Pneumonia, Empyema, and Lung Abscess

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- Consultant: Achaogen, Biomeriux, Merck & Co., Pfizer

This presentation was given at the 2012 Infectious Disease Live Course.

Test Categories of Lung Pneumonia Syndromes
- Must know:
  - Uncommon manifestations of common diseases
  - Common manifestations of uncommon diseases
- Probably should know
- (RARE)²: Nice to know
- Present the must know
- Homework with case presentations for Probably should know and Nice to know.

Multiple Speakers Address Etiologic Agents & Facets of Pneumonia
- Bacteria (Gilbert); (Chambers for S.aureus)
- Fungi and Misc. (Bennett)
- Respiratory viruses (Pavia)
- Parasites (Freedman)
- Rickettsia (Scheld)
- "Atypical" Pathogens (Gilbert)
- Mycobacteria (Gordin)
- Opportunistics (Alexander, Masur, Bennett)
- Congenital host defense def. (Holland)

Case Presentation
- 54 y.o. male non-smoker suddenly develops rigors, fever, and cough productive of purulent sputum in January.
- Examination and chest X-ray consistent with RLL pneumonia
- WBC elevated with left shift. Hg/Hct is 10/30. U/A shows 3+ protein. ESR is 120 mm in 45 minutes. Procalcitonin is 10 (N: <0.05 ng/ml)
- S.pneumoniae urine antigen is positive
**#1 Why did patient develop pneumococcal pneumonia?**

- Influenza tracheobronchitis and pneumonia?
- Hypogammaglobulinemia due to nephrotic syndrome?
- Undiagnosed Multiple Myeloma?
- Common variable acquired hypogammaglobulinemia?

**How does Multiple Myeloma (MM) Predispose to Pneumococcal Pneumonia?**

- Opsonizing antibody major host defense
- In MM, overproduction of immunoglobulin by neoplastic B cells
- Concomitant suppression of function of normal B-lymphocytes
- Hence, functional hypogammaglobulinemia

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**Pathogenesis and Complications**

- What are the three pathways to pneumonia? - aspiration, inhalation of droplet nuclei (e.g., M. tb), and haematogenous
- Complications of pneumonia: e.g., pulmonary (abscess/empyema) and/or extra pulmonary (bacteremia/endocarditis/meningitis/osteomyelitis, septic arthritis)
- Always ask: Is patient immunocompetent?

**Laboratory Diagnosis of Pneumococcal Pneumonia***

- Sputum (25 % +); Blood (10% +) cultures
- *S. pneumoniae*. Soluble polysaccharide antigen detection (in urine**, CSF**, bronchoalveolar lavage, pleural fluid) and positive blood cultures.
- Quantitation of DNA “load” in Nasopharynx by PCR
- *S. pneumoniae* in blood by culture & PCR
- Serum procalcitonin to separate carriage from invasive disease

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**Parapneumonic Effusion (40% of bacterial pneumonias)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Uncomplicated</th>
<th>Complicated</th>
<th>Empyema</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC</td>
<td>&lt;10,000</td>
<td>&gt;10,000</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td>LDH</td>
<td>&lt;200</td>
<td>&gt;200</td>
<td>&gt;200</td>
</tr>
<tr>
<td>Protein</td>
<td>&lt;3</td>
<td>&gt;3</td>
<td>&gt;3</td>
</tr>
<tr>
<td>Glucose</td>
<td>&lt;160</td>
<td>&gt;160</td>
<td>&gt;160</td>
</tr>
<tr>
<td>pH</td>
<td>&gt;7.4</td>
<td>&lt;7.0, +*</td>
<td>&gt;7.3</td>
</tr>
<tr>
<td>Culture</td>
<td>Negative</td>
<td>Neg./Pos.</td>
<td>Positive</td>
</tr>
<tr>
<td>Appearance</td>
<td>Serous</td>
<td>Cloudy</td>
<td>Pusulent, odoriferous</td>
</tr>
<tr>
<td>Therapy</td>
<td>Antibiotics</td>
<td>Antibiotics + tube thoracotomy</td>
<td>Antibiotics + Surgical drainage</td>
</tr>
</tbody>
</table>

*Low pH: Malignancy, tuberculosis, Rheumatoid lung, Lupus

**Empiric Therapy of Severe CABP Requiring Hospitalization**

- Always need activity vs. *S. pneumoniae*
- In smoker, also need activity vs. *M. catarrhalis* and *H. influenzae*
- Guidelines suggest: (ceftriaxone plus azithromycin) or a respiratory fluoroquinolone
- Why the azithromycin?
- Why is vancomycin plus piperacillin popular?

