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# Approach to Electrolyte Abnormalities

**Erasmus Erebu Okello**

Anaesthesiologist | Critical Care Physician



# Hospital

Every Second Counts



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# Disclosures

I am a Critical Care Physician

A background image of Keanu Reeves as Neo from the movie The Matrix. He is wearing his iconic black trench coat and sunglasses, with his right hand raised in a palm-forward gesture. He is surrounded by a dense field of falling silver bullets, which are suspended in mid-air around him. The background is a blurred, greenish-yellow cityscape.

## Emergency & Critical Care *aka, Hope*

Functional Restoration

Renewed Promise

Reunion of families

Second Chances

Salvage & Salvation

Healing

Making impossible Possible



# Focus

- Recognition, pre-hospital and ED assessment & investigation
- Management and disposition
- Management of common complications

# Special Requests

1. Common electrolytes imbalances in cancer patients-**Wilson Okot**
2. Clinical features of various electrolytes-**William Kinani**
3. Most common electrolyte imbalances, how to diagnose in a low resource setting and initial mgt of such cases-**Mazzinga Herbert**
4. Common electrolyte imbalances in critical care and management-**Niringiye Gerald**
5. Clinical signs to note without having lab results-**Malinga Paddy**
6. Causes and predisposing factors, Preventive measures, Mgt, Complications-**Paddy Mwebaza**

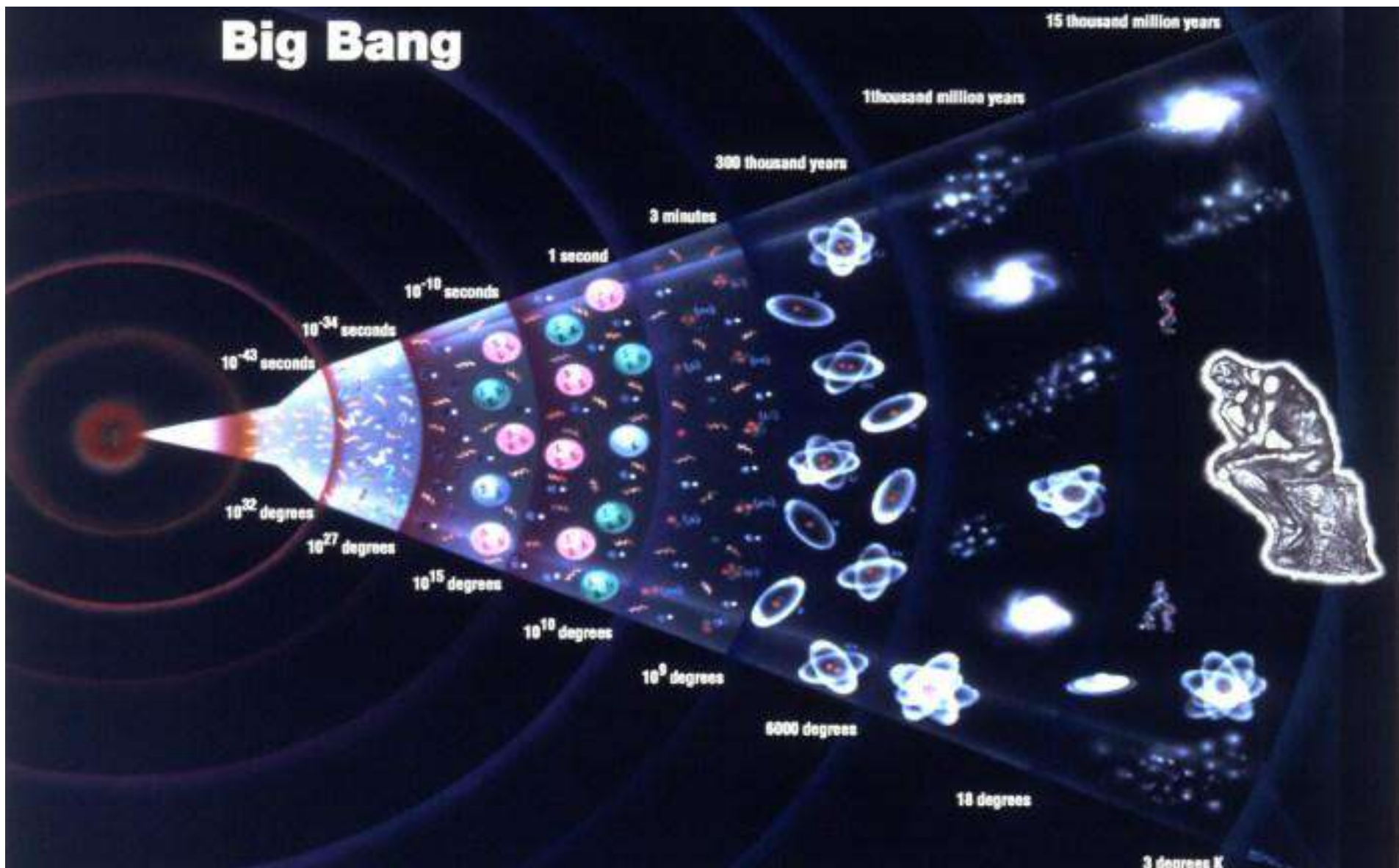


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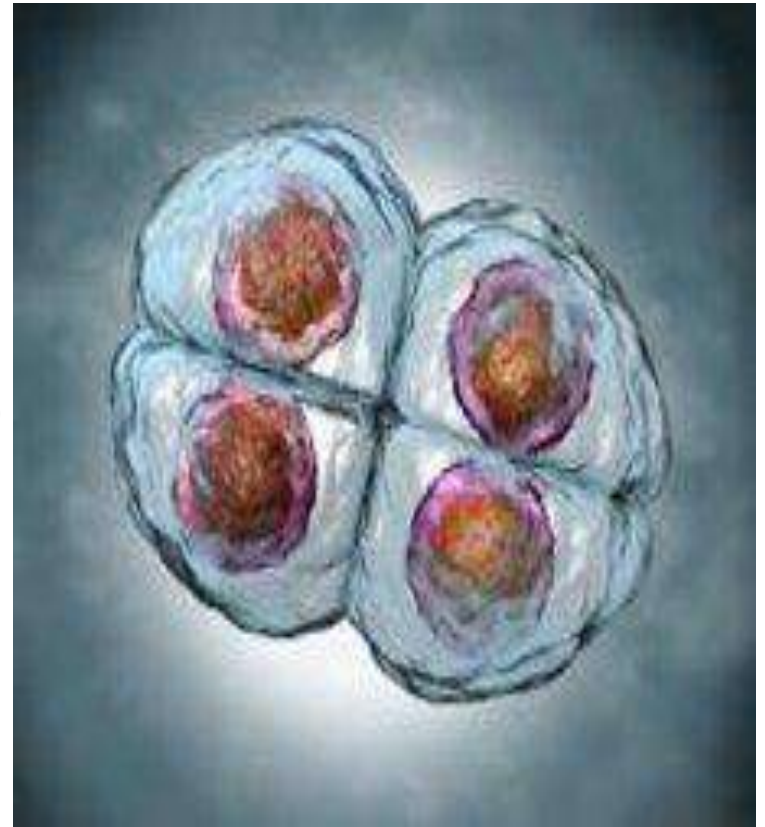
# Big Bang



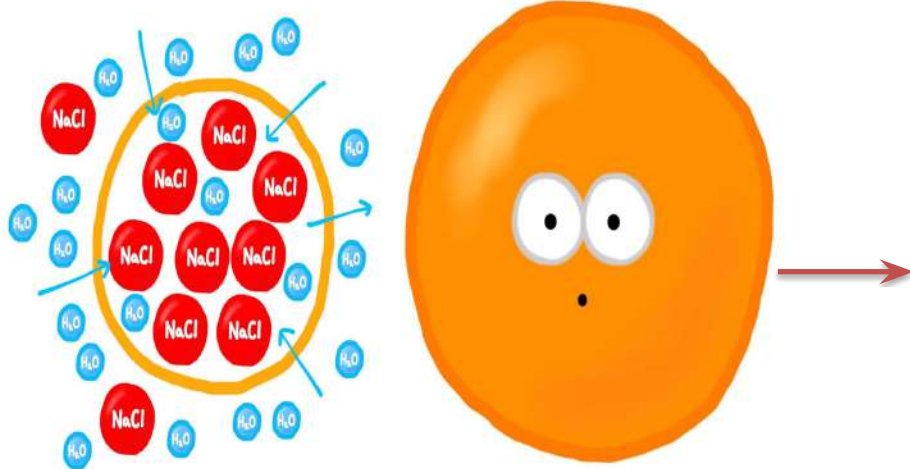
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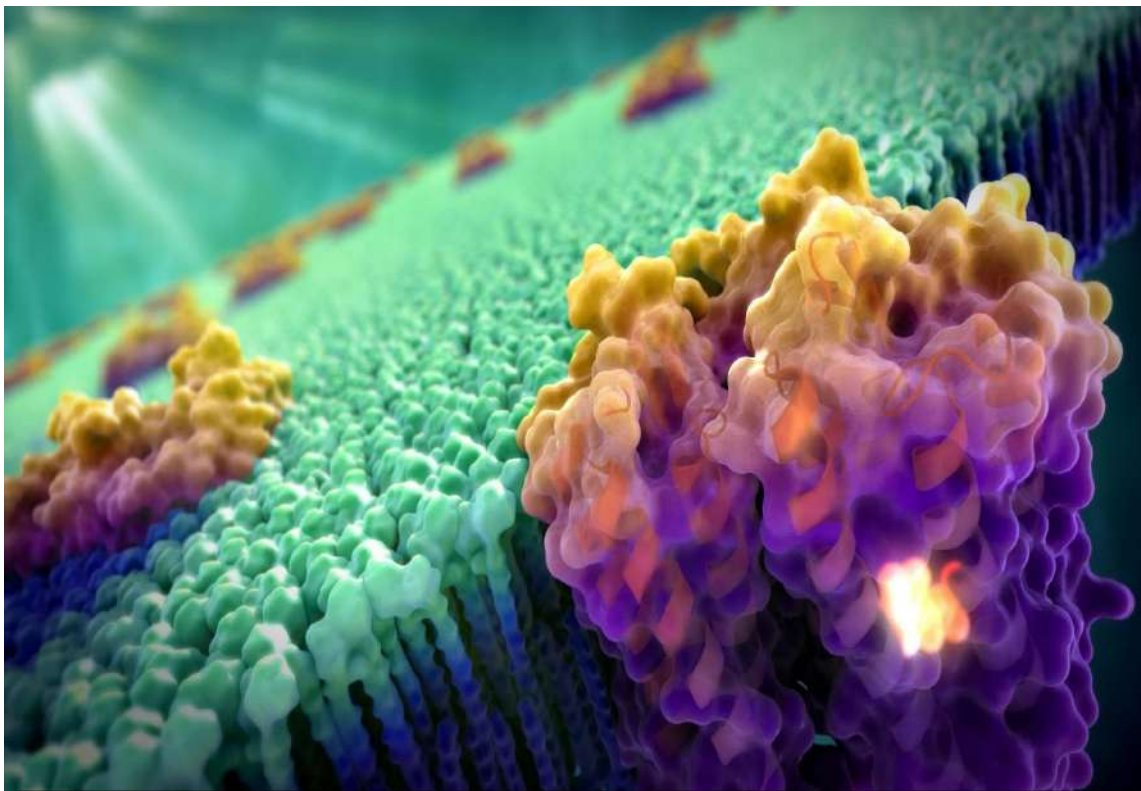


