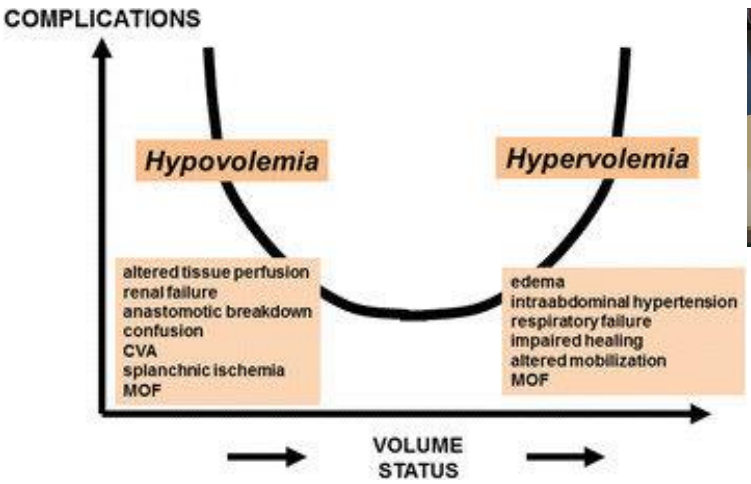
Fluids and Electrolytes

1

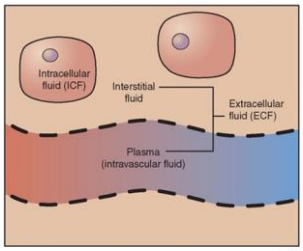
Fluid volume excess - Hypervolemia

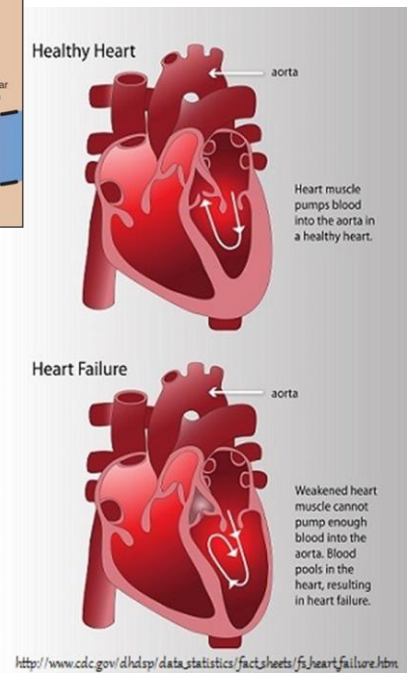


2

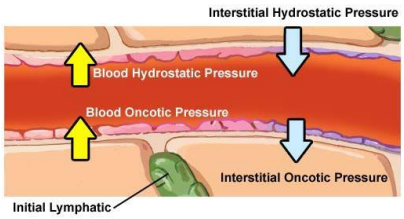
Hypervolemia

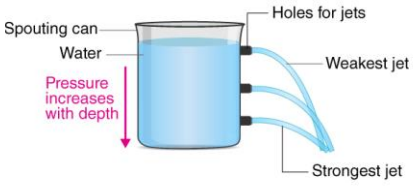
- What is Hypervolemia?
- Fluid volume excess in the vascular space
  - Also including the chambers of the heart





  - 1st hypervolemia in the ___ (interstitial space? intravascular space?)
  - then leak into the tissue, causing edema

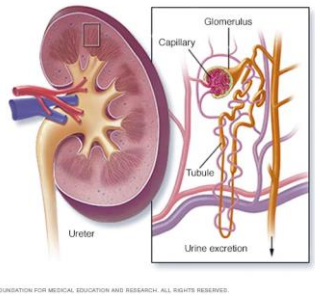




3

CONGESTIVE HEART FAILURE

- Heart is weak => ↓ Cardiac Output
- ↓ Kidney Perfusion => ↓ urinary output
  - - the volume stays/accumulates in the vascular space



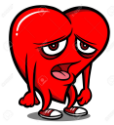
RENAL FAILURE

- ↓ urinary output
  - - the volume accumulates in the vascular space

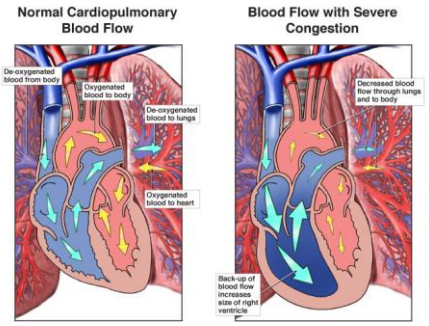
- Alka-Seltzer
- Fleet enema =>↑water retention=> ↑ volume => the volume accumulates in the vascular space
- IV fluids with sodium

4

1)How can heart failure cause hypervolemia (or fluid volume excess)?

