

Electrolytes



POTASSIUM

normal range: 3.5-5.0 mEq/L

- role:
- heart + muscle function
 - fluid balance + BP



SODIUM

normal range: 135-145 mEq/L

- role:
- blood volume + BP
 - fluid balance



MAGNESIUM

normal range: 1.5-2.5 mEq/L

- role:
- muscle relaxation
 - immune system
 - blood glucose
 - bones



CALCIUM

normal range: 8.5-10.3 mg/100ml

- role:
- neuron stability
 - bones
 - heart rate
 - clotting factors



PHOSPHATE

normal range: 2.5-4.5 mg/dl



Chloride

normal range: 96-106 mEq/L

Daily Fluid Requirements

- ~ Water: 30-35 ml/kg
- ~ K: 1 mEq/kg
- ~ Na: 1-2 mEq/kg
- ~ Cl: 1.5 mEq/kg
- ~ Ca: 1-3 gram

Daily Secretions

- ~ Bile: 1L/24 h
- ~ Gastric: 2L/24 h
- ~ Pancreatic: 600 ML/24 h
- ~ Small intestine: 3 L/24 h
- ~ Saliva: 1500 ml/24 h

Normal Water Loss

- ~ Urine: 1200-1500 ml/24h
- ~ Sweat: 200 ml
- ~ Respiratory losses: 500-700 ml
- ~ Feces: 100-200 ml

Values you should know:

- ~ Hyperglycemia: >160 mg/dL
- ~ High Amylase: >200 unit/L
- ~ High Lipase: >200 unit/L
- ~ BUN: 6-20 mg/dL
- ~ Creatinine: 6-20 mg/dL
- ~ HCO₃: 22-29 mEq/L

↑K⁺ = ↓Na⁺
↓K⁺ = ↑Na⁺

↑K⁺ = ↑Mg
↓K⁺ = ↓Mg

↑Na⁺ = ↓K⁺
↓Na⁺ = ↑K⁺

↑Mg²⁺ = ↑K⁺
↓Mg²⁺ = ↓K⁺

↑Mg²⁺ = ↑Ca²⁺
↓Mg²⁺ = ↓Ca²⁺

↑Ca²⁺ = ↑Mg²⁺
↓Ca²⁺ = ↓Mg²⁺

or 2.2-2.5 mmol/L

HYPO Natremia

HYPER Natremia

types

mild	130-134 mEq/L
moderate	120-129 mEq/L
severe	<120 mEq/L

moderate	146-159 mEq/L
severe	≥160 Eq/L

cause

Hypotonic Hypertonic Isotonic

* Hypo-Volemic :

1. NG suction
2. Burns
3. Pancreatitis
4. Diaphoresis

* Eu-Volemic :

1. SIADH
2. CNS

* Hyper-Volemic :

1. RF
2. CHF
3. LIVER FAILURE
4. DILUTIONAL
5. FLUID OVERLOAD

* Surgical causes:

its mostly due to volume depletions with inadequate hydration

* Others :

- Diabetes Insipidus (DI)
- Vomiting
- Diarrhea
- Diuretics

C/P

1. Seizures
2. Confusion
3. Lethargy
4. Coma
5. Weaknes

CNS symptoms

1. Seizures
2. Confusion
3. Tremors
4. Respiratory paralysis

TTT

HypoVolemic => IV NS & Correct underlying cause

EuVolemic => fluid restriction

HyperVolemic => fluid restriction and diuretics

hypotonic fluids

- D5W
- 1/2 NS
- 1/4 NS

** Always don't forget to correct hyponatremia slowly (0.25-0.5 mEq/L per hour), to avoid central pontine myelinolysis

** Slow lowering of serum sodium is very important less than 12 mEq/day TO AVOID SEIZURES. (brain edema)

HYPO Kalemia

cause

- 1. GIT LOSS:**
 - A. LOW INTAKE
 - B. HIGH LOSS (Vomit, NG TUBE, Diarrhea)
- 2. RENAL LOSS:**
 - A. DIURETICS
 - B. INCREASED ALDOSTERONE ACTIVITY
- 3. ALKALOSIS**
 where serum potassium goes into the cells to replace the outgoing H ions in an attempt to correct the alkalosis.
 ↳ e.g. ; gastric outlet obstruction
- 4. INSULIN THERAPY**
 ↳ (K goes into the cell)

C/P

1. G.i. Contractility [paralytic Ileus]
2. Respiratory Muscles Contractility
3. Cardiac Arrhythmia

ECG changes

- Flat T waves
- U waves
- ST depression
- PAC
- PVC
- AF

TTT

REPLACEMENT:-
KCL IV

MAX RATE THROUGH:
 ~ PERIPHERAL IV LINE : 10 mEq/hour
 ~ CENTRAL LINE : 20 mEq/hour

BE CAREFUL OF HYPERKALAEMIA
 ~ RAPID CORRECTION CAUSE
 CARDIAC ARREST IN DIASTOLE

HYPER Kalemia

- ACIDOSIS
 - DESTRUCTION OF CELLS
 - ALDOSTERONE SHUTDOWN
- } in brief

- 1- Severe Trauma
 - 2- Burns
 - 3- Crush Injury
 - 4- Severe Catabolic State
 - 5- Renal Failure
 - 6- Addison's Disease
 - 7- Blood Transfusion
 - 8- Acidosis
 - 9- Leucocytosis (Marked)
 - 10- Thrombocytosis (>1million)
 - 11- Haemolysis
 - 12- Haemolysed Specimen
- sepsis
- pseudo hyperkalemia

