Pathology Pulmonary

ATELECTASIS

Neonatal Atelectasis
- The lungs of the neonate never inflate, a consequence of congenital defect, premature birth (insufficient surfactant), or other consequence, also called Patchy Atelectasis

Adult or Acquired Atelectasis
- Collapse of Previously Inflated lung, creating areas of “airless parenchyma”
- Produces a well-perfused but poorly-ventilated region, predisposing for infection
- Is a reversible disorder (except in the case of contraction)

  - Resorption Atelectasis
    - Consequence of complete obstruction without impairment to blood flow
    - A decreased lung volume results in a mediastinal shift towards affected lung
    - Caused by a mucous plug associated with Asthma, Bronchitis, or Aspiration Pneumonia

  - Compression Atelectasis
    - Consequence of partially or totally filled pleura with exudate (CHF), tumor, air (pneumothorax), blood (hemothorax), when air pressure threatens the function of lungs and great vessels (tension pneumothorax), or with an extra-pulmonary mass compressing lung parenchyma.
    - Compressed lung tissue cannot expand and is therefore poorly ventilated.
    - Compression pushes lung resulting in a mediastinal shift away from affected lung

  - Contraction Atelectasis
    - Fibrotic changes prevent expansion, resulting in reduced lung volume and ventilation
    - This form is irreversible

PULMONARY EDEMA

Pulmonary Edema is simply the accumulation of fluid in the alveolar spaces. The source of the fluid varies, as does the treatment (dependent on the etiology). Edema, as always, is favored by an increased capillary hydrostatic pressure, a decreased capillary oncotic pressure, or an increased vascular permeability.

Hemodynamic Pulmonary Edema = “Forcing Fluid Out”

- Dependent on an increased hydrostatic pressure (most commonly Left Sided heart Failure)
- Basal Regions develop edema first (dependent edema) b/c pressure greatest in dependent areas
- Alveolar Macrophages have hemosiderin in them, called siderophages or heart failure cells
- Fibrosis and thickening of the affected areas results in a gross brown and firm appearance, called brown induration.
- This is the type of edema we talked about in cardiovascular block
Pathology Pulmonary

**Microvascular Injury Pulmonary Edema.** = “Leaky Capillaries”

- Dependent on an **increased capillary permeability**; the second most common form of edema
- Increased capillary permeability is a result of microvascular injury
  - Most commonly associated with **pneumonia** (localized edema)
  - Also caused by **inhaled gases** (O₂, Smoke) **Liquid Aspiration** (near-drowning) or **Trauma**
  - Remember pharm link to **Bleomycin** and **Amphotericin B**.
- Edema begins in the **vascular endothelium** then moves into the alveoli
- When **local**, the underlying cause overshadows the edema; when **diffuse** it is life threatening

**Acute Respiratory Distress Syndrome**

The extreme case of microvascular injury pulmonary edema. It is a serious, life-threatening disorder that correlates to an **extreme microvascular injury** that is both diffuse and abundant. Anything that causes microvascular injury pulmonary edema can lead to this pathological state. You can think of this as the endpoint of a spectrum of microvascular diseases. “**New, Diffuse, Bilateral Infiltrates, NOT CHF**”

- **Morphology**
  - Acute Gross = Heavy, Firm, Red, and Boggy lungs
  - Acute Histo
    - **Interstitial** and **Interalveolar Edema**
    - **Inflammation** = neutrophils (see below)
    - **Hyaline membrane** = fibrin rich edema with cytoplasmic/lipid remnants
- **Pathogenesis**
  - End result of multiple and/or severe **diffuse damage to alveolar capillary walls**
  - Damage occurs first to capillary endothelium (most often) or alveolar epithelium (occasionally) eventually leading to an increase in permeability (allowing alveolar exudate)
  - Exudate **cannot be resolved** (in contrast to CHF pulmonary edema) leading to **fibrosis** and **scarring**; pneumocytes do not proliferate, but rather fibroblast proliferation
  - Neutrophils
    - 30 minutes post lung injury = IL-8 = **sequestration** and **margination of neutrophils**
    - Neutrophils cause damage (**leukotrienes, oxidants, PDGF**) and sustain inflammation (**fibroblast proliferation**)
  - Clinical Course
    - Admit for predisposing event (near-drowning or aspiration pneumonia)
    - Increased cyanosis refractory to O₂, respiratory failure, diffuse bilateral infiltrates on Chest X-ray develop later. If you have **new** (acute onset) **bilateral infiltrates** with a **normal pulmonary hydrostatic pressure** with a Fi ratio <200, you’ve got ARDS
    - Fatality ~ 60%

**Treatment**
- **Ventilate** and **Oxygenate** with **Positive End Expiratory Pressure**, but keep tidal volumes and ventilator pressures low. The goal is to get rid of the edema by adding positive pressure, but prevent further damage to alveoli (ventilation and oxygenation can induce ARDS)
OBSTRUCTIVE AIRWAY DISEASES (Bronchitis, Emphysema, Asthma, COPD)

**Bronchitis**

- **Definition**
  - Generally Cough with productive sputum resulting in airway obstruction
  - Simple Chronic Bronchitis = productive cough with sputum without airway obstruction
  - Chronic Bronchitis = productive cough with sputum for 3 months in 2 consecutive years
  - Chronic Asthmatic Bronchitis = Chronic Bronchitis + Hyperreactive Airways → Wheezing
  - Obstructive Chronic Bronchitis = This is the end game, usually found in chronic smokers and with emphysema, resulting in COPD

- **Pathogenesis**
  - Initiating factor is chronic exposure to a pulmonary irritant (smoke, silica dust, cotton)
  - Hypersecretion of Mucous from Submucosal Gland Hypertrophy and Goblet Cell Hyperplasia, all protective changes in response to irritant, cause obstruction of airways with mucous plugs
  - Inflammation undoubtedly plays a role, but to what extent is uncertain
  - Infection: Bronchitis predisposes for infection, Infection perpetuates bronchitis

- **Morphology**
  - **Gross**
    - Hyperemia, Swelling, Edema of mucous membranes
  - **Histological**
    - Chronic Inflammation by lymphocytes
    - Increase in goblet cells (though the count is unreliable)
    - Increase in mucosal glands (determined by an increase in the Reid Index)
    - Advanced disease demonstrates fibrosis, increased severity of the above, eventually resulting in a loss of airway lumen, termed bronchiolitis Obliterans

- **Clinical**
  - Cardinal Symptom = Persistent Cough with Productive Sputum
  - Take years to develop dyspnea on exertion, which has a slow onset
  - Continued irritation (smoking) = digression to COPD, often with emphysema
  - Infection, Hypoxemia & Hypercapnia (poor V/Q mismatch) leads to edema and cyanosis, therefore called “Blue Bloaters”

Blue Bloater = Bronchitis
Heavier in weight with global edema (especially in ankles and lower extremities), is blue (cyanotic) with persistent productive sputum. Remember 90% of patients have both. Obstructive disease means a decreased FEV1/FVC.

Pink Puffer = Emphysema.
Depressed Diaphragm, hyaline markings on Xray. He’s thin because of increased work to breathe. He has a barrel-chest, is pink (normal), breathing through pursed lips, and has wheezing. Remember, 90% of patients have both. Obstructive disease means a decreased FEV1/FVC.
**Pathology Pulmonary**

**Emphysema**

**Definition**
- Abnormal, permanent **enlargement** distal to terminal bronchiole accompanied by **destruction** of their walls **without fibrosis** leading to increased work to breathe

**Types** = Based on Location within the lobule

**Centriacinar (Centrilobular) Emphysema**
- Central and Proximal parts of acini are affected, **distal alveoli are spared**
- Affects **Upper Lobes** especially in **chronic smokers**, predominantly in **apex**
- Emphyematous and normal airspaces exist within the same acinus and lobule

**Panacinar (Panlobular) Emphysema**
- The acini are **uniformly enlarged from respiratory bronchiole → distal alveoli**
- Affects **Lower Lobes**, especially in the **bases**
- Associated with **α antitrypsin (α₁-AT) deficiency**

**Distal Acinar (Paraseptal) Emphysema**
- Central and Proximal parts of acini are **spared, distal alveoli are affected**
- Forms along the pleura and the lobule margins adjacent to fibrosis or scarring
- May form a cyst-like structure associated with pneumothorax in young adults

**Irregular Emphysema**
- Asymptomatic, Clinically insignificant, almost always found on autopsy
- Irregular pattern of alveolar enlargement always associated with scarring

**Morphology**

**Gross**
- Large, voluminous lungs with hyperinflation (well developed Pan- and Centri)
- Bullae/Blebs associated (Distal Acinar Emphysema)

**Micro**
- Abnormally **large alveoli** separated by **thin septa**, large alveoli from trapped air
- Pores of Kohn are so large that septae seem to float in alveoli
- **Blood vessels are compressed** by emphysematous alveoli

**Clinical Presentation** “Pink Puffer”
- A **thin elderly smoker**, with insidious or slow onset **dyspnea**, cough, and **wheeze**
- A **barrel chest** from overdistended lungs, depressed, **flattened diaphragm** on X-ray
  - Decreased diffusion capacity → increased ventilatory rate → normal ABG
- Patients will lean forward, have a **prolonged expiration** through **pursed lips**

**Pathogenesis**

**Antiproteinase-Proteinase Imbalance** (see image on bronchitis page)
- Neutrophils secrete proteinases and pro-inflammatory cytokines
- Smoking/Irritants increase neutrophils access to interstitum and alveoli
- **Smoking** = Increase proteinase, normal antiproetinase
- **Antitrypsin Deficiency** = Normal Proteinase, Decrease antiproetinase

**Free Radicals**
- Neutrophils + Smoke = Free Radicals = Damage/Destruction
Other Forms of “Emphysema” referring to an enlargement of alveoli or of lungs without inflammation or degenerative properties

- **Compensatory Hyperinflation**
  - Dilation of Alveoli but **without septal wall destruction**
  - Caused by loss of lung substance elsewhere, recoil allowing alveolar expansion
    - Follows surgical removal of diseased lung

- **Obstructive Overinflation**
  - Expansion of lung because of trapped air but **without septal wall destruction**
  - Tumor, FBAO, Asthma with:
    - Partial Obstruction = Ball-Valve allows air in but not out
    - Complete Obstruction + collateral air flow through Pores of Kohn
  - Can be life-threatening because emphyematous tissue compresses good lung