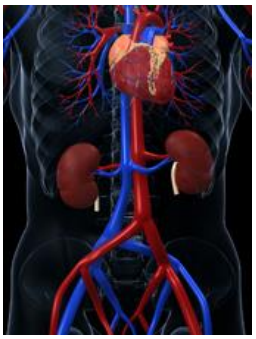


- The heart being weak = decreased cardiac output
  - which means the kidneys aren't being perfused well.
  - Decreased perfusion leads to a decreased urinary output.
  - Fluid then stays in the vascular space



2)How can renal failure cause fluid volume excess?

- If the kidneys are not working then the fluid will be retained in the vascular space



3)How can alka-seltzer and fleet enema cause hypervolemia?

- Since they both have lots of sodium, causes retention of fluid in the vascular space

5

- ALDOSTERONE

- the main mineralocorticoid hormone, is a steroid hormone produced by the zona glomerulosa of the adrenal cortex in the _____ gland.

- When blood volume gets too low → aldosterone secretion ____ (increases? Decreases?)

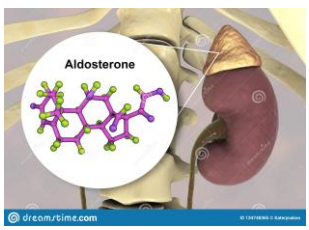
⇒Causing retention of _____ and water → blood volume _____ (increase? Decrease?)*

What is the normal action of aldosterone?

- Aldosterone causes retention of sodium and water in the vascular space

⇒Diseases with too much Aldosterone:
- ⇒ Heart diseases
- ⇒ Liver diseases
- ⇒ Cushing syndrome
- ⇒ Hyperaldosteronism / Conn's disease

*When you have questions about aldosterone, always think "sodium and water"

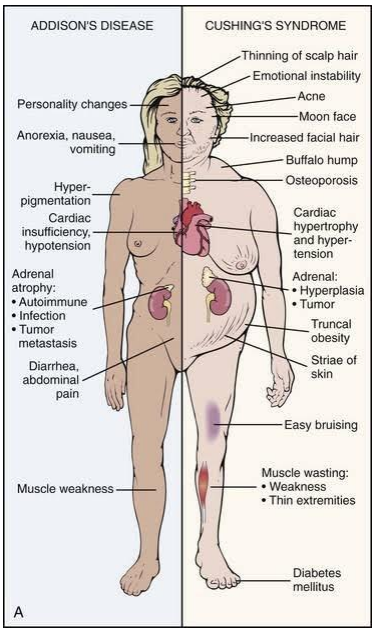


6

- If my body is producing too much aldosterone, I will retain too much _____ and _____ in the _____ space. This will cause a fluid volume _____ (deficit? excess?)

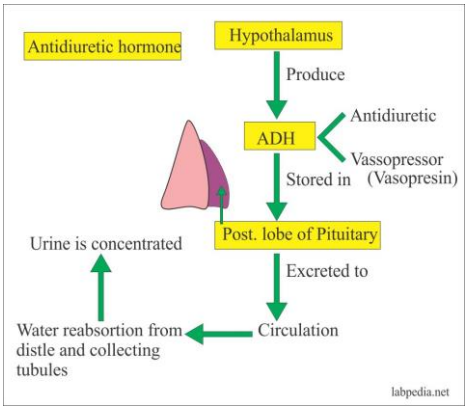
- If my body stops making enough Aldosterone I can't retain ___ and ___. I will come to a fluid volume ___ (deficit? excess?), because will be losing ___ and ___ .

- 1)What is the disease where there is insufficient production of aldosterone? _____ (Cushing? Addison's? Dartmont's?)



7

ADH (arginine vasopressin)



- Does ADH makes you to retain or diuresis?
  - what? (Sodium? Water? Both?)*
- Normal action: antidiuretic
- Where the water is retained? (tissue or vascular?)