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The pros and cons of azithromycin

- **Pro**
  - Activity vs. "atypical" pathogens
  - Anti-inflammatory effect enhances survival in animal models
- **Con**
  - Small increase in CV deaths (47 deaths / one million recipients)
  - Roughly 20% of the *S. pneumoniae* are resistant

Why the empiric use of Vancomycin?

- Fear of CA-MRSA pneumonia
- How often is CA-MRSA the etiology of CABP?
  - Of 627 ER patients with CABP, MRSA in 2.4% overall and in 5% of patients admitted to the ICU*
  - Clinical features and epidemiology of little help
  - Increased Rel.Risk in uninsured, dialysis, cirrhosis, prior MRSA, multiple infiltrates
  - Increase in morbidity/mortality if specific treatment delayed; hence vanco or linezolid

*CID 2012;54:1126 & 1134

There are many drugs with predictable activity vs. *S. pneumoniae*. Which one of the following lists include drugs with limited to no activity vs. *S. pneumoniae* in vivo?

- Erythromycin, azithromycin, and clarithromycin
- Aztreonam, gentamicin, and daptomycin
- Clindamycin, linezolid, and telavancin
- Cefoxitin, ceftazidime, and ceftaroline

#2 Which one of the following mechanisms causes high level resistance of *S. pneumoniae* to macrolide antibiotics?

- Enzymatic alteration of the antibiotic?
- Methylation of the drug target?
- Efflux pump activation?
- Reduction in cell wall permeability?

Specific Treatment of Pneumococcal Pneumonia

- No penicillin allergy and no resistance:
  1. Penicillin G, ampicillin
  2. Ceftriaxone + azithromycin
  3. Respiratory fluoroquinolone
- Severe Pen. Allergy and resistance to Macrolides and FQs:
  - Choice of clinda, doxy, tmp/smx, Q/D, and vancomycin
  - No activity: aztreonam, gentamicin, dapto

How long to treat community-acquired bacterial pneumonia?

- Guidelines:
  - Minimum of 5 days
  - Afebrile for 2-3 days
- Emerging:
  - Treatment duration based on resolution of biomarkers
  - For example, treat until procalcitonin level has returned to less than 0.2 ng/ml
Pneumococcal Polysaccharide 23 Valent Vaccine

<table>
<thead>
<tr>
<th>Immunocompetent</th>
<th>Immunocompromised: over age 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>• All persons over age 65</td>
<td>• HIV</td>
</tr>
<tr>
<td>• Age 19-64: CHF, COPD, DM, Chronic liver disease, CSF leak, Cochlear implant, NH resident, Sickle cell disease, splenectomy</td>
<td>• Malignancy</td>
</tr>
<tr>
<td>• Smokers</td>
<td>• Nephrotic syndrome</td>
</tr>
<tr>
<td></td>
<td>• Cong./acquired immune deficiency: e.g., Common variable agammaglob., Chronic lymphocytic leukemia, Mult. Myel. CGD</td>
</tr>
<tr>
<td></td>
<td>• Transplant recipients</td>
</tr>
</tbody>
</table>

Prevents invasive pneumococcal infection

Is there a role for the protein conjugate vaccine in adults?

**PRO:**
- More immunogenic
- Induces immunologic memory

**CON:**
- Coverage is less (13 vs. 23 capsular antigens)
- Expensive

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Case Presentation

- 56 y.o. married short haul truck driver presents in July with fever, non-productive cough, dyspnea, and N/V of 48 hrs. duration
- Several episodes of non-bloody emesis and two to three episodes of watery diarrhea
- No tobacco, alcohol, illicit drugs, pets
- Febrile, tachypneic and hypoxic

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Labs:

- WBC is 11,500 with 76 polys and 6 bands
- Blood cultures no growth; sputum culture, normal flora
- *S.pneumo.* And Legionella urine antigens are negative
- Procalcitonin: 6 ng/ml (N: <0.05)
- Later in the day: WBC 15,000 with 67% polys and 21% bands; FiO2 increasing

