

# **PNEUMONIA AND PLEURAL EFFUSIONS**

**K. Brat**

# Pneumonia

- ⦿ Different epidemiological types of pneumonia require different treatment options and procedures
- ⦿ CAP (Community-Acquired Pneumonia)
- ⦿ HAP (Hospital-Acquired Pneumonia)
- ⦿ VAP (Ventilator-Associated Pneumonia)
- ⦿ HCAP (Health Care-Associated Pneumonia)

# CAP

- ⦿ Correct diagnosis
  - ⦿ Risk stratification: ambulatory treatment / hospital admission / intensive care
  - ⦿ Optimal antibiotic treatment (choice and duration)
  - ⦿ Prevention of CAP
- 
- ⦿ 80% of pneumonia cases treated ambulatory way – mortality <1%
  - ⦿ 20% of cases treated in hospitals – mortality ca 14%

# Infectious Diseases Society of America/American Thoracic Society Consensus Guidelines on the Management of Community-Acquired Pneumonia in Adults

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AUDIT, RESEARCH AND GUIDELINE UPDATE

## British Thoracic Society community acquired pneumonia guideline and the NICE pneumonia guideline: how they fit together

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# Diagnosis of CAP

- ⦿ Clinical signs, lab (CRP + leukocytes), CXR
- ⦿ In severe CAP (PSI class IV-V) also microbiology: sputum, legionella and pneumococcal antigen in urine, blood culture, serology Mycoplasma/Chlamydia

# Pneumonia Severity Index (PSI)

>14.000 pts, confirmed by further studies

## Sex

- M (0 points)  
 F (-10 points)

## Demographic factors

- Age (1 point for each year)  
 Nursing home resident (10 points)

## Comorbid illnesses

- Neoplastic disease (30 points)  
 Liver disease (20 points)  
 Congestive heart failure (10 points)  
 Cerebrovascular disease (10 points)  
 Renal disease (10 points)

## Physical examination findings

- Altered mental status (20 points)  
 Respiratory rate  $\geq 30$ /minute (20 points)  
 Systolic blood pressure  $< 90$  mmHg (20 points)  
 Temperature  $< 35$  degrees C or  $\geq 40$  degrees C (15 points)  
 Pulse  $\geq 125$ /minute (10 points)

## Laboratory and radiographic findings

- Arterial pH  $< 7.35$  (30 points)  
 Blood urea nitrogen  $\geq 30$  mg/dL (11 mmol/L) (20 points)  
 Sodium  $< 130$  mEq/L (20 points)  
 Glucose  $\geq 250$  mg/dL (14 mmol/L) (10 points)  
 Hematocrit  $< 30$  percent (10 points)  
 Partial pressure of arterial oxygen  $< 60$  mmHg or oxygen saturation  $< 90\%$  (10 points)  
 Pleural effusion (10 points)

Class I 0.1% Mortality
51 to 70 Points: Class II 0.6% Mortality
71 to 90 Points: Class III 0.9% Mortality
91 to 130 Points: Class IV 9.3% Mortality
131 to 395 Points: Class V 27.0% Mortality

PREDICTION RULE TO IDENTIFY LOW-RISK PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA

A PREDICTION RULE TO IDENTIFY LOW-RISK PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA

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## RESPIRATORY INFECTION

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

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

*Thorax* 2003;**58**:377–382

CURB-65 score	Mortality Risk	Recommendation per Derivation Study
0	0.60%	Low risk; consider home treatment
1	2.70%	Low risk; consider home treatment
2	6.80%	Short inpatient hospitalization or closely supervised outpatient treatment
3	14.00%	Severe pneumonia; hospitalize and consider admitting to intensive care
4 or 5	27.80%	Severe pneumonia; hospitalize and consider admitting to intensive care

# CURB-65

Confusion

No 0

Yes +1

BUN > 19 mg/dL (> 7 mmol/L)

