# Community-Acquired Pneumonia

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Clin Infect Dis 2007;44(S2):27-72

# Microbiology

***Bacterial***
**Common**
*Streptococcus pneumoniae*
*Staphylococcus aureus*
*Haemophilus influenzae*
Mixed anaerobic bacteria (aspiration)
- *Bacteroides* spp.
- *Fusobacterium* spp.
- *Peptostreptococcus* spp.
- *Peptococcus* spp.
- *Prevotella* spp.

Enterobacteriaceae
- *Escherichia coli*
- *Klebsiella pneumoniae*
- *Enterobacter* spp.
- *Serratia* spp.

*Pseudomonas aeruginosa*
*Legionella* spp. (including *L. pneumophila and L. micdadei*)
**Uncommon**
*Acinetobacter* var. *anitratus*
*Actinomyces* and *Arachnia* spp.
*Aeromonas hydrophilia*
*Bacillus* spp.
*Moraxella catarrhalis*
*Campylobacter fetus*
*Eikenella corrodens*
*Francisella tularensis*
*Neisseria meningitidis*
*Nocardia* spp.
*Pasteurella multocida*
*Proteus* spp.
*Pseudomonas pseudomallei*
*Salmonella* spp.
*Enterococcus faecalis*
*Streptococcus pyogenes*

***Fungal***
Aspergillus spp.
*Candida* spp.
*Coccidioides immitis*
*Cryptococcus neoformans*
*Histoplasma capsulatum*
Agents of mucormycosis
- *Rhizopus* spp.
- *Absidia* spp.
- *Mucor* spp.
- *Cunninghamella* spp.

**Rickettsial**
*Coxiella burnetii*
*Rickettsia rickettsiae*
**Mycoplasma and Chlamydia**
*Mycoplasma pneumoniae*
*Chlamydophila psittaci*
*Chlamydia trachomatis*
*Chlamydophila pneumoniae* (TWAR)
**Mycobacterial**
*Mycobacterium tuberculosis*
Nontuberculous mycobacteria
**Parasitic**
*Ascaris lumbricoides*
*Pneumocystis carinii*
*Strongyloides stercoralis*
*Toxoplasma gondii*
*Paragonimus westermani*

***Viral***
**CHILDREN**
**Common**
Respiratory syncytial virus
Parainfluenza virus types 1, 2, 3
Influenza A virus
**Uncommon**
Adenovirus types 1, 2, 3, 5
Influenza B virus
Rhinovirus
Coxsackievirus
Echovirus
Measles virus
Hantavirus
**ADULTS**
**Common**
Influenza A virus
Influenza B virus
Adenovirus types 4 and 7 (in military recruits)
**Uncommon**
Rhinovirus
Adenovirus types 1, 2, 3, 5
Enteroviruses
- Echovirus
- Coxsackievirus
- Poliovirus

Epstein-Barr virus
Cytomegalovirus
Respiratory syncytial virus
Varicella-zoster virus
Parainfluenza virus
Measles virus
Herpes simplex virus
Hantavirus
Human herpesvirus 6
Metapneumovirus
Coronavirus (SARS)

Principles and Practice of Infectious Disease, 6th edition 2005

60M with EtOH cirrhosis presents with fevers and cough x 3 days. No sick contacts. Exam: T 102, P 120, RR 26, O2 Sat 92% RA. Right lung base with crackles and egophony. CXR demonstrates right lung base consolidation. Blood cultures reveal GPC in pairs.

What is the most likely organism responsible for this patient's condition?

