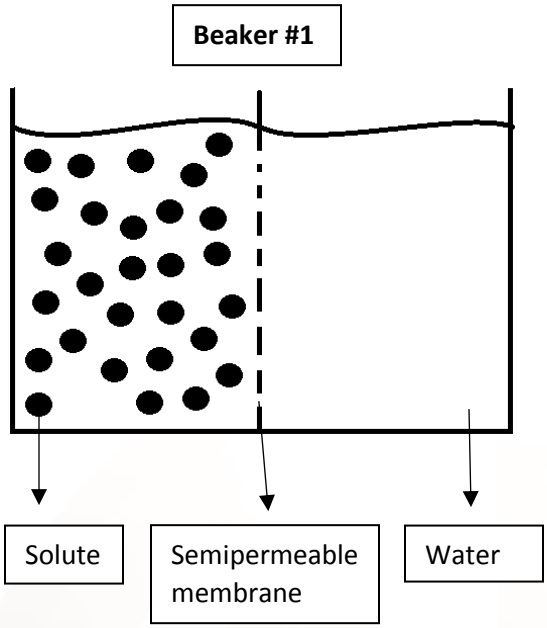
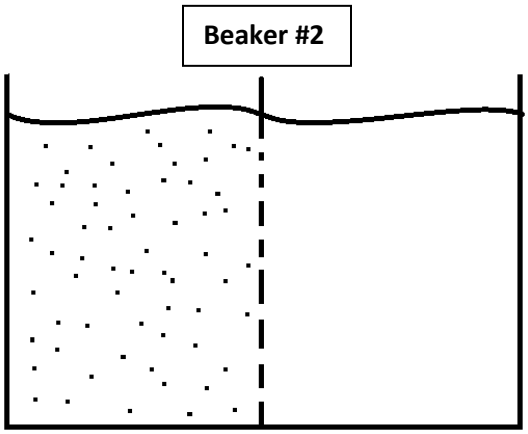
Hyponatremia AHD – Learner Guide
November 14th, 2019

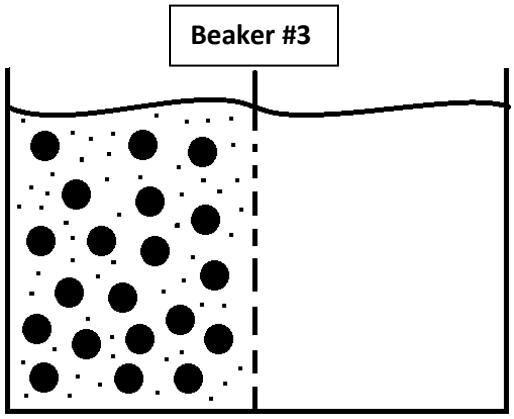
What is the difference between tonicity and osmolality?

Let's explore this difference by taking a look at some examples. There are three beakers below, and each has two compartments separated by a semipermeable membrane that only allows small solutes to pass. A solute has been added to one compartment of each beaker.

Is the compartment on the left hyper-, iso-, or hypotonic relative to the compartment on the right? Is it hyper-, iso-, or hypo- osmolal? Predict how the solutes and water will shift in each example.







What are the main solutes present in serum? How do you calculate serum osmolality?

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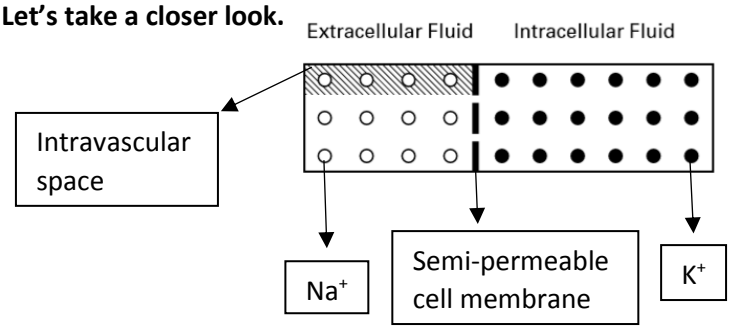
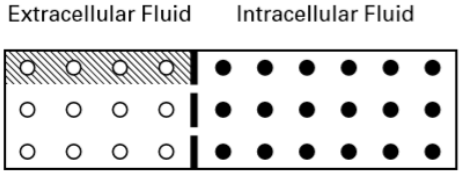
Are sodium, glucose, and urea effective osmoles? In other words, can differences in the concentrations across cell membranes cause a shift of water?