- **Interstitial Emphysema**
  - Entrance of air into **connective tissue stroma** of lung, mediastinum or SubQ tissue
  - Caused by alveolar tears (cough + alveolar obstruction as in emphysema), punctures (fx of ribs pierce lung) or trauma (air outside gets into thorax) or mechanical ventilation (“Blowing out a Lung”)

- **Definition**
  - Chronic Inflammatory disorder of the airways that causes recurrent episodes of wheezing, breathlessness, chest tightness, and cough, particularly at night and/or in the early morning. These symptoms are usually associated with widespread but variable bronchoconstriction and airflow limitation that is at least partly reversible, either spontaneously or with treatment. It is thought that inflammation causes an increase in airway responsiveness (bronchospasm) to a variety of stimulants – Robbins

- **Pathogenesis**
  - Inflammation = Broken Balance between Th1 and Th2 responses
    - If Th2 is unrestrained, or gets the upper hand, it leads to airway inflammation

<table>
<thead>
<tr>
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<th>T1h1</th>
<th>T1h2</th>
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<tbody>
<tr>
<td></td>
<td>Induce macrophages and intracellular killing</td>
<td>Induce Allergic Inflammation and IgE synthesis (B cell activation) via Interleukins</td>
</tr>
<tr>
<td>Inhibit Th2 response via IFN-γ</td>
<td>Inhibit Th1 response via IL-4</td>
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<td></td>
<td>Prominent Component of Inflammation</td>
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- **Airway Remodeling**
  - Hypertrophy of smooth muscle + Deposition of Collagen lead to luminal stenosis and creates a predisposed environment for small vasoactive changes causing severe symptoms

- **Types**
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- **Atopic (“Allergic”) Asthma** = most common asthma (that 7y/o with glasses and an inhaler)
  - Elicited by Allergen or Antigen, mediated by **IgE Type I Hypersensitivity** (shows wheeze-and-flare hypersensitivity)
  - **Acute/Immediate Response**
    - Airborne antigens react first with mast cells on **epithelial surface** causing an increased permeability, access to submucosal mast cells, an enhanced Type 1 response.
    - **Direct Stimulating** of Subepithelial Vagal Receptor resulting in constriction
    - Sum total is **bronchoconstriction, edema, mucous secretion**
  - **Late Response**
    - Swarm of **leukocytes** drawn by **chemotactic factors** from mast cells, airway epithelium, and vascular endothelium, and other leukocytes
    - **Eosinophils’ major basic proteins** = epithelial damage and airway constriction
    - **Potential Mediators** (how well antagonistic drugs work to fix it)

<table>
<thead>
<tr>
<th>Successful Intervention (Major Role)</th>
<th>Failed Intervention (Minor Role)</th>
<th>Unknown Role, but Suspected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leukotrienes bronchoconstrict</td>
<td>Histamine bronchoconstrict and vasodilate</td>
<td>IL-1, IL-6, and TNF-alpha are proinflammatory cytokines</td>
</tr>
<tr>
<td>ACh bronchoconstrict</td>
<td>Prostaglandin D vasodilates and bronchoconstrict</td>
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</table>

- **Nonatopic Asthma = Intrinsic or Adult Type**
  - Triggered by the **cold, exercise, or stress** (aka, we don’t really know)
  - **Normal IgE levels**, and a **negative skin-test** (no flare and wheal) with an adult onset
  - This is why some runners have to
- **Drug Induced Asthma**
  - Aspirin can induce asthma at high doses by inhibiting COX (and thereby eliminating bronchodilatory prostaglandins) and allowing unrestrained LOX (thereby tipping the balance in favor of bronchoconstrictive leukotrienes). See NSAIDs 2, Pharm.

  - **Morphology**
  - **Gross**
    - Lungs are **overinflated** (decreased resistance on inhalation allows air in, increased resistance on exhalation traps air in), though this change is only in severe asthma attacks (**status asthmaticus**)
    - Thick tenacious **mucous plugs** in bronchi and bronchioles
  - **Histo**
    - Mucous plugs contain whorls of shed epithelium called **Corschman Spirals**
    - There will be **eosinophils** called **Charcot-Laden Crystals** within the mucous plugs
    - Airway remodeling is characterized by
      - Thicked Basement membrane, Edema and Inflammatory Infiltrate in the lamina propria, submucosal hypertrophy, and bronchial wall hypertrophy

  - **Clinical Course**

---

Spelling is different in Robbins and lecture
Pathology Pulmonary

- Paroxysmal disabling attacks of severe dyspnea, coughing, and wheezing triggered by bronchospasm that can spontaneously resolve or resolve with intervention
- Attack lasts minutes to hours followed by copious mucous secretions and expectoration
- Patient is relatively normal to completely asymptomatic between attacks
- In the most severe form (status asthmaticus) where ventilatory function can be impaired (and be fatal), asthma symptoms may last for hours to day and are refractory to treatment

**Bronchiectasis**

- **Definition**
  - Permanent dilation of bronchioles caused by destruction of muscle and elastic tissue as a result of chronic necrotizing infections
- **Cause**
  - **Obstruction and Infection**
    - Obstruction (mucus plug, tumor, ciliary failure) leads to pooling and the inability to clear distal secretions, making a happy home for infection
    - Infections develop distal to the blockage, often repeatedly
    - Repeated Infection (means Necrosis) +Repeated Inflammation (means fibrosis) results in Chronic Destruction of Bronchiole Walls (means permanent dilation)

<table>
<thead>
<tr>
<th>PREDISPOSING CONDITIONS TO BRONCHIECTASIS</th>
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<tr>
<td><strong>Cystic Fibrosis</strong></td>
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<tr>
<td>Decreased Ciliary activity + a defective chloride channel with thick secretions lead to mucus plugs</td>
</tr>
<tr>
<td>Super increased risk of infection and therefore Bronchiectasis (usually via Psuedomonas or Aspergillus)</td>
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</tbody>
</table>

**Morphology**

- **Gross**
  - **Lower Lobes Bilaterally** (dependent regions) unless caused by a focal obstruction (tumor or foreign body aspiration) in which case there are focal lesions
  - Airways are dilated sometimes up to 4x normal size which can be traced to the pleural surface, where, on dissection, they look like cysts filled with pus
- **Histo**
  - Acute = inflammatory exudate associated with desquamation of the epithelium or even ulcerations
  - Chronic = pseudostratification and squamous metaplasia, almost always with fibrosis
  - Organisms can be cultured at any phase, often H. Influenzae or Aspergillus
Pathology Pulmonary

There is no reading assignment in Robbins and the Index puts me all over the place, so we are going with what we get in lecture.

**Case 1:** 4 month old African American infant with a low grade fever and wheezing for 2 days (thinking upper respiratory tract infection). It had a term birth without perinatal problems and all the immunizations are covered. Its vitals look scary (160 bpm for the heart rate, 60 on the respiratory rate) but since this baby is the side of your forearm, the vitals are only a little fast (normal 120 hr, 30 rr). The thing that is really bad is that the baby is retracted and wheezing with a pCO\textsubscript{2} of 55 and a respiratory acidosis at a pH of 7.32. The chest X-ray reveals hyperinflation without focal infiltrates and the diagnosis of bronchiolitis, a viral infection of small airways, is made.

**Bronchiolitis**

- Epidemiology
  - Effects children less than 2 years of age usually occurring in colder months (Oct-Mar)
  - Spread by large particle/self-inoculation – wash your hands!
- Agents Responsible – all viral
  - RSV (respiratory syncytial virus) is the most common
  - Other viruses can do it too Influenza, Parainfluenza, and Adenovirus
- Presentation
  - Above = Retracted, Wheezing, Hyperinflation, Respiratory Acidosis
- Pathogenesis
  - The airway becomes obstructed from swelling of the bronchiole walls.
  - This allows air in (expansion during inhalation decreases resistance) but then traps it (contraction of lungs on expiration increases resistance) causing hyperinflation and increased work of breathing.
  - This results in necrosis of the epithelium, accumulation of debris in bronchioles, and obstruction leading to higher lung volumes.
  - The air is present, but poorly ventilated, leading to hypoxemia from a V/Q mismatch

Reminder: Causes of Hypoxemia are listed on slide 11. V/Q Mismatch, Shunt, Diffusion Abnormality, Hypoventilation (isn’t this a V/Q mismatch?) and abnormal hemoglobin.
Case 2: A 20 year old woman who smokes a pack a day and has had no prenatal care delivers a 28 gestational week neonate that exhibits bruising, tachypnea (rapid breathing), and grunting. He is a little light (800g). It is diagnosed with Respiratory Distress Syndrome (RDS). Keep in mind this is not the same path as Adult Respiratory Distress Syndrome (ARDS); in fact it is totally different despite a similar name.

**Respiratory Distress Syndrome** (former name is hyaline membrane syndrome)

- Presentation
  - Premature Birth, Tachypnea, grunting
  - **Grunting** provides natural Positive End Expiratory Pressure (PEEP) which maintains the airways open with extra pressure at the end of expiration, increasing the **functional residual capacity** thereby increasing alveolar ventilation
  - **Tachypnea** comes with hypoxemia, in an attempt to draw in more air.

- Pathogenesis
  - There is a general **lack of alveoli** or **decreased surfactant** that results in **collapsed peripheral airspaces**. Essentially, it is as if the lungs never expand.
  - There is **increased epithelial permeability** leading to edema of serum proteins
  - With collapsed lungs (called Atelectasis), there is an alveolar hypoventilation which leads to **hypoxemia** as a result of V/Q mismatch
  - The lungs do not expand easily on inhalation, and are deemed poorly compliant (**restrictive pathophysiology**), so there is an enormous increase in work of breathing.

- Pathophysiology
  - Surfactant is the lubricant made by **type II pneumocytes** that decreases friction, permitting the lungs to easily expand by overcoming surface tension
  - Without surfactant there is significant resistance to expansion.

Reminder: Corticosteroids induce the production of surfactant early on, or just give them Surfactant!

Reminder: Adult Respiratory Distress Syndrome is caused by diffuse or severe microvascular injury with subsequent increased permeability that resolves with fibrotic healing. VERY different from RDS.
CASE 3

6 week old infant born at 28 gestational weeks maintained via mechanical ventilation on an FiO₂ of 40% suffering from slow weight gain. The diagnosis of Bronchopulmonary Dysplasia is made. This could have been the kid in the last case that we had to treat in order to save. Our treatment led to this disease.