# HYPOTONIC

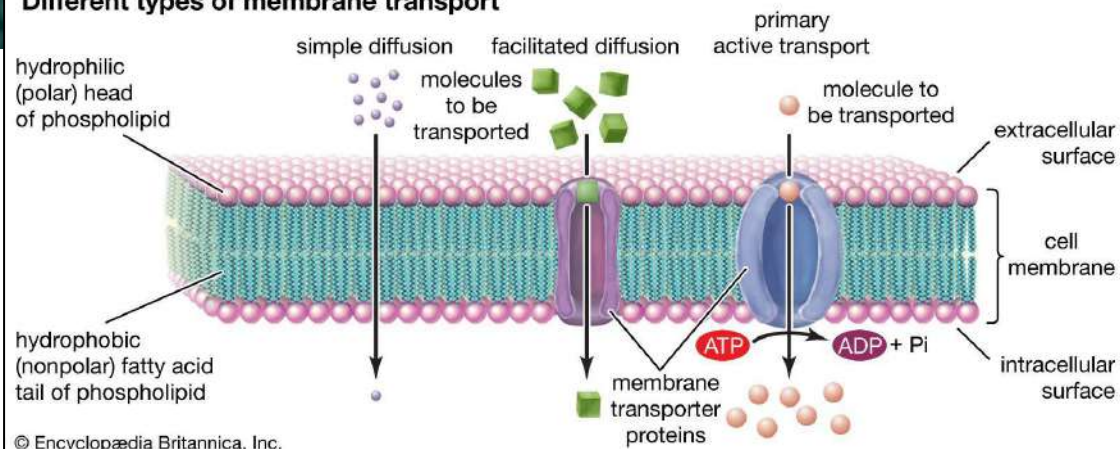


# CYTOLYSIS

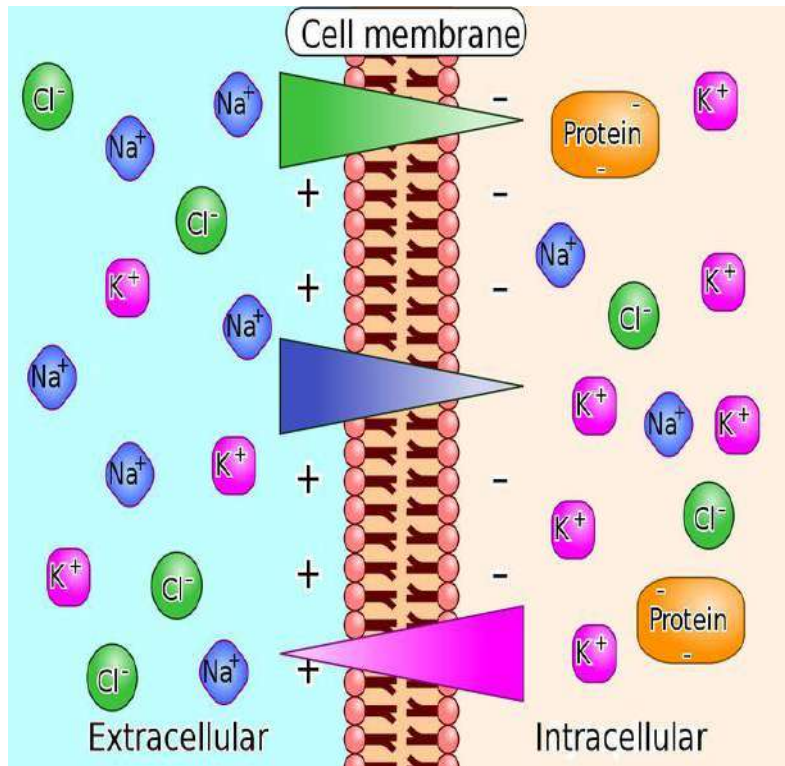




### Different types of membrane transport





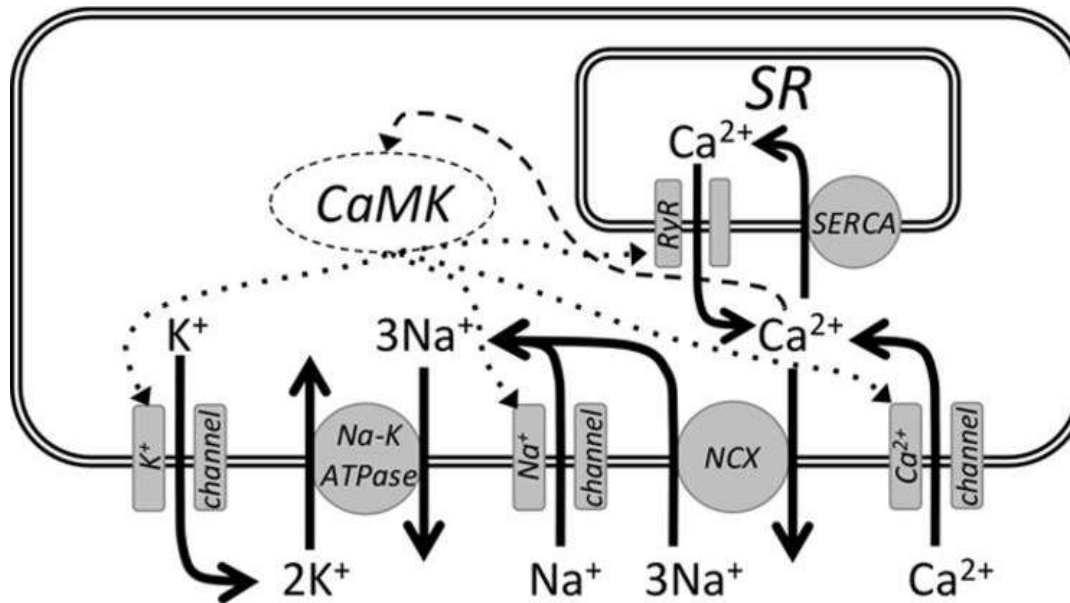


## Ionic distribution

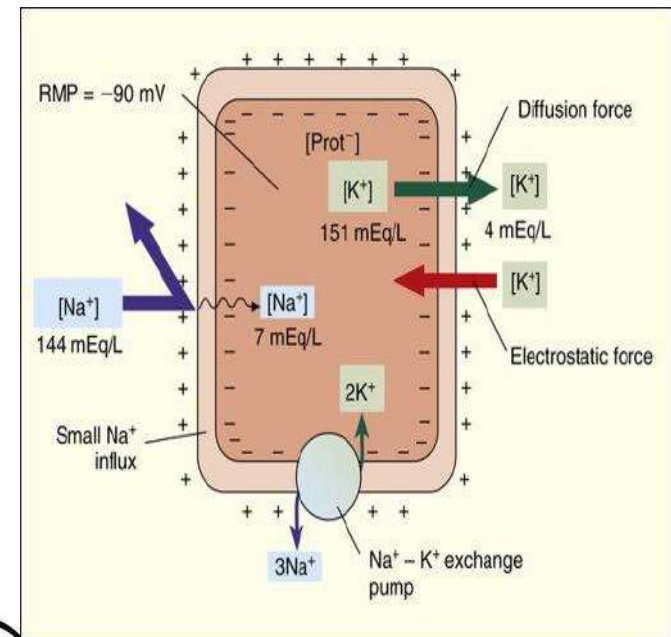
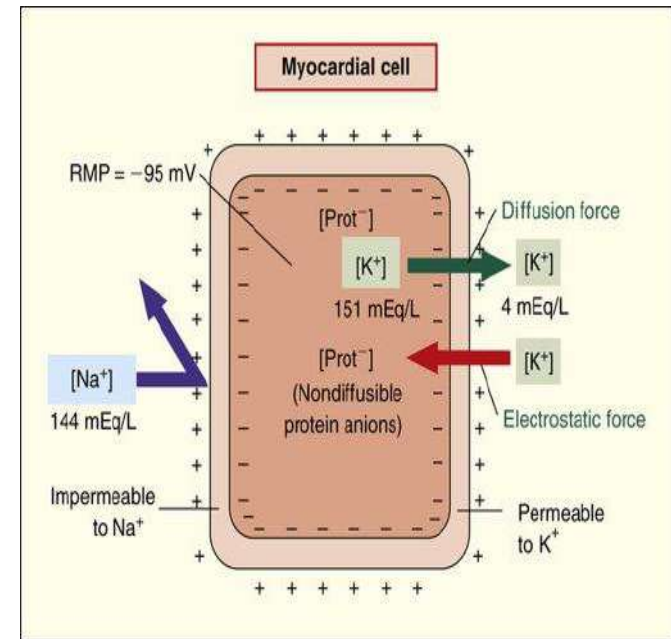
Ion	Intracellular	Extracellular
$\text{Na}^+$	10	142
$\text{K}^+$	140	4
$\text{Cl}^-$	4	103
$\text{Ca}^{2+}$	0	2.4
$\text{HCO}_3^-$	10	28

Ion	Intracellular	Extracellular	Nernst potential
$\text{Na}^+$	10	142	+58
$\text{K}^+$	140	4	-92
$\text{Cl}^-$	4	103	-89
$\text{Ca}^{2+}$	0	2.4	+129
$\text{HCO}_3^-$	10	28	-23

(mmol/l)



$\text{Mg}^{2+}$  is co-factor for  $\text{Na-K}$  and  $\text{SERCA}$  pump. It also closes the  $\text{K}^+$  channel gate  
 $\text{Po}_4^{3-}$  provides the P in ATP





# Electrolyte Homeostatic Functions

## Osmosis

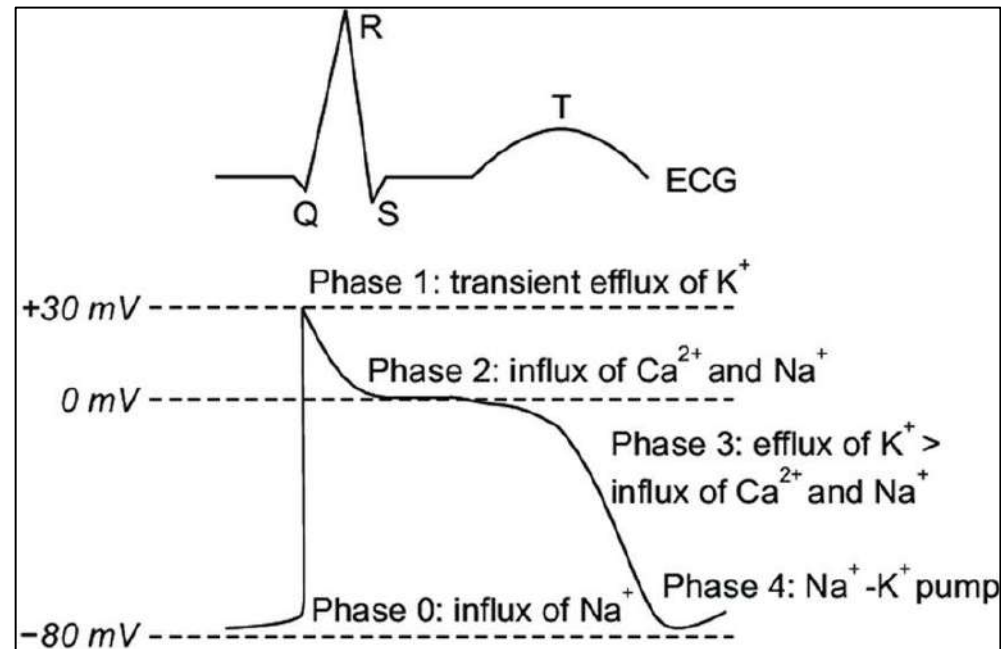
- Cell shape & size

## Enzyme Function

## Acid-Base

## Electrophysiology

- Heart
- Muscle
- Nerves



# Pathophysiology

## Extracellular Electrolytes

- Gain or loss from the body
  - Intake
  - Hormones
  - Drugs
  - Disease
- Fluid status changes
  - Intake
  - Hormones
  - Drugs
  - Disease

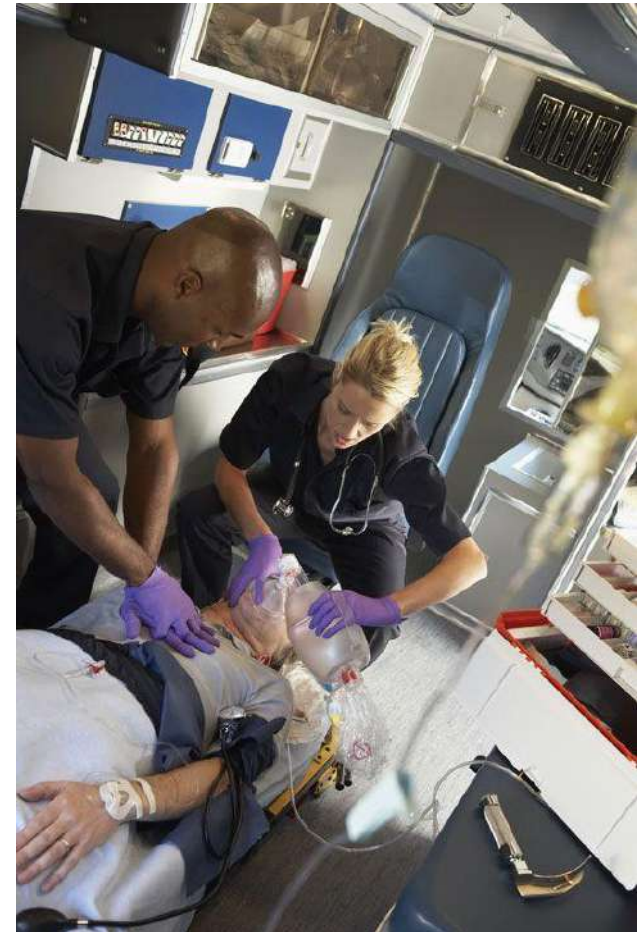
## Intracellular Electrolytes

- Cellular shifts
  - Disease
  - Drugs
  - Hormones
- Excretion
  - Renal
  - GI
  - Meds

# Clinical Presentation

Non-sensitive, non-specific

- Dead
- Cardiac Arrest
- Extreme Organ Dysfunction
- Part of another severe Disease
- Asymptomatic/Incidental Finding
- Spurious/Factitious