No 0

Yes +1

Respiratory Rate  $\geq$  30

No 0

Yes +1

Systolic BP < 90 mmHg or Diastolic BP  $\leq$  60 mmHg

No 0

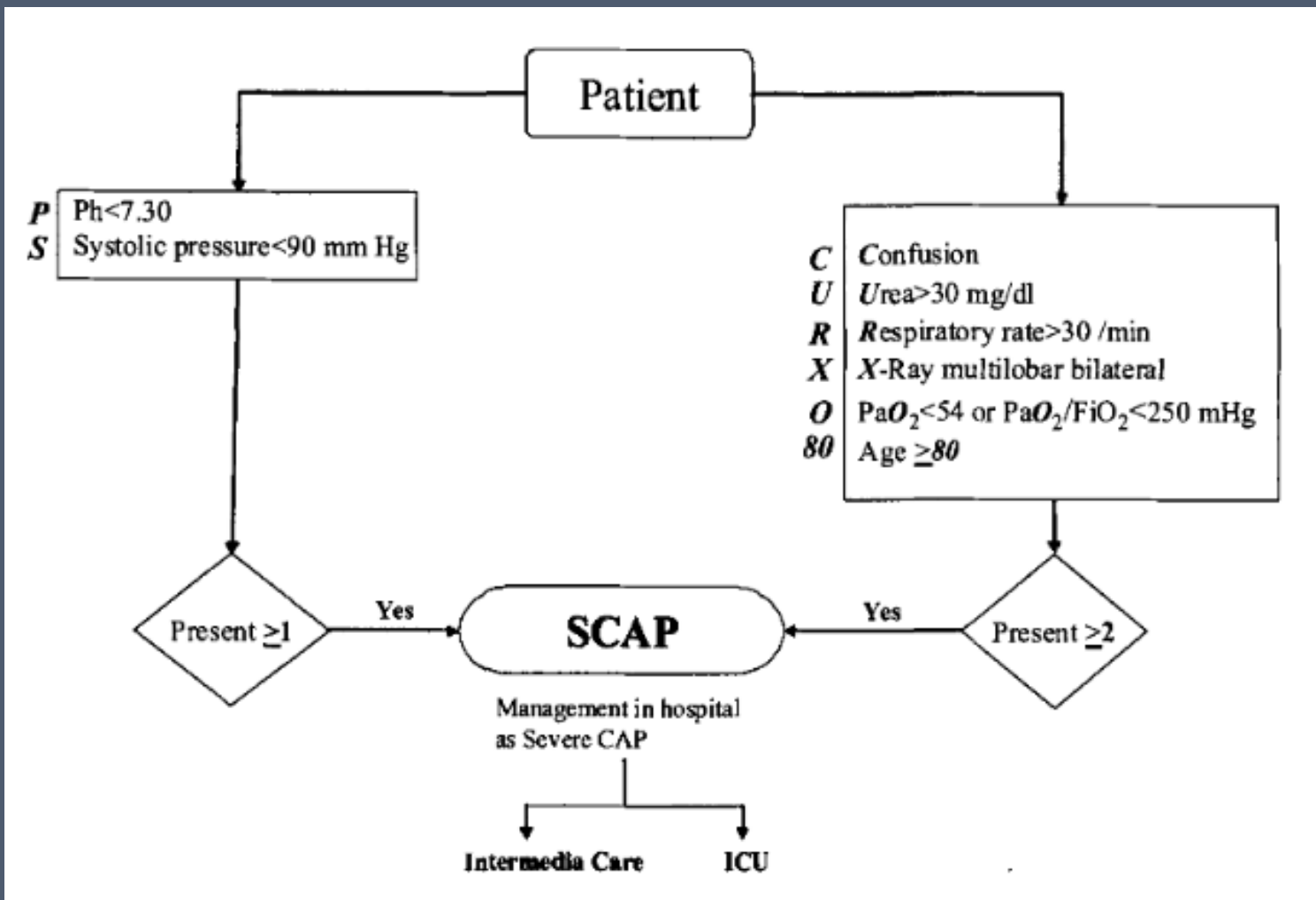
Yes +1

Age  $\geq$  65

No 0

Yes +1

# SCAP – next generation risk stratification tool





# Antibiotic treatment of CAP

## ⊙ Low-risk patients:

- 1) amoxicillin
- 2) clarithromycine or doxycycline

## ⊙ Moderate-risk patients (standard department) – start the treatment ASAP

- 1) amoxicilline oral
- 2) amox + clarithro iv
- 3) moxifloxacin

## ⊙ High-risk patients (ICU) - start the treatment immediately:

- 1) amoxicillin/clavulanic acid + clarithromycine
- 2) cefuroxim + klaritromycin

⊙ I.v. antibiotics unless body temperature below 37°C for 24hrs.