A - Staphylococcus aureus

B - Streptococcus pneumoniae

C - Streptococcus pyogenes

D - Haemophilus influenzae

E - Klebsiella pneumoniae

# Acute CAP Microbiology

| Patient type | Etiology |
|---|---|
| Outpatient | *Streptococcus pneumoniae*<br>*Mycoplasma pneumoniae*<br>*Haemophilus influenzae*<br>*Chlamydophila pneumoniae*<br>Respiratory viruses[a] |
| Inpatient (non-ICU) | *S. pneumoniae*<br>*M. pneumoniae*<br>*C. pneumoniae*<br>*H. influenzae*<br>*Legionella* species<br>Aspiration<br>Respiratory viruses[a] |
| Inpatient (ICU) | *S. pneumoniae*<br>*Staphylococcus aureus*<br>*Legionella* species<br>Gram-negative bacilli<br>*H. influenzae* |

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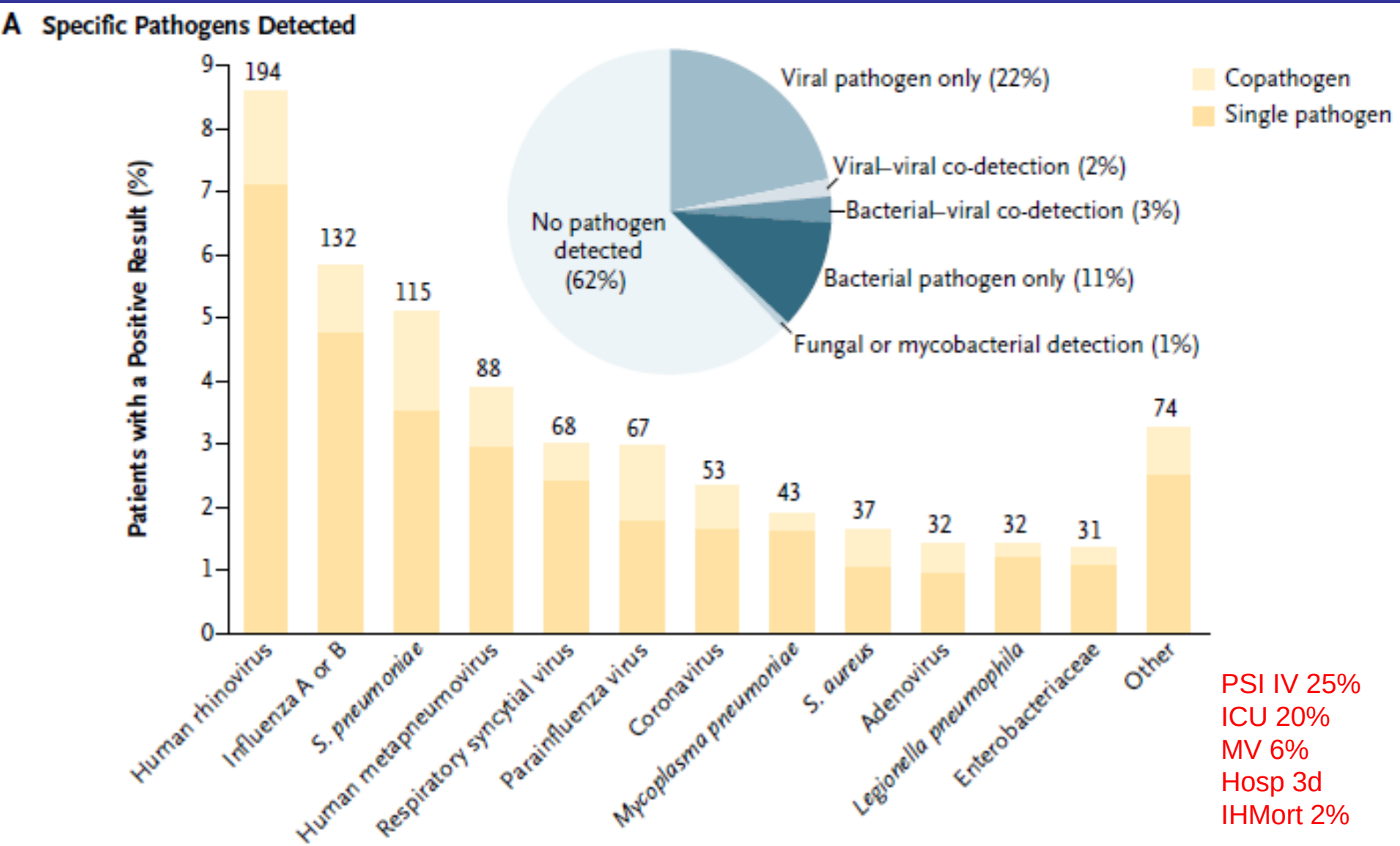



