# Endocrine, Metabolic, & Nutrition

## Acid/Base

### *Definitions*

- Acidemia: low blood pH
- Alkalemia: high blood pH
- Acidosis: the process that lowers pH
- Alkalosis: the process that raises pH

### *Classifications*

| | Primary | Response | Response Mechanism |
|---|---|---|---|
| Metabolic Acidosis | ↓ HCO3 | ↓ pCO2 | Hyperventilation |
| Metabolic Alkalosis | ↑ HCO3 | ↑ pCO2 | Hypoventilation |
| Respiratory Acidosis | ↑ pCO2 | ↑ HCO3 | ↑ renal HCO3 absorption |
| Respiratory Alkalosis | ↓ pCO2 | ↓ HCO3 | ↓ renal HCO3 absorption |

- The compensatory response and primary problem are in the SAME direction
- Normal values: pH 7.4 / HCO3 24 / $pCO_2$ 40 / AG 12 +/-2 **(*Memorize!)**

### *4 Step Approach to Abnormal pH*

1. Acidemia vs Alkalemia
2. Respiratory vs Metabolic
3. Look for mixed disorder
4. In metabolic acidosis, look for anion gap (AG)

#### Acidemia vs Alkalemia

- Is the pH above or below 7.4?

#### Respiratory vs Metabolic

- Look at HCO3 and pCO2
    - ↓ HCO3 = primary metabolic acidosis
    - ↑ pCO2 = primary respiratory acidosis
    - OPPOSITE if alkalosis

### Look for Mixed-Disorder

- Focus on compensatory response
- Renal response can take 3-5 days; respiratory response immediate
- **Compensation for Respiratory (1325)**
    - Respiratory Acidosis
        - Acute: ↑ pCO2 10 = ↑ HCO3 **1**
        - Chronic: ↑ pCO2 10 = ↑ HCO3 **3**
    - Respiratory Alkalosis
        - Acute: ↓ pCO2 10 = ↓ HCO3 **2**
        - Chronic: ↓ pCO2 10 = ↓ HCO3 **5**
- **Compensation for Metabolic**
    - Metabolic Alkalosis (007)
        - ↑ HCO3 1 = ↑ pCO2 0.7
    - Metabolic Acidosis: **Rule of 15s**
        - HCO3 + 15 = pCO2 +/- 2 and last 2 digits of pH +/- 2
        - If rule is violated = mixed disorder!

### In Metabolic Acidosis, Look for Anion Gap (AG)

- Na – (HCO3 + Cl)

## *Differential Diagnoses*

- Wide Anion Gap Metabolic Acidosis: **MUDPILES**
    - **M**ethanol, **U**remia, **D**KA/AKA, **P**araldehyde, **I**soniazid, **L**actic Acidosis, **E**thylene Glycol, **S**alicylate
- Non-Gap Metabolic Acidosis: **HARDUPS**
    - **H**yperventilation (compensation), **A**cetazolamide, **R**enal tubular acidosis, ***D****iarrhea*, **U**reteral diversion, **P**ancreas, ***S****pironolactone*
    - **MOST COMMON: Diarrhea + Spironolactone!**
- Respiratory Acidosis (any cause of hypoventilation)
    - Pulmonary edema, pneumonia, obstruction
- Respiratory Alkalosis
    - Anxiety, mechanical ventilation, CNS disease
- Metabolic Alkalosis
    - Volume contraction, vomiting, diuretics

## *Pearls*

- Respiratory versus metabolic: remember compensation is same direction but switch the variable!
- Look for mixed disorder: know how to calculate compensation
- Respiratory acidosis/alkalosis: remember **1325** (acute vs chronic)
- Metabolic acidosis: remember gap or no gap and 0.7 (HCO3 by 1; CO2 by 0.7)
- Metabolic alkalosis: **rule of 15s** (HCO3 + 15 = pCO2, last 2 digits of pH)

- Know Differential Diagnosis:
    - Gap Metabolic Acidosis: MUDPILES
    - Non Gap Metabolic Acidosis: HARDUPS (*diarrhea/spironolactone)
    - Respiratory Acidosis: any cause of hypoventilation
    - Respiratory Alkalosis: anxiety, mechanical vent, CNS disease
    - Metabolic Alkalosis: volume contraction, vomiting

# Glucose Metabolism - Diabetes

### *Basics*

- Glucose Metabolism: insulin allows tissue uptake of glucose, decreases hepatic glucose production, and decreases lipolysis
- Type I Diabetes (T1DM): a deficiency of insulin
- Type II Diabetes (T2DM): the body develops resistance to insulin
- Symptoms (regardless of type): polyuria, polydipsia, weight loss, nocturia, blurry vision, yeast infection

