Community-acquired pneumonia

May 29, 2021 by Josh Farkas


CONTENTS

- Rapid Reference
- Diagnosis
  - 1) Does this patient have pneumonia?
  - 2) Post-diagnosis testing
- Triage: who needs ICU?
- Treatment
  - Antibiotic selection
  - Resuscitation
  - Respiratory support
  - Adjuvant therapies
  - Effusion management
- Treatment failure
- Duration of treatment
- Podcast
- Questions & discussion
- Pitfalls
- Supplemental media
- PDF of this chapter (or create customized PDF)

rapid reference

back to contents/summary

main checklist:
Severe Community Acquired Pneumonia

Diagnostic Tests
- Blood cultures x2 (don’t repeat if done at another hospital).
- Sputum gram stain & culture if possible (especially if intubated).
- Urine legionella & pneumococcal antigens.
- Nares PCR for MRSA.
- Nasopharyngeal PCR: COVID, relevant viruses (e.g., influenza).
- Procalcitonin.
- Ultrasound, if needed to exclude effusion.
- CT scan if diagnostic uncertainty (e.g., vs PE) or substantial immunocompromise.
- Epidemiologic review (travel/animal exposures?).

Atypical coverage
- Usually azithromycin 500 mg IV daily x3 days. This is safe regardless of QTc and can be used in nearly all patients.
- Animal exposure: Doxycycline 100 PO/IV BID.

Beta-lactam backbone
- Usually ceftriaxone, 1-2 grams daily.
- Consider cefepime or piperacillin-tazobactam if risk for pseudomonas:
  - Septic shock.
  - Structural lung disease (severe COPD, bronchiectasis, cystic fibrosis).
  - Broad-spectrum antibiotics for >7d in last month.
  - Hospitalization for >1 day in last three months.
  - Immuno-compromised (e.g., chemotherapy, chronic steroid >10 mg/d).
  - Nursing home resident with poor functional status.

Consider MRSA coverage
- Figure below indicates if MRSA coverage is required. If so:
  - Linezolid may be preferred (600 mg IV/PO q12 hours).
  - Vancomycin also acceptable.

Adjunctive therapies
- High-flow nasal cannula if significant dyspnea.
- Steroid if no contraindication (e.g., 6 mg/day dexamethasone, 50 mg/day prednisone, or 40 mg/day methylprednisolone).
- Avoid large-volume fluid resuscitation.

is MRSA coverage needed for CAP?

- Shorr score 6-10.*
- Cavitary pneumonia.
- Post-influenza pneumonia.
- IV drug use.
- Skin pustules suggestive of MRSA.
- Known prior colonization with MRSA.

Cover for MRSA & re-evaluate within <24 hours:

Are either one of the following present?
- Nares MRSA PCR is negative.
- Procalcitonin is negative (<0.5 ug/mL).

Continue MRSA therapy.
Re-evaluate 48-72 hours after admission:

Is there any solid evidence that the patient has MRSA?
- Positive MRSA PCR.
- Positive MRSA culture.

Complete treatment course for MRSA pneumonia

*Shorr score (6-10 = high risk; 2-5 = intermediate risk)
diagnosing pneumonia can be tricky!

- Diagnosis is generally based on three lines of evidence:
  - **Imaging** evidence of a chest infiltrate (e.g., CXR, CT, ultrasound)
  - **Inflammation** (e.g., fever/hypothermia, rigors, night sweats, leukocytosis, left-shift, procalcitonin)
  - **Pulmonary symptoms** (e.g., dyspnea, cough, sputum production, pleuritic chest pain) and signs (tachypnea, hypoxemia).

- Elderly patients may present with non-pulmonary complaints (e.g. falling, delirium, sepsis).

- When in doubt, it is reasonable to get cultures and start antibiotics for pneumonia. Within the next 24-48 hours, the diagnosis may be re-considered and antibiotics discontinued as appropriate.

- More common pneumonia mimics are listed below. These can be devilishly hard to find, because you’re searching for a needle in a haystack.

