

Electrolyte Imbalance and Resuscitation

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Presentation plan

- Definition of the electrolyte disturbances
- Conditions causing dysrhythmia
- Treatment of electrolyte disturbances
- Summary

Electrolyte Imbalances

- K^+
- Ca^{++}
- Mg^+
- Na^+

Lethal electrolyte imbalances

- **Hyperkalemia**
- Hypokalemia
- Magnesium
- Calcium
- Sodium

Sodium abnormalities

The seizures will kill the the patient before cardiac effects could occur.

Calcium abnormalities

- Calcium abnormality as an etiology of cardiac arrest is rare.
- There are no studies evaluating the treatment of hypercalcemia or hypocalcemia during arrest.
- In case of hyperkalaemia and hypermagnesemia don't forget to use calcium

Potassium abnormalities

- Adults: 3.5-5.0 mEq/L or mmol/L
- Children: 3.4-4.7 mEq/L or mmol/L
- It is an intracellular ion, 98%
- Small changes in the extracellular potassium level can have profound effects on the function of the cardiovascular and neuromuscular systems.

Hyperkalemia

- $>5.5 \text{ mmol}^{-1}$
- $5.5\text{--}5.9 \text{ mmol}^{-1}$ Mild elevation
- $6\text{--}6.4 \text{ mmol}^{-1}$ Moderate elevation
- $\geq 6.5 \text{ mmol}^{-1}$ Severe elevation

HYPERKALEMIA CAUSES

I. Shifting of K into extracellular space

- A. Tissue (lots of cells) damage: burns, crush injury, rhabdomyolysis, tumor lysis
- B. Acidosis
- C. Hyperosmolar states
- D. Insulin deficiency

II. Impaired Renal Excretion (↑ total body K)

- A. Renal insufficiency/failure
- B. Endocrine: adrenal insufficiency, ↓ renin, ↓ aldosterone, pseudohypoaldosteronism

III. Iatrogenic

- A. K in IVF or TPN
- B. Medications: NSAIDS, ACE inhibitors, beta blockers, K sparing diuretics, trimethoprim, and many, many others

Diagnosis

- Hyperkalemia can be difficult to diagnose clinically because complaints may be vague.
- Can cause to sudden cardiac death from dysrhythmias.
- Hurry up!

Signs and symptoms

- Generalized fatigue
- Weakness
- Paresthesias
- Paralysis
- Palpitations

Vital signs are essential; hemodynamic stability, cardiac arrhythmias.

Diagnosis

I. Muscle

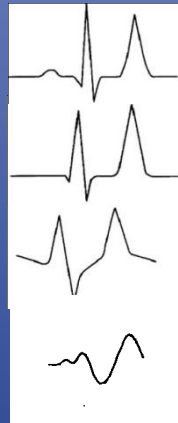
- A. Ascending muscle weakness and paralysis
- B. Respiratory muscle weakness rare

II. Cardiac

- A. Conduction abnormalities and arrhythmias

- B. EKG Changes

- 1. Peaked T waves
- 2. Loss of P wave
- 3. Widened QRS
- 4. Sine wave pattern



- 5. Ventricular tachycardia
- 6. Bradycardia
- 7. Cardiac arrest; pulseless electrical activity [PEA], V F/VT, Asystole