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The “Atypical” Pneumonias

- Atypical in amount of, and character of, exudate as compared to pyogenic exudative pneumonias
- Gradual onset
- More extra-pulmonary manifestations
- WBC is often normal.
**Clinical Syndrome of Severe “Atypical” Pneumonia**
- Non-zoonotic etiologies: Mycoplasma, Chlamydia pneumoniae, Legionella
- Zoonotic: Chlamydia psittaci, F. tularensis, and C. burnetii (Q-Fever)
- Severe viral infection can mimic: e.g., adenovirus 14
- The positive test in our patient was the Legionella PCR

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**Legionella and the Lab**
- 85% of the patients infected by Legionella pneumophila, serogroup 1
- For other pathogenic Legionella need positive culture, sequential antibody titers, or PCR
**Initial Results**

Lab. results
- H/H 11.6/33.4
- WBC 8,300 with 83% polys
- Procalcitonin 0.14 (N <0.05)
- Na 134, K 3.5, Cl 101, HCO₃ 23
- Creatinine 0.7
- Alk. Phos. 217 (32-110)
- ALT/AST 40/56

Other
- CXR: Bilat., mainly left, lung infiltrates
- EKG: normal
- Urine antigens negative
- Sputum and blood cultures negative for pathogen
- Nasopharyngeal respir. Virus and Bordetella PCR panel negative

**Which one of the Etiologies of Atypical Pneumonia is Most Likely in This Patient?**

Non-Zoonotic:
1. *Mycoplasma pneumoniae*
2. *Chlamydia pneumoniae*
3. *Legionella species*

Zoonotic:
4. *Chlamydia psittaci*
5. *Francisella tularensis*
6. *Coxiella burnetii*
Diagnosis
- Within 24 hours of admission
- PCR was positive for *Mycoplasma pneumoniae*
- Subsequently antibody titers:
  - IGM 4.15 (+ equals > 0.33)
  - IgG 1.73 (+ equals > 0.96)

Mycoplasma
- Smallest free living organisms
- Usually, severe tracheobronchitis in the young and the geriatric
- Cough lasts more than 14 days
- Cough can cause post-tussive syncope, incontinence, vomiting
- Long incubation period.

Epidemiology
- In USA, one case per each 1000 persons per year or 2 million cases annually
- Incubation: 3 weeks
- Cumulative attack rate in families nearly 90%
- Highest attack rate: ages 5-20.
- Most severe in neonates and the elderly

Respiratory Infection
- Severity of the cough suggestive: post-tussive vomiting, syncope, and/or urinary incontinence
- Usually tracheobronchitis; fulminant pneumonia described
- Little sputum production and not purulent
- Pleural effusion small and rare
- Procalcitonin levels are low

Extrapulmonary Mycoplasma
- Cold agglutinin induced hemolysis: 50-75% of patients; severity varies.
- Variety of CNS syndromes: encephalitis, aseptic meningitis, transverse myelitis
- Skin: macular-papular rash to Stevens-Johnson syndrome
- Bullous myringitis (rare)

Diagnosis and Treatment of Mycoplasma
- Diagnosis: PCR on secretions from respiratory tract
- Treatment: Doxycycline, Azithro/Clarithro, or respiratory fluoroquinolone
- Why not penicillin, cephalosporin?
**Diagnosis and Treatment of Mycoplasma**
- Diagnosis: PCR on secretions from respiratory tract
- Treatment: Doxycycline, Azithro/Clarithro, or respiratory fluoroquinolone
- Why not penicillin, cephalosporin?

  **NO TARGET; no cell wall!!**

**Macrolide Resistance***
- In 67 M. pneumoniae isolates from adults in China, 46 (69%) were resistant to macrolide antibiotics
- Due to target site mutation
- Correlated with slow clinical response to therapy
- Fluoroquinolone used as alternative

  *CID 2010;51: 189

**Remember**
- Bad cough and fever, think influenza; bad cough for over 14 days, think pertussis and mycoplasma
- Mycoplasma PCR for quick diagnosis; maybe confirm with serology if unusual
- Azithromycin—but resistance can occur
- Doxycycline and fluoroquinolones should work
- Expect secondary cases in other family members

**Too much material for 30 minutes**
- Time for homework
- A dozen more clinical syndromes presented in the following reproduced slides
- These are the probably should know and nice to know pneumonia entities that may not be covered by other speakers
- Enjoy and remember-------------!!!