---

### more common & convincing pneumonia mimics

<table>
<thead>
<tr>
<th>Disease</th>
<th>Clues</th>
<th>Diagnostic tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspiration pneumonia</td>
<td>History of aspiration or swallowing problem</td>
<td>May be impossible to diagnose up front.</td>
</tr>
<tr>
<td></td>
<td>Non-specific symptoms of pneumonia with rapid recovery</td>
<td>CXR shows very rapidly (over 36-48 hours)</td>
</tr>
<tr>
<td></td>
<td>Infections located in dependent lung segments</td>
<td>Procalcitonin is often negative</td>
</tr>
<tr>
<td>Pulmonary edema</td>
<td>Hemoptysis (only 50% of patients have it)</td>
<td>Unilateral hemoptysis</td>
</tr>
<tr>
<td></td>
<td>Diffuse infiltrates</td>
<td>Blood cultures ESR &amp; CRP</td>
</tr>
<tr>
<td></td>
<td>Pleural effusion</td>
<td>Bronchoscopy shows chronic hemorrhage</td>
</tr>
<tr>
<td></td>
<td>May have previously diagnosed pneumonia</td>
<td>Sputum can be helpful (e.g., ANCA)</td>
</tr>
<tr>
<td>Acute respiratory distress</td>
<td>More respiratory distress might be present (but usually not)</td>
<td>Bronchoscopy shows chronic hemorrhage</td>
</tr>
<tr>
<td></td>
<td>Younger adults with severe illness, after requiring intubation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes obliterative exposure (e.g. recent onset smoking)</td>
<td></td>
</tr>
<tr>
<td>Cryptogenic organizing pneumonia</td>
<td>Otherwise gradual onset than usual PNA</td>
<td>High to diagnose (these biopsy needed)</td>
</tr>
<tr>
<td>Drug-induced pneumonia</td>
<td>Exposure to drug implicated in causing pneumonia.</td>
<td>Hard to diagnose (these biopsy needed)</td>
</tr>
<tr>
<td></td>
<td>May occur in patients with rheumatologic disorders, chemotherapy</td>
<td></td>
</tr>
<tr>
<td>Pneumocystis pneumonia (PP)</td>
<td>HIV- Non-HIV Chronic steroid use, chemotherapy/immunosuppressive drugs</td>
<td>HIV serology may exclude HIV-PP</td>
</tr>
<tr>
<td></td>
<td>Non-HIV- Chronic steroid use, chemotherapy/immunosuppressive drugs</td>
<td>Bronchoscopy with BAL and fungal stain &amp; PCR</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Otherwise indistinct than bacterial pneumonia.</td>
<td>Some organisms (e.g., mycobacteria)</td>
</tr>
<tr>
<td></td>
<td>Radiologic pattern more nodular.</td>
<td>CT scan can be suggestive</td>
</tr>
<tr>
<td></td>
<td>Can affect normal (bronchiolitis), but after-effects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Immunocompromised patients (e.g. FNA-inhibitors &amp; steroids)</td>
<td></td>
</tr>
<tr>
<td>Extrapleural fibrothorax</td>
<td>History of chronic pulmonary illitation</td>
<td>CT scan may be suggestive (honeycomb scarring)</td>
</tr>
<tr>
<td></td>
<td>Prior diagnosis of idiopathic pulmonary fibrosis</td>
<td>CT scan may be suggestive (honeycomb scarring)</td>
</tr>
<tr>
<td>Pulmonary Embolism</td>
<td>Wedge-shaped pulmonary infiltrates may reaccumulate as PNA.</td>
<td>CT angiography</td>
</tr>
<tr>
<td></td>
<td>Pulmonary embolism may be unapparent compared to symptoms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Right ventricular strain pattern on EKG/echo.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signs/symptoms of DVT (leg swelling, pain)</td>
<td></td>
</tr>
<tr>
<td>Septic Pulmonary Emboli</td>
<td>Diffuse infiltrate which need to contibute</td>
<td>CT scan shows characteristic pattern with multi-focal</td>
</tr>
</tbody>
</table>

---

does this patient have pneumonia?
avoid pneumonia over-diagnosis

- Patients often present to the hospital with septic shock plus pulmonary infiltrates on chest X-ray. Two possibilities are:
  1. Pneumonia
  2. Chest infiltrates due to atelectasis/aspiration plus occult focus of sepsis elsewhere (e.g. abdominal sepsis)

- A common error is to assume that the septic shock must be due to pneumonia, when in fact the chest infiltrates are a red herring. When in doubt, err on the side of investigating further to exclude an alternative source of sepsis.

