



EM CASES SUMMARY

Episode 130 Emergency Management of Community Acquired Pneumonia

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Sources of the high misdiagnosis rate of CAP in the ED

Some of the reasons why we misdiagnose CAP up to 1/3 of the time in the ED include pressure to make early treatment and disposition decisions (because of time-to-antibiotic “rules” in some jurisdictions), the expectation to have a definitive diagnosis when consulting services for admission, because the classic constellation of symptoms (cough, shortness of breath and fever) is often absent, there are many pneumonia mimics (CHF and PE being the most critical to identify and treat in the ED), early **anchoring bias**, there is overlap in clinical presentation of viral URI and pneumonia, blood tests may be misleading, CXR has poor accuracy, and there is no single historical or physical exam finding that has high enough likelihood ratio to shift pretest probability significantly.

To aid diagnostic accuracy and avoid over prescribing antibiotics, force yourself to consider the diagnostic criteria for CAP: fever, respiratory symptoms and imaging evidence of an infiltrate. Pay close attention to respiratory rate and oxygen saturation – the vast majority of patients with CAP will have an elevated respiratory rate and abnormal O₂ sat,

but don't be fooled by the marathon runner – they can maintain perfectly normal vitals with their CAP.

Likelihood ratios for physical findings in CAP

The highest positive likelihood ratios of clinical findings for CAP from a 2019 meta-analysis are RR \geq 20 (3.47), fever (3.21) and HR $>$ 100 (2.79).

Normal vital signs combined with a normal pulmonary examination had a summary estimate -LR \square = 0.10 in a 2018 metaanalysis.

Normal vital signs alone have a -LR = 0.18 for CAP.

***Pitfall:** Using diagnosis of “acute bronchitis” in patients with viral respiratory illness, as it is a non-specific term that sets expectations by patients to be treated with antibiotics for a viral illness.*

Blood tests for diagnosis and prognosis of CAP are promising statistically but usually not pragmatically useful

WBC $>$ 10,400 per mm³ has +LR = 3.4, -LR = 0.52 for CAP, but normal values do not rule out pneumonia and WBC is not included in any of the prognostic decision tools. WBC in the extremes ($<$ 4, $>$ 20) may be of prognostic significance.

CRP of $>$ 200mg/L have been found to have a +LR $>$ 5, while $<$ 75mg/L have been found to have a -LR $<$ 0.2, however, most patients will have values between these extremes, in which case there is little diagnostic or prognostic utility.

Procalcitonin may be a significantly better predictor for blood culture positivity in CAP than WBC count, C-reactive protein, and other clinical parameters, may reduce antibiotic exposure, and has been used to help guide cessation of antibiotic treatment, however procalcitonin

does not appear to pragmatically change antibiotic exposure, LOS or mortality in the ED setting. Our experts recommend not ordering procalcitonin in the ED.

Hypoglycemia (blood glucose < 70 mg per dL or 3.89 mmol per L) at presentation is associated with increased 30-day mortality even after adjustment for other variables, including comorbid illness and Pneumonia Severity Index (PSI) score.

Lactate has been shown to be a better predictor of 28-day mortality, hospitalization and ICU admission than CURB-65 in ED CAP patients.

Chest x-ray indications, accuracy, false negatives and false positives for community acquired pneumonia

Indications for chest x-ray in patients with acute respiratory illness for CAP:

1. At least one abnormal vital sign (Fever, tachycardia, RR>20)
2. Two of: decreased breath sounds, crackles, absence of asthma

Common conditions that may lead to false negative chest x-ray in CAP

- Volume depletion
- Neutropenia
- Emphysema
- Early disease (first 12 hours)

Subtle chest x-ray findings that are often missed in CAP

- Silhouetting of heart border

- Small pleural effusion
- Retrocardiac infiltrate

Pitfall: *Assuming that a non-apical lung infiltrate cannot be acute pulmonary tuberculosis*

Indications for CT chest in suspected community acquired pneumonia

- Clinical course is not as expected (long duration, worsening despite appropriate CAP treatment)
- Recurrent infections
- An x-ray with atypical findings
- Neutropenic patients
- Profound immunocompromised state

While CT chest may be more accurate than chest x-ray at visualizing the upper lobes/lingula, showing interstitial edema of atypical pathogens, further characterizing necrotizing infection, multilobar disease, empyema, and pleural involvement, it is rarely indicated in the ED for suspected CAP.

POCUS performed by experienced operators is more accurate than chest x-ray for community acquired pneumonia, but is limited by the time it takes to perform

A 2014 meta-analysis concluded that, *in the hands of experienced operators*, ultrasound examination has a sensitivity and specificity as high as 94% and 96%, respectively. Ultrasound examination may offer an ideal alternative diagnostic modality in pediatric patients and critically ill patients in whom it is difficult to obtain a 2-view chest x-

ray. However, for patients who are stable enough to go to the radiology department to get a 2 view chest x-ray, the time required to complete a thorough lung POCUS exam may be a limiting factor.

