SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIO PULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME : Pharmacology Pathology and Clinical Microbiology

II nd YEAR

TOPIC : ELECTROLYTES

Electrolytes

Electrolytes

- Charged particles in solution
- Cations (+)
- Anions (-)
- Integral part of metabolic and cellular processes

Positive or Negative?

- Cations (+)
  - Sodium
  - Potassium
  - Calcium
  - Magnesium
- Anions (-)
  - Chloride
  - Bicarbonate
  - Phosphate
  - Sulfate

Major Cations

EXTRACELLULAR

– SODIUM (Na+)

INTRACELLULAR

– POTASSIUM (K+)

Electrolyte Imbalances

- Hyponatremia/ hypernatremia
- Hypokalemia/ Hyperkalemia
- Hypomagnesemia/ Hypermagnesemia
- Hypocalcemia/ Hypercalcemia
- Hypophosphatemia/ Hyperphosphatemia
- Hypochloremia/ Hyperchloremia

Sodium

- Major extracellular cation
- Attracts fluid and helps preserve fluid volume
- Combines with chloride and bicarbonate to help regulate acid-base balance
- Normal range of serum sodium 135 - 145 mEq/L

Sodium and Water

- If sodium intake suddenly increases, extracellular fluid concentration also rises
- Increased serum Na+ increases thirst and the release of ADH, which triggers kidneys to retain water
- Aldosterone also has a function in water and sodium conservation when serum Na+ levels are low

Sodium-Potassium Pump

- Sodium (abundant outside cells) tries to get into cells
- Potassium (abundant inside cells) tries to get out of cells
- Sodium-potassium pump maintains normal concentrations
- Pump uses ATP, magnesium and an enzyme to maintain sodium-potassium concentrations
- Pump prevents cell swelling and creates an electrical charge allowing neuromuscular impulse transmission

Hyponatremia

- Serum Na+ level < 135 mEq/L
- Deficiency in Na+ related to amount of body fluid
- Several types
  - Dilutional
  - Depletional
  - Hypovolemic
  - Hypervolemic
  - Isovolemic

Types of Hyponatremia

- Dilutional - results from Na+ loss, water gain
- Depletional - insufficient Na+ intake
- Hypovolemic - Na+ loss is greater than water loss; can be renal (diuretic use) or non-renal (vomiting)
- Hypervolemic - water gain is greater than Na+ gain; edema occurs
- Isovolumic - normal Na+ level, too much fluid

What Do You See?

- Primarily neurologic symptoms

  - Headache, N/V, muscle twitching, altered mental status, stupor, seizures, coma
- Hypovolemia - poor skin turgor, tachycardia, decreased BP, orthostatic hypotension
- Hypervolemia - edema, hypertension, weight gain, bounding tachycardia

What Do We Do?

MILD CASE

- Restrict fluid intake for hyper/isovolemic hyponatremia
- IV fluids and/or increased po Na+ intake for hypovolemic hyponatremia

SEVERE CASE

- Infuse hypertonic NaCl solution (3% or 5% NaCl)
- Furosemide to remove excess fluid
- Monitor client in ICU

Hypernatremia

- Excess Na+ relative to body water
- Occurs less often than hyponatremia
- Thirst is the body's main defense
- When hypernatremia occurs, fluid shifts outside the cells
- May be caused by water deficit or over-ingestion of Na+
- Also may result from diabetes insipidus

What Do You See?

- Think S-A-L-T
  - Skin flushed
  - Agitation
  - Low grade fever
  - Thirst
- Neurological symptoms
- Signs of hypovolemia

What Do We Do?

- ❑ Correct underlying disorder
- ❑ Gradual fluid replacement
- ❑ Monitor for s/s of cerebral edema
- ❑ Monitor serum Na+ level
- ❑ Seizure precautions

Potassium

- Major intracellular cation
- Untreated changes in K+ levels can lead to serious neuromuscular and cardiac problems
- Normal K+ levels = 3.5 - 5 mEq/L

Balancing Potassium

- Most K+ ingested is excreted by the kidneys
- Three other influential factors in K+ balance :
  - Na+/K+ pump
  - Renal regulation
  - pH level

Sodium/Potassium Pump

- Uses ATP to pump potassium into cells
- Pumps sodium out of cells
- Creates a balance

Renal Regulation

- Increased K+ levels ⇒ increased K+ loss in urine
- Aldosterone secretion causes Na+ reabsorption and K+ excretion

pH

- Potassium ions and hydrogen ions exchange freely across cell membranes
- Acidosis ⇒ hyperkalemia (K+ moves out of cells)
- Alkalosis ⇒ hypokalemia (K+ moves into cells)

Hypokalemia

- Serum K+ < 3.5 mEq/L
- Can be caused by GI losses, diarrhea, insufficient intake, non-K+ sparing diuretics (thiazide, furosemide)

What Do You See?