### *Diagnosis of Diabetes*

- Fasting Blood Sugar >126 mg/dL
- Random Blood glucose >200 mg/dL WITH symptoms (e.g. polyuria/dipsia)
- Blood sugar >200 mg/dL after OGTT (oral glucose tolerance test)
- Hemoglobin A1C >6.5%

### *Type 1 DM: Insulin Deficiency*

- Who: childhood disease; bimodal peaks at 4-6 years and 10-14 years; thin; autoimmune (destruction of pancreatic beta cells); runs in families
- Initial presentation: polyuria/polydipsia or frank DKA
- Tx: insulin

### *DKA in Type 1 DM*

#### Basics

- Pathophysiology: hormones levels change in childhood → glucose excess → osmotic diuresis causing dehydration with excess urination. Increased lipolysis → increased Acetyl CoA → Acetyl CoA shunted to anaerobic metabolism → ketones produced (beta-hydroxybutyrate and acetone)
- DKA precipitants: infection, omission of insulin dose, first presentation of DM, myocardial infarction, no specific cause identified
- Symptoms: polyuria, polydipsia, weight loss, vomiting, abdominal pain, weakness, blurry vision, history “I ran out of my Insulin”
- Physical Exam: dehydration, acetone (fruity) smell, abdominal tenderness, tachycardia/hypotension/shock, altered mental status (AMS), Kussmaul respirations, coffee ground emesis
    - Coffee ground emesis: up to 9%; erosive esophagitis, hemorrhagic

gastritis; *rarely need emergent GI endoscopy for Hemorrhagic gastritis in DKA!*

## Work Up

- Fingerstick glucose, CBC, Chem panel (look at bicarb), serum pH, UA or serum ketones
- **Diagnosis of DKA:** blood glucose >250, pH <7.3, serum bicarb <18, anion gap >10, serum/urine ketones positive, beta-hydroxybutyric acid positive
- Remember to check glucose every hour and electrolytes/pH every 2-4 hours
- Other tests *to consider*: EKG, blood cultures, CXR, LFTs, lipase, CK, troponin, lumbar puncture
- VBG vs ABG: no difference in pH + ABG carries added risk of median nerve palsy and radial artery aneurysm = do VBG instead!

## Grading Severity of DKA

- Mild: pH 7.25-7.30, serum bicarb (mEq/l) 15-18, alert
- Moderate: pH 7.00-7.24, bicarb 10-15, drowsy
- Severe: pH <7.0, bicarb <10, coma = keep a CLOSE eye on these patients!

## Tx of DKA: Four Major Components

1. FLUIDS: will decrease glucose to 300 mg/dL
    a. Fluid deficit is ~100mL/kg
    b. Start with a 2L NS bolus in adults (kids: 10-20 ml/kg)
    c. Once glucose <250 change to D5 ½ NS
2. ELECTROLYTES
    a. **Potassium**: total body potassium deficit; average deficit is 3-5 mEq/kg (may see relative hyperkalemia 2/2 hydrogen-potassium pump in acidosis)
        i. EKG
        ii. *Do not treat with insulin until you know the K+ level.* If you give insulin to a patient with low K, it will drive additional K into the cell and can cause death
        iii. K <3.3: 40 mEq KCL; no insulin until K >3.3
        iv. K 3.3-5.0: 20-30 mEq KCL in each L NS
        v. K >5.0: Insulin and NS, don't need to replace K
        vi. When replacing K, replace Magnesium
    b. **Bicarbonate**: controversial; recommended by ADA for pH <7.0
        i. If patient is in severe DKA and intubated, you can consider giving bicarbonate, but there is no great evidence to support it
    c. **Magnesium*:*** depleted 2/2 osmotic diuresis, replace Mg
    d. **Sodium**: Falsely lowered in DKA
        i. Add 1.6 to measured Na+ for every glucose value of 100 over 100 mg/dL
        ii. Will correct with fluids
        iii. If high treat with ½ NS
3. INSULIN: shuts off ketogenesis
    a. Start with 0.1 units/kg/hr gtt, if glucose doesn't decrease by 50 mg/dL in first hour then double the rate (no need for initial bolus)
    b. Goal is NOT normoglycemia, but resolution of acidosis/ketosis

   c. Transition to Regular Insulin SQ when pH is >7.3
      i. Give 5 units per glucose value of 50 over 150 mg/dL (max of 20 units)
      ii. Stop the gtt 1 hour after SQ insulin administered
4. Treat the PRECIPITANT of the DKA!