**The motto of Infectious Diseases**
- A day without pus is a day without sunshine.
These slides will not be presented during the Live Course and are for at-home review.

**1. Name the organism**
- S. pneumoniae is the most common cause of bacterial pneumonia in patients with influenza tracheobronchitis.
- Which one of the following is the second most common cause of pneumonia and the most frequent cause of empyema?
  - 1. S. pyogenes
  - 2. S. aureus
  - 3. S. anginosus
  - 4. S. agalactiae

**Pneumonia due to S. pyogenes**
- Often follows viral infection
- Epidemics in military recruits
- Abrupt onset, blood streaked copious thin sputum
- Patchy bronchopneumonia but up to 40% develop an empyema; S. pyogenes to pleural space very quickly
- Complications: mediastinitis, pericarditis

**2. Case Presentation**
- 50 y.o. male farmer presents with a non-productive cough, fever (40 C), and no rales.
- Chest X-Ray: diffuse bilateral infiltrates
- Labs: Normal WBC but thrombocytopenia
- Labs: ALT/AST 6X normal
- Liver biopsy: “Doughnut like” granulomas

**Which one of the following is the most likely etiologic organism?**
- Coxiella burnetii ?
- Chlamydia psittaci ?
- Mycoplasma pneumoniae ?
- Francisella tularensis ?

**Q (Query)- Fever**
- Etiology: Coxiella burnetii: intracellular bacterium
- Antigenic (phase) variation:
  - Fresh isolate=phase I=infecious form in nature; reacts with IgG antibody signifies chronic infection
  - Subculture=phase II=not infectious; reacts with IgM and IgG antibody signifies acute infection
- Reservoir: mammals, birds, arthropods
- Transmission: aerosol inhalation from parturient fluids/placenta of infected livestock; domestic cats
Q-Fever
- Acute: flu-like, pneumonia, hepatitis, endocarditis
- Chronic: > 6 months; 5% of patients; usually have endocarditis
- Diagnosis:
<table>
<thead>
<tr>
<th>IgM</th>
<th>IgG</th>
<th>Antigen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Infect</td>
<td>&lt;10</td>
<td>&gt;5000</td>
</tr>
<tr>
<td>Chronic</td>
<td>-----</td>
<td>&lt;500</td>
</tr>
</tbody>
</table>
- Treatment: Acute—Doxy; Chronic—FQ+(Rif. Or Doxy.)

3. Another Favorite Zoonotic Atypical Pneumonia
- *Francisella tularensis*: Fastidious GNB
- Infects > 100 species of vertebrates & invertebrates
- Transmission: ticks, handling infected animals, ingesting meat, aerosols, splashing/rubbing eyes
- Forms: Ulceroglandular / Glandular, Typhoidal, Pneumonic (inhalation or bacteremic), Oculoglandular, Oropharyngeal
- Treatment: Streptomycin

4. 55 y.o. male diabetic/alcoholic
- Admitted with Cough, Fever, Pleuritic pain, dyspnea, tachypnea and production of “currant jelly” appearing sputum
- Chest X-ray: Lobar consolidation of posterior bronchopulmonary segment of the RUL with bulging fissure sign.
- Sputum gram-stain: Plump encapsulated GNB; 24 hr. colonies: Sticky with positive string sign

Which one of the following is the most likely etiologic organism?
- *Klebsiella pneumoniae/oxytoca*?
- *Morganella morganii*?
- *Enterobacter aerogenes*?
- *Pseudomonas aeruginosa*?

Klebsiella pneumoniae/oxytoca
- Aerobic, lactose fermentor, GNB
- Virulence: Capsule, Mucoviscous exopoly saccharide (38% of isolates), LPS
- Susceptible Hosts: alcoholics, DM, Malignancy, COPD
- Complications: Lung abscess, Empyema, Liver abscess, Bacteremia, Death
- Watch out for ESBLases and KPCs

5. Three subtypes of Pneumonia due to Pseudomonas aeruginosa*
- 1. Upper airway colonization, aspiration=CAP in patients with COPD or cystic fibrosis
- 2. Colonization of endotracheal tube/tracheostomy, aspiration=VAP
- Regardless of subtype: Low incidence but high attributable mortality
*Chest 2011;139:909
**Pseudomonas aeruginosa pneumonia**
- Diagnosis:
  - Hard to separate colonization from invasive disease
  - Protected specimen brush quantitation works in absence of antibiotic therapy
  - Biomarker of invasion may help: e.g., Procalcitonin
  - Treatment: Monotherapy with aminoglycoside failed; retrospective studies: dual therapy advantageous (e.g., pip-tazo +Cipro.).

