### GI BLOCK

#### Causes of epigastric pain

<table>
<thead>
<tr>
<th>Loss of motor control in any 3 phases of swallowing:</th>
</tr>
</thead>
<tbody>
<tr>
<td>-neurological damage to CNV, VII, IX, X, XII</td>
</tr>
<tr>
<td>-Parkinson’s, cerebral palsy, stroke (CVA)</td>
</tr>
</tbody>
</table>

- Insufficient saliva lubricating food:
  - xerostomia
- Pain:
  - oral mucositis
  - ulcerations
- Narrow esophagus:
  - neoplasm
  - esophageal strictures (H&N radiation)

#### Hypotheses for dysphagia

<table>
<thead>
<tr>
<th>Small/large bowel</th>
</tr>
</thead>
<tbody>
<tr>
<td>- obstruction</td>
</tr>
<tr>
<td>- IBD</td>
</tr>
<tr>
<td>- appendicitis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hepatobiliary</th>
</tr>
</thead>
<tbody>
<tr>
<td>- biliary colic</td>
</tr>
<tr>
<td>- cholecystitis</td>
</tr>
<tr>
<td>- acute hepatitis</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gastro-duodenal</th>
</tr>
</thead>
<tbody>
<tr>
<td>- infectious gastroenteritis</td>
</tr>
<tr>
<td>- erosive gastritis</td>
</tr>
<tr>
<td>- peptic ulcer disease</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>- side effects from medications, drugs</td>
</tr>
<tr>
<td>- alcohol</td>
</tr>
</tbody>
</table>

#### Differential diagnosis of dyspepsia

- GERD, PUD, hiatal hernia, IBS, lactose intolerance, biliary colic or cholecystitis, anxiety/depression, side effects of caffeine/alcohol/meds (ASA, NSAIDs, abx, steroids, digoxin, theophylline), gastric cancer, swallowed air

#### Causes of lower GI tract bleeding

- anal fissures, colon polyps/cancer, diverticulosis (abnormal pouches in colon), hemorrhoids (common cause), inflammatory bowel disease (Crohn’s or UC), small bowel tumor, trauma/foreign body

#### Causes of hematemesis

- Mallory-Weiss tear, vomiting of ingested blood after hemorrhage in oral cavity/nose/throat, vascular malfunctions of GI tract (bleeding gastric or intestinal varices), neoplasia of stomach/esophagus, gastroenteritis, gastritis, peptic ulcer

#### Malabsorptive disorders

- pancreatic insufficiency
- bacterial overgrowth of SI
- liver disease
- IBD → CD or UC
- biliary tract disorder
- diffuse small bowel mucosal abnormality (celiac disease)

#### Advanced alcoholic liver disease symptoms

- jaundice – mucosa, sclera, bleeding disorders, oral cancer, sialosis
- impaired/delayed healing following trauma, extractions, periodontal scaling/root planning or surgery
- prominent lingual varicosities

#### Signs + symptoms of jaundice

| Symptoms: pale stool, dark urine, skin itch, nausea, vomit, rectal bleeding, diarrhea, fever/chills, weakness, weight loss, LoA, confusion, abdominal pain, headache, swelling of leg, swelling/distension of abdomen |
| Signs: spider naevi, palmar erythema, clubbing, alcoholic cirrhosis, xanthomas, splenomegaly, hepatomegaly, hirsutism |

#### Common dental drugs metabolized by liver

| LA: lidocaine, mepivacaine; Analgesics: ASA, acetaminophen, codeine, Demerol (meperidine); Sedatives: benzodiazepines (diazepam); Antibiotics: tetracycline, amoxicillin |
### Oral Manifestations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Oral Manifestation</th>
<th>Symptoms</th>
<th>Diagnosis</th>
<th>Complications/Extra Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heartburn</td>
<td>- dry, burning mouth</td>
<td>- pain is burning (heartburn)</td>
<td>- pain is burning (heartburn)</td>
<td>- Barret’s esophagus</td>
</tr>
<tr>
<td></td>
<td>- bitter taste in mouth</td>
<td>- radiates from epigastrium into retrosternal area</td>
<td>- relieved by antacids</td>
<td>- Esophageal adenocarcinoma</td>
</tr>
<tr>
<td></td>
<td>- sore throat</td>
<td>- during day, worse at night → awaken pt</td>
<td>- frequent belching</td>
<td>- bleeding</td>
</tr>
<tr>
<td></td>
<td>- water brash</td>
<td>- relieved by antacids</td>
<td>- persistent dysphagia</td>
<td>- esophageal stricture disease</td>
</tr>
<tr>
<td></td>
<td>- voice changes</td>
<td>- sensation of lump in throat</td>
<td>- sensitivity of lump in throat</td>
<td>(scarring can lead to dysphagia)</td>
</tr>
<tr>
<td></td>
<td>- dental erosion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GERD</td>
<td>- dental erosion</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td>- Endoscopy → most accurate</td>
<td>- hemorrhage</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>- pale oral mucosa</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td>- Endoscopy → most accurate</td>
<td>- bowel obstruction</td>
</tr>
<tr>
<td></td>
<td>- sialosis</td>
<td></td>
<td></td>
<td>- perforation</td>
</tr>
<tr>
<td></td>
<td>- altered tissue homeostasis + reduced tissue repair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vit B12 def.,</td>
<td>- atrophic glossitis + glossodynia (CLASSIC)</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
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<tr>
<td>pernicious anemia</td>
<td>- angular cheilitis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- candidiasis</td>
<td></td>
<td></td>
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<tr>
<td>Folic acid deficiency</td>
<td>- angular cheilitis</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO NEUROLOGIC ABNORMALITIES seen in pernicious anemia</td>
<td>- atrophic glossitis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vit C deficiency</td>
<td>- delayed wound healing</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vit D deficiency</td>
<td>- gingivitis</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein deficiency</td>
<td>- increased tooth mobility</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver disease + alcoholism</td>
<td>- irregular dentin formation</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IBD</td>
<td>- severe: scurvy</td>
<td>- pain!! <strong>Duodenal:</strong> burning epigastric pain, can localize to tip of xiphoid; develops 2-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Symptoms related to defective collagen production</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>Symptoms related to energy deficits</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Symptoms related to dysregulation of calcium and phosphate levels</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Symptoms related to energy deficits</td>
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<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Risk Factors</td>
<td>Symptoms</td>
<td>Pathophysiology</td>
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</tbody>
</table>
| of stomach or duodenum | - NSAIDs (50%)  
- physiological stress (7%)  
- alcohol/tobacco can exacerbate but not cause | hrs AFTER meals, relieved by eating/antacids | Red flag: new dyspepsia after age 45, weight loss, dysphagia, evidence of bleeding, anemia |
| | | - H. pylori test (Ab, urea breath test, stool test, biopsy of stomach) | - increase risk of gastric malignancy → 90% adenocarcinomas, 5% MALT lymphomas  
- pancreatitis |
| Barrett’s esophagus – acid induced injury to squamous cell epithelium | - metaplasia of normal squamous esophageal epithelium to columnar  
- result of epithelial response to injury from long-standing GERD | Management: PPI indefinitely or surgical fundoplication; endoscopy every 3 years if no dysplasia  
- low grade dysplasia: surveillance + endoscopic ablation/resection  
- high grade dysplasia: regular + frequent surveillance with intensive biopsy, endoscopic ablation/resection | Endoscopy → erythematous epithelium in distal esophagus  
| | | - predispose to malignancies → esophageal adenocarcinoma; adenocarcinoma arises from glandular cells (lower 3rd of esophagus) |
| Dysphagia – difficulty swallowing | Causes:  
- GERD, eosinophilic esophagitis, diffuse esophageal spasm, peptic strictures  
- Schatzki ring (benign circumferential ring of tissue above LES)  
- achalasia (esophageal motility disorder → SM of esophagus fails to relax)  
- scleroderma (chronic systemic AI disease characterized by hardening of epidermis + CT)  
- esophageal atresia (congenital, esophagus ends before connecting to stomach)  
- esophageal cancer (SCC + adenocarcinoma)  
- Zenker’s diverticulum (outpouching of mucosa of pharynx) | Difficulty initiating swallowing → choking, coughing, nasal regurgitation  
Symptoms:  
- heartburn, anemia, appetite changes, regurgitation, pain on swallowing, cough at night, food cravings, halitosis, Chagas disease, drugs (bisphosphonates) |
| Oropharyngeal dysphagia | Risk factors:  
- age, smoking, excessive alcohol, meds, teeth/dentures in poor condition | Difficulty initiating swallowing → choking, coughing, nasal regurgitation  
| | Difficulty initiating swallowing → choking, coughing, nasal regurgitation | Pathophysiology: neurological, muscular (dystrophy, myasthenia gravis), structural (Zenker’s diverticulum) |
| Esophageal dysphagia | Risk factors:  
- GERD, obesity, diet, tobacco/alcohol  
- Barrett’s esophagus, history of other cancers (lung, oral, pharyngeal)  
- HPV, achalasia, Plummer Vinson syndrome (web in upper esophagus)  
- workplace exposure, injury (lye – household cleaner)  
- SSC → non-keratinized squamous cells lining esophagus (smoke/alcohol)  
- SCC → cells that make + release mucus/fluids (GERD, BE) | Inability to move food down esophagus → manifest: weight loss, heartburn, reflux symptoms | Pathophysiology: mechanical obstruction (canceroma, peptic stricture), neuromuscular (scleroderma, achalasia) |
| Esophageal cancer | Risk factors:  
- age, gender (men), GERD, obesity, diet, tobacco/alcohol  
- Barrett’s esophagus, history of other cancers (lung, oral, pharyngeal)  
- HPV, achalasia, Plummer Vinson syndrome (web in upper esophagus)  
- workplace exposure, injury (lye – household cleaner)  
- SSC → non-keratinized squamous cells lining esophagus (smoke/alcohol)  
- adenocarcinoma → cells that make + release mucus/fluids (GERD, BE) | - CBC, serum iron, ferritin  
throat culture  
- HIV Ab + viral load  
- chest radiograph/CT  
- barium swallow  
- endoscopy  
esophageal manometry | Most common type: SSC + adenocarcinoma |
| Chronic pancreatitis – chronic | Most common cause:  
- gallstones + alcoholism  
Other: | | - alcohol → direct inflam effect on pancreas → precipitation of proteins in pancreatin ducts |
| Inflammatory process with episodes of acute inflammation | - idiopathic pancreatitis  
- pancreatic neoplasms  
- traumatic pancreatitis  
- cystic fibrosis, AI conditions  
- familial pancreatitis |  
→ diffuse atrophy of acinar cells → fibrosis → calcification  
- eventually impairs one to digest food + make pancreatic hormones |  
| Acute pancreatitis | - gallstones + alcoholism account for >70% cases  
- infections, drug toxicity, neoplasms, hypertriglyceridemia | - abdominal pain radiating to back/chest  
- nausea, vomiting  
- tachycardia, hypotension, fever  
- jaundice, ascites | Pathophysiology:  
- pancreatic duct obstruct’n → unreg. activation of trypsin w/in pancreatic acinar cells → autodigestion of gland + inflamm’n |  
| Cholelithiasis – gallstone formation | - cholesterol + calcium bilirubinate accumulation |  | Pathophysiology:  
- substance in bile becomes supersaturated and precipitate, crystalize → stone |  
| Sialosis/ sialadenosis – autonomic neuropathy, demyelinating polyneuropathy | - idiopathic  
- chronic malnutrition  
- alcoholism, liver disease  
- obesity, diabetes mellitus  
- eating disorders  
- drugs (antihypertensives) | - primarily affect parotid gland (can involve submand. + minor salivary gland too)  
- chronic, bilateral, diffuse, painless, non-inflammatory hypertrophy, non-neoplastic swelling |  
| Crohn’s disease – chronic inflammation disease of intestines esp colon + ileum | - associated with ulcers + fistulae | - bleeding, fever, elevation of WBC  
- diarrhea, cramping abdominal pain  
- anemia, fistulae  
**Theory of cause:**  
- viral/bacterial/allergic reaction initially inflames small or large intestine → depending on genetic predisposition → Ab develop → chronically attack intestine → inflammation | - history, physical exam  
- colonoscopy  
- cross-sectional imaging (CT)  
- blood tests  
- fecal calprotectin = stool test to detect inflammation in intestines (migration of neutrophils to intestinal mucosa)  
- extra-intestinal manifestations – skeletal system, skin, eyes  
- abscess, bowel obstruction (will need surgery to treat)  
- malnutrition |  
| Ulcerative colitis – inflamm’n + ulcers in lining of rectum + colon | - involved inner lining of colon |  |  |  
| Hyperbilirubinemia → jaundice | 1. **Prehepatic**: hemolytic anemia → increased rate of hemolysis, resulting in increased unconj. bilirubin blood concentration | - Liver functioning properly but overwhelmed + can’t conjugate to excrete elevated levels of unconj. bilirubin | UNCONJUGATED HYPERBILIRUBINEMIA | Other common causes:  
- malaria, sickle cell disease, thalassemia, G6PD deficiency, drugs/toxins, autoimmune disorders |  
<p>| 2. <strong>Hepatic</strong>: hepatitis (A, B, C, D, E, alcoholic), cirrhosis, | - loss of hepatic function limits livers ability to conjugate + excrete bilirubin | UNCONJUGATED HYPERBILIRUBINEMIA | Other causes: Gilbert syndrome, liver cancer, Crigler-Najjar syndrome |</p>
<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Other causes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Autoimmune disorder, drugs/toxins</strong></td>
<td>-abnormality in bilirubin transport, conjugation or excretion</td>
<td>CONJUGATED HYPERBILIRUBINEMIA - elevated 5'-nucleotidase</td>
</tr>
<tr>
<td><strong>3. Post-hepatic: gallstones, biliary obstruction, cancer, stricture of bile duct</strong></td>
<td>-Prevents conjugated bilirubin from getting incorporated into bile so it doesn’t reach small intestine to get excreted</td>
<td>Other causes: cholangitis, pancreatitis, parasites (Clonorchis sinesis/Chinese liver fluke)</td>
</tr>
<tr>
<td><strong>Wernicke encephalopathy</strong></td>
<td>-acute syndrome, require emergency treatment to prevent death + neurological morbidity</td>
<td>-Cause of both = brain damage caused by lack of vit B1 (chronic alcoholism, malnutrition)</td>
</tr>
<tr>
<td><strong>Korsakoff syndrome</strong></td>
<td>-chronic neurological condition usually occur b/c of WE</td>
<td>-blood from bleeding ulcers + esophageal varices incompletely metabolized to ammonia → travel to brain → encephalopathy</td>
</tr>
</tbody>
</table>
| **Chronic alcoholism → liver disease**       | Pathological stages: 1. **Fatty liver** – reversible 2. **Alcoholic hepatitis** – diffuse inflame disease of liver characterized by destructive cellular changes, may be reversible 3. **Cirrhosis** – irreversible, progressive fibrosis + abnormal regeneration of liver in response to chronic injury/insult -Hepatomegaly, splenomegaly, jaundice, ascites, lower extremity edema, spider angiomas **Liver failure** can lead to systemic health problems: protein deficiency (coag. factors), thrombocytopenia, impaired glucose metabolism, drug/toxin metabolism, ammonia metabolism, urea synthesis, encephalopathy (Korsakoff syndrome), portal hypertension, hepatic cancer, jaundice, endocrine disturbance, renal failure, malnutrition -CBC → WBC, anemia, thrombocytopenia -total + direct bilirubin (higher) -albumin, prothrombin time, partial thromboplastin time -aminotransferases (ALT, AST) → usually 2-7x higher; AST/ALT ~1 -rise in: GGTP, alkaline phosphatase, uric acid -lipid panel, HA | \***REVIEW OF BLI**  
Lab values in liver failure:  
- ↑ PT  
- N/↑ PTT  
- N/↓ platelet count  
- Normal RBC count |
| **Hepatomegaly**                             | Alcohol abuse, hepatitis, CHF, hepatocellular carcinoma, cancer metastases, biliary cirrhosis, sarcoidosis, steatosis (fatty liver)                                                                                                                                                                                                 |                                                                                                 |

**Alcohol withdrawal syndrome**  
-usually starts within 8hr after last drink, but can happen days later  
symptoms usually peak at 24-72hr but can persist for weeks  
-common symptoms: anxiety, nervousness, depression, fatigue, irritability, jumpiness/shakiness, mood swings, nightmares, not thinking clearly  
-other: clammy skin, dilated pupils, headache, insomnia, loss of appetite, nausea + vomiting, pallor, rapid heart rate, sweating, tremor of hands/body parts  
-severe: “delirium tremens” → agitation, fever, hallucinations, seizures, severe confusion
**BLI BLOCK**

**Questions** – previous bleeding/bruising

- bleeding problems in relatives
- excessive bleeding post-op, surgical procedures, tooth exos, after trauma
- use of drugs for prevention of coagulation or chronic pain
- past + present illness
- occurrence of spontaneous bleeding (e.g. epistaxis)

**Tests + purpose**

<table>
<thead>
<tr>
<th>Test</th>
<th>Purpose/Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platelet count</td>
<td>Quantitate platelet number</td>
</tr>
<tr>
<td>- low in ITP, TTP, DIC</td>
<td></td>
</tr>
<tr>
<td>aPTT</td>
<td>Measure intrinsic path (factors VIII, IX, XI, XIII) and common pathway; used to monitor heparin therapy, ppl w/ hemophilia, vWD [activated partial thromboplastin time]</td>
</tr>
<tr>
<td>PT</td>
<td>Measures extrinsic pathway (factor VII) and common pathway (I, II, V, VII, X) - evaluates ppl with liver disease, on warfarin [prothrombin time]</td>
</tr>
<tr>
<td>INR</td>
<td>Permits determination of extrinsic pathway status independent of lab performing measurement; used to monitor warfarin therapy (target 2-3.5)</td>
</tr>
<tr>
<td>TT</td>
<td>Thrombin time – normal in pt with defects in extrinsic/intrinsic/common prior to conversion of fibrinogen to fibrin - prolonged in pt with low fibrinogen or on heparin (impair fxn of thrombin) → indicates problem converting fibrinogen to fibrin (time for fibrin clot recorded)</td>
</tr>
<tr>
<td>Fibrinogen</td>
<td>Measure time plasma to clot → inversely proportional fibrinogen activity (longer=less fibrinogen) - low in ↑ consumption (DIC, massive hemorrhage), impaired production (liver disease, congenital hypofibrinogenemia) - elevated in inflammation, infection, malignancy</td>
</tr>
<tr>
<td>Mixing studies</td>
<td>Differentiate inhib of CFs from a deficiency in CF - mix pt’s plasma with normal plasma in 1:1 ratio, repeat abnormal test</td>
</tr>
<tr>
<td>Euglobulin lysis time</td>
<td>Looks for accelerated fibrinolysis - accelerated in DIC or CF XIII deficiency; decreased in hereditary deficiency of fibrinogen</td>
</tr>
</tbody>
</table>

**“Significant” bleed”**

- continues >12 hours
- causes pt to call/return to dental office or seek medical/emergency care
- formation of hematoma or ecchymosis within soft tissues
- requires blood product support

**Primary vs. Secondary bleeding disorders**

<table>
<thead>
<tr>
<th>Injury/lesion</th>
<th>Primary (PLATELET)</th>
<th>Secondary (COAGULATION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface cuts</td>
<td>Excessive, prolonged bleed</td>
<td>Normal/slightly prolonged</td>
</tr>
<tr>
<td>Onset after injury</td>
<td>Immediate</td>
<td>Delayed</td>
</tr>
<tr>
<td>Site of bleeding</td>
<td>Superficial (mucosal, skin)</td>
<td>Deep (joints, muscle)</td>
</tr>
<tr>
<td>Lesions</td>
<td>Petechiae, ecchymosis</td>
<td>Hemarthroses, hematomas</td>
</tr>
</tbody>
</table>

**Test**

<table>
<thead>
<tr>
<th>Test</th>
<th>Purpose/Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESR</td>
<td>Non-specific screening test indirectly measure presence of inflammm’n in body - reflects tendency of RBC to settle more rapidly in face of disease states (usually because of ↑ in plasma fibrinogen, lgs, acute-phase reaction proteins) - change in RBC shape/# also affects ESR</td>
</tr>
<tr>
<td>Creatinine</td>
<td>Cr= waste product made by muscle from breakdown of creatine - made at constant rate; Cr removed from body by kidneys (almost all) - test of renal function → blood levels of Cr indicator of kidney function</td>
</tr>
<tr>
<td>D-dimer</td>
<td>-formed when polymerized fibrin is cleaved by plasmin → proof prior thrombus formation - elevated → not specific to thrombosis, may be associated with non-specific disease/inflammatory states: recent surgery/trauma, cancer, DIC, healthy elderly, normal pregnancy, acute/chronic infectious/inflammatory diseases</td>
</tr>
<tr>
<td>Child-Pugh</td>
<td>MELD score: model for end-stage liver disease → used to prioritize adult pt for liver transplants; severity index indicating mortality risk + urgency - calculated by total bilirubin, INR, Cr → 4 levels: &gt;25 gravelly ill, &lt;10 less ill</td>
</tr>
<tr>
<td>Antinuclear Ab</td>
<td>An antibody made by the body which targets the nucleus of cells. It is not normal and may be present in autoimmune diseases</td>
</tr>
<tr>
<td>Anti-smooth muscle Ab</td>
<td>An antibody made by the body which targets in smooth muscles It is not normal and is present in autoimmune hepatitis type 1</td>
</tr>
<tr>
<td>Anti-liver kidney microsomal Ab</td>
<td>An antibody made by the body which targets cytochrome P450 2D6 enzyme which is present in the liver. It is not normal and present in autoimmune hepatitis type 2</td>
</tr>
<tr>
<td>Anti-soluble liver Ag</td>
<td>Not normal and sometimes present in autoimmune hepatitis type 1 or type 2</td>
</tr>
</tbody>
</table>
Bleeding disorders

1. Coagulation abnormalities: medication (heparin, warfarin, novel oral anticoagulants, congenital/acquired clotting factor deficiencies, impaired hepatic function, malabsorption syndromes

2. Platelet disorders
   a. quantitative (thrombocytopenia): ↓ prod’n by bone marrow (aplastic anemia, drug induced, neoplasm), ↑ destruction in peripheral blood (ITP, DIC), sequestration (splenomegaly)
   b. qualitative: congenital/acquired abnormal platelet fxn

3. non-hematologic defects: trauma to blood vessels, local/systemic infections (URTI, hemorrhagic fevers), decreased vessel integrity

Hereditary
- vWD, hemophilia A/B, factor V, XIII deficiency, hereditary hemorrhagic telangiectasia, protein C def, antithrombin III def

Acquired
- liver disease, vit K def, DIC, drug-induced platelet or CF dysfunction, ITP, TTP

Coagulopathy:
- petechiae – pinpoint capillary hemorrhage in skin/mucosa <2mm
- purpura – small hemorrhage 2mm-1cm, skin/mucosa/serosal
- ecchymoses – skin/mucosal hemorrhage >1cm
- mucosal – epistaxis, gingival, hematuria, hematochezia, melena
- hemorrhrosis – bleeding into joints
- deep hematoma – bleeding into epidural/subdural space, around esophagus, retroperitoneal, intramuscular hemorrhage

Dental management: patients with bleeding disorders

- LA technique: infiltration, intraligamentary, intrapulpal
- sedation: IV conscious sedation – just don’t damage vein; oral sedation OK
- post-extraction analgesia: contraindicated ASA/advil; acetaminophen preferred; T3
- hemostatic measure: surgical into socket, resorbable suture, black teabag, continuous compression
- persistent hemorrhage: communicate w/ physician before extraction, surgical, gelfoam, topical thrombin, direct pressure, DDAVP (unless contraindicated)
- cryoprecipitate (VIII, XIII, vWF, fibrinogen, fibronectin) can be used to treat all types of vWD
- other agents: platelet, fresh frozen plasma (II, V, VII, IX, X, XI, XII, XIII), FVIII concentrate, FIX concentrate, epsilon-aminocaproic acid, tranexamic acid

Extra: tea bag → tannins (hemostatic), astringent (constrict blood vessels), mild antiseptic, absorbent
### Differential diagnosis for Neutropenia/Thrombocytopenia + dental surgery

<table>
<thead>
<tr>
<th>Neutropenia</th>
<th>Thrombocytopenia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal= 2500-7500 cells/μL</td>
<td>40-75,000/μL – platelet transfusion pre-op and post-op</td>
</tr>
<tr>
<td>&gt;2,000/μL – no abx prophylaxis</td>
<td>&lt;50,000 – no dental/perio surgery in office</td>
</tr>
<tr>
<td>1-2,000: abx prophylaxis required</td>
<td>&lt;40,000 – postpone dental treatment</td>
</tr>
<tr>
<td>&lt;1,000 – postpone dental treatment (if emergency, discuss ab, hospitalization, post-op IV abx might be needed)</td>
<td>&lt;30,000 – platelet transfused 1 hr before procedure → obtain immediate post-transfusion platelet count; transfuse regularly (maintain at &gt;30-40,000)</td>
</tr>
</tbody>
</table>

### Liver transplant

<table>
<thead>
<tr>
<th>Who can get it?</th>
<th>Who can’t donate?</th>
<th>Organ rejections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypermotility: mins – hours, recipient has pre-existing Ab to Ag on organ; Ag-Ab complex form, triggering immune system; complement activation destroy capillaries → thrombosis → death of organ</td>
<td>Hypoactive: week-6mo, cellular rejection; DC in donor tissue act as APC and enter circulation of recipient; cellular immune response, humoral rejection. All recipients will have some degree of this. Managed with immunosuppression</td>
<td></td>
</tr>
<tr>
<td>Change in diet, Crohn’s, diabetes, hyperthyroidism, IBD, meds, alcohol, cocaine, peptic ulcer, UC, cancer</td>
<td>Chronic: mo-yrs, cellular/humoral rejection mech persist; scarring + fibrosis of organ; managed with immunosuppression, but can’t be prevented</td>
<td></td>
</tr>
</tbody>
</table>