⊙ Duration: low-risk pts 7 days, moderate-risk 7-10 days, high-risk may be extended up to 14-21 days

# Prevention of CAP... vaccination

- ⊙ Str.pneumoniae – patients >65 yr
- ⊙ Influenza – patients >65, health care professionals, pts >50 let + severe CV or renal comorbidities or diabetes

# Treatment of HAP

- ❖ HAP is the 2<sup>nd</sup> most frequent type of nosocomial infection
- ❖ Empirical antibiotics: cefotaxime / moxifloxacin / ertapenem
- ❖ Pseudomonas?... tazocin / meropenem / imipenem / ceftazidime + amikacin / ciprofloxacin
- ❖ MRSA?...tazocin / meropenem / cefotaxime + linezolid, vancomycin

# Pleural effusion

- ⊙ Epidemiology - Czech Rep. (5 most frequent causes):
- ⊙ Acute heart failure (45-65%)
- ⊙ Parapneumonic effusion/empyema (22-30%)
- ⊙ Malignant/paramalignant effusion (17-24%)
- ⊙ Effusion secondary to pulmonary embolism (cca 5-8%)
- ⊙ Hemothorax (5-10%)
  
- ⊙ Other (ca 15%)  
(Marel et al. Chest 104: 1486-9)

# Differential diagnosis of pleural effusions

## *Diferenciální diagnóza pleurálního výpotku – nejčastější příčiny výpotků*

<u>Hemotorax</u>	Traumatický <u>Iatrogenní (po pleurální punkci, drenáži hrudniku, kanylaci centrální žily)</u>
<u>Chylotorax</u>	Traumatický Pooperační Spontánní ( <u>lymfangioliomyomatóza, obturace ductus thoracicus – lymfom, metastázy do nitrohručních uzlin</u> )
<u>Transsudát</u>	Levostranné <u>kardiální selhání</u> <u>Postperikardotomický syndrom</u> <u>Embolizace do plicnice</u> <u>Konstriktivní perikarditida</u> Onemocnění ledvin ( <u>chronické ledvinné selhání, nefrotický syndrom, glomerulonefritida</u> ) Sekundární <u>výpotek při jaterním selhávání a ascitu</u> <u>Hypalbuminémie</u>
<u>Exsudát</u>	<u>Parapneumonický výpotek</u> Maligní onemocnění ( <u>maligní nebo paramaligní výpotky</u> ) <u>Empyém</u> <u>Tuberkulózní výpotek</u> <u>Embolizace do plicnice</u> <u>Indukované výpotky (subfrenický absces, pankreatitida, mediastinitida, zánět obratlů)</u> Systémové nemoci pojiva ( <u>SLE, RA, Wegenerova granulomatóza</u> ) <u>Sarkoidóza</u> <u>Benigní tumor ovaria (Meigsův syndrom)</u>

# Biochemic examination of effusions – Light`s criteria

Biochemický ukazatel	Transsudát	<u>Exsudát</u>
<b>Celková bílkovina (CB)</b>	< 30 g/l výpotek/sérum < 0.5 gradient výpotek/sérum > 31 g/l	> 30 g/l výpotek/sérum > 0.5 gradient výpotek/sérum < 31 g/l
<u>Laktátdehydrogenáza (LD)</u>	výpotek/sérum < 0.6 < 2/3 horního limitu v séru	výpotek/sérum > 0.6 > 2/3 horního limitu v séru
Albumin	gradient výpotek/sérum > 12 g/l	gradient výpotek/sérum < 12 g/l
Cholesterol	výpotek/sérum < 0.3 < 1.5 mmol/l	výpotek/sérum > 0.3 > 1.5 mmol/l
<u>Bilirubin</u>	výpotek/sérum < 0.6	výpotek/sérum > 0.6
Specifická váha	< nebo = 1.016 g/l	> 1.016 g/l
<u>pH</u>	obvykle > 7.30	často < 7.30

**Major criteria**

Minor criteria

# Parapneumonic effusions (infectious pleurisy)

- 30-40% of pts with pneumonia develop pleural effusion
- Ca 15% of parapneumonic effusions are complicated (i.e.  $\text{pH} < 7.20$ )

# Complicated parapneumonic effusions / empyema

- ⦿ The incidence doubled in last 20 years
- ⦿ Morbidity: mean hospitalization duration 14 days
- ⦿ Surgery unavoidable in up to 35% pts
- ⦿ 1-year mortality 20% (no change during last 20 years)
- ⦿ The most valuable predictor of poor outcome is  $\text{pH} < 7.20$  (effusion)



