Pneumonia Severity Scores:
Are they Accurate Predictors of Mortality?

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Disclosure

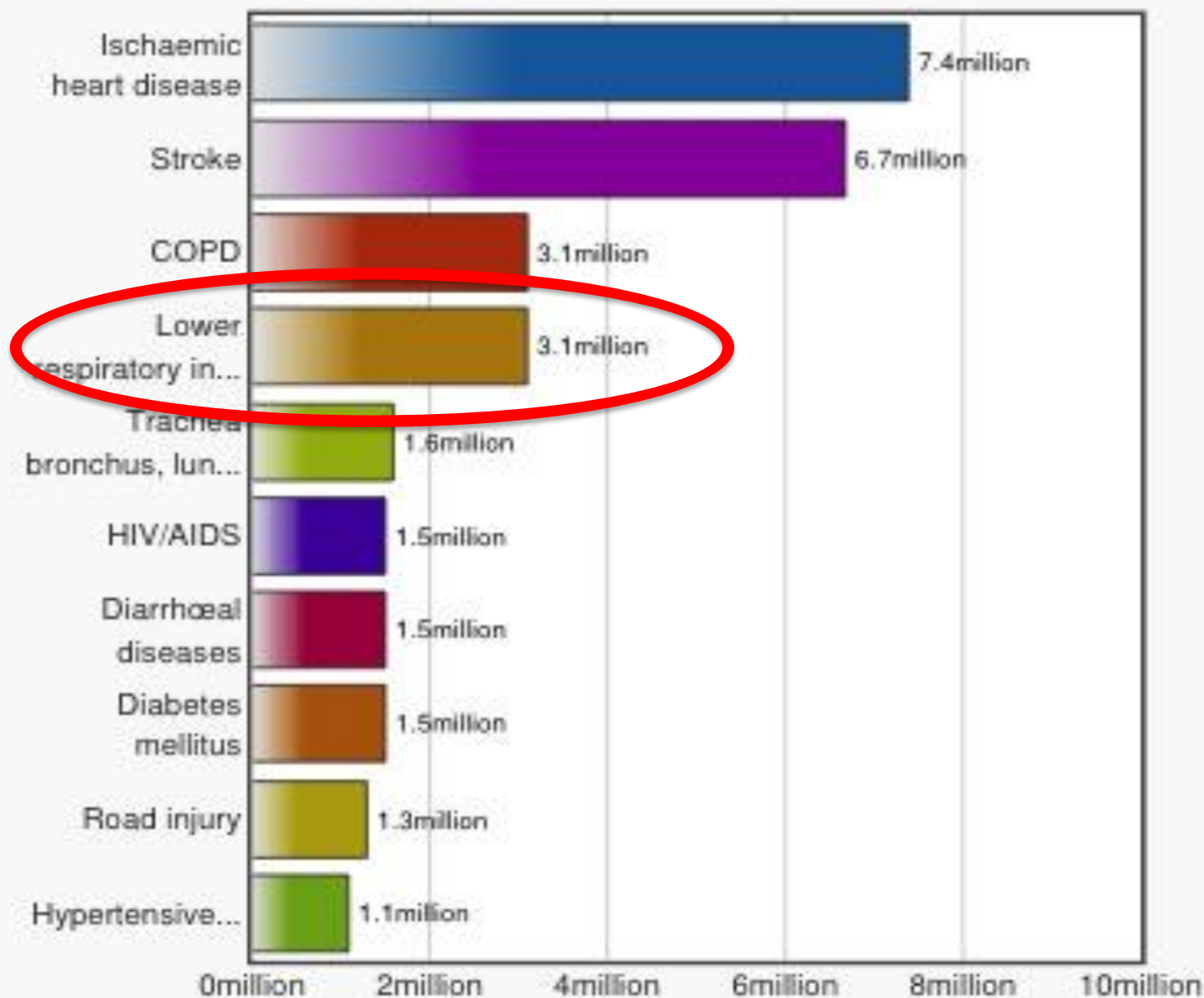- I have no actual or potential conflict of interest in relation to this presentation

