Axis deviations Bundle branch blocks Fascicular blocks

Signs and Symptoms

- Neuromuscular effects:
  - Paraesthesias
  - Weakness progressing to flaccid paralysis
  - Deep tendon reflexes are depressed or absent
- Metabolic effects:
  - Mild hyperchloremic metabolic acidosis

Treatment

- Given emergently in the following situations:
  - Plasma potassium > 6.5 mEq/L
  - EKG manifestations of hyperkalemia regardless of potassium value

Treament

- Goals of therapy (in order of importance):
  1. Antagonize the effect of potassium on excitable cell membranes
     - Calcium
  2. Redistribute extracellular potassium into cells
     - Insulin
     - Beta agonists
     - Bicarbonate
  3. Enhance elimination of potassium from the body
     - Bicarbonate
     - Diuretics
     - Exchange resin (Kayexalate®/sodium polystyrene sulfonate)
     - Dialysis

Treatment

- **B-** beta agonist and bicarbonate
- **I-** insulin (regular)
- **G-** gluconate (calcium)
- **K-** Kayexalate®
- Then there is also dialysis and diuretics

Treatment: Calcium

- Given for symptomatic hyperkalemia to stabilize the myocardium preventing abnormal arrhythmias
- Calcium gluconate preferred over chloride
  - Chloride salt is 3x more concentrated
  - Chloride salt can cause tissue necrosis
- Dose: calcium gluconate 1 g IV over 2-10 minutes; repeat in 5 minutes if no improvement in EKG
- Onset: immediate
- Duration: 30-60 minutes

Treament: Insulin

- Given to redistribute potassium intracellularly
- Dose: 10 units IV of regular insulin in combination with 25 g of dextrose 50% in normoglycemic patients
- Onset: < 15 minutes
- Duration: 4 to 6 hours
- Typically lowers potassium by 0.5-1.5 mEq/L

Treatment: Beta Agonists

- Given to redistribute potassium intracellularly
- Dose: Albuterol 10-20 mg nebulized over 10 minutes
- Onset: 30-90 minutes
- Duration: 2 hours
- Typically lowers potassium by 0.5-1.5 mEq/L
- Resistance:
  - Patients taking non-selective beta blockers
  - As many as 40% of patients not taking beta blockers are non-responders

Treatment: Bicarbonate

- Given to redistribute potassium intracellularly vs enhanced renal elimination
- Dose: Sodium bicarbonate 50 mEq over 5 minutes or as a continuous infusion
- No effect on decreasing potassium should be anticipated
- Efficacy is controversial

Treatment: Kayexalate®

- Cation-exchange resin that exchanges sodium for potassium, resulting in intestinal excretion of potassium
- Dose: 15-30 g PO/PR Q6H prn
- Onset: > 2 hours
- Duration: 4-6 hours
- Efficacy: highly variable and unpredictable
- Not for emergent treatment of hyperkalemia

Treatment: Kayexalate®

- Constipation is a side effect of the resin complex
- Sorbitol component is used as a cathartic
- 70% sorbitol mixture no longer recommend due to intestinal necrosis
- Caution use in those with kidney or heart failure due to the sodium component of the medication

Treatment: Dialysis

- Hemodialysis (HD):
  - Method of choice for removal of potassium from the body
  - Expected decrease of potassium:
    - ~1 mEq/L in the first hour
    - ~2 mEq/L after 3 hours
  - Rebound of potassium:
    - 35% of reduction abolished after 1 hour
    - 70% of reduction abolished after 6 hours
    - Magnitude of post-HD rebound is proportional to pre-HD potassium value
- Peritoneal dialysis (PD):
  - Rate of removal is much slower when compared to HD
  - Decrease of potassium is due mainly to the glucose load of the PD solution pushing the potassium back intracellularly

Treatment: Diuretics

- Enhanced renal elimination of potassium
- Ineffective in those with advanced kidney disease
- Loop diuretics:
  - Furosemide or bumetanide:
    - Onset: 15 minutes
    - Duration: 2-3 hours

Patient Case

- 95 YO F admitted with AKI, hyperkalemia, and volume depletion
- PMH: recurrent UTIs, h/o of DVT, HTN, HLD, hypothyroidism, GERD, bradycardia s/p pacemaker, dementia, h/o PNA
- SH: negative for EtOH and tobacco and lives at Alexian Villiage
- Home meds: Norvasc, Cipro (completed), Celexa, Clonidine, Depakote, Aricept, Synthroid, Ativan, Cozaar, Risperdal

Patient Case

- Pertinent labs:

	SCr	BUN	K^+	pH	pCO_2	HCO_3
Baseline	1-1.2	--	--	--	--	--
6/25	16.8	163	7.6	7.26	32	13.7
6/26	15.11	156	7.1	--	--	--

Patient Case

- Hospital treatment course:
  - 6/25 (K^+ = 7.6):
    - $NaHCO_3$ 100 mEq @ 1632
    - Regular insulin 10 units IV @ 1729
    - Dextrose 50% 1 syringe @ 1729
    - Calcium gluconate 1 amp @ 1729
  - 6/26 (K^+ = 7.1):
    - D5W with $NaHCO_3$ 150 mEq @ 75 mL/hr then changed to 100 mEq @ 120 mL/hr (x1 liter)
    - Regular insulin 10 units IV @ 1032
    - Dextrose 50% 1 syringe @ 1032
    - Calcium gluconate 1 amp @ 1441
  - 6/27: Patient transferred to hospice care
  - 6/28: Discharged to hospice

Patient Case

- What are some potential causes of patient's hyperkalemia?
  - Decreased PO intake
  - Impaired kidney excretion
  - Medication-Cozaar
  - Acidosis
- Was the patient treated appropriately?
  - Beta agonists?
  - Calcium gluconate given 4 plus hours after insulin/dextrose on 4/26. This should have been given first.

Conclusion

- Hyperkalemia is one of the few potentially lethal electrolyte disorders and is consider a medical emergency
- Treatment of hyperkalemia should not be withheld despite no EKG changes
- Treatment should be given for a plasma potassium of > 6.5 mEq/L and/or EKG changes

References

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- Weisburg, LS. "Management of severe hyperkalemia." *Crit Care Med* 2008;36:12.