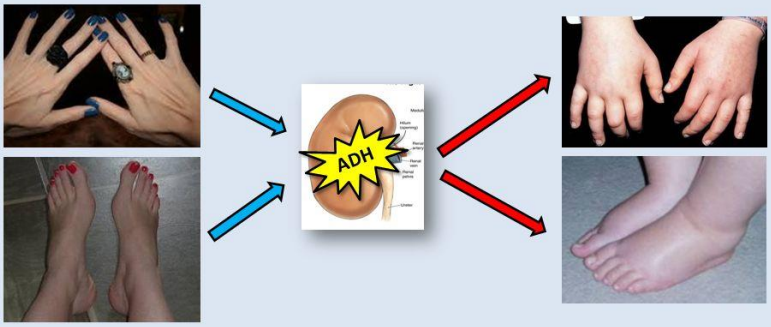
- Too much ADH => retain too much ___ in the _____
  - => this causes a fluid volume ___ (deficit? Excess?)
- (name of the disease: SIADH – Syndrome of Inappropriate ADH Secretion))

  - *When the question is about ADH, think "water"

8

The Posterior Pituitary

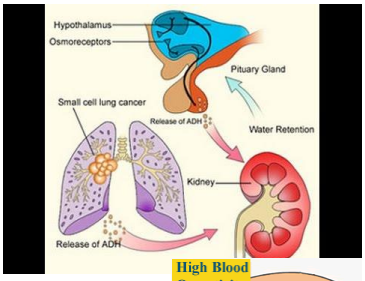
- ADH (**Antidiuretic Hormone**)
  - Regulates water concentration in the body by causing the kidneys to retain water.



  - **Negative Feedback/ Homeostasis:** When your body needs water, ADH secretes and you retain. When you have too much water, you urinate.

9

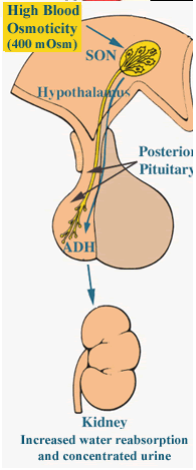
ADH (arginine vasopressin)



In general:

- The blood and the urine mirror each other
  - Ex: ↑water ingestion → more diluted urine
  - Diabetic: glycemia → glycosuria)

- In SIADH (Syndrome of inappropriate antidiuretic hormone secretion)
  - condition in which the body makes too much antidiuretic hormone (ADH)
  - Blood will be ___ (concentrated? diluted?) and the urine will be ___ (concentrated? diluted?).

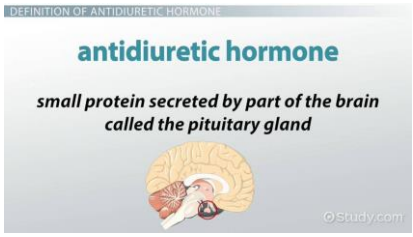


Normally when there is fluid volume excess => urine output ___ (↑ or ↓?)

In SIADH: urine output goes ___ (↑ or ↓?)

- the person has Fluid Volume Excess, but the urine output goes ___ (↑ or ↓?)
- the little urine output is ___ (diluted? concentrated?)

10



In SIADH: urine output goes ↓
- the person has Fluid Volume Excess, but the urine output goes ↓
- the little urine output is _____ (concentrated? Diluted?)

- Blood is diluted :
  - serum sodium goes___ (up or down?)

_____

Not producing enough ADH:

- can you retain water? ___
- Pt goes to Fluid Volume ___ (excess or deficit?)
- # 1 concern: _____
  - Normally, when pt bleeding and going to shock, urine output goes ___ (up or down?) – (compensatory mechanism)
- Here the patient is going to shock. How is his/her urine output?
  - But this patient, even going to shock, urine output still in large amount, diluted.
  - This pt can go to a vascular collapse
    - How can we interrupt this process? Giving ___. Why? ___
      - (Desmopressin ; oxytocin; others)
  - Urine diluted- Blood concentrated
    - Urine specific gravity: ___ (low or high?)