Objectives

- Review Pneumonia Prediction Scores
- Distinguish the usefulness of existing scores for predicting low risk vs high risk patients
- Determine if there is a Pneumonia Prediction Score that is useful in predicting mortality

The 10 leading causes of death in the world
2012

Cause	Deaths
Ischaemic heart disease	7.4million
Stroke	6.7million
COPD	3.1million
Lower respiratory in...	3.1million
Trachea bronchus, lun...	1.6million
HIV/AIDS	1.5million
Diarrhoeal diseases	1.5million
Diabetes mellitus	1.5million
Road injury	1.3million
Hypertensive...	1.1million

Pneumonia

- Community Acquired Pneumonia (CAP)
  - Most outpatient, low mortality ~1%
  - Hospitalized, mortality ~15%

- Other
  - Hospital Acquired Pneumonia (HAP)
  - Health Care Associated Pneumonia (HCAP)
  - Ventilator Associated Pneumonia (VAP)

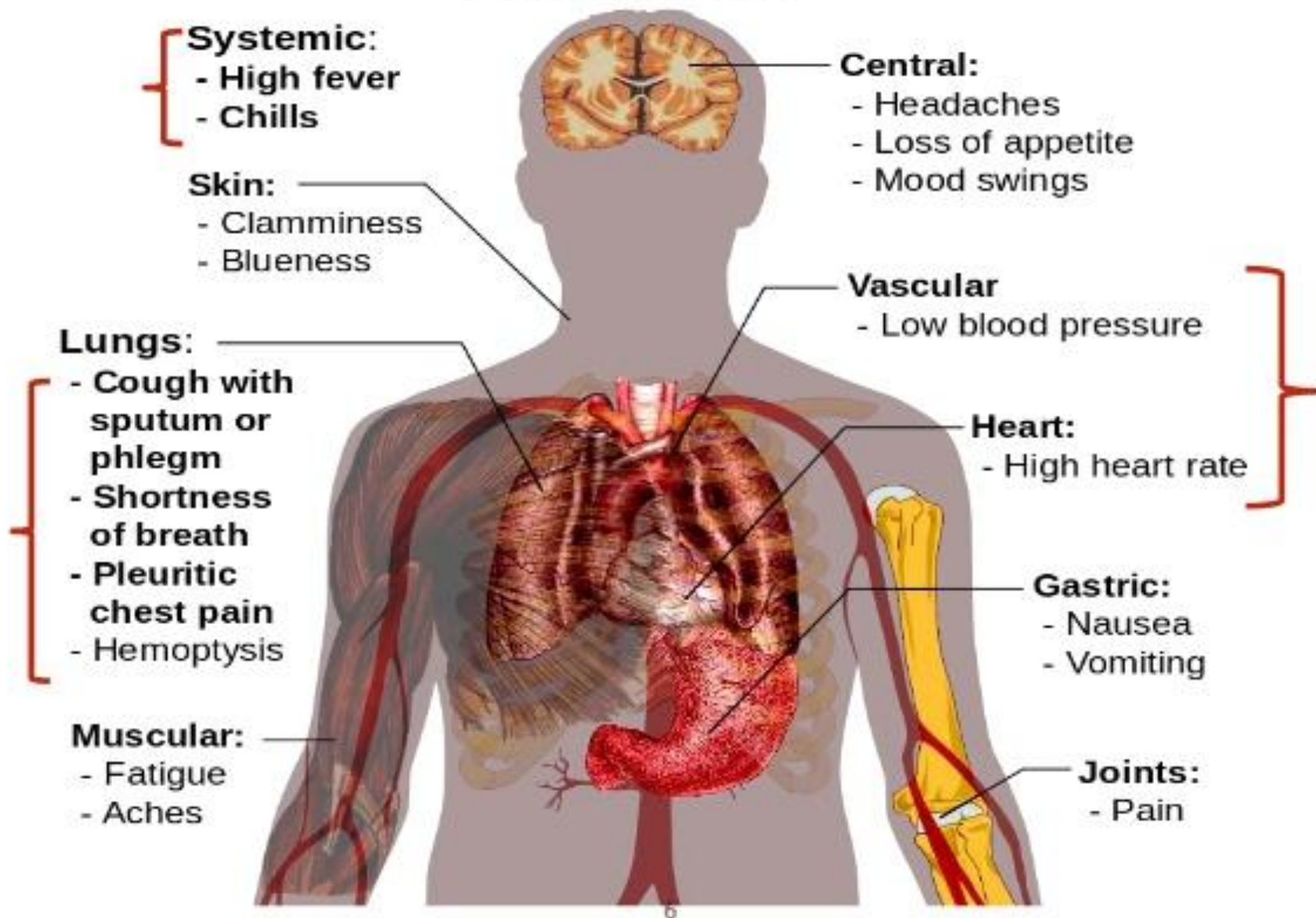# Community Acquired Pneumonia Definition