Why the focus on tonicity? Hypotonic vs. hypertonic hyponatremia have different etiologies and different potential complications. Let's take a closer look.

To the right is a patient with a normal renal panel. Glucose and urea are omitted in the diagram.



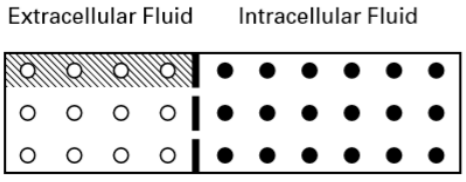
Scenario #1: What will happen if this patient's glucose is 800 instead of 100? Add ■ to the diagram to represent glucose. Will there be any other shifts?



Will this patient be at risk for cerebral edema?

Scenario #2: What will happen if a patient develops SIADH? Draw shifts onto the diagram

Will this patient be at risk of cerebral edema?



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The brain adapts to chronic hypotonicity (>48 hours) by losing intracellular solutes to approach the tonicity of serum. What will happen with rapid correction of chronic hyponatremia in brain cells?

Is the patient in scenario #1 at risk of osmotic demyelination syndrome? How about scenario #2?

You've likely seen different algorithms to workup HYPOTONIC hyponatremia. While there may be slight variations (one on the next page), these algorithms usually include the following: exam findings, urine osmolarity, and urine sodium. Lets discuss how does each of those factors help you determine the etiology of hyponatremia.

- **Physical exam**

- **Urine osmolality**

- **Urine sodium**

In what instances is the urine sodium unreliable?