1. Decreased DTR
2. Weakness
3. Parasthesia
4. Paralysis
5. Respiratory failure

- Peaked T wave
- Depressed ST segment
- Prolonged PR
- Wide QRS
- Bradycardia
- V.Fib

Emergency Treatment (for acute):

- ~ Calcium Gluconate I.v. (Reverses the Action of [K] on the Heart)
- ~ 10 Units of Regular Insulin in 100 ml of 50% Dextrose I.v.
- ~ Insulin Pushes [K] Into the Cell
- ~ Sod, bicarb, corrects Acidosis (but This is Cotroversial)

Slow Correction (for chronic):

- ~ Oral cation exchange resin [Sodium Polystyrene Sulfonate] => Kayexalate
 ↳ ((takes potassium in exchange for Sodium and gets rid of [K] in the stool))

HYPERKALAEMIA due to RENAL FAILURE NEEDS DIALYSIS

HYPO Calcemia

(<1.8 mmol/L)

cause **Most common causes:**

1. After thyroid surgery
2. Renal Failure
3. Pancreatitis

- 1- Hypoparathyroidism
- 2- Hypomagnesemia
(Patients on Iv Feeding for Long Time)
- 3- Severe Pancreatitis
- 4- Renal Failure (Acute & Chronic)
- 5- Severe Trauma
(Blood Loss) => [albumin Loss]
- 6- Massive Blood Trasfusion
- 7- Crush Injury (Renal Failure)
- 8- Necrotizing Fasciitis
- 9- Rhabdommyolysis

**** ALL SOFT TISSUE INJURY CAN CAUSE HYPOCALCEMIA**

C/P

~ Circumoral Numbness and Tingling Tips of Fingers & Toes

~ Neuromucular Hyperactivity

- A- Exagerated Deep Reflexes
- B- Positive Chvostek Sign
- C- Carpopedal Spasm
- D- Muscle Cramps
- E- Abdominal Cramps
- F- Convulsions [rare]

Management

Acute

- A. Check First Blood [Ph]
- B. Alkalosis Should Be Treated
- C. I.V Calcium in Real Hypocalcemia
[ca Gluconate or Chloride]

Chronic

CHECK Mg level

CHECK ALBUMIN

- A. Oral Calcium +
- B. Vit.D [1-alfa-chole-calciferol]
- C. Alum.hydroxide (to Bind Dietary Phosphate)

HYPER Calcemia

- 1- Calcium Supplemntation IV
- 2- Hyper Parathyroidism
Hyper Thyroidism
- 3- Immobility / Iatrogenic
- 4- METS / Milk- alkali Syndrome
- 5- Paget's Disease
- 6- Addison Disease / Acromegaly
- 7- Neoplasm:
[Colon // Lung // Breast // Ovary // Prostate // Kidney // Multiple Myeloma]
- 8- Zollinger-Ellison Syndrome
- 9- Excessive Vitamine D
- 10- Excessive Vitamin A
- 11- Sarcoid

"CHIMPANZEES"

2+4+7 account for
90% of HYPER Calcemia

1. Easy fatigability
2. Muscle weakness
3. Constipation
4. Anorexia & Vomiting
5. Depression
6. Polyurea then Oligurea due to dehydration
7. Polydipsia
8. Calcinosis [anywhere but renal in particular]
9. Severe forms cause coma and death

**NEUROMUSCULAR
LOW ACTIVITY**

"BONES, STONES, ABDOMINAL GROANS & PSYCHIC MOANS" in HyperParathyroidism

1. Correct dehydration and wash out calcium through the kidney by N/S infusion
2. Furosemide [Lasix] & sod.Sulfate increase urinary excretion of calcium
3. I.V inorganic phosphates. Inhibit bone resorption
3. Plicamycin => for bone mets
4. Steroids for => A. sarcoidosis
B. vit.D intoxication
C. Addison`s disease
5. Calcitonin => for renal & CVS disease
6. Hemodialysis => for renal failure

HYPO Magnesemia

cause

1. TPN
2. Renal failure
3. Diarrhea
4. Vomiting

C/P *Clinical Picture like LOW Ca*

1. EXAGGERATED TENDON REFLEXES
2. CHVOSTEK SIGN
3. TETANY

IT IS ALWAYS ASSOCIATED WITH Ca AND K DEFICIENCY

TTT

REPLACED BY:

- ~ Mg sulfate
- ~ chloride solution } (or)
- ~ IV MgSO₄

Always remember that its impossible to correct hypokalemia without correction of the Mg

HYPER Magnesemia

RENAL FAILURE :

IN ASSOCIATION WITH => HIGH K
HIGH Na
LOW Ca

Clinical Picture like High Ca

- WEAKNESS
- LOSS OF REFLEXES
- PARALYSIS
- COMA
- DEATH

ECG CHANGES like High K

- ~ Calcium Gluconate IV
- ~ Insulin + Glucose
- ~ Dialysis

HYPO Phosphatemia <1 mg/dL

Cause ~ Re-feeding syndrome
~ ICU patients

C/P

1. Muscle weakness
2. Failure to wean from the ventilator
3. Infection risk due to poor leukocyte chemo-taxis from low ATP
4. Encephalopathy

TTT Potassium Phosphate

HYPER Phosphatemia

~ Renal Failure

Majority are asymptomatic but may have symptoms associated with hypocalcaemia

- ~ Sevelamer Chloride₉
- ~ Phosphate Binder
- ~ Low phosphate diet
- ~ Dialysis