### Dry eyes
- Sjogren’s syndrome
- Conjunctivitis due to allergy or infection
- Cranial nerve (V or VII) trauma
- Medications
- Dehydration

### Dry mouth
- Sjogren’s syndrome
- Meds (tricyclic antidepressants, antihistamine, antimuscarinics, anti-epileptics, beta blockers, diuretics)
- Radiotherapy to H/N
- Dehydration
- Diabetes
- Smoking/tobacco
- Salivary gland obstruction/infection

### Frail, thin, weight loss
- Change in diet, Crohn’s, diabetes, hyperthyroidism, IBD, meds, alcohol, cocaine, peptic ulcer, UC, cancer

### Pallor
- Hypoglycemia, anemia, shock, panic attack, orthostatic hypotension, heart disease

### Fatigue
- Anemia, cold/flu, dehydration

### Yellow eyes
- Liver disease (hepatitis, cirrhosis, cancer), jaundice (prehepatic, hepatic, post hepatic), end-stage renal disease
<table>
<thead>
<tr>
<th>Condition</th>
<th>Oral Manifestation</th>
</tr>
</thead>
</table>
| Multiple myeloma                | -dental radiograph: punched out lesions or mottled areas that represent tumors → osteolytic lesions of MM more common in posterior mandible, may be associated with cortical plate expansion  
- extramedullary plasma cell tumours can occur in oropharynx  
- amyloid-like protein sometimes found in oral soft tissues (e.g. tongue) as result of MM → swollen + painful |
| Aplastic anemia                 | -petechiae, ecchymoses, mucosal pallor, ulceration (possibly w/ infection), gingival bleeding, necrotizing ulcerative gingivitis  
- more susceptible to infection + bleeding; clinical recognition of condition before invasive dental procedure imperative |
| Hemolytic anemia                | - pallor of oral mucosa: soft palate, sublingual tissue, tongue  
- severe: jaundice in soft palate + sublingual tissues  
- dental radiograph: prominent lamellar striations from medullary spaces that become enlarged due to hyperplasia of erythroid elements of bone marrow  
- stepladder trabeculae pattern may be seen in alveolar bone b/w tooth roots |
| Iron deficiency anemia          | - gingival + mucosal pallor, atrophic glossitis, angular cheilitis |
| Pernicious anemia               | - dysphagia, dysgeusia, atrophic glossitis, angular cheilitis, glossodynia, advanced disease= neurological defect → ↓ muscle tone |
| Folic-acid deficiency anemia    | - angular cheilitis, atrophic glossitis, severe → ulcerative stomatitis, pharyngitis  
NO NEUROLOGICAL ABNORMALITY |
| Sickle cell anemia              | - pale with possible jaundice, orofacial pain, pulpal necrosis in absence of any dental disease (lack O2), enamel hypomineralization  
- stepladder trabeculae pattern in alveolar bone b/w tooth roots (increased erythropoietic activity → bone marrow hyperplasia)  
- alveolar bone denser & features distinct lamina dura  
- overjet, overbite (bone marrow hyperplasia → enlarged hemopoietic maxilla)  
- skeletal NOT dental maturation delayed |
| Acute leukemia                  | - gingival enlargement (due to inflammation from infiltration by leukemic cells)  
- gingival ulceration, bleeding, oral infection, lymphadenopathy, oral petechiae/purpura, mucosal pallor (anemia)  
*high risk of infections due to neutropenia → need to exam FMS prior to chemo |
| Chemotherapy                    | - mucositis + ulceration, infection (note: usual clinical signs of inflam’n may not be seen due to immunosuppression)  
- pain/neurotoxicity – vincristine/vinblastine can cause constant deep pain, bilateral, mimetic toothache  
- xerostomia, taste alteration, bleeding (thrombocytopenia), dental developmental abnormalities (enamel defect, malformed roots...)  
Management: ice chips, Tantum oral rinse (benzydamine 0.15% oral rinse), amphogel, 2% lidocaine, chlorhexidine rinse, surgilube/lanolin (AVOID VASELINE → holds moisture, encourage bacterial/fungal growth), treat candida/viral infections (herpes) |
| Plummer-Vinson syndrome         | - premalignant condition that increases risk of SCC of esophageus + pharynx  
- dysphagia (muscular degeneration of esophagus)  
- esophageal webs, atrophic glossitis, angular cheilitis, xerostomia, atrophic changes in oral mucosa/pharynx |
<p>| Hematopoietic stem cell transplant | - mucositis, infections, graft versus host disease, diminished salivary flow, xerostomia, osteoporosis + bone necrosis (irradiation, corticosteroid therapy), second malignancies (lymphoproliferative disorders, hematological malignancies, solid neoplasm, SCC) |
| Organ transplant                | - lip/oral cancers, drug-induced gingival overgrowth, infections, hairy leukoplakia, post-transplantation lymphoproliferative disorders, oral lichenoid lesions (GVHD), mucositis, HSV infections, candidiasis, aphthous ulcers, unusual alveolar bone loss, |</p>
<table>
<thead>
<tr>
<th>Condition</th>
<th>Etiology</th>
<th>Symptoms</th>
<th>Diagnosis</th>
<th>Complications/extra info</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thrombocytopenia</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General info</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| # of platelet too low | Pathophysiology:  
1. **↓ production of platelets**  
- General disease of bone marrow: bone neoplasm, drug induced, aplastic anemia  
2. **↓ platelet survival**  
- Immunological mediated destruction: ITP, DIC  
3. Sequestration  
- Splenomegaly | -bruisng and abnormal bleeding more likely | <100,000 per microlitre platelet count | e.g. malaria drug quinine, cardiac (quinidine), heparin |
| Drug-induced       | Immune Drug leads to production of Ab targeting platelets                |                                               |                                               |                                                                                          |
| Non-immune         | Chemotherapy → suppress bone marrow prod’n of platelets                  |                                               |                                               | e.g. antiepileptic (valproate), cardiac drug amrinone, antibiotic linezolid              |
| Thrombocythemia    |                                                                           |                                               |                                               |                                                                                          |
| - # of platelet too high |                                                                           |                                               |                                               | At risk for: cardiovascular incident, cerebrovascular accident, pulmonary embolism, other thrombotic events (DVT) |
| Leukocytosis       | - Infection, inflammation, leukemia                                        |                                               |                                               |                                                                                          |
| Pancytopenia       | Aplastic anemia                                                          |                                               |                                               |                                                                                          |
| Von Willebrand disease |                                                                           |                                               |                                               |                                                                                          |
| disease – most common inherited bleeding disorder | General info | Condition that can cause prolonged/excessive bleeding  
- Deficiency of vWF (reduced level, abnormal function resulting from point mutation or major deletion) | - Severity of bleeding variable  
- Mucous membrane bleeding (epistaxis, menorrhagia)  
- Excessive blood loss from superficial cuts/abrasions  
- Operative + post-traumatic hemorrhage  
- Hemarthrosis + muscle hematomas rare (except in type 3) | - Normal PT, platelet, RBC  
- N/↑ PTT  
*Occasional reduced CF VIII levels b/c vWF is a carrier molecule for factor VIII (protects it from premature destruction) | Treatment:  
1. Desmopressin (DDAVP)*  
2. vWF replacement therapy  
3. Antifibrinolytic agents  
4. Topical agents (thrombin)  
5. Estrogen therapy in women with no contraindications  
Cryoprecipitate (F VIII, XIII, vWF, fibrinogen, fibronectin) – treats all vWD |
<p>| Type 1             | Quantitative partial deficiency                                           | Mildest form, usually no symptoms until operation |                                               | Incidence: 75%                                                                           |
| Type 2             | Functional abnormality                                                    | Amount is normal, just not working             |                                               | 20-25%                                                                                   |
| Type 3             | Complete deficiency                                                      | Most severe type, very little vWF → very little VIII |                                               | Rare                                                                                     |</p>
<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Diagnostic Evaluation</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hemophilia A</strong></td>
<td>- insufficient CF VIII</td>
<td>- prolonged aPTT - normal PT, platelet, RBC</td>
<td>Factor IX is part of the PTT (intrinsic) pathway - important in amplification once coagulation starts</td>
</tr>
<tr>
<td><strong>Hemophilia B</strong></td>
<td>- insufficient CF IX - X-linked recessive trait (only males affect, 1:30000)</td>
<td>- increased risk of bleeding from mild trauma/spontaneous bleeding</td>
<td><strong>Dental management:</strong> intralig./infiltration injection, local hemostatic measure, morning appt, early in week</td>
</tr>
<tr>
<td><strong>Factor VII deficiency</strong></td>
<td></td>
<td>- prolonged PT, INR</td>
<td></td>
</tr>
<tr>
<td><strong>Factor XIII deficiency</strong></td>
<td></td>
<td>- accelerated fibrinolysis</td>
<td></td>
</tr>
<tr>
<td><strong>DIC (disseminated intravascular coagulation)</strong></td>
<td>Pathologic activation of blood clotting system → massive tissue injuries, pregnancy complications, sepsis -↑ TF, ↓ thrombomodulin</td>
<td>Can lead to hemolytic anemia, infarction, ischemia</td>
<td>Widespread deposition of fibrin within microcirculation</td>
</tr>
<tr>
<td><strong>ITP (immune thrombocytopenic purpura)</strong></td>
<td>Acquired thrombocytopenia caused by autoantibodies directed against platelet antigens - pathogenesis unknown - could be IgG autoantibodies directed against platelet membrane glycoproteins (such as IIb/IIIa) - viral/bacterial infections can trigger prod’n of these antibodies</td>
<td>- bleeding can occur in up to 2/3 of pt - skin/mucous membrane, minimal epistaxis - platelet type bleeding, petechiae, purpura - uncommon: severe hemorrhage (intracranial bleeding or GI bleeding) if severe (&lt;30,000uL)</td>
<td><strong>Diagnosis of exclusion:</strong> ISOLATED THROMBOCYTOPENIA (platelet &lt;100,000/uL) without anemia, leukopenia, or any other cause of thrombocytopenia</td>
</tr>
<tr>
<td><strong>TTP (thrombotic thrombocytopenic purpura)</strong></td>
<td>- rare blood disorder where blood clots form in small blood vessels throughout body - arise from autoantibody mediated inhibition of enzyme ADAMTS13 (metalloprotease that cleaves large strands of vWF)</td>
<td>- normal PT, PTT, RBC - ↓ platelet</td>
<td>- normal PT, pTT - ↓ platelet</td>
</tr>
<tr>
<td><strong>Hereditary hemorrhagic telangiectasia (HHT)</strong></td>
<td>- disorder where abnormal telangiectatic capillaries result in freq bleeding episodes, primarily from nose + GI tract</td>
<td>- arteriovenous malformation (AVM) in lung, brain, liver can occur - often seen on oral/nasal mucosa - epistaxis ~12 yrs old, &gt;95% of affected individuals by middle age</td>
<td></td>
</tr>
</tbody>
</table>
| **Rouleaux formations**  
-see DD p. 6 | Aggregates of RBC resembling stacks of coins  
-caused by presence of high levels of circulating acute-phase proteins which increase RBC stickiness |  |  |
| --- | --- | --- | --- |
| **Hypercalcemia** | Principal causes:  
-hyperparathyroidism, vit D toxicity, cancer | Fatigue, muscle weakness, nausea, polyuria, dehydration, constipation, polydipsia, confusion, coma | Untreated, severe: fatal  
→ seizure, coma, cardiovascular collapse |
| **Multiple myeloma**  
-malignant prolif. of plasma cells derived from single clone | -mutations occur in genes responsible for Ig production  
-bone pain/fracture, susceptibility to infection, anemia, fatigue  
-pain w/ movement, at night  
-swelling, SoB, evidence of heart/kidney failure, hypercalcemia | -protein electrophoresis of serum/urine  
→ presence of myeloma or monoclonal (M) protein band | -normal antibody function of the immunoglobulin lost |
| **Acute leukemia** | General info  
-Most cases, etiology never identified  
-some rare congenital/acquired disorders can predispose (X-linked agammaglobulinemia, SCID, down syndrome)  
-abrupt/insidious onset  
-bone marrow infiltration  
-• pallor, fatigue (anemia)  
-• fever, infxn (leukopenia)  
-• purpura, epistaxis, bruise (thrombocytopenia)  
-loss of appetite, malaise, bone/joint pain, lymphadenopathy (30%), hepatosplenomegaly (10%), mediastinal mass (10%)  
-gingival enlargement due to leukemic infiltration of tissue | Bone marrow aspiration + biopsy  
**Definition:**  
>20% nucleated cells are blasts in bone marrow (normal <5%)  
-Lumbar puncture to determine if present in CSF (5-10% of ALL)  
**Peripheral smear in ALL/AML:**  
- anemia (75%)  
- leukopenia (50%)  
- thrombocytopenia (70%)  
**Pediatric ALL:**  
- 85% pre-B cell  
- 15% T cell  
- 1% mature B cell | ALL more common in children & better prognosis  
**Prophylactic dental treatment** prior to chemo  
→ eliminate source of existing/potential infection w/o delaying cancer therapy (non-vital teeth, grossly carious teeth, gingivitis, perio)  
→ don’t start flossing just before chemotherapy  
→ remove ortho |
<p>| <strong>ALL</strong> | 80% pediatric leukemia (peak 2-4y/o) | T cell ALL has poorer prognosis |
| <strong>AML</strong> | 20% pediatric leukemia |  |
| <strong>Splenomegaly</strong> | Viral (mononucleosis), bacterial (syphilis, endocarditis), parasitic (malaria), cirrhosis/hepatic disease (due to portal hypertension), hemolytic anemia, leukemia, myeloproliferative neoplasms, lymphomas, metabolic disorders |  |  |</p>
<table>
<thead>
<tr>
<th>Lymphadenopathy – disease of lymph nodes; abnormal in size/consistency</th>
<th>-infection, autoimmune disorders (juvenile RA, sarcoidosis, GVHD) -meds (phenytoin, allopurinol) -iatrogenic causes, malignancy. <strong>Risk factors for malignancy:</strong> age &gt;40, male, Caucasian, supraclavicular location of nodes, presence of systemic symptoms: fever, night sweats, unexplained weight loss Painless, hard, irregular mass or firm rubbery lesion that’s fixed may be <strong>malignant</strong> &lt;2cm insignificant unless in supraclavicular fossa -left: abdominal disease -right: intrathoracic disease</th>
<th>Blood test, imaging, biopsy (fine needle or core needle aspiration, open excisional biopsy)</th>
<th><strong>Treatment:</strong> antibiotics may be used to treat acute unilateral cervical lymphadenitis 1.1% cases can be related to malignancy. <strong>Classification:</strong> submental, submandibular, anterior cervical, posterior cervical, preauricular, supraclavicular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hodgkin’s lymphoma</td>
<td>Involves Reed Sternberg cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>Begin in B lymphocytes, T lymphocytes or NK cells</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sepsis – inflammatory state resulting from systemic response to bacterial infection</td>
<td>Pathological activation of acute inflammatory mediators + hemostatic system; alteration of endothelial cell function (increased permeability/loss of barrier function → edema)</td>
<td>-Fever, tachycardia, diaphoresis, tachypnea, confusion -hypotension (b/c ↑ permeability → intra to extravascular)</td>
<td><strong>Clinical evidence of infection + evidence of 2+ systemic response:</strong> -temp &gt;38 or &lt;36degC -HR &gt;90bpm, RR &gt;20bpm -PaCO₂ &lt;32mmHg -WBC &gt;12000cells/uL or &lt;4000cells/uL or &gt;10% immature forms <strong>Treatment:</strong> fluid resuscitation, abx, surgical excision of infected/necrotic tissue, drainage of pus Cytokines: TNF-a, IL-1, IL-6</td>
</tr>
<tr>
<td>Bacteremia</td>
<td>Bacteria in blood stream</td>
<td>Confirmed by culture</td>
<td></td>
</tr>
<tr>
<td>SIRS (Systemic inflammatory response syndrome)</td>
<td>-can be from infection -acute pancreatitis, major trauma (burns)</td>
<td>Has 2 or more of the <strong>systemic response</strong> (see sepsis diagnosis) SIRS is defined as sepsis if proven infection is associated</td>
<td></td>
</tr>
<tr>
<td>Septic shock</td>
<td>Sepsis with refractory hypotension (systolic BP &lt;90mmHg) + impaired end organ perfusion despite adequate fluid</td>
<td>Sepsis with organ failure -cardiovascular failure -resp. failure → hypoxemia -renal failure → oliguria -hematologic failure → coagulopathy (DIC) <strong>See treatment in sepsis section</strong></td>
<td></td>
</tr>
<tr>
<td>Neutropenia</td>
<td>1. ↓ neutrophil prod’n from BM 2. margination 3. sequestration in spleen 4. immune destruction</td>
<td></td>
<td>↓ prod’n = congenital, HIV, malignancy in BM, chemo, AI, nutritional</td>
</tr>
<tr>
<td>Neutrophilia</td>
<td>Pathogenesis: Infection (bacterial → cytokine → ↑ release), acute inflam’n (tissue necrosis, MI, burns), glucocorticoids (↑ demargination, ↑ immature neutrophils from BM, ↓ extravasation), acute stress (↑ demargination of peripheral blood neutrophils)</td>
<td></td>
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</tbody>
</table>

*DDAVP=synthetic analogue of antiidiuretic hormone, without vasopressor activity → act by increasing vWF and factor VIII levels by indirectly stimulating release from endothelial cells. Administer intravenous, intramuscular or intranasal. Works in 30-60mins, for 6-12 hours*
**Anemia** – SYMPTOM NOT A DIAGNOSIS, classified based on size of RBC or MCV

### 3 mechanisms can cause anemia

<table>
<thead>
<tr>
<th>1. blood loss</th>
<th>Microcytic (low MCV)</th>
<th>Normocytic (normal MCV)</th>
<th>Macrocytic (high MCV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• acute tooth extraction, chronic GI bleeding (NSAID)</td>
<td>Iron deficiency anemia (also hypochromic)</td>
<td>Acute blood loss (hemorrhage)</td>
<td>Aplastic anemia</td>
</tr>
<tr>
<td>2. increased RBC destruction (excessive hemolysis)</td>
<td>Anemia of chronic disease (some- prolonged illness)</td>
<td>Anemia of chronic disease (most)</td>
<td>Anemia of chronic liver disease or alcohol excess</td>
</tr>
<tr>
<td>• deficiency in blood forming components: malnutrition, low iron/vitB12/folic acid</td>
<td>Thalassemia</td>
<td>Hemolytic anemia</td>
<td>Myelodysplastic syndromes*</td>
</tr>
<tr>
<td>• bone marrow failure</td>
<td>• Thalassemias are inherited blood disorders with underproduction of normal globin chains</td>
<td>Bone marrow infiltration or suppression</td>
<td>Hemolytic anemia with high reticulocyte count</td>
</tr>
<tr>
<td>• decreased erythropoietin (renal disease)</td>
<td>• Classified by the specific part of hemoglobin that is affected (alpha or beta), or the severity of thalassemia</td>
<td>Many cases of toxic poisoning</td>
<td></td>
</tr>
<tr>
<td>3. decreased RBC production (deficient erythropoiesis)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• hemolysis (hemolytic disease)</td>
<td>Folic-acid deficiency anemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• hemorrhage (acute/chronic)</td>
<td>Folic-acid deficiency anemia</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Signs and symptoms

- pallor of skin, fingernail beds, mucous membranes
- fatigue, weakness, general malaise,
- dyspnea, tachycardia, angina pectoris
- lightheaded, cold hands + feet, headache, low BP, splenomegaly

### Dental Management

- proper screening (CBC, blood smear, Hb/hematocrit, platelet count, Sickledex test)
- refer directly to pt if signs seen
- men → may have PUD or carcinoma
- increased complication so make sure to detect before treatment

### Aplastic anemia *see oral manifestations on page 9*

- bone marrow + HSC are damaged resulting in pancytopenia

**Primary:** unknown etiology, young children

**Secondary:** known cause (drug/chemical/radiation), any age, much better prognosis

### Hemolytic anemia *see oral manifestations on page 9*

#### 1. Intravascular vs extravascular destruction

- more common in extravasc. space – spleen, liver, BM

#### 2. Intrinsic RBC defects

- membrane/cellular rigidity causing splenic sequestration with extravasc. hemolysis
- cell membrane defect (hereditary spherocytosis)
- abnormal Hgb molecule (sickle cell anemia, thalassemia)
- metabolic defects (G6PD deficiency)

#### 3. Extrinsic defects

- immune destruction (post blood transfusion)
- non-immune: infection (septic hemolysis, parasitic), destruction by abnormal vasculature (mec heart valve, TTP)

### Folic-acid deficiency anemia

- same presentation as pernicious anemia but NO neurologic abnormalities

### Pernicious anemia *see oral manifestations on page 9*

- autoimmune disease causing anemia b/c decreased prod’n of intrinsic factor by parietal cells → vit b12 malabsorption
- similar presentation seen w/ other causes of vit B12 def (Crohn’s, pancreatitis)

### Microcytic (low MCV)

- Iron deficiency anemia (also hypochromic)
- Anemia of chronic disease (some- prolonged illness)
- Thalassemia
- Folic-acid deficiency anemia

### Normocytic (normal MCV)

- Acute blood loss (hemorrhage)
- Anemia of chronic disease (most)
- Hemolytic anemia
- Many cases of toxic poisoning
- Mixed deficiencies**

### Macrocytic (high MCV)

- Aplastic anemia
- Thalassemia
- Anemia of chronic liver disease or alcohol excess
- Hemolytic anemia with high reticulocyte count
- Megaloblastic anemia (B12 or folate deficiency or antimetabolite drugs)

### Signs and symptoms

- headache, low BP, splenomegaly
- lightheaded, cold hands + feet
- fatigue, weakness, general malaise
- pallor

### Management

- may have PUD or carcinoma
- increased complication so make sure to refer directly to pt if signs seen
- proper screening (CBC, blood smear, Hb/hematocrit, platelet count, Sickledex test)

### Anemia of chronic disease = protective mech to limit iron availability

**Found in:**

- inflammatory conditions, autoimmune conditions (rheumatoid arthritis)
- chronic kidney/liver disease, IBD, chronic infections (TB, endocarditis)
- malignancy, endocrine disorders (hypothyroid/ hypopituitarism)

### Pathogenesis:

- macrophage → increase hepatic synthesis of hepcidin
- hepcidin: lower dietary iron absorption, reduce iron exit from MØ + liver

As result, erythropoiesis is impaired b/c inappropriate iron sequestration
- macrophage retain iron from senescent RBCs
- less RBC production, impaired iron utilization

### Diagnosis:

- Modest decline in hemoglobin
- low normal range (9.5-10.5g/dL)
- early on RBCs are normocytic, change to microcytic with time

### Sickle cell anemia

- autosomal recessive condition caused by abnormal hemoglobin protein (hgb S) that affects shape + function of RBC
- less flexibility, reduce RBC lifespan
- most common in ppl of Hispanic or African American descent
- can lead to BV blockage → pain, stroke, tissue damage
Autoimmune hemolytic anemia (AIHA)
- auto-antibody production against RBCs
- often classified based on type of Ab produced (warm or cold)
- usually idiopathic, or secondary (SLE, systemic lupus erythematosus)
- warm AIHA most common, made at body temp
- cold Ab type → IgM made at 0-4degC
- Ab-Ag complex removed by phagocytosis in mononuclear phagocyte system in liver + spleen → SPLENOMEGALY

Iron deficiency anemia
Due to:
- excessive blood loss – GI: peptic ulcer, neoplasm, hemorrhagic gastritis; GU: renal, pelvic, bladder tumors
- iron malabsorption
- increased requirements – pregnancy (40%), growing infants
- dietary – rare in industrialized world but possible w/ vegans

- indicated by RBCs that are microcytic and hypochromic

Pericoronitis – see James DALE BLI Block

Immunodeficiency disorder: cannot generate appropriate immune responses against invading microorganisms

### Primary Immuno-deficiency
- hereditary; occur alone or as part of syndrome
- manifest during infancy & childhood as abnormally frequent (recurrent) or unusual infections
- transmission often X-linked, 60% cases male
- classification: component of immune system that is deficient/absent/defective
  - **Humoral (B cell defect)** - Most common (50-60%)
    - Serum Ig Ab titers ↓ → bacterial infection ↑
    - Most common B cell disorder is selective IgA deficiency
  - **Cellular (T cell defect)** - 5-10% of PID
    - Predispose pt to infxn by virus, fungi, opportunistic organisms, common pathogens
    - T-cell disorders also cause Ig deficiencies b/c B & T cell immune systems are interdependent
  - **Combined** humoral & cellular immunity - 20% of PID
  - **Phagocytic cells** - 10-15% of PID
    - Most common phagocytic cell defect is chronic granulomatous disease – neutrophils have impaired fxn: less phagocytic
  - **Complement proteins** - Rare <2%
    - Deficiencies result in defective opsonization, phagocytosis & lysis of pathogens & in defective clearance of Ag-Ab complexes
    - Most serious consequence of complement deficiencies=recurrent infection (defective opsonization) & SLE & glomerulonephritis (defective clearance of Ag-Ab complex)

### Secondary Immuno-deficiency
- acquired, much more common
- systemic disorders (leukemia, malnutrition, HIV infection)
- immunosuppressive treatments (corticosteroid, chemotherapy, radiation, bone marrow ablation before transplantation)
- Prolonged chronic illness → critic ill, or hospitalized patients
- Can mimic B and T-cell defects
- Treatment focuses on underlying disorder