11

URINE SPECIFIC GRAVITY (USG)

- USG measures the concentration of particles in urine and the density of urine compared with the density of water.
- Measuring USG is an easy and convenient way to gauge a patient's hydration status as well as the functional ability of his kidneys.
- It provides a fair estimate of urine osmolality if the urine doesn't contain appreciable amounts of protein, glucose, or other large molecules such as radiocontrast media. As ordered, you may perform specific gravity testing at the patient's bedside or send a urine specimen to the lab.
- ***Who gets the test?*** Urine specific gravity measurements are indicated in many patients (*Ex:* those with alterations in fluid volume status, renal dysfunction, and certain conditions, such as diabetes insipidus.
- ***Preparing the patient.*** When a special evaluation of specific gravity is ordered separately from the urinalysis, the patient should fast for 12 hours before specimen collection. Before you obtain a routine USG (which is part of a urinalysis), certain drugs, including those that increase USG, such as carbenicillin, I.V. albumin, and I.V. dextran, may need to be discontinued.
- ***Collecting the specimen.*** Collect the urine as a "clean-catch" or midstream specimen, or follow your facility's policies and procedures. For a regular urinalysis with USG, collect about 20 mL.
- If you're testing USG *at the bedside, do it soon after collecting the urine*, following facility policy. If testing *won't be done right away, refrigerate the specimen*; a delay of more than 2 hours can cause unreliable results.

12

Possible causes of ADH inappropriate secretion :

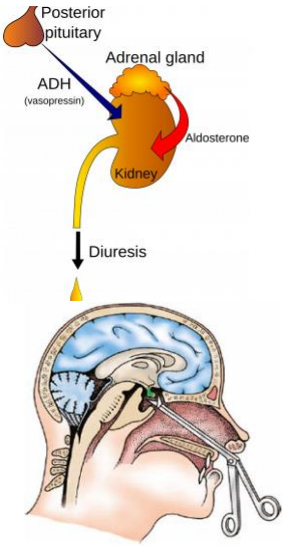
- Disorders of the brain, such as injury, infections, stroke
- Sinus surgery (Craniotomy/sinus or brain surgery in the region of the hypothalamus, head injury, pituitary tumor)

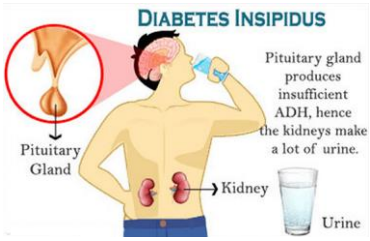
*questions with head problems and urine output data=> think ADH

- Ex: Post surgery close to the hypothalamus => check for ADH problems
  - Transsphenoidal hypophysectomy

- Central Diabetes insipidus
  - (think "diuresis" first)
  - Does this type of diabetes has to do with blood sugar?

- Lung disease, such as pneumonia, tuberculosis, cancer, chronic infections





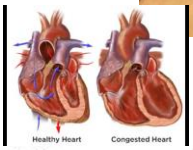
13

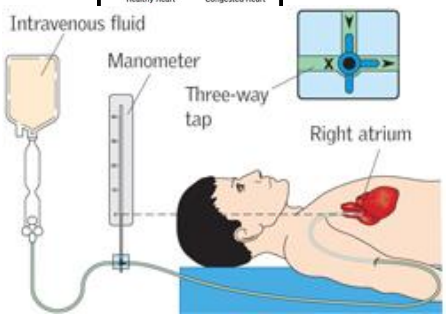
Signs and Symptoms of Excessive Fluid Volume

(EVERYTIME YOU SEE THE WORD "ASSESSMENT OR "EVALUATION" => think s/s)

Signs and Symptoms:

- Distended neck veins and peripheral veins=> because the vessels are ___.
- Peripheral edema in 3rd spacing => because vessels start to ___
- CVP => ___ (higher or lower?) – (*because "more volume"=> "more pressure")*
- Lungs sounds: adventitious, crackles/rales
  - You first hear these sounds up on low/basis of the lungs?
- Polyuria *(kidneys are trying to diurese)*
- Pulse (up or down?)
  - HR- Heart beating faster, trying to pump the excess blood forward.
  - Complication: Pulmonary edema (why?)
- Blood Pressure (up or down?) *"more volume"=> "more pressure")*
- Weight (up or down?) any acute weight gain is fluid (not fat)
  - That is why we daily weight
    - Same time, same scale, same clothes, have pt void 1st
    - If fluid retention => worry Heart problems 1st