Think S-U-C-T-I-O-N

- Skeletal muscle weakness
- U wave (EKG changes)
- Constipation, ileus
- Toxicity of digitalis glycosides
- Irregular, weak pulse
- Orthostatic hypotension
- Numbness (paresthesias)

What Do We Do?

- Increase dietary K+
- Oral KCl supplements
- IV K+ replacement
- Change to K+-sparing diuretic
- Monitor EKG changes

IV K+ Replacement

- Mix well when adding to an IV solution bag
- Concentrations should not exceed 40-60 mEq/L
- Rates usually 10-20 mEq/hr

NEVER GIVE IV PUSH POTASSIUM

Hyperkalemia

- Serum K+ > 5 mEq/L
- Less common than hypokalemia
- Caused by altered kidney function, increased intake (salt substitutes), blood transfusions, meds (K+-sparing diuretics), cell death (trauma)

What Do You See?

- Irritability
- Paresthesia
- Muscle weakness (especially legs)
- EKG changes (tented T wave)
- Irregular pulse
- Hypotension
- Nausea, abdominal cramps, diarrhea

What Do We Do?

- Mild
  - Loop diuretics (Lasix)
  - Dietary restriction
- Moderate
  - Kayexalate
- Emergency
  - 10% calcium gluconate for cardiac effects
  - Sodium bicarbonate for acidosis

Magnesium

- Helps produce ATP
- Role in protein synthesis & carbohydrate metabolism
- Helps cardiovascular system function (vasodilation)
- Regulates muscle contractions

Hypomagnesemia

- Serum Mg++ level < 1.5 mEq/L
- Caused by poor dietary intake, poor GI absorption, excessive GI/urinary losses
- High risk clients
  - Chronic alcoholism
  - Malabsorption
  - GI/urinary system disorders
  - Sepsis
  - Burns
  - Wounds needing debridement

What Do You See?

- CNS
  - Altered LOC
  - Confusion
  - Hallucinations

What Do You See?

- Neuromuscular
  - Muscle weakness
  - Leg/foot cramps
  - Hyper DTRs
  - Tetany
  - Chvostek's & Trousseau's signs

What Do You See?

- Cardiovascular
  - Tachycardia
  - Hypertension
  - EKG changes

What Do You See?

- Gastrointestinal
  - Dysphagia
  - Anorexia
  - Nausea/vomiting

What Do We Do?

- Mild
  - Dietary replacement
- Severe
  - IV or IM magnesium sulfate
- Monitor
  - Neuro status
  - Cardiac status
  - Safety

Mag Sulfate Infusion

- Use infusion pump - no faster than 150 mg/min
- Monitor vital signs for hypotension and respiratory distress
- Monitor serum Mg++ level q6h
- Cardiac monitoring
- Calcium gluconate as an antidote for overdosage

Hypermagnesemia

- Serum Mg++ level > 2.5 mEq/L
- Not common
- Renal dysfunction is most common cause
  - Renal failure
  - Addison’s disease
  - Adrenocortical insufficiency
  - Untreated DKA

What Do You See?

Decreased neuromuscular activity

Hypoactive DTRs

Generalized weakness

Occasionally nausea/vomiting

What Do We Do?

- Increased fluids if renal function normal
- Loop diuretic if no response to fluids
- Calcium gluconate for toxicity
- Mechanical ventilation for respiratory depression
- Hemodialysis (Mg++-free dialysate)

Calcium

- 99% in bones, 1% in serum and soft tissue (measured by serum Ca++)
- Works with phosphorus to form bones and teeth
- Role in cell membrane permeability
- Affects cardiac muscle contraction
- Participates in blood clotting

Calcium Regulation

- Affected by body stores of Ca++ and by dietary intake & Vitamin D intake
- Parathyroid hormone draws Ca++ from bones increasing low serum levels *(Parathyroid pulls)*
- With high Ca++ levels, calcitonin is released by the thyroid to inhibit calcium loss from bone *(Calcitonin keeps)*

Hypocalcemia

- Serum calcium < 8.9 mg/dl
- Ionized calcium level < 4.5 mg/Dl
- Caused by inadequate intake, malabsorption, pancreatitis, thyroid or parathyroid surgery, loop diuretics, low magnesium levels

What Do You See?