PSI IV 25%
ICU 20%
MV 6%
Hosp 3d
IHMort 2%

NEJM 2015; 373:415-27

60M with bronchiectasis presents with fevers and cough x 3 days. No sick contacts. Exam: T 102, P 120, RR 26, O2 Sat 92% RA. Right lung base with crackles and egophony. CXR demonstrates right lung base consolidation. Sputum culture GS with GNRs.

What is the most likely organism responsible for this patient's condition?

A - Staphylococcus aureus

B - Streptococcus pneumoniae

C - Haemophilus influenzae

D - Klebsiella pneumoniae

E - Pseudomonas aeruginosa

# Other Pathogens

## *Pseudomonas*

- Structural lung disease
- COPD + abxs/steroids
- Significant immunocompromise
- Pseudomonas colonization

## *MRSA*

- Post-influenza
- Necrotizing/cavitary pneumonia
- ESRD on HD, IDU
- MRSA colonization/exposure

## *Influenza*

- Pregnancy, morbid obesity, IS

## *Coccidioides*

- Subacute/chronic presentation
- Failed antibiotic therapy
- Eosinophilia
- Mediastinal LAN
- Desert Rheumatism:
  - Erythema nodosum
  - Polyarthralgias
- Disseminated Disease:
  - Skin
  - Joint/Bone
  - Meningitis
- Negative serology - acute disease

80M with HTN and DM presents to ED with fevers and non-productive cough x 3 days. + Diarrhea on day of admission. No sick contacts. Exam: T99, P120, RR24. Right lung base with crackles. CXR neg. After IVF, patient appears better and likely to be d/c'ed home.

What is the next best test (if any) to perform on this patient?

A – Blood cultures

B – Procalcitonin

C – NP swab for multiplex PCR (Myco, Chlam, viruses)

D – CT chest

E – None of the above

# Diagnosis

- Clinical symptoms + PE + **Radiographic evidence**
- Absence of any vital sign abnormality – rare
  - HR > 100, RR > 20, Temp > $37.8^0$C
- Negative CXR – rare
  - Possibly due to early presentation
  - Repeat CXR in 24-48 hours
  - Can miss retrocardiac infiltrate without PA/LAT
- CT chest
  - Not recommended for routine use
  - Can help clarify diagnosis if negative/equivocal CXR

# Diagnostic Testing

**Table 5. Clinical indications for more extensive diagnostic testing.**

| Indication | Blood culture | Sputum culture | *Legionella* UAT | Pneumococcal UAT |
|---|---|---|---|---|
| Intensive care unit admission | X | X | X | X |
| Failure of outpatient antibiotic therapy | | X | X | X |
| Cavitary infiltrates | X | X | | |
| Leukopenia | X | | | X |
| Active alcohol abuse | X | X | X | X |
| Chronic severe liver disease | X | | | X |
| Severe obstructive/structural lung disease | | X | | |
| Asplenia (anatomic or functional) | X | | | X |
| Recent travel (within past 2 weeks) | | | X | |

Blood culture:
- Yield ~10% (usually S.pneumo)
- Severe CAP
- Host defect ↑ risk for bacteremia

Sputum culture:
- Yield ~10-50%*
- *Dependent on quality of sample & lab
- Maybe useful if negative (S.aureus)

*Consider NP swab for resp virus PCR if appropriate.

80M with HTN and DM presents to ED with fevers and cough. Exam: T99, P125, BP 100/60, RR30. Oriented x1, right lung base with crackles. CXR with right lower lung consolidation. WBC 12, BUN 30, Cr 1.1, Alb 3.0. He is diagnosed with CAP.

What is this patient's CURB-65 score and where should he be treated?