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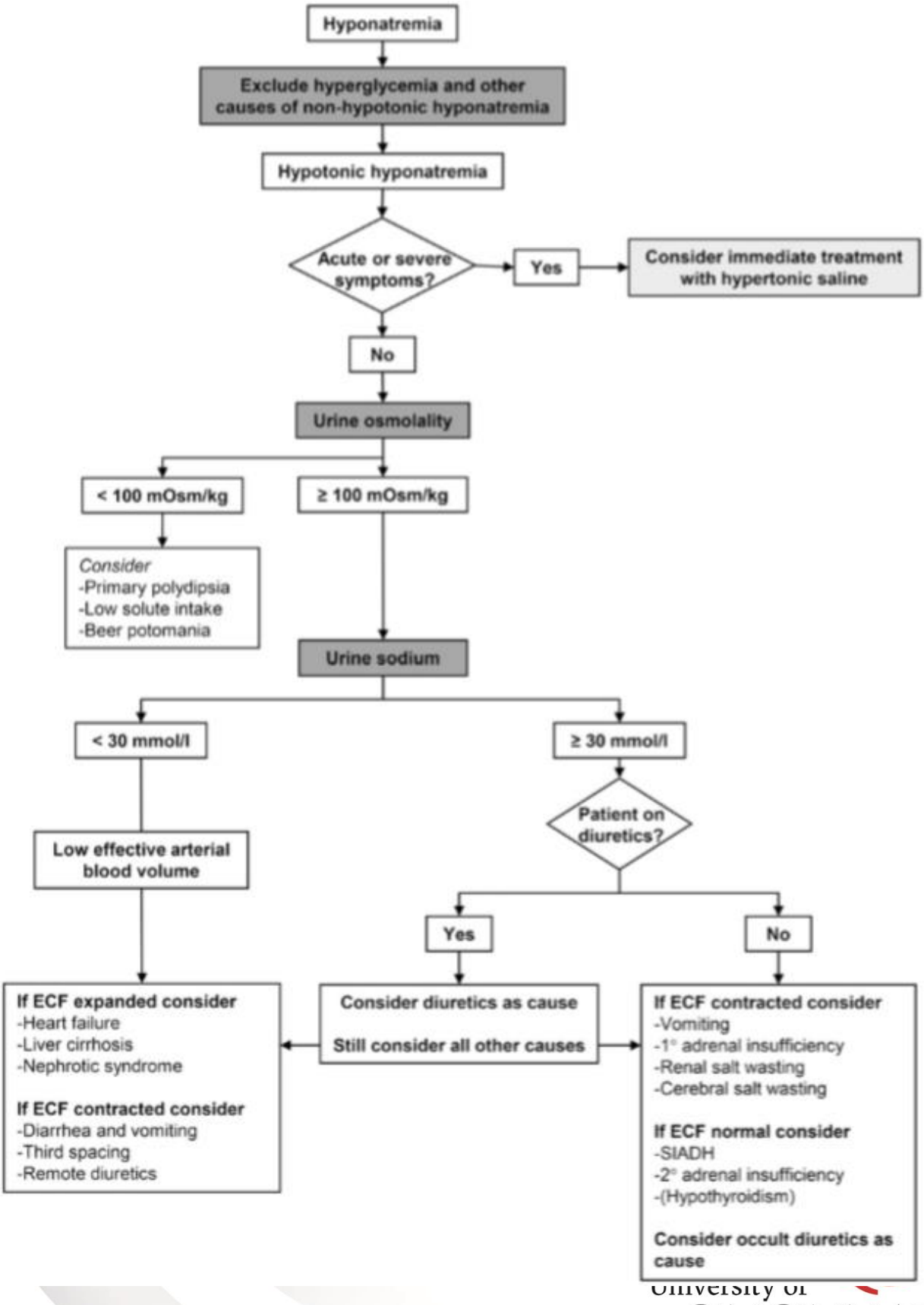

Case #1

A 60 yo male with a PMH significant for HTN and CAD presents with nausea, vomiting, and abdominal cramps for 3 days. He also reports weakness and dizziness. He has been babysitting his granddaughter who has been home from preschool with similar symptoms. Medications include ASA, metoprolol, and simvastatin.

Vitals: T 98.9, BP 98/69, P 103, RR 18, SaO2 98% on RA.
General: Appears ill
HEENT: dry mucous membranes
Cardiac: regular rhythm, normal heart sounds
Abd: Diffuse tenderness without rebound or guarding. No distension
Msk: No peripheral edema.

126 | 85 | 42 < 98 8.8 \ 16.3/ 383
3.6 | 26 | 1.6 /48.9

What type of hyponatremia is this? Why do you think this patient is hyponatremic?

What do you predict this patient's urine osmolality and urine sodium will be?

How will you treat this patient? How often will you check labs?

Is this patient at risk for cerebral edema?

Is this patient at risk for osmotic demyelination syndrome if Na is corrected too quickly?

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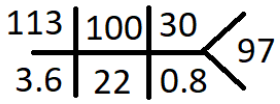
Case #2

A 68 yo man is brought in to the ED by his family for 3 days of worsening confusion and lethargy. He was brought in today because his family can hardly wake him up. He has no significant PMH, doesn't take any meds, and doesn't see any doctors. He has an 80 pack year history of smoking. His family notes that he has recently been coughing a lot, and at times coughs up blood. They also feel like he has lost a lot of weight and has had a poor appetite.

Vitals: T 98.9 BP 143/88 HR 88 RR 22 SpO2 98% on room air

HEENT: Moist mucous membranes
Cardiovascular: Regular rhythm, pulses normal, heart sounds normal
Pulmonary: Unlabored breathing. Wheezing in the right upper lobe, otherwise clear lung sounds
Abdomen: Soft, non-tender, non-distended.
Msk: No peripheral edema
Neuro: He requires physical stimuli to awaken, is oriented to self only, follows commands, but quickly becomes very drowsy without continued stimulus.