CT scan to assist the diagnosis of pneumonia

- Some patients with pneumonia will have a negative chest X-ray with a positive CT scan (due to subtle infiltrates). However, among patients who are critically ill due to pneumonia, there really ought to be some abnormality seen on chest X-ray.
- The main use for CT scan is differentiation from pneumonia mimics. As shown in the table above, a CT scan is probably the single most versatile test to differentiate pneumonia from a mimic.
- CT scan can be helpful to detect pneumonia in patients with chronic lung disease and chronically abnormal chest X-ray.

bronchoscopy

- Occasionally useful to exclude a pneumonia mimic (e.g. diffuse alveolar hemorrhage, eosinophilic pneumonia).

post-diagnosis testing

tests to obtain after diagnosing pneumonia

- **Blood cultures**
  - Recommended for severe pneumonia, although yield is low (~10%). (29968985)
  - If patient already had blood cultures at another hospital, don't repeat them (follow up on results from the outside hospital lab).
- **Sputum for gram stain & culture**
  - Intubated patient: tracheal aspirate is very useful.
  - Non-intubated patient: expectorated sputum (low yield, but very helpful when high-quality sputum reveals single type of organism). (29968985)
- **Urine legionella antigen**
  - Sensitivity 80% and specificity of ~95%. (29968985)
  - Negative result doesn't exclude legionella, but positive result may allow focusing antibiotic therapy on legionella.
- **Urine pneumococcal antigen**
  - Sensitivity 70% and specificity 95% (may have false-positive due to pneumonia within past several weeks). (29968985, 29119848)
- **Nares PCR for MRSA**
  - MRSA nares PCR can be reliably used to guide empiric and targeted antibiotic therapy, with a negative predictive value of 96-99%. (32127438, 32101906)
- **Winter: PCR for influenza & respiratory viruses**
  - If nasopharyngeal influenza PCR is negative and high suspicion remains, a lower respiratory tract PCR may be positive. (21048054)
  - Be careful: patients may be co-infected with viral and bacterial pathogens. Just because the viral PCR is positive doesn't mean that you should stop antibacterial therapy. (29968985)
- **Procalcitonin**
  - Procalcitonin is not intended to guide the initiation of antibiotics. However, procalcitonin may support the decision to discontinue antibiotics (functioning as an antibiotic-stopping tool).
  - Procalcitonin <0.5 ng/mL argues against typical bacterial pneumonia. However, procalcitonin is often not elevated among patients with atypical infections. (32127438)
  - Procalcitonin is unreliable in immunocompromised patients (e.g. neutropenia).

- **Epidemiological history** (table below).
- **Review of radiograph** for diagnostic clues (table below)

epidemiological history

<table>
<thead>
<tr>
<th>Organism</th>
<th>Risk factors</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1N1</td>
<td>High fever, NY flu, MRSA, cholinergic reaction</td>
<td>Hospital isolation, antivirals</td>
</tr>
<tr>
<td>MRSA</td>
<td>High fever, neutropenia, sepsis, shock</td>
<td>Isolation, antibiotics, supportive care</td>
</tr>
<tr>
<td>Legionella pneumophila</td>
<td>High fever, rash, respiratory failure</td>
<td>Hospital isolation, antibiotics, supportive care</td>
</tr>
<tr>
<td>Mycoplasma pneumonia</td>
<td>Unusual respiratory symptoms, rash</td>
<td>Supportive care, antibiotics</td>
</tr>
<tr>
<td>Pneumocystis jirovecii</td>
<td>Unusual respiratory symptoms, immunodeficiency, HIV</td>
<td>Supportive care, antifungals</td>
</tr>
<tr>
<td>Reed-Sternberg cells</td>
<td>High fever, lymphadenopathy, splenomegaly</td>
<td>Supportive care, chemotherapy</td>
</tr>
<tr>
<td>SARS-CoV-2</td>
<td>Unusual respiratory symptoms, fever, cough</td>
<td>Supportive care, antivirals</td>
</tr>
<tr>
<td>Toxoplasma gondii</td>
<td>Unusual respiratory symptoms, fever, rash</td>
<td>Supportive care, antifungals</td>
</tr>
</tbody>
</table>
radiographic patterns

- Cannot be entirely relied upon. However, they can provide useful clues, so they shouldn't be ignored either.
- In general, radiographic patterns should be used primarily to broaden the differential diagnosis (not to narrow it).

ultrasonography for effusion

- If there is any doubt regarding possible effusion (e.g. basilar opacities), bedside ultrasonography should be performed to clarify this.
- Ultrasonography should be repeated daily to watch for the development of an effusion or empyema over time.