14

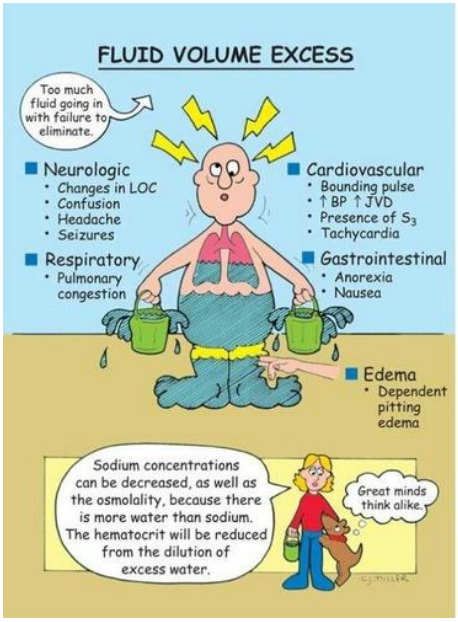
Excessive fluid volume

INTERVENTION

- Sodium restricted diet
- Diuretics
  - *ex:* loop diuretics, thiazides– check potassium (worry about hypokalemia)
  - Potassium sparing diuretic – (ex: Aldactone) (worry about hyperkalemia)
- Bed rest (induces diuresis)
  - If pt. is bedridden (supine=> higher kidney perfusion=> urine output goes ___ (UP OR DOWN?)

  - Why we worry about IMMOBILITY?
    - more diuresis=> blood thicker=> more prone to thrombosis/kidney stones/pulmonary secretion thicker (risk of pneumonia)/bowel secretions thicker (risk for constipation). Pressure ulcers., etc.
    - Encourage the pt to drink fluid (if not contraindicated)
  - Avoid hypervolemia when giving IV fluids (extreme ages → slowly)

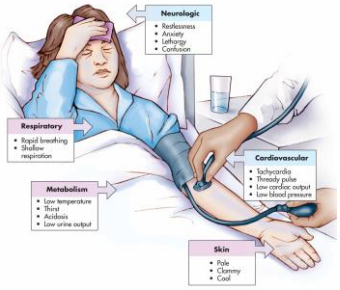
15



16

Deficient fluid volume - Hypovolemia

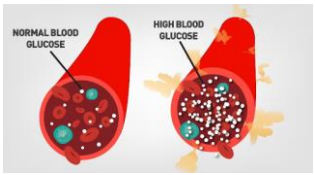
- If more severe => shock (hypovolemic shock)
- CAUSES:
  - Loss of fluid=> ↓intravascular volume (vomit, diarrhea, centesis, hemorrhage, etc.)
    - Third spacing
      - from intravascular to interstitial space/ from *functional* to *non-functional* body fluid compartments
      - Ex: ascites, burn
  - Diabetes
    - Too much particles of sugar intravascular (Hyperglycemia) -> altered *particle to water ratio* => PID (Particle Induced Diuresis/ Osmotic Diuresis) – kidneys trying to eliminate excess sugar
    - when you lose sugar particle, you also lose volume => Polyuria => shock => organs die

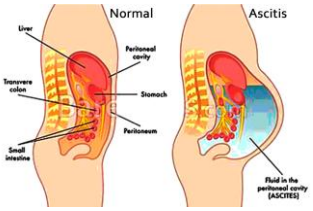


- Why diabetes leads to Polyuria?*
- How Polyuria affects intravascular volume?**
- *(Particle Induced Diarrhea/ osmotic diuresis)
- ** Polyuria can quickly deplete any given patient's intravascular volume leading to hypotension and organ hypoperfusion
  - Only 20 min for acute kidney necrosis

Reminder!

-from polyuria -> oliguria -> anuria





17

Deficient fluid volume - Hypovolemia

Signs and Symptoms:

- Weight (up or down?)
- Skin turgor (increased? decreased?)
- Mucous membrane (dry? hydrated?)
- Kidneys output (increased? decreased?) *(kidneys with low perfusion or trying to compensate)*
- Blood Pressure (increased? decreased?) *(less volume = less pressure)*
- Pulse (increased? decreased?) *(compensatory mechanism)*
  - *What kind of Pulse? (weak or strong?) (full/bounding or thready?)*
- CVP? (up or down?) *(less volume = less pressure)*
- Peripheral veins and neck veins?
  - Is it easy to start an IV on this person?
- Urine Specific Gravity? (increase or decrease?)
  - Urine concentration? (diluted urine or concentrated?)
- Extremities? (cold? warm?) *(peripheral vasoconstriction-compensatory mechanism)*

HYPOVOLEMIC SHOCK

- Which is the 1st organ to die?*
- Are the kidneys continue with polyuria?

Reminder!