**Bronchopulmonary Dysplasia BPD** (expanded using Robbins)

- **Cause**
  - High concentrations of oxygen administered for prolonged periods of time in the treatment of RDS (together with corticosteroids for surfactant production) induce certain side effects known as "**Oxygen Toxicity**" via free radical generation
  - **Prolonged Mechanical Ventilation results in BPD** (what you usually have to do for premature ventilation)
  - Gentler ventilation and antenatal corticosteroids have reduced the incidence of BPD

- **Morphology**
  - Old school = epithelial hyperplasia, alveolar wall thickening, interstitial fibrosis
  - New School = **Decreased Alveolar Number** termed **Alveolar Hypoplasia**
  - X-ray = alternating regions of hyperinflation and collapse

- **Pathogenesis**
  - Arrested development of alveolar septation at the saccular stage
  - With treatment, and time,

Another possible sequella of RDS with aggressive oxygen therapy is **retrolental fibroplasia** (fibrosis occurring behind the lens of the eye = bad for future vision)

Continued next page.
CASE 4
There is a 6 year old with pneumonia. He’s gotten pneumonia 4 times all in the same space. 4 pneumonias may tip you off to an immunodeficient child, but they all happen in exactly the same spot.

Pulmonary Sequestration

This refers to the presence of a discrete mass of lung tissue without any normal connection to the airway system. Blood supply to the sequestered region arises not from the pulmonary arteries but instead to from the aorta or its branches. There are two kinds of sequestrations: extralobar and intralobar. Extralobar are external to the lung usually found in thorax, mediastinum or the abdomen. Intralobar Sequestrations are internal to the lung, but are effectively disconnected and useless, and are primary sites of infections to prop up. Obviously, since they are disconnected from the rest of the airway, systemic therapy for pneumonias must be made (inhaled won’t work).

Extralobar Sequestrations can be anywhere. Like a tumor, you find lung tissue where is shouldn’t be.

Intralobar Sequestrations are in the lung. They can be formed (like with a foreign body that cuts off the route to the airways) or they can be congenital (like a cyst).

A Bronchogram (drip radio-opaque dye into the airways) shows all the different branches of the bronchial tree. Notice in the image to the right, that there is NOTHING to the bottom left, where the pneumonia is supposed to be. Well if you inject die into the aorta (center image), you get total perfusion to the pneumonia area. This is an example of a piece of pulmonary tissue, disconnected from the bronchial tree, perfused by the aorta. This is the quintessential extralobar sequestration.

CASE 5

A 1 week old with apnea demonstrates an abnormal sleep study (hypercarbia, hypoxia and prolonged period of apneas). But when the kid wakes up he’s got near normal awake blood gases. So, when he sleeps, he forgets to breathe! This is the case with congenital central hypoventilation syndrome (CCHS).

We learned about this last year as “Ondine’s Curse.” These patients require nighttime ventilation to live.

CASE 6.

An 8 year old with ascending symmetric paralysis has difficulty coughing and swallowing. He is diagnosed with Guillain-Barre Syndrome. There was little said about this disease, so here is some information from Large Robbins. It is more neurological than pulmonary, but here it is.
- **Guillain-Barre Syndrome**
  - Clinical Course
    - Follows an infection by Cytomegalovirus, Epstein-Barr, or Mycoplasma Pneumoniae
    - Hallmark is **ascending paralysis** with loss of deep tendon reflexes and distal sensation followed by progressive loss of proximal nerve function
  - Pathogenesis
    - No definitive organism has been isolated from nerves
    - Current thinking = **inflammatory process** progressively destroys the myelin sheath
  - Morphology
    - **Inflammation of the peripheral nerve** with lymphocytic infiltrates in a diffuse, peripheral pattern

Remember: Infection → Inflammation of peripheral motor nerves → ascending paralysis.

**CASE 7**

There is a full-term infant with respiratory problems, presenting with tachypnea and a decreases pulse oxygen saturation (SpO2). Nurses applied a Bag-Valve-Mask for ventilation which didn’t work. In fact, it got worse. The infant got intubated. There were two important physical findings. There was a scaphoid abdomen and decreased breath sounds on the left side only.

The causes of decreased breath sounds are:

1. **Airway Obstruction** – either a foreign body (like a marble, ET advanced too far) or a tumor blocking airway
2. **Acoustic Impedance** – air (pneumothorax) or fluid (pleural effusion, hemothorax) compressing lung
3. **Absent Lung** – which would be really bad

It turns out that the “Obstruction” in this case is the baby’s own colon. He is diagnosed with Diaphragmatic Hernia. If you remember from Embryo there are two types: **Bochdalek** (posterolateral) and **Morgagni** (anterior and medial). The colon comes through a hole in the diaphragm and compresses the lung. Bet you wished you paid attention in Embryo, huh? I know I don’t wish I had. Learning it now is fine by me.

<table>
<thead>
<tr>
<th></th>
<th>Bochdalek</th>
<th>Morgagni</th>
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<tbody>
<tr>
<td><strong>Epidemiology</strong></td>
<td>A rare hernia (1:2200-3500 births) that affects the left side, through the posterolateral fusion of the diaphragm</td>
<td>A more common anterior hernia (1:300 live births) that is more common on the right.</td>
</tr>
<tr>
<td><strong>Clinical Presentation</strong></td>
<td>Presents early in life with tachypnea, cyanosis, and retractions. Bowel sounds can be heard in the thorax.</td>
<td>It is often asymptomatic and found incidentally on Chest X-ray</td>
</tr>
<tr>
<td><strong>Pathophys</strong></td>
<td>The bowel is allowed to penetrate the diaphragm and compress the lung into not working.</td>
<td>The bowel is allowed to penetrate the diaphragm and compress the lung into not working.</td>
</tr>
</tbody>
</table>

The baby got worse with Nurse Bag-Valve because without an airway adjunct (ET Tube) you inevitably blow air into the esophagus which inflates the bowel. Inflating the bowel compresses the lungs further.
CASE 8

A 13 month old comes in with stridor. The patient has had symptoms of an upper respiratory infection for 2 days along with a low grade fever. There are intercostal retractions and stridor at rest. His immunizations are up to date. The patient definitely has an upper respiratory infection, but what exactly does he have? Well, there are three possibilities: Croup, Bacterial tracheitis, and Epiglottitis. He is really pulling hard to get air in, he has a seal-like bark, and he is following an infection.

In adults, the narrowest area is at the cords. In children, it is below the cords, so when it swells, they have a tough time breathing.

In croup, the most common in young kids, the airway narrows below the vocal cords. It is caused by a virus, usually following an infection. These kids don’t do so bad. When they are barking they get blue, but in between coughs they look good.

In epiglottitis is almost always caused by Group A Strep. Since we invented H. Influenza Vaccine, epiglottitis is essentially eliminated (though Group A can still cause it). If this is going to get a kid, its going to be in the 2-6 year age range. Our patient is just over a year.

Bacterial Tracheitis. This is a necrotic infected mucosal cast. These kids look terrible even in between “barks.” Its caused by Staph Aureus. It can be a slow onset or come on suddenly. This is the one of the three you don’t want to get because it presents like croup but where the kid is just awful.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>Bronchiolitis</td>
<td>Viral Infection = Bronchial Swelling</td>
<td>Relive trapped gas, cure infection</td>
</tr>
<tr>
<td>Respiratory Distress Syndrome</td>
<td>Too little surfactant, usually premature</td>
<td>Ventilate, intubate, oxygenate</td>
</tr>
<tr>
<td>Bronchopulmonary Dysplasia</td>
<td>Mechanical Ventilation and Oxygen Toxicity</td>
<td>Wean off, give surfactant</td>
</tr>
<tr>
<td>Pulmonary Sequestration</td>
<td>Intralobar (in lungs) Extralobar (out lungs)</td>
<td>Surgically remove</td>
</tr>
<tr>
<td>Guillain-Barre</td>
<td>Ascending Paralysis</td>
<td>Nothing</td>
</tr>
<tr>
<td>CCHS</td>
<td>Forgets to breathe while asleep</td>
<td>Ventilate at Night</td>
</tr>
<tr>
<td>Diaphragmatic Hernia</td>
<td>Morgagni (front) Bochdalek (side/back)</td>
<td>Surgically repair</td>
</tr>
<tr>
<td>Epiglottitis</td>
<td>2-6years old, swelling of epiglottis</td>
<td>Treat infection</td>
</tr>
<tr>
<td>Croup</td>
<td>0-5years old, narrowing of sub glottis</td>
<td>Treat infection, Intubate</td>
</tr>
</tbody>
</table>

PULOMANARY INFECTIONS, aka Pneumonia
Pathology Pulmonary

Pulmonary Infections are caused by a wide variety of organisms, and often set in when host defense mechanisms fail (loss of ciliary motion, loss of cough reflex, mucous plugs associated with other diseases, or even other pulmonary infections). It is important to realize that pneumonias beget pneumonias – one infection can lead to another. Most deaths associated with pulmonary infections are related to nosocomial infections (acquired in the hospital), often in patients hospitalized for a less virulent pneumonia. While inhaled infections are the most classic form of pulmonary infection, hematogenous spread or contact with local mediastinal infections is also possible. Finally, pulmonary infections are typed based on the organism doing the infecting or, if no organism can be isolated, the clinical setting (which is likely to narrow down the organism doing the infecting). We begin with 4 types of Acute Pneumonia and then change over into Chronic Pneumonia before finishing with Lung Abscesses.