Autoimmune disorders: generate immune response against itself

- Misdirected immune responses have the presence of autoantibodies or T lymphocytes reactive with host antigens
- Examples: Diabetes mellitus type I, systemic lupus erythematosus (SLE), Sjogren’s syndrome, Hashimoto’s thyroiditis & Graves disease, Idiopathic thrombocytopenic purpura, rheumatoid arthritis (RA), Addison’s disease
- 3 main sets of genes suspected in autoimmune diseases
  - Genes related to: immunoglobulins, T-cell receptors, HLA (human leukocyte antigens)
- Mechanisms
  - Host antigens become immunogenic if they are altered in some way
    - Alteration of self-antigen → self-antigens may be altered chemically, physically or biologically

| Chemical | - bind with self-antigens, make them immunogenic, as occurs in drug-induced hemolytic anemia
  - e.g. cephalosporin antibiotics, most common cause |
| Physical | - UV light induces keratinocyte apoptosis and subsequent altered immunogenicity of autoantigens, resulting in photosensitivity
  - e.g. occurs in cutaneous lupus erythematosus |
| Biologic | - Persistent infection with an RNA virus that combines with host tissues alters autoantigens biologically, resulting in an autoimmune disorder resembling SLE
  - Antibodies to foreign antigen may cross-react with an unaltered antigen
    - E.g. antibodies to streptococcal M protein may cross-react with cardiac muscle (myocardium) |
## Autoimmune conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Etiology</th>
<th>Pathophysiology</th>
<th>Symptoms, associated conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celiac disease</td>
<td>Inflammation of the small intestine triggered by ingestion of gluten in wheat, rye, or barley. Will lead to villous atrophy, but villi will regenerate after a gluten-free diet has been re-established</td>
<td>These unique MHC’s are known to bind to gliadins (protein subunit of gluten) Intestinal T cells are activated when their MHC’s bind to the epitopes of these gliadins or prolamines. T cells in the lamina propria may release interferons to cause inflammation.</td>
<td>B12 anaemia, Iron, folate, and calcium absorption deficiency, Stunted growth, Diarrhoea</td>
</tr>
<tr>
<td>Sjogren’s syndrome</td>
<td>Disease of the exocrine glands, insidious disease (gradually gets worse) Primary SJS: exocrine gland dysfunction only. Secondary SJS: exocrine gland dysfunction and connective tissue disorders (rheumatoid arthritis, systemic lupus erythematosus)</td>
<td>Not completely understood. Genetic predisposition, hormonal influence, and viral infections are thought to trigger SJS. Once the epithelial cells are triggered, CD4 T cells and B cells infiltrate (thought to be via TLR upregulation by the epithelial cells). Immune reaction in the ducts causes atrophy. Intraductal cell proliferation can cause luminal narrowing and blockage, further accelerating atrophy.</td>
<td>Gritty feeling in the eyes, Parotitis (often bilaterally), Dermatitis, Pruritis (itchiness), Erythema (redness), Difficulty swallowing.</td>
</tr>
<tr>
<td>Rheumatoid arthritis (RA)</td>
<td>Insidious disease; chronic inflammatory disease targeting the synovial tissues (joints). Triggers can be smoking, infections or trauma coupled with genetic predisposition. Once initiated by a trigger, the immune response is perpetuated by autoantigens.</td>
<td>Cells responsible for cellular immunity (CD4, phagocytes, neutrophils) cause the inflammatory reaction. Synovial cells undergo hyperplasia and inflammation. Progresses to chronic inflammation and destroys cartilage, bone, tendons, ligaments, blood vessels, and muscle.</td>
<td>Early morning stiffness, Fatigue, Low-grade fever, Anaemia, Pain on motion, Swelling, Deformity + instability of joints, Osteoporosis.</td>
</tr>
<tr>
<td>Systemic Lupus erythematosus</td>
<td>Manifests in the skin, joints, kidney, CNS, CV, serosal membranes, hematologic, and immune systems involves autoantibodies which have multiple specificities. Commonly binds to nucleic acid binding proteins.</td>
<td>Not completely understood. Triggers are thought to be from UV light, the immune cells begin making autoantibodies to the nuclear fragments of these lysed cells. These are named “antinuclear antibodies” which are a diagnostic tool for SLE. The antigen antibody complex can deposit anywhere in the body. This initiates an immune response and inflammation.</td>
<td>Symptoms are typically waxing and waning but can be chronic. Rash, Scarring from chronic rash, Photosensitivity, Ulcers in mucosa, Arthritis, Renal disorders, Anemia.</td>
</tr>
<tr>
<td>Autoimmune hepatitis</td>
<td>Therapy: corticosteroids $\rightarrow$ anti-inflammatory/immunosuppressive</td>
<td><strong>Type 1:</strong> circulating antinuclear Ab and/or anti-smooth muscle Abs -predominant form seen in adults/adolescents. <strong>Type 2:</strong> defined by presence of Ab to liver/kidney microsomes (ALKM-1) and/or liver cytosol antigen (ALC-1) -typically diagnosed in infants, girls, young women.</td>
<td></td>
</tr>
</tbody>
</table>
Hypersensitivity disorder: excessive immune response to often harmless foreign antigens resulting in damage to tissues

**Type I reactions - immediate hypersensitivity, IgE mediated**
- Most common form of allergic diseases (anaphylaxis, asthma, allergic rhinitis, urticaria)
- B-cells stimulated (by CD4+ Th2 cells) to produce IgE Ab specific to an Ag
- Later exposure to same allergen cross-links bound IgE on sensitized cells (tissue mast cells & blood basophils) resulting in degranulation of granules → release histamine, proteases, cytokines, platelet-activating factor, chemotactic factors and synthesis of prostaglandins and leukotrienes → vasodilation, capillary permeability, mucus hypersecretion, smooth muscle spasm, tissue infiltration with eosinophils, Th2 cells and other inflammatory cells
- Type I rxns underly atopic disorders: allergic asthma, rhinitis, conjunctivitis, anaphylaxis, some cases of angioedema, urticaria, latex and some food allergies
- Type I reactions develop <1hr after exposure to antigen

ATOPY = exaggerated IgE-mediated immune response; all atopic disorders are type I hypersensitivity disorders

ALLERGY = any exaggerated immune response to a foreign Ag regardless of mechanism

*All atopic disorders are considered allergic but many allergic reactions (e.g. hypersensitivity pneumonitis) are not atopic

-Latex sensitivity: exaggerated immune response to water-soluble proteins in latex products (e.g. rubber gloves, dental dams) → reaction can be acute (IgE-mediated Type I) or delayed (cell-mediated Type IV); acute reactions cause urticaria and anaphylaxis, delayed reactions cause dermatitis

**Type II reactions – Ab-dependent cytotoxic hypersensitivity**
- Ab-Ag complexes activate cytotoxic cells (NK cells, eosinophils, macrophages), complement or both → result in cell death and tissue damage
- Examples: hyperacute graft rejection of organ transplant, autoimmune hemolytic anemias, Hashimoto thyroiditis (autoimmune disease), anti-glomerular basement membrane disease

**Type III reactions – immune complex disease**
- Cause inflam’m’n in response to circulating Ag-Ab immune complexes deposited in vessels or tissue
- Complement system or certain immune cells get activated, resulting in release of inflammatory mediators
- Larger immune complexes tend to be deposited in various tissues (glomeruli, blood vessels) → cause systemic reactions
- Examples: SLE, RA, leukocytoclastic vasculitis, glomerulonephritis

**Type IV reactions – Delayed hypersensitivity**
- Ag-specific T-cell mediated disorders that appear after a time lag
- Ag targeted by T-cells not Abs as in other types of reactions
- The reaction stimulates the release of mediators of inflammation → tissue injury
- Example: Contact dermatitis following exposure to certain metals and plants (poison ivy); allograft rejection, immune response to TB, drug hypersensitivity
- Takes 2-3 days to develop
- T cells (sensitized after contact with a specific antigen) are activated by re-exposure to Ag → damage tissue by direct toxic effects or thru release of cytokines which activate eosinophils, monocytes & macrophages, neutrophils or NK cells

- Allergic & other hypersensitivity disorders are inappropriate or exaggerated immune reactions
- Allergic & atopic disorders involve exaggerated immune responses to foreign antigens
- Allergen bind to IgE-sensitized mast cells + basophils → histamine released from intracellular granules → histamine facilitates inflammation primary mediator of clinical atopy
  - Mast cells concentrated in skin, lungs, GI mucosa (although widely distributed)
- Physical disruption of tissue and various substances (e.g. tissue irritants, opiates, surface-active agents, complement) → trigger histamine release directly, independent of IgE

**Mast Cells:**
- Extravascular immune cell
- Make classic inflammatory mediators (histamine, heparin, leukotrienes, platelet-activating factor)
- Proteases (tryptase)
- AMPs (cathelicidin and defensins)
- Basophils and mast cells are the source of hypersensitivity reactions associated with allergic responses

**Histamine effects:**
- Local vasodilation → erythema
- Increased capillary permeability & edema → wheal
- Vasodilation of surrounding arterioles → flare (redness around a wheal)
- Stimulation of sensory nerves → itching
- Smooth muscle contraction in airways (bronchoconstriction) & GI tract (increase GI motility)
- Increased nasal, salivary and bronchial gland secretions

***NOTE: Hypersensitivity reactions & autoimmune diseases overlap but not same thing

- Hypersensitivity reactions are mechanisms (not specific diseases) → describe how the body reacts or overreacts to certain stimuli
- Not all hypersensitivity reactions are linked to an autoimmune disease (Type I hypersensitivity is not involved in autoimmune diseases)
- Not all autoimmune diseases are caused by a known hypersensitivity reaction; sometimes etiology is unknown
- Autoimmune diseases characterized by body attacking itself
- Many (but not all autoimmune diseases have a hypersensitivity reaction as part of their pathogenesis
## Acid-Base Balance

**Summary:**
- **Chemical** buffering is immediate
  - act very quickly, low capacity as the body will exhaust its supply of chemical buffers rather quickly
- **Pulmonary** regulation occurs over minutes to hours
  - ~50-75% effective but doesn’t completely normalize pH
- **Renal** regulation occurs hours to days after changes in acid-base status
- Increasing pulmonary and renal activity is slower but sustainable over long periods

### Respiratory Acidosis & Alkalosis

- caused primarily by changes in carbon dioxide exhalation due to lung or breathing disorders (COPD, cystic fibrosis, severe asthma, pulmonary edema, chronic bronchitis, emphysema pneumonia, hyperventilation b/c of fever, pain, etc.)

**ACIDOSIS CAUSE:**
- due to elevation in arterial partial pressure of carbon dioxide (PaCO₂) concentration
- lung disorders listed above
- sleep apnea
- disorders of nerves or muscles of chest that impair breathing such as Guillain-Barre syndrome, amyotrophic lateral sclerosis (ALS)
- overdose of drugs such as alcohol, opioids and strong sedatives

**ACIDOSIS SYMPTOMS:**
- headache & drowsiness
- stupor and coma (can develop within moments if breathing stops or is severely impaired; over hours if breathing less dramatically impaired)

**ALKALOSIS CAUSE:**
- anxiety, aspirin overdose (early stage), fever, hypoxemia, pain

**ALKALOSIS SYMPTOMS:**
- irritability, muscle twitching/cramps
- if severe, prolonged contraction & spasms of muscles (tetany) can develop

### Metabolic Acidosis & Alkalosis

**ACIDOSIS CAUSES:**
- ingestion of alcohol, aspirin, iron
- lactic acidosis (buildup of lactic acid as result of shock)
- loss of bases such as bicarbonate, through digestive tract due to diarrhea, ileostomy or colostomy
- advanced kidney disease
- toxins such as carbon monoxide, cyanide, ethylene glycol and methanol
- diabetic ketoacidosis (buildup of ketones)

**ACIDOSIS SYMPTOMS:**
- nausea, vomiting, fatigue
- breathing becomes deeper and slightly faster
- weak, drowsy and may feel confused, nauseated as acidosis worsens
- BP drops, leading to shock, coma & death

**ALKALOSIS CAUSES:**
- loss of acid from vomiting or drainage of stomach
- overactive adrenal gland (Cushing syndrome & some adrenal tumors)
- use of diuretics (thiazides, furosemide)

---

**Metabolic Acidosis & Alkalosis**

- Acidosis & alkalosis categorized as metabolic or respiratory (depends on primary cause)
  - Presence of acidosis or alkalosis is often indicative of an underlying disorder
- Metabolic acidosis & metabolic alkalosis are caused by imbalance in production of acids or bases and/or their excretion by the kidneys
## Drugs mentioned in BLI lectures

<table>
<thead>
<tr>
<th>Drug + Class</th>
<th>Indications</th>
<th>Pharmacologic actions</th>
<th>Effect on dental treatment</th>
</tr>
</thead>
</table>
| **Ramipril, ACEI** | - treatment of heart failure (HF) after myocardial infarction (MI)  
- treatment of hypertension, alone or in combination with thiazide diuretics  
- to reduce the risk of MI, stroke, and death in patients ≥55 years of age at high risk of developing major cardiovascular events | - ACE inhibitors lower BP by reducing the production of angiotensin II, thereby reducing vasoconstriction | Patients may experience orthostatic hypotension as they stand up after treatment; especially if lying in the dental chair for extended periods of time. Use caution with sudden changes in position during and after dental treatment  
• An ACE inhibitor cough is a dry, hacking, nonproductive cough that can potentially interfere with longer dental procedures if the patient has this side effect |
| **Hydrochlorothiazide, antihypertensive/thiazide diuretic** | - Management of mild-to-moderate hypertension  
- Treatment of edema due to heart failure, hepatic cirrhosis, various forms of renal dysfunction (e.g. nephrotic syndrome, acute glomerulosclerosis, chronic renal failure) | blocks salt and fluid reabsorption from the urine in the kidneys, causing increased urine output (diuresis) | Patients may experience orthostatic hypotension as they stand up after treatment; especially if lying in the dental chair for extended periods of time. Use caution with sudden changes in position during and after dental treatment |
| **Warfarin, anticoagulant/vit K antagonist** | - Prophylaxis and treatment of thromboembolic disorders and embolic complications arising from atrial fibrillation or cardiac valve replacement  
- reduce risk of systemic embolism (e.g., recurrent MI, stroke) after MI  
- treating patients with DVT  
- treating patients with pulmonary embolism | -prevents the formation of blood clots by reducing the production of factors II, VII, IX, and X, and proteins C+S  
-The production of these factors by the liver are dependent on adequate amounts of vitamin K  
-Warfarin antagonises vit K | Key adverse event(s) related to dental treatment:  
• oral ulcers  
• taste disturbance  
• Signs of warfarin overdose may first appear as bleeding from the gingival tissue  
Hemostasis is established locally by packing the extraction sockets with oxidised cellulose (Surgicel) and suturing with 3-0 silk sutures |

**CAUTION**
- metronidazole interacts with warfarin and should be avoided wherever possible  
- If it cannot be avoided the warfarin dose may need to be reduced by a third to a half

**Corticosteroids (systemic):** May enhance the anticoagulant effect of Warfarin. **Risk C: Monitor therapy**

**Concurrent antibiotic use:**
- A retrospective study evaluating over 38,000 patients ≥65 years of age showed exposure to any antibiotic agent was associated with at least a 2-fold increased risk of bleeding that required hospitalisation among continuous warfarin users  
- All 5 antibiotic drug classes examined (macrolides, quinolones, cotrimoxazole, penicillins, and cephalosporins) were associated with an increased risk of bleeding

**Exposure to anazole antifungal (fluconazole, ketoconazole, or miconazole) while on warfarin was associated with a 4-fold increased risk of bleeding.**
- Drug interactions, internal bleeding, bleeding intolerance, alopecia, GI discomfort, rash, skin necrosis
like all anticoagulants, the major side effect of warfarin is bleeding

- Warfarin should be avoided during pregnancy, particularly during the first trimester
- Warfarin crosses the placenta and can cause fetal abnormalities

Target INR is:
- 2.5 with a range of 2.0 - 3.0 for most indications for warfarin therapy
- 3.0 (range of 2.5 - 3.5) for: mechanical heart valves in mitral position & non-bileaflet valve in aortic position

| Dabigatran, direct thrombin inhibitor oral anticoagulant | Dabigatran is replacing warfarin as a standard anticoagulant with the main advantages that **INR monitoring is not needed, and it is not affected by foods**
Dabigatran levels peak **1 to 2 hours** after oral administration
  - half-life of 12 - 14 hrs |
| - By binding reversibly to the active site of thrombin, dabigatran **reduces thrombin activity and reduces fibrin formation** |
| Consult the family physician or specialist regarding the proposed dental surgery procedure, explaining the surgical complexity and the planned approach:
  - surgical extraction, Surgicel/gelfoam hemostatic gauze placed into socket, resorbable chromic gut sutures placed over the dressings to prevent their displacement, tea bags to maintain pressure over the sockets for several hours post-extraction
  - Ask the physician to advise the patient about his/her recommendations. Ensure the patient follows instructions
  - **Given the rapid onset of action of dabigatran (2 hours) and its relatively short half-life (12-14 hours), it is recommended that procedures be performed as late as possible after the most recent dose** |

**Bleeding Tests and dabigatran:**
**INR (international normalised ratio) ➔** relatively insensitive to dabigatran with only supra-therapeutic concentrations of dabigatran resulting in an INR of approximately 2.0

**Thrombin time ➔** very sensitive for patients on Dabigatran
A prolonged thrombin time indicates:
- a fibrinogen abnormality
- impairment of fibrin formation
- **thrombin inhibitory effect (e.g. - Heparin, Dabigatran)**
  - **Thrombin inhibitory effects include the following:** Heparin, direct thrombin inhibitors

**aPTT ➔** moderately sensitive for patients on Dabigatran
- Why? Thrombin is involved in the Intrinsic Pathway
- Activates Factor VIII and helps activate Factor XI in the Intrinsic Pathway

*A normal thrombin time excludes abnormalities in the fibrin formation process of the coagulation cascade*
### Cardio Block

#### Atherosclerosis

<table>
<thead>
<tr>
<th><strong>Body mass index</strong></th>
<th>Measure of body fat based on height and weight of adult male/female. Underweight &lt;18.5, normal 18.5-24.9, overweight 25-29.9, obese 30+</th>
</tr>
</thead>
</table>

**Atheroma**
- Lipids, inflammatory cells, smooth muscle cells, connective tissue matrix, thrombi in various stages of organization, calcium deposits -patchy intimal plaques that encroach on the lumen of medium and large sized arteries
- atherosclerosis is characterized by atheromas

| **Arteries** | Tunica externa – outer connective tissue layer; made of CT and collagen  
|--------------|----------------------------------------------------------------------------------------------------------------------------------|
|              | Tunica media – middle layer composed of SMC & elastic tissue  
|              | Tunica intima – innermost layer, direct contact w/ flow of blood (endothelial cells); Weibel-Palade bodies (vWF and P-selectin → hemostasis & inflammation)  
|              | Diff types of arteries:  
|              | Elastic artery = conducting → aorta, pulmonary trunk & arteries  
|              | Muscular artery = distributing → carotid, femoral  
|              | Arteriole = small diameter BV in microcirculation → capillaries |

<table>
<thead>
<tr>
<th><strong>Lipids</strong></th>
<th>Water insoluble organic molecules → fats, sterols, fat-soluble vitamins (A,D,E,K), monoglycerides, diglycerides, triglycerides, phospholipids,...</th>
</tr>
</thead>
</table>
|            | Diff types of lipids:  
|            | Storage – triglycerides (triacylglycerol, TAG)  
|            | Structural – phospholipids  
|            | Signaling – steroid hormones  
|            | Transporting – lipoproteins; chylomicrons, VLDL, IDL, LDL, HDL  
|            | Cholesterol – essential biological molecule, precursor for prod’n of bile acids, vit D, steroid hormones; critical structural element in cell membranes |

| **Cholesterol** | Acquired thru biosynthesis (75%) & dietary (25%)  
|                | -main sterol made primarily in hepatic cells  
|                | -also made in intestines, adrenal glands, reproductive organs  
|                | -dietary source mainly animal fats (cheese, egg yolk, beef, pork, poultry, fish, ...) |

| **Lipoproteins** | Made of cholesterol, triglycerides & proteins; Main fxn = transport hydrophobic lipid molecules  
|                 | -single layer phospholipid & cholesterol outer shell → hydrophilic outside, hydrophobic inside |

---

### Lipoproteins

| **Types** |  
|-----------|----------------------------------------------------------------------------------------------------------------------------------|
| Chylomicrons – carry triglycerides from intestines → liver, skeletal muscle, adipose tissue  
| VLDL – made in liver, carry triglycerides from liver → adipose tissue & muscle  
| IDL – as IDL particles lose triglycerides, become LDL  
| LDL – deliver cholesterol, triglycerides, phospholipids to peripheral tissues; most cholesterol content of all lipoproteins (80%); MAIN carrier of circulating cholesterol within body, used by hepatic cells for cell membrane + steroid hormone synthesis  
| HDL – made in liver, mobilize cholesterol from periphery (including atheromas), transport to liver (reverse cholesterol transport) |

| **Lipid metabolism** | Lipoprotein lipase – on blood vessel endothelial cells → hydrolyze lipids in chylomicrons & lipoproteins → release glycerol & fatty acids → absorbed by adipose/muscle cells for energy/storage  
|                     | -adipose tissue TAG = body’s major energy store  
|                     | -glucagon, cortisol, growth hormone, epinephrine INCREASE lipolysis  
|                     | -insulin DECREASE lipolysis  
| **3 main pathways** |  
| 1. Exogenous pathway | -dietary absorption thru intestine  
| 2. Endogenous pathway | -hepatic-derived lipoproteins; lipoproteins circulate thru blood continuously until lipids they contain are taken up by peripheral tissues or lipoproteins are cleared by the liver  
| 3. Reverse cholesterol transport | -trf unused cholesterol from cells back to liver; HDL |

| **Xanthelasma** | Depositions of cholesterol-rich material related to hyperlipidemias  
|                | -not diagnostic but increases risk for cardiovascular disease |

| **Dyslipidemia** | Common causes:  
|                 | -diet – high calories, bad fats, excessive ethanol ingestion  
|                 | -underlying disease states: chronic kidney disease, hypothyroidism, cholestatic liver disease, diabetes mellitus, anorexia nervosa  
|                 | -drugs: antipsychotics, high dose diuretics, isotretinoin, BB, antiretroviral agents, cyclosporine, tacrolimus, estrogen, progestins, glucocorticoids |
### Calcified carotid artery atheroma (CCAA)

- Atherosclerosis involving carotid arteries
- Patients with confirmed CCAA must be referred with radiographic images
- Treatment: medical if stenosis <50%, surgical if >50%

**Disease mechanism:** Stenotic atheromatous plaque in extracranial carotid vasculature

**Location:** Atherosclerosis first develops at arterial bifurcations as a result of increased endothelial damage from shear forces at these sites; calcified lesions may be visible on pano radiograph in soft tissues of the neck (superior or inferior to greater cornu of hyoid bone → where common carotid artery splits into external and internal carotid arteries, adjacent to C3/C4)

- Periphery & shape: usually multiple, irregular shape, sharply defined from surrounding soft tissues
- Management: should be referred for further investigation; can have clinically significant stenoses with increased risk for cerebrovascular accident

### Diabetes

**Definition:**
Metabolic disorder characterized by presence of hyperglycemia due to:

1. Defective insulin secretion
2. Defective insulin action

**Chronic hyperglycemia** of diabetes is associated with: microangiopathy, macroangiopathy, neuropathy

**Diagnostic criteria** for diabetes based on thresholds of glycemia that are associated with microvascular disease, especially retinopathy:

1. Fasting plasma glucose > 7.0 mmol/L
2. 2 hr plasma glucose ≥ 11.1 mmol/L
3. Glycated hemoglobin (A1c) > 6.5%
4. Random PG > 11.1 mmol/L

**Prediabetes** = impaired fasting glucose, impaired glucose tolerance, A1c 6-6.4%

**Classification of diabetes**

<table>
<thead>
<tr>
<th>Type I</th>
<th>Aka insulin-dependent diabetes mellitus (IDDM), juvenile diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diabetes encompasses diabetes that is primarily as result of pancreatic beta cell destruction and is prone to ketoacidosis</td>
</tr>
<tr>
<td></td>
<td>Usually begin at childhood; 5-10%</td>
</tr>
</tbody>
</table>

**Etiology:**

1. Genetics – only 10% association
2. Autoimmune- destruction of beta cells, autoantibodies
3. Environmental- viral infection → autoimmune response; infant cow milk diet
4. Idiopathic (10-15%)

<table>
<thead>
<tr>
<th>Type II</th>
<th>Aka non-insulin-dependent diabetes mellitus (NIDDM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90-95% of diabetic patients,</td>
</tr>
<tr>
<td></td>
<td>Due to either insulin insensitivity or not enough insulin to meet metabolic demand</td>
</tr>
<tr>
<td></td>
<td>Usually combo of peripheral tissue insulin resistance + inadequate secretion of insulin</td>
</tr>
<tr>
<td></td>
<td>Cells fail to respond to insulin properly &amp; can progress to insufficient insulin being produced (beta cell dysfunction → compensation fails due to b-cell exhaustion, glucotoxicity, lipotoxicity</td>
</tr>
<tr>
<td></td>
<td>Caused by genetic (MORE than type I, 38%), environmental (obesity, high fat diet, sedentary lifestyle) and aging components (&gt;45)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gestational</th>
<th>Abnormal glucose tolerance w/ onset or first recognition during pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-7% of all pregnancies (pregnancy hormone interfere w/ insulin &amp; receptor)</td>
</tr>
<tr>
<td></td>
<td>Usually ok after birth but increase risk (50%) for developing type 2 DM within 20yrs</td>
</tr>
<tr>
<td></td>
<td>Can have fetal complications (spontaneous abortion, large fetus)</td>
</tr>
</tbody>
</table>

**Risk factors:** Obesity, family history of DM, previous history of GDM, previous child birthweight >4kg, current glucocorticoid therapy