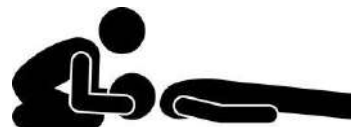
Detect



Get Help



Resuscitate



Stabilize



Support Organs



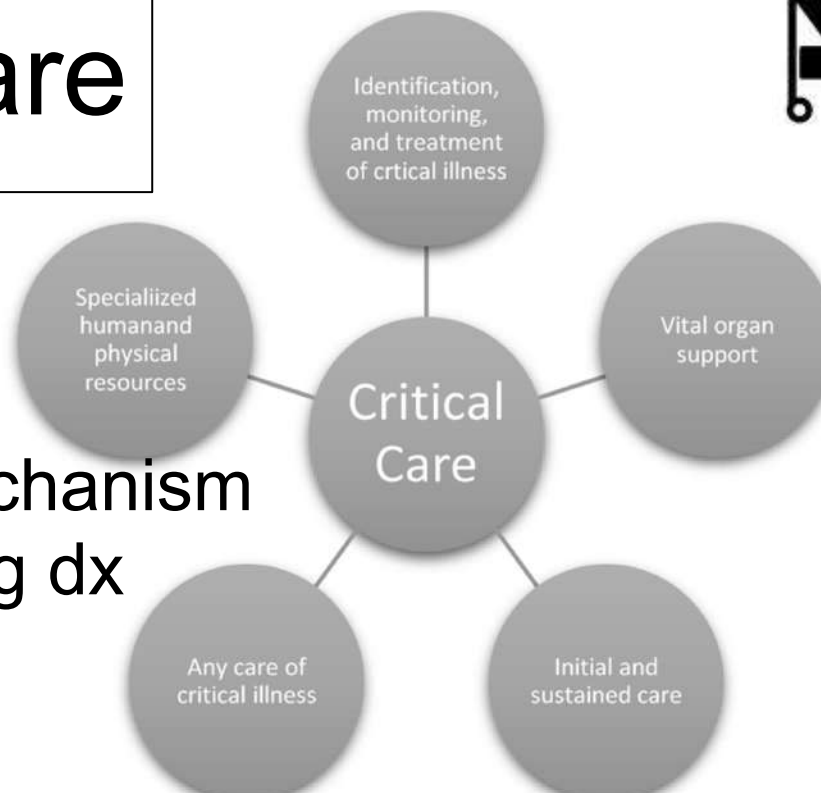
Treat Cause

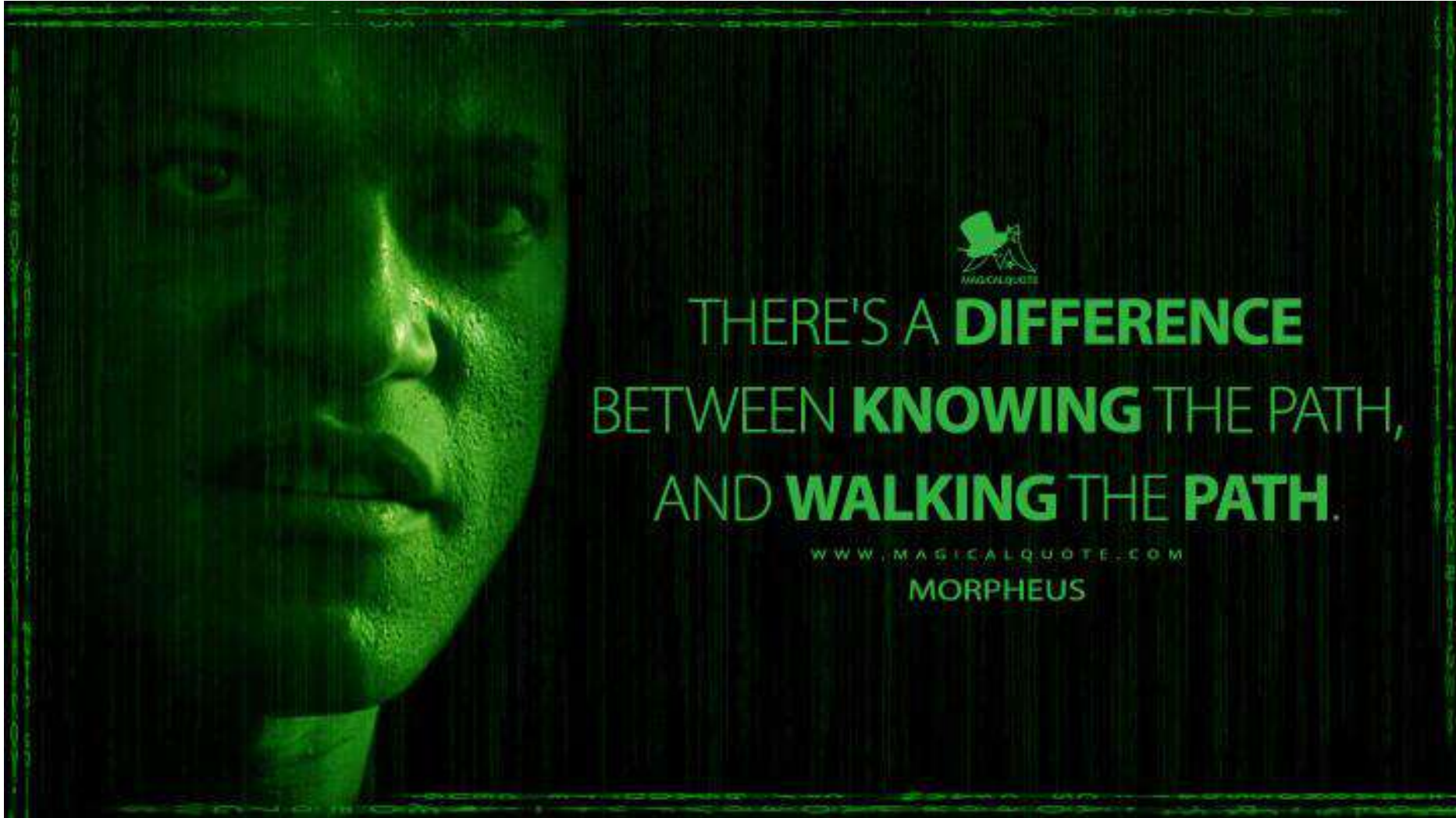


Rehabilitate

# Approach to Care

Spot  
 Save-Resuscitate  
 Sustain-Organ Support  
 Stabilize-Underlying mechanism  
 Salve/Palliate-Underlying dx





THERE'S A **DIFFERENCE**  
BETWEEN **KNOWING** THE PATH,  
AND **WALKING** THE **PATH.**

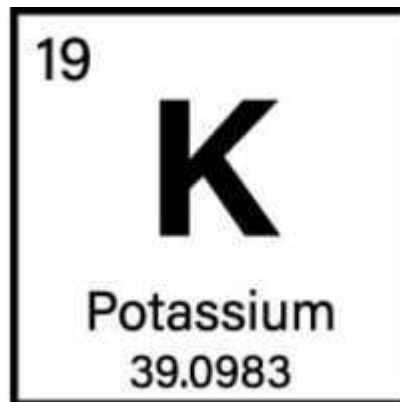
[WWW.MAGICALQUOTE.COM](http://WWW.MAGICALQUOTE.COM)

MORPHEUS

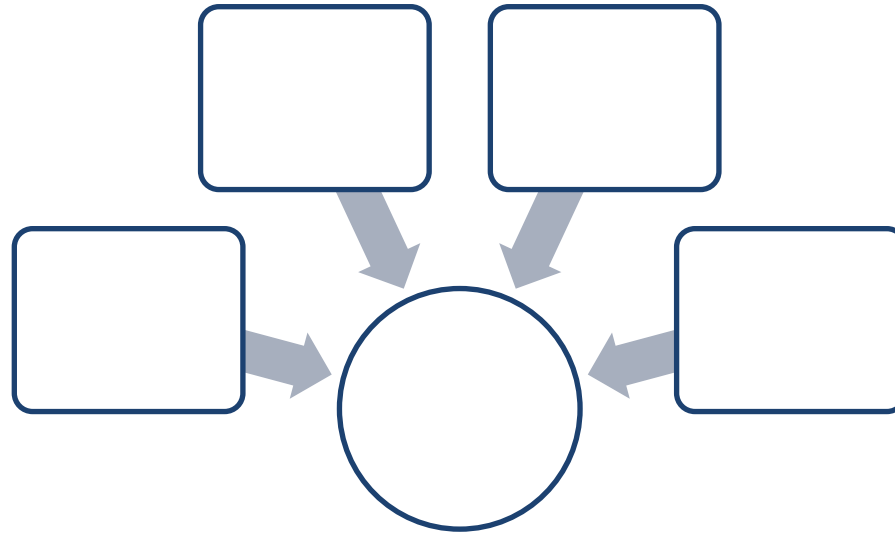


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# Potassium



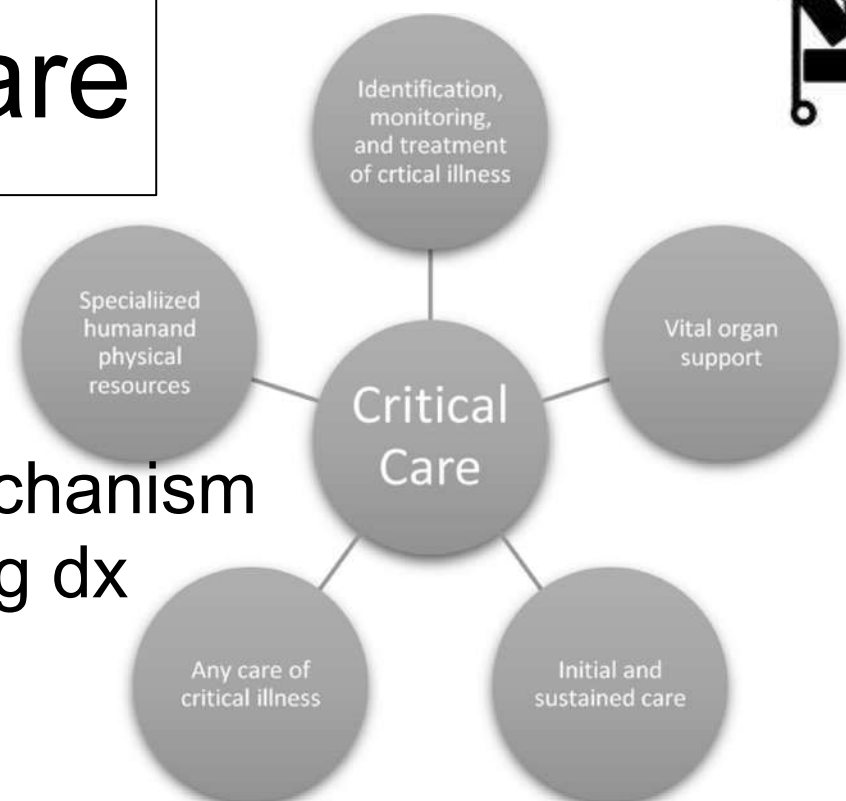
- Isolated in 1807 from plant ash soaked in pots of water, hence *pot-ash*
- 140 mmol/L intracellular, 4 mmol/L extracellular
- Normal Serum Levels 3.5-4.5 mmol/L





# Approach to Care

**Spot**  
**Save-Resuscitate**  
**Sustain-Organ Support**  
**Stabilize-Underlying mechanism**  
**Salve/Palliate-Underlying dx**



