Diagnosis and management of community-acquired pneumonia in children

What you might know more about by the end of this talk:

• How does one decide which children have bacterial pneumonia?
• What antimicrobials should one usually choose for bacterial pneumonia in children in Canada?
• When should one maybe investigate further +/- choose different antimicrobials?

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Is it really pneumonia?

- Almost all children with pneumonia have fever, cough, tachypnea +/- oxygen saturations below 97%.
- However, the majority of children with these signs and symptoms do not have pneumonia. Many of those under 2 years of age have viral bronchiolitis and many older children have a viral upper respiratory tract infection precipitating an asthma attack.

Do I need to always do a CXR in children with possible pneumonia?

- Controversial:
  - American Academy of Pediatrics (AAP) says NO
  - Canadian Pediatric Society (CPS) says YES if you intend to start antibiotics (unless it is not practical to get a CXR)
I decide to do what you told me. I did the CXR. Can at least the radiologists agree on who has pneumonia?

- Inter-observer variation reported to be about 80% for pediatric radiologists in Brazil (Xavier-Sousa G et al. The inter-observer variation of chest radiograph reading in acute LRTI among children. Pediatr Pulmon 2013; 48:464-9).
- We’ve all been taught that the CXR can be normal early on (which is no doubt true) so even the most skilled radiologist will miss some cases.

The Latest Stuff

- A study showed that ultrasound is about 85% sensitive and specific for consolidation with air bronchograms when performed by emergency physicians with 1 hour of training. (Shah VP. JAMA Pediatrics 2013;167:119-125.) There are a few other recent studies with similar results.
  - Advantages of ultrasound
    - no radiation
    - can find empyema earlier
    - ? more objective than CXR

Problem #2

I’ve called it pneumonia, but is it bacterial?
The main differential diagnosis is viral pneumonia.

Fungal pneumonia in the normal host:

Is it bacterial pneumonia?

MOST OF THE TIME, EVEN THE EXPERTS DON'T KNOW FOR SURE

Problems in proving that pneumonia is bacterial:

- One can usually only get sputum from adolescent males. Even then, interpretation of sputum gram stain and cultures is an inexact science.
- Blood cultures are rarely positive in bacterial pneumonia.
- If you detect parainfluenza, human metapneumovirus, or RSV in the nasopharynx, the child likely has viral pneumonia without secondary bacterial infection. If you detect influenza, it is still likely all viral but secondary bacterial pneumonia is a bit more common. If you detect rhinovirus, all that means is that the child had rhinovirus in the last few months.
- False positives seem to occur with Mycoplasma serology.

Bottom line – Diagnosis of bacterial pneumonia is fraught with error.
Clues to viral versus bacterial pneumonia

- Viral pneumonia is way more common in the first 2 years of life than after that.
- WBC and C-reactive protein (CRP) are higher with bacterial than with viral pneumonia but there is tremendous overlap. Procalcitonin levels appear to be a bit more sensitive and specific for bacterial versus viral infection in general but are not available in Alberta.
- The height of the fever is really not helpful.
- On CXR, a lobar infiltrate/pleural effusion is likely bacterial and an interstitial infiltrate is likely viral. However, many CXRs in children with pneumonia are compatible with viral or bacterial pneumonia.

Problem #3

I have decided that this is likely bacterial pneumonia. How do I decide which antibiotics to choose?

CPS guidelines are based on the following somewhat tenuous assumptions:

- Over 1 month of age, the vast majority of bacterial pneumonia in previously well children is due to Mycoplasma or pneumococcus.
- Staphylococcus aureus pneumonia is quite rare. Think of it with empyemas, pneumatoceles, and post-influenza pneumonia.
- Group A streptococcal pneumonia occurs, but is likely to be covered by all common choices of antimicrobials.
- Non-typeable Haemophilus influenzae and Moraxella catarrhalis mainly cause pneumonia in children with underlying pulmonary pathology.
We used to think that we could tell *Mycoplasma* and pneumococcal pneumonia apart:

<table>
<thead>
<tr>
<th></th>
<th>Mycoplasma (Atypical pneumonia)</th>
<th>Pneumococcus (Typical pneumonia)</th>
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</thead>
<tbody>
<tr>
<td><strong>Clinical picture</strong></td>
<td>Sub-acute onset, often with extra-pulmonary symptoms</td>
<td>Acute onset of pulmonary symptoms</td>
</tr>
<tr>
<td><strong>Fever</strong></td>
<td>Not too high</td>
<td>High</td>
</tr>
<tr>
<td><strong>WBC</strong></td>
<td>Not too high</td>
<td>High</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td>School age</td>
<td>Any age</td>
</tr>
<tr>
<td><strong>Need for ICU</strong></td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td><strong>Pleural effusion</strong></td>
<td>Never</td>
<td>Often if you look for it</td>
</tr>
<tr>
<td><strong>CXR</strong></td>
<td>Patchy bronchopneumonia</td>
<td>Lobar infiltrate</td>
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**Pneumococcal versus Mycoplasma pneumonia**

- Studies now show that there is way more overlap than we used to realize.
- However, in general, it is way more of a problem if you don’t treat pneumococcal pneumonia adequately than if you wait a few days to adequately treat *Mycoplasma*.

- Choice of antibiotics used to be simple as macrolides (clarithromycin/ azithromycin) covered both *Mycoplasma* and pneumococcus. Pneumococcal resistance rates are rising:
  - Canadian Antimicrobial Resistance Alliance (CANWARD) data 2011- clarithromycin resistance ranges from 13% in Quebec to 30% in the western provinces
  - CPS guidelines emphasize covering pneumococcus adequately as the #1 goal
    Interesting tidbit: Resistance of *Mycoplasma* to macrolides is now very common in some parts of Asia.
What antibiotics should one choose for bacterial pneumonia?

- First line – usually amoxicillin in an outpatient or ampicillin in an inpatient
- For inpatients, go to a third generation cephalosporin only if this looks like the kind of child who might yet see the inside of the PICU.

Coverage that you gain over ampicillin: MSSA, some H. influenzae, Moraxella, maybe some advantages for penicillin-resistant pneumococci.

- If pneumonia is post-influenza, amoxicillin/clavulanate PO or cefuroxime PO/IV may be better than amoxicillin/ampicillin as they offer coverage for methicillin sensitive S. aureus (MSSA).
- If the child has rapidly progressive disease or pneumatoceles on the chest x-ray, the child has features of septic shock or purpura fulminans, the child has severe pneumonia and methicillin resistant S. aureus (MRSA) accounts for more than 5% of all S. aureus in the community, or the child has severe pneumonia and is colonized with MRSA, add vancomycin to cover MRSA.
- Remember that cloxacillin is far superior to vancomycin for MSSA.

So when do I get to use a macrolide (clarithromycin/azithromycin)?

- Totally typical atypical pneumonia
- Severe disease because:
  1. Rarely, Mycoplasma or other atypicals may be the culprits and one cannot afford to gamble with severe disease.
  2. Some experts think that addition of macrolides to beta lactams is of benefit in severe pneumococcal pneumonia.
Problem #4

What if the child with suspected bacterial pneumonia does not improve on antibiotics?

The child should be a bit better in 24 hours and afebrile and way better in 48 hours.

If not:

• Repeat CXR, looking for empyema or lung abscess.
• Ultrasound is very useful if CXR suggests that there is pleural fluid.
• Arrange drainage by a surgeon or radiologist if there is a significant amount of fluid (typically very useful therapeutically and sometimes diagnostically).
• If you don’t find an empyema or abscess, one often adds a macrolide just in case it is Mycoplasma or another atypical.
• If you still don’t have an answer, consult ID (typically of minimal use, but they will make you feel better about sending the child for a bronchoscopy or for sampling of tissue).

Problem #5

When should you think rather than just following the guidelines?
When should you think rather than just following the guidelines?

The child has:

- Hospital-acquired pneumonia (enteric flora)
- Congenital or acquired immunodeficiency (*Pneumocystis*, fungi, *Nocardia*, *Legionella*, CMV, atypical *Mycobacteria* and many more)
- Chronic lung disease (enteric flora, *H. influenzae*, Moraxella, *S. aureus*)
- Aspiration (mouth flora including anaerobes)
- Radiographically proven recurrent pneumonia
- A travel history that is more exotic than your own
- Unusual zoonotic exposures
- Potential exposure to TB any time since birth
- Exposure to antibiotics in the previous 2 months

Treatment of pediatric pneumonia is not really evidence-based. Our inability to accurately make the diagnosis interferes with our ability to perform high quality studies of therapy.