**Treatment:** Diet modification, exercise, insulin
## Dental considerations
- Higher rates of refractory periodontitis (due to localized ischemia), slow heal
  - **Oral complications:** gingivitis, periodontal disease, salivary gland dysfunction, xerostomia, benign parotid hypertrophy (sialosis), increase risk of infxn, oral candida infxn, angular cheilitis, neuropathy (dysgeusia, glossitis), altered tooth eruption
  - Poor controlled DM → compromised neutrophil adherence, chemotaxis, phagocytosis, bactericidal activity, cell mediated immunity
  - During appointment: change to meds, make sure they ate (give juice prn), ensure they didn’t just take insulin injection, keep short, LA w/ vasoconstrictors avoided, properly aspirate b4
  - After appointment: glucocorticosteroids prescribed w/ caution due to increased blood glucose; be aware of swelling, pain erythema
  - UNCONTROLLED/brittle diabetic: anesthetic w/ no epi, abx after treatment, hospital care recommended if complicated treatment for precise insulin management

## Advanced glycation end products (AGEs)
- Proteins/lipids become glycated as result of exposure to sugars → induce crosslinking of collagen → vascular stiffening & entrapment of LDL in artery walls
  - Also cause glycation of LDL → promote oxidation → development of atherosclerosis
  - Bind to RAGE (receptor for AGE) → oxidative stress, activ’n of inflammatory pathways

## Long term complications

<table>
<thead>
<tr>
<th>Microvascular</th>
<th>Neupathy, nephropathy (CKD) → renal failure, eye complications (retinopathy, cataracts, blurred vision, glaucoma, blindness), foot complications (ulcers, gangrene, arthritis), paresthesia, ischemia, impaired wound healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrovascular</td>
<td>- Coronary circulation (MI due to accelerated atherosclerosis, hypertension), - Cerebral circulation (TIA, CVA) - Peripheral circulation (ischemia, claudication – pain of skeletal muscle due to ischemia) - Foot complications (ulcers, gangrene, arthritis)</td>
</tr>
</tbody>
</table>

## Signs & symptoms
- Main: polyuria, polydipsia, polyphagia, weight loss (DM-1), loss of strength
- Other: paresthesia, repeated skin infxn, irritability, headache, malaise, xerostomia, ketoacidosis, cataracts, blurred vision, dry/flushed skin, impotence, hypertension

## Diabetic dyslipidemia
- Atherogenic combo of high TGs, high LDL, low HDL
  - DM 2 esp at risk if obese & poor control → increase circulating FFAs → increase hepatic VLDL prod’n
  - Insulin resistance → increase lipolysis & FFAs → liver → increase hepatic synthesis of VLDL
  - VLDL → transfer TG + cholesterol to adipose tissue → LDL increases

## Smoking + perio health
- Smoking ↑ expression of cytokines involved in periodontal destruction
  - Smoking induces negative effects on PMNs leading to abnormal phagocytosis
  - Heavy smokers have 6-7x more alveolar bone loss

## Perio health + cardiovascular disease
- Periodontal and cardiovascular diseases (CVD) are inflammatory diseases
  - Recent epidemiological studies associated effect of periodontitis on CVD progression → findings of oral pathogens in carotid atheromas provide plausible relationship b/w these 2 diseases
  - Possible mechanism: plasma infiltration of oral/periodontal pathogens thru inflamed & ulcerated gingival epithelium → translocation of oral pathogen → systemic circulation → affect vascular tissue → cascade of inflammatory reactions detrimental to cardiovascular system
  - Possible mechanism: leakage of pro-inflamm. cytokines/chemokines from ulcerated periodontium into blood stream → hepatic acute-phase proteins → chronic bacteremia, activate adaptive immune system → Ab produced trigger cross-reaction b/w endothelial cells & modified LDL → enhance subendothelial movement of LDL

## Coronary artery atherosclerosis
- Location: most common site in heart = anterior descending branch of left coronary artery (oclusion of this vessel → infarction → major morbidity/death rate)
- Signs + symptoms: chest pain, SoB, weakness, reduced exertional capacity, dizziness, palpitations, heart murmurs, syncope, leg edema, diaphoresis, stable angina pectoris, intermittent claudication (muscle pain during exercise), tachypnea, xanthelasmata

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**DEFINITIONS:**

- Angina pectoris, intermittent claudication (muscle pain during exercise), tachypnea, xanthelasmata
- Signs + symptoms: chest pain, SoB, weakness, reduced exertional capacity, dizziness, palpitations, heart murmurs, syncope, leg edema, diaphoresis, stable angina pectoris, intermittent claudication (muscle pain during exercise), tachypnea, xanthelasmata

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**Dentists role**
- Recognize periodontal health status (severity correlates with risk level)
- Educate pt concerning association (CVD + bacteremia ↑ systemic inflammation)
- Comprehensive periodontal therapy, urge lifestyle modification
**Acute coronary syndrome**: ACS, umbrella term for myocardial ischemia, including unstable angina pectoris and myocardial infarction (with or without ST segment elevation)

**Unstable angina**: cardiac chest pain that is new, worsening (more severe/prolonged/frequent than before), or occurring at rest without serological evidence of myocyte necrosis (no ↑ troponin/creatine kinase (CK-MB))

**ST segment elevation MI**: STEMI, acute-onset cardiac chest pain, serological evidence of myonecrosis and persistent (>20min) ST segment elevation

**Non-STEMI**: cardiac chest pain with serological evidence of myonecrosis and w/o ST segment elevation

### Acute Myocardial infarction

**Can result from**: arrhythmias (V tach), heart failure, valve insufficiency, embolization

**Serological evidence**

1. **Myoglobin** present in both heart & skeletal muscle and is rapidly released from damaged tissue (<2h)
   - Early myoglobin release into blood suggestive of myocardial damage; confirmed using more cardiac specific marker such as **troponin** (I and T limited to cardiomyocyte)

2. **Creatine kinase-MB (CKMB)** present in both heart and skeletal muscle
   - Levels increase w/ myocardial damage (although normally present in small quantities in blood)
   - Rises quickly in blood, can be used as rapid indication of myocardial damage
   - Less specific than troponin assays but used with pts w/ acute chest pain

**Prognosis**
- 5-10% hospitalized pt for STEMI die (rest depends on infarct size/severity, age, co-morb., development of hypotension or heart failure)
- post discharge mortality 6-8% (half die within first 3 months, 4% within following year)
- determining factors of prognosis depend on LV dysfunction, residual myocardial ischemia, ventricular arrhythmias, history of prior MI

### MI and dental care

**History of MI**
- before treatment consult w/ physician, ask about unstable angina and exercise tolerance, use adequate local analgesia to minimize pain/discomfort/anxiety → minimize release of endogenous catecholamines
- short morning appointments (stress reduction)
- if recent <1 mo, should defer elective treatment depending on clinical circumstances (if care necessary, consult physician)
- management: establish IV, sedation, oxygen, cautious use of vasoconstrictors, prophylactic nitroglycerin, monitor (ECG, pulse oximeter, BP)
- **past MI >1 mo without symptoms** – intermediate risk: elective dental care may be provided with following management: assess vitals, confirm NG, LA (limit epi to 0.04mg → <2 cartridge containing 1:100,000 epi), stress and anxiety reduction, adequate postop pain control
- if pt on aspirin or platelet aggregation inhibitor, excessive bleeding controlled thru local measures (don't discontinue meds)
- if pt has pacemaker or implanted defibrillator, abx prophylaxis not recommended
- if pt on warfarin, INR checked within 24 hrs of any dental surgery (<3.5)
- abx prophylaxis not recommended for pt w/ history of CABG, angioplasty or stent

**VASOCONSTRICTORS**:
- in pts at major risk of developing perioperative cardiovascular complications, vasoconstrictors should be used only in consultation with patient’s physician who may be recommend avoiding
- high risk category: very recent MI (within last 4 weeks), decompensated heart failure, significant arrhythmias (AV block, ventricular-related arrhythmia)
- some studies show that very modest quantities of vasoconstrictor are safe in high risk pts when accompanied by oxygen, sedation, NG, adequate pain control

### Stress reduction protocol

**Hypertensive patients**
- open communication about fears
- gentle chairside manner
- preop sedation (benzo), intraop sedation (N2O-O2)
- profound LA, adequate postop pain control
- short appointments (morning)
- f/u pt evening of procedure
Oral manifestations – cardiac medications

| Metoprolol | Lichenoid drug reactions |
| Nitroglycerin | Xerostomia |
| Simvastatin | Xerostomia, lichenoid drug reactions |
| Hydrochlorothiazide | Xerostomia, lichenoid drug reactions |
| Angiotensin II receptor blocker | Nifedipine, diltiazem – gingival hyperplasia |
| Ramipril | Cough, dysgeusia, lichenoid drug reactions, angioedema, burning sensation in the mouth |

Prolonged Aspirin therapy
- gingival bleeding, petechiae, ecchymoses, prolonged bleeding after dental procedures

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**Signs and symptoms of shock**

1. Low systolic BP<90mmHg
2. Rapid HR: sympathetic stimulation
3. Weak & rapid pulse: reduced CO, fast HR
4. Cool, pale, clammy skin: sympathetic constriction + diaphoresis
5. Altered mental state: reduced oxygen to brain
6. Reduced urine formation: increased ADH, aldosterone
7. Thirsty: from loss of ECF
8. Blood pH low (acidosis): lactic acid buildup- anaerob respiration
9. Nausea: impaired blood flow to GI

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**Metabolic syndrome**

| At least 3 of 5: |
| Abdominal (central) obesity |
| Elevated BP |
| Elevated fasting plasma glucose |
| Dyslipidemia (high serum triglycerides, low HDL) |

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**Congestive heart failure**

**Symptoms**

| Pitting edema (legs, hands) |
| Fluid retention |
| Organ enlargement |
| Neck veins |
| Shortness of breath |
| Gastrointestinal |

**Left-sided heart failure**

| Mild to moderate |
| Pulmonary edema (fluid in lungs) and pleural effusion (fluid around lungs) |
| Heart |
| Mild to moderate raised JVP |
| Prominent dyspnea |
| Present but not as prominent |

**Right-sided heart failure**

| Moderate to severe |
| Abdomen (ascites) |
| Heart + liver |
| Severe JVP, neck veins visibly distended |
| Dyspnea present but not as prominent |
| Loss of appetite, bloating, constipation, symptoms significantly more prominent than LVF |

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**Medical Emergencies**

*Staff must rehearse role of emergencies at least 2x a year*

**Emergency drugs + dentistry**

| Flumazenil | Antidote to benzodiazepines overdose |
| Naloxone kit | Opioid overdose |
| Nitroglycerine | Pain of angina |
| Diphenhydramine Chlorpheniramine | Allergic reactions 50mg IM or IV |
| | Allergic reactions 1mg IM or IV |

0.3-0.6mg SL
| **Hydrocortisone sodium succinate** | -anaphylaxis/allergic reactions + acute asthmatic attack/bronchoconstriction  
-100mg in 2ml vial | **Salbutamol** | Asthmatic bronchospasm  
2 puffs (200ug) |
|---|---|---|---|
| **Midazolam** | Status epilepticus or LA overdose resulting in seizure  
-2-4mg IM, if elderly, start with 2mg  
-children dose: 0.05mg/kg IM | **ASA** | MI  
160-325mg |
| **Oxygen** | Most important drug to have  
Adult dose: 100% inhalation  
Indication: every medical emergency except hyperventilation | **Sugar cubes**  
50% dextrose | 1 or 2 for hypoglycemia (conscious)  
Titrate IV for hypoglycemia (unconscious) |
| **Epinephrine** | Drug of choice for: cardiac arrest (1mg IV), anaphylaxis (0.5mg IM or 0.3mg IV), asthma that doesn’t respond to salbutamol (0.5mg IM or 0.3mg IV)  
\(\beta_1\)- agonist \(\rightarrow\) stimulates the heart  
- Positive inotrope \(\rightarrow\) increases force of cardiac muscle contraction  
- Positive chronotrope \(\rightarrow\) increase heart rate  
\(\beta_2\)- agonist \(\rightarrow\) dilates bronchioles and vasculature  
\(\alpha_1\)- agonist \(\rightarrow\) vasoconstricts  
- Although alpha receptors are less sensitive to epi, when activated, they override vasodilation mediated by \(\beta\)-adrenoreceptors b/c there are more peripheral \(\alpha_1\) receptors than \(\beta\)-adrenoreceptors \(\rightarrow\) results in vasconstrictions at high levels of circulating epinephrine  
- At lower levels of circulating epi, \(\beta\)-adrenoreceptors stimulation dominated \(\rightarrow\) vasodilation followed by decrease of peripheral vascular resistance  
Cardiac arrest: ACLS (advanced cardiovascular life support), give epi IV, intraosseous, endotracheal tube | **Spontaneous breathing** | \(\%O_2\) | (+) pressure ventilation | \(\%O_2\) |
| | Nasal cannulae w/ O2 | 25-45% | Mouth to mouth or mask | 16% |
| | Simple face mask | 40-60% | Bag-valve-mask + room air | 21% |
| | Non-rebreather face mask w/ O2 | 90-100% | Bag-valve-mask with oxygen | 75-95% |
| **Oxygen** | Delivery of \(O_2\)  
- for every emergency (except hyperventilation)  
- portable source ("E"-size cylinder)  
- full face mask if patient is conscious or unconscious yet breathing  
- bag-valve-mask device if pt is unconscious, not breathing  
- flow rate 6L/min, well-fitting oxygen mask, always ensure tank is full | **Generic algorithm for any emergency** | - stop procedure, call for help \(\rightarrow\) activate EMS \(\rightarrow\) vitals (BP, P, RR) \(\rightarrow\) oxygen (except hyperventilation) \(\rightarrow\) move dental chair, positional changes \(\rightarrow\) basic life support, call for help (CAB = circulation, airway, breathing) \(\rightarrow\) emergency drugs |
| **Pre-syncpe** | Symptoms (KNOW)  
- dizziness, light-headedness, pallor, palpitations, nausea, diaphoresis, change in vision, bradycardia, hypotension, pupil dilation, peripheral coldness, tachypnea | **Syncope** | *most frequent of medical emergencies in dental practice*  
1. vasovagal – fear, emotional stress, pain  
- Mechanism: brainstem is activated \(\rightarrow\) simultaneous enhancement of parasympathetic nervous system (vagal) tone \(\rightarrow\) withdrawal of sympathetic nervous system tone  
- Results in cardioinhibitory response (drop HR + contractility) \(\rightarrow\) drop CO \(\rightarrow\) lose consciousness  
- Vasodilation of BV due to withdrawal of sympathetic tone in BV  
2. situational – micturition, defecation, deglutition, cough, carotid sinus syncpe  
3. orthostatic hypotension  
Definition: transient, self-limited loss of consciousness with an inability to maintain postural tone that is followed by spontaneous recovery. Excludes: seizures, coma, shock, epilepsy |
4. cardiac – cerebral ischemia (heart not pumping enough, BP not enough tone to maintain BP, not enough blood); vascular disease (ischemic heart disease, hypertension), cardiomyopathy (CHF, CHD), arrhythmia, valvular dysfunction, stress (increase endogenous epi, tachycardia, hypertension)

5. medication – acquired long QT segment

Factors influencing syncope: fasting long hours, taking in too little fluids/food, low BP, physical exercise in excess of energy reserve of body, emotional distress, lack of sleep, orthostatic hypotension

Cardiac causes of syncope: arrhythmias (SVT, AF, VT, VF), aortic stenosis, mitral stenosis, CAD, myxoma, pulmonary hypertension/stenosis/embolus, hypertrophic cardiomyopathy

Differential diagnosis: medication-related hypotension, hypoglycemia, cerebrovascular accident, seizure disorder, cardiac etiology, anaphylaxis, anxiety attack, hyperventilation syndrome

Prevention: control predisposing factors, stress reduction, pre-op sedation, patient monitoring, administer 100% oxygen, place pt in supine position, early recognition of impending syncope, minimize fear/anxiety

Management: Trendelenburg position, assess consciousness (BLS), establish airway, 100% oxygen, monitor vital signs, apply cold compress

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**ANGINA PROTOCOL**

UBC angina attack protocol
- ask if it’s happened before, if they have own NG, administer if they do
- call instructor → say we have CODE BLUE, instructor stays with patient
- student transports Crash Cart with oxygen and AED to scene
In office angina attack protocol
- ask if it’s happened before, if they have own NG, administer if they do
- NG contraindicated if systolic BP <90mmHg or if Viagra taken within 24 hrs, or if Cialis within 4-5 days
- administer oxygen 6L/min by nasal cannula or mask
- record vital signs
- if first dose of NG ineffective and BP >90/60mmHg, repeat dose every 5 mins, max 3 doses
- if angina is NEW, or departs from usual pattern in a patient with chronic angina → call 911
- pt should be transported to ER
- give 162/325mg chewable aspirin

Cardiovascular emergencies
- when SA node stops firing, the ventricles usually begin to quiver in rapid unorganized rhythm that’s incapable of pumping any blood out of the heart → ventricular fibrillation; the most common initial rhythm associated with cardiac arrest
- another rhythm associated with cardiac arrest = ventricular tachycardia (SA node has failed, ventricles pumping so rapidly they don’t have time to fill with blood + not pumping any out of heart)

- may present with: severe hypertension, chest pain, dysrhythmia, cardiopulmonary arrest
  - See above for angina protocol
  - Cardiopulmonary arrest = sudden, unexpected loss of blood flow attributable to cessation of cardiac mechanical activity
    - Causes: cardiovascular, metabolic, infectious, neurologic, inflammatory, traumatic
    - 6H’s 6T’s
      - Hypovolemia, hypoxia, hydrogen ion (acidosis), hypo/hyperkalemia, hypo/hyperglycemia, hypothermia
      - Tension pneumothorax, tamponade (cardiac), toxins/tablets, trauma, thrombosis (PE, MI)
      - End point of disorders = VF, VT, pulseless electrical activity (PEA), asystole
      - AED: shockable = VF, VT; non-shockable = pulseless electrical activity, asystole
      - PEA = rhythm that’s seen when cardiac arrest occurred due to a failure of the pump (ventricles) rather than the electrical system (SA node); looks like normal sinus rhythm, but no pulse will be felt; SA still works in organized pattern but ventricles stop contracting
        - CPR should be continued because PEA is considered a survivable rhythm
      - Asystole = flat line, no evidence of electrical or pump function in heart (defib not useful)
        - CPR should be continues as it can convert to v fib in some cases
      - Pulseless VT or VF
        - CPR, open airway, place airway device → oxygen, treat identified reversible causes (6H’s and T’s), place AED, shock patient once, resume CPR after attempted defib (beginning with chest compressions)
        - If persistent/recurrent VT/VF, perform 2ndary CAB survey
        - Epi – 1mgIV push, repeat every 3-5mins
        - Unwitnessed cardiac arrest >4min down time → 5 cycles of CPR (~2mins)
        - Witnessed cardiac arrest <4min down time → shock can be administered immediately if pt is in VF or pulseless VT, follow by 5 cycles of CPR
**Congenital heart disease**

### Fetal circulation
- Receive oxygenated blood from placenta via umbilical vein into fetal inferior vena cava
- Patent foramen ovale allows more oxygenated blood to cross into left atrium from right atrium → bypass immature fetal pulmonary system

#### 3 Major fetal shunts:
1. **Foramen ovale** – will physiologically close after birth due to orientation of flaps, change in pulmonary vascular resistance, changes in left atrial pressure
2. **Ductus arteriosus** – allow blood bypass unexpanded lungs (pulmonary artery → aorta)
3. **Ductus venosus** – allow blood from umbilical vein → directly into inferior vena cava (bypass liver)

- Purpose of shunts = bypass lungs and liver (organs work after birth)

### Circulation changes at time of birth – upon taking first breath
- Decrease in pulmonary vascular resistance:
  - Lung expands, alveoli in lungs cleared of fluid
  - Baby’s blood pressure increases
  - Pulmonary pressures go down significantly
- This increases pulmonary blood flow
- These changes raise pressure of left atrium of heart and lower the pressure in right atrium
- Shift in atrial pressure causes functional closure of foramen ovale

### Failure to thrive
- Defined as decelerated or arrested physical growth
- Height and weight measurements fall below 5th percentile

#### Causes:
- Congenital birth defects (Down syndrome, CHD)
- Endocrine abnormalities, damage to brain/CNS → feeding difficulties in infant
- Cardiopulmonary disorders, anemia, GI disorders, chronic infections, metabolism problems, complications during pregnancy or low birth weight

### Patent ductus arteriosus (PDA)
- Represents failure of normal physiological spontaneous closure that occurs between 24hrs – 1 week of life
- 10% of all congenital heart defects, present in 1/2500 full term infants (significantly higher in premature)
- Results in pulmonary over-circulation
- Characteristic murmur heard due to turbulent flow across ductus itself
- Ductus arteriosus normally patent during fetal life, patency promoted by continual production of PGE2 by ductus
- PG antagonism (maternal use of NSAIDs) → can cause premature closure of fetal ductus arteriosus → severe fetal cardiovascular compromise

#### Surgical options:
- Conservative as spontaneous closure is common (diuretics and fluid restriction – symptomatic neonates)
- Surgical ligation remain standard treatment of larger PDA that requires treatment in infancy, before 1st bday
- After 1st bday, most common treatment = occlusion with cardiac catheterization
- **Transcatheter occlusion** is least invasive → procedure of choice
  - Single/multiple coils or fitted plug delivered to site of PDA by catheter
  - Device positioned in opening and released from catheter → coil expands and blocks pathway
- Video-assisted thoracic surgical (VATS) repair also used → surgeon operated thru small incision in chest using video guidance to perform repair

(c) Patent ductus arteriosus
### Congenital heart disease

Physiological consequences of congenital heart anomalies vary greatly:
- asymptomatic heart murmur, abnormal pulses, severe cyanosis, congestive heart failure (CHF)

Signs/symptoms of CHF in infants:
- tachycardia, tachypnea, dyspnea with feeding, diaphoresis, restlessness, irritability, hepatomegaly

<table>
<thead>
<tr>
<th>Coarctation of aorta</th>
</tr>
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<tbody>
<tr>
<td>- localized narrowing of aortic lumen → 6-8% of CH anomalies</td>
</tr>
<tr>
<td>- occurs at proximal thoracic aorta just beyond left subclavian artery &amp; before opening of ductus arteriosus</td>
</tr>
</tbody>
</table>

Results in:
- Pressure overload in arterial circul’n proximal to coarctation
- Hypoperfusion distal to coarctation

Outcomes:
- Upper extremity hypertension (including brain)
- Left ventricular hypertrophy → pressure overload proximal to obstruction may cause CHF
- Decreased perfusion of the abdominal organs & lower extremities
- Heart murmur → turbulent flow thru obstructed (stenotic) point
- Headache, chest pain, cold extremities, fatigue, leg claudication, CHD, eventually shock

### Congenital pulmonary stenosis

- 8-12% of congenital heart defects
- Increased resistance leads to RV hypertrophy → right heart failure
- Hypertrophy of heart muscle helps initially, but leads to situation where RV muscle cannot get enough oxygen to meet its needs and right heart failure follows
- RV can’t cope with increased afterload as well as LV

Symptoms: heart murmur, cyanosis, dyspnea, dizziness, upper thorax pain, edema in lower extremities

### Tetralogy of Fallot

- Most common cyanotic condition (blue baby syndrome)

**Right to left shunt** with:
1. Pulmonary valve stenosis
2. Ventricular septal defect
3. RV hypertrophy
4. Overriding aorta (aorta slightly shifted to right and lies directly above ventricular septal defect; receive blood from both R & L ventricles

### Eisenmenger syndrome

CHRONIC elevated pulmonary artery pressure → may lead to arteriolar vascular changes and pulmonary vascular disease
- In baby Lucas’ case, this could lead to Eisenmenger syndrome

Eisenmenger syndrome occurs when a long-standing LEFT TO RIGHT cardiac shunt caused by congenital heart defect causes pulmonary hypertension and eventual reversal of the shunt into a cyanotic right-to-left shunt

*Eisenmenger syndrome is a complication of an uncorrected left-to-right shunt
- Increased pulmonary resistance may develop over time → bidirectional shunting and then to right to left shunting → deoxygenated blood enters systemic circulation causing symptoms of hypoxia
- Changes that can occur: pulmonary vasculature develops intimal hyperplasia & pulmonary vasoconstriction → pulmonary hypertension, right sided heart failure
**Heart sounds**

| Normal: caused by closure of valves during cardiac cycle |
| Abnormal: clicks, opening snaps caused by closure/opening of abnormal valves |
| Other heart sounds may be caused by: turbulent flow, increased flow, flow into a non-compliant ventricle |

**Murmurs:**

- made by turbulent flow (thru stenotic or regurgitant valve) or increased flow (flow thru shunt/fistula)
- systolic murmurs can be caused by: aortic valve stenosis, mitral regurgitation, pulmonary stenosis, tricuspid regurgitation, coarctation of the aorta

| S1 = closing of atrioventricular valves |
| S2 = closing of semilunar valves |
| S3 = indicates ventricular dysfunction and increased volume of blood within ventricle |
  - Often referred to as ventricular gallop |
  - Normal in children and adults <40 |
  - Can be caused by: CHF, dilated cardiomyopathy with dilated ventricles, mitral/tricuspid regurgitation, constrictive pericarditis, anemia |
| S4 = indicates stiff, non-compliant ventricular wall |
  - Causes: LVH, aortic stenosis, hypertension, ischemic or hypertrophic cardiomyopathy |

**Left to right shunt**

- Basic problem = increased blood flow through right side of heart and pulmonary circulation 
- leads to hypertrophy and dilation of cardiac chambers (right atrium and/or ventricle) 
- increased pulmonary blood flow which may lead to increased pulmonary artery resistance and pressure

**Right to left shunt**

- Oxygen desaturation occurs because less blood exiting LV or eventually de-oxygenated venous blood is being pushed into LV and is delivered to tissues 
- this is generally described as cyanotic congenital heart disease

**Increased pulmonary blood flow**

- Changes in heart anatomy that can increase pulmonary circulation: communication between right and left heart at any level → atrial, ventricular, great artery 
- can be due to PDA, ASD, VSD, AV canal (AVC)