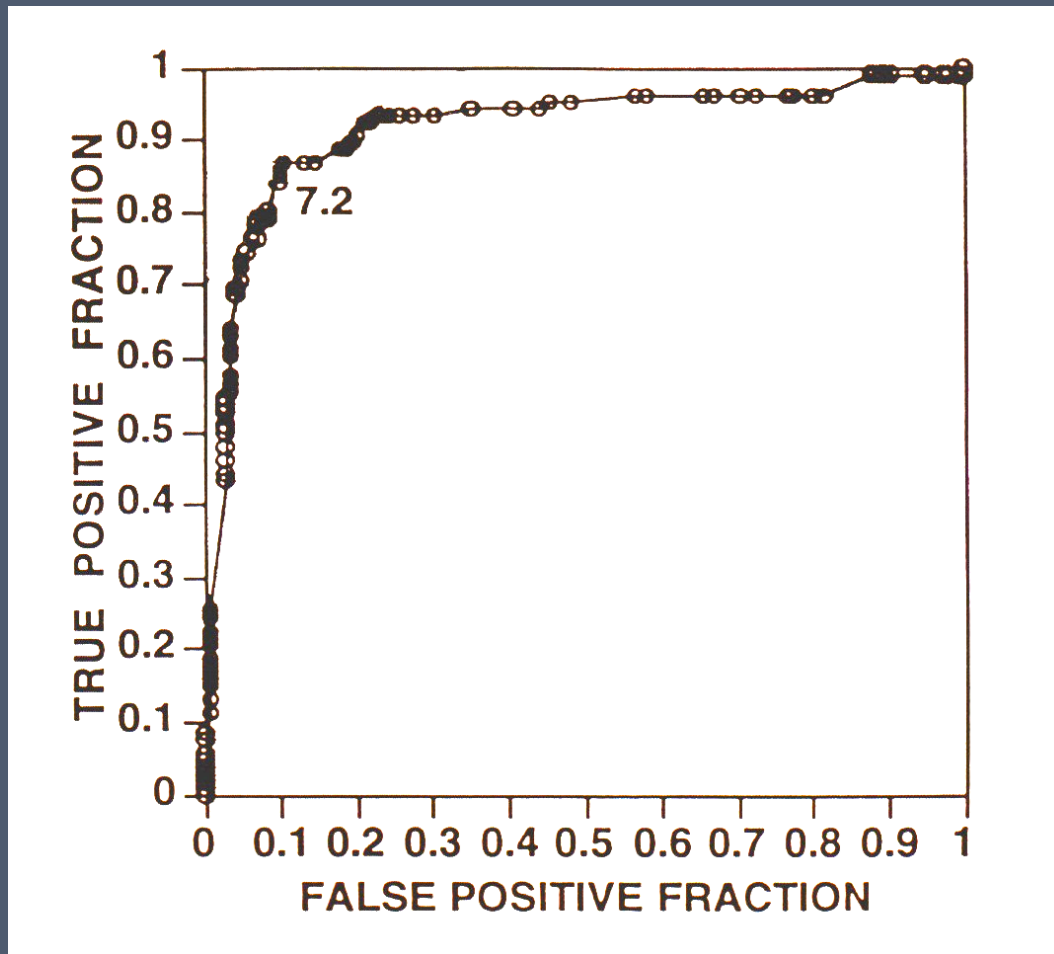
# Classification of parapneumonic effusions

Table 26.3 Pleural fluid characteristics according to stage of pleural infection

	Simple parapneumonic effusion	Complicated parapneumonic effusion	Empyema
Appearance	May be turbid	May be cloudy	Pus
Biochemical markers	pH > 7.30 LDH may be elevated Glucose > 60 mg/dL or Glucose pleural/serum ratio > 0.5	pH < 7.20 LDH > 1000 IU/L Glucose < 35 mg/dL	n/a
Nucleated cell count	Neutrophils usually < 10 000/ $\mu$ L	Neutrophils abundant (usually > 10 000/ $\mu$ L)	n/a
Gram's stain	Negative	May be positive	May be positive
Culture	Negative	May be positive	May be positive

