Endocrine and Metabolic Disorders

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Metabolic Syndrome

• Diagnosis requires at least three of the following
  – Fasting plasma glucose level $\geq 110$ mg/dL
  – Abdominal obesity (waist girth $>40$ inches in men, 35 inches in women)
  – Serum triglyceride level $\geq 150$ mg/dL
  – Serum high-density lipoprotein cholesterol level $<40$ mg/dL in men, $<50$ mg/dL in women
  – Blood pressure $\geq 130/85$ mmHg
Insulin Preparations

- Onset Peak Duration
- SHORT ACTING
  - Human regular 30 min 2-4 hr 5-8 hr
  - Lispro (Humalog) 10-15 min 1-2 hr 3-6 hr
  - Aspart (NovoLog) 10-15 min 1-2 hr 3-6 hr
- INTERMEDIATE
  - Human NPH 1-2 hr 6-10 hr
  - 10-20 hr
  - Lente 1-2 hr 6-10 hr
  - 10-20 hr
- LONG ACTING
  - Ultralente 4-6 hr 8-20 hr
  - 24-48 hr
  - Glargine (Lantus) 1-2 hr
  - – no peak 24 hr
Diabetic Ketoacidosis (DKA)

- Serum glucose level (mg/dL) ≥300
- pH ≤7.3
- $\text{HCO}_3^-$ (mEq/L) ≤18
- Serum osmolarity (mOsm/L) <320
- Moderate to high levels of serum and urine ketone
Treatment of DKA

• Large amounts of normal saline and effective doses of insulin
• Initiate IV loading dose of 0.1 unit/kg of regular insulin plus a low-dose insulin infusion of 0.1 unit/kg/hr
• Insulin administration must be continued until a normal acid-base status is achieved. The insulin rate is reduced when hyperglycemia is controlled, the blood pH is higher than 7.3, and bicarbonate level is more than 18 mEq/L.
• Potassium, phosphate, Mg replacement
• Sodium replacement necessary – if fail to replace, cerebral edema
• NaHCO₃ if pH < 7.1
• Overall mortality 5-10%
Hyperosmolar Hyperglycemic State (HHS)

- Glucose level ≥600 mg/dL
- pH ≥7.3
- HCO$_3$ ≥15 mEq/L
- Serum osmolarity ≥350 mOsm/L
Treatment of HHS

- Significant fluid resuscitation, insulin administration, and electrolyte supplementation.
- If plasma osmolarity >320 mOsm/L, large volumes of hypotonic saline (1000 to 1500 mL/hr) should be administered until the osmolarity is less than 320 mOsm/L, at which time large volumes of isotonic saline (1000 to 1500 mL/hr) can be given.
- Insulin therapy – IV bolus of 15 units of regular insulin followed by a 0.1 unit/kg/hr infusion
- Insulin infusion is decreased to 2-3 units/hr when the glucose level decreases to approximately 250-300 mg/dL
- Electrolyte deficits are significant but usually less severe than in DKA
- Overall mortality rate in 10-15%
Diabetic Autonomic Neuropathy

• Damaged vasoconstrictor fibers, impaired baroreceptor function, and ineffective cardiovascular reactivity
• CVS – resting tachycardia and loss of heart rate variability during deep breathing, systolic and diastolic dysfunction with a reduced ejection fraction. Dysrhythmias may be responsible for sudden death. In advanced stages, severe orthostatic hypotension.
• GI – impaired gastric secretion and gastric motility, eventually causing gastroparesis
• RS – altered respiratory reflexes and impaired ventilatory responses to hypoxia and hypercapnia
Intraoperative Management

- Patient on subcutaneous insulin each night – two thirds of this dose (NPH and regular) should be administered the night before surgery, and one half of the usual morning NPH dose should be given on the day of surgery.
- Daily morning dose of regular insulin should be held.
- If the patient uses an insulin pump, the overnight rate should be decreased by 30%. On the morning of surgery, the pump can be kept infusing at the basal rate or discontinued and replaced with a continuous insulin infusion at the same rate; alternatively, the patient can be given subcutaneous glargine and the pump discontinued 60-90 min after administration.
- If the patient uses glargine and lispro or aspart for daily glycemic control, the patient should take two thirds of the glargine dose and the entire lispro or aspart dose the night before surgery and hold all morning dosing.
- Oral hypoglycemics should be discontinued 24-48 hrs preoperatively. Avoid sulfonylureas because they block the myocardial potassium ATP channels that are responsible for ischemia- and anesthetic-induced preconditioning.
# Thyroid Disease

