

Case Studies of Electrolyte  
Disorders  
ACOI Board Review 2018

Mark D. Baldwin D.O. FACOI

# Disclosures

- None, just working for The Man

# Question 1

The first thing in evaluating a patient who has a disorder of Sodium and/ or Water is?

- a. Urine Electrolyte studies
- b. Compare Serum Sodium to Urine Sodium
- c. Compare Serum Osmolarity to Urine Osmolarity
- d. Urinary Anion Gap
- e. Evaluate the patient's fluid status

## Question 2

You are seeing a patient with a history of lung cancer with metastasis, his serum Na is 109. He is only on MS Contin and has been eating, however, but feels weak; he appears cachectic with a BP of 130/68 and no evidence of volume depletion. Your next step would be?

- a. Renal ultrasound
- b. Urine Sodium
- c. Urine Osmolarity
- d. Serum Osmolarity
- e. b, c, and d.

# Question 3

The most likely etiology of the patient's hyponatremia is?

- a. Dehydration
- b. Sepsis
- c. Surreptitious use of diuretics
- d. Syndrome of Inappropriate secretion of ADH
- e. Diabetes Insipidus

# Question 4

The appropriate treatment is?

- a. Fluid restriction
- b. Tolvaptan-V2 Receptor blocker
- c. 3% Saline at 60 ml/hr for 24 hours
- c. Hydrochlorothiazide
- e. Furosemide

# Question 5

You are seeing a patient with a serum Na of 112, Serum Osmolarity is 260 and Urine Osmolarity is 280, they are not on any medications and BP is 146/84. The most likely diagnosis is?

- a. Dehydration
- b. Sepsis
- c. Surreptitious use of diuretics
- d. Syndrome of Inappropriate secretion of ADH
- e. Diabetes Insipidus

# Barter-Schwartz criteria for SIADH

- Hyponatremia
- Hypoosmolarity (serum)
- Urine Sodium  $>20$
- Urine Osmolarity  $>$  Serum Osmolarity (less than maximally dilute)
- Euvolemia, Uric acid  $< 4\text{mg/dl}$
- Normal Cardiac, Renal, Thyroid, Pituitary Axis, Liver

Barter, F, Schwartz, W, *Am J Med*, (42) 5, 790-806



# Question 6

A 23 year old female collapses at a while doing a 100 mile bicycle race. She is lethargic but able to answer question; she complains of a progressive headache, blurred vision, nausea and vomiting. She has vomited up blue liquid consistent to what is in her water bottle. BP 128/90, HR 92, Resp. 20, glucose is 92 and sodium is 122. Her exam is remarkable for mild lethargy and diaphoresis.

# Question 6 (continued)

Your first treatment would be:

- a. 100 ml of 3 % saline
- b. Normal saline (0.9%) 500 bolus then 150 ml/hr
- c. 1 amp of D50
- d. 500 ml of Lactated Ringers then 150 ml/min.
- e. None of the above

# Exercise Associated Hyponatremia (EAH)

- EAH is a dilutional hyponatremia caused by an [RAPID] increase in total body water relative to the amount of total body exchangeable sodium. The primary etiological factor is the consumption of fluids (water and sports drinks) in excess to total body fluid losses: insensible (transcutaneous, respiratory and GI) and renal losses.

2<sup>nd</sup> Conference on Exercise Associated Hyponatremia 2007 (2<sup>nd</sup> Conference EAH)

*Clin J Sport Med*; 18(2): 111-21, 2008

# Principles of Treatment 3% Saline

- A SMALL correction can lead to a good outcome. (2-3 mEq/l initially) Do not over correct or normalize.
- Do not correct unless evidence of hyponatremia is present or compelling clinical situation e.g. seizure, myoclonus, confusion, coma, etc.
- 100 ml of 3% saline should provide some improvement, if none it may be repeated every 10 min. for a total of 3 doses or clinical improvement
- Fluid restriction
- 2<sup>nd</sup> Conference EAH

# Influence of Gatorade/Pepsi and GSK

1996 American College of Sports Medicine\*

- Recommended that athletes drink as much as tolerated during exercise.
- Sports drinks were a better alternative to water
- Tried to correlate professional endurance cyclist's and runner's fluid and electrolyte needs to that of the amateur athlete.
- Large body of flawed, biased research

\*Gatorade and Gatorade Sports Institute were "Platinum Sponsors" of ACSM that year

Noakes T, *Br J Sport Med*; 40, 567-72, 2006

# Question 7

A 54 y.o male has recently had undergone a CABG. Pre-op creatinine

was 1.2 mg% and he has a history of Type 2 Diabetes. Intra-operatively, he required 2 hours on bypass pump and post-operatively he has been hypotensive, requiring pressors. 3 days post-op his creatinine is 3.2 mg%. CXR and Renal US are negative, his C.O. is 0.9 and C.I. is 1.6 with a PCWP of 6. He is afebrile but has had little urine output over the past 24 hours, WBC is 9.1 and Hb is 8.9 gm. Your treatment would consist of?