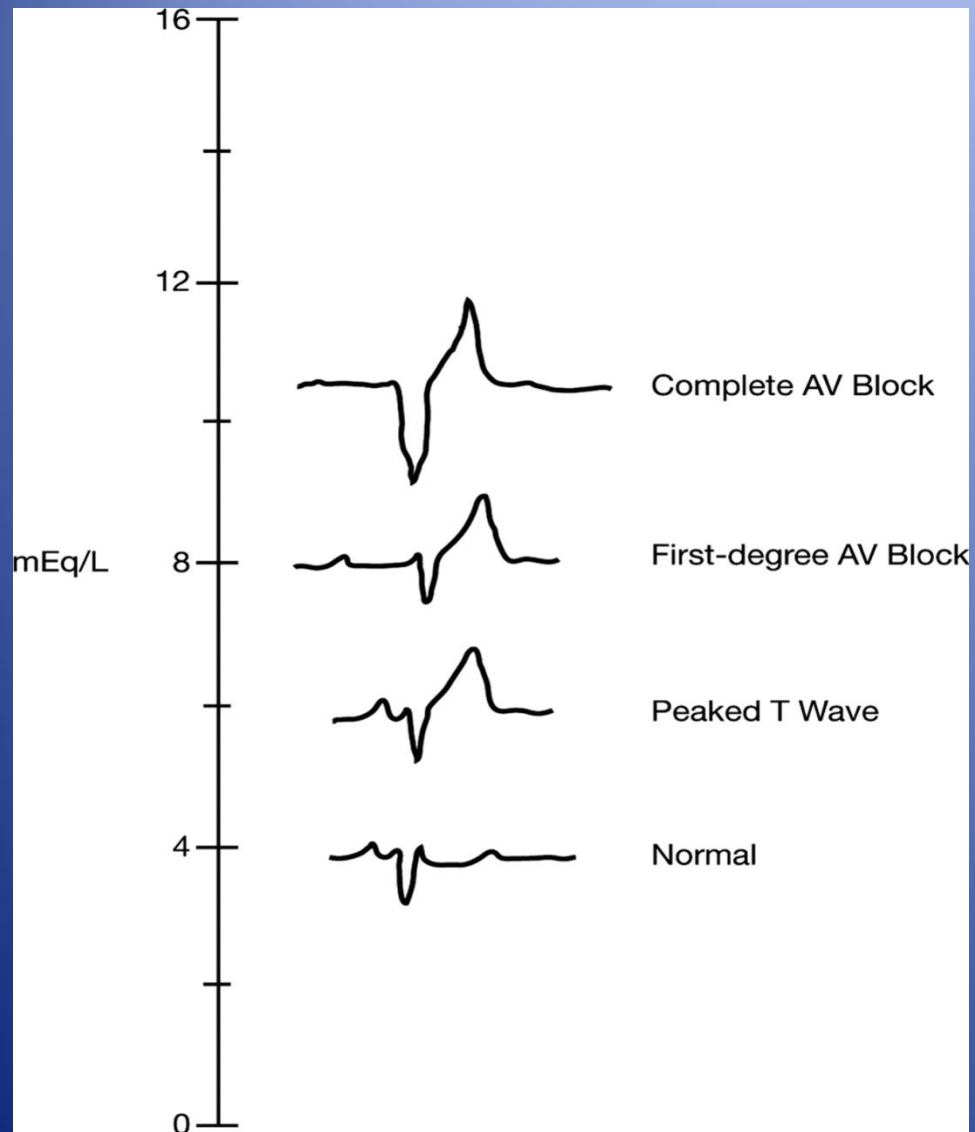
