CXR (if pneumonia at base then you can see diaphragm border vs if effusion at base you can't see diaphragm border)
What Do You Do

(1) Differentiate URTIs, LRTIs, and Pneumonia
(2) Recheck RR, Oxygenate, Fluids
(3) CXR (if no findings then do NOT treat, high sensitivity and specificity, rule out empyema with decubitus)
(4) Sputum Gram Stain and Culture (50% sensitivity and 80% specificity and therefore not needed for diagnosis but usually done b/c it can be used to generate local resistance profiles)
    a. good specimen if >25 PMNs aka infection and + macrophages and <10 surface epithelial cells aka not "spit" but distal airway per low-power field (x100)
    b. remember GS does not pick up atypicals
    c. consider acid-fast stain for TB and silver stain for fungi
(5) Blood Culture (consider) b/f antibiotics (+ in only 15% of pts much higher in pneumococcal PNA)
(6) Legionella Urine Antigen, Chlamydia acute and convalescent serology, Mycoplasma acute and convalescent serology, Influenza (consider)
(7) Serology Ig are rarely done
(8) Bronch w/ BAL
(9) CBC
(10) ABG
(11) Pneumovax/Influenza Vaccine, smoking cessation
(12) f/u w/ PCP in 6wks for CXR to see if there is any other underlying cause for the development of PNA like a mass and to rule out complications like empyema and to make sure changes have resolved (there should be no abnormalities on CXR after 6wks)

Types: (1) lobar, (2) bronchial, (3) interstitial, (4) military
Complications: (1) necrotizing, (2) abscess, (3) vascular invasion w/ infarction, (4) cavitation, (5) parapneumonic effusion or empyema

Patient Outcome Research Team (PORT) NEJM 1997:336:4:222
NB two new scoring systems have been developed: CURB-65 and PSI

- stratification of pts who present into the ER with pneumonia
    (1) Age
        i. nursing home = 10 pts
        ii. male = age pts, female = age-10 pts
    (2) Comorbidities
        i. cancer = 30 pts
        ii. liver dz = 20 pts
        iii. CHF = 10 pts
        iv. cerebrovascular dz = 10 pts
        v. renal dz = 10 pts
    (3) PEx
        i. AMS= 20 pts
        ii. RR >30 = 20 pts
        iii. SBP <90 = 20 pts
        iv. T <95/35 or >104/40 = 15 pts
        v. HR >125 = 10 pts
    (4) Lab/CXR Findings
        i. academia = 30 pts
        ii. BUN >30 = 20 pts
        iii. Na <130 = 20 pts
        iv. Glucose >250 = 10 pts
        v. Hct <30% = 10 pts
        vi. PaO2 <60 or O2Sat <90 = 10 pts
        vii. pleural effusion = 10 pts

Class	Point Total	Mortality	In vs. Out Pt
I	<51	0.3%	Out
II	51-70	0.6%	Out
III	71-90	0.9%	Out/In
IV	91-130	9.5%	In
V	>131	26.7%	In

NB other indications for in-pt management: empyema and severe lobar involvement
NB esophageal atresia w/ or w/o tracheoesophageal fistula resulting in chemical pneumonitis or aspiration pneumonia, also consider if excessive salivation, associated w/ VVACTERRL Syndrome (Vertebra/Vascular problems, Anorectal problems, Cardiac problems, TE fistula, Esophageal atresia, Radial-limb/Renal problems, Lumbar/Limb problems)

Empiric Antibiotic Therapy
(NB switch to po ASAP and, remember, you can continue treatment outpt)