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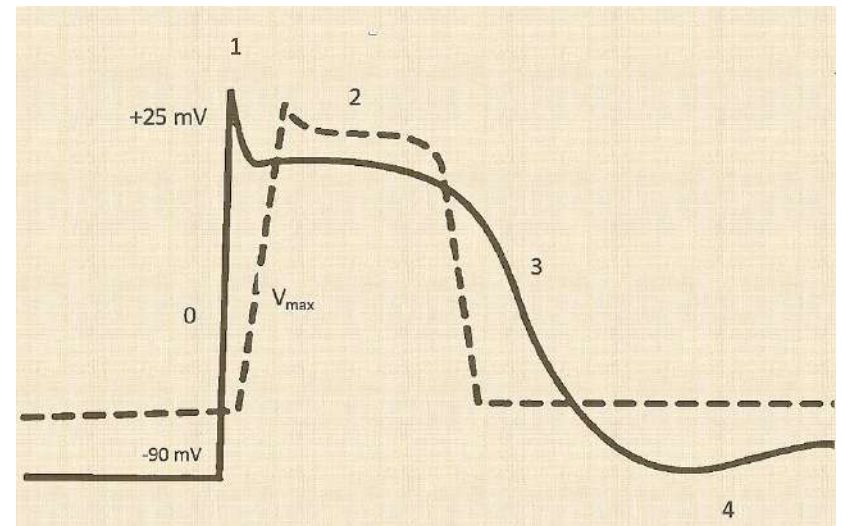
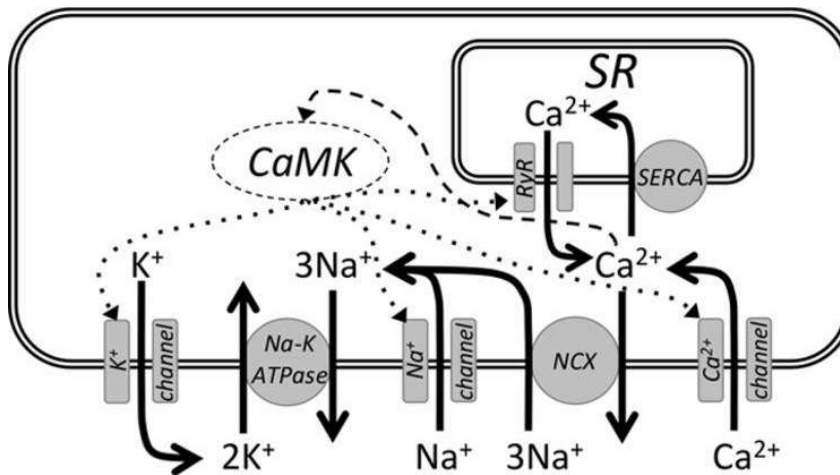
# Hyperkalemia



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# Pathophysiology





## Spot

- H&P
- Labs
  - K, Na, Mg, Ca, U&C
  - CBC
  - ABG, Glu
  - Urine lytes/Osmo
- ECG
  - Brady, Tented T-waves, absent P, Wide QRS, ST-T changes, Wide
  - Sine wave VT, VF, Asystole
- Targeted Dx for underlying Dx

\* Muscle Twitches → Cramps → Paresthesia

\* Irritability & Anxiety

\* ↓ BP

\* EKG Changes

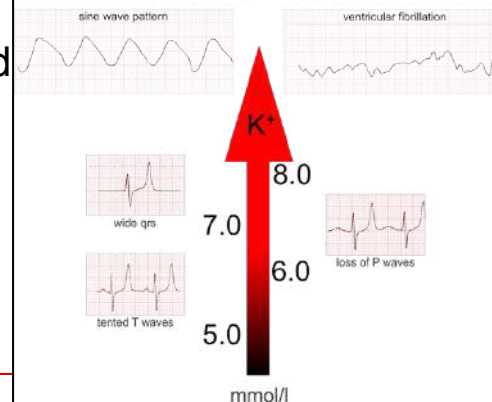
\* Dysrhythmias - Irregular Rhythm

\* Abdominal Cramping

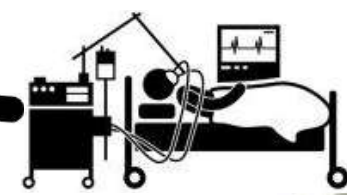
\* Diarrhea



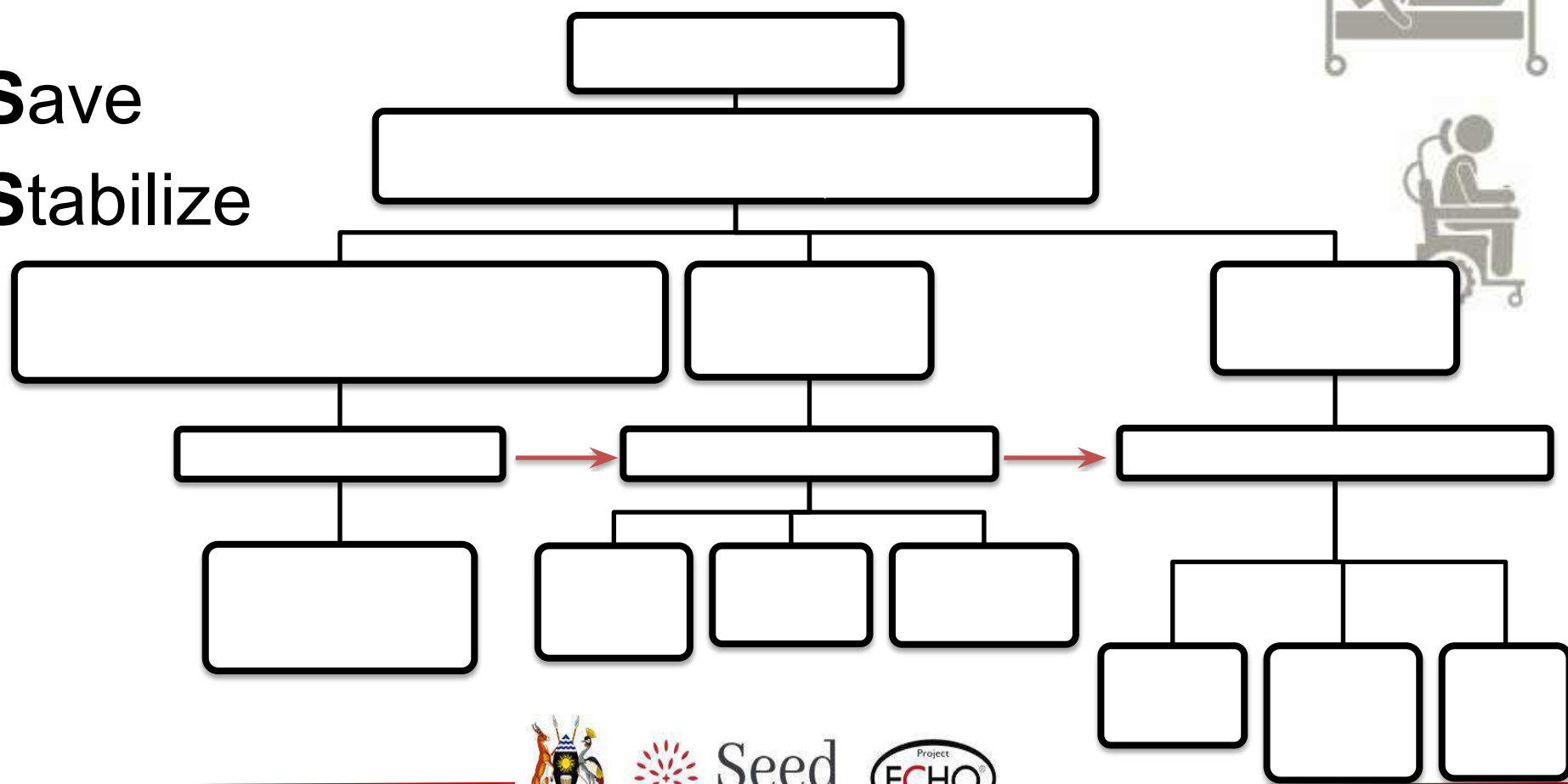
ECG/EKG changes in hyperkalemia





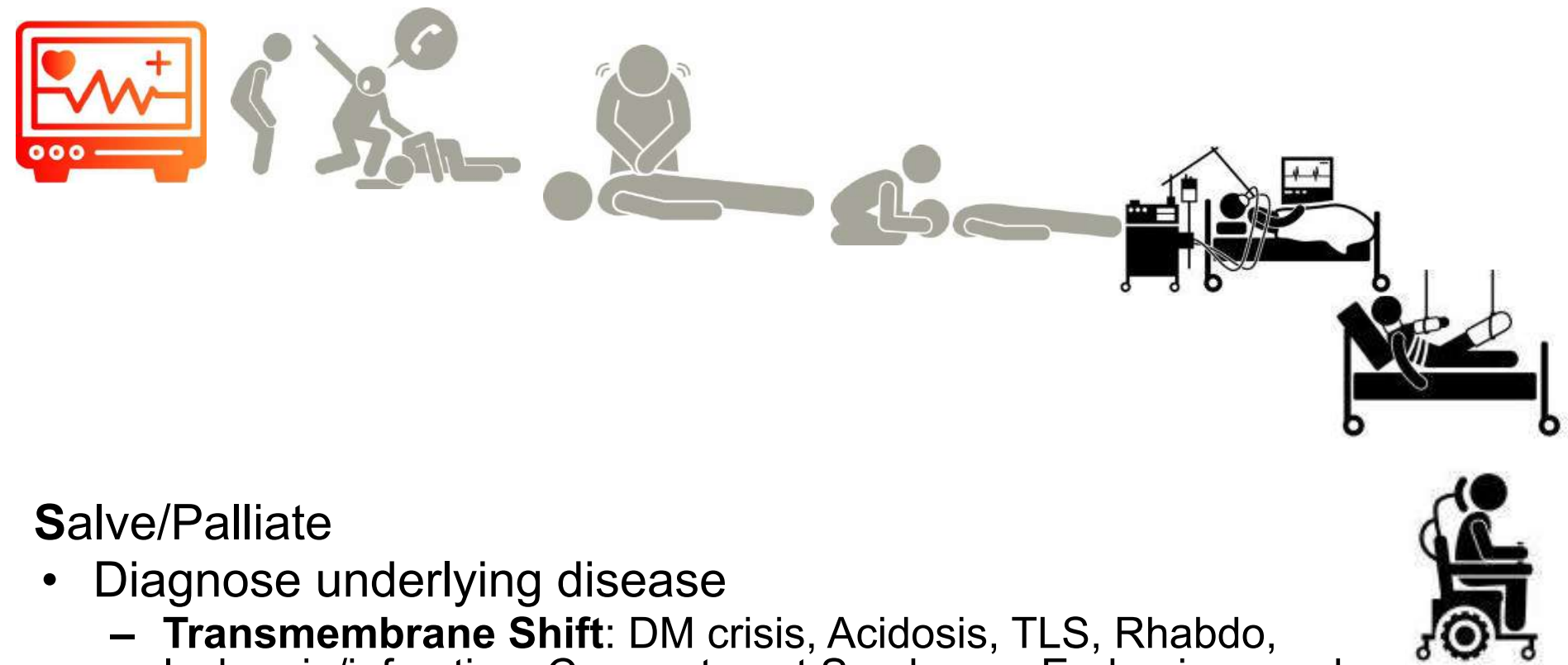


**Save**  
**Stabilize**



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## Salve/Palliate

- Diagnose underlying disease
  - **Transmembrane Shift:** DM crisis, Acidosis, TLS, Rhabdo, Ischemia/infarction, Compartment Syndrome, Endocrine, meds
  - **Decreased Elimination:** AKI/CKD, Meds
  - **Increased Intake:** Meds, Diet, GI Bleed, Transfusion
- Continue Organ support as needed
  - Essential consults: ICU, Nephro, Surgery, Oncology
  - Disposition: ICU/HDU, Ward, OR

# Hypokalemia



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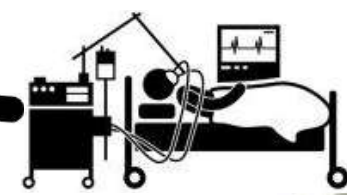