Indications for blood cultures in suspected community acquired pneumonia

In a case-control study of 605 patients hospitalized with CAP, establishing an etiologic diagnosis did not influence the choice of antibiotic therapy, length of hospital stay, or mortality. Blood cultures have a low overall yield of approximately 6-9% for CAP. Antibiotic choice rarely changes from standard empiric therapy as a result of blood cultures, with broadening of antibiotics in only 0.5-1.0% of cases. Guidelines recommend limiting blood cultures in the setting of CAP to:

- Severe CAP requiring ICU admission
- Evidence of sepsis
- Cirrhosis, asplenia or neutropenia
- Cavitory lesions or empyema on chest x-ray

Indications for sputum gram stain and cultures in suspected community acquired pneumonia

Patients with CAP are able to produce a valid sputum sample only 70% of the time. The sensitivity of sputum Gram stain ranges from 15% to 69% and specificity ranges from 11% to 100%. Many elderly patients with CAP are not able to produce an adequate specimen. Consider sputum gram stain and cultures in the ED for patients with:

- Severe CAP
- Intubated patients with CAP

- History of alcohol abuse, liver disease, lung disease, leukopenia, cavitory infiltrates, asplenia, pleural effusion, and recent travel

Urine Legionella and Pneumococcus are rarely indicated in the ED

A 2009 retrospective analysis of *Legionella* CAP found 6 factors to be independent predictors:

1. Fever (OR 1.67, $p < 0.0001$)
2. Absence of sputum production (OR 3.67, $p < 0.0001$)
3. Low serum Na (OR 0.89, $p = 0.011$)
4. Elevated lactate (OR 1.003, $p = 0.007$)
5. Elevated CRP (OR 1.006, $p < 0.0001$)
6. Thrombocytopenia (OR 0.991, $p < 0.0001$)

Legionella may occur any time of year, but more illness is found in the summer and early fall.

Urine antigen testing in a 2009 meta-analysis showed a pooled sensitivity of 74% and specificity of 99% based on poor quality evidence.

In low prevalence areas, urine *Legionella* testing is not recommended in the ED by our experts as it is not cost effective.

Testing for *Pneumococcal* urine antigen in the ED is not recommended by our experts because empiric therapy will cover strep pneumococcus.

Antibiotic recommendations for community acquired pneumonia in Ontario

Consult your local biogram for recommendations in your area

- No risk factors for MRSA or pseudomonas, hemodynamically stable, non-ICU: **amoxicillin** or **doxycycline** (if penicillin allergy) or **amoxicillin-clavulanic acid** (if poor oral hygiene or non-ICU inpatient admission anticipated)
- No risk factors for MRSA or pseudomonas and are hemodynamically unstable, or have ICU admission planned, or are unable to tolerate oral antibiotics: IV **ceftriaxone**
- MRSA risk factors: add **vancomycin** or **linezolid**
- Pseudomonas risk factors: **piperacillin-tazobactam** or **miropenem**

The vast majority of pneumonias are caused by only 2 bacteria: *Streptococcus pneumoniae* and *Haemophilus influenzae*. All strep pneumoniae and most H flu are susceptible to penicillin or amoxicillin. Therefore, the first line antibiotic for CAP patients without risk factors for MRSA or pseudomonas and who are hemodynamically stable, based on a Cochrane review is **amoxicillin 1g po bid**. For patients with true penicillin allergy **doxycycline 100mg po bid** is the recommended first line antibiotic for these with CAP. It has good atypical coverage and a low risk for C. diff.

Amoxicillin-clavulanic acid (Clavulin) does not appear to confer added coverage against strep pneumo (as the mechanism for resistance is not via beta-lactamase), however it can be considered as an alternative to amoxicillin or doxycycline in patients with poor oral hygiene and for non-ICU inpatients.

There is no consensus in the literature around adding **azithromycin** for atypical coverage. A 2014 JAMA article suggests that time to clinical

stability favours the addition of azithromycin but there is no benefit for patient oriented outcomes. Likewise, the often mentioned anti-inflammatory properties of azithromycin does not confer benefit for patient oriented outcomes. In high prevalence *Legionella* regions, in patients with predictors (listed above) it is not unreasonable to prescribe azithromycin in the ED.