(1) **Atypicals: macrolides (1° azithromycin 2° clarithromycin) OR respiratory quinolones (levo is most studied but not as effective as gati/moxi/gemi)**
(2) **Typicals: 3rd cephs (1° ceftriaxone 2° cefotaxime) OR respiratory quinolones (above)**
    a. Community Acquired Out-Pt or Mild In-Pt
        i. likely atypical but you still want to cover for the typicals: (3rd ceph + macrolide) or (respiratory quinolone)

b. Community Acquired Severe In-Pt or ICU
    i. likely typical but you still want to cover for the atypcials but since quinolones cannot be given alone as monotherapy for severe typical CAP but it can be used for monotherapy for atypical CAP the choice of abx is slightly different than above: (3rd ceph + macrolide) or (3rd ceph + respiratory quinolone)
c. Nosocomial Acquired (70% are GN enterobacteriaceae and 25% are GP like S.aureus) or Psuedomonal Risk (structural lung disease)
    i. HCAP (>2d w/in last 90d in NH, chemo, HD, etc), HAP (>48hr of in pt), VAP (>48hrs of intubation)
    ii. Likely weird MDR bacteria
    iii. abx w/in past 3mo, hospitalized for ≥2d, hospitalization for ≥5d during the past 3mo, home infusion therapy, chronic dialysis within the past mo, home wound care, family member w/ MDR bug, immunosuppressive disease/therapy, nursing home)
    iv. NB to prevent Ventilator Acquired Pneumonia (VAP) apply methylcellulose paste (2% polymixin, 2% tobramycin, 2% amphotericin B) to mouth QID
        1. (piperacillin/tazobactam or cefepime or meropenem) + (quinolone or gentamycin+macrolide)
d. MRSA Risk
    i. based on hx or risk factors add vancomycin or linezolid
e. Anaerobes Risk
    i. based on hx or risk factors specifically aspiration add clindamycin

0-5 years old	**5-50 years old**	**50+ years old**
60% Viruses	70% Mycoplasma/Chlamydia	85% Typical Bacteria
30% Mycoplasma/Chlamydia	20% Typical Bacteria	10% Mycoplasma/Chlamydia
15% Typical Bacteria	10% Viruses	5% Viruses

If pneumonia does not resolve in 2 days consider unusual pathogens (MDRB, rare bacteria, TB, fungi), sequestered infections (emyema or abscess), immunodeficient, or non-infectious problem (bronchoalveolar cell carcinoma, diffuse histiocytic lymphoma, pulmonary infarction, BOOP, vasculitis, drug toxicity like amio, methotrexate, bleomycin, nitro, etc, diffuse alveolar hemorrhage)

- MDRB
- TB
- Fungi
- Nocardia/Actinomyces
- Zoonosis

To make a dx of pneumonia you need findings (not + sputum or Gram Stain) w/ correlating image finding (some CXRs are normal therefore definitive diagnosis is CT) "dry" pts might not have infiltrates but when you give fluids they can fluff up and appear

~20% are polymicrobial

- Lung Cavities b/c of necrotizing process
    - Infection: Staph, GN, TB, Fungal, Anaerobe, Nocardia
    - Non-Infection: cancer, infarct, rheumatologic

Community Acquired Pneumonia (CAP) – Acute Typical (aka alveolar pneumonia of which there are 2 types)
Half of normal people aspirate a small amount of oropharyngeal secretions during sleep, most of the bugs that cause CAP are normal inhabitants of the oropharynx

CXR/Pathology:
(1) *Lobar Pneumonia*: unilateral consolidation of alveoli diffusely across entire lobe w/ air bronchogram (adult pt)
Four Stages
Congestion (heavy, boggy aka "soaked", red lung) bacteria in alveoli, engorged capillary
Red Hepatization (heavy, firm, airless, very red lung) "looks like liver" bacteria, RBC, neutrophils, fibrin in alveoli
Grey Hepatization (heavy, dry, grey lung) fibrin in alveoli
Resolution (normal lung) exudate is enzymatically digested producing debris that is resorbed or ingested by macrophages
Concurrently a pleural fibrinous reaction can occur because of the inflammatory reaction below it. It can resolve or more often can reorganize leaving behind fibrous thickening or permanent adhesions.
(2) *Bronchopneumonia*: preexisting bronchitis with subsequent bilateral consolidation of alveoli around airways in a patchy pattern along the base of many lobes (young and elderly pt)
No Stages just dry, grey-yellow-red, granulated