## Spot

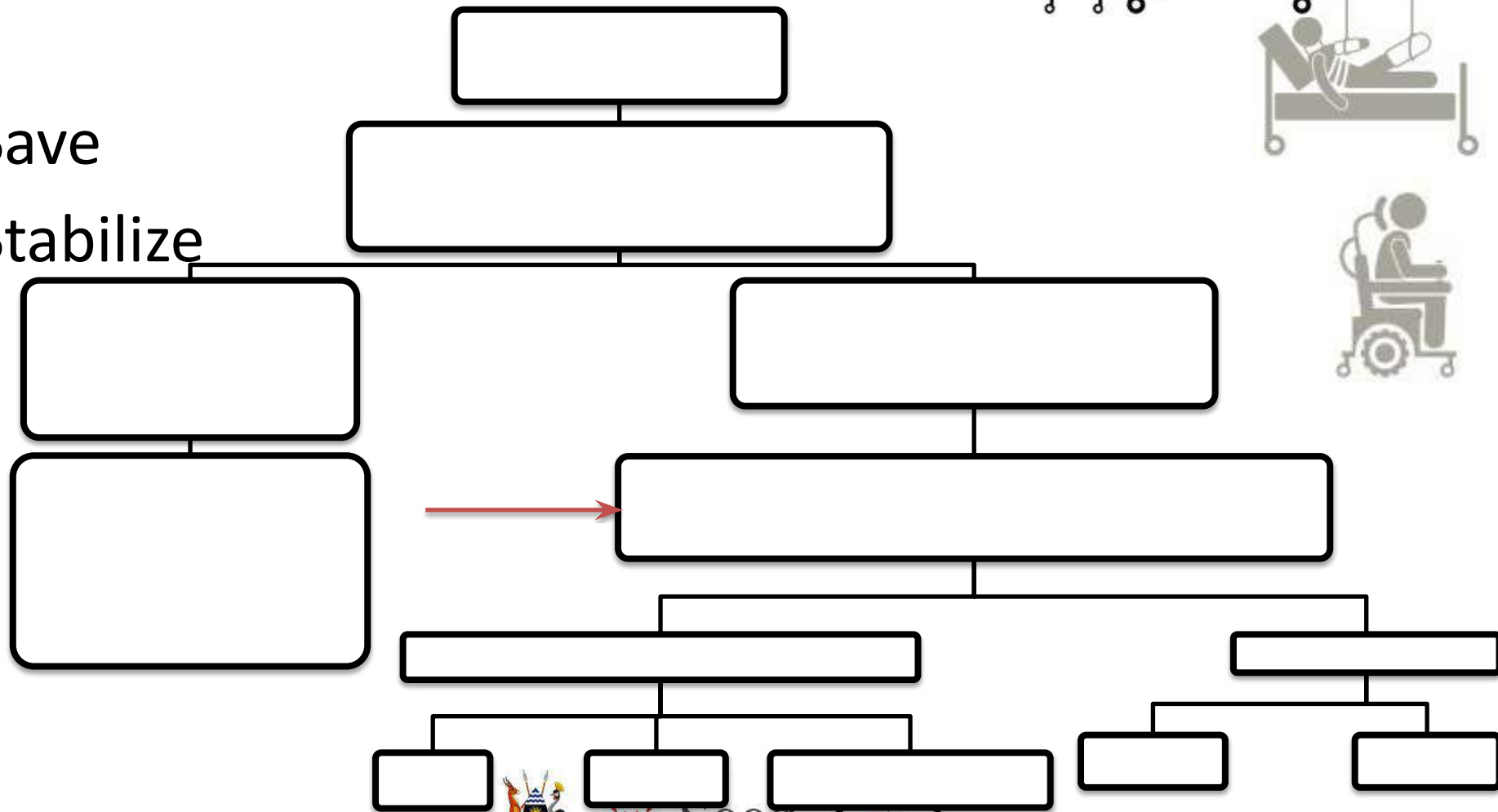
- H&P
- Labs
  - K,Na,Mg,Ca,U&C
  - CBC
  - ABG,Glu
- ECG
  - Long QT, U waves, ST-depression, Tiny T-waves
  - Tachycardia, Frequent PVCs, Polymorphic VT, VF, Asystole
- Targeted Dx for underlying Dx







Save  
Stabilize



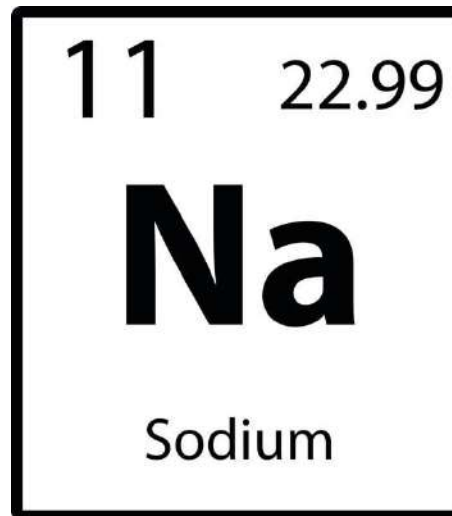
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## Salve/Palliate

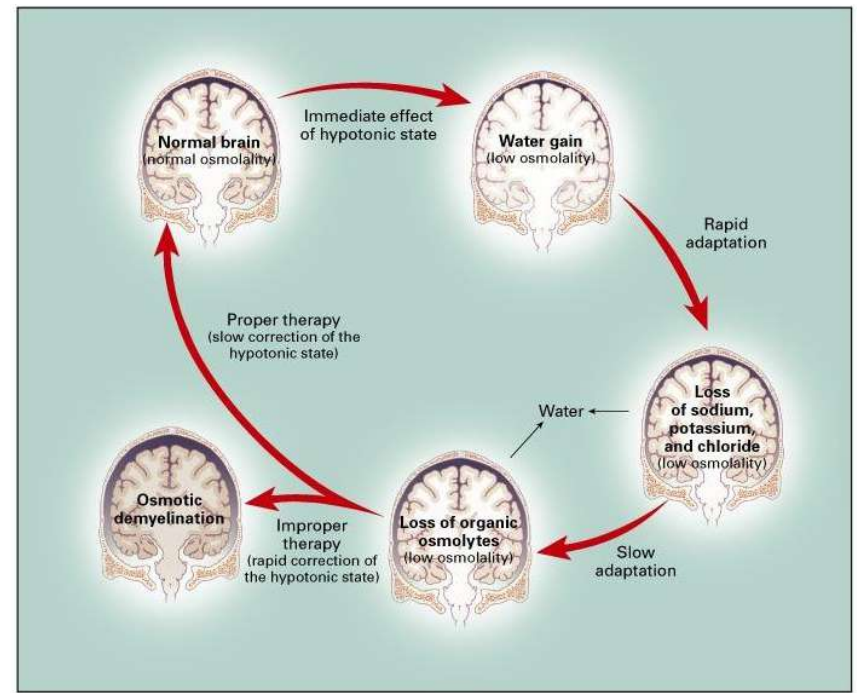
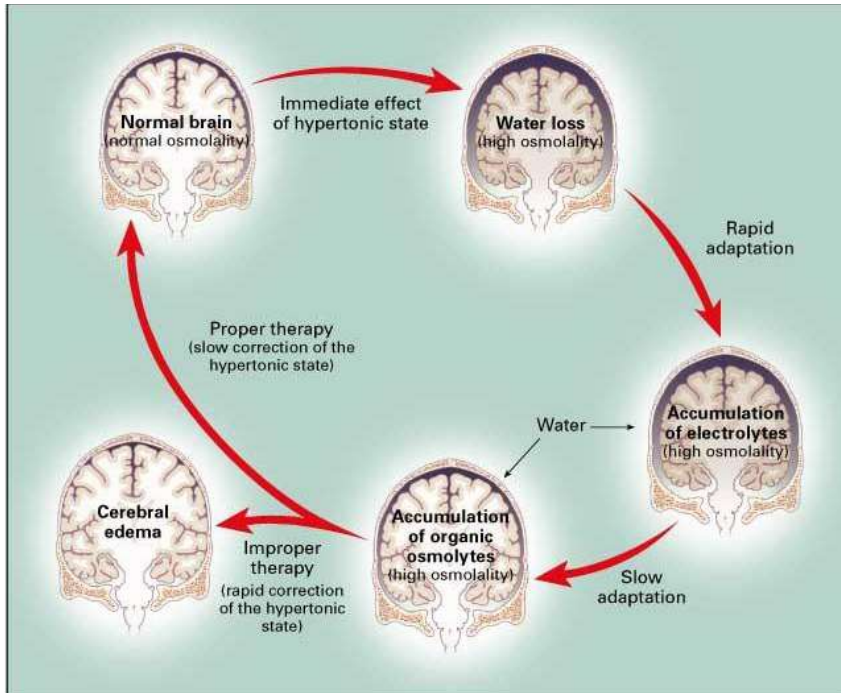
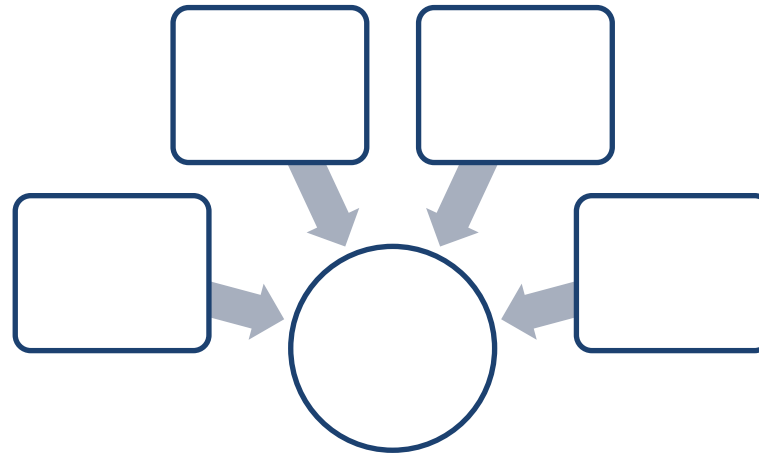
- Diagnose & treat underlying disease
  - **Transmembrane Shift:** Alkalosis, Drugs, Refeeding
  - **Increased Elimination:** Diuretics, Endocrine, Meds
  - **Decreased Intake:** Vomiting, Diarrhea, Starvation
- Continue Organ support as needed
  - Essential consults: ICU, Nephro, Surgery, Oncology
  - Disposition: ICU/HDU, Ward, OR



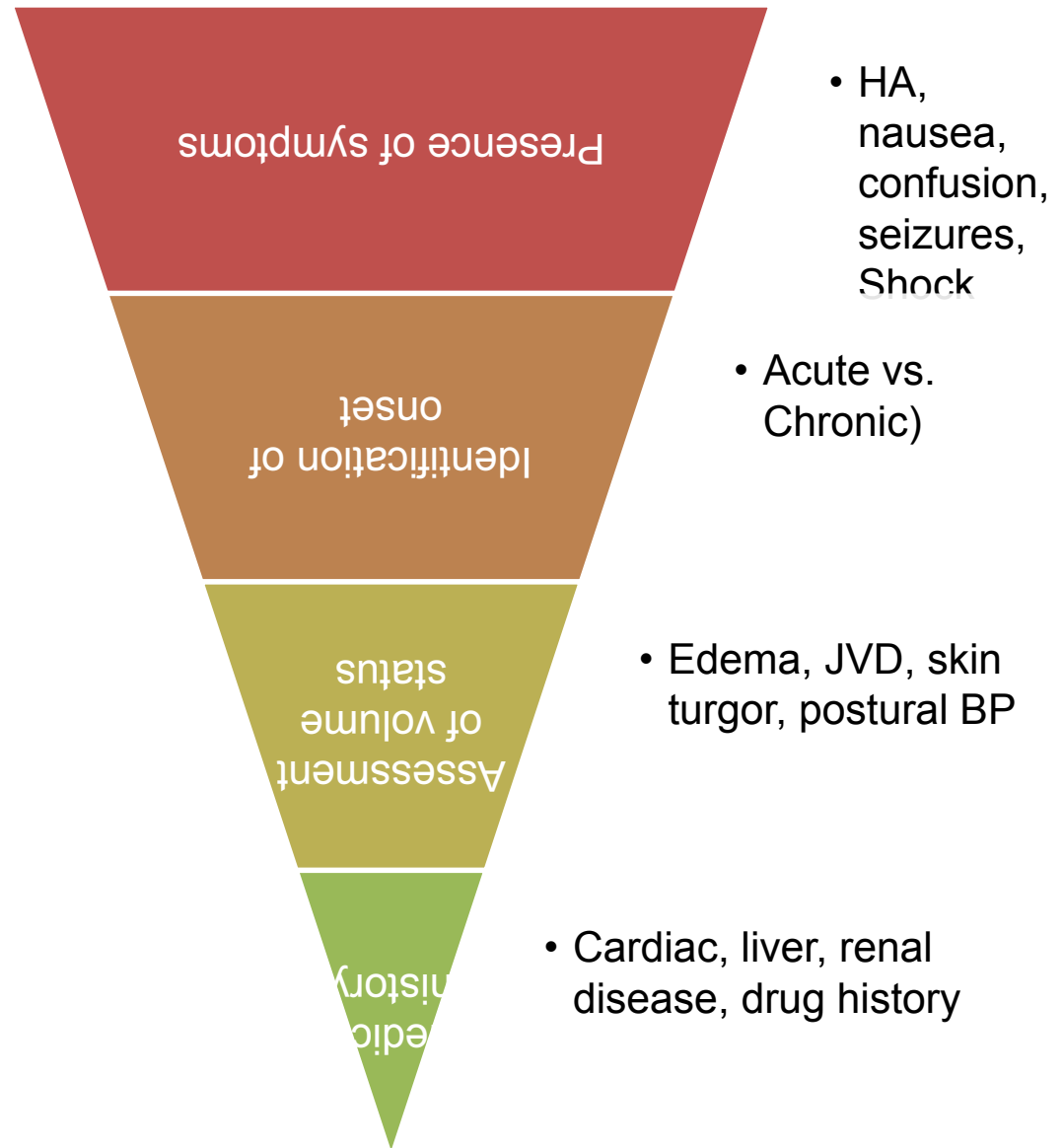
# Sodium

- Most abundant Extracellular Electrolyte
- 140 mmol/L Extracellular, 10 mmol/L Intracellular
- Normal Serum Levels 135-145 mmol/L
- Kept out by the Na-K ATPase
- Responsible for RMP, AP, Osmosis