### Complications of DKA Treatment

- Minimized by: glucose check q 1 hour, electrolytes 1 2-4 hours, pH q 2-4 hours, flow sheet
- Hypoglycemia (add D5 to fluids when glucose <250), Hypokalemia, Hyperglycemia, return of DKA, Hyperchloremia (change to ½ NS), and cerebral edema

Cerebral Edema

- Mortality up to 50%, 1/3 survivors in vegetative states
- Risk Factors: less than 5 yo, new onset T1DM
- Symptoms: AMS, seizures, pupillary changes
- Pathophysiology: unknown; not associated with IVF
- Treatment: *mannitol 1-2 gm/kg IV*; consider intubation/decadron/hypertonic saline

### When Are We Done Treating DKA?

- Glucose not reliable, AG better
- pH/HCO3 even better
- Serum beta-hydroxybutyric acid the best

## *Type 2 DM: Insulin Resistance*

- Who: obesity, increased cholesterol, hypertension, runs in families
- Drugs can cause glucose intolerance (e.g. glucocorticoids, anti-hypertensives)
- High risk for stroke, MI ...
- Sx: polyuria, polydipsia, weight loss, nocturia, blurry vision, yeast infections (esp. males)
- Complication:  Hyperosmolar coma
- Tx: oral diabetic medications +/- insulin
    - Exercise, weight loss, lifestyle modification can help control

## *Diabetes Medications*

### Insulin

- Many types that all have different onsets, peaks and durations of activity
- Ultra-short acting: Aspart, lispro (take right before meal, onset in 15 min, only last a couple hours)
- Long-acting: Insulin Glargine (24 hour basal state)

### Oral Medications

- Sulfonylureas
    - Stimulate pancreas to release insulin
    - *Can cause hypoglycemia*
    - Glipizide, glyburide
- Biguanides
    - Suppress hepatic gluconeogenesis (cannot cause hypoglycemia!)
    - *Can cause lactic acidosis*, GI side effects common
    - Metformin

- Thiazolidenediones (TZDs)
    - Increase sensitivity to insulin
    - Side effects include hepatitis and edema
    - Actos, Avandia

### *Hyperosmolar Coma*

- Occurs in patients with T2DM
- Similar precipitants as DKA
- pH is normal and there are essentially no ketoacids
- Severe dehydration (8-12 L) deficit
- Blood glucose very high (>1000 mg/dL)
- Sx: neurologic symptoms due to extreme dehydration from high plasma osmolality (abdominal pain rare, unlike DKA)
- Tx: fluids +/- insulin

### *Hypoglycemia*

- A complication of both T1DM and T2DM
- Causes: medications, missed meal, renal dysfunction, alcohol (suppresses hepatic
- gluconeogenesis)
- Sx: adrenergic - sweaty, shaking, personality changes, confusion, stroke mimic
- Tx: glucose! 1 amp of D50 IV, glucagon IM, or PO juice/candy

### *Pearls*

- T1DM is due to insulin deficiency and T2DM is due to insulin resistance
- Diabetic ketoacidosis (DKA) treatment includes fluids, electrolytes, insulin, and treating the precipitating factor
- In DKA, check potassium level prior to giving insulin
- Cerebral edema is a rare but important complication of DKA typically in children and is treated with mannitol
- Oral medications used in T2DM have a range of side effect profiles, including sulfonylureas, which can cause hypoglycemia
- Treat hyperosmolar coma patients aggressively with fluids

## Fluid & Electrolyte Disturbances

### *Basics*

- Body Fluid Composition: Males 60%, Females 50%, Infant 75%, Elderly 45%
- Maintenance fluid calculation = 4/2/1 rule
    - 4mL/kg for 1st 10kg
    - 2mL/kg for 2nd 10kg
    - 1mL/kg for each additional kg up to max of 120 mL/hour
    - Ex: 80kg man is 120mL/hr (40 + 20 + 60 = 120mL/hr)

### *Fluid States*

### Volume Overload

- Due to excessive fluid or salt intake, CHF, cirrhosis, nephrotic syndrome, steroids, fluid shifts (d/t iatrogenic substances such as albumin, mannitol)
- Sx: peripheral edema, anasarca, ascites, jugular venous distention (JVD), pulmonary vascular congestion, paroxysmal nocturnal dyspnea