Symptoms: (*abrupt onset*, *very sick*, *lasts <48hours*, and *other family members are NOT sick*)
- Typical PNA is a pulmonary infection w/ S/S confined to the lungs vs Atypical PNA is a systemic infection that has a pulmonary component

Classic Picture: chills ® F, pleuritic pain, productive cough
(1) High F
(2) constitutional signs: chills (considered a classic symptom but does not usually occur)
(3) pleuritic chest pain if effusion
(4) dyspnea
(5) cough productive with mucopurulent sputum (can become hemoptytic if lobar pneumonia)
(6) tachypnea/tachycardia

Signs:
(7) occasional if empyema then plueritic chest pain and pleural rub leading to splinting
(8) increased fremitus, dullness to percussion, rales, egophony, whispered pectoriloquy, decreased BS
(9) cultures of sputum are not helpful b/c usually contaminated by nasopharyngeal organisms which are the usual source of bacteria that cause pneumonia
(10) WBC >15 (neutrophilic infiltrate)
(11) CXR: usually not as bad pt's appearance and no lymphadenopathy
(12) even though symptoms improve within 48 hours CXR does not improve for another 3wks if healthy or 4mo if unhealthy

Complications:
(13) pulmonary parenchyma destruction, necrosis, and **abscess** formation (air-fluid level)
(14) 50% of patients get parapneumonic effusions (if >1cm on decubitus then should be aspirated) but only a 1% get **empyemas**
(15) organization of the exudates in the alveoli into **solid tissue**
(16) **bacteremia** which can lead to **pericarditis, endocarditis, meningitis**, **arthritis/peritonitis** which can then lead to **DIC**

40% of time pathogen is not found
1º *Streptococcus pneumoniae* aka *Pneumococcal pneumoniae* 60% (very common to have prior viral URTI, smoking, HIV, DM, COPD, Alcoholism, **rust colored sputum**) (2° Bacterial >4mos, Urine Strep Ag sens 70% spec 90%
2º *Haemophilus influenza* 15% (COPD, elderly) small G- pleomorphic (very common to have prior viral URTI)
3º *Moraxella catarrhalis* (COPD) large G+ pleomorphic, in general a more mild PNA

Staphylococcus aureus including MRSA (IVDU, DM, dialysis, nosocomial, immunocompromised, post-influenza!!!) very fulminant course w/ necrotizing cavitations
GNR (nosocomial, nursing homes) very bad and fortunately uncommon
Acinetobacter/Stenotrophomonas (alcoholism)
Klebsiella pneumoniae (alcoholism, upper lobes, currant jelly sputum, sometimes cavitary lesions)
Pseudomonas aeruginosa (bronchitis, CF, pts w/ structural lung problems like brochiectasis not just CF)
E. coli (neonates)
Group B Strept *(neonates)*
Fungi

•Endemic: Histo, Coccidio, Paracoccidio, Paragonimiasis (consuming undercooked crab)
•PCP (usually non-productive cough, hypoxia out of proportion to CXR, many times the initial CXR is nl but as the disease progresses bilateral infiltrates develop, to make a dx you need to bronch)

TB

HAP: Staph aureus, Psuedomonas aeruginosa, Strept pneumonia, E. coli
•Aspirate ET/Trach Secretions aka Sputum for culture or Bronch w/ protected specimen brush (PSB) or broncho alveolar lavage (BAL)
•Thoracentesis of an effusion

Anaerobes polymicrobial oral anaerobes, foul smelling sputum (alcoholism, bad dentition)

Aspiration Pneumonia (often fatal)

Patient: debilitated because of neurologic disorder or anesthesia or unconscious because drunk (therefore w/o functioning gag reflex, cough reflex, etc.) aspirate bacteria and gastric contents resulting in initial chemical pneumonitis due to acid then infection

Symptoms, Signs, and Complications: (similar to one of the two community acquired above BUT often fatal)
- usually in right lung (RLL) (lower segments of lobes when upright vs posterior segments of lobes when recumbent)
- main complication are lung abscesses due to liquefactive necrosis resulting in cavities with evident air-fluid levels on CXR
- if abscess forms there is no need for resection/drainage they surprisingly respond well to abx