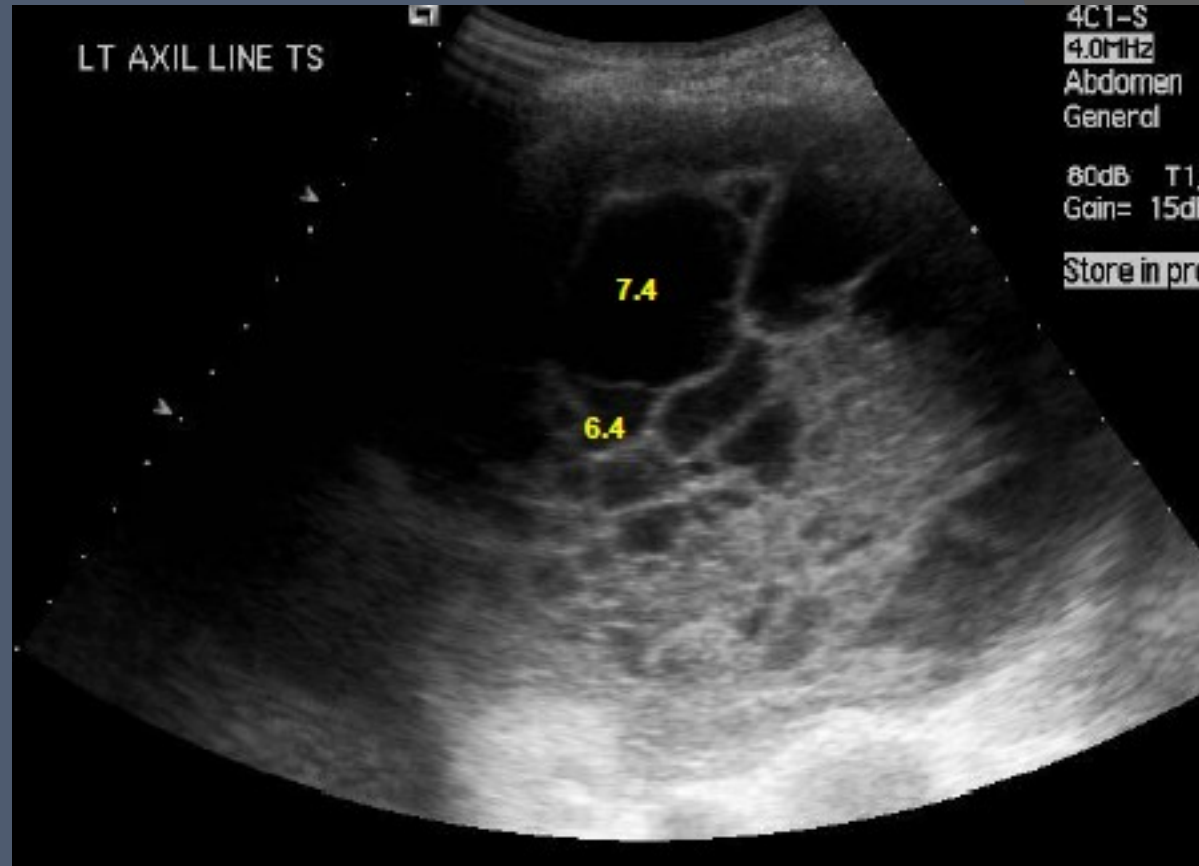
LDH, lactate dehydrogenase.