- Neuromuscular
  - Anxiety, confusion, irritability, muscle twitching, paresthesias (mouth, fingers, toes), tetany
- Fractures
- Diarrhea
- Diminished response to digoxin
- EKG changes

What Do We Do?

- Calcium gluconate for postop thyroid or parathyroid client
- Cardiac monitoring
- Oral or IV calcium replacement

Hypercalcemia

- Serum calcium > 10.1 mg/dl
- Ionized calcium > 5.1 mg/dl
- Two major causes
  - Cancer
  - Hyperparathyroidism

What Do You See?

- Fatigue, confusion, lethargy, coma
- Muscle weakness, hyporeflexia
- Bradycardia ⇒ cardiac arrest
- Anorexia, nausea/vomiting, decreased bowel sounds, constipation
- Polyuria, renal calculi, renal failure

What Do We Do?

- If asymptomatic, treat underlying cause
- Hydrate the patient to encourage diuresis
- Loop diuretics
- Corticosteroids

Phosphorus

- The primary anion in the intracellular fluid
- Crucial to cell membrane integrity, muscle function, neurologic function and metabolism of carbs, fats and protein
- Functions in ATP formation, phagocytosis, platelet function and formation of bones and teeth

Hypophosphatemia

- Serum phosphorus < 2.5 mg/dl
- Can lead to organ system failure
- Caused by respiratory alkalosis (hyperventilation), insulin release, malabsorption, diuretics, DKA, elevated parathyroid hormone levels, extensive burns

What Do You See?

- Musculoskeletal
  - muscle weakness
  - respiratory muscle failure
  - osteomalacia
  - pathological fractures
- CNS
  - confusion, anxiety, seizures, coma
- Cardiac
  - hypotension
  - decreased cardiac output
- Hematologic
  - hemolytic anemia
  - easy bruising
  - infection risk

What Do We Do?

- MILD/MODERATE
  - Dietary interventions
  - Oral supplements
- SEVERE
  - IV replacement using potassium phosphate or sodium phosphate

Hyperphosphatemia

- Serum phosphorus > 4.5 mg/dl
- Caused by impaired kidney function, cell damage, hypoparathyroidism, respiratory acidosis, DKA, increased dietary intake

What Do You See?

- Think C-H-E-M-O
  - Cardiac irregularities
  - Hyperreflexia
  - Eating poorly
  - Muscle weakness
  - Oliguria

What Do We Do?

- Low-phosphorus diet
- Decrease absorption with antacids that bind phosphorus
- Treat underlying cause of respiratory acidosis or DKA
- IV saline for severe hyperphosphatemia in patients with good kidney function

Chloride

- Major extracellular anion
- Sodium and chloride maintain water balance
- Secreted in the stomach as hydrochloric acid
- Aids carbon dioxide transport in blood

Hypochloremia

- Serum chloride < 96 mEq/L
- Caused by decreased intake or decreased absorption, metabolic alkalosis, and loop, osmotic or thiazide diuretics

What Do You See?

- Agitation, irritability
- Hyperactive DTRs, tetany
- Muscle cramps, hypertonicity
- Shallow, slow respirations
- Seizures, coma
- Arrhythmias

What Do We Do?

- Treat underlying cause
- Oral or IV replacement in a sodium chloride or potassium chloride solution

Hyperchloremia

- Serum chloride > 106 mEq/L
- Rarely occurs alone
- Caused by dehydration, renal failure, respiratory alkalosis, salicylate toxicity, hyperpara-thyroidism, hyperaldosteronism, hypernatremia

What Do You See?

- Metabolic Acidosis
  - Decreased LOC
  - Kussmaul's respirations
  - Weakness
- Hypernatremia
  - Agitation
  - Tachycardia, dyspnea, tachypnea, HTN
  - Edema

What Do We Do?

- Correct underlying cause
- Restore fluid, electrolyte and acid-base balance
- IV Lactated Ringer's solution to correct acidosis

THANK YOU