

# Upon completic should be abl - Discuss the pathophysio - Discuss the account for arrhythmic a

### **Objectives**

Upon completion of this lecture the learner should be able to:

- Discuss the functions, physiology, and pathophysiology of magnesium .
- Discuss the unique properties of magnesium that account for its beneficial effects as an anti arrhythmic and as a smooth muscle relaxant.
- Discuss the clinical settings or risks for magnesium emergencies .
- Identify abnormal signs, symptoms, and clinical features of magnesium emergencies.



### **Priorities - review**

- When fluids and electrolytes are altered, they should be corrected in the following order:
  - Volume
  - pH
  - Potassium, magnesium, and calcium
  - Sodium and chloride



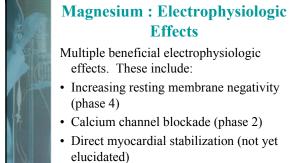
### Magnesium physiology

- Distribution :
  - ECF: 1% (potassium-like)
  - ICF : the second most common intracellular
  - cation
  - 1/3 is protein bound (calcium-like)
- Serum levels
  - 1.5 2.5 mEq/L [not useful]



### Magnesium physiology

- Function:
  - Potassium-like
    - Muscular
    - Neuromuscular
    - Cardiac conduction
  - Sodium-like
  - NeurologicalCellular
    - Enzymatic
    - · Cell wall function
- Excretion
  - Renal





### Magnesium : Electrophysiologic Effects

Thus:

- Magnesium stimulates the Na-K ATPase pump to make the cell more negative
- Decreases the relative refractory period by speeding repolarization and by decreasing the duration of phase 2



### **Magnesium for Torsades**

Mechanism of Action

- · Reverses underlying etiology
- Decreases Q-T interval
- Non Arrhythmogenic
- · Rapidly effective
- Much safer and quicker than non-magnesium therapies for Torsades:



### **Mechanism for Digitalis OD**

 Mg<sup>++</sup> fixes a poisoned Na-K pump (digitalis toxicity): leak of K out of the cell and Na into the cell

### **Mechanism in SVTs**

- Mg block of AV conduction
- reduction of sympathetic influences on AV node
- altered slow channel calcium movement
- Hypokalemia correlates with hypomagnesemia
  - AF and MAT are associated with hypokalemia
  - Only recently we have begun to appreciate how important magnesium is and how often we miss magnesium deficiency:

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### "Magnesium - The Forgotten Electrolyte"

- "Hypomagnesemia is the most underdiagnosed electrolyte deficiency in current practice"
  - Geiderman et al JACEP 1979



### Hypomagnesemia

- Common
- · Often underdiagnosed in critically ill patients"



### Hypomagnesemia

- Total Body Stores and Accurate Mg \*\* Level
  - labs can not yet reliably do an ionized Mg ++ testing
  - Lab values cannot tell you the total body stores or intracellular magnesium status of a patient.
  - An important rule is:
    - FOR SYMPTOMATIC PATIENTS
    - in the setting of hypomagnesemia, DON'T WORRY ABOUT THE EVENTUAL TOTAL SERUM MAGNESIUM LEVELS determined after arrival in ED
    - OR YOU WILL MISS CLINICALLY SIGNIFICANT HYPOMAGNESEMIA



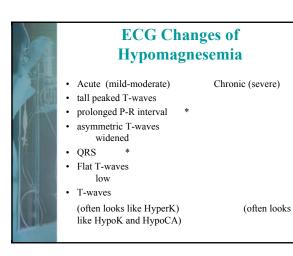
## The 5 Causes of Hypomagnesemia

- Dietary
- Gastrointestinal
- Renal losses (diuretics)
- Drug
- Endocrine-Metabolic



# High Risk For Clinically Significant Hypomagnesemia

- · Patients on diuretics
- · Alcoholic or malnourished patients
- · Patients with hypokalemia
- · Patients with AMI
- · Patients with ventricular arrhythmias



### **Toxicity of Magnesium**

- Hypermagnesemia ( and Side Effects of rapid Magnesium Infusion )
- Flushing (common), diaphoresis, and drowsiness
- Hyporeflexia / loss of DTR's
- · Hypotension and hypoventilation
- · Conduction disturbances and arrhythmias
- · Cardiac or respiratory arrest

Symptoms and levels do not correlate perfectly but loss of DTRs preceeds the more serious side effects

### **Clinical Effects of** Hypermagnesemia **Effect** Mg Level (mg/dl) Decreased DTR's 4-5 Hypotension 5-7 10 Respiratory Insufficiency Heart Block 10-15 Respiratory Paralysis 15+ Cardiac Arrest 15-24



### Hypermagnesemia

- Rare
- Usually introgenic or in chronic renal failure
- Beware Mg cathartics and antiacids (Maalox; MOM)
- Symptoms rare below 8-10 mg/dl



### Magnesium in Alcohol Withdrawal

- Decreases potassium losses
- Total body Magnesium deficit is 10-20 grams



### Magnesium in Eclampsia

- Its major benefit is that it blocks vasospasm:
  - Magnesium is a calcium blocker
  - Magnesium blocks vasospasm

and

· Lowers incidence of seizures

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### **Magnesium and Seizures**

- Magnesium infusion corrects abnormal neuronal firing
- A change of 1 mEq/l dramatically suppresses EEG spikes



### Magnesium in COPD +/or Asthma

- Magnesium :
  - Bronchial muscle relaxation



### Magnesium in Bronchospasm

- Magnesium is a calcium blocker
  - Smooth muscle relaxation



### **Hypermagnesemia**

- Renal Failure
  - Magnesium ingestion +/-
  - Lithium ingestion
  - Suspect a coexisting hyperkalemia

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### **Summary**

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