- a. Fluid challenge to attempt to raise BP and PCWP
- b. Broad spectrum antibiotics for sepsis
- c. Transfuse 2 units of packed RBCs
- d. Start dialysis
- e. High dose loop diuretics to increase urine output

# Question 8

A 66 y.o. female is admitted for mental status changes. She has a history of metastatic breast cancer and has been declining recently. On exam she is very lethargic with a BP of 75/50 and a pulse of 130. Her lab reveals: Na 134, Co2 16, K 5.7, BUN 89, Creatinine 1.9, and Ca 17.2. The most likely explanation of the patient's presentation is?

- a. Production of a PTH-related protein
- b. Production of lymphokines
- c. Direct bone invasion
- d. Production of a Vitamin D like substance
- e. Any of the above

# Question 9

The first treatment would consist of?

- a. I.V. Saline at 30 ml/hr
- b. I.V. Saline for several liters then followed by a loop diuretic
- c. Corticosteroids
- d. Calcitonin
- e. Dialysis



# Question 10

In a patient with Hypernatremia, regardless of the cause, which of the statements is true?

- a. Elevated glucose can increase the Sodium level
- b. Elevations in Potassium will almost always occur
- c. There is always a free water deficit
- d. All of the above
- e. None of the above

# Question 11

You are seeing a 52 y.o. male with a history of bipolar disorder for which he has taken Lithium for a number of years. His BP is 128/62 and is not orthostatic. His serum Na is 153 mg% and he drinks a considerable amount of water to compensate for frequent urination. Based on the information, your working diagnosis is?

- a. SIADH
- b. Dehydration
- c. Psychogenic polydipsia
- d. Central Diabetes Insipidus
- e. Nephrogenic Diabetes Insipidus

# Question 12

To make the diagnosis, the next test would be?

- a. Measure a Serum ADH level
- b. Measure Urine ADH level
- c. Saline suppression test
- d. Water restriction test/ DDAVP
- e. None of the above

# Question 13

The results after the water both deprivation test and DDAVP were:  $U_{osm} < 300$ , . Your treatment now would be?

- a. Thiazide diuretic
- b. Amiloride
- c. Daily NSAID use
- d. Low Sodium and low protein diet
- e. All of the above

# Diabetes Insipidus

- Central-due to trauma, edema, ischemia or removal of the Pituitary, or congenital
- Nephrogenic-due to the kidneys loss of response to ADH, drugs, obstruction, ureteral reflux, salt wasting, chronic renal disease, congenital
- Large volumes of dilute urine (10-15 l/day)
- Polydipsia

# Urine osmolality (mosm/kg) in DI

<u>Fluid deprivation</u>	<u>DDAVP</u>	<u>Dx</u>
<300	>750	Central DI
<300	<300	Neph DI
>750	no chg	1° polydipsia

Di Iorgi *Horm Res Paediatr* 2012; 77: 69-84

# Plasma Osmolality mosm/kg

Fluid deprivation

Uosm > Posm

Dx

1° polydipsia/NDI

DDAVP

Posm > Uosm

N DI

Uosm > Posm

C DI

Di Iorgi *Horm Res Paediatr* 2012; 77: 69-84

# Diabetes Insipidus

- Diagnosis with water deprivation test/DDAVP
- Hyponatremia
- Hyperosmolarity
- Dilute urine
- Treatment: ADH replacement (Central)
- Thiazides, amiloride, NSAIDs (?)



# Question 14

You are seeing a 32 y.o. female with hypertension. Her medications include: Dyazide, Metoprolol, and Lisinopril; despite her compliance her BP is 168/78. Her lab is remarkable for a Na of 148 mg% and a K of 2.8 mg%. Your next diagnostic test would be?

- a. Plasma Renin Activity, Aldosterone level
- b. Serum Glucose
- c. Serum ADH level
- d. Plasma Catecholamines
- e. CT of the Adrenal glands

# Question 15

In the above mentioned patient, you would expect to find edema.