**Community Acquired Bacterial Pneumonias**

- **Definition**
  - Pneumonia that you get out of the hospital, at high risk for certain pathogens
- **Bacterial Pneumonias**
  - **Strep Pneumoniae**
    - Most common cause of bacterial Community Acquired Pneumonia
    - **Gram (+)** Lancet Shaped Diplodocci can be cultured from sputum
    - May be part of normal flora yielding false positives
    - Responds readily to penicillin, but antibody sensitivity should be checked
    - **Capsulated Organism** with an adult vaccine to capsular proteins
  - **Haemophilus Influenzae**
    - **Pleomorphic Gram (-)** that causes meningitis in children and Pneumonia in adults
    - **Type b** (HiB) is the most virulent **encapsulated** form now with a vaccine
    - Causes Sinusitis, Otitis Media, and Bronchopneumonia
    - Pili attach to the mucous membranes, IgA protease degrades mucosal IgA, **capsule** prevents opsonization and promotes hematogenous entry
    - Before vaccine, this was fatal to children via meningitis, now with vaccines, this causes pink eye and some pneumonias
  - **Moraxella Catarrhalis**
    - Up-in-coming agent of adult pneumonia and COPD exacerbation
    - Part of the normal flora and is a **gram (-) cocci**
  - **Staph Aureus**
    - Virulent **Gram (+) Cocci** causing secondary bacterial pneumonia following URI
    - Causes Lung Abscess and Empyema (complications discussed later)
    - **IV drug users** can get Staph Pneumonia along with endocarditis
  - **Klebsiella Pneumoniae** (“Freelander’s Pneumonia”)
    - **Capsulated Gram (-) Rod**, most common of the gram negative pneumonias
    - Common in malnourished individuals (like **chronic alcoholics** and **diabetics**)
    - Thick and gelatinous (red jelly) sputum caused by the capsular proteins
  - **Pseudomonas**
    - Often a **nosocomial infection** but also rampant in **cystic fibrosis** patients

- **Kids** get Strep, H. Influenzae and Moraxella
- **IV users** get Staph
- **Alcoholics** get Klebsiella
- **Cystic Fibrosis**: Pseudomonas
- **Organ transplant**: Legionella
Pathology Pulmonary

- Pt who are neutropenic are at risk for virulent hematogenous entry and sepsis.
- Causes necrotic pneumonia and is resistant to antibiotics and phagocytosis
- Blue haze around blood vessels with absent septae (because of coag necrosis)
  - Legionella
    - Causative agent of Legionnaire’s Disease and Pontiac Fever
    - Grows in artificial aquatic environments such as A/C units or water cooling towers
    - Immunocompromised (organ transplant or elderly) are at high risk, mortality approaches 50% in these patients
    - Culture is gold standard but Legionella Antigen can be found in urine, and immunohistochemistry can reveal positive antibodies in sputum.
    - Requires a special silver stain to identify in culture.

Clinical Course
- Abrupt Onset High Fever, shaking chills, cough productive of sputum
- Can induce a fibrinosupparative pleuritis = pleuritic chest pain friction rub
- Chest X-ray will show either
  - a well-circumscribed radio-opaque lobe (lobar pneumonia) or
  - patchy infiltrates throughout the lung field (bronchopneumonia)
- With antibiotics, the disease is well controlled, with only 10% of patients hospitalized for pneumonia succumbing to the disease, and often fatalities are attributed to complications (empyema, pleuritis, septicemia)

- Morphology
  - Two distinct gross anatomic patterns that represent a possible continuum
    - Bronchopneumonia = extremely old or extremely young
      - Patchy consolidation of the lung, consolidating areas of acute suppurative inflammation without resolution, often with fibrotic granulation tissue.
      - Gross = Dry, granular, grey to yellow, poorly delineated areas of the lung
      - Histo = Suppurative, neutrophil-rich exudate that fills air spaces
    - Lobar Pneumonia = previously healthy teens to adults
      - Fibrinosupparative Consolidation of a large portion of a lobe or an entire lobe
      - 4 stages, still with neutrophils
        - Congestion = vascular engorgement, intra-alveolar fluid with few neutrophils in a grossly heavy, boggy, and red lung
        - Red Hepatization = intra-alveolar fluid is a mass of RBCs, Neutrophils, and Fibrin with a gross distinctly red, firm, and airless lung (that looks like a liver)
        - Grey Hepatization = resolution of RBCs, stealing the red color, but leaving the fibrin, turning the red lung grey. Neutrophils Predominate
        - Resolution = Fibrin + fluid is either organized (fibrinous) or removed by macrophages resulting in a contracted or normal lung. Resolution is often complete back to the “pristine lung” now with antibiotics

Atypical “Walking” Pneumonia = Virus, Mycoplasma, and Chlamydia
Pathology Pulmonary

- **Definition**
  - Acute Febrile disease with patchy inflammatory changes in the lungs, Pneumonia with:
    - Small amount of sputum
    - No physical findings on consolidation
    - Lack of alveolar exudate (though may be minor)

- **Cause**
  - Variety of organisms with *Mycoplasma Pneumoniae* being common in adults
  - Viruses of the respiratory tract, too: *Influenza A and B, RSV, Adenovirus, Rhinovirus*

- **Pathogenesis**
  - Attachment of organism to the upper respiratory tract followed by necrosis and inflammation which remains mainly in the interstitum (CXR can be “clear”)
  - Descending down to alveoli can cause alveolar damage with exudate (showing as patchy infiltrates on CXR), predisposing for secondary infection

- **Morphology**
  - **Gross**
    - Pattern is variable = uni/bi lateral, patchy/total lobe, upper/lower lobes
    - Areas affected as red-blue, congested and subcrepitant
    - Pleuritis and pleural effusions are rare
  - **Histo**
    - Predominantly Interstitial Inflammation with monocytes
    - Intra-alveolar exudate is possible, but not classic. It results from diffuse alveolar damage with a characteristic pink hyaline membrane (as was seen in ARDS)

- **Clinical Course**
  - Sporadic Occurrence with a low mortality rate
  - Also known as walking pneumonia since the low fever, head ache, and muscle aches are annoying more than they are debilitating
  - There will be a patient with a recent respiratory tract infection + a cough without sputum

**Nosocomial Pneumonia**

- Nosocomial = Hospital Acquired
- Common in patients with an underlying cause (the reason for hospitalization), especially those on prolonged antibiotics, immunosupression, ventilator, or those with indwelling catheters
- Gram negative rods (such as Enterobacteriacae and Pseudomonas) as well as Staph

**Aspiration Pneumonia**

- Patients with an impaired gag and/or swallowing reflex inhale gastric contents producing both a chemical irritant (gastric acid / decaying food) and a bacterial infection (flora)
- Typically follows a fulminant course leading to death
- Those who survive will have lung abscesses
I don’t like lists, but we are back to Micro, so get ready for some meaningless memorization. This is a review table for the types of acute pneumonias and there causes.

<table>
<thead>
<tr>
<th>Type of Acute Pneumonia</th>
<th>Agent that Causes it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community-Acquired Pneumonia</td>
<td>Strep Pneumoniae, Hemophilus Influenzae, Moraxella Cattarrhalis, Legionella, Klebsiella and Pseudomonas</td>
</tr>
<tr>
<td>Community Acquired Atypical Pneumonia</td>
<td>Mycoplasma Pneumoniae, Chlamydia, Coxiella Burnetti, RSV, Influenza, Adenovirus, SARS, Hanta</td>
</tr>
<tr>
<td>Nosocomial Pneumonia</td>
<td>Gram Negative Rods (enterobactericaeae and pseudomonas)</td>
</tr>
<tr>
<td>Immunocompromised Host (HIV)</td>
<td>Cytomegalovirus, Mycobacterium Avian Complex, Pneumocystis Carinii (Jerivecki)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Pneumonia</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Acute Pneumonia</td>
<td>Neutrophils, Alveolar Infiltrate</td>
</tr>
<tr>
<td>Atypical Acute Pneumonia</td>
<td>Monocytes, Interstitial Infiltrate</td>
</tr>
<tr>
<td>Aspiration Pneumonia</td>
<td>Lung Abscess</td>
</tr>
<tr>
<td>Nosocomial</td>
<td>Staph Leads the List, then Pseudomonas</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobar Pneumonias</td>
<td>Strep Pneumonia, Klebsiella, Legionella</td>
</tr>
<tr>
<td>Necrotizing Pneumonias / Abscess Formation</td>
<td>Klebsiella, Staph Aureus, Type 3 Pneumococcus, Gram Negative</td>
</tr>
<tr>
<td>Bronchopneumonia</td>
<td>Legionella</td>
</tr>
<tr>
<td>Chronic Non-Granulomatous</td>
<td>Actinomyces, Nocardia</td>
</tr>
<tr>
<td>Chronic Granulomatous</td>
<td>TB, Fungi (Histoplasmosis, Coccidiomycosis, Blastomycosis)</td>
</tr>
</tbody>
</table>

The following information was presented in our pneumonia lecture, and represents more agents of Acute Pneumonia. You may find it useful for the tutorial section on infections. They are scattered throughout Robbins and are a lot of recall from Micro. Congratulations. Its back.

**Influenza:**

- Produces laryngotracheobronchitis *(causes cough)*; bronchiolitis *(necrotizing)*
-  In pulmonary parenchyma the injury pattern is that of **diffuse alveolar damage with hyaline membranes**
- No specific viral inclusion are produced
- Virus produces Hemagglutinin *(adhesion to host cell)* and neuraminidase *(release of mature virons from infected cells)*
- Influenza Strain A – continuous changes in H and M *(antigenic drift)*; abrupt major changes in H and M *(antigenic shift)* allows for pandemics
- Influenza B may cause similar illness; Influenza C causes mild URT infection; types B and C do have exhibit antigenic shift
- **Parainfluenza**: viral respiratory illness in children; causes croup *(due to necrotizing laryngotracheobronchitis)*; produces a pattern of **giant cell pneumonia** in 2/3 case
Respiratory Syncytial Virus Pneumonia:
- Major cause of serious lower respiratory tract infections in children less than 1 yo
- May produce life threatening pneumonia in elderly
- Purulent bronchiolitis and chronic peribronchiolitis
- In lung pattern may be diffuse alveolar damage or giant cell pneumonia
- Intracytoplasmic inclusions (acidophilic) in bronchiole, bronchiolar, and alveolar epithelial cells

Adenovirus Pneumonia
- Infants, young children, military recruit, and immunocompromised
- In infants there may be a long term sequella; bronchiectasis or bronchiolitis obliterans
  (organization of exudates in airways, fibrin effectively blocking them off, causes air trapping and
distention of the lung)
- Necrotizing bronchitis and bronchiolitis
- Bronchiolocentric alveolar damage pattern with characteristic homogeneous deep purple
  intranuclear inclusions (smudge cells)

Measles Pneumonia
- Serious pneumonia more common in Immunosuppressed children
- Inclusion bearing giant cells of epithelial origin with intranuclear and Intracytoplasmic inclusions
- Old term Hecht’s giant cell pneumonia is now recognized as measles infection in
  Immunosuppressed patient without typical rash

Herpetic Pneumonia
- Immunosuppressed, chronic diseases, burns, alcoholics
- May be descending infection from airways or patter implying hematogenous spread
- Type I herpes virus is more common
- Nodular foci of necrosis with characteristic early and late intranuclear inclusions and
  multinucleated giant cells