### Dehydration

- Due to GI losses (vomiting/diarrhea), Renal (diuretics), Skin (sweating, burns), third-spacing (pancreatitis, crush injury)
- Sx: dry mucous membranes, poor skin turgor (skin tenting), muscle cramps, dizziness, increased thirst, hypotension, concentrated urine and hematocrit
    - Can lead to electrolyte abnormalities and altered mental status (AMS)

## *Electrolyte Abnormalities*

### Hyponatremia

- Na <135 mEq/L; severe if <125 mEq/L
- Relative excess of water in relation to Na
- Sx: N/V, HA, muscle weakness or cramps; can lead to lethargy, AMS, coma, seizure
- Differentiated based on fluid status:
    - Hypervolemic: CHF, cirrhosis, nephrotic syndrome, sepsis
        - Tx underlying disease, water restriction (50%), diuretics
    - Euvolemic: trauma, SIADH, hypothyroid, adrenal insufficiency (glucocorticoids)
        - Tx underlying disease, water restriction (50%)
    - Hypovolemic: vomiting, diarrhea, third spacing, diuretics, NG tubes
        - Tx with Normal Saline (NS) vs ½NS

Pseudohyponatremia

- Falsely lowered sodium
- Causes: hyperglycemia (most common), hyperlipidemia and hyperproteinemia
- Correction factor for hyperglycemia: add 1.6 to measured Na for every 100 over 100 mg/dL of glucose

Sodium Correction

- Asymptomatic + Na 120-140 mEq/L = NO EMERGENT TX
- Goal correction rate = 0.5 mEq/hr
    - *Rapid correction can result in Central Pontine Myelinolysis (CPM), a demyelinating process not limited to the pons (can be catastrophic)
- *Hypertonic saline reserved for Na <120 mEq/L + Coma/AMS/Active sz
    - 100cc 3% saline over 10 min followed by another 100cc over 50 min if needed

### Hypernatremia

- Due to unreplaced water losses, decreased water intake, or high Na intake
- Elderly patients particularly susceptible

- Sx: dehydration, lethargy, poor skin turgor, weakness, AMS
- Tx: calculate free water deficit = 0.6 x wt (kg) x [(measured Na/140)-1]
    - Provide NS if hypovolemic until euvolemic, then change to D5W vs D5½NS
    - Give 50% over first 12hrs, remainder over next 24hrs
    - Goal correction rate = 1-2 mEq/hr
    - Rapid correction can result in Cerebral Edema

### Hyperkalemia

- Most common cause: pseudohyperkalemia (lab or lab draw error) → re-send lab!
- Other causes: renal failure, metabolic acidosis, cell death, meds (succinylcholine, calcium channel blockers, beta-blockers)
- 3 categories of treatment:
    - K+ Shifters: D50 and Insulin, inhaled beta-agonist, 2 amps HCO3
    - K+ Excreters: Furosemide, Kayexalate, Hemodialysis
    - Cardioprotection: Calcium Chloride only if wide QRS
        - EKG Changes: peaked T waves → PR prolonged → lose P wave → wide QRS → Vtach/VFib

### Hypokalemia

- Due to GI losses (vomiting, diarrhea), diuretic use, poor nutrition
- Sx: cramps, weakness, arrhythmias, respiratory muscle weakness, GI muscle weakness
- EKG changes: can be almost any rhythm, *U waves are specific*
- Treatment
    - IV K+ replacement 10-20 mEq/hr (causes pain if faster)
    - Consider oral K+ (difficult to give too much)
    - Give 100mEq K+ for every 0.3 below normal serum potassium level
    - *Supplement with Magnesium

### Hypercalcemia

- Most commonly due to hyperparathyroid, also in malignancy of breast, bone, lung (osteolytic mets, PTH-related protein, Vitamin D analog production)
- Sx: Bones (bone pain), Stones (renal, biliary), Groans (abd pain, N/V), Thrones (polyuria), Psychic overtones (depression, anxiety, insomnia)
- EKG: short QT
- When to treat
    - Ca <12 = no treatment
    - Ca 12-14 = symptom based
    - Ca >14 = tx immediately
- Treatment
    - Aggressive IVF (rarely fixes problem as sole therapy)
        - 1 L up front then 200cc/hr; keep urine output at 100cc/hr
    - Calcitonin: increases excretion and inhibits osteoclasts (lowers by 1-2 mg/dL max; works in 4-6hr)
    - Bisphosphonates: inhibit osteoclast fxn, more potent, require days to work
    - Glucocorticoids: renal excretion, decreases intestinal absorption of Calcium

### Hypocalcemia

- Due to hypoparathyroid, Vit D deficiency, hyperphosphatemia, hypomagnesemia (PTH resistance), hypermagnesemia (PTH suppression), meds