Acute infection of pulmonary parenchyma associated with:

- At least some symptoms of acute infection plus
  - ✓ Acute infiltrate on radiograph OR
  - ✓ Pneumonia findings on auscultation
- Patient not hospitalized or living in a long term care facility x past 14 days

Bartlett: Clinical Infectious Diseases 2000;31:347-82

Main symptoms of infectious
Pneumonia

Systemic:
- **High fever**
- **Chills**

Central:
- Headaches
- Loss of appetite
- Mood swings

Skin:
- Clamminess
- Blueness

Vascular
- Low blood pressure

Lungs:
- **Cough with sputum or phlegm**
- **Shortness of breath**
- **Pleuritic chest pain**
- Hemoptysis

Heart:
- High heart rate

Gastric:
- Nausea
- Vomiting

Muscular:
- Fatigue
- Aches

Joints:
- Pain

Challenges

- Antibiotic resistance
- Changing pathogens
- Aging population
- Cost constraints
- Empirical therapy
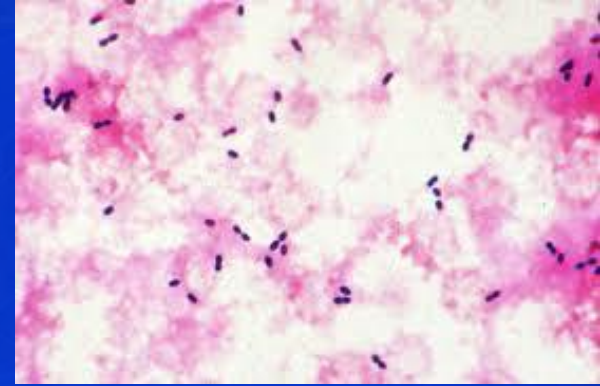- Identifying those at risk for increased mortality

Risk Factors

- Elderly/dementia
- COPD/Asthma
- Smoking
- Alcoholism
- Immunosuppression
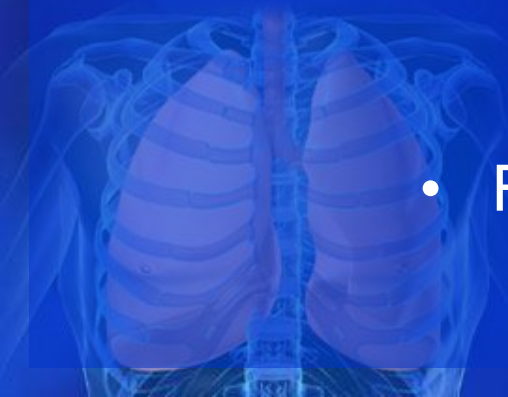- Institutionalization

Common causative pathogens

- S. pneumoniae
- H. influenza

  } 50% of hospitalized

Atypicals
- Legionella
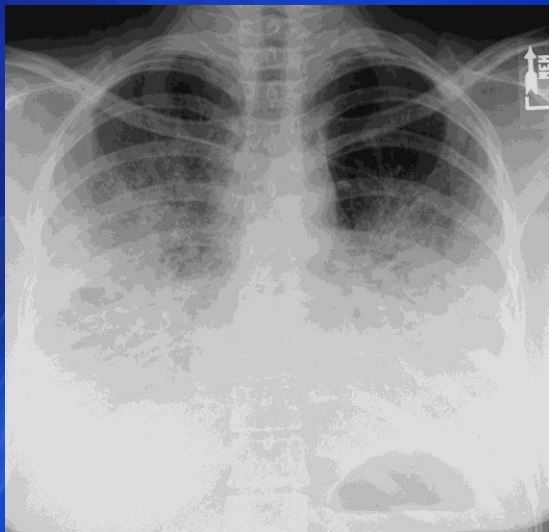- Mycoplasma
- Chlamydophila pneumoniae