**Cyanosis vs pallor**

**Cyanosis** = dusky/purplish color clinically seen on physical examination which is associated with abnormal presence of deoxygenated blood in systemic arterial circulation → can be due to many causes (both pulmonary or cardiovascular origin) 
**Pallor** = skin/mucous membranes look pale (common cause is anemia)
**Heart valve disease**

| Cardiac anatomy review | - mitral valve has 2 cusps whereas the other have 3  
- chordae tendineae prevent prolapse by becoming tense and pulling the flaps, holding them in closed position (chordae tendineae are attached to papillary muscles that create the tension)  
*prolapse*= when flaps of valve flop or bulge back into atrium during systole or towards ventricles during diastole |
|------------------------|---------------------------------------------------------------|
| Rheumatic fever         | Inflammatory disease that can develop as a complication of inadequately treated strep throat or scarlet fever group A streptococcus  
- can involve heart, joints, skin, brain  
- typically develops 2-4 weeks after strep throat infection  
- if infection is untreated rheumatic fever can occur in up to 3% of people  
- underlying mechanism believed to be autoimmune disorder (auto-antibodies made) |
| Bacterial endocarditis  | Endocarditis = inflammation of endocardium, usually involves heart valves  
- serious & potentially life-threatening bacterial infection of lining of heart and heart valves  
- when endocardium becomes damaged, bacteremia’s can infect heart valves/lining  
- characterized by lesions (vegetations) which are a mass of platelets, fibrin, microcolonies of bacteria |
| Heart valve disease → heart failure | **Heart valve disease cause** = damage + scar tissue from MI, atherosclerosis, injury to heart, endocarditis, hypertension, congestive heart failure, narrowing of aorta (atherosclerotic plaques, calcification, congenital disorders  
**Heart failure** = inability of heart to fill and eject blood/supply the proper amount of oxygenated blood to meet the metabolic needs of the body  
etiology includes both functional and structural factors  
- Functional: increased workload on heart due to increased SVR, high BP  
- Structural: myocardial damage, valvular disease |
| Preload, afterload, contractility | BP = CO x SVR  
Normal heart functioning is influenced by these three basic factors.  
**Preload** = volume of blood inside ventricle (end diastolic volume) immediately before contraction (systole)  
- decrease in preload will decrease amount of stroke volume ejected  
  - Exposure to elevated preload for long time → remodel heart  
  → ventricle will become dilated to accommodate extra volume  
**Afterload** = resistance to left ventricular ejection  
- force against which the ventricle must overcome in order to eject blood out of the ventricle  
- influenced by state of blood vessels and SVR (↑BP due to ↑SVR is common cause of ↑afterload)  
- narrowing of aortic valve another common cause of ↑afterload  
- raising afterload decreases SV, and lowering afterload increased SV  
  - Chronic elevation in afterload result in **remodelling of the heart** → **ventricle hypertrophy**  
  - Next mechanism to cope with increased functional demand = dilation of LV  
  - If afterload still too ↑, hypertrophy and dilation not enough → fatigue, dyspnea  
  - Severe complication: LVF, angina, MI, HF  
**Contractility** = measure of cardiac performance which describes how well the myocardium can contract  
- regulated by sympathetic nervous system  
- intrinsic strength of ventricle, independent of loading conditions |
Ejection fraction

**Definition:** measurement of the % of blood leaving the heart each time it contracts

- LV become less efficient in CHF so ejection fraction decreases and stroke volume decreases
- 50-75% is normal, 36-49% below normal, <35% low

### Aortic valve calcification

- can lead to aortic valve stenosis
- active disease process similar to atherosclerosis
- similar clinical risk factors: smoking, HT, hyperlipidemia, diabetes, metabolic syndrome

**MoA**

1. Lipid accumulation – apolipoproteins (LDL)
2. Inflammation – macrophage & T lymphocyte infiltration, IL-1B, TGF-B1
3. Calcification

**thickening & calcification → increase stiffness → aortic stenosis**

- unlike atherosclerosis (acute clinical events are due to plaque rupture & thrombosis), obstruction in calcific aortic stenosis is due to the bulk of the lesion rather than plaque instability

### Aortic regurgitation

**Etiology:**

- Aortic root dissection
  - Serious condition in which there is tear in wall of aorta
  - As tear extends along wall of aorta, blood flows b/w layers of blood vessel wall
- Aortic root dilation (with or without bicuspid valve)
  - Aortic root is a portion of the ascending aorta
  - Indicative of an aortic aneurysm
- Myxomatous degeneration
  - Pathological weakening of connective tissue
  - Term most often used in context of mitral valve prolapse
- Connective tissue disorders – Marfan syndrome
  - Genetic disorder
- Rheumatologic disorders – SLE, arthritis, psoriatic arthritis, ankylosing spondylitis

### IE prophylaxis

1. Prosthetic cardiac valve repair, including transcatheter-implanted prostheses and allografts
2. Prosthetic material used for cardiac valve repair, such as annuloplasty rings and chords
3. History of infective endocarditis
4. Specific serious congenital (present from birth) heart conditions, including:
   - Unrepaired or incompletely repaired cyanotic congenital heart disease, including those with palliative shunts and conduits
   - A completely repaired congenital heart defect with prosthetic material or device whether placed by surgery or by catheter intervention, during the first six months after the procedure
   - Any repaired congenital heart defect with residual defect at the site or adjacent to the site of a prosthetic patch or a prosthetic device
5. Cardiac transplant that develops a problem in a heart valve- valve regurgitation due to a structurally abnormal valve

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See rest of cardio on FMS1
Pulmonary Block

**Hypoxemia causes**
- Decreased % of inspired oxygen (PaO₂)
- Right to left cardiac shunt
- Poor ventilation → alveolar hypoventilation
- Problems with diffusion/perfusion
- Anemia

**Hypercapnia causes**
1. Not enough total ventilation due to: CNS depression or respiratory muscle weakness
2. Too much of the total ventilation ending up in dead space ventilation due to: COPD, rapid, shallow breathing
3. Combination of 1 + 2

**Bloody sputum differential diagnosis**
- Oral mucosa – trauma
- Gingiva – periodontal disease
- Nose – nose bleed
- Esophagus – Mallory-Weiss syndrome (tears in mucosa commonly at the gastro-esophageal junction caused by severe vomiting)
- Esophageal varices – swollen veins in the lining of the lower esophagus
- Lung – any lesion of the airways, the parenchyma, the vasculature

**Chronic cough differential diagnosis**

<table>
<thead>
<tr>
<th>Common</th>
<th>Less common</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Postnasal drip syndrome in sinus disease</td>
<td>-bronchial tumors</td>
</tr>
<tr>
<td>-cough variant asthma</td>
<td>-sarcoïdosis</td>
</tr>
<tr>
<td>-GERD</td>
<td>-left heart failure</td>
</tr>
<tr>
<td>-COPD: chronic bronchitis</td>
<td>-OSA</td>
</tr>
</tbody>
</table>

**Hyperventilation vs. hypoventilation**
- Refers to elevated or reduced alveolar ventilation
  -Defined by partial pressures of CO₂ in arterial blood (PaCO₂)
  -In health individuals, PaCO₂ = 38-42mmHg

**Hyperventilation**
- Decreased ventilation to a level less than required to meet metabolic needs (results in elevated PaCO₂)
  - When PaCO₂>42mmHg = hypercapnia

**Hypoventilation**
- Increased ventilation to a level greater than required to meet metabolic needs (results in decreased PaCO₂)
  - When PaCO₂<38mmHg = hypopcapnia

**Sleep apnea**
- Apnea = absence of inspiratory airflow for at least 10 seconds or at least 75% decrease in inspiratory airflow for at least 10 seconds

**Hypopnea**
- Decrease in airflow (less than 75%) that lasts for at least 10 sec with oxygen desaturation >4% from baseline

Types: OSA, CSA, mixed (complex)
Note: dentists don’t diagnose!! We provide oral appliance therapy only AFTER receiving written request or prescription from attending physician

**Dental appliance - OSA**
OSA: see pg. 39
OSA dental appliances don’t work for CSA
  - Recommended by American Academy of Sleep Medicine for mild-mod OSA + severe OSA in individuals who can’t tolerate CPAP

**Advantages** of OSA dental appliance
- Comfortable, easy to wear, quiet, portable, easy to care for, don’t require power source

**Adverse effects**
- Short: excessive salivation, mouth dryness, dental pain, gingival irritation, headaches, TMJ discomfort
- Long: reduction in overjet → create end-to-end or Class III occlusion; reduction in overbite → create posterior open bite; increase facial height, increase degree of mouth opening, change in inclination of incisors

**Examples**:
- Klearway (successful 80% mild-mod OSA, 6% severe OSA), Silencer, Herbst, Twin Block, TAP

**Conditions affecting pleural space**
- Pleural effusion: excess fluid in pleural cavity (viral infxn)
- Malignant pleural effusion (30% lung cancer complic’n)
- Pneumothorax: air in pleural space
- Hemothorax: blood in pleural space
- Mesothelioma: cancer of pleural membranes (asbestos)

Sophia Kim
**Oral effects of smoking/tobacco**

- squamous cell carcinoma
- nicotinic stomatitis*
- periodontitis
- hairy tongue
- epithelial dysplasia
- smoker’s melanosis
- snuff dipper’s keratosis
- verrucous carcinoma (cauliflower like lesion)
- in pipe smoking, abrasion can occur on occlusal surface where pipe stem is held
- ↑ risk of orofacial clefts with maternal smoking
- suggested link between failure of dental implants and smoking (not definitive)
- dark brown/black discoloration of cervical margins of teeth

**Nicotine effects on oral tissues diminish:**
- gingival blood flow, cytokine production, immune cell function, connective tissue turnover

*nicotinic stomatitis* = hyper-keratinization + acanthosis (diffuse epidermal hyperplasia) with sub-epithelial inflammation

**Pulmonary diagnosis**

<table>
<thead>
<tr>
<th>Physical finding</th>
<th>Inspection</th>
<th>Palpation</th>
<th>Percussion</th>
<th>Auscultation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumothorax</td>
<td>Trachea moves to opposite side</td>
<td>Decreased tactile fremitus</td>
<td>Hyper-resonant</td>
<td></td>
</tr>
<tr>
<td>Hemothorax</td>
<td></td>
<td></td>
<td>Dull</td>
<td>All have decreased breath sounds</td>
</tr>
<tr>
<td>Pleural effusion</td>
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<tr>
<td>Lobar atelectasis</td>
<td>Trachea moves to affected side</td>
<td>Increased tactile fremitus</td>
<td>Hyper-resonant</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>&lt;&gt; movement of trachea</td>
<td></td>
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</tbody>
</table>

**Metaplasia vs. Dysplasia**

<table>
<thead>
<tr>
<th>Metaplasia</th>
<th>Dysplasia</th>
</tr>
</thead>
<tbody>
<tr>
<td>- reversible change of one mature cell type to another; in response to chronic irritation/inflammation - pulmonary example – replacement of normal columnar ciliated epithelial cells of bronchial lining by stratified squamous epithelial cells in response to smoking → new cells don’t secrete mucus or have cilia → loss of vital protective mechanisms</td>
<td>- abnormal changes in size, shape, organization; atypical hyperplasia - strongly associated with neoplastic growths &amp; found adjacent to cancerous cells - precancerous, can be reversible if stimulus removed</td>
</tr>
</tbody>
</table>

**Tumour grading/staging**

**Grading:** histo/cellular characteristics of tumor
- more poorly differentiated, more malignant!!
- Grades I to IV

**Staging:** clinical spread of disease (TNM system)
- T – size & extent of primary tumor
- N – involvement of regional lymph nodes
- M – extent of metastatic involvement
- T0, N0, M0 → T4, N3, M1

**OTHER:**
- Carcinoma in situ
- Localized
- Regional
- Distant
- Unknown

**Characteristics of Benign vs Malignant Neoplasms**

**Benign neoplasms**

- Well-encapsulated with well-defined border
- cells with more cohesive than those of malignant neoplasms (stick together)
- slow growth rate
- blood supply is less profuse than malignant
- non-infiltrative → doesn’t metastasize
- well-differentiated cells; look like parent cell
- primarily localized signs/symptoms depending on location (non-systemic) → produce effects from obstruction, pressure + secretion
- usually not fatal, but benign tumors can be dangerous due to location (brain, spinal cord)

**Malignant neoplasms**

- poorly differentiated
- infiltrate + destroy surrounding tissues rather than pushing them aside
- greater blood supply than normal tissue
- cells are not cohesive
- metastasizes to other organs (route=blood, lymph)
- systemic signs + symptoms: weight loss (cancer cells use nutrients due to hypermetabolic state), fatigue, pain (cells not encapsulated + chemical mediators released)
- signs and symptoms vary with location/expandability of cavity
## Medical Emergency

<table>
<thead>
<tr>
<th>Emergency</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acute asthma attack</strong></td>
<td>- Upright → salbutamol (2 puffs stat, repeat 15-20mins if still symptomatic)</td>
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<td></td>
<td>- 100% oxygen (6L/min, goal 92% saturation); monitor vitals</td>
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<td></td>
<td>- Activate EMS if refractory to salbutamol (severe: bronchodilator not working, drop in FEV1, severe dyspnea, tachypnea &gt;25bpm, tachycardia &gt;110bpm)</td>
</tr>
<tr>
<td></td>
<td>- If severe administer 0.3-0.5 of 1:1000 epinephrine IM</td>
</tr>
<tr>
<td><strong>Status asthmaticus</strong></td>
<td>- Salbutamol inhaler 2 puffs (use Aerocamber to improve administration if needed)</td>
</tr>
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<td></td>
<td>- If symptoms progress or rapid development → activate EMS</td>
</tr>
<tr>
<td></td>
<td>- Admin oxygen 5-10L/min by face mask (pt may require positive pressure ventilation if cyanotic or losing consciousness; can use bag-valve-mask or Laerdal mask with oxygen inlet at 10L/min)</td>
</tr>
<tr>
<td></td>
<td>- Epi 1:1000 0.3-0.5ml subcutaneously (children dose 0.01ml/kg); can repeat epi 10-15mins if waiting for ambulance &amp; pt has significant wheezing</td>
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<tr>
<td></td>
<td>- Hydrocortisone succinate 100mg IM if delay in transport (prednisone 40-60mg oral if unavailable)</td>
</tr>
<tr>
<td><strong>Allergic rxn</strong></td>
<td>- Upright, 100% O2, monitor vitals, if mild Benadryl 25-50mgIM or oral is less severe, if rapid progress symptoms (bronchoconstriction/wheeze/rash/wheal) activate EMS</td>
</tr>
<tr>
<td><strong>Anaphylaxis</strong></td>
<td>- Stop procedure/admin of drugs → admin epi 0.3-0.5mg IM, repeat prn (10-15min)</td>
</tr>
<tr>
<td></td>
<td>- Oxygen + ventilate manually if necessary using bag-valve-mask device (5-10L/min)</td>
</tr>
<tr>
<td></td>
<td>- Basic life support, monitor vitals (document + record); admin Benadryl, hydrocortisone if delayed EMS; if bronchospasm, 2puff salbutamol q15-20min</td>
</tr>
<tr>
<td></td>
<td>- Cricothyrotomy if trained, provide IV access if able, prepare for transport</td>
</tr>
<tr>
<td><strong>Respiratory obstruction</strong></td>
<td>- ARE YOU CHOKING? Mild → encourage coughing, don't do anything yet; severe → 5 back blow alternating 5 abdominal thrust if conscious. CPR if unconscious</td>
</tr>
<tr>
<td>For infants (&lt;1-year-old):</td>
<td>- Back blows and chest thrusts:</td>
</tr>
<tr>
<td></td>
<td>- In a seated position, support the infant in a head-downwards, prone position to let gravity aid removal of the foreign body</td>
</tr>
<tr>
<td></td>
<td>- Support the head by placing the thumb of one hand at the angle of the lower jaw, and one or two fingers from the same hand at the same point on the other side of the jaw. Do not compress the soft tissues under the jaw, as this will aggravate the airway obstruction</td>
</tr>
<tr>
<td></td>
<td>- Deliver up to five sharp blows with the heel of the hand to the middle of the back (between the shoulder blades)</td>
</tr>
<tr>
<td></td>
<td>- After each blow, assess to see if the foreign body has been dislodged and, if not, repeat the manoeuvre up to five times</td>
</tr>
<tr>
<td></td>
<td>- After five unsuccessful back blows, use chest thrusts: turn the infant into a head-downwards supine position by placing your free arm along the infant’s back and encircling the occiput with your hand. Support the infant down your arm, which is placed down (or across) your thigh</td>
</tr>
<tr>
<td></td>
<td>- Identify the landmark for chest compression. This is the lower sternum, about a finger’s breadth above the xiphisternum. Deliver five chest thrusts. These are like chest compressions for CPR, but sharper in nature and delivered at a slower rate</td>
</tr>
<tr>
<td>Children (1-year-old to puberty):</td>
<td>- Back blows and abdominal thrusts:</td>
</tr>
<tr>
<td></td>
<td>- Blows to the back are more effective if the child is positioned head down. A small child can be placed across the lap as with an infant. If this is not possible, support the child in a forward-leaning position. Deliver up to 5 sharp back blows with the heel of one hand in the middle of the back between the shoulder blades.</td>
</tr>
<tr>
<td></td>
<td>- After 5 unsuccessful back blows, abdominal thrusts may be used in children over 1-year-old:</td>
</tr>
<tr>
<td></td>
<td>- Stand or kneel behind the child, placing arms around torso. Placed clenched fist between the umbilicus and xiphisternum (ensuring no pressure is applied to either landmark)</td>
</tr>
<tr>
<td></td>
<td>- Grasp this hand with your other hand and pull sharply inwards and upwards, repeating up to 5x</td>
</tr>
<tr>
<td></td>
<td>- If the child becomes unconscious, place him or her on a flat, firm surface, shouting for help if none has arrived. Open the mouth and look for any obvious object. If one is seen, make an attempt to remove it with a single finger sweep (do not do blind finger sweeps)</td>
</tr>
<tr>
<td></td>
<td>- If unsuccessful, begin CPR as for pediatric BLS, beginning with 5 rescue breaths, checking for rise and fall of the chest each time (reposition the head each time if a breath does not make the chest rise, before making the next attempt)</td>
</tr>
<tr>
<td><strong>Aspiration of gastric contents</strong></td>
<td>- The patient with a diminished gag reflex caused by sedation, unconsciousness, or topical anaesthesia in the oropharynx is at greatest risk for gastric aspiration</td>
</tr>
<tr>
<td></td>
<td>- The sedated or unconscious patient who aspires a significant amount of gastric material will first show signs of respiratory difficulty such as tachypnea and wheezing</td>
</tr>
<tr>
<td></td>
<td>- Tachycardia and hypotension may soon occur, and as ventilatory capability worsens, cyanosis appears</td>
</tr>
<tr>
<td></td>
<td>- Eventually, respiratory failure that is refractory to BLS occurs, and intubation and the delivery of high concentrations of oxygen are required</td>
</tr>
<tr>
<td></td>
<td>- An unconscious (or deeply sedated) patient who begins to vomit should be immediately placed into a head-down, feet-raised position, and turned onto the right side to encourage oral drainage of vomitus → high-volume suction should be used to assist removal of vomitus from the oral cavity</td>
</tr>
<tr>
<td>If the clinician suspects that gastric material may have entered the lower respiratory tract, emergency assistance should be contacted immediately</td>
<td>- The patient should be placed on supplemental oxygen and vital signs monitored. If suitably trained, the dentist should start an IV line and administer normal saline or 5% dextrose in water to help treat a possible falling blood pressure and to enable emergency technicians to administer IV bronchodilators, if necessary</td>
</tr>
<tr>
<td></td>
<td>- Immediate transportation to an emergency facility is required</td>
</tr>
<tr>
<td></td>
<td>- The pregnant patient should be placed in the left lateral decubitus position</td>
</tr>
</tbody>
</table>
**Obstructive lung diseases differential diagnosis**

<table>
<thead>
<tr>
<th>Diagnostic possibility</th>
<th>Cough</th>
<th>Shortness of breath</th>
<th>Sputum production</th>
<th>Hyperinflation</th>
<th>Wheeze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bronchitis</td>
<td>++</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>++</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>+/-</td>
</tr>
<tr>
<td>COPD</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Asthma</td>
<td>+</td>
<td>++</td>
<td>+/-</td>
<td>++ (acute)</td>
<td>++ (acute)</td>
</tr>
<tr>
<td>Lung malignancy</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Obesity</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Key: ++ very common, + common, +/- occasional, - uncommon

**Pulse oximeter**

Pulse oximeter: spectrophotometer that measures the absorption of light at 2 wavelengths, one in infrared range wavelength 940nm (absorbed by oxyhemoglobin) and other at 660nm (absorbed by deoxyhemoglobin).

- absorption of 2 wavelengths is compared & percentages of oxy/deoxyhemoglobin are calculated
- accuracy of most oximeters decrease <75% saturation
- pulse oximeter compares absorption measured during systole and diastole & uses the difference to reflect only absorption of arterial blood, thereby limiting errors induced by absorbance in venous blood and other tissues

**Acute vs Chronic Dyspnea**

<table>
<thead>
<tr>
<th>Acute Dyspnea (mins-hours)</th>
<th>Chronic Dyspnea (weeks-months)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cardiac</strong> causes: ischemic heart disease, CHF exacerbation, cardiac tamponade</td>
<td><strong>Cardiac</strong> causes: valvular heart disease, decreased CO</td>
</tr>
<tr>
<td><strong>Pulmonary</strong> causes: airway obstruction (anaphylaxis, foreign body), airway disease (asthma, COPD, bronchitis), parenchymal lung disease (ARDS, pneumonia), pulmonary vascular disease (PE, vasculitis), pleural disease (pneumothorax, tension pneumothorax), respiratory control (metabolic acidosis, ASA toxicity)</td>
<td><strong>Respiratory</strong> causes: pulmonary vascular disease (pulm HTN, vasculitis), parenchymal lung disease (interstitial disease), pleural disease (effusion), airway disease (asthma, COPD)</td>
</tr>
<tr>
<td><strong>Psychiatric</strong>: anxiety/psychosomatic</td>
<td><strong>Hematological</strong> causes: severe anemia</td>
</tr>
<tr>
<td><strong>Neuromuscular + chest wall disorders</strong>: deconditioning, obesity, pregnancy, neuromuscular disease</td>
<td></td>
</tr>
</tbody>
</table>
### Pulmonary neoplasms