A - Score = 1, treat as outpatient

B - Score = 2, treat as inpatient (Gen Med ward)

C - Score = 3, treat as inpatient (Telemetry)

D - Score = 4, treat in ICU

E - Score = 5, consult hospice

# Clinical Scoring Tools

- Identify patients at high risk of adverse outcomes
  - Inpatient versus Outpatient treatment
  - ICU versus Medical ward
  - Mortality rate
- Clinical Scoring Tools:
  - Pneumonia Severity Index
  - CURB-65 (or derivative)
  - SMART-COP
- Who cares?
  - 50% of CAP ICU admissions initially admitted to non-ICU
  - Higher mortality rate with late transfer to the ICU

# Inpatient versus Outpatient

| CHARACTERISTIC | POINTS ASSIGNED* |
|---|---|
| Demographic factor | |
| Age | |
| Men | Age (yr) |
| Women | Age (yr) − 10 |
| Nursing home resident | +10 |
| Coexisting illnesses† | |
| Neoplastic disease | +30 |
| Liver disease | +20 |
| Congestive heart failure | +10 |
| Cerebrovascular disease | +10 |
| Renal disease | +10 |
| Physical-examination findings | |
| Altered mental status‡ | +20 |
| Respiratory rate ≥30/min | +20 |
| Systolic blood pressure <90 mm Hg | +20 |
| Temperature <35°C or ≥40°C | +15 |
| Pulse ≥125/min | +10 |
| Laboratory and radiographic findings | |
| Arterial pH <7.35 | +30 |
| Blood urea nitrogen ≥30 mg/dl (11 mmol/liter) | +20 |
| Sodium <130 mmol/liter | +20 |
| Glucose ≥250 mg/dl (14 mmol/liter) | +10 |
| Hematocrit <30% | +10 |
| Partial pressure of arterial oxygen <60 mm Hg§ | +10 |
| Pleural effusion | +10 |

**Pneumonia Severity Index:**

| Risk Class | 30d Mortality |
|---|---|
| Class 1 (50yo+0) | 0.1% |
| Class 2 (≤70) | 0.6% |
| Class 3 (71-90) | 0.9% |
| Class 4 (91-130) | 9.3% |
| Class 5 (>130) | 27% |