- Sx: tetany (peri-oral numbness to spasm), Chvostek's sign (face), Trousseau's sign (BP), seizure, QT prolongation
- Treatment
    - IV Calcium if severe symptoms and Ca < 7.5mg/dL
    - Oral Calcium for mild symptoms and Ca >7.5mg/dL
    - Give Vit D if deficient
    - Give Magnesium if hypomagnesemic

### ***Pearls***

- Maintenance fluid: 4/2/1, max of 20
- Hyponatremia: volume problem = ⅔ treated with fluid restriction
    - goal of therapy is 0.5mEq/hr to prevent CPM
    - save hypertonic saline for Na < 120 + coma, acute AMS, seizing
- Hypernatremia
    - Calculate free water deficit (1/2 12 hours)
    - goal of therapy is 1-2 mEq/hr to prevent cerebral edema
- Hyperkalemia: treatment guided by EKG; treat with shifters, excreters, cardioprotectors
- Hypokalemia: U wave on EKG
- Hypercalcemia: bones, stones, groans, moans and psychic overtones; hydration first line of therapy
- Hypocalcemia: Trousseau's and Chvostek's signs

## ***The Nutritional Deficiencies***

### Thiamine (Vitamin B1) Deficiency

- Who: chronic alcoholics (poor dietary intake), extreme diets, poor nutrition, dialysis

Clinical Manifestations

- ***Wernicke's Encephalopathy***
    - Dx: Triad: altered mental status (most common), ataxia, ocular dysfunction (i.e. nystagmus)
        - *complete triad rare*
    - Tx: Thiamine 500mg IV, improves in hours; gets better in hours; untreated = coma/death
- ***Korsakoff's Psychosis*** – late manifestation of Wernicke's
    - Dx: memory loss (usually short term), irreversible
- ***"Wet" Beriberi***
    - Chronic thiamine deficiency
    - Vasodilation/fistula formation → dependent edema/signs of CHF → high output failure
    - Tx: Thiamine 100mg IV

### Niacin (Vitamin B3)

- Who: lack of dietary niacin (leafy greens, fish), carcinoid syndrome
- Pellagra ("Sour skin")
    - **The 4 D's: *Diarrhea***, ***Dermatitis*** (symmetric, scaling, photosensitive),

***Dementia***, ***Death*** (eventually)

### Cobalamin (Vitamin B12)

- General: in animal products; stored in our liver; must be able to absorb from gut; deficiency takes years
- Who: low GI absorption (Crohn's), inadequate intake (vegans, alcoholics, elderly), meds (*PPI's*), genetic
- Diagnosis
    - Oval macrocytic RBCs/hypersegmented neutrophils; can progress to pancytopenia
    - Labs: low B12 level, serum and bone marrow aspiration
    - ***Neuro symptoms** (gradual, symmetric, range from paresthesias to clonus); Psychiatric (memory loss, psychosis, depression)
    - ****Pernicious Anemia**: antibody to intrinsic factor → cannot absorb B12
- Tx: parenteral B12 with taper, high B12 diet

### Folic Acid

- General: animal products, green veggies (leafy, fruits, grains), fortified foods in US; deficiency takes months
- Who: poor diets, alcoholics, elderly, infants (fed with goat's milk), drugs *(**phenytoin*)
- Clinical: similar to B12 **(megaloblastic anemia) but <u>NO NEURO CHANGES</u>**
- Dx: serum folate; tricky to diagnose with serum folate level (affected by diet) → treat clinically
- Tx: Oral folic acid (daily x 1-4 mon)

### Vitamin D

- General: facilitates calcium absorption from gut
- Who: dark skinned, lack of sunlight, inadequate intake (fish, egg), exclusively breast fed babies
- Presentation depends on age
    - **Children: Rickets**
        - Bow legs, poor mineralization → stunted growth
    - **Adults: Osteomalacia**
        - Bone/muscle pain, normal height
- Tx: sunlight, diet supplement, PO Vit D, symptom support (bracing, surgery)

### Vitamin C (Scurvy)

- General: works in collagen formation → rough/bloody skin, gum dz, poor wound healing
- Nutritional deficiency

## *The Vitamin Toxicities*

General: Four vitamins cause excess syndromes: A, D, E, K **("remember the attic/ADEK")**

### Vitamin A

- Beta-carotene is provitamin A → excess not toxic → orange skin
- Acute toxicity (large single dose; beware polar bear liver): N/V, vertigo, blurry vision
- Chronic toxicity: ataxia, visual impairment, hair loss

