

FLUID & ELECTROLYTE DISORDERS

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Disclosures

- I have nothing to disclose
- This talk is intended to cover **adult** electrolyte issues

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GOALS AND OBJECTIVES

- Identify causes of common electrolyte abnormalities found in primary care office patients.
- Discuss signs and symptoms found in patients who have common electrolyte abnormalities.
- Become comfortable with treatment modalities that can be used to correct common electrolyte abnormalities.

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ELECTROLYTES

- We will cover:
 - High and low sodium
 - High and low potassium
 - High and low calcium
 - High and low magnesium

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SOME BASIC PRINCIPLES

- Kidneys prioritize fluid and electrolyte balance at the possible expense of acid-base balance.
- Normally functioning kidneys have a great capacity to handle increased or decreased intake of most electrolytes.
- Most electrolyte abnormalities found are in asymptomatic patients.
- Sodium abnormalities are usually actually water abnormalities

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BASIC METABOLIC PROFILE

- Sodium (Na⁺) 136-150
- Chloride (Cl⁻) 100-110
- Bicarbonate (CO₂) 22-28
- Potassium (K⁺) 3.6-5.0
- BUN (blood urea nitrogen) 5-18
- Creatinine 0.6 - 1.3

- Anion Gap (Na⁺ - {Cl⁻ + CO₂}) = ~ 12
- Calcium (Ca⁺⁺) 8.5 – 10.3
- Magnesium (Mg⁺⁺) 1.5 - 2.3

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SODIUM



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UPMC LIFE CHANGING MEDICINE

HYPONATREMIA CAUSES

- Suppressed ADH
 - CKD
 - Polydipsia
- Increased ADH
 - CHF
 - Cirrhosis
 - Thiazide diuretics
 - SIADH
 - Pregnancy/hypothyroidism/adrenal insufficiency

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HYPONATREMIA w/ HIGH/NL OSMO

- Hyperlipidemia
- Hyperproteinemia
- Mannitol administration
- Hyperglycemia
- CRF (BUN ineffective osmol)

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HYPONATREMIA SYMPTOMS

- Usually none
- If not pseudohyponatremia (+ low osmolality), then symptoms are usually related to development of cerebral edema
 - Nausea/vomiting
 - Malaise/lethargy
 - Headache
 - Seizures/coma/respiratory arrest

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HYPONATREMIA WORK-UP

- Urine osmol.
 - Low (< 100) in primary polydipsia
 - Higher (>100) in renal damage or ADH present)
- Serum osmol
 - Differentiate from pseudohyponatremia
- Urine Na⁺
 - SIADH = > 20-40 mEq/l
 - Hypovolemia = < 25 mEq/l

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HYPONATREMIA & MORTALITY

- Mild hyponatremia (often caused by severe medical issues) = significantly higher mortality
- Severe hyponatremia (often drug induced) = less higher mortality

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HYPONATREMIA TREATMENT

- Assess volume status
- Check TSH/cortisol?
- Fluid restriction?
- Saline or hypertonic saline?
- Correct slowly (osmotic demyelination)
- ? Desmopressin
- Vasopressin (ADH) receptor antagonists
 - Tolvaptan

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HYPERNATREMIA CAUSES

- Hypovolemic (common)
 - Diuretic use
 - GI loss (v/d)
 - Insensible loss (sweating, burns)
 - Osmotic diuresis
 - Hyperosmolar non-ketotic coma
 - Mannitol use

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HYPERNATREMIA CAUSES

- Euvolemic
 - Diabetes insipidus
 - Central
 - Nephrogenic
 - Decreased water intake
 - Fever
 - Meds
 - Aminoglycosides
 - Phenytoin
 - Lithium
 - Amphotericin

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HYPERNATREMIA CAUSES

- Hypervolemia (uncommon)
 - Cushing’s syndrome
 - Hyperaldosteronism
 - Hemodialysis
 - Iatrogenic
 - IV saline, bicarb
 - Saline enemas
 - Salt water ingestion
 - Enteral feedings

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HYPERNATREMIA SYMPTOMS

- Acutely can cause brain volume loss = more likely to have cerebral hemorrhages, demyelinating lesions
- Lethargy, weakness, irritability
- Can progress to twitching, seizures, coma
- Very high mortality if > 180
- Significant concern if > 158

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HYPERNATREMIA TREATMENT

- Calculate total water deficit =
 - $CBW \times (Na^+/140 - 1)$

CBW = 0.5 x weight for men, 0.4 x weight for women

So for 60 kg female w/ $Na^+ = 168$, would get:

$$0.4 \times 60 \times (168/140 - 1) = 4.8 \text{ liters}$$

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HYPERNATREMIA TREATMENT

- Correct max rate of 0.5 mEq/hr, 10 mEq/day if slow onset, 1.0 mEq/hr if rapid onset
- Check serum lytes q every few hrs
- Add in fluids to replace insensible (30 -40 mL/hr) and other losses (e.g. N/G tube drainage)
- Treat orally if possible
- Often use D5W if IV
- Treat cause when possible
- Watch for cerebral edema

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POTASSIUM



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HYPOKALEMIA CAUSES

- Diuretics
- Beta adrenergic agonists; insulin
- Inadequate intake
- Excess sweating
- Vomiting, diarrhea
- Metabolic alkalosis
- Steroids, aldosteronism
- Renal tubular disease
- Bartter and Gitelman syndromes

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HYPOKALEMIA SIGNS/SYMPTOMS

- Usually none
- If severe:
 - Weakness
 - EKG changes (u waves)
 - Palpitations
 - Arrhythmias (usually in pt w/ underlying cardiac disease)

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HYPOKALEMIA WORK-UP

- Assess acid base status if significant
- Check magnesium
- Assess trans-cellular shifts
- Urine potassium?
- Potassium/creatinine ratio?