# pH of infectious effusion – main decision-making parameter (for the introduction of invasive procedures)



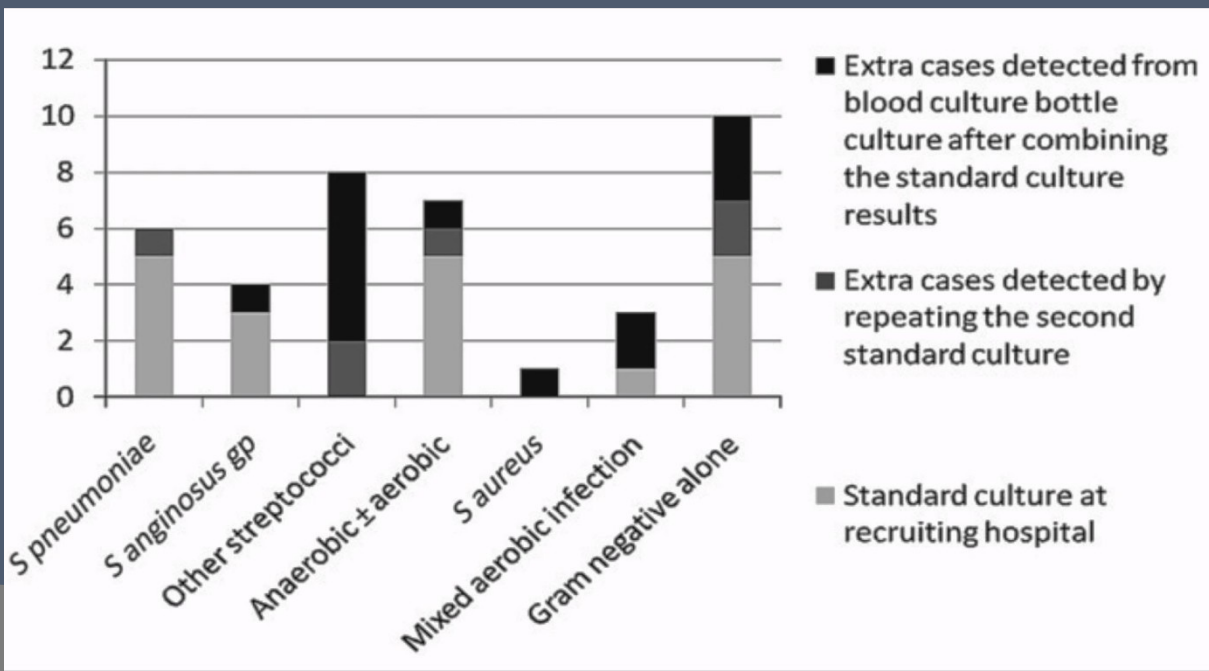
# Presence of septation can modify lab results

- pH of effusion  
modified also by:
- Time delay (...lab)
- Air in syringe
- Traces of local anesthetics
- Proteus-infection