<table>
<thead>
<tr>
<th></th>
<th>Lung Cancer</th>
<th>Mesothelioma</th>
<th>Occupational inhalation conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pathophysiology</strong></td>
<td>-most are carcinomas (cancers of epithelial cells)</td>
<td>-asbestos embed in pleura, cause inflammation &amp; scarring → tumors</td>
<td>-arsenic, beryllium, cadmium</td>
</tr>
<tr>
<td><strong>Well-defined sequence of cellular changes:</strong></td>
<td>-thickening of epithelium, hyperplasia</td>
<td>-fibres directly or indirectly damage DNA → neoplasm</td>
<td>-chemicals used in rubber manufacturing, iron, and steel founding &amp; painting</td>
</tr>
<tr>
<td></td>
<td>-loss of ciliated columnar cells, replaced by squamous epithelium (metaplasia)</td>
<td></td>
<td>-chloromethyl ethers</td>
</tr>
<tr>
<td></td>
<td>-proliferation of basal cells (dysplasia) accompanied by development of abnormal cell structure and abnormal nuclei</td>
<td></td>
<td>-chromium compounds</td>
</tr>
<tr>
<td></td>
<td>→ results in new squamous cells that don’t secrete mucous or have cilia and causes loss of vital protective mechanisms</td>
<td></td>
<td>-cobalt-tungsten carbide</td>
</tr>
<tr>
<td></td>
<td><strong>Initiated by activation of oncogenes &amp; inactivation/mutation of tumor suppressor genes</strong></td>
<td></td>
<td>-mustard gas, radon, silica, nickel, diesel engine exhaust</td>
</tr>
<tr>
<td><strong>Risk factors</strong></td>
<td>Cigarette smoking (85%) - tobacco</td>
<td>-Asbestos: 45x more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radon gas, asbestos, second-hand smoke, air pollution</td>
<td>-Tobacco smoke (synergistic)</td>
<td></td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td><strong>Symptoms:</strong> Respiratory: coughing, hemoptysis, wheezing, dyspnea</td>
<td>Cancer that develops in epithelium that lines pleura, peritoneum &amp; pericardium (mesothelium)</td>
<td>13-29% of lung cancers in men secondary to on-the-job exposure to chemicals &amp; materials that increase lung cancer</td>
</tr>
<tr>
<td></td>
<td>Systemic: weight loss, weakness, fever, fatigue, night sweats, loss of well-being</td>
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<tr>
<td></td>
<td>Cancer mass pressing on adj structures: chest/bone pain, SCV obstruction, dysphagia</td>
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</tr>
<tr>
<td><strong>Small cell lung cancer (SCLC)</strong></td>
<td>-12% -look small, mostly filled with nucleus -usually caused by smoking -often metastasizes early on -poor prognosis</td>
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<td></td>
<td><strong>Non-Small cell lung cancer (NSCLC) – 87%</strong></td>
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<td></td>
<td>-adenocarcinoma – 45%</td>
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<td></td>
<td>o Quicker growth than SCC, develops from mucus cells in lining of airways, usually not associated with smoking</td>
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<tr>
<td></td>
<td>-squamous cell carcinoma – 25%</td>
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</tr>
<tr>
<td></td>
<td>o Bronchial epithelial cells that have undergone squamous metaplasia</td>
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<td>o Often found near centre of lung in one of the main airways (L/R bronchus)</td>
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<tr>
<td></td>
<td>o Strongly linked with smoking</td>
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<tr>
<td></td>
<td>o Slower growth, progressively obstruct</td>
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<tr>
<td></td>
<td>-large cell carcinoma – 15%</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>o grows quickly</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Treatment</strong></td>
<td>Diagnosis: chest x-ray, CT, PET-CT, cytopathology, exam of pleural fluid/sputum, bronchoscopy-guided biopsy + core biopsy; sometimes open lung biopsy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment: surgery, chemotherapy, radiation therapy or combo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Pathophysiology</td>
<td>Risk factors</td>
<td>Significance</td>
</tr>
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</tr>
</tbody>
</table>
| **RDS** | Respiratory distress syndrome, AKA Surfactant Deficiency disorder (SDD)  
Lungs of premature infants collapse due to lack of surfactant  
-syndrome in premature infants caused by developmental insufficiency of pulmonary surfactant production → structural immaturity in the lungs  
- Can also be consequence of neonatal infection  
- Can also result from genetic problem with prod’n of surfactant associated proteins | - Obesity → direct effect: fat deposit in upper airway, reduction in vol  
- Upper airway dilator muscle dysfunction, heightened chemosensitivity & low arousal threshold  
- Abnormal pharyngeal dilator muscle collapsibility  
- Male gender, genetics, family history, aging, post menopause, alcohol, sedative use → enlarge upper airway structures | Affects 1% of newborn infants + is leading cause of death in preterm infants (affects nearly all born before 28 weeks of pregnancy)  
**Treatment:** surfactant replacement, NCPAP |
| **OSA** | Upper airway occlusion with continued activity of inspiratory thoracic muscles  
- reduction in activity of genioglossus muscle → tongue fall backwards toward oropharynx  
- pt w/ narrowing of airway, tongue can obstruct airway  
- obstruction → PaCO2 levels rise → stimulates respiratory muscles → breathing resumes with loud gasp, snort/body jerk, can happen +30x/hour in severe cases  
- upper airway narrowing can lead to varying clinical expressions depending on extent (snoring, hypopnea or apnea)  
- narrowing can happen anywhere b/w nasal cavity & larynx  
  - Most common: retropalatal, retroglossal  
  - Can have more than 1 site narrowing  
  - Upper airway edema contributes  
- narrowing nasopharynx causes: hypertrophic pharyngeal tonsils, elongated soft palate or edematous uvula  
- narrowing oropharynx causes: enlarged tongue, retrognathia, enlarged palatine tonsils/lingual tonsil, redundant palatopharyngeal folds | - Obesity → direct effect: fat deposit in upper airway, reduction in vol  
- Upper airway dilator muscle dysfunction, heightened chemosensitivity & low arousal threshold  
- Abnormal pharyngeal dilator muscle collapsibility  
- Male gender, genetics, family history, aging, post menopause, alcohol, sedative use → enlarge upper airway structures  
**DENTIST DOESN'T DIAGNOSE**  
**Dental appliance:** increase airway space & reduce collapsibility  
1. **Mandibular repositioning dental appliances**  
(mandibular advancement splints) → acrylic resin; protrude mandible, prevents tongue falling back & blocking  
- need teeth to work  
2. **Tongue retaining appliances**  
- rest over dental arches/alveolar (edentulous)  
silicone; suction hold tongue forward | |
| **CSA** | CNS dysfunction: occurs in people with **highly sensitive chemoreceptors**; small chemical changes in body causes over-response of respiratory feedback loop (loop gain)  
- PaCO2 usually rises during sleep → induce hyperventilation to decrease PaCO2 and increase PaO2 in normal pt but in people with CSA, hyperventilation will occur to level below normal → PaCO2 lvl decrease below apneic threshold  
- marked decrease in PaCO2 → ponto-medullary resp rhythm generator to cease activity → interrupt innervation to inspiratory thoracic muscles  
- after central respiratory drive withdrawn, apnea continues until PaCO2 rises above apneic threshold | transient reduction by pontomedullary pacemaker in generation of breathing rhythm |
| Pleuritis | **Pain due to inflammation of parietal pleura** (visceral doesn’t have pain receptors)  
- disturbances displace normal pleural fluid → forces membranes to rub rather than glide → irritate nerve endings → pain  
- chest noises: faint squeak to loud creak (friction rub)  
- rapid shallow breathing due to pain (hallmark= intense chest pain → shooting/stabbing, mild cramp)  
- **Primary symptom**: chest pain  

<table>
<thead>
<tr>
<th>Pleural effusion</th>
<th>Dry Pleurisy</th>
</tr>
</thead>
</table>
| - More common, accumulation of fluid within pleural space  
- less pain b/c fluid forces membrane surfaces apart but can lead to respiratory distress + possible lung collapse (extra fluid places pressure on lungs) | - Inflamm’n w/o fluid build up |

| TB | - macrophage engulf infected droplet → M. tuberculosis replication occurs within alveolar macrophages, infection spreads to regional lymph nodes  
- TB damages tissues by producing granulomatous inflammation that leads to necrosis in lungs → **hypersensitivity type IV**  
*note: can be latent for one’s lifetime*  
**Symptoms**: productive cough, hemoptysis, night sweats, fever, weakness/fatigue, loss of appetite, weight loss, pain in chest  
**Diagnosis**: sputum smear + culture, rapid molecular-based diagnostic tests; radiographic (patchy/lobular infiltrates, calcified granulomas, radiolucency’s from necrosis)  
**Treatment**: multiple antimicrobial drugs at least 6 mo (cure rate 95-97% if drug-susceptible; 30-60% if drug-resistant TB)  

| Infection in pleural space most common irritant, but also caused by abnormal presence of air, blood, infiltrative cells  
**Main causes**: respiratory infection, disease (pulm embolism, immune disorders, cancer), injury (rib fracture, collapsed lung, blood clot, toxin (asbestos), drug reactions treating TB, cancer, immune disorders  

| Oral lesion: painful, deep, irregular ulceration, on dorsum of tongue  
**Can affect**: palate, lips, buccal mucosa, gingiva, jaws (osteomyelitis), cervical/submandibular lymph nodes (extrapulm TB ~10-20%, more often HIV pt)  
**Dental treatment**: depends on infectivity status; only treat if latent (can do infectious only at hospital) |

| Cystic fibrosis | Autosomal recessive condition, typically causing pulm infections  
Involves **pancreatic insufficiency** w/ failure to thrive  
Most common fatal genetic disease affecting Canadian children  
Sticky/thicken mucous secretion → obstruction & malfunction of resp & GI  
- Blockage → remodel/infection in lung, damage b/c of accumulated digestive enzymes in pancreas, block in intestines  
**Treatment**: bronchial inflammation & infection; high calorie, high fat diet recommended  

| Dental findings: abnormal dentition, enamel defect, candidiasis, calculus deposits  
- Can be due to failure to thrive or side effect of treatment |

| Influenza | - symptomatic 2 days after exposure, last 1 week  
- cough can last 2 weeks  

| Caused by influenza virus  
3 types: A, B, C  

| **Symptoms**: |
-**complications**: viral pneumonia, 2ndary bacterial pneumonia, sinus infections, worsening of other health problems: asthma, COPD, heart failure

| Pneumonia | Acute inflammation of lungs caused by infection with: virus, bacteria, parasite, fungi, eosinophilic pneumonia  
  **Symptom**: productive cough, chest pain due to pleuritis, fever, dyspnea, tachypnea, confusion  
  **Diagnosis**: based on symptoms, physical exam, chest x-ray, blood test, culture of sputum  
  **Symptom**: spread thru air  
  -usually identified thru high fever with sudden onset  
  **Diagnosis**: Cystic fibrosis, COPD, asthma, diabetes, CHF, smoking, impaired ability to cough, immunocompromised  
  **Symptom**: fever, extreme coldness, nasal congestion, runny nose, sore throat, body ache, headache, sneezing, coughing, fatigue, irritated, watering eyes...

| Idiopathic pulmonary fibrosis (IPF) | -most common idiopathic interstitial pneumonia  
  -interstitial inflammation occurs with lymphocyte, plasma cells, histiocyte infiltration→ deterioration (infection, PE, pneumothorax, HF)  
  **Symptom**: fine Velcro crackles, cough, exertional dyspnea  
  **Diagnosis**: history, physical exam, high-res CT, lung biopsy  
  **Treatment**: antifibrotic drugs, oxygen (but survival ~3yr from diagnosis)  
  **Symptom**: combo of environmental, genetic, unknown factors  
  -cig smoke, metal, coal, wood dust  
  -possible irritant: chrome-cobalt molybdenum alloy, beryllium, silica, acrylic dust...  
  -dentist have 23x higher occurrence (work env haz)  
  -IPF often overlooked b/c clinical similarities to more common diseases (bronchitis, asthma, heart failure)

| Fungal lung infection | -opportunistic or primary  
  -invasive pulm aspergillosis & systemic candidiasis more prevalent opportunistic  
  -immunocompromised → asthma, pneumonia, sinusitis; can also lead to hemorrhagic necrosis, infarction, emphysema  
  **Symptom**: certain geographic areas  
  -immunodeficiency  
  If immunocompromised, infxn can cause:  
  -asthma, pneumonia, sinusitis → hemorrhagic necrosis, infarction

| Carbon monoxide poisoning | CO competes with O2 for binding sites in Hb (200x greater than O2)  
  -CO will bind same amt of Hb as O2 at partial pressure 200x lower than O2  
  -CO also increases Hb’s affinity for O2, shifting oxyhemoglobin disassociation curve to the LEFT → less O2 gets released into tissues

| Changes at elevation | **Hypoxia at high altitudes** → decrease exercise, increase ventilation  
  -severe altitude illness 3500-5500m (SO2 < 90%, PaO2 < 60mmHg)  
  -2,3-DPG substance made in RBCs to promote release of oxygen from RBCs to body tissues → MORE made at high altitudes in response to hypoxemia  
  -hypoxemia sensed by carotid bodies → increase breathing depth & rate (hyperpnea → respiratory alkalosis)  
  -full acclimatization requires days or even weeks (changes: ↑HR, ↑2,3-BPG, ↑concentration of capillaries in skeletal muscle tissue, ↑myoglobin, ↑mitochondria, ↑aerobic enzyme concentration, RVH, ↑pulm artery pressure in effort to oxygenate more blood  
  **Symptom**: tachycardia, increase 2,3-BPG, RV hypertrophy, increased myoglobin, mitochondria, aerobic enzyme concentration, higher concentration of capillaries in skeletal muscle tissue, pulm artery pressure increase to try to oxygenate more blood
<table>
<thead>
<tr>
<th>Definition/Cause/Pathophysiology</th>
<th>Symptom/Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Winding (solar plexus syndrome)</strong></td>
<td><strong>Symptom/Treatment</strong>: go into knees bent position, upper body brought forward + down helps relax diaphragm; slow breaths</td>
</tr>
<tr>
<td>Blow to abdomen → injures solar plexus (celiac plexus) → nerve compression → diaphragm compression → spasm → difficulty breathing</td>
<td></td>
</tr>
<tr>
<td><strong>Atelectasis</strong></td>
<td><strong>Symptom/Treatment</strong>: almost always secondary phenomenon, may occur more freq in children</td>
</tr>
<tr>
<td><strong>Definition</strong>: collapse of lung tissue with loss of volume</td>
<td><strong>Consequence</strong>: decrease ventilation, V/Q mismatch, hypoxemia, tissue hypoxia, pneumonia, dyspnea, respiratory failure if extensive</td>
</tr>
<tr>
<td>affects sub-segment of lung/entire lung and is almost always secondary phenomenon</td>
<td><strong>Treatment</strong>: maintain cough &amp; deep breathing -treat cause</td>
</tr>
<tr>
<td><strong>Cause</strong>:</td>
<td></td>
</tr>
<tr>
<td>intrinsic obstruction of airways (foreign body, tumor, mucous plug) → bronchiolitis, CF, endobronchial tuberculosis, aspiration due to swallowing disorder or GERD, increased abnormal airway secretions</td>
<td></td>
</tr>
<tr>
<td>extrinsic compression of airways → tumor, lymphadenopathy</td>
<td>Treatment: go into knees bent position, upper body brought forward + down helps relax diaphragm; slow breaths</td>
</tr>
<tr>
<td>alveoli may incompletely expand, eventually collapse due to suppression of respiration or cough caused by: general anesthesia, over sedation, severe pleuritic pain</td>
<td></td>
</tr>
<tr>
<td>compression/collapse of lung parenchyma due to large pleural effusion, pneumothorax</td>
<td></td>
</tr>
<tr>
<td>supine positioning, particularly in obese patients</td>
<td></td>
</tr>
<tr>
<td><strong>Bronchiolitis</strong></td>
<td><strong>Symptom/Treatment</strong>: coughing, wheezing dyspnea, difficulty feeding</td>
</tr>
<tr>
<td>Inflammation of bronchioles, usually caused by respiratory virus</td>
<td></td>
</tr>
<tr>
<td>children &lt;2 years, majority ~3-6 mo</td>
<td></td>
</tr>
<tr>
<td><strong>Wheezing</strong></td>
<td><strong>Symptom/Treatment</strong>: coughing, wheezing dyspnea, difficulty feeding</td>
</tr>
<tr>
<td><strong>Definition</strong>: High-pitch whistling made by movement of air thru narrowed/compressed small airways</td>
<td></td>
</tr>
<tr>
<td>more likely in forced expiration (further narrow airway b/c ↑ intrathoracic press.)</td>
<td></td>
</tr>
<tr>
<td>- if both in/expiration, more severe airway narrowing</td>
<td></td>
</tr>
<tr>
<td><strong>Cause</strong>: asthma, bronchiolitis, cystic fibrosis, foreign body aspiration, viral lower resp tract infection, pneumonia, mass obstructing lower airway, congestive HF, inhaled irritants, pulm edema, sepsis</td>
<td></td>
</tr>
<tr>
<td><strong>Stridor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Definition</strong>: Harsher, high-pitched</td>
<td></td>
</tr>
<tr>
<td>-predom inspiratory sound caused by rapid, turbulent flow of air thru narrowed/partially obstructed segment of extrathoracic upper airway</td>
<td></td>
</tr>
<tr>
<td>-involved areas: pharynx, epiglottis, larynx, extrathoracic trachea</td>
<td></td>
</tr>
<tr>
<td><strong>Cause</strong>: foreign body in upper intrathoracic airway, lesion of airway (neoplasm), congenital lesion in children</td>
<td></td>
</tr>
<tr>
<td><strong>Hyper-ventilation syndrome</strong></td>
<td><strong>Diagnosis</strong> – NOT made by dentist...don’t breathe into paper bag as it can be other conditions ACUTE = rapid, shallow breathing, agitation, sense of terror, chest pain, paresthesia, peripheral tetany, pre-syncope or syncope</td>
</tr>
<tr>
<td>Usually young women, but can occur any sex/age</td>
<td></td>
</tr>
<tr>
<td>-separate from panic disorder, but can overlap</td>
<td></td>
</tr>
<tr>
<td>-acute: easier to recognise than chronic</td>
<td></td>
</tr>
<tr>
<td>-chronic: more common than acute</td>
<td></td>
</tr>
</tbody>
</table>
| **Acute bronchospasm** | Contraction of smooth muscle surrounding bronchi $\rightarrow$ force airway obstruction/narrowing  
- bronchial smooth muscle tone regulated by autonomic nervous system  
  - Parasympathetic – vagus nerve $\rightarrow$ when stimulated causes constriction (bronchospasm)  
  - Sympathetic – produce dilation (bronchodilation)  
- can also wheeze & cough |
| --- | --- |
| **Dysarthria** | Motor speech disorder affecting muscles in mouth, tongue, larynx or vocal cords  
- characterised by slurred or slow speech that can be difficult to understand  
- a person w/ dysarthria has/had a nerve/brain/muscle lesion that makes it difficult to sue or control these muscles  
**Causes:** brain injury, tumor, degenerative brain disease, multiple sclerosis, Parkinson disease, stroke |
| **Asthma** | **Definition:** chronic inflammatory disease of airways, primarily involve conducting airways  
**Risk:** genetics, allergic condition, obesity, smoking, exposure to tobacco smoke, occupational triggers, upper resp tract infection, exercise, cold air, meds, chemicals, emotional state  
- small % progress to COPD & respiratory failure  
**Characterized by:**  
1. Reversible airflow obstruction  
2. Bronchial hyper-responsiveness  
3. Underlying inflammation  
**Categories:**  
1. Extrinsic/allergic 35% – trigger antigen result in activation of IgE on mast cells, basophils, eosinophils $\rightarrow$ bronchoconstriction, increase mucus plug production, inflammation  
2. Intrinsic/idiosyncratic 30% – emotional stress, GERD, vagal system (NO IgE)  
3. Drug-induced 30-40% - ASA, BB, ACEI, NSAIDs  
4. Exercise-induced – cold air=irritant  
**Pathophysiology:** infiltration of airways by T-helper cells that release cytokines such as IL-4/5/13  
  - Stimulate leukocyte movement $\rightarrow$ basophil, eosinophil, mast cells  
  - Release of inflammm cell mediators $\rightarrow$ bronchospasm, mucus production, airway edema, amplification of inflammatory response  
**Airflow obstruction due to:**  
1) Bronchial smooth muscle spasm $\rightarrow$ exaggerated response/hyper responsiveness to exogenous and endogenous stimuli  
2) Inflammation of bronchial mucosa  
**Symptom:** cough, dyspnea, wheezing, sputum production, tachypnea, tachycardia, chest tightness, flushing  
**Diagnosis:**  
- Called **“Reactive Airway Disease”** until it is confirmed to be recurrent  
- Diagnosed and monitored by pulmonary function tests and peak flow meters  
- Pts with asthma show a marked improvement after bronchodilator or steroid use  
- Diffusion capacity is normal or increased in asthma  
- Chest X-Ray: hyper-inflation only during asthma attacks, otherwise normal  
**Treatment:**  
- relieve symptoms, avoid specific triggers of acute exacerbations  
**Medical therapy includes:**  
- Inhaled corticosteroids (anti-inflammatory)  
- Inhaled $\beta_2$ adrenergic receptor agonists  
  - act by increasing bronchial smooth muscle relaxation  
  - produce bronchodilation in 3-5 minutes  
- Moderate doses of inspired oxygen (5-6 L/min)  
- goal oxygen saturation of 94% |
3) Airway wall edema  
4) Mucus hypersecretion  
5) Sputum plugging can occlude bronchi and bronchioles  
6) Stim. of parasympathetic innervations of bronchial tree → bronchoconstriction  

**Severity**: based on frequency, impairment of lung function, risk of attacks  
- **Mild**: q1w but less than q1d, FEV1 >80%  
- **Moderate**: 60-80% FEV1, daily symptoms  
- **Severe**: <60% FEV1, ongoing symptoms limiting normal activity  

Avoid opioids due to histamine release, which may provoke bronchospasms; avoid ASA (esp nasal polyps); avoid some abx (macrolide, cipro, clinda if taking theophylline)  

- Administering 6 L/min oxygen to acutely ill highly recurrent asthma patients can result in respiratory depression with retention of carbon dioxide, particularly in patients who are severely obstructed with significant remodelling of their airways  

Dental Management: avoid potent sedatives, chair position semi-supine; profound anesthesia; rubber dam with hole; pulse oximetry, supply oxygen (2-3L/min) when saturation drops <94%  

---  

**Status asthmaticus**  
**Definition**: severe + prolonged asthmatic attack (one lasting longer than 24 hrs) that is refractory to usual therapy  
- often associated with respiratory infection and can lead to exhaustion, severe dehydration, peripheral vascular collapse and death  
- life-threatening form of asthma in which progressively worsening reactive airways are unresponsive to therapy  

Can lead to in severe bronchospasm, airway inflammation, mucous plugging causing:  
- hypercapnia, hypoxemia, cyanosis, respiratory failure, cardiac arrest  

**Dental treatment**: identify type of asthma, precipitating substances, freq + severity of attacks, when attacks occur, management of attacks, emergency treatment with acute attacks  
- have pt take corticosteroid dose morning of appointment; short appointments early in day; make sure pt has their inhaler and its accessible  
- obtain spirometry readings before undergoing treatment in more severe cases  

---  

**Anaphylaxis**  
**Definition**: sudden + severe allergic reaction characterized by cardiovascular collapse (severe hypotension) and respiratory compromise (bronchospasm)  
Causes: a reaction to foods, environment (e.g. latex, bee stings), and meds  

**Pathophysiology**: interaction of Ag with IgE on basophils + mast cells → release histamine, leukotrienes → diffuse smooth muscle contraction (bronchoconstriction, vomit, diarrhea) and vasodilation with plasma leakage (urticarial, angioedema)  

**Onset**: Injected drugs 5-30mins, oral up to 2 hours  
**Treatment**: see page 36  

**Signs + symptoms**: itchy rash, throat/tongue swelling, SoB, vomiting, decrease in BP  

<table>
<thead>
<tr>
<th>Skin</th>
<th>Respiratory</th>
<th>CNS</th>
<th>CVS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flushed face, rash, urticaria, tingling, angioedema</td>
<td>Apnea, dyspnea, dysphagia, coughing, dysphonia, inspiratory stridor, wheezing</td>
<td>Diaphoresis, impending doom, altered consciousness, seizure, incontinence</td>
<td>Cyanosis/pallor, dizziness, hypotension, tachycardia to bradycardia, vascular collapse, cardiac arrest</td>
</tr>
</tbody>
</table>
**Pneumothorax**

**Definition:** abnormal presence of air in the pleural cavity leading to partial or complete collapse of the lung → lung collapses (pneumothorax) when chest wall is perforated

**Cause:** perforation by wound or surgical incision

**Types:**

<table>
<thead>
<tr>
<th>Traumatic</th>
<th>Spontaneous</th>
<th>Iatrogenic</th>
<th>Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caused by trauma</td>
<td>Caused by rupture of bleb or bullae*</td>
<td>Results in acute onset of chest pain and SoB</td>
<td>Life-threatening, develops when injured tissue forms 1 way valve → air inflow but no outflow - vol of intrapleural air ↑ with ea inspiration; pressure rises significantly within affected hemi-thorax</td>
</tr>
</tbody>
</table>

*Bleb: blister-like air pocket that form on visceral pleura; Bullae: air-filled cavities/cysts within lung tissue (emphysema, CF)
- When these blebs/bullae rupture → communication b/w thoracic cavity and lungs → pneumothorax

If pneumothorax is significant, it can cause a shift in mediastinum + compromise hemodynamic stability

**Tension pneumothorax:**
- Pressure increase → mediastinum shift toward contralateral side → impinge/compress both contralateral lung & impair venous return to right atrium
- Rapidly progresses to respiratory insufficiency, cardiovascular collapse, death (if untreated)

**Initial signs of tension pneumothorax:**
- hypotension, hypoxia, chest pain, dyspnea

**Hemoptysis**

**Definition:** coughing up of blood or bloody sputum from lungs or airway; may be self-limiting or recurrent

-massive hemoptysis: 200-600mL of blood coughed up within period of 24hrs

**Causes:** (most common= 80% infective)
- airway disease: bronchitis, bronchiectasis, sarcoidosis, neoplasms (SCLC, NSCLC), cystic fibrosis
- airway damage: foreign body, drug abuse (crack cocaine), trauma
- pulmonary parenchymal disease: infection (TB, pneumonia, fungal infections, parasitic disease, lung abscess), coagulopathy (thrombocytopenia, anticoagulants)
- vascular disease: pulmonary embolism, pulmonary arteriovenous malformation, aneurysms, HHT
- idiopathic: up to 30%

**Oral cancer**

**High risk areas:** floor of mouth, lateroventral tongue, soft palate, lower lip

Histological progression model: normal → epithelial hyperplasia and/or hyperkeratosis → mild dysplasia → moderate dysplasia → severe dysplasia → carcinoma in situ → invasive SCC

Information needed w/ biopsies: patient demographic data, description of clinical appearance of lesion & suspected diagnosis, site of biopsy, relationship of lesion to restorations (esp amalgam), detailed drug history, medical history, smoking/alcohol

**Treatment:** ask history (how long, size changes, symptomatic?), determine identified local conditions (trauma, infection or inflammation), take away causative factors and reassess 2-3weeks - if still present, diagnostic biopsy is indicated - leukoplakia of FoM biopsy immediately - incisional biopsy: size 15 scalpel blade → 3:1 length to width ratio, elliptical shape; inferior incision made first

**Bronchiectasis**

**Definition:** permanent dilation of the bronchi, accompanied by inflammatory changes in their walls + adjacent lung parenchyma → dilated bronchi are often filled with mucopurulent material

**Pathogenesis:** due to recurrent inflammation leading to fibrosis of bronchial walls and surrounding parenchyma

**Infective/Acquired causes:** pneumonia, TB, immune system issues, cystic fibrosis
Obstructive lung disease

Increased resistance to airflow due to changes in:
1. within lumen → increased secretions
2. in airway wall → thickening + inflammation
3. supporting structures surrounding airway → smooth muscle contraction in asthma

Common diagnoses: asthma, COPD, bronchiectasis, bronchiolitis, cystic fibrosis

COPD

**Definition:** pulmonary disorders characterized by **chronic airflow limitation** that is not fully reversible (chronic bronchitis, emphysema → both usually co-exist in same pt)
- Progressive disease!!! Increasing dyspnea + hypercapnia unless intervention is provided early on

**Diagnosis:** when patients have pulmonary symptoms and FEV₁ <70% of predicted volume (FVC) in the absence of any other pulmonary disease