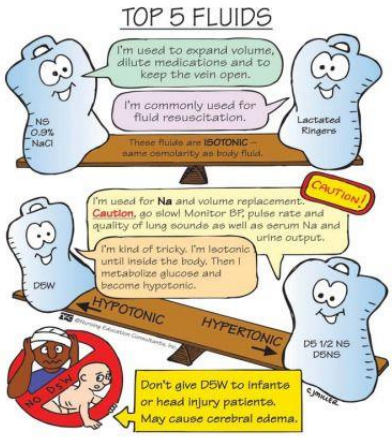
- It only takes 20 min of lack of perfusion for kidney necrosis
- Why Polyuria can lead to Oliguria and then Anuria? (compensatory mechanism)

18

Deficient fluid volume – Hypovolemia Nursing Interventions

- If MILD DEFICIT => PO fluids
- If SEVERE DEFICTIT => IV fluids

- IV Fluids => ISOTONIC
  - (go to the vascular space and stay there)=> risk of overload
    - BP ↑
  - Normal Saline, Lactated Ringer, D5W
- If I need exchange between vascular space and extravascular space => HYPOTONIC or HYPERTONIC
  - Hydrate but do not change BP

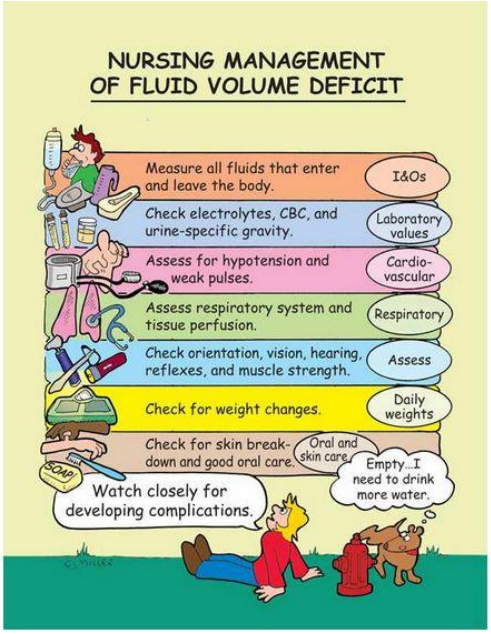


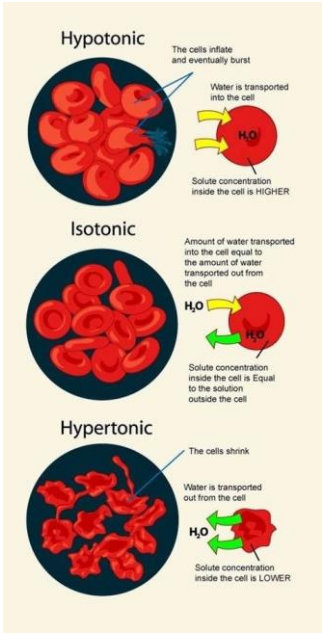
- If a dr. gives an order of an Isotonic solution for a patient whose BP is 190 x 120, you:

(a) start the infusion immediately

(b) question the order

19





20

Magnesium and Calcium

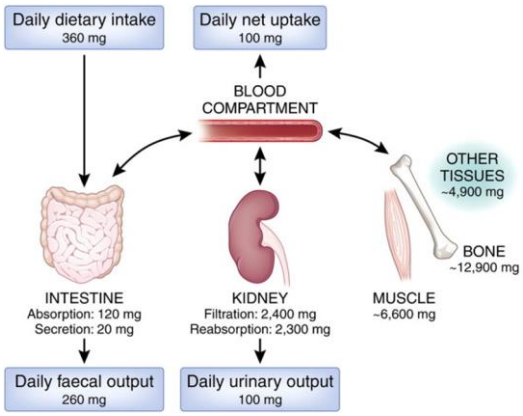
Act like a sedative- Central nervous system depressive

- Mg is excreted by the _____ and _____
  - If renal failure => Hypermagnesemia
  - Antacids (have a lot of Mg)

Signs and Symptoms of hyper magnesia and calcemia

- Mg => blood vessels dilate
  - Flushing
  - BP ↓
  - Mg => Relax muscles (decrease seizures)
    - (Mg sulfate => used when Pregnancy-Induced Hypertension (**PIH**)
- Deep tendon reflexes (↓ or ↑?)
- Muscle tone? (week or strong?)
- Can we have arrythmias?*
- LOC (↓ or ↑?)
- Pulse (↓ or ↑?)
- Respiration (Pt in mg sulfate – always check RR)