**Treatment of P. aeruginosa pneumonia**
- Increasing resistance (33–40% of isolates):
<table>
<thead>
<tr>
<th>Mechanism of Resistance</th>
<th>Substrate Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-lactamases</td>
<td>Penicillins, cephalosporins, monobactam, carbapenems</td>
</tr>
<tr>
<td>Adenylases, Acetylases</td>
<td>Aminoglycosides</td>
</tr>
<tr>
<td>Efflux pumps</td>
<td>FQs, Beta-Lactams</td>
</tr>
<tr>
<td>Target mutations</td>
<td>FQs</td>
</tr>
<tr>
<td>Decreased cell wall permeability</td>
<td>Carbapenems, AGs, FQs</td>
</tr>
</tbody>
</table>
- Often start with two drugs to increase chance that one is active to avoid increased mortality

**Optimization of treatment of P. aeruginosa**
- Aminoglycosides: Once daily therapy
- Beta-lactams: Continuous infusion or protracted infusion
- Ciprofloxacin: 400 mg q8h, not usual q 12 h
- Polymyxin E (Colistin): loading dose and then BID
- Do not combine two beta-lactams

**6. Weeks to months of cough, low grade fever, night sweats, wt. loss, anemia, and maybe pleuritic pain.**
- Periodontal Disease
  - 10^9 Bacteria/ml in gingival crevice
  - Excessive alcohol; other sedatives
- Aspiration
  - Pneumonia that progresses to: Abscess and/or Empyema

**Haematogenous Lung Abscess**
- Pharyngitis Tonsillitis: 
  - *Fusobacterium necrophorum*
- Suppurative phlebitis of jugular vein
- Haematogenous lung abscesses

**Name three examples of haematogenous lung abscesses?**
- *Staphylococcus aureus*
- *Fusobacterium necrophorum*
- *Klebsiella oxytoca*
**Lung Abscess Bacteriology**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Aerobic bacteria only</th>
<th>Anaerobic bacteria only</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td><strong>Aerobes:</strong> S. aureus, P. aeruginosa, K. pneumoniae, S. pneumo(rare), S. anginosus group.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td><strong>Anaerobes:</strong> Peptostreptococcus, Prevotella, Bacteroides species, Fusobacterium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>*Immunocompromised host, add: Rhodococcus, Nocardia, Fungi, Mycobacteria</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Be aware: patient with clinical features of putrid lung abscess and:**
- Positive sputum culture for *S. aureus*, or *P. aeruginosa*
- Pathogen or colonization?
- Foul smelling sputum suggests anaerobic organism
- Treat the anaerobic pathogens even though often no culture guidance

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**Treatment of Putrid Anaerobic Lung Abscess Due to Aspiration**
- 40-60% of anaerobic pathogens produce penicillinases
- Clindamycin drug of choice
- Alternative: Piperacillin-tazobactam
- Metronidazole? NO!! 50% failures due to lack of activity vs. anaerobic/microaerophilic streptococci and actinomycosis. Penicillin plus metro. Probably OK

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**Reasons for failure in treatment of lung abscess**
- Occult obstruction by foreign body or tumor
- Unrecognized co-pathogen: fungus or AFB
- Unrecognized empyema (CT scan helps)
- Wrong diagnosis. Really cavitating neoplasm or vasculitis (e.g., Wegener's)

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**Hematogenous Pneumonia:
Look for the clues.**
- Multicentric foci of lung infection
- IVDU with fever: *S. aureus* (+/- endocarditis)
- Recent sore throat, suppurative jugular vein phlebitis: Fusobacterium necrophorum (Lemierre's syndrome)
- Tender abdomen, diarrhea, fever and rose spots: Salmonella species