Cytomegalovirus Pneumonia
- Most seen in debilitated or immunosuppressed and in renal, lung, and bone marrow transplant
  patients (CD4+<50)
- Characteristic inclusions may be seen in epithelial and endothelial cells; Owl eye inclusion with
  ring of cytoplasmic clearing
- Reaction pattern may be little or no pneumonitis, hemorrhagic necrosis, DAD or localized
  interstitial pneumonitis
- Infected monocytes probably carry virus to the lung rather than inhalation
Pneumocystis pneumonia

- Causes severe pneumonia in patients with AIDS a CD4+<200
- Leading cause of death in AIDS patients; also seen in patients with organ transplant and pts with malignancies, esp hematopoietic (all of these patients have reduced immunity)
- Pulmonary changes are those of class intraalveolar frothy fibrinous exudates or diffuse alveolar damage with hyaline membranes
- Cysts (4-6 microns) round and cup shaped are demonstrated by Gomori methanamine silver stain (GMS) in the alveolar fibrin mesh; with a mild interstitial inflammatory reaction
- Regular reoccurrence of CMV infection

Actinomycosis

- Suppurative Inflammation and Sinus Tracts with yellow Sulfur Granules, Anaerobic
- Can cross anatomic barriers via tracts that may drain through pleura, chest wall, and to the skin.
- Weakly Acid-Fast Filamentous Organism, seen on H&E Stain
- It the draining sinus tracts with sulfur granules really give this one away.
- Usually infects immunocompetent individuals

Nocardia

- Filamentous Aerobic Organism that causes Subacute Suppuration with ill-defined granulomas
- Weakly Acid-Fast, but is gram positive, but not seen on H&E Stain
- Usually infects immunocompromised individuals

Aspergillus

- Grow as a mold in the host and in the environment (they are not dimorphic)
- Produces uniform, narrow, septate hyphae that classically branch at acute angles
- Two Forms of disease
  - Bronchopulmonary Aspergillosis
    - Colonization of mucous plugs in airways by non-invasive Aspergillus
    - Seen in asthmatics with histologic changes of asthma + Aspergillus
    - Sensitization to Aspergillus causes exacerbation of asthma (eosinophils and IgE)
  - Fungus Ball (Mycitoma)
    - Colonizes a previously made cavity again without invasion
    - Fruiting Bodies of Aspergillus are diagnostic for Aspergillus
  - Invasive Pulmonary Aspergillus
    - Profoundly neutropenic patients (immunocompromised) get infected.
    - Radiating pattern invading the lung parenchyma and loves to invade vessels
    - Yellow infarct with rimmed hemorrhage, centered on an invaded vessel that leads to thrombosis = Targetoid Lesion

Zygomycosis

- Broad “crinkling” hypi at right angles with rare septations.
- Seen commonly in diabetic keto-acidosis, invading vessels as a necrotizing pneumonia
- Problems from rhinocerebral mucor zygomycosis involves the sino-nasal cavity that can lead to brain invasion and necrosis
CHRONIC PNEUMONIA = granuloma pneumonia

The outline format of this section on pneumonia breaks down pretty rapidly. For chronic pneumonia, we investigate the dimorphic fungi (“mold in the cold, yeast in the beast”) that affect specific regions of the United States and are known to cause pneumonia in normal, immunocompetent patients. After these three fungi, we explore the pneumonias of immunocompromised patients (HIV+ being the classic case)

Histoplasmosis = “Fungal Flu” or “Fungal TB”

- **Clinical Picture** = MOSTLY ASYMPTOMATIC IN MOST CASES
  - Vignette will show recent trip to Ohio/Mississippi Valley or Spelunking with exposure to bats or bird droppings
  - Very similar presentation to TB
    - Self-Limited Latent Pulmonary Involvement with coin lesions on xray
    - Secondary lung disease in apices with cough, fever, night sweats, and weight loss
    - Possibility for focal lesions in extrapulmonary sites

- **Pathogenesis**
  - Is inhaled from bat or bird droppings in the highly infectious mold form (microconidia)
  - Transforms into the yeast form and is phagocytized by macrophages
  - Inhibits oxidative burst and is able to grow intracellularly with eventual lysis

- **Morphology**
  - Epithelioid Granulomas in immunocompetent patients as expected for intracellular pathogens with Coagulative necrosis that produces large areas of consolidation
  - Healed regions undergo fibrosis and concentric calcification (tree-bark lesions)
  - Histologically differentiated by presence of methenamine silver stained organisms

- **Types**
  - Primary and Chronic Histoplasmosis = picture above = grey-white granulomas, cough, fever, night sweats, weight loss (immunocompetent) with calcifications
  - Disseminated Histoplasmosis = no epithelioid granulomas, with focal accumulation of monocytes filled with organisms throughout the body.

**Blastomycosis**

Localized to South Central Area of the Country
- Recent visit to Beaver Dams (rotting wood) reveals Broad Based Budding Yeasts on Histo
- Presents with Night Sweats, Fever, Cough, and Weight loss
- Persistence of yeast (because it evades phagocytosis) recruits neutrophils

**Coccidiomycosis**

- Endemic to US Southwest and have mold spores in soil
  - 80% of population in endemic area have a positive skin reaction (exposure without symptoms)
  - Most people who are exposed are asymptomatic
  - Some get lung lesions, fever, cough, chest pain, Erythema Nodosum (San Joaquin Fever)
  - Organisms are intracellular pathogens that block fusion of the phagolysosome, and reproduce intracellularly within a spherule that ruptures releasing infectious organisms and eosinophilia
  - Forms granulomatous lesions such as in TB or Histoplasmosis.
**Lung Abscess**

- **Definition**
  - Local suppurative process within the lung characterized by necrosis of lung tissue

- **Morphology**
  - **Gross**
    - Abscesses can be of varying size and location
    - Aspiration usually ends up in the **right mainstem bronchus** and is **single**
    - Pneumonia usually are **multiple, basal, and diffuse**
    - Septic Emboli are haphazardly spread throughout the lung
    - Continued infection results in **gangrene lung** which is large, fetid, green-black cavities with poor demarcation
  - **Histo**
    - Suppurative Destruction of Lung Parenchyma within area of central cavitation

- **Clinical Course**
  - Usually follows one of the “pathogenesis” infections or routes
  - Presents with **cough, fever, and copious foul-smelling sputum**
  - Fever, chest pain, and weight loss are common; clubbing of fingers and toes is rare
  - Complications are usually minimal with antibiotic therapy, though **brain abscess** (from septic emboli) and **meningitis** can occur

- **Pathogenesis**
  - **Organisms**
    - Any organism can cause an abscess, but several are often cultured out of one
    - **Staph Aureus** is a major player and is highly virulent (brain abscess)
    - **Anaerobes** from the oral cavity (Bacteroides, Fusobacterium, and Peptococcus)
    - **Host of Gram Negative** bacteria (those that cause pneumonia, above)
  - **Portals of Entry**
    - Aspiration of infective material is the most common. This includes food, gastric contents or foreign objects that must first pass through the oral cavity
    - Antecedent Bacterial Infection = pneumonia and Bronchiectasis that are caused by or predispose infection, giving a home to nasties (Staph, Klebsiella, Penumococcus)
    - Septic Emboli either venous (DVT, Right Endocarditis) or arterial (Left Endocarditis)
    - Neoplasia compresses proximal airway giving bugs room to grow distally
    - Miscellaneous = trauma
    - **Primary Cryptogenic** = Idiopathic = We don’t know
Pathology Pulmonary

PULMONARY VASCULATURE DISORDERS

Pulmonary Embolism

- Definition
  - Emboli (usually a clot) that occludes the pulmonary vasculature (right sided clot)
  - Most commonly blood clots from DVT, though air (iatrogenic), bone marrow (from rib fx
during cardiopulmonary resuscitation) or foreign bodies (IV drug users) possible

- Causes of Clots
  - Primary = Factor V, Prothrombin 20210, Hyperhomocysteinemia, Lupus
  - Secondary = Bed-Ridden, Obesity, Cancer, Oral Contraceptives, Post-Op

- Morphology
  - Dependent on size and state of circulation (intact, normal bronchial arterial supply?)
    ▪ Large emboli impact the pulmonary artery = sudden death or acute cor Pulmonale
    ▪ Small emboli get farther and cause infarctions
      ◊ If bronchial supply is good = no infarct, but yes hemorrhage
      ◊ If bronchial supply is busted (old, sick people) = yes infarct, yes hemorrhage
  - Infarcts are in the shape of a wedge with the apex at the occluded vessel
    ▪ Classically hemorrhagic, starting red-blue (first 24 hrs), becoming paler with RBC
      lysis and replacement with WBC (up to 48 hrs), becoming red-brown with hemosiderin (48hrs-2 weeks), and finally becoming a white fibrous scar (2weeks+)
  - Histologically there is necrosis of alveoli, vessels, and bronchioles within the sites of
    hemorrhage. If neutrophils are abundant then you have a septic infarct
  - D-dimer will be elevated from internal natural fibrinolysis (recall heme-onc)

Clinical Course

- Large Embolus = Sudden Death, or, during a code, electromechanical disassociation
  ▪ Survivors mimic and MI = Chest Pain, Dyspnea, Fever, and a pleural friction rub
- Small embolus = hemorrhage w/o infarct presenting as transient chest pain and dyspnea
- Resolution of clots occurs with fibrinolysis, fibrosis, and lung contraction
  ▪ Lung volume is smaller because of contraction
  ▪ Pulmonary Vascular Resistance is increased with fibrosis
- Results in
  ▪ Respiratory Compromise = ventilated but not perfused alveoli (V/Q mismatch)
  ▪ Hemodynamic Compromise = increased resistance results in both an acute
    (embolus blocks flow) or chronic (fibrosis increases resistance) cor Pulmonale

Diffuse Pulmonary Hemorrhagic Syndromes

- Good Pastures (Inflammation Block)
  - Type II Autoimmune = antibodies against basement membrane of lung and kidneys
  - Progressive Glomerulonephritis (peeing blood) and Necrotizing Pneumonitis (coughing
  blood) occurs in men in their twenties (compare to Wegener’s)
  - “Ribbon Pattern” on immunofluorescence on kidney
  - Focal Necrosis of lung with pneumocytes hypertrophy, fibrous thickening of septae
  - Healed with plasma exchange and immunosuppresion
Pathology Pulmonary

- **Wegner’s**
  - Vasculitis that affects **lungs, kidneys** and **nose/sinus**
  - Poorly formed granulomas (opposed to sarcoidosis) with capillaritis that leads to hemorrhage (though Wegner’s does not require hemorrhage for Dx)
  - Treat it with **cyclophosphamide** with good response

**Pulmonary Hypertension** *(subject got TWO lectures)*

- Normal Physiology
  - Endothelium produced vasoactive substances
    - **Constrictors**
      - Endothelin = powerful vasoconstrictor
      - Thromboxane = vasoconstrictor
    - **Dilators**
      - Nitric Oxide = relaxing factor, short half life
      - Prostacyclin = vasodilatory and thromboxane antagonist
    - **Equilibrium** between the two decide constant tone, HTN develops from overexpression of endothelin/thromboxane or undertexpression of NO/prostacyclin

- Normal Pressure Values
  - Pulmonary Arterial = 22/10, average 15mmHg, does not normally exceed 30/15mmHg
  - **Pulmonary Hypertension** defined as a systolic of **40mmHg**
  - Pulmonary Wedge = 7-15mmHg, Right Ventricle = 15-39mmHg, Left Atrium = 5-12mmHg

- **Pulmonary Arterial Hypertension (Group 1)**
  - Pressure comes from “before the lung”
  - May be idiopathic (called **primary pulmonary hypertension**)
  - May be familial (CVD, portal HTN, HIV, drugs)

- **Pulmonary Venous Hypertension (Group 2)**
  - Pressure comes from “after the lung”
  - Left-sided atrial or ventricular heart disease (valve problems or Left Ventricular Failure)
  - Causes an **increased pulmonary wedge pressure**.