- a. True
- b. False

# Primary Hyperaldosteronism

- In a patient w/ spontaneous hypokalemia:
  - Aldo (PAC)  $>15$  ng/dL and PRA  $< 1.0$  ng/mL/hr
  - AND PAC/PRA  $>20$  ng/dL per ng/mL/hr  
Highly suggestive of Primary Hyperaldo
- If PAC/PRA  $> 30$  is almost diagnostic of Primary Hyperaldo

# Hyperaldosteronism/Conn's Syndrome

- Excess production of Aldosterone by an adrenal adenoma or multiple microadenomas
- Refractory hypertension
- Refractory hypokalemia
- Mild hypernatremia
- Mild metabolic acidosis
- Aldosterone escape-no edema

# Question 16

You are seeing a 40 y.o. patient with HIV, he has recently been found to have military T.B. He appears ill and has a BP of 88/62 and a pulse of 120. His exam is remarkable for diffuse tanning. Lab reveals a Na 147 mg%, K 6.2, CO<sub>2</sub> 15 with an anion gap of 10, BUN is 32 and Creatinine is 1.5. WBC is 4.2 with 12% Eosinophils. The lab was obtained after several liters of Saline and normalization of BP. What is the most likely explanation for the patient's condition?

- a. Type I RTA
- b. Acute Renal Failure
- c. Sepsis
- d. Addison's Disease
- e. Lab error

# Question 17

You are seeing a 56 y.o. Type 2 Diabetic, his lab is : Glucose 260, Na 138, K 5.7, CO2 17, BUN 29, Creatinine is 1.7 he is chronically non compliant with all of his meds and diet. What is the explanation of his lab?

- a. Occult alcohol abuse
- b. Dehydration
- c. Addison's Disease
- d. Type IV RTA
- c. Uncontrolled Diabetes

# Question 18

You are seeing a patient for CHF. He has been aggressively treated with diuretics and despite equally aggressive potassium replacement, his K remains low. What is your next step?

- a. Double the dose and frequency of potassium replacement
- b. Stop all diuretics
- c. Add an ACE-I
- d. Switch to a potassium sparing diuretic
- e. Measure Serum Magnesium

# Role of magnesium in potassium balance

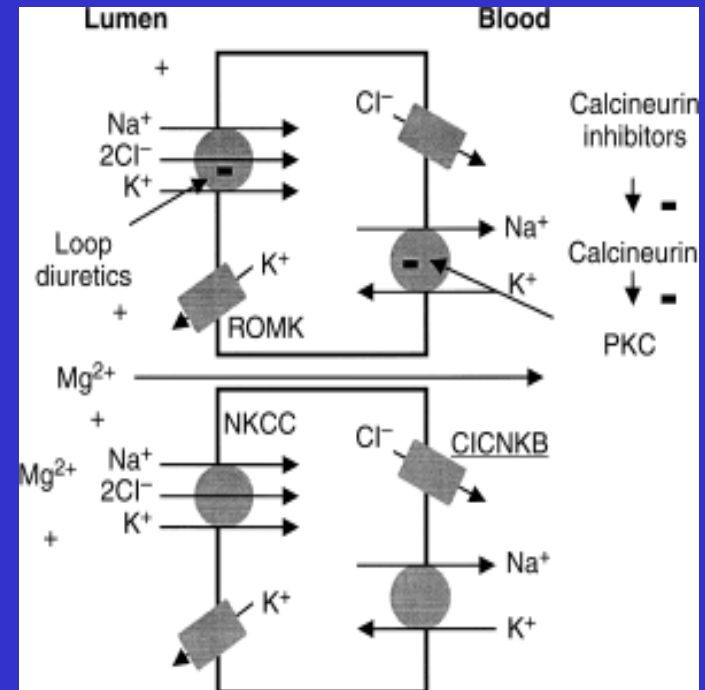
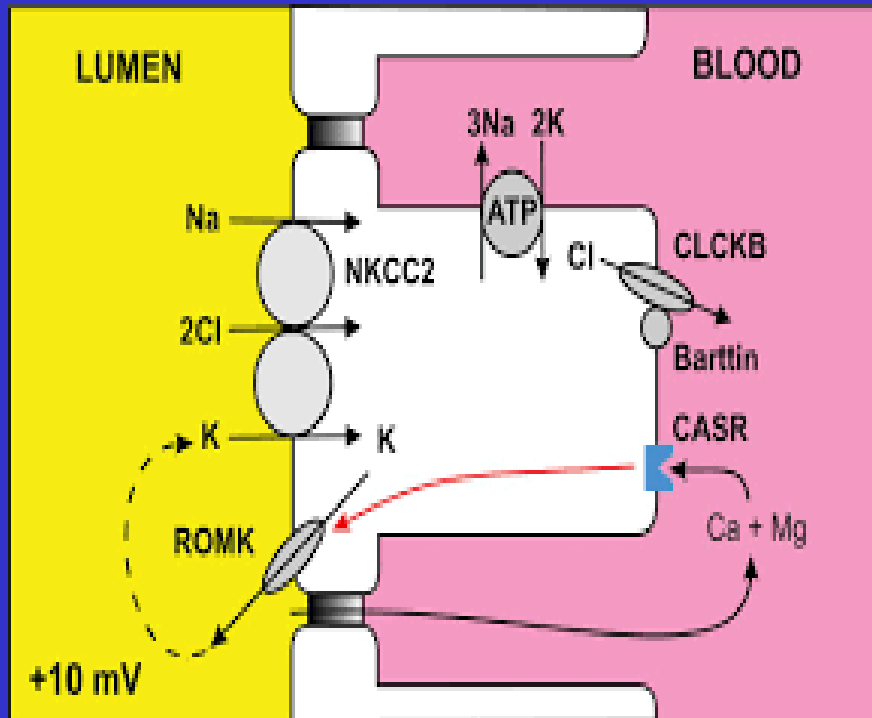
- In patients with refractory hypokalemia, hypomagnesaemia may be the cause.
- Causes: diuretics (thiazide and loops), diarrhea, chronic ETOH and withdrawal, malnutrition, PPI, refeeding, hungry bone, pancreatitis, diuretic phase of AKI, treatment of DKA