- Viral
  - Influenza
  - Parainfluenza

    } 18% of hospitalized

  - RSV
- Fungal
  - Pneumocystis jirovecii

Common causative Pathogens in ICU admissions

- S. pneumonia
- Legionella
- Staphylococcus aureus (including MRSA)
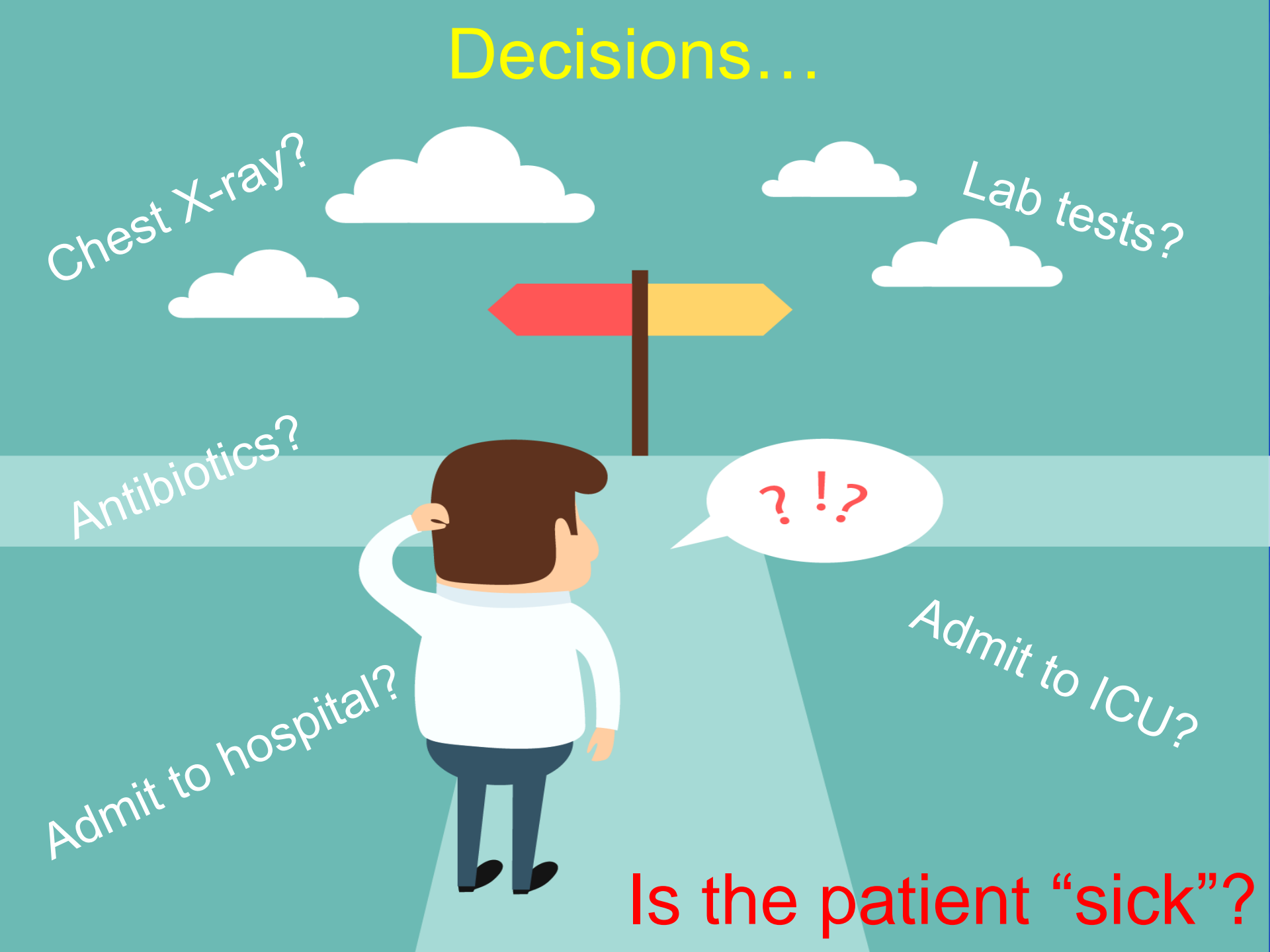- Gram negative bacilli