<table>
<thead>
<tr>
<th>Chronic bronchitis</th>
<th>COPD</th>
<th>Symptom:</th>
</tr>
</thead>
<tbody>
<tr>
<td>-excessive tracheobronchial mucus production sufficient to cause cough with expectoration for at least 3 months of the year for more than 2 consecutive years</td>
<td>Definition: pulmonary disorders characterized by <strong>chronic airflow limitation</strong> that is not fully reversible (chronic bronchitis, emphysema → both usually co-exist in same pt)</td>
<td>-hypoxemia (result of ventilation-perfusion mismatch accompanying airflow inflammation, fibrosis + destruction)</td>
</tr>
<tr>
<td>-obstruction present on both inspiration + expiration</td>
<td>-Progressive disease!!! Increasing dyspnea + hypercapnia unless intervention is provided early on</td>
<td>-hypercapnia develops &amp; is often progressive</td>
</tr>
<tr>
<td><strong>Pathophysiology:</strong> large airway vs. small airway obstruction</td>
<td></td>
<td>-decreased diffusion capacity b/c of thick blood-gas barrier</td>
</tr>
<tr>
<td>Large airway</td>
<td>Small airway</td>
<td>-late disease process: severe hypoxia, pulmonary hypertension, cor pulmonale (RHF)</td>
</tr>
<tr>
<td>-thickened bronchial walls w/ inflammatory cell infiltrate</td>
<td>-narrowing + fibrosis</td>
<td><strong>Complications:</strong> asymptomatic for years except for cough + sputum production → progressive dyspnea + hypercapnia</td>
</tr>
<tr>
<td>-hypertrophy of mucous glands</td>
<td>-increased sputum prod’n</td>
<td>- recurrent pulmonary infections with influenza</td>
</tr>
<tr>
<td>-goblet cell hyperplasia</td>
<td>-mucous plugging</td>
<td>-pneumonia</td>
</tr>
<tr>
<td></td>
<td>-collapse of peripheral airways</td>
<td>- poor quality sleep due to nocturnal hypoxemia</td>
</tr>
</tbody>
</table>

**Emphysema**

- distension + permanent enlargement of air spaces distal to the terminal bronchioles b/c of destruction of alveolar walls
- pts often have increase in chest wall size

**Pathophysiology:**
- dyspnea b/c emphysema leads to loss of elastic recoil of lungs, making them more compliant, wheezing present varying degrees
- **enlarged space, pulmonary bullae, loss of elastic recoil** b/c of proteolytic loss of lung parenchyma; risk for pneumothorax
- chronic smoke inhalation injures lung parenchyma + pulmonary capillaries
  - Toxin in cigarette smoke injury alveolar epithelium → inflammatory mediators → activated mØ + neutrophil go to site of damaged epithelium → release enzymes such as elastase that destroy alveolar walls → enlarged space distal to terminal bronchioles + loss of elastic recoil → BV also destroyed, reducing perfusion → unsupported + enlarged airspaces collapse on expiration

**Management:** smoking cessation, avoid pulmonary irritants, influenza/pneumococcal vax, pulm rehab (exercise, education, nutrition), bronchodilators, inhaled corticosteroid w/ severe COPD (FEV₁<50% predicted), oxygen therapy where appropriate (if PO₂<91%)

**Dental management:** assess severity, consult physician if mod or high-risk COPD, encourage smoking cessation, avoid stress, pulse oximetry monitoring, bronchodilator available for emergency, chair position
  - nitrous oxide/oxygen sedation **CONTRAINDICATED** → O₂ flow can suppress hypoxic drive that maintains respiration in mod-severe COPD
<table>
<thead>
<tr>
<th>Risk factor: <strong>#1=SMOKING</strong> (20% heavy smokers develop COPD; 85-90% of COPD related deaths due to smoking)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lung inflammation also due to genetic predisposition (absence/deficiency of $a_1$-antitrypsin), latent/persistent viral lung infections, pollution, occupational exposures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Candidiasis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment:</strong></td>
</tr>
<tr>
<td>- Oral troche (clotrimazole 10mg): dissolve 1 troche in oral cavity, 5x/day</td>
</tr>
<tr>
<td>- Nystatin oral suspension (100000U/mL): rinse 5mL QID for 2mins and expectorate</td>
</tr>
<tr>
<td>- Clotrimazole 1% cream or nystatin 100000U/g cream/ointment: apply thin layer to inner + outer corner of mouth QID after meals OR apply thin layer to tissue side of denture and infected oral mucosa QID after meals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Acute respiratory distress syndrome (ARDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ARDS $\rightarrow$ hypoxemic respiratory failure</strong></td>
</tr>
<tr>
<td><strong>Definition:</strong> severe arterial hypoxemia + diffuse bilateral pulmonary infiltrates not due to exclusively to cardiogenic or hydrostatic causes (syndrome resulting from a number of etiologic factors). ARDS is associated with diffuse alveolar damage (DAD) and pulmonary capillary endothelial injury</td>
</tr>
<tr>
<td><strong>Causes:</strong> sepsis, trauma, pneumonia, aspiration (gastric contents, near drowning), toxic gas inhalation, drug overdose (narcotics, sedatives), embolism (fat)</td>
</tr>
<tr>
<td>- Due to <strong>increase in permeability of alveolar-capillary barrier</strong> leading to an influx of fluid into alveoli and interstitial tissues</td>
</tr>
<tr>
<td>- Variety of insults resulting in damage either to vascular endothelium or to alveolar epithelium could result in ARDS</td>
</tr>
</tbody>
</table>

| - LA for simple procedures; avoid potent sedatives b/c of depressive effects on respiratory system (low dose benzos ok) |
| - **UNSTABLE = SoB at rest, persistent productive cough, upper resp infxn, oxygen saturation <91% $\rightarrow$ DEFER TREATMENT |

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</tr>
<tr>
<td>Drug</td>
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<tr>
<td>--------</td>
</tr>
<tr>
<td>Spiriva</td>
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<tr>
<td>Advair</td>
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</tbody>
</table>
| Salbutamol | highly selective β2-adrenergic receptor agonist | bronchodilator effect  
- relaxes the smooth muscles of airways, from trachea to terminal bronchioles  
- inhibits the release of bronchoconstrictor mediators such as histamine and leukotriene from the mast cells in the airway | -It is used to relieve bronchospasm in bronchial asthma, chronic bronchitis, emphysema and other airway diseases  
-After inhalation, salbutamol reaches the lungs directly and acts within 3-5 minutes with a peak at 15-20 minutes  
-overall duration of action is 4-6 hours  
-It is metabolized in the intestinal tract and in the liver and is excreted via the urine | |
<table>
<thead>
<tr>
<th>COPD</th>
<th>Asthma</th>
</tr>
</thead>
</table>
| **Definition** | • A group of chronic, progressive, expiratory lung diseases characterized by limited airflow with variable degrees of air sac enlargement and lung tissue destruction  
• Emphysema and chronic bronchitis are most common forms of COPD | • Chronic but reversible airway inflammation characterized by periodic attacks of wheezing, shortness of breath, chest tightness and coughing  
• Airways hyper-responsive to triggers/antigens leading to acute obstructive symptoms by bronchoconstriction, mucous plugging, and increased inflammation  
• Cannot be diagnosed at first presentation; called reactive airway disease until recurrent presentations  
• Peak flow meters are useful in the office and at home for monitoring |
| **Role of smoking** | > 10 pack year | Not causal, known trigger |
| **Reversibility of airflow obstruction** | Airflow obstruction is chronic and persistent | Airflow obstruction is episodic and usually reversible with therapy |
| **Evolution** | Slow, progressive worsening (with periodic exacerbations) | Stable, episodic, less than 50% will outgrow |
| **History of allergy** | Infrequent | Over 50% patients |
| **Precipitations** | Environmental irritants (air pollution), cigarette smoking, alpha-1 antitrypsin deficiency, viral infection, occupational exposure (firefighters, dusty jobs) | Environmental irritants (dust, pollen), animal fur, cold air, exercise, URIs, cigarette smoke, use of beta-blockers/ASA |
| **Symptoms/Signs** | Chronic cough, sputum and/or dyspnea | Wheeze (hallmark symptom), dyspnea, chest tightness, cough which is worse in cold, at night and in early AM, prolonged expiration |
| **Diffusion Capacity** | Decreased (more so in pure emphysema) | Normal (for pure asthma) |
| **Hypoxemia** | Chronic in advanced stages | Not usually present, episodic with severe attacks |
| **Spirometry** | May have improvement with bronchodilators but not universally seen | Marked improvement with bronchodilators or steroids |
| **Chest X-ray** | - Often normal  
- Increased bronchial markings (chronic bronchitis) and chronic hyperinflation (emphysema) often co-exist, bullae | - Often normal or episodic hyperinflation  
- Hyperinflation during asthma attack |
| **Management** | Mild  
**Step 1**: Short Acting Beta Agonist (SABA) prn (salbutamol)  
**Step 2**: SABA prn + Long-Acting Anticholinergic (LAAC) (i.e. tiotropium) or + long acting β-2 agonist (LABA) (i.e. salmeterol)  
**Moderate**:  
**Step 1**: SABA prn + LAAC + low-dose combined inhaled corticosteroid (ICS)/LABA; consider inhaled vs. oral steroids  
**Severe**:  
**Step 4**: +/- theophylline, pneumococcal vaccination, annual influenza immunization | Ongoing patient education and environmental control  
- SABA taken prn as rescue medication + maintenance meds  
- Maintenance medications;  
  **Step 1**: low-dose ICS  
  **Step 2**: Medium/high-dose ICS or low-dose ICS plus either LABA, LT modifier or long-acting theophylline  
  **Step 3**: Medium/high-dose ICS plus either LABA, LT modifier or long-acting theophylline  
  **Step 4**: As above plus immunotherapy +/- oral glucocorticosteroids + pneumococcal vaccination, annual influenza immunization |

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
<th>Investigations</th>
</tr>
</thead>
</table>
| **Chronic Bronchitis (Blue Bloat®)** | - Chronic productive cough  
- Purulent sputum  
- Hemoptysis  
- Mild dyspnea initially | - Cyanosis (secondary to hypoxemia and hypercapnia)  
- Peripheral edema from RVF (cor pulmonale)  
- Crackles, wheezes  
- Frequently obese | **CKR**:  
- AP diameter normal  
- ↑ bronchovascular markings  
- Enlarged heart with cor pulmonale |
| **Emphysema (Pink Puffer®)** | - Dysnea (~ exertion)  
- Minimal cough  
- Tachypnea  
- Decreased exercise tolerance | - Pink skin  
- Pursed-lip breathing  
- Accessory muscle use  
- Cachectic appearance  
- Hyperinflation/barrel chest  
- Decreased diaphragmatic excursion | **PFT**:  
- ↑ TLC (hyperinflation)  
- ↑ RV (gas trapping)  
- ↓ DLco  
| **CKR**:  
- ↑ AP diameter  
- Flat hemi-diaphragm bullae |

\[ CO_2 + H_2O = H_2CO_3 = H^+ + HCO_3^- \]

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>pH</th>
<th>CO₂</th>
<th>HCO₃⁻</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory acidosis</td>
<td>Uncompensated</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Partially compensated</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>Pneumonia</td>
</tr>
<tr>
<td>Fully Compensated</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>Hypoventilation</td>
</tr>
<tr>
<td>Respiratory alkalosis</td>
<td>Uncompensated</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Partially compensated</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
<td>Panic attack</td>
</tr>
<tr>
<td>Fully Compensated</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>Aspirin Poisoning</td>
</tr>
<tr>
<td>Metabolic acidosis</td>
<td>Uncompensated</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Partially compensated</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>Lactic acidosis</td>
</tr>
<tr>
<td>Fully Compensated</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>Alcohol, salicylate</td>
</tr>
<tr>
<td>Metabolic alkalosis</td>
<td>Uncompensated</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Partially compensated</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>Loss of potassium</td>
</tr>
<tr>
<td>Fully Compensated</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td></td>
</tr>
</tbody>
</table>
Pulmonary function tests

**Expiratory flow**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Diagnostics</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Forced Expiratory Volume (in 1 sec)</td>
</tr>
<tr>
<td>FVC</td>
<td>Forced Vital Capacity</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC</td>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC ratio (expressed as percentage)</td>
</tr>
</tbody>
</table>

**Lung volume**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TLC</td>
<td>Total Lung Capacity (volume of gas and lungs at the end of maximal inspiration)</td>
</tr>
<tr>
<td>FRC</td>
<td>Functional Residual Capacity (volume of gas in the lungs at relaxation point, when elastic inward pull of lungs is balanced by outward pull of the chest wall and diaphragm)</td>
</tr>
<tr>
<td>ERV</td>
<td>Expiratory Reserve Volume (volume of gas expired from FRC to maximal expiration)</td>
</tr>
<tr>
<td>RV</td>
<td>Residual Volume (FRC - ERV, volume of gas left in lungs after maximal exhalation)</td>
</tr>
</tbody>
</table>

**Diffusing capacity**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D&lt;sub&gt;CO&lt;/sub&gt;</td>
<td>Diffusing capacity for carbon monoxide</td>
</tr>
</tbody>
</table>

**Arterial blood gases**

- PaO<sub>2</sub>: Partial pressure of oxygen in arterial blood
- PaCO<sub>2</sub>: Partial pressure of carbon dioxide in arterial blood

**pH**: Negative log of hydrogen ion concentration

<table>
<thead>
<tr>
<th>Condition</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC</th>
<th>FVC</th>
<th>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC ratio</th>
<th>TLC</th>
<th>RV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>Obstructive</td>
<td>↓</td>
<td>↓</td>
<td>↑ to ↑↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Restrictive</td>
<td>↓</td>
<td>↓</td>
<td>↑ to ↓↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Weak chest wall</td>
<td>↓</td>
<td>↓</td>
<td>Normal or↑</td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
</table>

FEV<sub>1</sub> = max amt of air that can be forcefully exhaled in 1 sec
FVC = forced vital capacity → greatest amt of air that can be forcefully exhaled with a complete breath
FEV<sub>1</sub>/FVC = ratio of the amt of air exhaled forcefully in 1 sec divided by the amt of air that can be forcefully exhaled with a complete breath regardless of how long it takes

- Calculated ratio used in diagnosis of obstructive + restrictive lung disease
- Normal values ~80%
- Presence of post-bronchodilator FEV<sub>1</sub>/FVC <0.70 confirms presence of persistent airflow limitation

**Spirometry**: measures amt of airflow obstruction + is primary method of diagnosing obstructive disease, particularly COPD

**Lung volume measurement**: most accurate=sit in sealed clear box OR breath nitrogen/helium gas thru tube for certain time → [gas] estimates volume

**Arterial blood gases (ABG)**: used to determine patient’s respiratory and acid-base status (PaO<sub>2</sub>, PaCO<sub>2</sub>, pH, bicarbonate, base excess); can also measure hemoglobin, blood glucose, electrolytes and lactate

**Diffusion capacity**: measured by breathing tracer gas (carbon monoxide) for a brief period, often only for 1 breath → concentration of gas in air breathed out is measured → difference in the amount of gas inhaled + exhaled measures how effectively gas travels from the lungs into the blood

- This test enables an estimate of how well the lungs move oxygen from the air into the bloodstream
<table>
<thead>
<tr>
<th>Space</th>
<th>Anterior</th>
<th>Posterior</th>
<th>Superior</th>
<th>Inferior</th>
<th>Superficial or Medial*</th>
<th>Deep or Lateral†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buccal</td>
<td>Corner of mouth</td>
<td>Masseter muscle Pterygomandibular space</td>
<td>Maxilla infraorbital space</td>
<td>Mandible</td>
<td>Subcutaneous tissue and skin</td>
<td>Buccinator muscle</td>
</tr>
<tr>
<td>Infraorbital</td>
<td>Nasal cartilages</td>
<td>Buccal space</td>
<td>Quadratus labii superioris muscle</td>
<td>Oral mucosa</td>
<td>Quadratus labii superioris muscle</td>
<td>Levator anguli oris muscle, maxilla</td>
</tr>
<tr>
<td>Infratemporal</td>
<td>Infra-temporal surface of the maxilla</td>
<td>Carotid sheath</td>
<td>Greater wing of sphenoid bone</td>
<td>Medial pterygoid muscle, Pterygomandibular space</td>
<td>lateral pterygoid plate, part of lateral pterygoid muscle &amp; lateral pterygoid muscle &amp; lateral pharyngeal wall</td>
<td>Temporalis muscle, ramus of mandible</td>
</tr>
<tr>
<td>Submandibular</td>
<td>Anterior belly of digastric muscle</td>
<td>Posterior belly digastric muscle, Stylohyoid muscle, Stylopharyngeus muscles</td>
<td>Inferior and medial surfaces of mandible</td>
<td>Digastric tendon</td>
<td>Platysma muscle, Investing fascia</td>
<td>Mylohyoid muscle Hyoglossus muscle Superior constrictor muscles</td>
</tr>
<tr>
<td>Submental</td>
<td>Inferior border of mandible</td>
<td>Hyoid bone</td>
<td>Mylohyoid muscle</td>
<td>Investing fascia</td>
<td>Investing fascia</td>
<td>Anterior bellies of digastric muscles†</td>
</tr>
<tr>
<td>Sublingual</td>
<td>Lingual surface of mandible</td>
<td>Submandibular space</td>
<td>Oral mucosa</td>
<td>Mylohyoid muscle</td>
<td>Muscles of tongue*</td>
<td>Lingual surface of mandible†</td>
</tr>
<tr>
<td>Pterygomandibular</td>
<td>Buccal space</td>
<td>Parotid gland</td>
<td>Lateral pterygoid muscle</td>
<td>Inferior border of mandible</td>
<td>Medial pterygoid muscle*</td>
<td>Ascending ramus of mandible†</td>
</tr>
<tr>
<td>Submasseteric</td>
<td>Buccal space</td>
<td>Parotid gland</td>
<td>Zygomatic arch</td>
<td>Inferior border of mandible</td>
<td>Ascending <strong>ramus</strong> of mandible*</td>
<td>Masseter muscle†</td>
</tr>
<tr>
<td>Lateral pharyngeal</td>
<td>Superior and middle pharyngeal constrictor muscles</td>
<td>Carotid sheath and scalene fascia</td>
<td>Skull base</td>
<td>Hyoid bone</td>
<td>Pharyngeal constrictors and retropharyngeal space*</td>
<td>Medial pterygoid muscle†</td>
</tr>
<tr>
<td>Retropharyngeal</td>
<td>Superior and middle pharyngeal constrictor muscles</td>
<td>Alar fascia</td>
<td>Skull base</td>
<td>Fusion of alar and prevertebral fasciae at C6-T4</td>
<td>Carotid sheath and lateral pharyngeal space†</td>
<td></td>
</tr>
<tr>
<td>Pretracheal</td>
<td>Sternothyroid- thyrohyoid fascia</td>
<td>Retropharyngeal space</td>
<td>Thyroid cartilage</td>
<td>Superior mediastinum</td>
<td>Sternothyroid- thyrohyoid fascia</td>
<td>Visceral fascia over trachea and thyroid gland</td>
</tr>
</tbody>
</table>

* Medial border; †Lateral border
Renal Block
Fluid volume and balance

<table>
<thead>
<tr>
<th>Hypovolemia</th>
<th>Hypervolemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor skin turgor</td>
<td>SOB at rest or exertion</td>
</tr>
<tr>
<td>Dry mucous membranes</td>
<td>Jugular venous distention</td>
</tr>
<tr>
<td>Dry axilla, Flat neck veins</td>
<td>S3</td>
</tr>
<tr>
<td>Tachycardia</td>
<td>Ascites</td>
</tr>
<tr>
<td>Orthostatic hypotension</td>
<td>Pitting edema</td>
</tr>
<tr>
<td>Hypothermia</td>
<td>Weight gain</td>
</tr>
<tr>
<td>Weight loss, Sunken eyes</td>
<td></td>
</tr>
</tbody>
</table>

Hyponatremia

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea and malaise</td>
<td>Depends on cause (cirrhosis of liver, CHF, chronic kidney disease, nephrotic syndrome in kidneys, massive edema)</td>
</tr>
<tr>
<td>Headache</td>
<td>Hypovolemic hyponatremia: IV fluids &amp; H2O restriction</td>
</tr>
<tr>
<td>Lethargy, decreased level of consciousness</td>
<td>• Isotonic saline given to replace contracted intravascular volume</td>
</tr>
<tr>
<td>Muscle weakness, spasms or cramps</td>
<td>Secondary to diuretics: may need K+ repletion</td>
</tr>
<tr>
<td>Seizures and coma</td>
<td>Symptomatic hyponatremia (seizure, severe neurological deficits): hypertonic 3% saline should be used</td>
</tr>
<tr>
<td>Neurologic symptoms most often are due to intracerebral osmotic fluid shifts and brain edema</td>
<td>ADH antagonist may be considered</td>
</tr>
</tbody>
</table>

Osmotic demyelination syndrome

Def’n: neurologic manifestations associated with overly rapid correction

- In response to hyponatremia, brain makes adaptations that lower cerebral volume toward normal & reduce likelihood of complications BUT brain’s adaptations make it vulnerable to injury if chronic hyponatremia is too rapidly corrected

Saline flow rate:

- Delayed correction → perpetuate cerebral edema → irreversible neurologic damage → death
- Overly rapid correction → osmotic demyelination

Symptoms:

- Fluctuating levels of consciousness, palsy, ataxia, dysarthria, dysphagia

Causes of acute hyponatremia include water intoxication in:

- Marathon runners
- Psychotic patients with polydipsia
- Users of ecstasy (MDMA)

Pathophysiology:

Mins after development of hyponatremia → brain cells swell b/c of decreased osmolality → rapid adaptation occurs within hours b/c of cellular loss of electrolytes

- Slow adaptation occurs over several days thru loss of organic osmolytes from brain to normalize brain volume
- Aggressive correction of hyponatremia → irreversible brain damage (osmotic demyelination) [oligodendroglial cells most susceptible]
Hypokalemia vs. Hyperkalemia

<table>
<thead>
<tr>
<th>Hypokalemia symptoms</th>
<th>Hyperkalemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nonspecific and predominantly are related to muscular or cardiac function</td>
<td>Cardiac electrical activity</td>
</tr>
<tr>
<td>• Weakness and fatigue = most common</td>
<td>Of most concern is the impairment of cardiac conduction, which can result in ventricular fibrillation or asystole. With mild to moderate hyperkalemia, there is a reduction of the size of the P wave and development of peaked T waves. Severe hyperkalemia results in a widening of the QRS complex</td>
</tr>
<tr>
<td>• Muscle cramps and pain = severe cases</td>
<td></td>
</tr>
<tr>
<td>• Worsening diabetes control or polyuria</td>
<td></td>
</tr>
<tr>
<td>• Palpitations</td>
<td></td>
</tr>
<tr>
<td>• Psychological symptoms</td>
<td></td>
</tr>
<tr>
<td>• psychosis</td>
<td></td>
</tr>
<tr>
<td>• delirium</td>
<td></td>
</tr>
<tr>
<td>• hallucinations</td>
<td></td>
</tr>
<tr>
<td>• depression</td>
<td></td>
</tr>
<tr>
<td><strong>Severe Hypokalemia:</strong></td>
<td></td>
</tr>
<tr>
<td>• Bradycardia with cardiovascular collapse</td>
<td></td>
</tr>
<tr>
<td>• Cardiac arrhythmias</td>
<td></td>
</tr>
<tr>
<td>• Acute respiratory failure from muscle paralysis</td>
<td></td>
</tr>
</tbody>
</table>

Renal Congenital Anomalies

**Autosomal recessive polycystic kidney disease**
- Affects kidneys & liver; kidneys enlarged & contain small cysts
- Renal failure common in childhood

**Fusion anomalies**
- Kidneys are joined, but ureters enter bladder normally
- Horseshoe kidney most common, isthmus of renal parenchyma or fibrous tissue joins at midline
- Crossed fused renal ectopia second most common, renal parenchyma on one side of vertebral column
- Fused pelvic kidney less common, single pelvic kidney served by 2 collecting systems and ureters

**Renal ectopia**
- Usually results when kidney fails to ascend from origin in true pelvis
- Rare exception occurs w/ superiorly ascended (thoracic) kidney

**Renal hypoplasia**
- Usually occurs b/c inadequate ureteral bud branching causes underdeveloped, small kidney with histologically normal nephrons

**Multicystic dysplastic kidney (MCDK)**
- Non-functioning kidney consisting of cysts with fibrosis + foci of cartilage
- Usually ureteral atresia also present
- Contralateral kidney usually normal

**Others:** duplication anomalies, mal-rotation, renal agenesis, renal dysplasia

**Tumor Lysis Syndrome (TLS)**
- Caused by rapid destruction of tumour cells, usually in response to chemotherapy
- Malignant cells have high turnover rate & make a lot of
  - nucleic acid by-products \(\rightarrow\) turns into uric acid
  - phosphate \(\rightarrow\) \(~4x\) the norm
- release of intracellular contents into blood \(\rightarrow\) increase serum level of uric acid, potassium, phosphate & decrease in calcium

**Kidneys need to eliminate by-products \(\rightarrow\) become saturated and imbalance of electrolytes occur \(\rightarrow\) cardiac arrhythmia, death**
- hyperuricemia \(\rightarrow\) precipitate uric acid crystals, obstruct’n \(\rightarrow\) decline in renal function \(\rightarrow\) acute renal failure (COMMON)
- hyperphosphatemia \(\rightarrow\) crystal \(\rightarrow\) nephrocalcinosis, obstruct’n
- hyperkalemia
Chronic Kidney Disease

Def'n: reduced renal function with effects on multiple organ systems
Result: anemia, abnormal bleeding, hypertension, electrolyte & fluid imbalance, drug intolerance, skeletal abnormality
- Reduced GFR → more Na+, H2O reabsorption → increase blood volume and CO

Risk factors: diabetes, hypertension, family history, glomerular disease, polycystic kidney disease, drug induced, obstruction

Oral Manifestations:
- oral mucosa pallor (anemia), xerostomia (less fluid intake, meds), parotid infections, dysgeusia (urea), candidiasis, poor oral hygiene, gingivitis, periodontal disease, petechiae, ecchymosis, oral lesions – ulcers, lichen planus, lichenoid-like lesions, hairy tongue, hairy leukoplakia, pyogenic granulomas, enamel hypoplasia, tooth erosion, pulp narrowing, reduction in caries (urea in saliva has buffering capacity), uremic stomatitis/frost, gingival enlargement pigmentation (carotene-like pigments → red-orange; hyperpigmentation → beta-melanocyte stimulating hormone)

Radiographic manifestations:
- osseous changes: loss of lamina dura, demineralized bone, widened trabeculations, loss of cortication, calcified extraction sites, localized radiolucent jaw lesions

Dental surgical treatment:
- consult nephrologist, prescribe drugs only after consultation, confirm if antibiotic prophylaxis & post-op antibiotics needed to prevent infection in ESRD
- Abx prophylaxis not routinely given; least nephrotoxic=clindamycin
- take vitals pre-op, peri-op, post-op
- traumatically as possible (poor healing), observe 45 mins post-op for hemostasis & systemic stability

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>(GFR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kidney damage with normal kidney function</td>
<td>90 or above</td>
</tr>
<tr>
<td>2</td>
<td>Kidney damage with mild loss of kidney function</td>
<td>89 to 60</td>
</tr>
<tr>
<td>3a</td>
<td>Mild to moderate loss of kidney function</td>
<td>59 to 44</td>
</tr>
<tr>
<td>3b</td>
<td>Moderate to severe loss of kidney function</td>
<td>44 to 30</td>
</tr>
<tr>
<td>4</td>
<td>Severe loss of kidney function</td>
<td>29 to 15</td>
</tr>
<tr>
<td>5</td>
<td>Kidney failure</td>
<td>Less than 15</td>
</tr>
</tbody>
</table>

**renal disease is irreversible once serum creatinine in an adult reaches ~3mg/dL**
## Acute Kidney Injury

**Def'n**: rapid decline in kidney function (decrease GFR, disordered ECF regulation, electrolyte+acid/base balance, accumul’n of nitrogenous wastes)

Common causes: medications (NSAIDs), sepsis, shock, surgery, pregnancy-related complications, trauma

**Intrinsic AKI** causes:
- Tubular injury – **acute tubular necrosis** following prolonged ischemia (nephrotoxins) – see below
  - Nephrotoxins: aminoglycosides, radiocontrast media, myoglobin, heavy metals
- Acute interstitial nephritis – b/c of drugs, infxn, autoimmune disease
  - Infiltrative diseases, infections, meds - NSAIDs
- Glomerular disease – glomerulonephritis, thrombosis, hemolytic uremic syndrome
- Vascular disease – vasculitis, cholesterol emboli, renal artery stenosis, renal vein thrombosis, cryoglobulinemia, thrombotic microangiopathy, hypertensive emergency
- Eclampsia

3 stages:
- Oliguria (urine vol <400mL/day)
- Diuresis (high urine vol output >400mL/day)
- Recovery

**Prerenal AKI**: due to sudden renal hypoperfusion → loss of kidney function
- Results from reversible changes in renal blood flow
- Most common cause of AKI ~50% cases
- AKA prerenal azotemia
- NOTHING wrong with kidney itself
- Etiologic factors associated: volume depletion, heart failure, cardiovascular shock, medications diminishing RBF, change in fluid volume distribution associated w/ sepsis & burns

Causes of prerenal AKI:
- Volume depletion: hemorrhage, severe vomit/diarrhea, burns
- Edematous states: cirrhosis, cardiac failure
- Hypotension: cardiogenic shock, sepsis, anaphylaxis
- Cardiovascular: severe cardiac failure, arrhythmias

**Postrenal AKI leading to renal failure** less common but most treatable
- conditions that block flow of urine from kidneys at any level of urinary tract & then decrease GFR (e.g. enlargement of prostate gland)

Causes of postrenal AKI:
- Calculus, blood clot, papillary necrosis, urethral stricture, prostatic hypertrophy/malignancy, bladder tumor, radiation fibrosis, pelvic malignancy, retroperitoneal fibrosis

### Risk factors for AKI progression to ESKD (end stage kidney disease) = hypertension, uncontrolled diabetes, dyslipidemia, smoking, nephrotoxins (NSAIDs), overweight/obesity, poor diet (excess sodium, nitrogen, etc.)