CT scan & bronchoscopy

- Main indications for more advanced evaluation:
  - Immunocompromise.
  - Unusual chest imaging (e.g. chest X-ray suggestive of nodular/cavitating pneumonia).
- CT scan may increase the index of suspicion for unusual pathogens, for example:
  - Diffuse infiltrates with a ground-glass pattern may suggest pneumocystis jiroveci pneumonia.
  - Multi-focal dense nodular infiltrates may suggest a fungal pneumonia
- Bronchoscopy may be needed to exclude unusual organisms.

triage: who needs ICU?

No criteria apply perfectly for every patient. However, the IDSA/ATS criteria may provide a useful conceptual framework for borderline situations.
**classic errors in pneumonia triage**

- (1) Triage solely based on the amount of oxygen the patient requires:
  - A common myth is that if the patient can saturate adequately on nasal cannula then it’s OK for them to go to the ward. This is completely and utterly wrong.
- (2) Triage based on CURB65 and PORT scores:
  - These are validated as mortality prediction tools, they aren't designed to determine disposition.
  - Not great at sorting out who needs the ward vs. ICU.

**IDSA/ATS criteria for severe pneumonia**

- These criteria have been validated for use in ICU triage (with severe pneumonia patients meriting ICU admission). Severe pneumonia is defined by either having at least one major criteria, or at least three minor criteria. (29609222, 21865188, 19789456)

  **Major criteria (only 1 required):**
  - Respiratory distress requiring mechanical ventilation. These criteria were created prior to the common use of high-flow nasal cannula. A patient with substantial work of breathing or tachypnea (e.g., respiratory rate >30) who requires high-flow nasal cannula should be considered for ICU admission. (29119848, 18513176)
  - Septic shock.

  **Minor criteria (at least 3 required):**
  - Respiratory rate >29 breaths/min.
  - Hypotension requiring volume resuscitation.
  - PaO2/FiO2 <250 (very roughly may correspond to requiring >3 liters oxygen). (17573487)
  - Temperature <36C.
  - Confusion.
  - Multilobar infiltrates.
  - BUN >20 mg/dL (>7 mM).
  - WBC <4,000/mm3.
  - Platelets <100,000/mm3.

**antibiotic selection**

- **Atypical coverage always**
  - Usually azithromycin 500 mg daily.
  - Doxycycline if mistral exposure or coinfection with atypical organisms.

- **Beta-lactam backbone**
  - Usually ceftriaxone (safe for use anaphylactic penicillin allergy).
  - Risk for pseudomembranous colitis or piperacillin/tazobactam.
  - Septic shock.
  - Structured hand hygiene (serum COPD, bronchiectasis, cystic fibrosis).
  - Blood culture antibiotics for >7 days in post-op.
  - Prolonged sepsis follow-up for 30 days in these criteria.
  - History of chronic lung disease, chronic liver disease, chronic renal failure >1mpg/dL.
  - History of pseudomembranous colitis or piperacillin/tazobactam.
  - Don’t use doxycycline (poor gram-positive coverage).

- **MRSA coverage?**
  - Only to selected cases (algorithm below)
  - Vancomycin 1st dose 600 mg q 12hr.
  - Vancomycin the same sort of critical care. (28518370)

**don’t forget atypical coverage!**

- Should always be included in the empiric antibiotic regimen for severe pneumonia.
- Remember: Legionella causes ~10-15% of severe pneumonia. This won’t be covered by the broadest beta-lactams in the world (e.g. cefepime, piperacillin-tazobactam, meropenem)