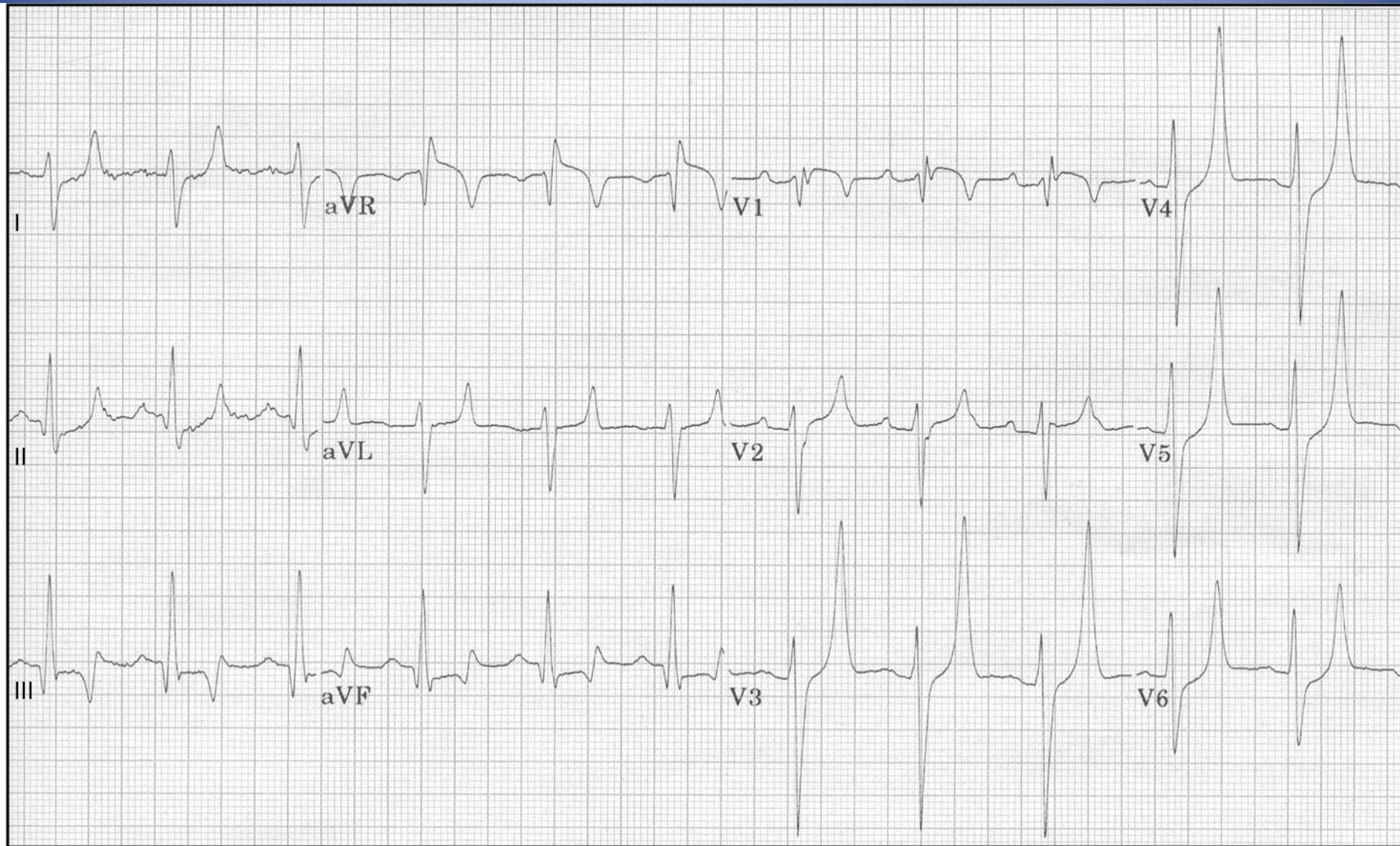
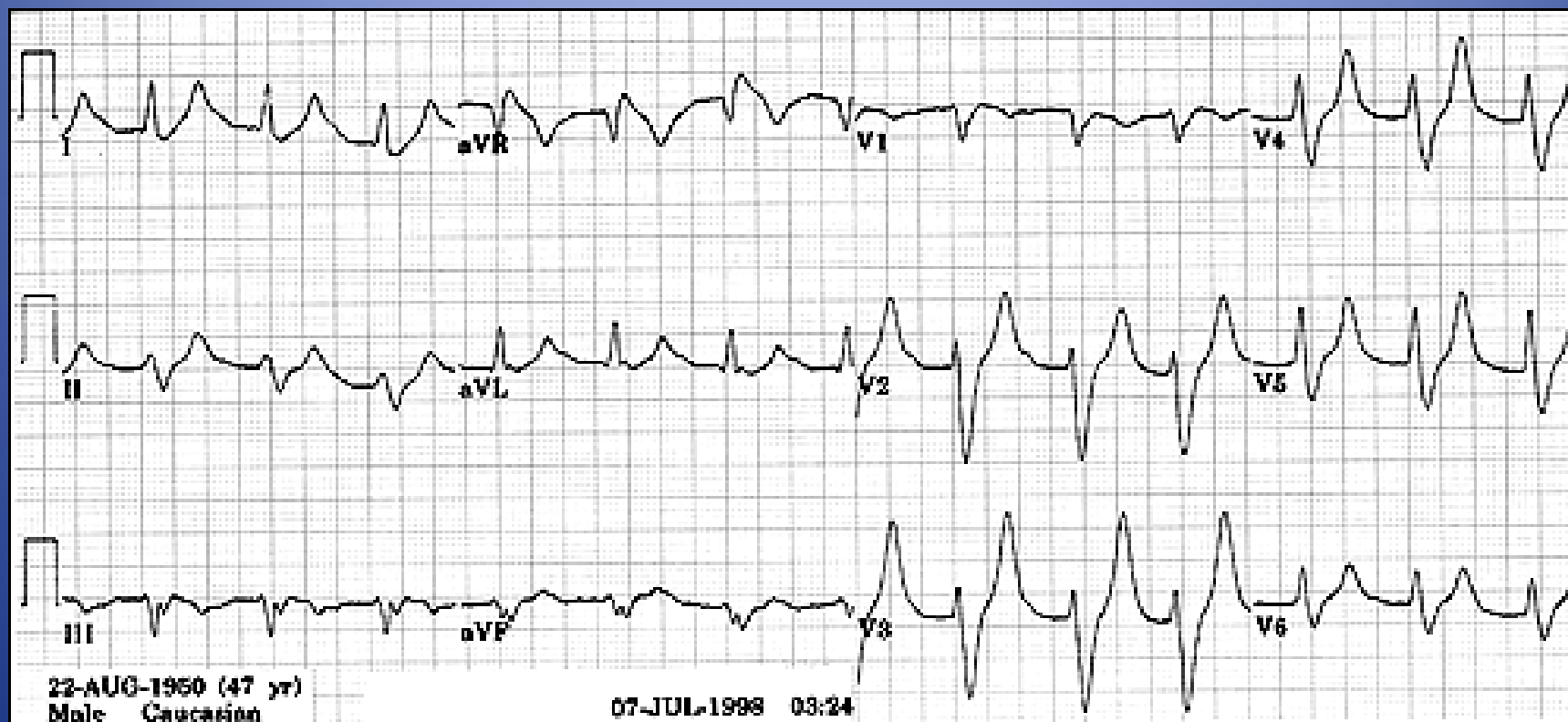