Decisions

- Hospital admission vs outpatient?

- Ward vs ICU?

"Severe" CAP

- Challenge to identify prospectively
- Use different empiric antibiotics
- May be initially felt to be mild, then later get admitted to ICU… (higher mortality)

Severity of Illness Scores / Prognostic Models

- Pneumonia Severity Index

- CURB-65 score

- CRB-65 score

Identify low risk patients for outpatient treatment

HOME   ARTICLES & MULTIMEDIA ⌄   ISSUES ⌄   SPECIALTIES & TOPICS ⌄   FOR AUTHORS ⌄   CME ›

ORIGINAL ARTICLE

A Prediction Rule to Identify Low-Risk Patients with Community-Acquired Pneumonia

Michael J. Fine, M.D., Thomas E. Auble, Ph.D., Donald M. Yealy, M.D., Barbara H. Hanusa, Ph.D., Lisa A. Weissfeld, Ph.D., Daniel E. Singer, M.D., Christopher M. Coley, M.D., Thomas J. Marrie, M.D., and Wishwa N. Kapoor, M.D., M.P.H.

- Pneumonia Patient Outcomes Research Team
- Immunocompetent adults
- PSI

Pneumonia Severity Index

2 step approach:

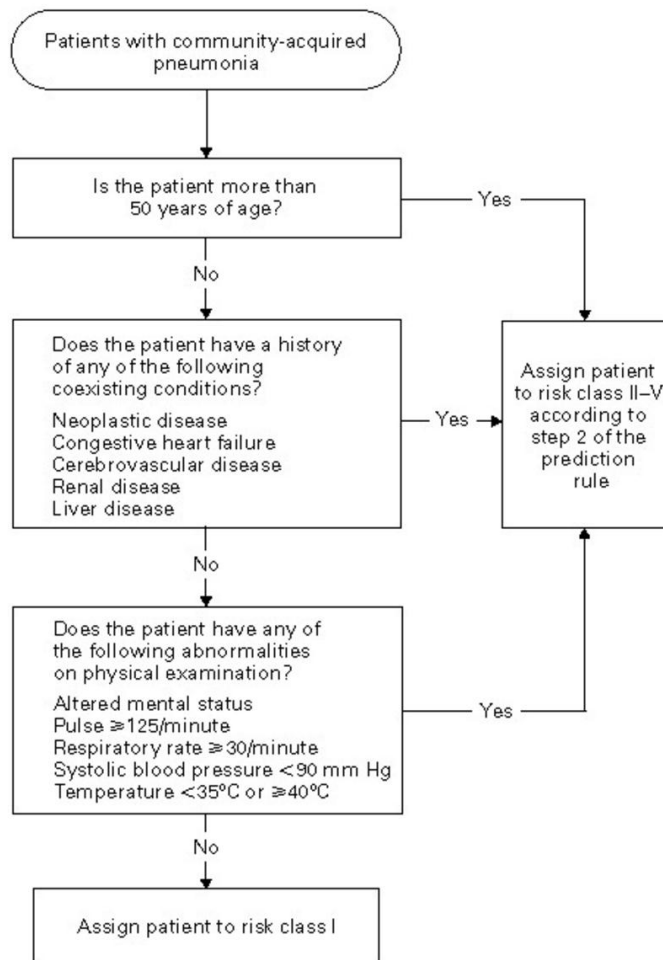1) Algorithm to determine low risk:

- <50

- No comorbidities (cancer, CHF, CVD, renal or liver disease, HIV)

- HR < 125, RR < 30, BP > 90 T > 40 or < 35

- Normal mentation

2) Apply Score if not "low risk"

PSI Calculation

Step 1

Step 2

TABLE 2. POINT SCORING SYSTEM FOR STEP 2 OF THE PREDICTION RULE FOR ASSIGNMENT TO RISK CLASSES II, III, IV, AND V.