### Vitamin D

- Excess results in *Hypercalcemia*
- Presentation**: Bones** (pain), **Stones** (renal/biliary), **Groans** (Abd pain, N/V), **Thrones** (Polyuria or "porcelain throne"), **Psychic Overtones** (Depression, anxiety, insomnia)
- EKG: shortened QT
- Tx: IVF, Bisphosphonates

***Pearls***

- Thiamine/Vitamin B1 deficiency can range from Wernicke's encephalopathy (reversible) and Korsakoff's psychosis (irreversible memory loss) to "wet beriberi" (high output failure)
- Pellagra is caused by Niacin/Vitamin B3 deficiency and consists of the 4D's (Diarrhea, Dermatitis, Dementia, Death)
- Cobalamin/Vitamin B12 and Folic Acid deficiency both present with megaloblastic anemia, but are differentiated by neuro symptoms (Neuro Sx: B12; Non-focal neuro: Folic Acid)
- Vitamin D deficiency can present differently based on age (Kids = rickets, Adults = osteomalacia)
- Vitamin C deficiency causes scurvy (pirates)
- Important vitamin toxicities include Vitamin A (causes vertigo/ataxia) and Vitamin D (causes hypercalcemia)

# Pituitary and Adrenal Disease

# The Pituitary

## *Basics*

- Major hormone control center located in bony sella turcica
- Connected to hypothalamus
- Divided into anterior/posterior sections
- ****Hormones nnemonic: GOAT FLAP** (letter on each knuckle, and "rock on" 1st fist to show posterior pit hormones)
    - **G**rowth Hormone
    - ***O**xytocin (posterior)*
    - ***A**ntidiuretic Hormone (posterior)*
    - **T**SH
    - **F**SH
    - **L**H
    - **A**CTH
    - **P**rolactin
- Hormonal feedback loop: pituitary (pit) sends hormones to target organs → target organs release affect hormones → affect hormones feedback on pit to decrease production

## *Hypopituitarism*

- General: usually hormones from **anterior lobe**
- Panhypopituitarism = all hormones out
- Causes: mass lesions, bleeds (pit apoplexy), hypothalamic dz, Sheehan's (postpartum)
- Dx: check hormones levels!
    - Labs tests: **ACTH (morning serum cortisol), TSH (& free T4), Gonadotropins, GH, Prolactin** (+/- reliable)
- Tx: Hormone replacement (same tx for all deficiencies)

### ACTH Deficiency

- Secondary adrenal insufficiency
- How: low cortisol → low vascular tone
- Sx: malaise, anorexia, weight loss, pale complexion
- Aldosterone (mineralocorticoid) are NORMAL

### TSH Deficiency

- Sx: general **"slowing"** of body → bradycardia, slow DTRs, hair loss, cold intolerance
- Results in low thyroid hormone

### Gonadotropin Deficiency

- Women: irregular periods, amenorrhea, decreased libido, vaginal dryness
- Men: decreased libido, erectile dysfunction, testes atrophy

### GH Deficiency

- Adults: usually asymptomatic; sx can be fatigue, decreased exercise tolerance, abdominal obesity, decreased muscle mass
- Kids: stunted growth

### Prolactin Deficiency

- Inability to lactate postpartum (can be only sx of Sheehan's syndrome)

## *Pituitary Tumors*

- Microadenoma (<1cm) vs macroadenoma (>1cm)
- Presentation: suspect based on mass effect → **visual field deficits, HA, hormonal sx**
- Dx: imaging (microadenomas harder to see), check all hormone levels
- Tx: transsphenoidal surgery; Gamma knife surgery
    - **** If Prolactinoma: medical treatment with Bromocriptine**

### Prolactinomas

- Usually  microadenomas
- Dx: Prolactin > 200 (level correlates with tumor size)
- MEDICAL MANAGEMENT (Bromocriptine)

### ACTH Tumors

- Cushing's syndrome
- Usually  microadenomas
- Tx: first line = surgery, if unsuccessful = medical
- Presentation: weight gain, truncal obesity, buffalo hump, moon face, excess sweating,

striae, hirsutism, insomnia

### GH Tumors

- Can be macroadenomas
- Presentation: **HA, visual field cuts** (tunnel vision)
- Dx: high GH and Insulin-like GF I (IGF-1)
- Usually recognized later in life ("Andre the Giant" - acaromegaly)
- Tx: surgical is first line

# Adrenal Glands

- General: located atop kidneys
- Medulla produces epinephrine & norepinephrine
- Cortex produces cortisol, androgens & aldosterone