<table>
<thead>
<tr>
<th>Physiologic state</th>
<th>Serum TSH</th>
<th>Serum Free T4</th>
<th>Serum T3</th>
<th>24-h radioiodine uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperthyroidism, untreated</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Hyperthyroidism, T3 toxicosis</td>
<td>Low</td>
<td>Normal</td>
<td>High</td>
<td>Normal or High</td>
</tr>
<tr>
<td>Primary Hypothyroidism, untreated</td>
<td>High</td>
<td>Low</td>
<td>Low or Normal</td>
<td>Low or Normal</td>
</tr>
<tr>
<td>Hypothyroidism secondary to pituitary disease</td>
<td>Low or Normal</td>
<td>Low</td>
<td>Low or Normal</td>
<td>Low or Normal</td>
</tr>
<tr>
<td>Euthyroid, on exogenous thyroid hormone</td>
<td>Normal</td>
<td>Normal on T4, Low on T3</td>
<td>High on T3, Normal on T4</td>
<td>Low</td>
</tr>
</tbody>
</table>
Thyroid Function Tests

- Free T4 or Free T3 superior to Total T4/T3 – independent of TBG levels
- T3 resin uptake – indirectly measures amount of unoccupied thyroid binding globulin (TBG sites). Test is performed by adding radiolabelled T3 (T3*) and resin to serum. T3 binds to TBG binding sites unoccupied by endogenous T3.
- Any T3* that does not attach to TBG is taken up by resin. Thus, T3* resin uptake is inversely proportional to TBG free binding sites
- T3*RU is high if T4 or T3 levels are high (e.g., hyperthyroidism) or TBG levels are low
- T3*RU low if T4 or T3 levels are low (e.g., hypothyroidism) or TBG levels are high
- Thyroid disease (e.g., hyper- or hypothyroidism) is likely if both T4 and T3RU are either both high or both low (i.e., if they vary concordantly). Abnormalities in TBG are likely if one is high and the other low (i.e., if they vary discordantly).
- Free T4 Index (FT4I) = Total T4 x DRU
Thyroid Storm

• Extreme anxiety, fever, tachycardia, CV instability, altered consciousness

• Shift from protein-bound thyroid hormone to free hormone secondary to circulating inhibitors to binding.

• Rx – IV glucose containing crystalloids, cooling measures, propranolol, labetalol, esmolol titrated to HR < 90, Dexamethasone 2 mg IV Q 6hrs, or cortisol 100-200 mg IV Q 8 hrs, PTU 200-400 mg Q 8 hrs PO/PR/Via NG. if circulatory shock- vasopressors, BB or digitalis for AFib

• Usually hormone levels returns to normal in 24-48 hrs, recovery within 1 week

• ASA- C/I- displaces thyroid hormone from binding sites – increase free hormone-exacerbate symptoms.

• High mortality – 20%
Myxedema Coma

• Elderly women with long standing h/o hypothyroidism: Delirium, unconsciousness, hypoventilation, hypothermia (80°F – cardinal feature, due to impaired thermoregulation from defective hypothalamic function), bradycardia, hypotension, severe dilutional hyponatremia
• Medical emergency – mortality rate >50%
• IV thyroxine 300-500 mcg loading dose, maintenance 50-200 mcg/day or L-triiodothyronine 25-50 mcg loading followed by infusion (more rapid onset – preferred)
• IV hydration with glucose containing saline, electrolyte balance, temp regulation, stabilization of cardiac and pulmonary systems, mechanical ventilation, IV hydrocortisone 100-300 mg/day to treat AI – common after hypothyroidism.
Pheochromocytoma

- Paroxysmal HTN, tachycardia, sweating, pallor, catecholamine induced CMP/CHF, stroke, MI, acute renal failure
- Diagnosis: plasma free metanephrines (most reliable), plasma catecholamines, plasma chromagranin A, total Urinary catecholamines, Urinary metanephrine, urine VMA
- Clonidine suppression test – clonidine lowers plasma catecholamines in pt with essential HTN but not in pheo.
- MRI, CT, scintigraphy with MIBG
Pheochromocytoma

- Preop treatment: Alpha blockade (phenoxybenzamine/prazocin) – protect myocardial performance and tissue oxygenation from adverse catecholamine effects. After adequate alpha blockade, beta blocker to control tachycardia.