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

- Stratifies patients into 5 mortality risk categories:
  - ✓ Class I   (0.1%) ⎫
  - ✓ Class II   (0.6%) ⎬ outpatient
  - ✓ Class III   (0.9%) — short stay
  - ✓ Class IV   (9.3%) ⎫
  - ✓ Class V (27.0%) ⎬ inpatient

Hospitalize if > 91

Defining community acquired pneumonia severity on presentation to hospital: an international derivation and validation study

W Lim, M M van der Eerden, R Laing, W Boersma, N Karalus, G Town, S Lewis, and J Macfarlane

CURB-65 Score

CURB-65 Score

- ✓ **C** onfusion
- ✓ **U** remia (BUN>7)
- ✓ **R** espiratory rate ⬆(> 30)
- ✓ **B** lood pressure (< 90 syst, or < 60 diast)
- ✓ **65** years or more

Modified from Infectious Diseases Society of America & American Thoracic Society CURB Score Criteria

Lim WS et al. Defining community IDSA/ATS Guidelines for CAP in Adults • CID 2007:44 (Suppl 2) • S65 acquired pneumonia severity on presentation to hospital: an international derivation and validation study. Thorax 2003; 58:377–82.

CURB-65 Score

0 =   0.7%*
1 =   2.1%   } outpatient

2 =   9.2%   — admit to hospital

3 = 14.5%
4 = 40.0%   } ICU
5 = 57.0%

*30 day mortality

CRB-65 Score for
office assessment

The Pneumonia Severity Index: A Decade after the Initial Derivation and Validation

Drahomir Aujesky[1] and Michael J. Fine[2,3]

[1]Division of General Internal Medicine, University of Lausanne, Lausanne, Switzerland; and [2]Veterans Affairs Center for Health Equity Research and Promotion, Veterans Affairs Pittsburgh Healthcare System, and [3]Division of General Internal Medicine, Department of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania

- Rigorously derived and validated prediction rule

- Empirically shown to safely increase the percentage of patients treated in the outpatient setting

- "Reference standard" for stratification of CAP

Table 4. Studies comparing the prognostic accuracy of the pneumonia severity index (PSI) and the CURB-65 score.

Study characteristic	Aujesky et al. [20]	Buising et al. [21]	Capelastegui et al. [22]	Man et al. [23]	Ananda-Rajah et al. [24]
Sites	32 EDs in the US	1 ED in Australia	1 ED in Spain	1 ED in Hong Kong	1 ED in Sweden
Total no. of patients	3181 Immuno-competent adults	392 Immuno-competent adults	1776 Immuno-competent adults	1016 Immuno-competent adults	408 Immuno-competent adults
Patients classified as low risk, %					
PSI risk classes I–III	68	44	64	47	28
CURB-65 scores 0–1	61	59	57	43	29
30-Day mortality, %					
PSI risk classes I–III	1.4	0.6	0.7	2.9	3.5
CURB-65 scores 0–1	1.7	…	0.4	3.0	6.7
Sensitivity for 30-day mortality, %					
PSI risk classes IV–V	79	97	93	84	94
CURB-65 scores 2–5	77	…	97	85	87
Specificity for 30-day mortality, %					
PSI risk classes IV–V	70	48	67	50	32
CURB-65 scores 2–5	63	…	60	46	33
PPV for 30-day mortality, %					
PSI risk classes IV–V	11	16	18	14	20
CURB-65 scores 2–5	9	…	15	13	19
NPV for 30-day mortality, %					
PSI risk classes IV–V	99	99	99	97	97
CURB-65 scores 2–5	98		100	97	93
AUC for 30-day mortality					
PSI	0.81	0.82	0.89	0.74	0.72
CURB-65	0.76	0.82	0.87	0.73	0.69

NOTE. The CURB-65 prediction rule uses 5 variables (confusion, urea level >7 mmol/L, respiratory rate ≥30 breaths/min, low systolic or diastolic blood pressure, and age ≥65 years). AUC, area under the receiver operating characteristic curve; CAP, community-acquired pneumonia; ED, emergency department; NPV, negative predictive value; PPV, positive predictive value.