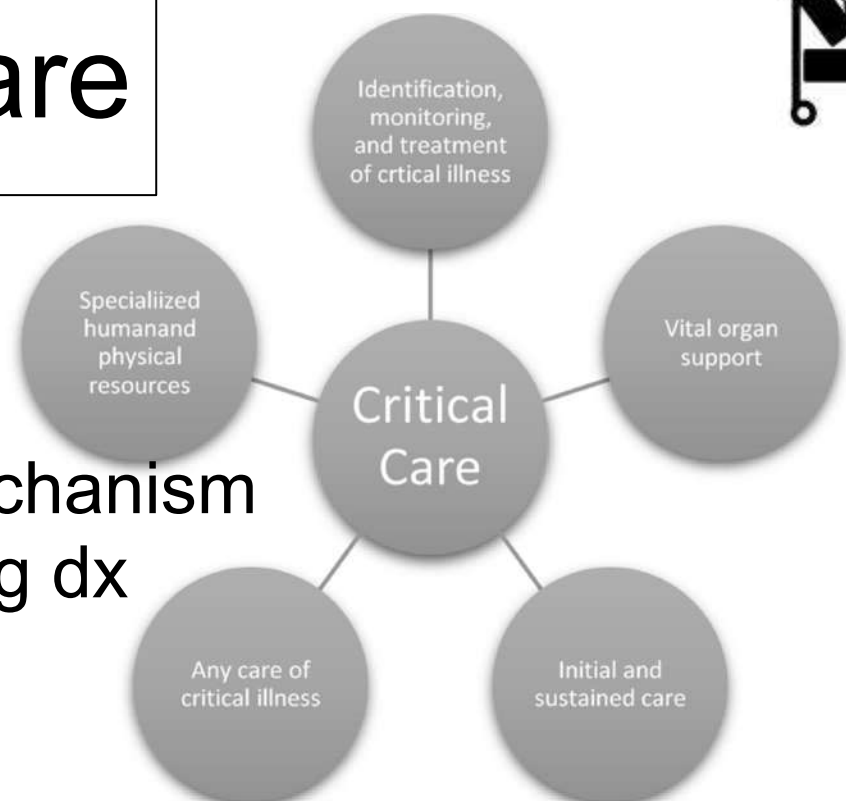
## Evaluation of Dysnatremia





# Approach to Care

**Spot**  
**Save-Resuscitate**  
**Sustain-Organ Support**  
**Stabilize-Underlying mechanism**  
**Salve/Palliate-Underlying dx**



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# Hypernatremia

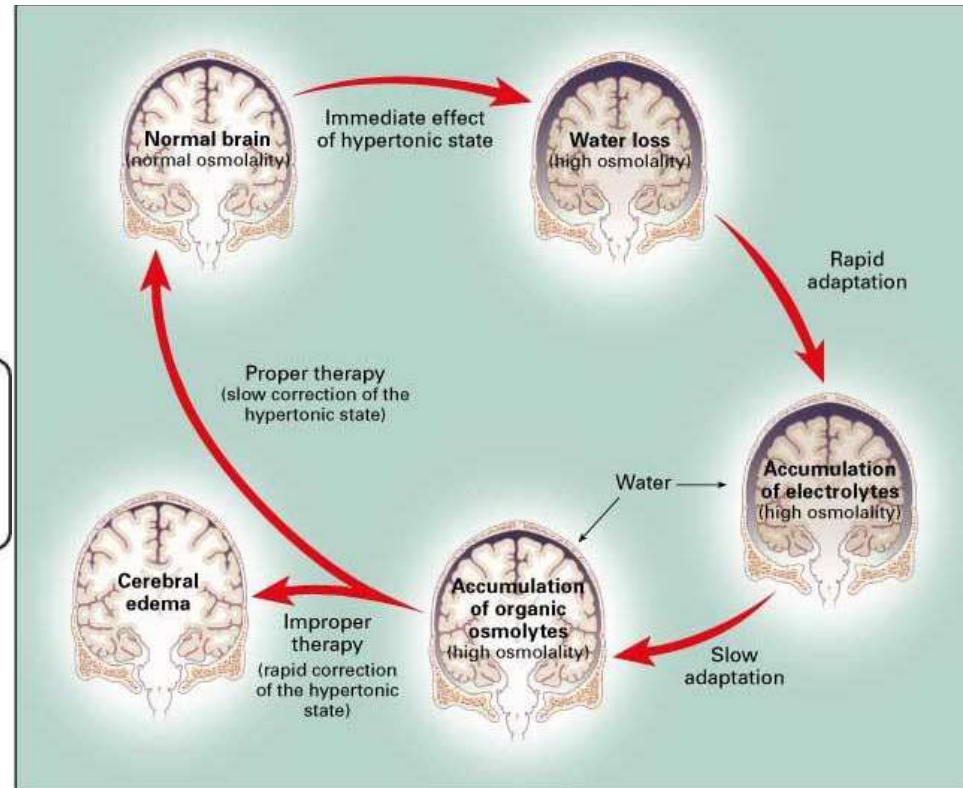
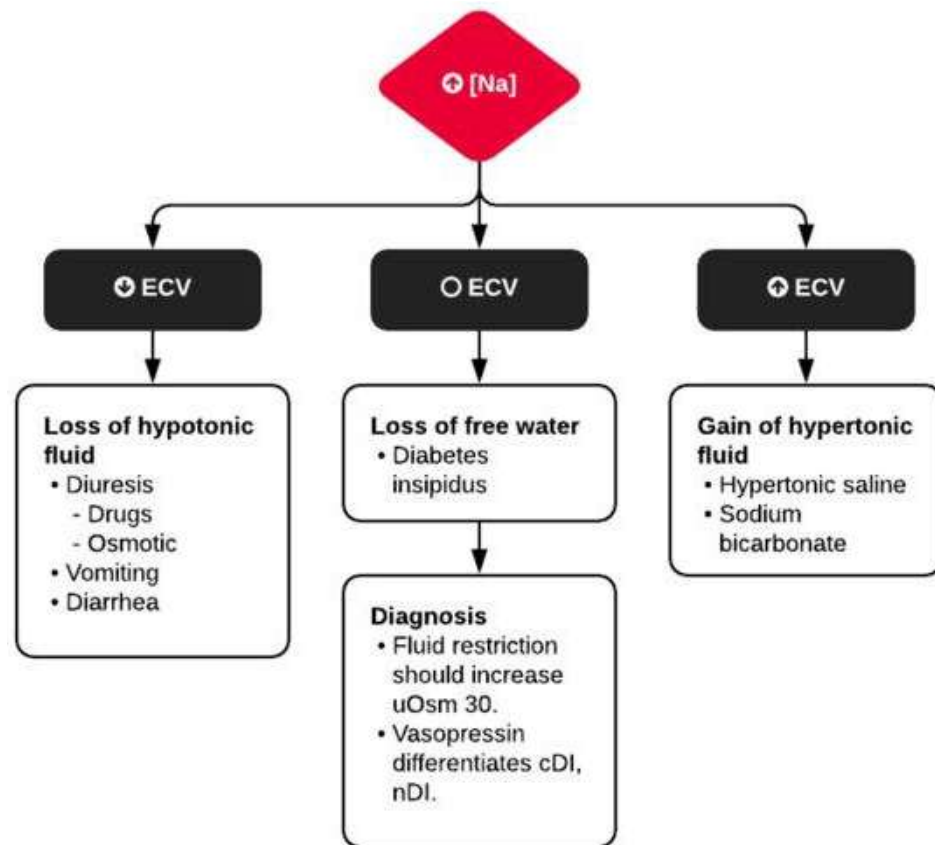


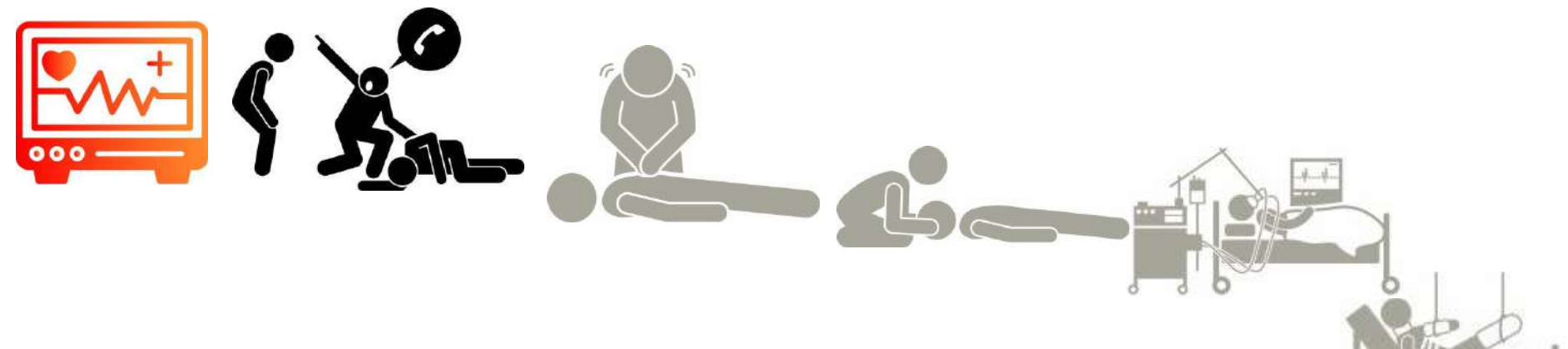
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# Pathophysiology





## Spot

- H&P
- Labs
  - K,Na,Mg,Ca,U&C
  - CBC
  - ABG,Glu
  - Serum Osmo
  - Urine lytes/Osmo
- ECG/ECHO/CXR/Abdo US
- Targeted Dx for underlying Dx

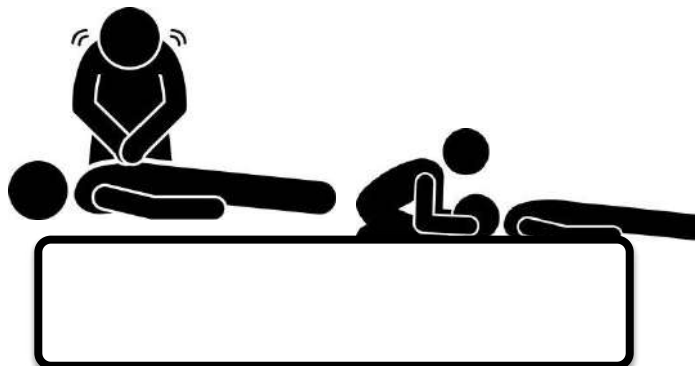
## Trying to die

- Status Epilepticus
- Altered LOC
- Shock-Due to cause

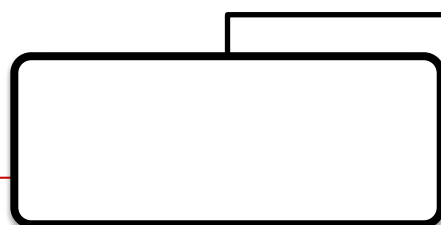
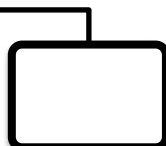
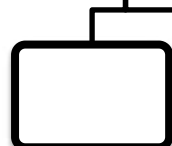
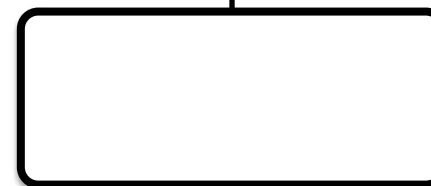
## Sick like a dog

- Hypovolemic
  - Dehydration
  - Orthostatic hypotension
- Hypervolemic
  - Fluid overloaded
  - Hypertensive