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**7. Case Presentation: a (Rare)2 Disease**
- 73 y.o. Vietnamese male emigrated to the USA in 1976. PPD positive. INHX 9 mo.
- In Vietnam: rice farmer; In USA, retired restaurant owner; No HIV risk factors.
- Complains of fever, night sweats, weight loss and chronic cough
- X-Ray: Posterior-right apical infiltrate with central cavitation.
- Interferon-gamma release assay: negative
7. Diagnosis

- Melioidosis
- Etiology: Burkholderia (formerly Pseudomonas) pseudomallei
- Found only in the soil of SE Asia and northern Australia
- Can cause acute pneumonia or latent disease that can reactivate years later

8. Which one of the following lung diseases predisposes to infection with the organism shown in the next slide? What is the organism.

- Chronic obstructive pulmonary disease?
- Hyper-immunoglobulin E (Job’s syndrome)?
- Pulmonary alveolar proteinosis?
- Interstitial pneumonia with thrombocytopenia due to Hantavirus?

Case Presentation: the underlying disease predicts the pathogen.

Modified acid-fast stain of aerobic organism

8. Diagnosis:

- Pulmonary alveolar proteinosis with secondary infection by Nocardia asteroides.

9. Case Presentation. Extra Credit

- 45 y.o. female has had 4 episodes of “pneumonia” in the last year.
- A recent high resolution chest CT scan shows both bronchiectasis and bilateral lower lobe bullae
- She smoked during college and a few years thereafter
- No diarrhea or weight loss
- Physical examination unremarkable
9. **ANSWER**
- Recurrent pneumonia in patient with congenital alpha-1-antitrypsin deficiency
- Other tests were for hypogammaglobulinemia, cystic fibrosis, Job's syndrome, and Chronic granulomatous disease

10. **Eosinophilia and Pneumonia**
- Etiology of pulmonary infiltrates and eosinophilia?
- Answer: Migrating round worms, paragonimiasis, coccidioidomycosis, M.tuberculosis, Hodgkin's, asthma, hypereosinophilia syndrome

11. **Dental trauma and chronic pneumonia**
- 20 y.o. man has a one month history of a tender mass in lower left chest wall
- Chest CT scan demonstrates inflammatory process that extends from the lung through the chest wall
- 6 weeks earlier the patient was in a bar room fight and suffered several broken and dislodged teeth

**Which one of the following tests is most likely to establish a diagnosis?**
- Serum level of alpha1-antitrypsin?
- Sweat chloride?
- Quantitative serum IgG, IgM, IgA?
- Quantitative serum IgE?
- PMN dihydrorhodamine 123 oxidation test
11. ANSWER
- Empyema necessitatis due to Actinomyces israelii

12. Name three etiologies of pneumonia detected by urine antigen tests
- Streptococcus pneumoniae
- Legionella pneumophila, serogroup 1
- Histoplasma capsulatum

THE END

Clinical Manifestations of Legionella are Non-Specific
- Cough, chills, and fever: 80-90%
- Dyspnea: 62%
- N/V and diarrhea: 50%
- Chest pain: up to 35%
- Confusion in up to 50%
- Elevated WBC

Respiratory Infection
- Severity of the cough suggestive: post-tussive vomiting, syncope, and/or urinary incontinence
- Usually tracheobronchitis; fulminant pneumonia described
- Little sputum production and not purulent
- Pleural effusion small and rare
- Procalcitonin levels are low

Microbiology
- 50 species and more than 70 serogroups
- 17 species linked to human disease: e.g., L. bozemanii, L. dumoffii, and L. longbeachae
- Aerobic, Gram-negative, need buffered charcoal yeast extract media to grow (3-5 days)
- Only L. pneumophila, serogroup 1 detected with urinary antigen; all other species and serogroups detected by PCR.
Treatment

- Upper Tract: Usually not diagnosed and do fine with no treatment
- Pneumonia: Treatment shortens the course
- Beta-lactams don’t work; no cell wall target
- Macrolides are the most active in vitro, followed by doxycycline and fluoroquinolones

What happened?

- Progressive respiratory failure requiring intubation and mechanical ventilation
- Switched to moxifloxacin, some steroid use, and some diuretic and slowly getting better
- Literature review: as of 1995, 46 fatal cases of Mycoplasma pneumoniae pneumonia in adults