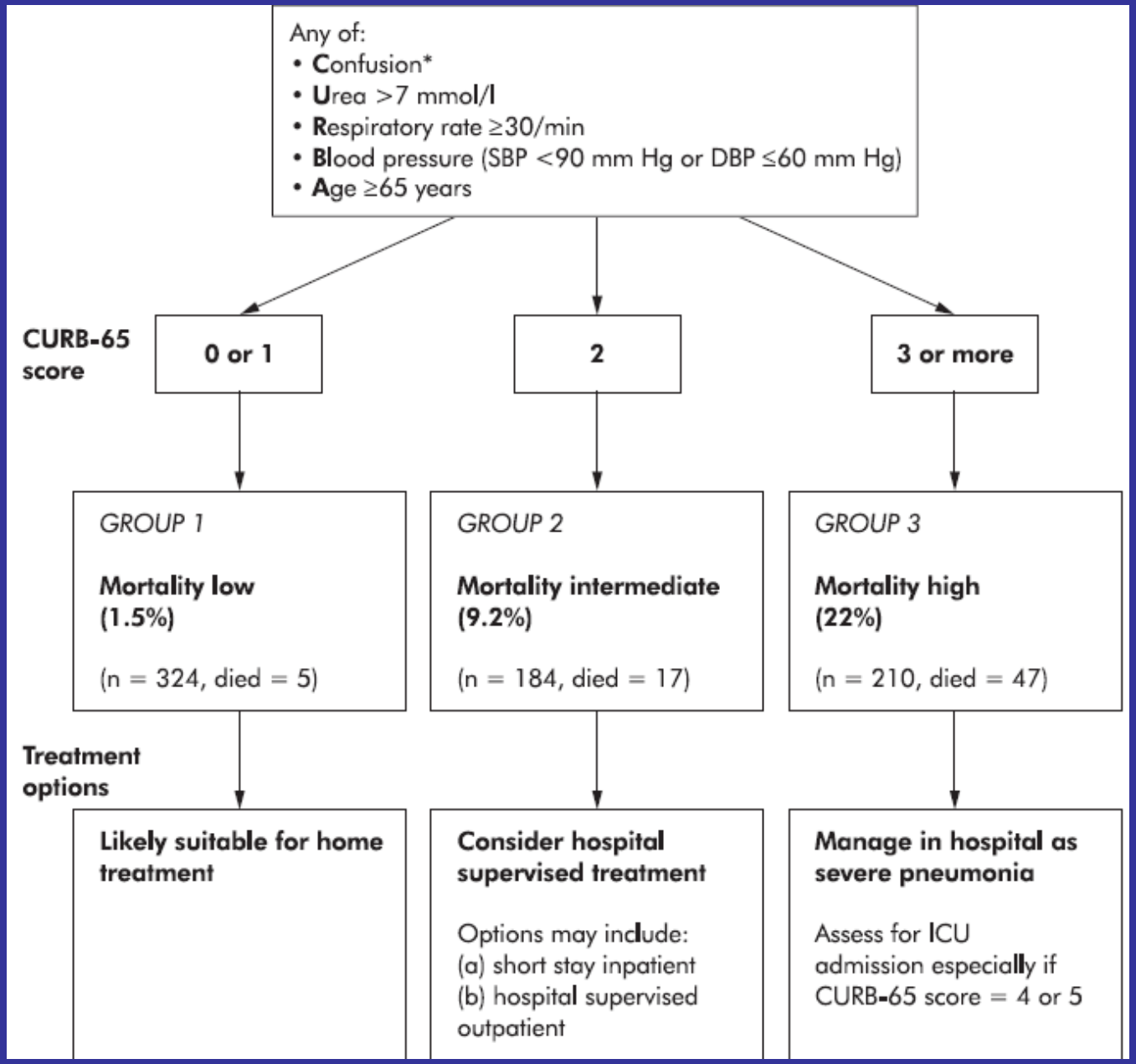
**Outpatient:** 1 & 2

**Observation:** 3

**Inpatient:** 4 & 5

http://pda.ahrq.gov/clinic/psi/psicalc.asp

NEJM 1997; 336:243-250




# CURB-65

Confusion

Oriented x3

Urea > 20mg/dL

RR ≥ 30/min

BP

SBP < 90

DBP ≤ 60

Age ≥ 65

Thorax 2003; 58:377-382

# Who Should Go to the ICU?

| | | |
|---|---|---|
| **S** | Systolic BP <90 mmHg | ☐ (2 points) |
| **M** | Multilobar CXR involvement | ☐ (1 point) |
| **A** | Albumin <3.5 g/dL* | ☐ (1 point) |
| **R** | Respiratory rate – age-adjusted cut-offs | ☐ (1 point) |

| Age | ≤50 yo | >50 yo |
|---|---|---|
| RR | ≥25 br/min | ≥30 br/min |

| | | |
|---|---|---|
| **T** | Tachycardia ≥125 bpm | ☐ (1 point) |
| **C** | Confusion (new onset) | ☐ (1 point) |
| **O** | Oxygen low – age-adjusted cut-offs | ☐ (2 points) |

| Age | ≤50 yo | >50 yo |
|---|---|---|
| $PaO_2$* | <70 mmHg | <60 mmHg |
| or: $O_2$ Saturation | ≤93% | ≤90% |
| or (if on $O_2$): $PaO_2/FiO_2$* | <333 | <250 |

| | | |
|---|---|---|
| **P** | Arterial pH <7.35* | ☐ (2 points) |

## SMART-COP

Score ≥ 3

Sensitivity 92%

ED → ICU 98%

Ward → ICU 84%

CURB-65 (≥3)

Sensitivity 38%

PSI Class 4 or 5

Sensitivity 73%

Clin Infect Dis 2008; 47(3):375-84

80M with HTN presents to ED with fevers and cough. Exam: T99, P125, BP 100/60, RR30. Oriented x1, right lung base with crackles. CXR right lower lung consolidation. Develops respiratory distress in ED and requires intubation, + aspiration event. No MDR risks.