**Any Mg and Ca question => think muscles first*



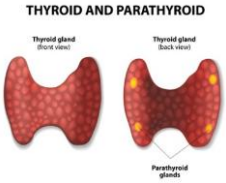
21

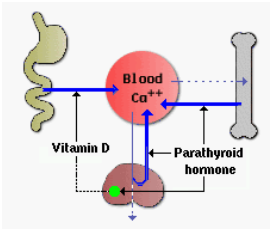
Treatment for Hypermagnesemia

- may need ventilator
- Dialysis – why?
- Ca gluconate => antidote for Mg toxicity

*Ca gluconate, in the presence of Mg, can inactivate each other

22

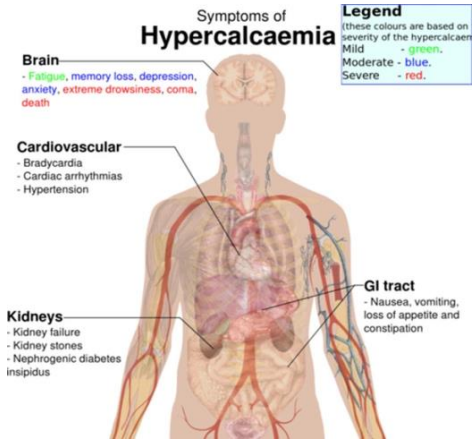




- HYPERCALCEMIA

Causes:

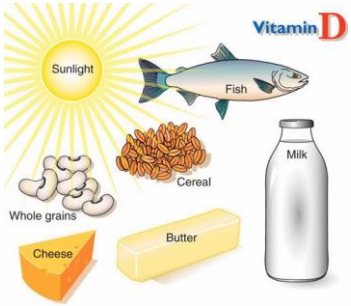
- Hyperparathyroidism (too much Parathormone -PTH) → PTH makes serum Calcium go up
  - When serum Ca↓ => PTH↑ => pulls Ca from ___ into the ___ => serum Ca goes ___.
    - PTH makes Ca goes up
- Thyazides (make retain Calcium)
- Immobilization contributes to decalcification – must bear weight to maintain Ca in the bones
  - If the person has hypercalc*emia:*
    - Bones will be _____
    - May have Kidney stones
    - s/s (remember: Ca acts like a sedative)

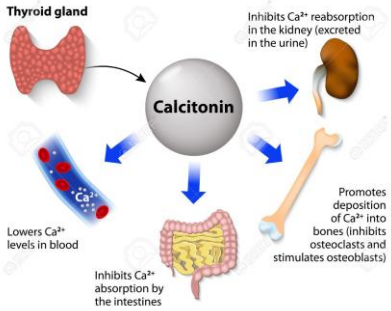


23

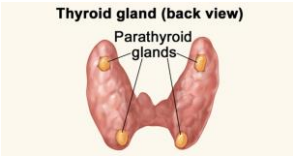
Hypercalcemia treatment

- Keep pt moving, bearing weight => Ca back to the bones
  - Avoid immobilization (Osteoporosis, Kidney stones, etc.)
- Hydrate (flush out Calcium)
  - Fluids => flush out excess, prevent stones
- Phosphate enemas => Ca react in opposite way with Phosphorus
- Diet rich in Phosphorus
- Steroids => decrease serum Ca
- Safety precocious => (sedated)
- Vit D
- Calcitonin (↓serum Ca)
  - Treat osteoporosis





24



Hypomagnesemia and Hypocalcemia
(not enough sedative)

- Diarrhea (lose a lot of Mg)
- Alcohol (suppresses ADH. Hypertonic. Less eating, more drinking => Diuresis and Mg is excreted by the kidneys)

Hypocalcemia causes:

- Not enough PTH
  - Hypoparathoidism
  - Radical neck and thyroidectomy (accidentally removal of parathyroid => not enough PTH)
- Muscles
  - Muscle tone (relaxed? Rigid and tight?)*
- Mind changes (LOC)
- Swallowing problems (when detected, worry about airway/respiration)

*risk for seizure, larynge spasm, positive Chvostek (hyperirritability), positive Trousseaus' sign, arrythmias, deep tendons reflex (hyperreflexia)**, mind changes, swallowing problems (risk for aspiration),

**Important when giving IV Mg sulfate (reflex sign detected before airway)

25

Hypomagnesia treatment

- Magnesium
  - Before administering: check kidneys
  - When administering: check airway; diuresis

If your pt is on IV magnesium sulfate and you're measuring output hourly. Hourly output is decreasing a little. Lower than before. Would you worry? Would you do 1st:

1. Reassess in 15 min
2. Call the doctor
3. Decrease the infusion
4. Stop the infusion

Think: Excessive mg acts like a ____. Excess is excreted by the ___. RR (↓ or ↑?)