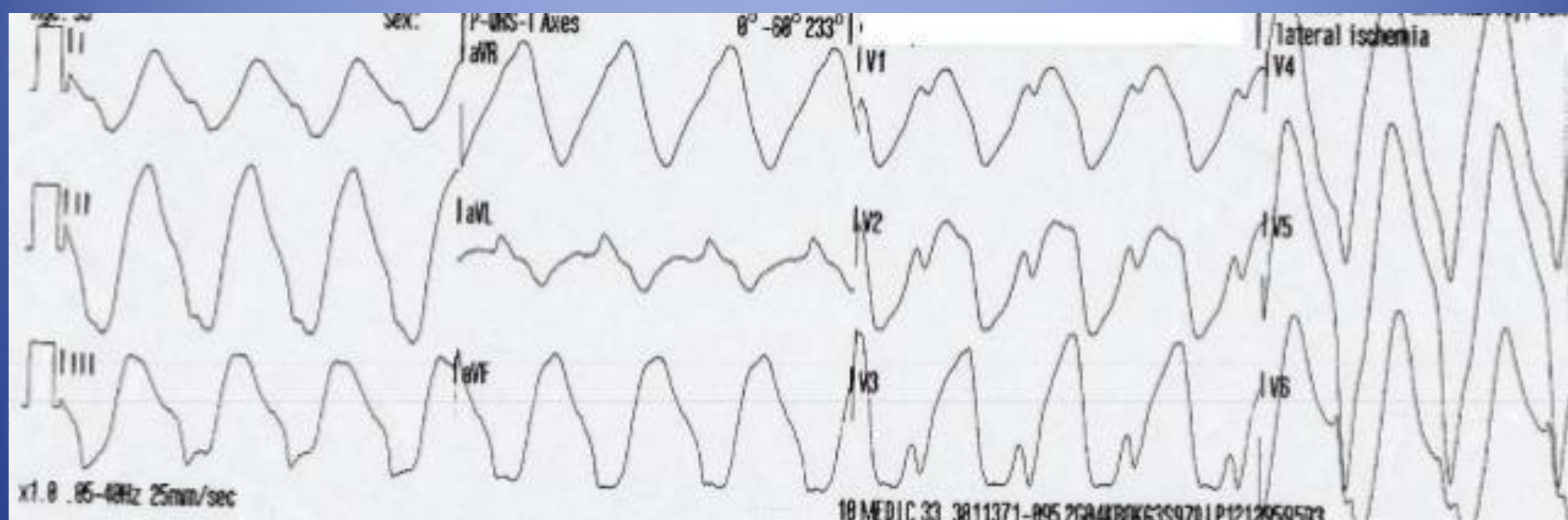