What is the optimal antimicrobial therapy for this patient?

A - Vanco + Zosyn

B - Ceftriaxone + azithromycin

C - Clindamycin

D - Clindamycin + ceftriaxone + levofloxacin

E - Vanco + Zosyn + levofloxacin

# Treatment

## Outpatient:

***Macrolide***

***or***

***Doxycycline (level III)***

- No antibiotic within 3 months

**Resp fluoroquinolone**

- Levofloxacin **750** mg

***or***

**β-lactam + macrolide**

- Comorbidity (DM, CRI, CHF, etc)
- Abx within 3 months (avoid same class)
- High macrolide-resistant *S.pneumo*

## Inpatient:

**Resp fluoroquinolone**

***or***

**β-lactam + macrolide***

Meta-analysis - mortality benefit[1,2]

RCT BL mono - delayed clinical stability[3]

RCT BL mono - 90d mortality, non-inferior[4]

## Inpatient - ICU:

**β-lactam + macrolide**

***or***

**β-lactam + Resp FQ**


1. J Antimicrob Chemother 2014; 69:1441-46
2. Clin Infect Dis 2012; 55:371-80
3. JAMA Intern Med 2014; 174:1894-1901
4. N Engl J Med 2015; 372:1312-23

80M with HTN and DM presents to ED with fevers and cough. Exam: T99, P125, BP 100/60, RR30. Oriented x1, right lung base with crackles. CXR right lower lung consolidation. Blood cxs performed, patient started on ceftriaxone and azithromycin. Admitted to the hospital. On HD #3 – much improved, normal MS, afebrile, RR 12, ambulating, eating. Blood cxs with Strep pneumo (2 of 2), which is pan-sensitive.

What is the optimal treatment for this patient?

A – continue IV ceftriaxone and azithro x 4d (total = 7d)

B – continue IV ceftriaxone x 11d (total = 14d)

C – change to PO levofloxacin x 11d (total = 14d)

D – change to PO amoxicillin x4d (total = 7d)

E – repeat BCxs, duration dependent on results

# Duration of Therapy

- Minimum 5 days
  - Typically 5-7 days
  - Can be as short as 3 days[1]
- Afebrile 48-72 hours and clinically stable
  - Pulse ≤ 100
  - RR ≤ 24
  - Systolic BP ≥ 90
  - $O_2$ Saturation ≥ 90%
  - Normal mental status and can take PO
- Corticosteroids for severe (acute) CAP
  - Probably has a mild mortality benefit[2]
  - Avoid in immunocompromised, influenza, fungal infections

1. BMJ 2006; 332:1355-60

2. Ann Intern Med 2015; 163(7):519-28

60M with DM and ESRD on HD presents to ED with fevers and cough x3 days. Good functional status at baseline. No hospitalization or antibiotics for the past 90 d. Resides at home. Exam: T99, P100, BP 120/60, RR24. Oriented x3, right lung base with crackles. CXR right lower lung consolidation. Admitted to Med ward.

What is the optimal antimicrobial therapy for this patient?

A - Vanco + cefepime

B - Vanco + cefepime + levofloxacin

C - Cefepime + tobramycin

D - Levofloxacin

E - Vanco + ceftriaxone + levofloxacin

# HCAP → CAP-DRP

- Purpose
  - Identify patients at risk for infection with MDRO
- Definition
  - Hospitalization or antibiotics within 90 d
  - Resident in nursing home or extended care facility
  - Chronic dialysis, wound care, home infusion within 30 d
  - Close contacts with documented MDRO
  - Immunocompromised host
- Microbiology
  - MRSA, Pseudomonas, MDR GNRs
  - Routine CAP pathogens

| Microbiologic and clinical outcomes | CAP ($n = 887$) | HCAP ($n = 526$) | *P* Value |
|---|---|---|---|
| Multidrug-resistant pathogens | 45/475 (9.5) | 74/320 (23.1) | <0.001 |
| CAP drug-resistant pathogens[†, ‡] | 38/442 (8.6) | 81/304 (26.6) | <0.001 |
| Inappropriate initial antibiotic treatment[‡, §] | 69/442 (15.6) | 99/305 (32.5) | <0.001 |
| Mechanical ventilation[‖] | 87 (9.8) | 44 (8.4) | 0.366 |
| 30-d mortality[¶] | 62 (7.0) | 107 (20.3) | <0.001 |
| In-hospital mortality | 89 (10.0) | 131 (24.9) | <0.001 |