NCLEX TIPS:

1 - Never delay treatment
2 - Don't call the dr. 1st if you can do something before
3 - Do not hurt

- Seizure precautions
- If patient starts with flushing and sweating → don't consider as normal

(if a drug is given in your Question, and you also have S/S → consider something abnormal is happening)

Tremor
Hyperactive deep tendon reflexes
Hyperreactivity to sensory stimuli
Muscular fibrillations
Positive Chvostek sign
Positive Trousseau signs
Carpopedal spasms progressing to tetany
Mental status changes: Irritability Disorientation Depression Psychosis
Reversible respiratory muscle failure may occur in severe hypomagnesemia

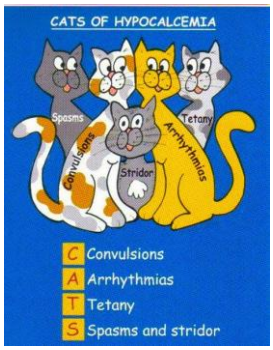
26

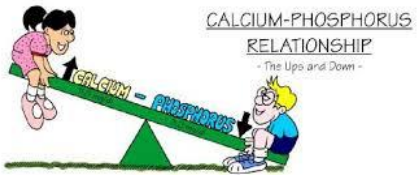
Hypocalcemia treatment

- Vit D
- Amphojel (aluminum hydroxide) → phosphorus binding (serum P goes ↓ → serum Ca goes ↑)
- IV Ca (make sure → heart monitor → can ↓ **HR** and also **widen QRS complex**)

TREATMENT

- Depends on the severity of the hypocalcemia, the rapidity with which it develops, and the accompanying complications.
- Acute, symptomatic hypocalcemia is initially managed with i/v calcium gluconate (10% w/v) 1 ampul diluted in 50 mL of 5% D or NS given over 5 min.
- Continuing hypocalcemia often requires a constant intravenous infusion (i.e. 10 ampuls of calcium gluconate in 1 L of 5% D or normal saline over 24 h).
- Accompanying hypomagnesemia, if present, should be treated with appropriate magnesium supplementation





27

Sodium

Your Na level depends on how much water (the only electrolyte that cares about water)

Reminder

Sodium and water always follow each other? (Hyponatremia, Hypernatremia, Dehydration)

Dehydration/Hypernatremia

Causes

- Hyperventilation
- Heat stroke
- Diabetes insipidus

Signs and Symptoms

- Dry mouth
- Thirsty
- Swollen tongue (severe cases - not common)
- Neuro changes* (priority) (both hyper and hypo natremia

Treatment

- Restrict sodium
- Dilute with IV fluids
- Daily weights (Na problem = fluid problem)
- Lab work
- Feeding tube tend to dehydrate

Hyponatremia (too much water) -

Causes

- vomiting and sweating (only drinking water)
- Psychogenic Polydipsia
- SIADH

Treatment

- Sodium
- If neuro problems => give hypertonic saline (ex: 3 to 5 %) (*careful)

28

Potassium

- Excreted by the kidneys

Hyperkalemia

- Causes:
  - Kidney problems
  - Aldactone
- **Signs and Symptoms**
  - Begins with muscle twitching
  - then weakness, flaccid paralysis
  - Arrythmia* (priority) (killer answer)
- **Treatment**
  - Dialysis
  - Ca gluconate (to ↓arrythmias)
  - Glucose and insulin (K and glucose into the cell)
    - IV insulin => worry about hypoglycemia and hypokalemia
  - Kayexalate (exchanges Na for K in GI tract=>inverse relationship => Na is brought ↑ => risk of dehydration)

Hypokalemia

- **Causes:**
  - Vomiting
  - NG suction
  - Diuretics
  - Not eating
- **Signs and Symptoms:**
  - Muscle cramps, weakness,
  - Arrythmias (priority)

Treatment

- Potassium (GI upset => give with food)
- Aldactone
- IV potassium
  - Assess urine output before and during giving K
  - Always IV K on a pump
  - Mix well in the bag before infusing
  - NEVER give as a push (instant death)
  - The greater the concentration, the more it burns
  - Careful with infiltration
  - Always gives with a new bag (start over again)

29