**ESRD**

**Most common causes of ESRD**: diabetes mellitus (37-44%), hypertension (25%), chronic glomerulonephritis (16%), polycystic kidney disease, interstitial nephritis, pyelonephritis, SLE, neoplasms

**Abnormalities developed**:
- anemia – decreased EPO production
- platelet dysfunction – decreased TPO, platelet aggregation
- coagulopathy – platelet dysfunction & excretion of clotting factors, anti-clotting factors
- compromised immunity – host defence compromised by hypogammaglobulinemia
- skeletal abnormalities – failing kidney doesn’t convert Vit D to calcitriol, calcium absorption in gut inhibited → hyperparathyroidism

**Treatment**: non-dialysis supportive care (conserv. care), dialysis, transplant

Signs and symptoms:
- fatigue, headache, leg cramp, insomnia, bone pain, bleeding disorders
- GI → loss of appetite, nausea, vomiting
- skin manifestations – ecchymoses, petechiae, purpura, gingival/mucous membrane bleeding, epistaxis
- **uremic pruritis** → accumulation of toxins, dry skin, reduced sweating, abnormal metabolism of calcium & phosphate (hyperparathyroidism), systemic inflammation, co-existing medical problems (diabetes and liver disease)

**Polycystic Kidney Disease**
- hereditary disorder characterized by multiple expanding cysts of both kidneys → cysts destroy renal parenchyma → failure
- large multiple cysts (>!5cm), distorting typical bean shape of kidneys
Peritoneal dialysis vs. Hemodialysis

**Peritoneal dialysis**

- Hypertonic solution is instilled into the peritoneal cavity through a permanent peritoneal catheter
- After a time, the solution and dissolved solutes are drawn out
- This method allows patients to perform dialysis at home, on their own schedule
- Its principal use is in patients in acute renal failure or high functioning patients with some healthy remaining nephrons who require only occasional dialysis

**Advantages:**
- low cost
- ease of performance
- no anticoagulation

**Disadvantages:**
- risk of peritonitis
- significantly lower effectiveness than that for hemodialysis

**Hemodialysis**

Most dialysis patients (80%) receive hemodialysis where their blood is passed through the machine, filtered, and returned to the patient

- Heparin is administered during the procedure to prevent clotting
- Treatments are performed every 2 or 3 days, depending on need
- 3 to 4 hours is required for each session
- Hemodialysis is the method of choice if dialysis is needed on a long-term basis and for patients with very little renal function who need the significantly more efficacious hemodialysis vs peritoneal dialysis
- In hemodialysis, blood is removed from the body and circulated through an extracorporeal (outside the body) hemodialyser then returned to the patient
- The hemodialyser contains a selectively permeable membrane that allows fluids and waste (uremic toxins) to pass through, but prevents the exchange of blood components

H= Hyperkalemia (refractory) A= Acidosis (refractory) V= Volume overload (refractory) E= Elevated urea
P= Pericarditis E= Encephalopathy E= Edema (pulmonary) HAVEPEE

- Hemodialysis consumes an enormous amount of the patient’s time and is extremely confining
- Between dialysis sessions, patients lead a relatively normal life
- More than 80% of the people who receive hemodialysis do so through a permanent and surgically created arteriovenous fistula (or graft), usually placed in the forearm
- In addition to heparin, hemodialysis is associated with the additional problem of platelet destruction by mechanical trauma of the procedure
- Patients ESRD also have bleeding tendencies due to altered platelet aggregation and decreased coagulation factors

~40% of patients on dialysis have CHF ⎢ 39% die of cardiovascular complications every year

### INDICATIONS FOR HEMODIALYSIS

<table>
<thead>
<tr>
<th>Absolute Indications</th>
<th>Relative Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume overload (refractory to diuretics)*</td>
<td>Loss of appetite (malnutrition, weight loss)</td>
</tr>
<tr>
<td>Hyperkalemia, hypercalcemia, hypocalcemia, or hyperphosphatemia*</td>
<td>Decreased cognitive functioning</td>
</tr>
<tr>
<td>Severe metabolic acidosis*</td>
<td>Profound fatigue and weakness</td>
</tr>
<tr>
<td>Neurologic signs or symptoms of uremia (encephalopathy, neuropathy, seizures)</td>
<td>Severe anemia unresponsive to erythropoietin</td>
</tr>
<tr>
<td>Uremic pericarditis or pleuritis</td>
<td>Persistent severe pruritus</td>
</tr>
<tr>
<td>Refractory accelerated hypertension*</td>
<td>Restless leg syndrome</td>
</tr>
<tr>
<td>Clinically significant bleeding (bleeding attributable to uremia)</td>
<td></td>
</tr>
<tr>
<td>Persistent severe nausea and vomiting</td>
<td></td>
</tr>
<tr>
<td>Plasma Cr &gt; 1060 μmol/L or urea &gt; 36 mmol/L</td>
<td></td>
</tr>
</tbody>
</table>

* unresponsive to medications
### Acute Tubular Necrosis

- Follows well-defined 3-part sequence: initiation, maintenance, recovery
  - **Initiation** phase is characterized by an acute decrease in GFR, with a sudden increase in serum creatinine and BUN concentrations
  - **Maintenance** phase has a sustained severe reduction in GFR that persists for a variable length of time, most commonly 1-2 weeks
    - the creatinine and BUN levels continue to rise
    - complications (e.g. uremic) typically develop during this phase
  - With treatment tubular function can be restored, resulting in increased urine volume and a gradual decrease in BUN and serum creatinine to their preinjury levels
  - The recovery phase of ATN is characterized by regeneration of tubular epithelial cells

<table>
<thead>
<tr>
<th>Causes of <strong>Ischemic acute tubular necrosis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypovolemic states:</strong></td>
</tr>
<tr>
<td>• hemorrhage, volume depletion from GI or renal losses, burns, fluid sequestration</td>
</tr>
<tr>
<td><strong>Low cardiac output states:</strong></td>
</tr>
<tr>
<td>• CHF, diseases of myocardium, cardiac valves, arrhythmia, pericardial diseases, tamponade</td>
</tr>
<tr>
<td><strong>Systemic vasodilation:</strong></td>
</tr>
<tr>
<td>• sepsis, anaphylaxis</td>
</tr>
<tr>
<td><strong>Disseminated intravascular coagulation Renal vasoconstriction:</strong></td>
</tr>
<tr>
<td>• cyclosporine, amphotericin B, norepinephrine, epinephrine, hypercalcemia</td>
</tr>
<tr>
<td><strong>Impaired renal autoregulatory responses:</strong></td>
</tr>
<tr>
<td>• cyclooxygenase (COX) inhibitors, angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs)</td>
</tr>
</tbody>
</table>

### Exercise-Induced Rhabdomyolysis – myoglobin & creatinine

<table>
<thead>
<tr>
<th>Pathophysiological condition of skeletal muscle cell damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>-result=increased serum levels of creatine kinase (CK) and myoglobin (Mb)</td>
</tr>
<tr>
<td>Can lead to: acute kidney injury, hepatic dysfunction, heart failure, arrhythmias, electrolyte imbalance, death</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Myoglobin: cytoplasmic hemoprotein, in cardiac myocytes + oxidative skeletal muscle fibres; reversibly bind O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Freely filtered at glomerulus b/c of low MW</td>
</tr>
<tr>
<td>• Normally small amt filtered each day, but reabsorbed in proximal tubule</td>
</tr>
<tr>
<td>• Presence in urine indicates excessive amts being filtered</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Creatine Kinase</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Enzyme that makes energy providing molecules; catalyzes reversible phosphorylation of Cr by ATP</td>
</tr>
<tr>
<td>• High serum [CK] indicates recent muscle damage (don’t know cause or location)</td>
</tr>
</tbody>
</table>

### Hypertension & Kidneys

<table>
<thead>
<tr>
<th>Renal Artery Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal artery disease can cause stenosis of the vessel lumen</td>
</tr>
<tr>
<td>• congenital or caused by diabetes +/- or atherosclerosis</td>
</tr>
<tr>
<td>• reduced lumen diameter reduces renal perfusion + reduces GFR</td>
</tr>
<tr>
<td>• reduced GFR leads to increased Na+ reabsorption</td>
</tr>
<tr>
<td>Reduction in renal perfusion stimulates renin release by the kidney ➔ increases circulating angiotensin II, aldosterone, and ADH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aortic Coarctation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Congenital defect most commonly found just distal to the left subclavian artery in the arch of the aorta</td>
</tr>
<tr>
<td>• Obstruction of aorta ➔ elevates arterial pressures proximal to coarctation (head and arms) and decreases BP distal to coarctation</td>
</tr>
<tr>
<td>• The reduced systemic arterial pressure distal to the coarctation affects the kidneys and activates the renin-angiotensin-aldosterone system, which leads to an increase in blood volume, CO, and SVR</td>
</tr>
<tr>
<td>• This mechanism further increases arterial pressures in the upper body and may regulate the BP in the lower body</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary Hyperaldosteronism</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increased secretion of aldosterone generally results from adrenal adenoma or adrenal hyperplasia</td>
</tr>
<tr>
<td>• Increased circulating aldosterone causes renal retention of sodium and water so blood volume and arterial pressure increase</td>
</tr>
<tr>
<td>• The patient will be hypokalemic due to the high levels of aldosterone</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pheochromocytoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Catecholamine secreting tumors in the adrenal medulla can lead to very high levels of circulating catecholamines</td>
</tr>
</tbody>
</table>
- These hormones increase blood volume by enhancing renal reabsorption of Na+ and H2O
- Increased angiotensin II also causes systemic vasoconstriction and enhances sympathetic activity
- As disease progresses renal ischemia also occurs -> EPO and increased BV

HT caused by renal artery stenosis results from increases in CO, SVR, BV

Chronic HT causes pathologic changes in small arteries of kidneys → renal arteries develop endothelial dysfunction & impaired vasodilation → impaired renal autoregulation, intraglomerular pressure vary directly w/ systemic arterial pressure
- No protection from BP fluctuation lead to nephron injury, fibrosis, necrosis → decrease GFR, increase Na+ and H2O reabsorption → increased renin
  - Therefore, increased blood volume, CO, SVR → exacerbate HT

Hypertensive Nephrosclerosis
- Presence of varying degrees of glomerulosclerosis, interstitial fibrosis, tubular atrophy, arteriosclerosis, arteriolosclerosis
- Causes: Luminal reduction of renal vasculature & loss of renal autoreg.
- Consequences: reduction in GFR, activation of RAAS

Glomerular Diseases

<table>
<thead>
<tr>
<th>Characterized by endothelial and epithelial cell injury</th>
<th>segments of basement membrane lack foot processes</th>
<th>increase glomerular permeability to proteins</th>
<th>accumulation of protein in mesangial matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins in the mesangial matrix leads to:</td>
<td>proliferation of mesangial cells</td>
<td>infiltration by macrophages</td>
<td>increased accumulation of extracellular matrix (ECM)</td>
</tr>
<tr>
<td></td>
<td>segmental sclerosis of glomeruli</td>
<td>progressing to full sclerosis of glomeruli</td>
<td>leading to necrosis of nephrons</td>
</tr>
<tr>
<td>-Chronic glomerulonephritis= one of most common causes of CKD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Primary glomerulonephritis is when kidney only organ involved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Secondary glomerular diseases occur when glomeruli are injured b/c of systemic disease (see on right)</td>
<td></td>
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</tbody>
</table>

2 broad categories of glomerular diseases: nephrotic and nephritic syndrome

**Nephrotic Syndrome**
- characterized by significant proteinuria resulting in hypoalbuminemia, edema, hyperlipidemia

**Nephritic Syndrome**
- characterized by hematuria, oliguria, azotemia (uremia; excess nitrogenous waste products in blood)

**Glomerulonephritis etiology** – commonly idiopathic
- **Systemic disease:** diabetes mellitus, hypertension, systemic lupus erythematosus (SLE), amyloidosis
- **Infections:** Streptococcus, respiratory and GI infections, hepatitis B and C, endocarditis, HIV, syphilis
- **Drugs:** NSAIDs, captopril, mitomycin C, cyclosporine, heroin
- **Malignancy:** renal, lung, colorectal, melanoma, Hodgkin’s lymphoma

**SUMMARY:**
- **Podocyte injury** – focal segmental glomerulosclerosis
- **Polyanion Loss** – minimal change disease
- **Metabolic disease** – Diabetic glomerulosclerosis

**3 basic findings** occur singly or in combo:
1. proteinuria 2. hematuria. 3. decreased GFR
- minimal change disease - Membranous nephropathy
- FSGS - Renal amyloidosis (amyloid fibril build-up in tissues)
- Diabetic nephropathy - IgA nephropathy
- Membranoproliferative glomerulonephritis

**Most common cause of CKD in North America = diabetic nephropathy**

- podocyte injury is underlying mechanism of proteinuria → may be caused by nonimmune causes (minimal-change disease & FSGS) or immune
  - **FSGS=Focal and Segmental Glomerulosclerosis** → podocyte injury; glomeruli have focal and segmental loss of foot processes and widespread sclerotic changes
    - Mediators in chronic inflammation + fibrosis (TGF-B) play role in sclerosis
    - Sclerosis causes: endothelial & epithelial cell injury, epithelial cell loss, loss of overlying foot processes, increased glomerular permeability to proteins, accumulation of proteins in mesangial matrix
    - Disease often resistant to therapy and may progress to ESRD
  - **Minimal change disease**: most frequent cause of nephrotic syndrome in children
    - Proteinuria due to loss of fxn of glomerular foot processes
    - Mech unknown; possibly disorder of T cells, release cytokine to cause damage to foot processes → decrease synthesis of polyanions
      - Polyanions constitute normal charge barrier to filtration of macromolecules (albumin)

- Hyperlipidemia is due to hypoalbuminemia (liver compensates for hypoalbuminemia & increases production of lipoproteins)
  - Hypoalbuminemia can cause ascites, pericardial effusion, pleural effusion, peripheral edema, hyperlipidemia

- Proteinuria causes: changes to glomerular basement membrane, podocytes, loss ability to filter serum protein selectively by size & charge
  - Lost in urine: albumin, gamma globulins, transferrin, clotting factors, molecules regulating coagulation (antithrombin III lost, increased risk of thrombosis)

**Diabetic nephropathy – AKA Diabetic glomerulosclerosis**

- Progressive renal disease initially caused by damage to glomerular capillaries (microangiopathy complications of diabetes)
- Characterized by nephrotic syndrome + diffuse fibrosis and scarring of glomeruli
- Found most often in patients with longstanding, poorly regulated diabetes → often progress to ESRD and dialysis
  - Develops into ESRD in 30% type I and II diabetics; peak 15 years after diabetes development
- Predictors: hypertension, poor glycemic control, albuminuria, retinal vascular disease

hypertension, elevated serum creatinine + BUN, variable degree of proteinuria (from none to nephrotic range)
- has both primary & secondary causes
- most commonly associated with infectious, post-infectious or autoimmune
- typical presentation = hypertension, renal failure, hematuria
- urine sediment includes erythrocytes & erythrocyte casts
- renal biopsy usually needed to clarify pathological process & define specific underlying cause

**Common causes of hematuria:**

<table>
<thead>
<tr>
<th>Intrarenal</th>
<th>Extrarenal</th>
</tr>
</thead>
<tbody>
<tr>
<td>- kidney trauma, renal stones, crystals, glomerulonephritis, infection (pyelonephritis), neoplasia (renal cell carcinoma), vascular injury</td>
<td>- trauma (catheter placement), infection (urethritis, prostatitis, cystitis), nephrolithiasis (ureteral stones), neoplasia (prostate, bladder)</td>
</tr>
</tbody>
</table>

*pyelonephritis*: effects of bacterial (E.coli) infection in kidney

- May present acute form w/ active pyogenic infection OR chronic form where symptoms are caused by injury sustained during preceding infection
- Any lesion producing obstruction in urinary tract can predispose patient to active pyelonephritis
- Can also occur as part of generalized sepsis (bacterial endocarditis)
### Diabetic ketoacidosis

**Ketoacidosis**= metabolic state that occurs with high levels of ketone bodies
- beta-oxid’n of FFA produces ketone bodies for energy → build up **decreases pH of blood** which leads to symptoms below:

**Symptoms:**
- hyperglycemia, dehydration (ECFV contraction), fatigue, nausea/vomit, severe abdominal pain, characteristic fruit odor, acetone-odour, deep, laboured breathing (Kussmaul), decreased lvl consciousness

**Clinical manifestations of DKA:**
- abdominal pain, vomit, nausea, dehydration, 
- reduced blood volume → hypovolemia, tachycardia, hypovolemic shock 
- fruity odor → acetoacetic acid metabolised from cell of brain, acetone is produced & builds up in serum of blood

**Precipitating events:**
- usually develops over 24-48 hour period 
- inadequate insulin admin, infection, infarction, drugs (cocaine), pregnancy

**Emergency treatment:** PCABD
- Position, Circulation, Airway, Breathing (adequate, admin 6L/min thru non-rebreather mask), Drugs (IV infusion 5% dextrose+water or normal saline, insulin)

**Objectives of management:** restoration, of normal ECFV & tissue perfusion, correction of acid/base balance, correction of electrolyte imbalance particularly potassium loss, hyperglycemia (correct with insulin), diagnosis + treatment of coexistent illness

### Hyperparathyroidism

**Diagnosis:**
1. Bone changes (excessive resorption)
2. Hypercalcemia: symptoms of elevated serum calcium levels = bones, stones, groans, moans
3. High immunoreactive PTH

**Radiographic finding:** generalized osteomalacia, mandibular fracture

**Secondary Hyperparathyroidism:**
- disease outside of parathyroid cause glands to become enlarged and hyperactive → usually caused by chronic renal failure 
- kidneys unable to make enough vit D or eliminate phosphorus produced by body → insoluble calcium phosphate forms in body & removes calcium from circulation

### Osteodystrophy

- Impaired production of calcitriol from vitamin D leads to hypocalcemia
- Low level of calcium causes secondary hyperparathyroidism, which encourages excess bone resorption
- The radiographic appearances are caused by a collection of bone disorders collectively called **osteodystrophy**

**Osteodystrophy progresses through 3 stages**
- **Osteomalacia** (increased demineralized bone matrix)
- **Osteitis fibrosa** (bone resorption with lytic lesions and marrow fibrosis)
- **Osteosclerosis** (enhanced bone density)
- With these patients there is an increased risk of pathologic bone fracture and healing is impaired
- Other manifestations include myopathy, aseptic necrosis of the hip and extraosseous calcifications
- **In children,** renal osteodystrophy causes **impaired bone growth**
- Secondary hyperparathyroidism along with the associated osseous changes in the jaws has been reported in up to 92% of patients receiving hemodialysis
**Vitamin D**

- commonly used term for any member of family of closely related molecules derived from cholesterol
- D3 = cholecalciferol, made in skin by UV radiation on precursors made in the body
- D3+D2 are ingested in food and in supplements
- Vitamin D has no significant biological activity until altered by liver and then proximal tubular cells within kidneys
  - Biotransformation of Vit D to active form **calcitriol** which is now a hormone
  - calcitriol=active hormone recognized by specific receptors in target tissues; bone promoting hormone
  - Major action=stimulate transcellular absorption of Ca2+ (and lesser extent PO4³⁻) in duodenum
  - Stimulates renal tubular reabsorption of both Ca2+ and PO4³⁻
  - Also inhibits synthesis of PTH in parathyroid glands
  - DEFICIENCY → decreased Ca2+ absorption from GI tract & kidneys → less availability for bone formation or remineralization
    - Rickets, osteomalacia, osteoporosis

**Rickets**= defective mineralization or calcification of bones before epiphysial closure

- Can lead to pathologic fractures, deformities
- Due to deficiency/impaired metabolism of Vit D, phosphate, calcium
- Predominant cause=vit D deficiency

**Osteomalacia** – impaired mineralization, soft bones

- Softening of bones b/c of deactivated bone mineralization primarily due to inadequate levels of phosphate and calcium
- Can also be due to increased resorption of calcium from bone
- Signs & symptoms: diffuse body pains, muscle weakness, fragility of bones → pathologic fractures
- Most common cause=vit D deficiency

**Osteoporosis** – reduced bone density (mass), porous brittle bones

- Decreased bone strength → pathologic fractures
- < normal peak bone mass & greater than normal bone loss
- Same symptoms as osteomalacia
- Improper osseous regulation so that ongoing bone formation & bone-dissolving processes are dominated by bone dissolution

**PTH functions primarily via 3 mechanisms:**
1. PTH is thought to stimulate PTH receptors mainly on osteoblasts, which then, through multiple cell-to-cell mechanisms, stimulate osteoclast formation and bone resorption → increased serum Ca²⁺ and PO₄³⁻ levels
2. PTH activates 1α-hydroxylase in the kidney, which catalyzes the conversion of nonactive 25-hydroxy (25-OH) vitamin D to activated 1,25 dihydroxy (1,25-OH) vitamin D → increased absorption of Ca²⁺ and PO₄³⁻ in the GI tract
3. PTH increases reabsorption of Ca²⁺ and decreases reabsorption of PO₄³⁻ in the kidney

**PTH stimulates the bone remodeling process**

- increase the movement of Ca²⁺ and PO₄³⁻ into the ECF
- PTH has a rapid effect (within minutes) stimulating osteoclasts to pump Ca²⁺ out of the fluid surrounding the bone (which has a higher Ca²⁺ concentration) and into the ECF
- Over a longer time course, PTH stimulates bone resorption by stimulating osteoclastogenesis
- Typical physiological remodeling results in no net change in total bone calcium → excessive PTH results in decreased bone hydroxyapatite
- Although PTH stimulates bone resorption, osteoblasts express PTH receptors → PTH stimulation of osteoblasts causes them to express RANKL that activates the RANK receptor on osteoclast precursors

**Calcitonin**

- produced in thyroid by parafollicular cells (C cells)
- blood calcium lowering factor
- hormone act to reduce serum calcium levels, opposing effects of PTH
- calcitonin release regulated by plasma Ca²⁺
  - HIGH Ca²⁺ = HIGHER calcitonin ➔ DECREASE [Ca²⁺]

Fxns: inhibit osteoclastic activity & decrease Ca²⁺ reabsorption in kidneys

- Increased deposition of Ca²⁺ in bone
- Increased renal Ca²⁺ excretion