- **Azithromycin** is an excellent choice here:
  - Solid track record in pneumonia.
  - Retrospective studies suggest mortality benefit, even in pneumococcal pneumonia sensitive to beta-lactams (possibly due to anti-inflammatory activity, or coinfection with atypical pathogens).
  - If the patient is diagnosed with pneumococcus, azithromycin should still be continued for 3-5 days. (17452932, 30118377)
  - Well-tolerated, very safe. Don’t worry about the QT interval, the concept that azithromycin causes torsade de pointes is mythological. (24893087)

- **Doxycycline** is also an excellent choice for atypical coverage, with the following advantages:
  - Covers unusual organisms acquired from animal contact (coxiella, tularemia, psittacosis, leptospirosis).
  - Doxycycline is generally active against MRSA *in vitro*, but it’s unclear whether this is effective for clinical MRSA pneumonia.
  - Fluoroquinolones are a poor choice for atypical coverage in the ICU for several reasons.

**beta-lactam backbone**
The beta-lactam backbone will cover gram-positives (especially pneumococcus) and gram negatives.

**Ceftriaxone** is an excellent choice for most patients.
  - It's controversial whether to use 1 or 2 grams IV daily. Increasing drug resistance over time may be an argument to use 2 grams. This should also be considered in obese patients.
  - Ceftriaxone is safe to use in most patients with penicillin allergy (more on this here).

**Pseudomonal beta-lactam** (piperacillin-tazobactam or ceftazidime) may be used in patients with risk factors for pseudomonas, for example:
  - Septic shock due to pneumonia.
  - Structural lung disease (e.g. bronchiectasis or advanced COPD with frequent exacerbations).
  - Broad-spectrum antibiotics for >7 days within past month.
  - Hospitalization for >1 day within past three months.
  - Immunocompromise (e.g. chemotherapy, chronic use of >10 mg prednisone daily).
  - Nursing home resident with poor functional status.

**Patients with penicillin allergy:**
  - Non-anaphylactic reaction to penicillin: may use ceftriaxone or cefepime.
  - Anaphylaxis or angioedema from penicillin: may use meropenem.

**MRSA coverage is occasionally needed as 3rd drug**

- MRSA is an uncommon cause of community-acquired pneumonia, with rates of ~1-3% (32101906, 32805298). This varies depending on geography and patient population, but overall most patients with community acquired pneumonia do not need MRSA coverage.
- Risk factors for MRSA are different from risk factors for drug-resistant gram negative organisms. Thus, a one-size-fits-all approach towards all drug-resistant organisms is suboptimal. A tailored strategy to guide the use of MRSA coverage is shown above (more detail here).
- Regardless of the exact approach used, the key is ongoing and thoughtful evaluation of data.
  - Staph generates lots of purulent sputum and is generally not difficult to isolate.
  - MRSA PCR has an excellent negative predictive value, so a negative PCR can often allow for discontinuation of MRSA coverage (32127438, 32101906).
  - MRSA coverage should be stopped within <48-72 hours unless there is some objective data that the patient has MRSA.
• Choice of agent:
  • **Linezolid** is arguably first-line therapy for MRSA pneumonia (compared to vancomycin, linezolid has superior lung penetration, causes no nephrotoxicity, and suppresses bacterial toxin synthesis). (26859379, 22247123)
  • **Vancomycin** is the traditional option if linezolid is contraindicated. Unfortunately, resistance to vancomycin is increasing over time. If susceptibility testing shows borderline sensitivity to vancomycin (MIC 1.5-2 mcg/mL) this may increase the risk of treatment failure and an alternative agent might be better. If the MIC is >2 mcg/mL then a different antibiotic should definitely be used.
  • **Ceftaroline** is a fifth-generation cephalosporin active against MRSA. It might be superior to vancomycin (particularly for strains with MIC>1 mcg/mL), but there is no high-quality evidence available. (28702467, 29147471)
  • Daptomycin isn’t an option here because it is degraded by surfactant and thus cannot treat pneumonia.

**double-coverage for pseudomonas is not needed**

• Unless you’re living in a post-apocalyptic hellscape where pseudomonas are insanely resistant to beta-lactams, this shouldn’t be necessary. Double-coverage doesn’t even appear to benefit patients with *ventilator-associated pneumonia* (which involves a much greater risk of resistant pseudomonas). More on this here.