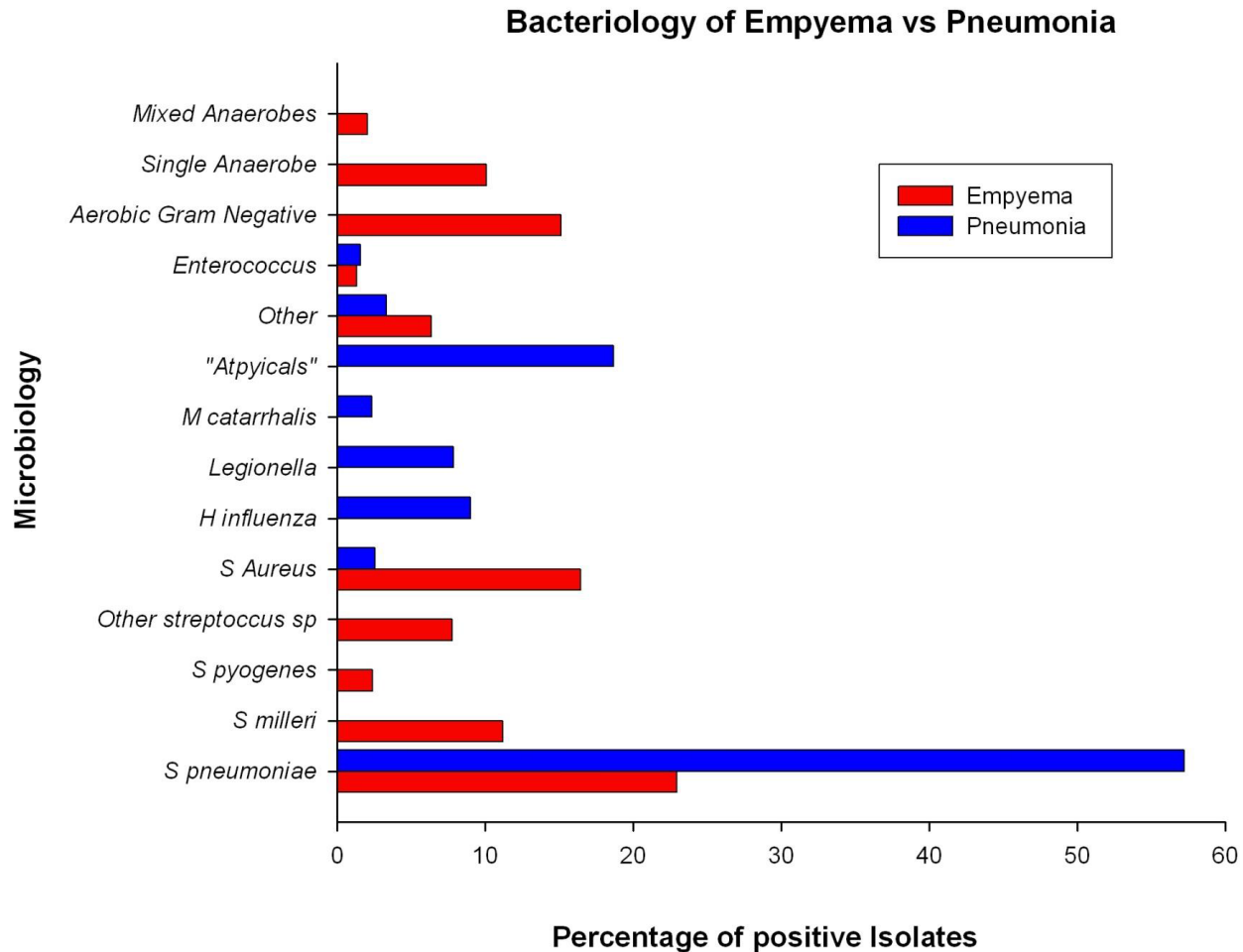
# Microbiology

- ⦿ Agent caught only in ca 50% of infectious pleurisy cases (incl. empyema!)
- ⦿ Inoculation on blood culture (aerobic a anaerobic type) increases pathogen detection by 20%

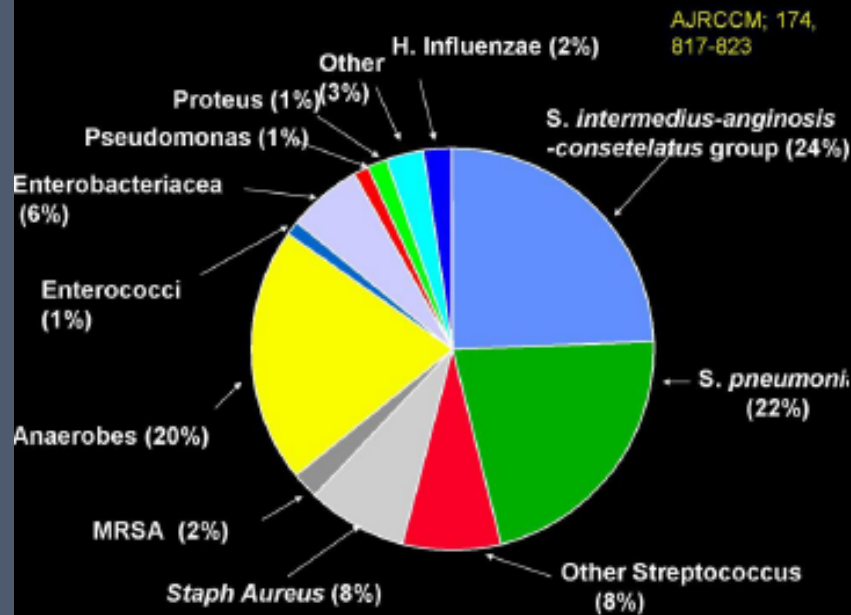


**Menzies et al, Thorax 2011;  
66:658**

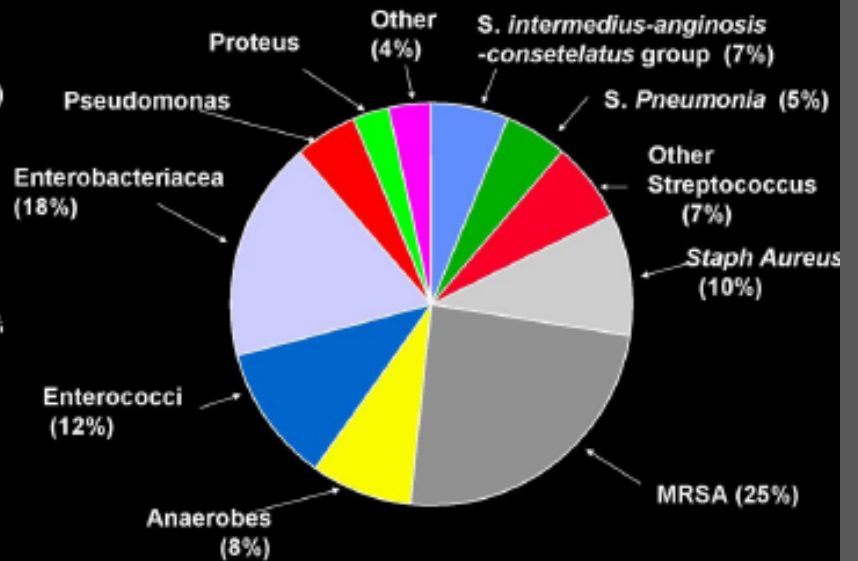
# Is empyema just a “pneumonia gone bad?”