Am J Respir Crit Care Med 2013; 188: 985-95 **PSI 4/5 40/20 40/40**

CAP – DRP (Drug Resistant Pathogens)

- Organisms not covered by ceftriaxone/azithro and resp FQs
- Pseudomonas/MRSA risks
- MDRO risks: recent hospitalization, recent abx, poor function
- Risk prediction models insufficient
- Consider DRPs when multiple risks or severe illness.
  - One risk factor = 10%
  - Three risk factors = 40%

# CAP-DRP Treatment

P.aerug/MDR GNR Risk

Antipseudomonal β-lactam

- Piperacillin-tazobactam
- Cefepime
- Imipenem

***plus***

2nd antipseudomonal

(IV abx within 90 days, high risk for mortality)

- Ciprofloxacin/Levofloxacin
- Aminoglycoside

MRSA Risk

Anti-MRSA agent

- Vancomycin
- Linezolid

Atypical agent

- FQ
- Macrolide

60M with DM and ESRD on HD presents to ED with fevers and cough x3 days. No other MDRO risks. Exam: T99, P100, BP 120/60, RR24. Oriented x3, right lung base with crackles. CXR right lower lung consolidation. Admitted to Med ward and treated with Vanco + Zosyn + levofloxacin. On HD #3 he is ready for d/c - afebrile x48 hrs, normal vitals. BCxs neg.

What is the optimal management for this patient?

A – Discontinue antibiotics

B – Continue Vanco + Zosyn + levofloxacin

C – Discharge on PO linezolid and levofloxacin

D – Discharge on PO levofloxacin

E – Discharge on PO azithromycin

60M with DM and ESRD on HD presents to ED with fevers and cough x3 days. Recent admission 3 months ago for MRSA bacteremia from HD CLABSI. Exam: T39C, P120, BP 80/50, RR32. Confused, debilitated, right lung base with crackles. CXR right lower lung consolidation. Intubated in ED started on Vanco + Zosyn + levofloxacin, admit to ICU. On HD #3: fevers resolved, remains on vent. WBC 32→20. Admission blood cx neg and endotrach aspirate cxs in ICU with normal flora.

What is the optimal management for this patient?

A – Discontinue antibiotics

B – Continue Vanco + Zosyn + levofloxacin

C – Stop vanco, continue Zosyn and levofloxacin

D – Stop vanco and zosyn, continue levofloxacin

E – Switch to ceftriaxone + azithromycin

52F with DM develops fever and cough 2d prior to admission. Presents to OSH and CXR with LLL consolidation. Influenza swab neg, WBC 13. Admitted and started on ceftriaxone and azithromycin. Continued daily fevers and malaise for the next 4 days. Transferred here for further evaluation. Exam: T103 F, P130, WBC 12. LLL crackles and egophony. Reports not feeling worse but no improvement in her symptoms.

Further studies from OSH (obtained on admission):