Pneumonia Severity of Illness Scores To Predict Patients at Risk for Increased Mortality

- PSI Class V / CURB-65 score
  - Proposed but not prospectively validated for ICU admission
- IDSA/ATS guidelines
  - not validated
- SMART-COP
- CURXO-80

Attempt to identify high risk patients who need ICU admission

Modified IDSA/TSA Criteria for Severe CAP

- **Minor Criteria**

  - Resp rate > 30
  - $Pa\,O_2 / Fi\,O_2$ ratio > 250
  - Multi-lobar infiltrates
  - Confusion
  - Uremia (BUN > 20 mg/dl
  - Leukopenia (WBC < 4000)
  - Thrombocytopenia (plat < 100,000)
  - Hypothermia (T < 36°C)
  - Hypotension

3 minor or 1 major criteria

Modified IDSA/TSA Criteria for Severe CAP

- Major Criteria
  - Invasive mechanical ventilation
  - Septic shock with need for vasopressors

  _____

  "Other criteria to consider"

  - Hypoglycemia (in non-diabetics)
  - acute alcoholism or withdrawal
  - hyponatremia
  - unexplained metabolic acidosis
  - elevated lactate level
  - cirrhosis

IDSA/ATS criteria

- Brown suggests threshold of 4 minor criteria
  - Higher positive predictive value at the expense of lower sensitivity (30% vs 54%)
- IDSA/ATS expert panel suggest 3 criteria
  - May over-admit to the ICU to ensure those at risk of decompensating are not left out on the wards

  Reassessment is key until a better scoring tool is available

SMART COP

Predicts intensive respiratory or vasopressor support*

- ↓ BP   2 points
- Multi-lobar CXR   1 point
- ↓ Albumin   1 point
- ↑ Resp rate   1 point
- ↓ Heart rate   1 point
- Confusion   1 point
- Poor oxygenation   2 points
- ↓ Arterial pH   2 points

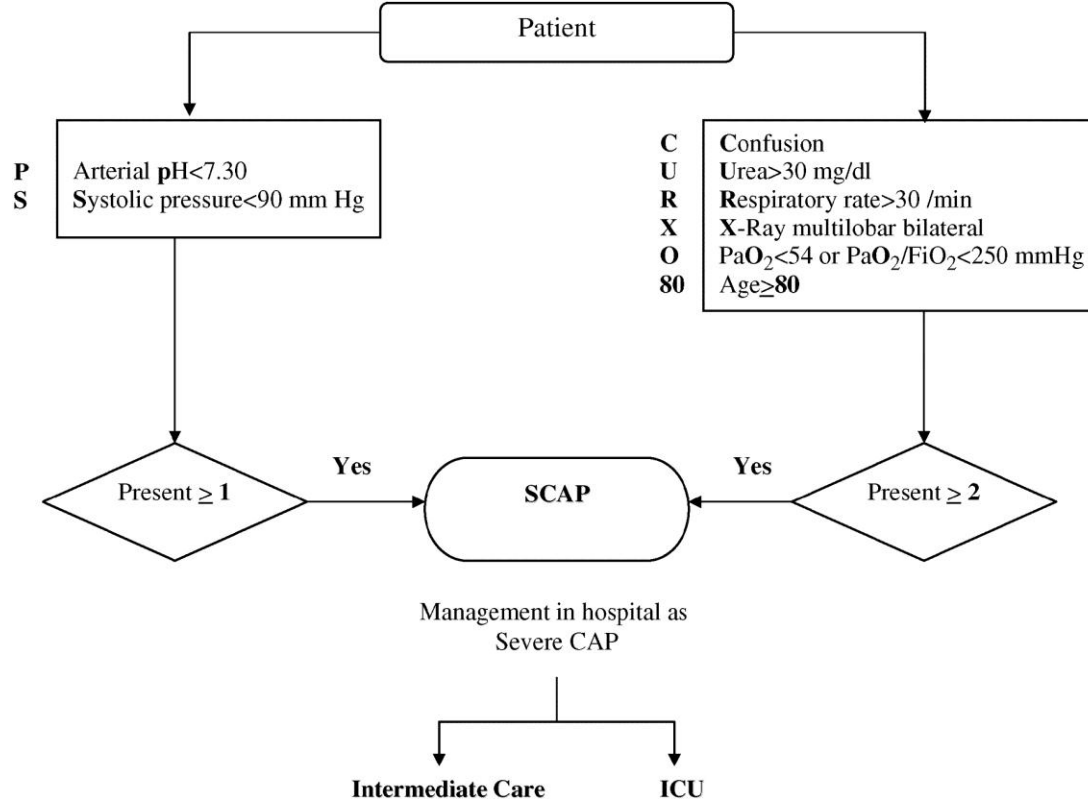> 3 = 92% received *intensive support
incl 84% who didn't need ICU initially