# Hypomagnesemia aggravates hypokalemia

- The Renal Outer Medullary K channel (ROMK) secretes K into the tubular lumen from the cell, down its concentration gradient
- The channel is regulated to by intracellular magnesium via the Calcium sensing receptor CASR

# Hypomagnesemia aggravates hypokalemia



# Hypomagnesemia

- If the magnesium level is low the cell will continue to secrete K into the lumen unabated
- Magnesium replacement will restore the regulatory mechanism

# Question 19

You are consulted by the Trauma Service; a 22 y.o. male was admitted for evacuation of a subdural hematoma following an accident. Despite aggressive post-op fluids, the patient had had significant polyuria, his Na is 154 with an Osmolarity of 320. The cause of the patient's Sodium abnormality is?

- a. Over secretion of ADH
- b. Over responsiveness of ADH receptors on the kidney
- c. Dehydration
- d. Under secretion of ADH
- e. Under responsiveness of ADH receptors in the kidney

# Question 20

In the previous patient, the best treatment would be?

- a. Fluid restriction
- b. Demeclocycline
- c. Thiazide
- d. Amiloride
- e. Desmopressin (DDAVP)

# Question 21

You have a patient who is on torsemide, chlorthaladone, and potassium bicarbonate/citrate. Her potassium usually runs a bit low, 3.4 mg/dl and her magnesium is normal. She had been vomiting, but is still able to take her medications. On exam her BP is 90/60 dry mucous membranes and poor skin turgor.

Today her lab reveals: Na 136, K 2.9, Cl 96, CO<sub>2</sub> 33. Mg is low at 1.0.

# Question 21 continued

Optimal fluid replacement would include:

- a. Saline, potassium bicarbonate and magnesium
- b. Potassium chloride and magnesium
- c. Potassium bicarbonate, and magnesium
- d. Potassium chloride, saline and magnesium
- e. Saline and magnesium

# Hypokalemia treatment

- Potassium chloride is the preferred replacement and will raise the potassium level more rapidly than other forms
- Hypokalemia is frequently associated with a metabolic alkalosis, unless chloride is replaced bicarbonate will continue to be produced
- K-Lyte (potassium bicarbonate/citrate) will further aggravate the alkalosis and hypokalemia

*Am J Physio.* 1975;229(1):161

*Am J Med.* 1965;38:172



# Question 22

A diabetic pt. w/ a baseline creatinine of 1.8 mg/dl is admitted for chest pain. Cardiology wants to cath her. What is the most important factor to decrease her risk of contrast associated AKI?

- a. N-acetyl cysteine 600 mg before and after cath
- b, Atorvastatin pre/post cath
- c. NS at 50 ml/hr 6 hours before and after
- d. Sodium bicarbonate 150 mEq/l 50 ml/ hr 6 hours before or after
- e. Stop metformin 48 before cath