## Triggering Disease State



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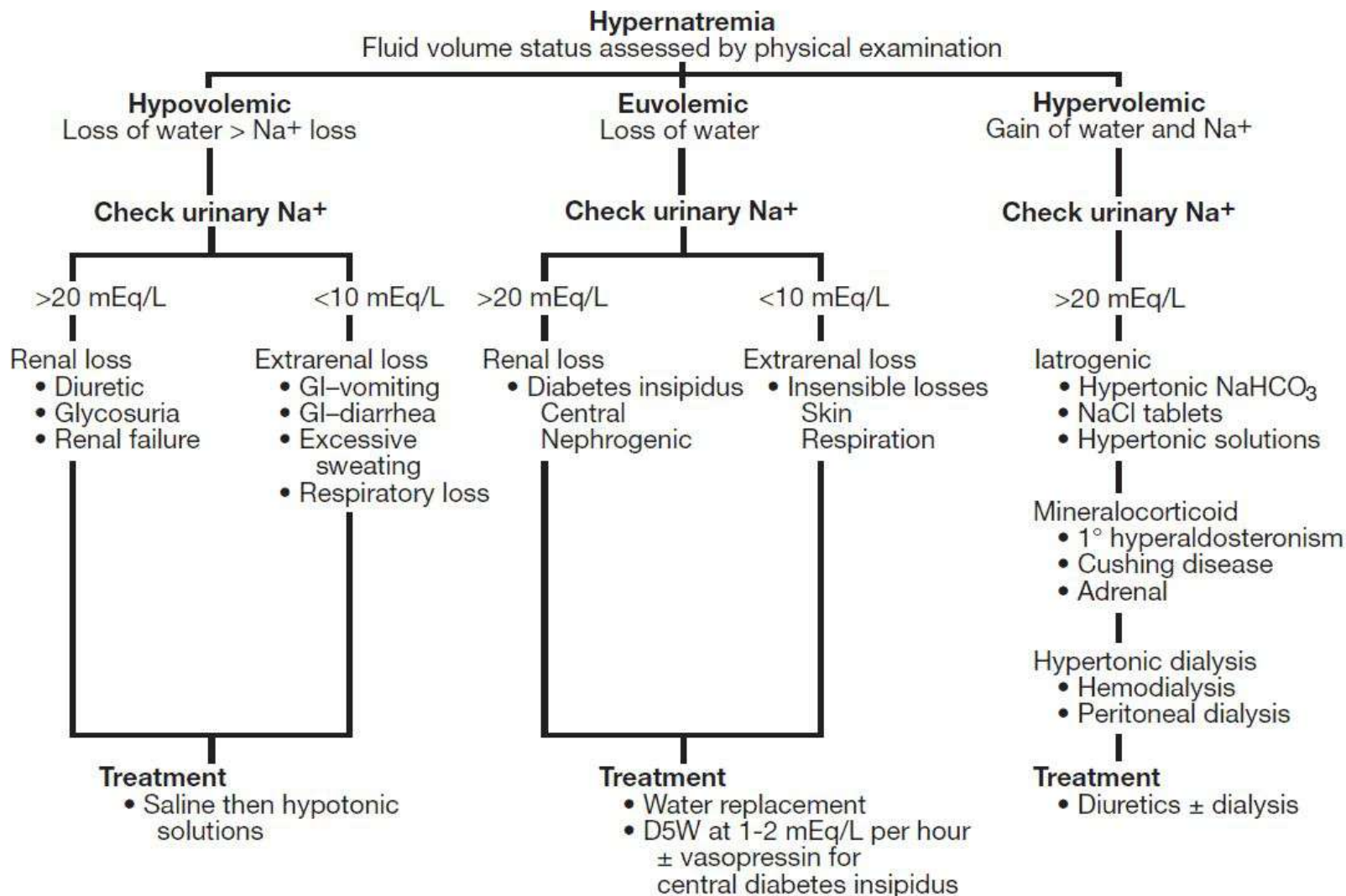




## Salve/Palliate

- Diagnose underlying disease
- Continue Organ support as needed
  - Essential consults: ICU, Nephro, Surgery, Oncology
  - Disposition: ICU/HDU, Ward, OR





Diagnosis and Management of Hypernatremia. D5W indicates 5% dextrose in water; GI, gastrointestinal tract; NA, sodium; NaCl, sodium chloride; NaHCO<sub>3</sub>, sodium bicarbonate.

Source : Mayo Clinic Internal Medicine 8th

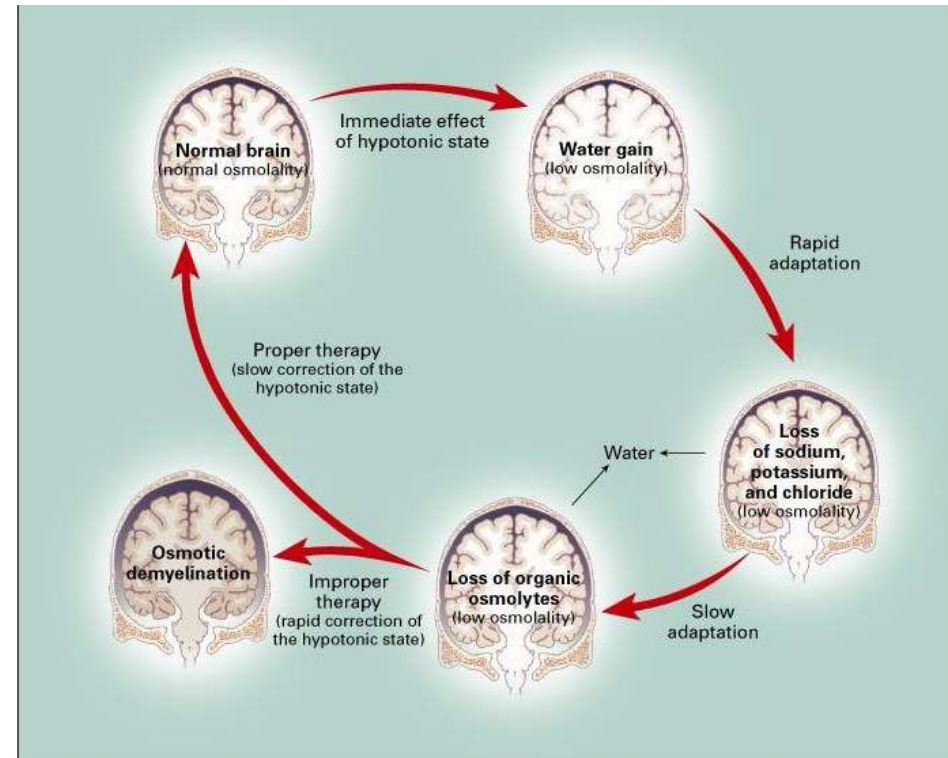
# Hyponatremia

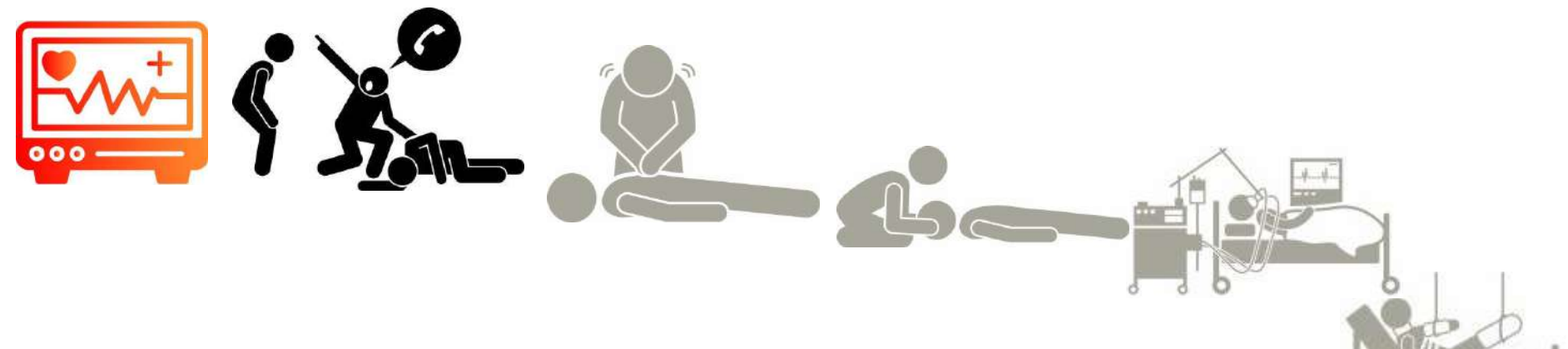


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# Pathophysiology





## Spot

- H&P
- Labs
  - K,Na,Mg,Ca,U&C
  - CBC
  - ABG,Glu
  - Serum Osmo
  - Urine lytes/Osmo
- ECG/ECHO/CXR/Abdo US
- Targeted Dx for underlying Dx

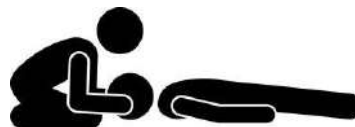
### Trying to die

- Status Epilepticus
- Altered LOC
- Shock-Due to cause

### Sick like a dog

- Hypovolemic
  - Dehydration
  - Orthostatic hypotension
- Euvolemic
  - Underlying cause
- Hypervolemic
  - Fluid overloaded
  - Hypertensive/Hypotensive

### Triggering Disease State

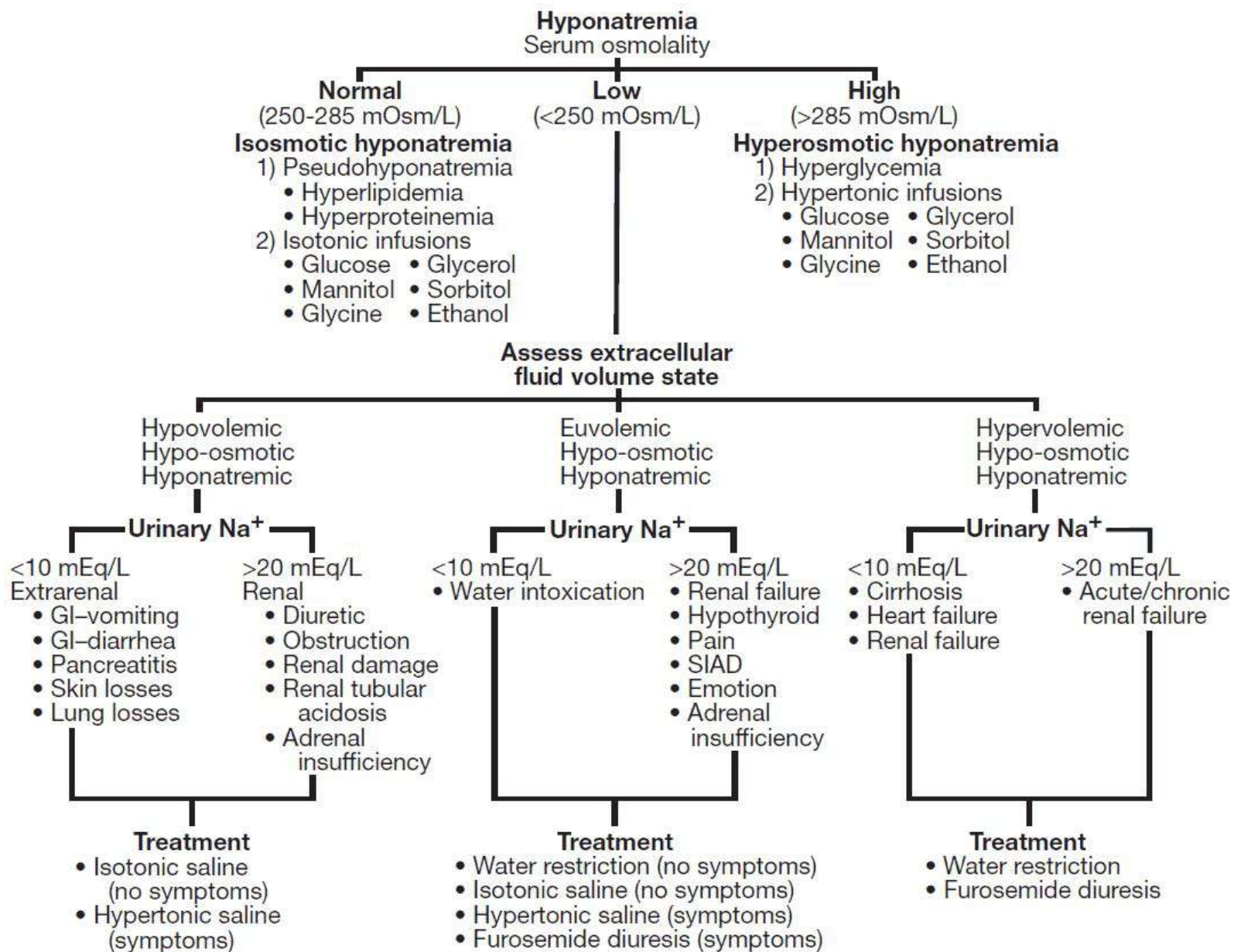


```

graph TD
    A[ ] --> B[ ]
    A --> C[ ]
    B --> D[ ]
    B --> E[ ]
    C --> F[ ]
    C --> G[ ]
    C --> H[ ]
    D --> I[ ]
    D --> J[ ]
    E --> K[ ]
    E --> L[ ]
    F --> M[ ]
    F --> N[ ]
    G --> O[ ]
    G --> P[ ]
    H --> Q[ ]
    H --> R[ ]
    
```





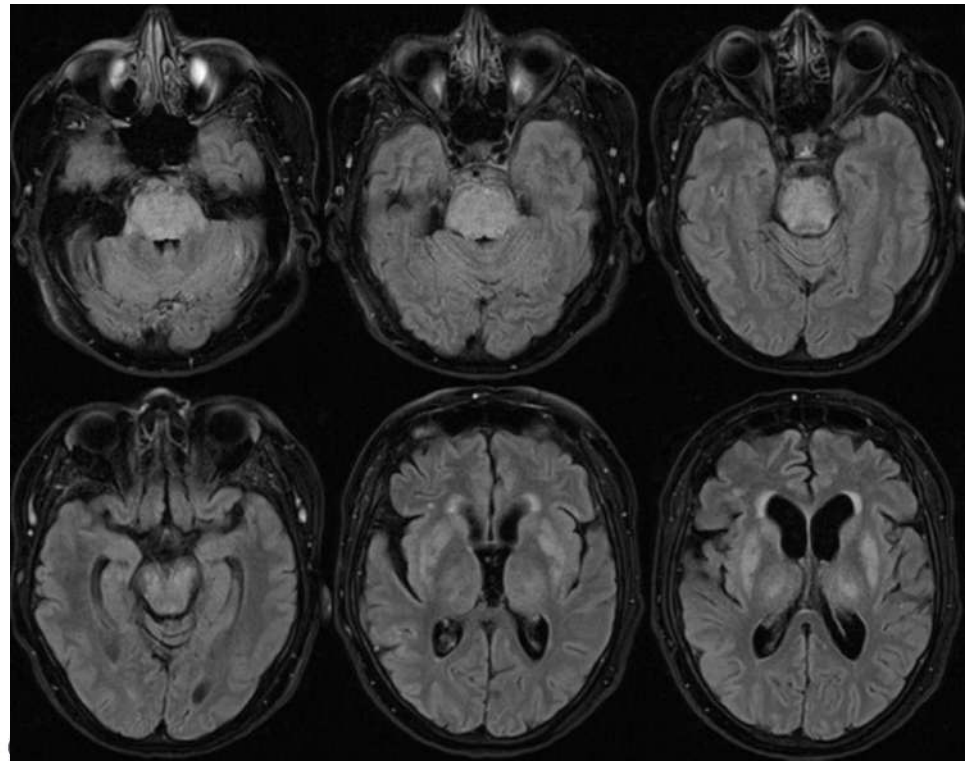


Diagnosis and Management of Hyponatremia. GI indicates gastrointestinal tract; Na, sodium; SIAD, syndrome of inappropriate antidiuresis.