Figure: circ.ahajournals.org





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Hyperkalemia treatment

I. Stabilize myocardial cell membranes:

IV calcium:

Calcium chloride (10%): 5 to 10 mL (500 to 1000 mg) IV or

Calcium gluconate (10%): 15 to 30 mL IV

II. Shift potassium into cells:

A. Sodium bicarbonate: 50 mEq IV

B. Insulin and glucose: mix 25 g (50 mL of D50) glucose and 10 U regular insulin IV

C. Nebulized Albuterol: 10 to 20 mg nebulized

III. Remove excess K from the body

A. Loop diuretics: furosemide 40 to 80 mg IV

B. Kayexalate: 15 to 50 g plus sorbitol per oral or per rectum

C. Hemodialysis

Indications for dialysis

- Renal failure
- Oliguric acute kidney injury
- Marked tissue break- down
- Resistant hyperkalemia

Hypokalemia

- $K^+ < 3.5 \text{ mmol}^{-1}$.
- $K^+ < 2.5 \text{ mmol}^{-1}$ Severe hypokalemia
- Hypokalaemia is common in hospital patients. Hypokalaemia increases the incidence of arrhythmias,
 - Heart disease and Digoxin use.

- Life-threatening hypokalemia is uncommon
 - Gastrointestinal losses
 - Renal losses
 - hypomagnesemia.

Hypokalemai causes

- **Renal losses**
 - Renal tubular acidosis
 - Hyperaldosteronism
 - Magnesium depletion
 - Leukemia (mechanism uncertain)
- **GI losses (medical or psychiatric^[6], ie, anorexia or bulimia)**
 - Vomiting or nasogastric suctioning
 - Diarrhea
 - Enemas or laxative use
 - Ileal loop
- **Medication effects**
 - Diuretics (most common cause)
 - Beta-adrenergic agonists
 - Steroids
 - Theophylline
 - Aminoglycosides
- **Transcellular shift**
 - Insulin
 - Alkalosis

Recognition of hypokalaemia

- Exclude hypokalaemia in every patient with an arrhythmia or cardiac arrest.
- Dialysis patients,
 - Haemodialysis session
 - During treatment with peritoneal dialysis
- The nerves and muscles are affected
 - fatigue,
 - weakness,
 - leg cramps,
 - constipation.

- In severe cases ($K^+ < 2.5 \text{ mmol l}^{-1}$),
 - Rhabdomyolysis
 - Ascending paralysis
 - Respiratory difficulties

- **ECG features;**

- U waves
- T wave flattening
- ST-segment changes
- Arrhythmias (digoxin use)
- Cardiopulmonary arrest
(PEA, pulseless VT/VF, asystole).