- **Pulmonary Hypertension with Hypoxemia (Group 3)**
  - Paradoxical reaction in pulmonary vasculature = vasoconstriction with hypoxemia
  - Conditions of hypoxemia (COPD, High Altitude) the pulmonary vasculature adjusts to be constricted... constricted = more resistance = HTN. Leads to chronic hypertrophy.

- **Pulmonary Hypertension due to chronic thrombotic disease**
  - Thromboembolic obstruction may be proximal or distal to pulmonary arteries
  - Obstruction by tumor, parasite, foreign material, or even emphysematous alveoli

- **Pathogenesis**
  - Genetic Associations = downregulation of Prostacyclin/NO or upregulation of endothelin and thromboxane. Tipping the scale in favor of the constrictors.
  - Medial Thickening – prolonged contraction results in hypertrophy of smooth muscle
  - Thrombosis – where there is fibrosis and intimal narrowing, there will be thrombosis

Note: Pulmonary Hypertension results from a increased resistance of arterioles in the lung, causing an increased afterload for the right ventricle. This occurs in congestive heart failure (when the blood backs up), in chronic hypoxic conditions (causing constriction of pulmonary vasculature), in increased flow states (L→R shunt) or recurrent obstruction to flow (thrombosis or emboli). It is not so important to know “Group 1 vs Group 2” only that there are multiple mechanisms for the development of Pulmonary Hypertension.
Hypoxia

- Induces vasoconstriction of pulmonary vasculature via endothelial cell derived vasoconstrictors (endothelin and serotonin), produced by an inhibition of voltage gated channels (maintaining depolarized state, which leads to contraction)
  - Acute = Reversible, Chronic = Structural Remodel

- Clinical
  - Test with Chest X-ray, ECG and Echo, follow up studies (lung biopsy, MRI, ventilation-perfusion ratio, swan-ganz cath) come later
  - Physical findings include JVD, Peripheral Edema as a result of Cor Pulmonale (Right Heart Failure), or Eisenmenger’s Reversal of L → R to R → L shunts with cyanosis.
  - Treatment
    - Treat the underlying cause first and foremost
    - Keep oxygen sats in the 90s, provide anticoagulation for thrombosis, bronchodilators to reduce hypoxia, diuretics to get rid of excess fluid, and digoxin if left heart failure is the cause; lung transplantation is final step
    - New therapies are pharmaceuticals to antagonize endothelin (Bosentan), agonize Nitric Oxide (sildenafil) or agonize prostacyclin (Illoprostol)

NEOPLASIA

- Most common tumor in lung is metastatic TO lung, not primary tumors of lung.
- Tobacco Smoking leads the list for causing, or at least increasing risk for, lung carcinomas
- Cannot demonstrate cancer just from exposing animals to cigarette smoke
- “Non-Small Cell Carcinoma” includes squamous, adenocarcinoma, and large-cell carcinoma

Intrathroacic Spread

- Recurrent Laryngeal Nerve extends down and can be impinged = ipsilateral hoarseness
- Phrenic Nerve can be compressed causing unilateral diaphragmatic paralysis
- Pancoast Tumor are those of the apex/cupula invading the sympathetic change = Horner’s
- Superior Vena Caval Syndrome obstructs VC, causing plethora (edema) of the head and neck
- Pericardium leading to a pericardial effusion, tamponade, and death

Paraneoplastic Syndromes

- Tumor has a distal effect without any invasion or metastasis; caused by products of tumor
- Endocrine Effects = ACTH-Cushing’s, ADH-HypoNa⁺⁺, PTH-HyperCa⁺⁺, Calcitonin-HypoCa⁺⁺
- Eaton-Lambert Syndrome = Myasthenia Gravis-like illness that produces antibody to Ca++ channels on ACh NMJ presynaptic neurons. Muscle weakness large muscles early in the morning
- Acanthosis Nigracans = darkened pigmentation localized to axilla, groin, and neck
- Hypertrophic Pulmonary Osteoarthropy = Clubbing of digits
Pathology Pulmonary

**Metastasis**

- Loves to go to the **kidney/adrenals** and to the **brain** (areas of high blood flow)
- Can also go to bone and liver.

**Small Cell Carcinoma** Aka “Oat Cell,” *Smoking withOUT In Situ*

- Neuroendocrine = dense core, membrane bound **neurosecretory granules** on EM
- When you find it, it’s too late, and is **already metastatic**; managed by chemo not surgery
- **Large central tumors without** any clear-cut in situ component, arising near bronchioles
- Very high mitotic rate that tend to necrosis that cuffs blood vessels.
  - Causes **paraneoplastic syndromes**
    - Cushing’s, Hypercalcemia, ADH, etc. depending on the granule created
    - For a test question, pick either ADH or ACTH (SIADH and Cushings)

**Squamous Cell Carcinoma** - *Smoking WITH In Situ Lesion*

- Most closely associated with **smoking**, gaining ground in women with women smoking
- Central, Hilar tumors of the lung, arising from **segmental bronchi**
- Produces **PTH-rp** a parathyroid-like-protein, causing hypocalcemia without feedback
- The only lung tumor that shows an intrabronchial precursor lesion (a classic display of dysplasia, squamous metaplasia and **carcinoma in situ**)
- **Keratin Pearls** are often present along with **intracellular bridges** of invasive cells

**Large Cell Carcinoma**

- Massive **peripheral tumors** that undergo necrosis and may **cavitate**
- Highly undifferentiated, but act closest to adenocarcinoma.
- The cells on histo are HUGE, with abundant pink cytoplasm, but are **anaplastic**

**Adenocarcinoma** = *No Smoking, No In Situ Component*

- **Non-smoking** women, always has been the most common carcinoma
- 3 “Ps” = Pleural Surface, Peripherally, Pucker Pleural Surface
- Tumors forming **granular spaces** that **produces mucin** destroying the alveolar septae
- Invade the pleura early, grow slower, and grow in the **periphery** that may appear as a **coin lesion** on a chest x-ray
- May grow around scar tissue

**Bronchial Carcinoid Tumor**

- **Low grade malignancies** (2 per 10 high power fields) that resembles small cell carcinoma
- Grow within the central or proximal bronchioles
- Serotonin released into pulomary vein causes **mitral valve fibrosis/stenosis** on the heart
- Look for **5-HIAA** in the Urine (breakdown product of serotonin)
### Cancer

<table>
<thead>
<tr>
<th>Gross</th>
<th>Histo</th>
<th>Notes</th>
<th>What it makes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Tumor with Cavitation</td>
<td>Intracellular Bridges, Keratin Pearls</td>
<td>Most closely associated with smoking</td>
<td>PTH-rp</td>
</tr>
<tr>
<td>Peripheral in Lung, Coin-Like Lesions</td>
<td>Mucin producing glandular tumors with collagenous stroma</td>
<td>Most common carcinoma</td>
<td>Nothing</td>
</tr>
<tr>
<td>Large central tumor around the bronchiole</td>
<td>Neuroendocrine (EM Granules)</td>
<td>Don’t surgically treat, it’s too late; worst to have</td>
<td>ADH and ACTH</td>
</tr>
<tr>
<td>Peripheral Tumor</td>
<td>Massive Pink, Anaplastic Cells</td>
<td>Usually not tested</td>
<td>Nothing</td>
</tr>
<tr>
<td>Central Tumor</td>
<td>Salt and Pepper Chromatin Neuroendocrine Granules</td>
<td>Causes Carcinoid Syndrome (Mitral Valve)</td>
<td>Serotonin, look for 5-HIAA in urine</td>
</tr>
</tbody>
</table>

### Pleural Effusion

- **Normal**
  - 15mL of serous, acellular, clear fluid
  - Changes in content come with changes in hydrostatic/oncotic pressures, vascular permeability, and lymph blockage

- **Two types of Pleural Effusion**

  - **Inflammatory = “Pleuritis”**
    - Common causes are disease within the lungs (TB, pneumonia, abscess) or systemic insults such as radiation or uremia. These often cause an exudate that resolves
    - **Empyema** is a purulent exudate resulting from bacterial or fungal infections
      - Yellow-green, local, creamy pus with lots of neutrophils.
      - Resolution is rare; fibrous adhesions obliterate pleura or encroach on lungs
    - **Hemorrhagic Pleuritis** is different from a hemothorax and must be closely considered for the tumor that caused it.