Source : Mayo Clinic Internal Medicine 8th

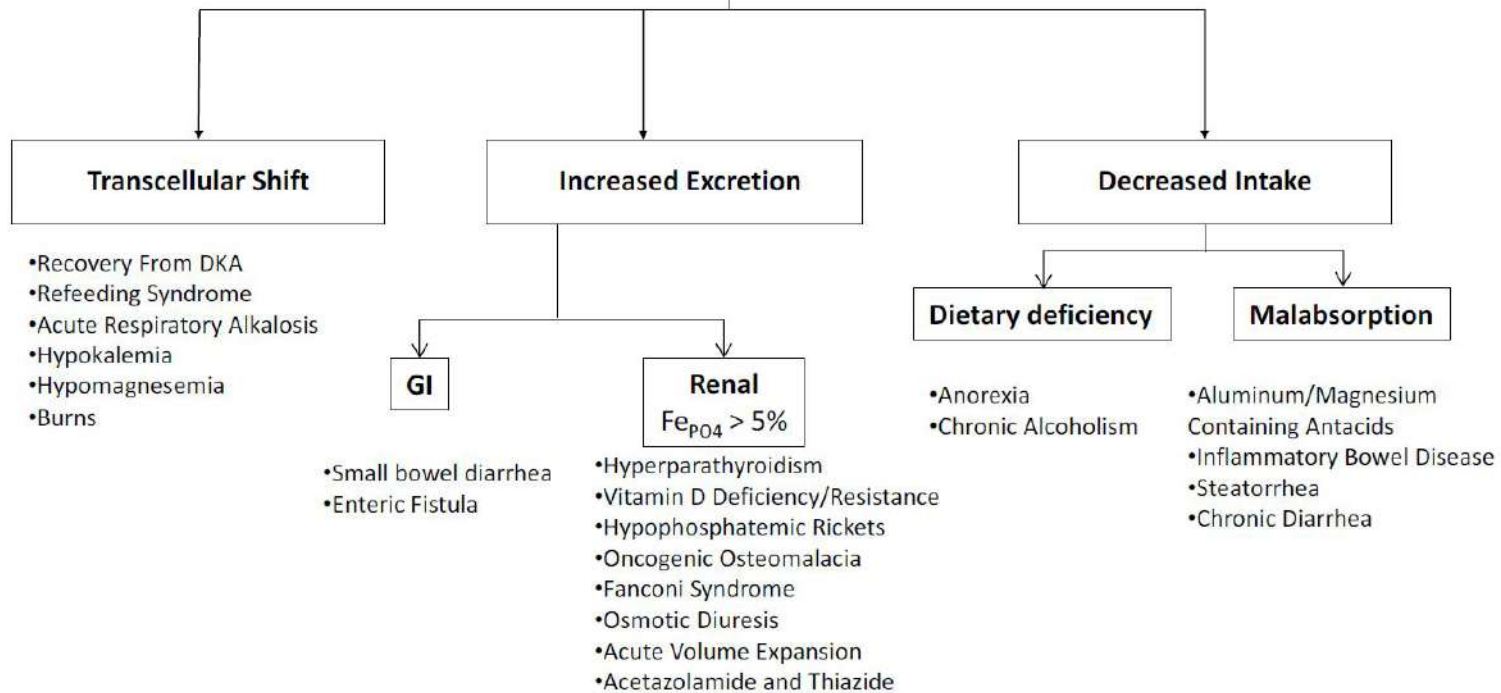
# Osmotic Demyelination/Central Pontine Myelinolysis

- ↑ risk if Na increased by  $>12$  mmol/L/d
- **Delayed presentation 2–6 days or weeks**
- Often irreversible.
  - Dysarthria
  - Dysphagia,
  - Paraparesis
  - Lethargy
  - Coma/seizures



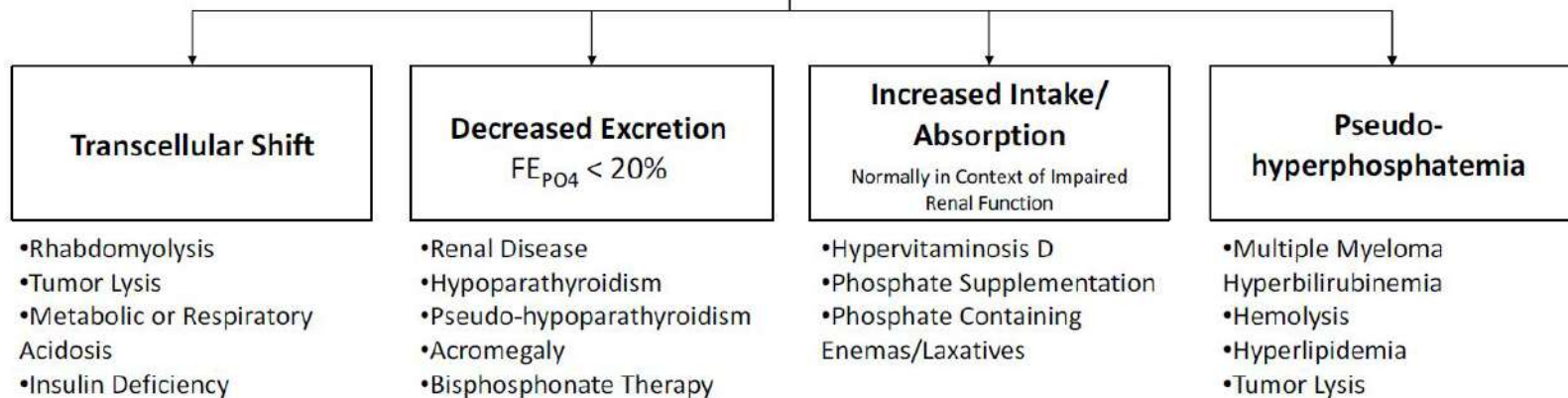
## Hypophosphatemia

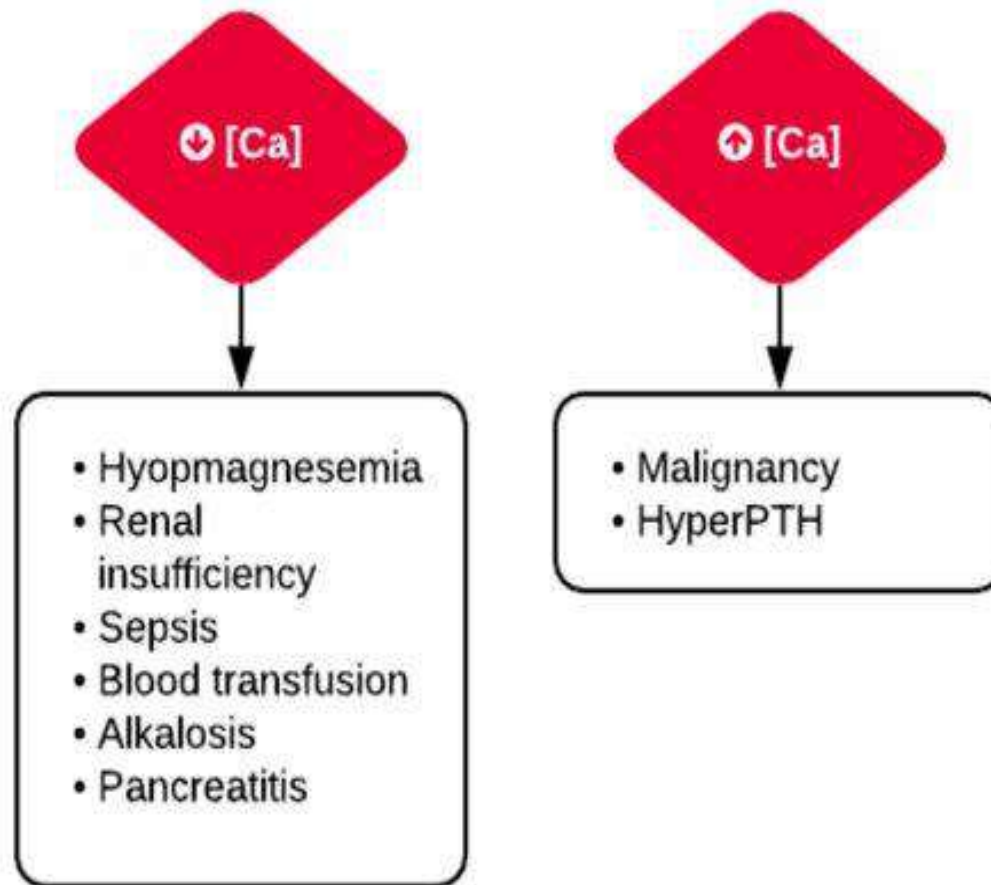
(< 0.8 mmol/L)



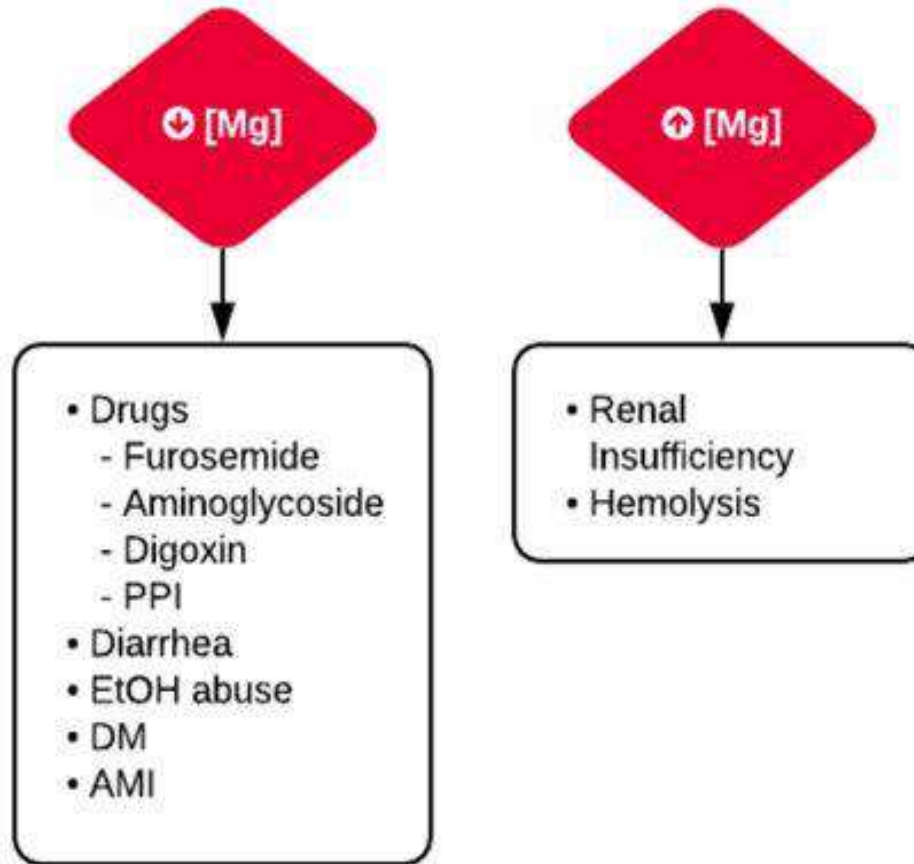
## Hyperphosphatemia

(> 1.46 mmol/L)









# Thank You



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