HR 90 PVC 9 RESP 22 T1 38.3



Treatment

- Gradual replacement of potassium is preferable
- The maximum recommended IV dose of potassium is 20 mmol/h
- 2 mmol/min for 10 in, followed by 10 mmol over 5–10 min

- Abdulaziz S, Dabbagh O, Al Daker MO, Hassan I. Hypokalaemia and refractory asystole complicating diabetic ketoacidosis, lessons for prevention. *BMJ Case Rep.* 2012 Dec 5;2012. pii: bcr-2012-007312. doi: 10.1136/bcr-2012-007312.
- Philips DA, Bauch TD. Rapid correction of hypokalemia in a patient with an implantable cardioverter-defibrillator and recurrent ventricular tachycardia. *J Emerg Med.* 2010 Apr;38(3):308-16. doi: 10.1016/j.jemermed.2007.06.019. Epub 2008 Mar 28.
- Bennett A, Stryjewski G. Severe hypokalemia caused by oral and rectal administration of bentonite in a pediatric patient. *Pediatr Emerg Care.* 2006 Jul;22(7):500-2

Magnesium abnormalities

Magnesium mirrors potassium

Hypermagnesemia looks like

hyperkalemia

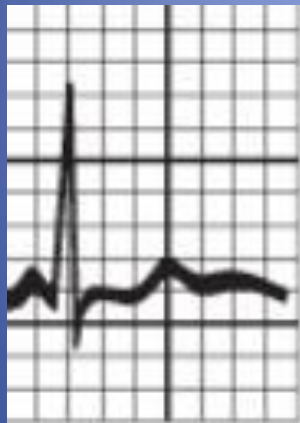
Hypomagnesemia looks like

hypokalemia

Hypermagnesemia = Give Calcium
Hypomagnesemia = Give Magnesium
Be aware of for Torsades

Summary

- Electrolyte abnormalities are among the most common causes of cardiac arrhythmias.
- Hyperkalaemia is most rapidly fatal.
- A high degree of clinical suspicion and aggressive treatment of underlying electrolyte abnormalities can prevent many patients from progressing to cardiac arrest.



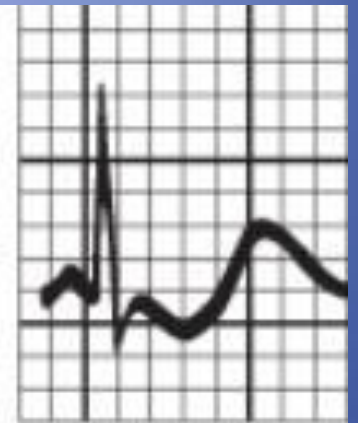
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2.5

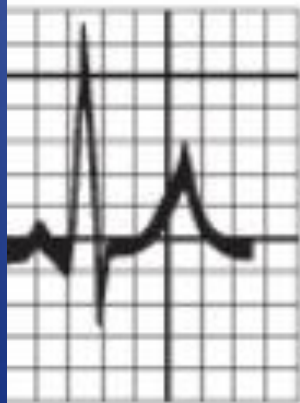


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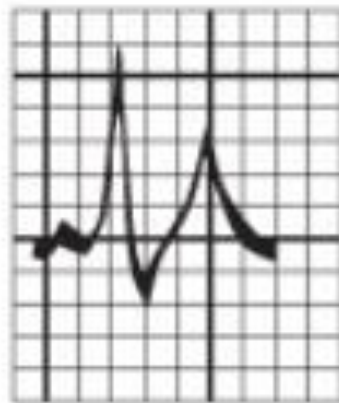


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Hypokalemia



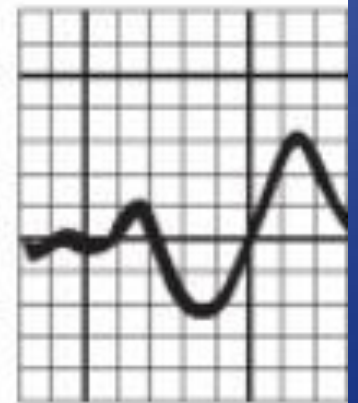
6.5



7.0



8.0



9.0

Hyperkalemia

References

2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and
Emergency Cardiovascular Care

European Resuscitation Council Guidelines for Resuscitation 2010

<http://emedicine.medscape.com/>