Urine osmolality 400, urine Na 32

What kind of hyponatremia does this patient have? What's on your differential?

What do you predict would happen if this patient received 1 liter of normal saline in the ED?

How do you treat this patient's hyponatremia?

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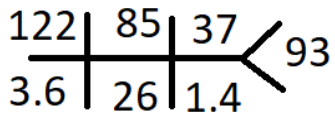
Case #3

A 65 yo male with a PMH significant for CAD s/p CABG 5 years ago presents with increasing dyspnea, fatigue, PND and edema.

Vitals BP 101/60 HR 100 RR 20 SaO2 88% on RA.
General: In no acute distress, but slightly tachypneic
Cardiac: regular rhythm, S3 present. Elevated JVD. 2+ pitting edema to mid-thigh bilaterally.
Pulmonary: Slightly tachypneic, speaks in full sentences. Bibasilar crackles
Abdomen: Soft, non-tender, non-distended.



How would you characterize this type of hyponatremia?

Why this patient is hyponatremic. What do you predict this patient's urine osmolality and urine Na to be?

What is the appropriate treatment?

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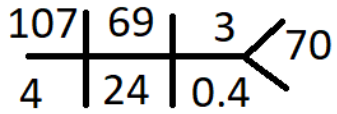
Case #4

A 52 yo male with a PMH significant for alcohol use disorder is brought in by his family because he has been confused and drowsy for the past 3 days. His family reports that the patient has had a problem with alcohol for years, and while he has had periods of sobriety, he has been drinking 30 cans of beer daily for weeks leading up to presentation. Patient reports abdominal pain, but it is difficult to get much more out of him.

Vitals: T 101.8 F BP 143/88 HR 99 RR 22 SpO2 98% on room air
General: Jaundiced. Disheveled, drowsy, malnourished
Cardiac: Regular rhythm, normal heart sounds, no edema
Pulmonary: Unlabored breathing, clear lungs
Abdomen: Soft, +hepatomegaly, right upper quadrant tenderness, non-distended
Msk: No peripheral edema
Neuro: He requires physical stimuli to awaken, is oriented to self only, follows commands, but quickly becomes very drowsy without continued stimulus.



AST 277	**WBC 14**	**urine osm 77 mosm/kg**
ALT 122	**Hgb 11**	**urine Na 15 mEq/L**
T bili 5	**Plts 113**	**Prothomrbin time 20 (normal = 12)**

What is on your differential?

How would you categorize this patient's hyponatremia? Why do you think this patient is hyponatremic?

What is the treatment for this patient's hyponatremia?

What additional treatment / workup may this patient require?

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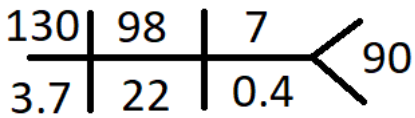
Case #5

A 61 yo female presents for follow up 2 weeks after initiation of a medication for hypertension. She has no complaints and ROS is negative.

Vitals: Temp 98F BP 115/70 HR 83 sitting, RR 18 SaO2 98% RA
Examination is unremarkable

A renal panel is obtained:



What are the symptoms of hyponatremia we should ask this patient about?

Does this patient need to be hospitalized?

What medication had you most likely prescribed this patient?

What do you think the urine Na is?

How do you treat this patient's hyponatremia?

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Sources

Adrogué, Horacio J., and Nicolaos E. Madias. "Hyponatremia." *New England Journal of Medicine* 342.21 (2000): 1581-1589.

Hoorn, Ewout J., and Robert Zietse. "Diagnosis and treatment of hyponatremia: compilation of the guidelines." *Journal of the American Society of Nephrology* 28.5 (2017): 1340-1349.