**anaerobic coverage is not needed for pneumonia**

• Sometimes there is concern that the patient may have aspirated, so they should be covered for anaerobes.
• The lung is the best oxygenated organ in the body, so it is not very susceptible to anaerobic infection. The only way anaerobic infection can occur is if there is an *anatomic disruption* that creates a poorly oxygenated compartment (abscess or fluid collection).
  • Arrow Anaerobic coverage is indicated only for empyema or lung abscess.

**resuscitation**

[back to contents](#top)

**avoid large-volume fluid resuscitation**

• Large volume fluid resuscitation may worsen hypoxemic respiratory failure and thereby precipitate the need for intubation.
• Most patients with pneumonia can be stabilized adequately with small-moderate volumes of fluid combined with vasopressors if needed.
  • Consider early institution of vasopressors. In many cases, a low-dose vasopressor (e.g. norepinephrine 5-10 mcg/min) may substantially reduce the amount of fluid which is needed to stabilize the patient.
• Fluid should be used only if the following conditions are met:
  • Organ hypoperfusion (e.g. poor urine output) or refractory hypotension PLUS
  • History and evaluation indicates *true volume depletion* (as opposed to hypotension which is merely due to vasodilation). Please note that a reduced central venous pressure or collapsed inferior vena cava doesn’t necessarily indicate volume depletion, these findings can also be caused by systemic vasodilation.
  • Lactate elevation is not a sign of organ malperfusion, nor is it an indication for fluid.

**respiratory support**

[back to contents](#top)

**high-flow nasal cannula (HFNC)**

• The FLORALI trial suggested improved mortality among patients with severe hypoxemia treated with HFNC.
• HFNC should be considered in patients with significant work of breathing and/or tachypnea. The goal of HFNC is to reduce the work of breathing, and thereby prevent patients from tiring out. In order for this to work, HFNC must be started *before* the patient is exhausted and in extremis.
• Advantages of HFNC:
  • Oxygenation support
  • Ventilation support due to dead-space washout
  • Humidification may promote secretion clearance
  • Doesn’t interfere with sputum clearance, coughing, or eating
  • Patients may remain on HFNC for several days if needed (often the case for severe lobar pneumonia).

**generally avoid BiPAP**

• BiPAP doesn’t allow patients to clear their secretions. Patients treated on BiPAP often do well initially, but eventually may fail due to retained secretions and mucus plugging.
• BiPAP may be used for limited periods of time to stabilize patients (e.g., for transportation).
• Occasional patients with COPD plus pneumonia may benefit from a rotating schedule of BiPAP and HFNC. Pulmonary toilet and secretion clearance may be performed while the patient is on HFNC.

**endotracheal intubation**

• Generally used as a second-line therapy after trying HFNC.
• Indications for intubation in pneumonia are usually:
  • Refractory hypoxemia
  • Progressively worsening work of breathing, respiratory exhaustion

**adjuvant therapies**

• Several RCTs show that steroid may reduce the length of stay and risk of intubation among pneumonia patients. The SCCM/ESICM guidelines currently recommend steroid for patients with severe community-acquired pneumonia. (29090327)
  • Steroid should be given to patients with severe pneumonia in the absence of contraindications.
  • Patients in whom steroid may be contraindicated:
    • Paralytic infusion (risk of myopathy)
    • Suspicition of pneumonia due to fungus, tuberculosis, or possibly influenza.
    • Immuno-compromise (HIV, chemotherapy, neutropenia)
  • There is no specific regimen of steroid. The following are all reasonable options:
    • Prednisone burst (e.g., 50 mg PO daily for 5 days) or equivalent dose of methylprednisolone (40 mg/day IV) or dexamethasone (6 mg/day).
    • Traditional stress dose steroid (50 mg hydrocortisone IV q6hr) – this may be preferred for patients in shock.

**effusion management**

• Pleural effusion and empyema are common in severe pneumonia.
• Effusion should be evaluated upon admission and every 1-2 days thereafter, using bedside ultrasonography.

**management is driven by ultrasonographic features:**

• Effusion is small & anechoic (black, without internal echoes) ==> follow with daily ultrasonography, intervene if the effusion expands.
• Effusion is large & anechoic ==> drain effusion dry with thoracentesis
• Effusion contains septations ==> place pigtail catheter, add tPA/DNAse if complete drainage doesn't occur.