Fluoroquinolones should *not* be first or even second line therapy. Serious adverse reactions include:

- Tendinopathy
- Multiple drug interactions
- Partial treatment of tuberculosis leading to diagnostic delay
- Increased risk of aortic dissection

Oral antibiotics are as effective as IV antibiotics for most community acquired pneumonia

Oral antibiotics are recommended over IV antibiotics in the vast majority of ED patients with CAP or suspected CAP. There are at least 9 RCTs that show no clinical benefit for IV antibiotics over oral antibiotics for CAP. The bioavailability of almost all antibiotics commonly used for CAP are comparable whether IV or po. In addition, IV antibiotics have a higher rate of side effects, and take longer time to administer in the ED.

IV antibiotics such as Ceftriaxone are indicated in CAP patients who:

- Are hemodynamically unstable
- Have ICU admission planned
- Are unable to tolerate PO

MRSA is on the decline but should still be considered for at risk patients

Empiric therapy with vancomycin or linezolid for MRSA was recommended in 2011 IDSA guidelines for MRSA for hospitalized patients with severe community-acquired pneumonia defined by one of the following:

- A requirement for admission to the ICU
- Necrotizing or cavitary infiltrates
- Empyema

However, the prevalence of MRSA since 2011 has been declining with two 2016 studies finding a prevalence of only 0.7-3%. MRSA nasal screening is of little value considering the low prevalence of MRSA CAP and the poor positive predictive value of the test. A meta-analysis of 22 studies with 5243 patients found that nasal screening had a pooled sensitivity of 70.9%, specificity of 90.3%, positive predictive value (PPV) of 44.8%, and negative predictive value (NPV) of 96.5% for MRSA pneumonia.

Indications for extended antibiotic coverage for *Pseudomonas* in community acquired pneumonia

Consider broadening antibiotic coverage to cover *Pseudomonas* with piperacillin-tazobactam, meropenem or ciprofloxacin in the setting of:

- Structurally abnormal lungs
 - CF
 - Bronchiectasis
 - Tracheostomy
- Septic shock
- Broad spectrum antibiotics for >7 days in the last month
- Hospitalization for >1 day in last 3 months

- Immunocompromised (chemo, chronic steroids)
- Nursing home resident with poor functional status

It is unnecessary to provide antimicrobial coverage for anaerobes in patients suspected of aspiration pneumonia in the ED

Even in the setting of true aspiration pneumonia, the organisms involved are usually susceptible to beta-lactams (ceftriaxone). There is no need to add metronidazole or clindamycin.

Five-7 days duration of antibiotic treatment for uncomplicated community acquired pneumonia is sufficient

For uncomplicated CAP, 5-7 days of antibiotics is sufficient. More complex cases involving immunocompromised patients and those with structural lung disease will likely benefit from longer therapy. A metaanalysis of studies comparing treatment durations of 7 days or less with durations of 8 days or more showed no differences in outcomes and prospective studies have shown that 5 days of therapy are as effective as 10 days and 3 days are as effective as 8.

Treatment failure is defined by lack of defervescence within 4-5 days and lack of subjective patient improvement within 72hrs

Our experts define treatment failure by a lack of defervescence within 4-5 days and lack of subjective patient improvement within 72hrs. Radiographic improvement can take weeks so is unreliable.

Adjunctive steroids may be of benefit in patients with severe community acquired pneumonia

Steroids are thought to curb the inflammatory response in CAP, reduce the frequency of acute respiratory distress syndrome, and decrease the length of illness. A systematic review and metaanalysis suggested that steroids reduce the need for mechanical ventilation and rate of acute respiratory distress syndrome by 5% with an NNT=20, however there are other high quality studies not reviewed in the metaanalysis that show no benefit. The SCCM/ESICM guidelines and expert consensus seems to favour steroids being reserved for those with severe CAP and those taking steroids chronically.

Initial steroid dosing options in the ED include:

- Dexamethasone 10mg IV
- Methylprednisolone 40mg IV
- Hydrocortisone 50mg IV

Resuscitation of the patient with community acquired pneumonia and septic shock

Fluid choice and volume: Based on the SALT-ED and SMART trials, most experts agree that Ringer's Lactate is the fluid of choice in septic shock patients. While massive fluid resuscitation may worsen hypoxemia respiratory failure and precipitate need for intubation, under-resuscitation may worsen end-organ damage. Aiming for a MAP \geq 65 is a reasonable goal in addition to physical signs of end organ perfusion such as urine output and normal sensorium.

Norepinephrine indications and timing: Based on the CENSER trial it is reasonable to start peripheral norepinephrine as soon as the MAP <65 and/or there are signs of poor organ perfusion; the trial suggests that early norepinephrine in addition to fluid resuscitation results in less cardiogenic pulmonary edema, and possibly lower mortality.

The role of NIPPV in severe CAP: While NNPV theoretically prevents CAP patients from clearing secretions and mucus plugging, it may be used for limited periods of time as a bridge to intubation, and may be especially helpful in those with concurrent COPD exacerbation, where the evidence is clear for clinical benefit.