  - **Noninflammatory “-Thoraces”**
    - **Hydrothorax** = serous fluid associated with CHF, found in the bases when upright
    - **Chylothorax** = milky fluid of lymphatic origin with fat, secondary to lymphatic obstruction.
    - **Hemothorax** = blood in pleural space (ruptured Aorta, Penetrating trauma) without inflammatory cells. It is rapidly fatal when associated with aorta or trauma
    - **Pneumothorax** = air in the pleural space from a ruptured bulla, penetrating trauma, or blown out lung (positive pressure ventilation).
      - **Spontaneous Idiopathic Pneumo** = young adults (especially the tall thin ones) that rupture a bulla into the SubQ tissue. It often resolves (air resorbed) without complication, though dyspnea and SubQ cracks can be heard
      - **Tension Pneumo** = Tissue acts as a valve-flap, allowing air into the pleural space on inhalation, but not back out on exhalation. With each breath the pneumothorax gets worse, trapping more air, crushing more lung. Eventually, there is so much pressure that the great vessels are occluded leading to hypotension and a mediastinal shift away from the injured lung.
        - “Popping the chest” with a chest tube of needle aspiration to alleviate the tension (letting the air out) may be the only life saving intervention for severe pneuo or hemothoraxes

---

**PLEURA**

**Hyperlucency** means lots of air. Its unilateral and the heart is shifted to the right (away from pneumothorax)

**Blood Air Interface**

**Hemothorax** with a blood interface on chest X-ray

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**Air of Affected Lung**

**Normal Lung**

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26 | Owl Club Review Sheets
**Pathology Pulmonary**

The person who wrote these review chart did NOT write the outline. It was made while studying for Step 1, listening to Goljan and reading First Aid. In particular, Tulane goes into massive detail on infections and organisms. You have to know it, but there is an overwhelming amount of information you can do without.

### ATELECTASIS

<table>
<thead>
<tr>
<th>Type</th>
<th>Character</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patchy</td>
<td>Occurs in neonates, particular in premature infants, a result of deficient surfactant. The lungs never inflate, inducing neonatal respiratory distress syndrome. A ratio of Lechitin to Sphingomyelin must be at least 1.5 for a birth to be viable (22 weeks min)</td>
</tr>
<tr>
<td>Resorption</td>
<td>Following a complete obstruction (aspiration of foreign object, asthma/bronchitis). Causes a decreased volume distal to the blockage (because air does not inflate it)</td>
</tr>
<tr>
<td>Compression</td>
<td>Something (blood, water, fluid) is inside the pleural space pushing on the lung. Pneumothorax (air), Hemorthorax (blood), Chylothorax (Lymph), Tension Pneumo</td>
</tr>
<tr>
<td>Contraction</td>
<td>Repeated damage (toxins, disease, infection) that results in inflammation leads to fibrosis. Fibrosis leads to contracture of the scar left behind, preventing expansion of lungs</td>
</tr>
</tbody>
</table>

With decreased ventilation of the collapsed segment there is a well-perfused but poorly ventilated section of lung. This is called a shunt, with a V/Q mismatch (V goes down, Q stays the same).

### PENUMOCONIOSES

<table>
<thead>
<tr>
<th>Disease</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestosis</td>
<td>Ferruginous Body (Iron, Ferrous) found in the lungs of shipyard workers, insulation installation, roofer. ↑ of Bronchogenic Adenocarcinoma and Mesothelioma though takes 25-30 years to get it</td>
</tr>
<tr>
<td>Anthracosis</td>
<td>Black pigment in the lung, City-dweller, chronic smoker. ↑ Risk of restrictive lung disease, not cancer</td>
</tr>
<tr>
<td>Silicosis</td>
<td>Sandblasters or in a Foundry who breathes in the dust. Huge nodules in the lungs. Caplan Syndrome = Rheumatoid Arthritis + Pneumoconiosis</td>
</tr>
<tr>
<td>Berlyiosis</td>
<td>Virtually eliminated from the united states, though aerospace industry (Boweing) still at risk. Granulomas in the lung, lymph nodes, and everywhere else.</td>
</tr>
</tbody>
</table>

This information is found in BRS Pathology, Environmental Toxicology and in Respiratory

### RESTRICTIVE LUNG DISEASE (↓ In all volumes, Normal or ↑FEV/FVC, ↓Compliance, ↑Elasticity)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarcoidosis</td>
<td>The vignette almost always has an African American Female with Dyspnea. Bilateral Hilar Lymphadenopathy, for the exam/board is pathognomonic for sarcoid. Noncaseating granulomas of the lung together with elevated ACE levels in the blood. Chronic inflammation may result in hypercalcemia</td>
</tr>
<tr>
<td>Neonatal Respiratory Distress Syndrome</td>
<td>Commonly associated with Premature Infants, Maternal Diabetes, or a C Section. Mom should have gotten some corticosteroids to induce surfactant production (which is too low). Hyaline Membranes of the alveoli, inhibit oxygen diffusion, ↓ surfactant = Atelectasis. O₂ therapy is required, but may be toxic: Bronchopulmonary Dysplasia, or Retrolental Dysplasia (eyes)</td>
</tr>
<tr>
<td>Adult Respiratory Distress Syndrome</td>
<td>Hyaline membranes in adults, though it is NOT caused by insufficient surfactant. Damage to the alveolus causes vascular permeability → neutrophils + protein exudate → hyaline. Neutrophils Damage Alveolar Wall, leading to the complement cascade and free radicals</td>
</tr>
<tr>
<td>Goodpastures</td>
<td>Hemoptysis and Hematuria are classic presentations of Goodpastures. Anti-Basement-Membrane Antibodies (Collagen Type 4, alpha 5 chain) Starts in the lungs, finishes in the kidneys. More important in the renal block, be aware of this here</td>
</tr>
</tbody>
</table>
### Pathology Pulmonary

#### OBSTRUCTIVE LUNG DISEASE (↑TLC, ↑FRC, ↓FEV1/FVC, ↓Elasticity, ↑Compliance)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>Eosinophilia in the wall, Charcot-Leyden Crystals within <strong>Mucous Plugs</strong> that fill the airway</td>
</tr>
<tr>
<td></td>
<td>Adult Form = idiopathic = cold, exercise, mucous production, called “exertional asthma”</td>
</tr>
<tr>
<td></td>
<td>Juvenile Form = allergic reaction (Type 1 Hypersensitivity) to allergens in the air = eosinophilic constriction</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>Diagnosed as a productive cough for &gt;3 consecutive months in &gt;2 years</td>
</tr>
<tr>
<td></td>
<td>Thickened bronchiolar walls with <strong>Increased Goblet Cells, Increase in Reid Index</strong> (Hyposecretion of mucous)</td>
</tr>
<tr>
<td></td>
<td>A “blue bloater” which is usually <strong>cyanotic</strong> with <strong>edema</strong>, associated with smoking</td>
</tr>
<tr>
<td></td>
<td>Produces the <strong>terminal bronchiole</strong> (there is NO gas exchange here)</td>
</tr>
<tr>
<td>Emphysema</td>
<td>Panacinar is caused by α1-Antitrypsin <strong>Deficiency</strong> = Lower Lobe (PMNs elastase &gt; anti-trypsin)</td>
</tr>
<tr>
<td></td>
<td>Centrilobular is caused by smoking, same elastase, but smoking ↑↑↑PMNs = Upper Lobe</td>
</tr>
<tr>
<td></td>
<td>Called “pink puffer” breathing through <strong>pursed lips</strong> who are <strong>not cyanotic</strong></td>
</tr>
<tr>
<td></td>
<td>Look for enlarged AP diameter, Barrel Chest, Accessory Muscle <strong>Hypertrophy</strong>, and emaciated (work of breath)</td>
</tr>
<tr>
<td></td>
<td>Disease is in the <strong>respiratory bronchiole/Alveoli</strong> = fusion of alveoli = ↓Surface Area Diffusion</td>
</tr>
<tr>
<td></td>
<td>Causes <strong>chronic CO2 retention</strong> resulting in <strong>hypoxic drive</strong> to breathe</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>Large, <strong>cystic-looking dilations</strong> especially at the periphery of the pleura</td>
</tr>
<tr>
<td></td>
<td>caused by recurrent severe infections, i.e. <strong>Pseudomonas or Staph Aureus</strong></td>
</tr>
<tr>
<td></td>
<td>May be associated with <strong>Kartagener’s Syndrome</strong> (deficiency of dynein arm of cilia, no escalator)</td>
</tr>
</tbody>
</table>

#### PNEUMONIA (not bugs)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobar Pneumonia</td>
<td>Occurs in previously healthy young adults, Typically caused by <strong>strep Pneumo</strong>,</td>
</tr>
<tr>
<td></td>
<td>Demonstrates a <strong>lobar consolidation</strong> on X-Ray. 4 Stages occur only in the absence of antibiotics</td>
</tr>
<tr>
<td></td>
<td>4 stages → <strong>Congestion</strong> (vascular engorgement), <strong>red Hepatization</strong> (intra-alveolar RBCs and Neutrophils), <strong>Grey Hepatization</strong> (resolution of RBCs, Neutrophils remain), Resolution (Fibrin+Fluid, Back to Normal)</td>
</tr>
<tr>
<td>Broncho-Pneumonia</td>
<td>Caused by <strong>Strep Pneumo</strong> and <strong>Haemophilus</strong> occurring usually in the very young or the very old</td>
</tr>
<tr>
<td></td>
<td>Causes a <strong>patchy infiltrate</strong> as infection is centered in the center of the lung, diffuse, around bronchi</td>
</tr>
<tr>
<td></td>
<td>Full of a neutrophil-rich supplicative inflammation</td>
</tr>
<tr>
<td>Empyema</td>
<td>Infection spreading from the lungs into the pleura. Any organism can do it</td>
</tr>
<tr>
<td>Abscess</td>
<td>Abscess are cavitary lesions called by particularly virulent strains of bacteria</td>
</tr>
<tr>
<td></td>
<td>Technically any bug can do it, but look for <strong>Staph Aureus</strong>, especially in an IV Drug User</td>
</tr>
<tr>
<td>Atypical Pneumonia</td>
<td>Slow, insidious onset, also called <strong>Walking Pneumonia</strong> with a <strong>nonproductive cough</strong></td>
</tr>
<tr>
<td></td>
<td>It is an <strong>interstitial pneumonia</strong> with chronic inflammation within the alveolar walls</td>
</tr>
<tr>
<td></td>
<td>Commonly in response to <strong>Mycoplasma</strong> producing a <strong>Cold Agglutinin Disease</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Diffuse Patchy Inflammation</strong> on X-ray</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td><strong>Ghon Complex</strong> is the primary infection, often found in the upper lobe (higher oxygen tension there)</td>
</tr>
<tr>
<td></td>
<td>In reactivation there is a <strong>cavitary lesion</strong> but no Ghon Complex</td>
</tr>
<tr>
<td></td>
<td><strong>Caseating Granulomas, cavitary lesions</strong> (differential from aspergillus/fungoid infections)</td>
</tr>
</tbody>
</table>