**treatment failure**

• No clear definition, but clinical improvement should generally be seen within ~3 days.
• Persistent or rising procalcitonin may be an early sign of treatment failure.
• Ongoing deterioration in oxygenation and infiltrates >24 hours after antibiotics is the most concerning feature.
• Radiographic improvement takes weeks. So failure for chest x-ray to improve over a few days means nothing.
  • Indeed, if the chest x-ray clears up within 24-48 hours that might be suggestive of aspiration pneumonitis, rather than true bacterial pneumonia.

**differential diagnosis**

• Wrong initial diagnosis (e.g., heart failure, pulmonary embolism, alveolar hemorrhage, cryptogenic organizing pneumonia, eosinophilic pneumonia, – see differential diagnosis figure above).
• Noninfectious complication of hospitalization (iatrogenic volume overload, pulmonary embolism, drug fever, aspiration).
Wrong antibiotic (e.g., multi-drug resistant organism, fungal pneumonia, Q-fever, psittacosis).
- Inadequate antibiotic dose or penetration into lung tissue.
- Intra-thoracic complication of infection (abscess, empyema, pleural effusion, ARDS).
- Metastatic infection (endocarditis, meningitis, arthritis).
- Weak host.

evaluation

- Review all data carefully (especially microbiology).
- CT chest is generally performed to secure the diagnosis of pneumonia and exclude anatomic complication (e.g. abscess or empyema) or pulmonary embolism.
- Repeat cultures (blood and sputum).
- Bronchoscopy may be considered.
- If a significant pleural effusion is present, it may be drained and sampled.
- Procalcitonin is helpful occasionally to sort out infectious vs. non-infectious illness.
  - Negative procalcitonin (<0.25 ng/ml) after three days suggests the presence of a non-infectious complication, whereas persistently elevated procalcitonin suggests active infection.
  - Among patients with renal insufficiency, C-reactive protein might be used in an analogous fashion (with CRP levels <30 mg/L roughly analogous to a negative procalcitonin). (19762338)

duration of treatment

Either time or procalcitonin may be used to guide the length of treatment. When in doubt, both factors may be considered:

time-based strategy:

- 5-7 days of treatment is generally adequate
- Indications for longer treatment:
  - Bacteremic infection with Staphylococcus aureus or Pseudomonas.
  - Legionella pneumonia.
  - Metastatic infection involving other organs (e.g. meningitis).
  - Anatomic complication (e.g. necrotizing pneumonia, lung abscess).

procalcitonin-based strategy:

- The following suggest discontinuation of antibiotic:
  - Procalcitonin level <0.25 ng/ml.
  - Procalcitonin has fallen to <20% the peak value.
- May be useful to support antibiotic discontinuation in a patient who remains clinically ill for non-infectious reasons (e.g. COPD exacerbation, ARDS).
- Not applicable in following situations:
  - Immunocompromise.
  - Renal dysfunction (PCT may have sluggish kinetics).
  - Patient has other causes of elevated procalcitonin (e.g. other site of infection, burns, trauma, surgery, pancreatitis).

Pitfalls

- Failure to cover for atypical (e.g. treating with piperacillin-tazobactam monotherapy).
- Unnecessary MRSA coverage in patients at low risk for MRSA. In particular, after 2-3 days if there is no evidence that the patient has MRSA (e.g. negative nares PCR & negative sputum), then MRSA coverage should be stopped.
- Triaging patients based on their oxygen requirement, while ignoring tachypnea and work of breathing.
• Under-utilization of high-flow nasal cannula, over-utilization of BiPAP.
• Under-utilization of steroid (especially in patients who may benefit substantially, e.g. underlying asthma/COPD).
• Missing a pleural effusion which develops insidiously after admission.
• Egregiously weird antibiotic regimens for dubious penicillin allergy (ceftriaxone is fine here, more on this to come).
• Using fluoroquinolones (it's a trap).
• Giving clindamycin for anaerobic coverage.
• Double-coverage of pseudomonas.
• Dumping 30 cc/kg fluid into a sick pneumonia patient on the verge of intubation because the lactate is elevated. Please, please, please, stop this madness, I beg of you.

references


The Internet Book of Critical Care is an online textbook written by Josh Farkas (@PulmCrit), an associate professor of Pulmonary and Critical Care Medicine at the University of Vermont.