Clinical Findings: abrupt onset, low grade fever, weight loss, cough productive with copious amounts of foul smelling, purulent sputum

Mixed Anaerobic/Aerobic Oral Flora (nosocomial)

Community Acquired Pneumonia (CAP) – ATypical (aka interstitial pneumonia)

CXR/Pathology:
- NO alveolar involvement rather there is infection and inflammation of the interstitium resulting in widened alveola septa due to mononuclear infiltrate and edema (no consolidation)
- CXR can be normal or there can be uni to bilateral, patchy ("scratchy") to diffuse ("groundglass") infiltrate
- if there is alveolar damage then exudation of proteinaceous material with subsequent membrane hyalinization can occur

Symptoms: (*gradual onset*, *not that sick hence usually called "walking pneumonia"*, *lasts >48hrs*, and *other family members affected*)

Classic Picture: sore throat, headache, muscle aches, malaise ® nonproductive cough and dyspnea
- each Atypical PNA has its own characteristic pattern of extrapulmonary organ involvement

(1) Low F ("Pulse-Temp Dissociation" in which F but no change in pulse)
(2) constitutional signs: N/V, malaise, headache, muscle ache, sore throat
(3) dyspnea
(4) dry cough

Signs:
(5) no change in percussion or fremitus
(6) macrophages and lymphocytic infiltrate

Complications: (same)

Non-Zoonotic

- *Mycoplasma pneumoniae* highly infectious, highly contagious, URT complications (otitis, bullous myringitis, pharyngitis) neuro complications (HA, AMS, malaise, meningoencephalitis, GBS, etc), GI (D), heme (AIHA), MS (myalgia/arthralgia), renal complications (GN), derm (Erythema nodosum) Dx: cold agglutinins (IgM that agglutinates RBC) only found in 50% of pts therefore dx confirmed w/ serology, Tx: Macrolides/FQ
- *Chlamydophyla* spp. (NB used to be called *Chlamydia pneumoniae/psittaci* but it was found that it was entirely different than then STD) h/o contact w/ birds, *unique features (dry cough, hoarseness, lack of fever, HA, blood streaked sputum, SM, bronchospasm, mild transaminasemia, extrapulmonary symptoms like the derm/URT complications as in Mycoplasma, but overall these pts are pretty asymptomatic, obligate intracellular parasite, Dx: serology, PCR, Tx: doxy)*
- *Legionella pneumophilia* is considered a combination of typical (b/c it is severe w/ high fever, bradycardia, hypoNa, pyuria/hematuria, ARI, LFTs) and atypical (b/c it lasts a long time and non prod cough, bilateral patchy infiltrates) obligate intracellular parasite, Mechanism: Aerosolized from Man Made Water Sources (No Person-to-Person) ® Infects Alveolar MF and Lives Inside Phagosome, Legionellosis: (1) Legionnaire's Dz (severe, pneumonia, GI (ab pain and D) and CNS (HA and delirium)) or (2) Pontiac Dz (mild, flu-like illness), Legionnaires' disease acquired its name in 1976 when an outbreak of pneumonia occurred among persons attending a convention of the American Legion in Philadelphia. Later, the bacterium causing the illness was named Legionella., Season: Summer/Fall Outbreaks, RFs: immunosuppressed b/c of meds or other dz, renal failure pts, liver disease pts, smokers, alcoholism, elderly (essentially rare in healthy and young pts), Dx: Silver Stain of ?, Urine Ag (only tests for Serogroups 1/14 which is seen in 85% of cases), very hard to culture, Tx: FQ = Azithromycin, add rifampin if severe, NB historically erythromycin was used for primary Tx
- Viruses: Respiratory Syncytial Virus (RSV), Adenovirus, Parainfluenza Virus, Influenza Virus (*** tracheobronchitis ® 1º viral pneumonia ® 2º *S. aureus* ***)

Zoonotic (refer)

- Q Fever
- Tuluremia
- Severe Acute Respiratory Syndrome (SARS)
- Hanatavirus Pulmonary Syndrome (HPS)