Charles PG, et al: SMART-COP: A tool for predicting the need for intensive respiratory or vasopressor support in community-acquired pneumonia. Clin Infect Dis 2008; 47: pp. 375-384

CURXO-80

- pH < 7.3
- BP < 90
- RR > 30
- Altered mental status
- BUN > 30
- $PaO_2/FiO_2 < 250$
- Age > 80
- Multi-lobar /bilateral lung involvement

Espana PP, Capelastegui A, Gorordo I, et al: Development and validation of a clinical prediction rule for severe community-acquired pneumonia. Am J Respir Crit Care Med 2006;174:1249–1256

Figure 3. The variables of score grouped in major and minor criteria. The evaluation of SCAP is based on the presence of one major criterion or two or more minor criteria. P = arterial pH; S = systolic pressure; C = confusion; U = blood urea nitrogen; R = respiratory rate; X = X-ray; O = PaO2; 80 = Age ⩾ 80 years.

TABLE 4. CHARACTERISTICS OF DIFFERENT CLINICAL PREDICTION RULES FOR SEVERE COMMUNITY-ACQUIRED PNEUMONIA

Rule	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	AUC (%)	p Value
SCAP prediction rule						
Derivation	92.1	73.8	21.4	99.2	0.83	
Internal validation	95.5	76.7	21.1	99.6	0.86	
External validation	84.3	60.3	22.0	96.7	0.72	
m-ATS*						
Derivation	51.3	95.9	49.4	96.2	0.74	<0.01
Internal validation	61.4	96.7	55.1	97.5	0.79	0.07
External validation	50.4	91.9	47.2	92.8	0.71	0.37
CURB-65 (3–5)[†]						
Derivation	68.4	86.8	28.6	97.3	0.78	<0.05
Internal validation	63.6	87.3	24.6	97.4	0.75	<0.01
External validation	60.3	78.4	26.7	93.8	0.69	0.17
PSI (IV-V)[‡]						
Derivation	94.7	68.1	18.7	99.4	0.81	0.24
Internal validation	88.6	69.3	15.9	98.9	0.79	<0.01
External validation	91.4	50.7	19.8	97.8	0.71	0.32
Adjusted PSI[§]						
Derivation	97.4	57.5	15.1	99.7	0.77	<0.01
Internal validation	95.5	61.2	13.8	99.5	0.78	<0.01
External validation	95.7	36.4	16.7	98.5	0.66	<0.05

Ideal Pneumonia Severity Score to predict ICU admission criteria* /30 day mortality

- Dynamic
- High NPV, high sensitivity
- Can't use AUROC
  - It assumes equal importance of false positives and false negatives*
- Simple, few factors, easy to remember
- Needs to be better than the "astute physician" at the bedside

*Abers M, and Musher D. Clinical prediction rules in CAP, lies, damn lies and statistics. Q J Med 2014; 107;595-596

Conclusion

- More research is needed to determine a valid Pneumonia Severity Score to differentiate patients at risk for mortality from those who are moderately ill
- Clinical judgment and frequent reassessments in moderately ill patients is key