## *Excess Cortisol*

- Etiology
  - **Exogenous** (Glucocorticoid use; most common cause)
  - Secondary (increased ACTH)
  - Primary (increased cortisol production)
- **"CUSHING" Mnemonic**: **C**entral Obesity/Collagen weakness, **U**rinary free cortisol elevated, **S**triae, **H**TN/hyperglycemia/hirsutism, **I**atrogenic, **N**eoplasms, **G**lucose Intolerance

## *Adrenal Insufficiency*

- Etiologies
  - Primary (Addison's, Congenital Adrenal Hyperplasia)
  - Secondary (pituitary, decreased ACTH)
  - Tertiary (hypothalamic dz, decreased corticotropin releasing factor)
- Presentations
  - **Primary**
    - Acute: **Shock**, Abdominal Pain, Fever (atypical; look for infection), Hypoglycemia, **Hyperpigmentation** (buccal)
    - Chronic: fatigue, weight loss
  - **Secondary/Tertiary**: Hyponatremia, Hypoglycemia (more common); no hyperpigmentation (no elevated ACTH); less hypotension; less common: hypotension, GI symptoms; NO hyperpigmentation
- Tx: Aggressive supportive care, IVF, Glucocorticoids, Vasopressors

## *Adrenal Cortex Tumors*

- General: most are benign (adenomas); usually incidental finding; 15% functional → Cushing's like syndrome

## *Adrenal Medulla Tumors*

- **Neuroblastoma**: **Pediatric** (2 years)
  - Presentation: **mass in abdomen, HTN**
  - Produces catecholamines
- **Pheochromocytoma**: all ages, part of MEN syndrome

- Presentation: **High blood pressure, headache, palpitations**
- Dx: 24 hr urinary catecholamine metabolites

### *Pearls*

- Remember the Pituitary hormones = GOATFLAP
- Pituitary tumors can present with only visual symptoms, but when you suspect it check imaging and all hormone levels
- Prolactinomas are the only pituitary tumors treated medically; all others are initially treated surgically
- Adrenal excess causes Cushing's, regardless of the cause
- Adrenal Insufficiency is always treated supportively (IVFs, glucocorticoids, vasopressors)
- Remember the adrenal medulla tumors: Neuroblastoma (kid, abdominal mass, HTN) and Pheochromocytoma (BP, HA, palpitations)

# Thyroid Disorders & Parathyroid Disease

## *General*

- TSH acts on thyroid gland to release inactive form of T4 (95%), and T3 (5%)
- In blood, 99% of thyroid hormone is bound to thyroid binding globulin (TBG), prealbumin and albumin
- T4 is converted to T3 in peripheral tissues
- Feedback loop: hypothalamus releases TRH → stimulates pituitary to release TSH → stimulates thyroid gland to release thyroid hormone → feedback when enough

### T3 Function

- Metabolism: increases glucose absorption from GI tract; catabolic effect on muscle mass
- Cardiovascular and respiratory: increases CO and RR; increases catecholamine levels
- BMR: increases oxygen consumption

## *Hyperthyroidism*

- **Thyrotoxicosis**: any condition that results in excessive thyroid hormone (includes entire spectrum of disease: Graves, toxic goiter, thyroiditis, med ingestion)
- **Hyperthyroidism**: hyper-functioning of thyroid gland itself
  - Graves in young
  - Toxic nodular goiter in elderly
- Causes
  - Graves (autoimmune, F>M)
  - Nodular goiter (elderly)
  - Iodine-induced (excessive intake, amiodarone use)
  - Thyroiditis
- Symptoms: anxiety, emotional lability, weight loss, weakness, tremor, palpitations, heat intolerance, perspiration, oligomenorrhea
- Exam: hyperactivity, rapid speech, warm moist skin, thin hair, tachycardia/A-fib, tremor, hyperreflexia, goiter, exophthalmos
  - Graves: proptosis, pre-tibial myxedema, lid lag

    - Thyroid size does not correlate to disease severity
- Labs: Low TSH, increased free T3/T4
- Treatment: 4-step approach
    - Anti-hormone Therapy
        - Propylthiouracil (PTU)/Methimazole: *1st med to give*; blocks new hormone synthesis
        - Iodides: SSKI; 2nd med, *must be given after PTU*; blocks release of preformed hormone
    - Blunt the Systemic Effects
        - Beta-blocker: often propranolol → decreases HR, BP, cardiac work
        - Glucocorticoids: prevent peripheral conversion of T4 to T3
    - Treat Precipitant
    - Prevent Decompensation
        - Aggressive IV fluids, w/ dextrose containing solution
        - Tylenol (*avoid NSAIDs*)
        - Cool w/ blankets or ice packs