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HYPOKALEMIA TREATMENT

- Change to ACE/ARB or K+ sparing diuretic
- Oral supplementation KCL
- IV supplementation if urgent or NPO
 - Arrhythmias
 - EKG changes
 - Symptoms

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HYPERKALEMIA CAUSES

- Specimen hemolysis (common)
- Metabolic acidosis
- Renal disorders/CKD
- Hypoaldosteronism
- Insulin deficiency
- Drugs (ACE-inh., diuretics, beta blockers)
- Tissue damage
- Hemolysis

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HYPERKALEMIA SIGNS/SYMPTOMS

- Usually none
- If severe:
 - Palpitations
 - Paresthesias
 - Muscle weakness/Ascending paralysis
 - Cardiac arrhythmias
 - Peaked T waves, shortened QT interval, BBB

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HYPERKALEMIA TREATMENT

- Calcium IV (stabilize heart)
- Albuterol
- Glucose and insulin
- Loop diuretic
- Sodium bicarbonate (if met acidosis)
- Kayexelate (exchange resin)??
- Patiromer/Zirconium cyclosilicate
- Dialysis

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HYPERKALEMIA TREATMENT

- Stop NSAIDs, ACE/ARBs, K+ sparing diuretics
- Low K+ diet/limit "No-salt"
- Thiazide diuretic if no renal disease

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CALCIUM



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HYPERCALCEMIA CAUSES

- Hyperparathyroidism
- Malignancy
- Hyperthyroidism
- Renal failure
- Sarcoidosis
- Thiazide diuretics
- Paget's disease
- Familial hypocalciuric hypercalcemia

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HYPERCALCEMIA SYMPTOMS

- Nausea/vomiting/constipation
- Irritability/ fatigue/ muscle weakness
- Depression
- Polyuria/polydipsia
- Kidney stones
- Lethargy/confusion/coma
- QT shortening, bradycardia, hypertension
- Coronary deposits

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HYPERCALCEMIA TREATMENT

- IV saline
- Calcitonin
- Loop diuretics (furosemide)
- Bisphosphonates (zoledronic acid)
- Denosumab
- Calcimimetics (cinacalcet)
- Steroids if secondary to sarcoid/lymphomas
- Dialysis

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HYPOCALCEMIA CAUSES

- Vitamin D deficiency
- Bisphosphonate tx
- Hyperphosphatemia
- Abnl magnesium metabolism
- Hypoparathyroidism
- Pancreatitis
- (Check albumin – if low would also expect Ca⁺⁺ to be low) – can measure ionized

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HYPOCALCEMIA SYMPTOMS

- Perioral tingling/numbness
- Muscle cramps
- Wheezing (bronchospasm)/laryngospasm
- Irritability/fatigue
- Diaphoresis
- Tetany/seizures
- Schvostek's/Trousseau's signs

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HYPOCALCEMIA W/U, TREATMENT

- Verify (check albumin/ionized calcium)
- Check PTH, MG++, phos, vit D, alk phos, creat.
- Supplement oral + Vit D?
- IV 1-2 gm calcium gluconate in 50 mL NSS over 15 minutes if severe or life threatening sx
- May need to give mag first if low

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MAGNESIUM



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HYPOMAGNESEMIA CAUSES

- Low in:
 - Poor intake
 - Chronic diarrhea
 - Pancreatitis
 - Renal disease
 - Alcoholism
 - Hypercalcemia
 - Diabetes
 - Diuretic tx; PPI tx

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HYPOMAGNESEMIA SYMPTOMS

- Tetany
- Weakness
- Apathy
- Tremor
- Seizures
- Widened QRS, PR; arrhythmias
- Delirium/coma
- (Can cause hypocalcemia & hypokalemia)

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HYPOMAGNESEMIA TREATMENT

- Treat mild or no sx PO (200- 1000 mg/d)
- Correct underlying disease
 - If unsure, can calculate fractional excretion of Mag
 - Caution with repletion in renal disease pts
- Treat severe sx IV while on cardiac monitoring
 - Stat dose 1-2 gm MgSO₄ over 15 minutes if emergent
 - 4-8 gm/24 hrs MgSO₄ if subacute

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HYPERMAGNESEMIA CAUSES

- High in:
 - Renal failure
 - Laxative abuse
 - Antacid abuse
 - Enemas
 - DKA
 - Milk-alkali syndrome
 - Occasionally w/ hyperparathyroidism
 - Tumor lysis syndrome

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HYPERMAGNESEMIA SYMPTOMS

- Somnolence
- Decreased DTR's
- Paralysis
- Hypotension
- Bradycardia
- Prolonged PR, QRS, QT; Complete heart block
- Mild = nausea, headache
- (Can cause hypocalcemia also)

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HYPERMAGNESEMIA TREATMENT

- Saline IV
- Loop diuretic
- Dialysis

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QUESTIONS???

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