The role of High-Flow Nasal Cannula (HFNC) in severe CAP: The FLORALI trial suggested that HFNC may improve 90 day survival as well as subjective dyspnea and respiratory discomfort at 1-hr compared to non-rebreather and BiPAP in severely hypoxic CAP patients. It also showed that HFNC is non-inferior to non-rebreather facemask and BiPAP for reducing the need for intubation. HFNC is thought to reduce the work of breathing prior to respiratory exhaustion.

Pneumonia Severity Index (PSI) is the risk stratification tool of choice for community acquired pneumonia

PSI is more sensitive than **SMART-COP** and much more sensitive than **CURB-65** for determining which patients will require ICU admission, while offering equal sensitivity for mortality for CAP overall. Despite CURB-65 having a higher specificity for CAP than PSI, our experts recommend PSI as the risk stratification tool of choice.

Problems with PSI

- PSI may underestimate the severity of pneumonia in an otherwise young healthy patients
- PSA does not include psychosocial conditions or cognitive impairments that may preclude discharge from the ED
- Any patient over 50 years of age is automatically classified as risk class 2 which may exaggerate their risk

Note that all CAP risk stratification tools rely on blood work so they do not apply to those well enough to not get lab testing.

Validated IDSA/ATS criteria for ICU admission

Patients with 3 or more criteria may benefit from ICU admission:

- Respiratory rate >29 breaths/min
- Hypotension requiring volume resuscitation
- PaO₂/FiO₂ < 250 (patients requiring >3 liters oxygen)
- Temperature < 36C
- Confusion
- Multilobar infiltrates
- BUN >20 mg/dL
- WBC <4,000/mm³
- Platelets <100,000/mm³

In addition, multilobar pneumonia is an independent risk factor for increased mortality in CAP.

Discharge criteria for outpatient care in patients with community acquired pneumonia

PSI Score	Risk	Disposition
≤70	Low risk	Outpatient care
71-90	Low risk	Outpatient vs. Observa

Some experts recommend a CURB-65 score of zero as criteria for outpatient care, however CURB-65 was validated as *mortality* prediction tool, and was not designed to determine disposition. Our experts recommend the following minimal criteria for outpatient care of CAP:

- RR < 24
- O₂sat ≥ 92%
- Normal mental status
- Able to tolerate oral intake
- Psychosocial support

Oxygen saturations less than 92% are associated with major adverse events in outpatients with CAP.

Take home points for emergency management of community acquired pneumonia

- We often misdiagnose CAP. To help us be better diagnosticians think about the diagnostic criteria (fever, respiratory symptoms and imaging evidence of infiltrate) and pay close attention to respiratory rate and oxygen saturation—the vast majority of patients with CAP will have an elevated respiratory rate and abnormal O₂ sat, but don't be fooled by the marathon runner – they can maintain perfectly normal vitals with their CAP.
- Not all cough is CAP. Think about the differential so that you do not overdiagnose CAP and you do not miss other important diagnoses.
- Not all patients in the ED with cough require a chest x-ray. Indications for chest x-ray include: At least one abnormal vital sign (fever, tachycardia, RR > 20) and 2 of decreased breath sounds, crackles or absence of asthma. If you do get a chest x-ray remember that they can be normal or near normal early on

the clinical course and in severely dehydrated or immunocompromised patients. Consider the differential diagnosis when you see an infiltrate – don't just assume CAP.

- Procalcitonin has little, if any, role in the ED but may be useful for the inpatient team in predicting prognosis and duration of therapy. While WBC is usually unrevealing, extremes of WBC can help risk stratify your patients.
- For the septic CAP consider high flow nasal oxygen and/or NIPPV as a bridge to intubation; fluid resuscitation requires a delicate balance of considerations – don't just slam in a few litres of crystalloid, but at the same time be sure not to under-resuscitate. Start peripheral norepinephrine early in CAP patients with septic shock – as soon as the MAP<65.
- For antibiotic choices, consult your local biogram. In Ontario, the recommended first-line outpatient therapy for CAP is currently amoxicillin 1g po bid. The recommended first-line inpatient non-ICU therapy for CAP is now amoxicillin-clavulanate 875mg/125mg po bid or ceftriaxone 1g iv q24h. Consideration for adding azithromycin empirically should only be given during the months of June through October to cover *Legionella*, MRSA only for those at risk (the prevalence is declining) and coverage for pseudomonas only in at risk patients. Oral antibiotics are as effective as IV antibiotics for the majority of patients with CAP.
- Recommended duration of therapy for most CAP is 5-7 days. Know the exceptions.
- PSI is the risk stratification tool of choice. Low-risk patients suitable for discharge from the ED should be defined by a PSI ≤ 70 and an oxygen saturation of at least 92% on room air. Use a PSI >130 as criteria for ICU admission.

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