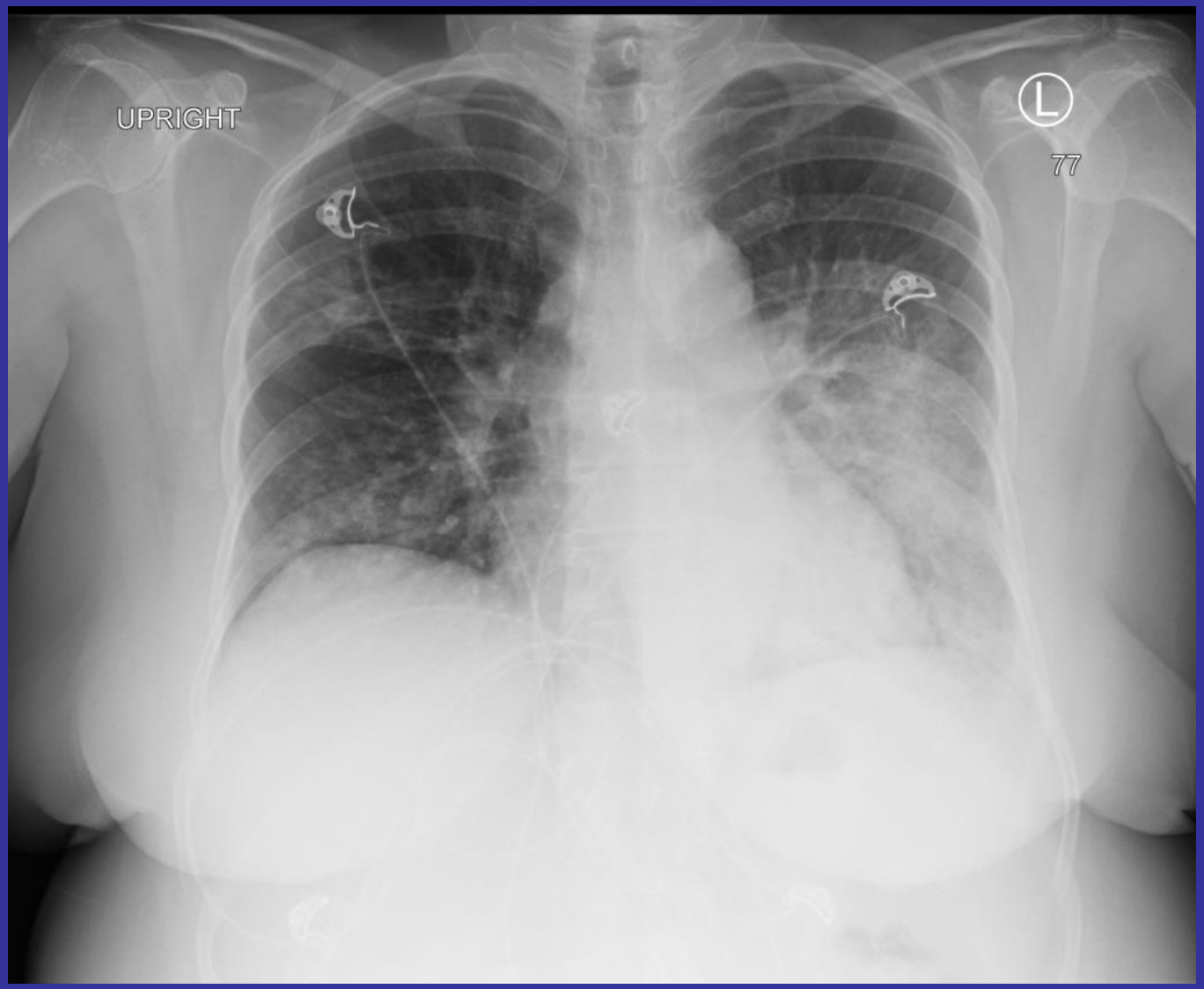
Blood cxs negative

Urine pneumococcal antigen neg

Urine legionella antigen neg

Cocci serologies neg

CXR (next slide)



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What is the next best step in management?

A – Add fluconazole
B – Bronchoscopy
C – Obtain CT chest
D – Change to vanco and Zosyn
E – Perform thoracentesis

# Non-responding Pneumonia

- Frequency 6-15%
- Definition – no clear cut definition
  - Failure to improve > 72 hours
  - Deterioration/progression – early or late
  - Persistent pulmonary infiltrates > 30d
- Differential
  - “Normal” response – severity of illness, comorbidities
  - Uncovered pathogen, resistant microorganism
  - Empyema/parapneumonic effusion
  - Nosocomial superinfection
  - Non-infectious