## *Hypothyroidism*

- More common than hyperthyroidism
- Causes: almost all primary (rarely d/t lack of TSH)
    - Painless
        - Hashimoto's: almost all cases in US; autoimmune; chronic
        - Medication-related
        - Postpartum
        - Iodine deficiency: most common cause worldwide
    - Painful
        - Subacute thyroiditis: de Quervain's; pain may radiate to ear; viral and self-limited
        - Infectious: bacterial; fever, chills, dysphagia; antibiotics
- Symptoms: fatigue, somnolence, "feel slow", weight gain, cold intolerance, pale/cool/dry skin, coarse hair, brittle nails, constipation
- Exam: periorbital edema, bradycardia and decreased cardiac output, low body temps, slow DTRs, hypertension, non-pitting edema
- Labs: high TSH, low free T3/T4, anemia
- Treatment
    - Thyroid hormone replacement (Synthroid = T4: lower threshold to start if elderly or pregnant)
    - Iodine

## *Thyroid Nodules*

- Much more common than hormonal disorders
- More common in women
- Smoking is a risk factor
- Most are asymptomatic
- Refer for FNA
- Less than 5% are cancerous, most cancers are papillary type (non-aggressive)

## *Thyroid Tumors*

- Very common CA but low mortality
- Starts as a nodule
- On the rise due to radiation
- Many types (papillary, follicular)
- Treatment
    - Surgery: thyroidectomy vs lobectomy
    - Radioactive Iodine-131: may occur post surgery for residual tissue
    - All will need thyroid supplementation

### *Pearls*

- Thyrotoxicosis is any condition resulting from excessive thyroid hormone, regardless of cause (versus hyperthyroidism which is only hyper-functioning of the gland itself)
- Treatment of hyperthyroidism should be a 4-step approach: 1) give anti-hormone therapy, 2) blunt the systemic effects, 3) treat the precipitant, and 4) prevent decompensation
- Hyperthyroid: tremor, tachy, sweaty, weight loss
- Thyroid storm is a real emergency
- Hypothyroidism usually either Hashimoto's or iatrogenic
- Hypothyroid: cool, dry, lethargic, weight gain

## *Hyperparathyroidism*

- General
    - Overactive parathyroid glands
    - Females > males
    - PTH hormone increases Ca absorption
    - Elevated calcium on routine blood tests
    - Diagnose by elevated PTH
- Symptoms
    - Bones (boney pain)
    - Stones (renal, biliary)
    - Groans (abdominal pain, nausea/vomiting)
    - Thrones ("porcelain throne," i.e. polyuria)
    - Psychic overtones (depression, anxiety, insomnia)
    - Short QT on EKG
- Treatment
    - Most pts will need surgery, but for emergency physicians the main point is to decrease Ca
    - Need for tx depends on Ca level, so know these numbers
        - <12 never treat
        - 12-14 treat if symptomatic
        - >14 treat immediately even if asymptomatic
    - Initial treatment: hydration
        - Aggressive IVF: 1L normal saline up front, then 200cc/hr (goal is urine output >100cc/hr); rarely fixes problem as sole therapy
    - +/- diuretics
    - Later treatment that will actually fix the problem
        - Calcitonin: increases renal Ca excretion and inhibits osteoclasts; lowers Ca by 1-2mg/dL in 4-6hr; given SQ or IM

    - Bisphosphonates: directly inhibit osteoclast function; very potent, but takes a few days to work
    - Steroids: increase urinary excretion and decreases GI uptake

### *Hypoparathyroidism*

- General
    - Not enough PTH
    - Blood calcium levels fall
    - Blood phosphorus levels rise
- Etiology
    - Often a result of thyroid surgery
    - DiGeorge syndrome: born without parathyroid glands
- Symptoms
    - Lethargy, muscle cramps, tetany, brittle nails, weakened tooth enamel, tingling lips/fingers/toes, seizures
    - *Pathognomonic signs*: Chvostek sign (tapping facial nerve causes facial spasm), Trousseau sign (extremity spasm distal to BP cuff)
- Treatment: replace Ca, vitamin D

### *Pearls*

- Think of parathyroid disease in terms of CALCIUM → Hyperparathyroid causes Hypercalcemia; Hypoparathyroid causes Hypocalcemia
- Aggressive IVF in early tx of hyperparathyroidism, especially with Calcium >14mg/dL