#### PLEURA

<table>
<thead>
<tr>
<th>Disease</th>
<th>Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemothorax</td>
<td>Bleeding into the pleural space, causing compression syndrome similar to, but not as severe as, tension pneumothorax</td>
</tr>
<tr>
<td>Hydrothorax</td>
<td>Serous effusion, often associated with CHF</td>
</tr>
<tr>
<td>Chylothorax</td>
<td>Milky fluid from obstruction or destruction of the lymph drainage</td>
</tr>
<tr>
<td>Spontaneous Pneumothorax</td>
<td><strong>Ruptured Subpleural Blebs</strong> occurring in tall athletes (think Marfan’s), usually in the apex</td>
</tr>
<tr>
<td></td>
<td>Will cause Atelectasis, with <strong>tracheal deviation towards the lesion</strong> and diaphragm flattening</td>
</tr>
<tr>
<td>Tension Pneumothorax</td>
<td><strong>Caused by a knife wound to the lung. It creates a pleural flap that allows air in (negative pressure) but then it traps the air on exhalation (positive pressure closes the flap)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Tracheal Deviation AWAY</strong> from the lesion as the air pushes everything over, causing a mediastinal shift</td>
</tr>
<tr>
<td></td>
<td>May cause compression syndromes: vena cava (no venous return = death), trachea (no breathing), esophagus</td>
</tr>
<tr>
<td></td>
<td>Treat with a <strong>chest tube</strong> inserting on top of the rib, usually rib 6 on the mid-axillary line</td>
</tr>
</tbody>
</table>
### TUMORS

<table>
<thead>
<tr>
<th>Disease</th>
<th>Finding</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Squamous Cell Carcinoma</td>
<td>↑ risk with <strong>smoking</strong>, occurs near the <strong>bronchus</strong>, with a preliminary <strong>squamous cell metaplasia</strong></td>
<td>Produces PTH-rp which can cause a hypercalcemia and osteoporosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Look for <strong>Keratin Pearls</strong> on an image or <strong>Cytoplasmic Bridging</strong> in a vignette</td>
</tr>
<tr>
<td>Small Cell Carcinoma</td>
<td>↑ risk with smoking, occurs near bronchus, and is a <strong>Neuroendocrine cell</strong>, no metastatic lesion</td>
<td>Produces ACTH (Cushings) and ADH (SIADH); <em>can</em> produce whatever, but pick these for test questions</td>
</tr>
<tr>
<td>Adenocarcinoma Carcinoma</td>
<td>They are near the <strong>pleura</strong>, they are <strong>puckered</strong>, and are <strong>peripheral</strong></td>
<td>May cause a <strong>Pancoast tumor</strong> ( apex of lung that causes Horner’s Syndrome or Superior Vena Cava Syndrome)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Horner’s</strong> = Miosis, Ptosis, Anhidrosis. <strong>Superior Vena Cava syndrome</strong> = vein distention of the face</td>
</tr>
<tr>
<td>Carcinoid</td>
<td><strong>Serotonin</strong> production causes <strong>mitral/aortic valve stenosis</strong> and resultant heart failure</td>
<td>Look for <strong>5-HIAA</strong> in the urine</td>
</tr>
<tr>
<td>Metastasis</td>
<td>Most common tumor of the lung, look for <strong>multiple lesions</strong> (pathognomonic for mets on Boards)</td>
<td>Mets from the Lung to Brain, Liver, but LOVE <strong>Adrenal Glands</strong>; mets to the lungs can come from anywhere</td>
</tr>
<tr>
<td>Large Cell</td>
<td>Don’t Worry About it, assume it doesn’t exist unless they say “large clear cells”</td>
<td></td>
</tr>
</tbody>
</table>

### PEDIATRIC DISEASES

<table>
<thead>
<tr>
<th>Disease</th>
<th>Notes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonatal Respiratory Distress Syndrome (Again)</td>
<td>Caused by a <strong>premature birth</strong> resulting in <strong>too little surfactant</strong> (Lethicin:Sphingomyelin ratio &lt; 1.5)</td>
<td>Should have given mom <strong>corticosteroids</strong> prior to delivery to induce surfactant production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alveolar Collapse without surfactant makes it hard to get the lungs to pop open</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Causes a <strong>hyaline membrane</strong>, with risks increasing in <strong>C-Sections</strong> and <strong>Diabetic Mothers</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Treated with ventilation and oxygenation, may lead to Bronchopulmonary Dysplasia</td>
</tr>
<tr>
<td>Bronchopulmonary Dysplasia</td>
<td>Causes both a fibrotic lung disease and retrolental fibroplasias of the eye</td>
<td>Patient presents with breathing problems (long, difficult weaning process from ventilator) and difficulty</td>
</tr>
<tr>
<td></td>
<td></td>
<td>seeing which exacerbates as the patient ages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mediated by <strong>Oxygen Radical Formation</strong> and subsequent neovascularization</td>
</tr>
<tr>
<td>Pulmonary Sequestration</td>
<td>Pieces of lung are connected to the <strong>blood supply</strong> but not the <strong>airway</strong></td>
<td><strong>Infection</strong> is highly likely, disseminated by blood, happy environment, without any way of getting out</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do not worry about distinguishing Intra and Extra pulmonary sequestration on exams</td>
</tr>
<tr>
<td>Guillan-Barre</td>
<td>Ascending Paralysis following a Vaccine or Viral Illness</td>
<td>Supportive care; it is self-limiting if patient is ventilated through the paralysis</td>
</tr>
<tr>
<td>CCHS</td>
<td>Forgets to breathe while asleep</td>
<td></td>
</tr>
<tr>
<td>Diaphragmatic Hernia</td>
<td>Congenital defect in the diaphragm allowing intestines into mediastinum.</td>
<td>Causes a <strong>compression syndrome</strong> limiting the development of the lungs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Morgagni (front) Bochdalek (posterolateral, and the most common), fixed with surgical correction</td>
</tr>
<tr>
<td>Epiglottitis</td>
<td>Patient is 2-6years old, presenting with <strong>painful swallowing</strong> and <strong>drooling</strong> (because he doesn’t swallow)</td>
<td>Caused by a <strong>Haemophilus Infection</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do NOT touch the epiglottis as it might rupture and compromise airway</td>
</tr>
<tr>
<td>Croup</td>
<td>Patient is usually &lt;5 years old presenting with a <strong>Seal-Bark Cough</strong> Caused by a <strong>narrowing of the glottis</strong> usually an RSV infection</td>
<td></td>
</tr>
</tbody>
</table>
# Pathology Pulmonary

<table>
<thead>
<tr>
<th>Infectious Organism Key Associations</th>
<th>Type</th>
<th>Classic Findings or Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Candida</td>
<td>Fungus</td>
<td>In-dwelling catheters, Psuedohyphae</td>
</tr>
<tr>
<td>Histoplasmosis</td>
<td>Fungus</td>
<td>Midwest US, bats, Caves, Spelunkers</td>
</tr>
<tr>
<td>Cryptococcus</td>
<td>Fungus</td>
<td>Pigeons, India Ink</td>
</tr>
<tr>
<td>Blastomycosis</td>
<td>Fungus</td>
<td>Broad-Based Budding yeast</td>
</tr>
<tr>
<td>Coccidiomycosis</td>
<td>Fungus</td>
<td>Spherule in the endospore</td>
</tr>
<tr>
<td>Aspergillus</td>
<td>Fungus</td>
<td>Fungus Ball, Vessel Invasion (thrombosis, Infarction), Asthma</td>
</tr>
<tr>
<td>Pneumocystis</td>
<td>Fungus</td>
<td>AIDS, Silver Stain, Hammered Cells. Used to be called <em>carinii</em>, now called <em>jirovecki</em></td>
</tr>
<tr>
<td>Rhinovirus</td>
<td>Virus</td>
<td>Common Cold</td>
</tr>
<tr>
<td>RSV</td>
<td>Virus</td>
<td>Bronchiolitis and Croup in Kids</td>
</tr>
<tr>
<td>Influenza</td>
<td>Virus</td>
<td>The Flu, Antigenic Drift, Shift, Vaccine</td>
</tr>
<tr>
<td>CMV</td>
<td>Virus</td>
<td>Owl Eye, Large Cells in Alveolar Macrophages or Pneumocytes, AIDS CD4 &lt;100</td>
</tr>
<tr>
<td>Actinomyces</td>
<td>Bacteria</td>
<td>Yellow Sulfur granules, Sinus Draining Tracts, Farmer Lung</td>
</tr>
<tr>
<td>Chlamydia</td>
<td>Bacteria</td>
<td>Staccato Cough, Kid in mom who is vaginally infected</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>Bacteria</td>
<td>Respiratory, Water Loving, Burn patients, Cystic Fibrosis</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>Bacteria</td>
<td>Drunks, Alcoholics, maybe diabetic (think Mucor or Rhizo for Diabetes)</td>
</tr>
<tr>
<td>Mucor / Rhizopus</td>
<td>Bacteria</td>
<td>Diabetic Ketoacidosis</td>
</tr>
<tr>
<td>Legionella</td>
<td>Bacteria</td>
<td>Water Loving, AC units, Garden Hoses</td>
</tr>
</tbody>
</table>

---

**Note:**
- *jirovecki* is the correct name for *Pneumocystis*. The term *carinii* was previously used but is no longer recommended.
- *Blastomycosis* is often associated with blistering and skin lesions in addition to respiratory symptoms.
- *Coccidiomycosis* is typically associated with pneumonia.
- *Aspergillus* is known for its ability to cause invasive aspergillosis, particularly in immunocompromised patients.
- *Histoplasmosis* is a common cause of fungal pneumonia in the Midwest US, particularly in bats and cave spelunkers.
- *Candida* is a common cause of fungal infections, often seen in catheters and immunocompromised patients.
- *Pneumocystis* is now known as *Pneumocystis jirovecii* and is a significant cause of pneumonitis in AIDS patients.
- *Rhinovirus* and *RSV* are major causes of respiratory infections, particularly in children.
- *CMV* is a common cause of pneumonia in immunocompromised patients, often presenting with large cell infiltrates in the lungs.
- *Actinomyces* is a common cause of actinomycosis, often seen in sinus or lung draining tracts and farmer lung.
- *Chlamydia* is a common cause of pneumonia, particularly in children and in women who are vaginally infected.
- *Pseudomonas* and *Klebsiella* are common causes of nosocomial infections, often seen in burn patients and patients with diabetes.
- *Legionella* is a cause of Legionnaires’ disease, often associated with water sources and AC units.

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**Sources:**
- Centers for Disease Control and Prevention (CDC).
- Infectious Disease Society of America (IDSA).

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**Disclaimer:**
This information is for educational purposes only and should not be used as the sole source of medical advice. Always consult with a licensed healthcare professional.