- Metyrosine – inhibits rate limiting enzyme tyrosine hydroxylase, decrease catecholamine production by 50-80%
## Adrenal Insufficiency

<table>
<thead>
<tr>
<th>Steroid</th>
<th>Antiinflammatory (glucocorticoid)</th>
<th>Na⁺ retention (mineralocorticoid)</th>
<th>Equivalent dose (oral or IV, mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SHORT ACTING</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cortisol (hydrocortisone)</td>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Cortisone</td>
<td>0.8</td>
<td>0.8</td>
<td>25</td>
</tr>
<tr>
<td><strong>INTERMEDIATE ACTING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prednisone</td>
<td>4</td>
<td>0.8</td>
<td>5</td>
</tr>
<tr>
<td>Prednisolone</td>
<td>4</td>
<td>0.8</td>
<td>5</td>
</tr>
<tr>
<td>Methylprednisolone</td>
<td>5</td>
<td>0.5</td>
<td>4</td>
</tr>
<tr>
<td>Triamcinolone</td>
<td>5</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td><strong>LONG ACTING</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dexamethasone</td>
<td>30-40</td>
<td>0</td>
<td>0.75</td>
</tr>
</tbody>
</table>

# Hyperparathyroidism/Hypercalcemia

<table>
<thead>
<tr>
<th>Organ system</th>
<th>Signs and symptoms</th>
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</thead>
<tbody>
<tr>
<td>Neuromuscular</td>
<td>Skeletal muscle weakness</td>
</tr>
<tr>
<td>Renal</td>
<td>Polyuria and polydipsia</td>
</tr>
<tr>
<td></td>
<td>Decreased glomerular filtration rate</td>
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<tr>
<td></td>
<td>Kidney stones</td>
</tr>
<tr>
<td>Hematopoietic</td>
<td>Anemia</td>
</tr>
<tr>
<td>Cardiac</td>
<td>Prolonged PR interval</td>
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<tr>
<td></td>
<td>Shortened QT interval</td>
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<tr>
<td></td>
<td>Systemic hypertension</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Vomiting</td>
</tr>
<tr>
<td></td>
<td>Abdominal pain</td>
</tr>
<tr>
<td></td>
<td>Peptic ulcer</td>
</tr>
<tr>
<td></td>
<td>Pancreatitis</td>
</tr>
<tr>
<td>Skeletal</td>
<td>Skeletal demineralization</td>
</tr>
<tr>
<td></td>
<td>Collapse of vertebral bodies</td>
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<tr>
<td></td>
<td>Pathologic fractures</td>
</tr>
<tr>
<td>Nervous</td>
<td>Somnolence</td>
</tr>
<tr>
<td></td>
<td>Decreased pain sensation</td>
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<tr>
<td></td>
<td>Psychosis</td>
</tr>
<tr>
<td>Ocular</td>
<td>Calcifications (band keratopathy)</td>
</tr>
<tr>
<td></td>
<td>Conjunctivitis</td>
</tr>
</tbody>
</table>
Treatment for Hyperparathyroidism

- Saline infusion: 150 mL/hr to restore volume
- Loop diuretics 40-80 mg IV Q 2-4 hrs, goal UO 3-5 L/day, Thiazide C/I
- Bisphosphonates – for life-threatening hypercalcemia
- HD
- Calcitonin – transient effect
- Mithramycin – limited use due to serious toxic effect
Acromegaly

- Upper airway changes – difficult mask ventilation
- Narrow glottic opening, subglottic narrowing – use smaller ETT
- Inadequate collateral circulation – caution during A-line
- B. Glucose monitoring
- Dose of NDMR guided by PNS – in presence of preexisting muscle weakness
# SIADH, DI, CSWS

<table>
<thead>
<tr>
<th></th>
<th>Diabetes insipidus</th>
<th>Syndrome of inappropriate antidiuretic hormone secretion</th>
<th>Cerebral salt wasting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine output</td>
<td>Increased</td>
<td>Decreased</td>
<td>Increased</td>
</tr>
<tr>
<td>Serum levels of sodium</td>
<td>High or normal</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Urine levels of sodium</td>
<td>Low</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Serum osmolality</td>
<td>High or normal</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Urine osmolality</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

Image courtesy of Remedica Journals