## Community



## Hospital

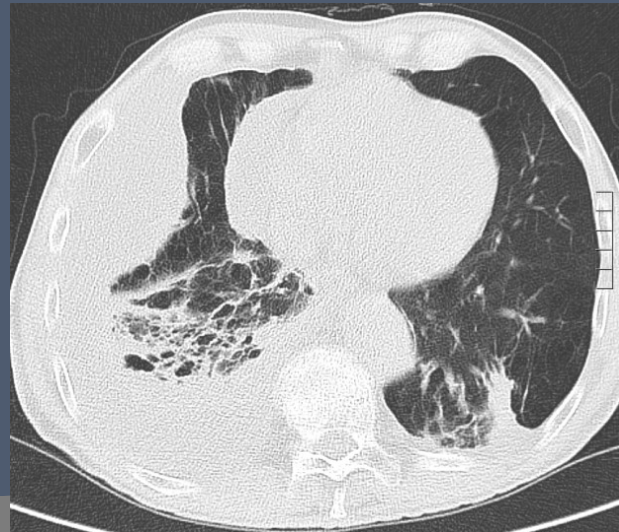
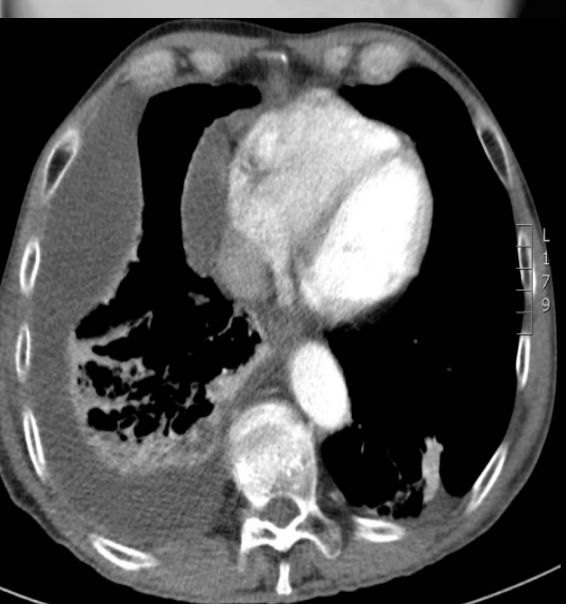
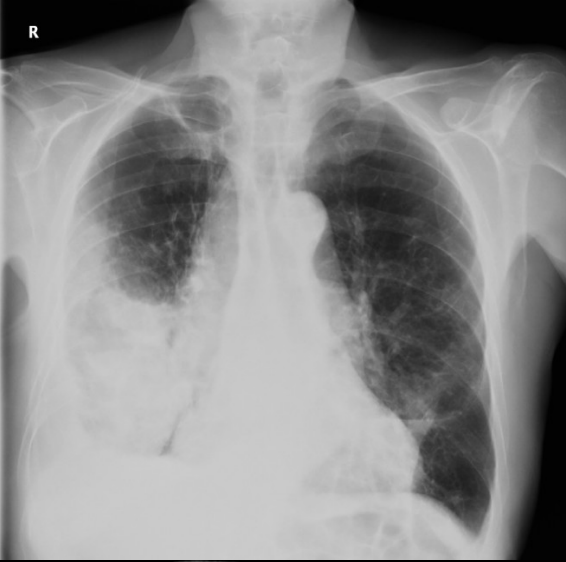


# Antibiotic treatment of infectious pleurisy

Wrightson et al, Chest 2015 1:148(3)

- ⊙ Target on streptococci, S.aureus, G- bacilli, anaerobes
- ⊙ Anaerobes are less frequent
- ⊙ Mycoplasma and Legionella do not induce pleural effusions, i.e. no need for antibiotics targeted on „atypicals“

# CXR / CT / chest ultrasound – effusion volumetry and septation



- AP CXR „finds“ more than 200ml effusion / septation usually missed
- Side CXR – accurate from 50ml...
- CT scan / tens of mililiters... / septation of long duration – fibrous septae
- Chest ultrasound – accurate from tens of ml / loculation found from early stage septation ... and without irradiation!



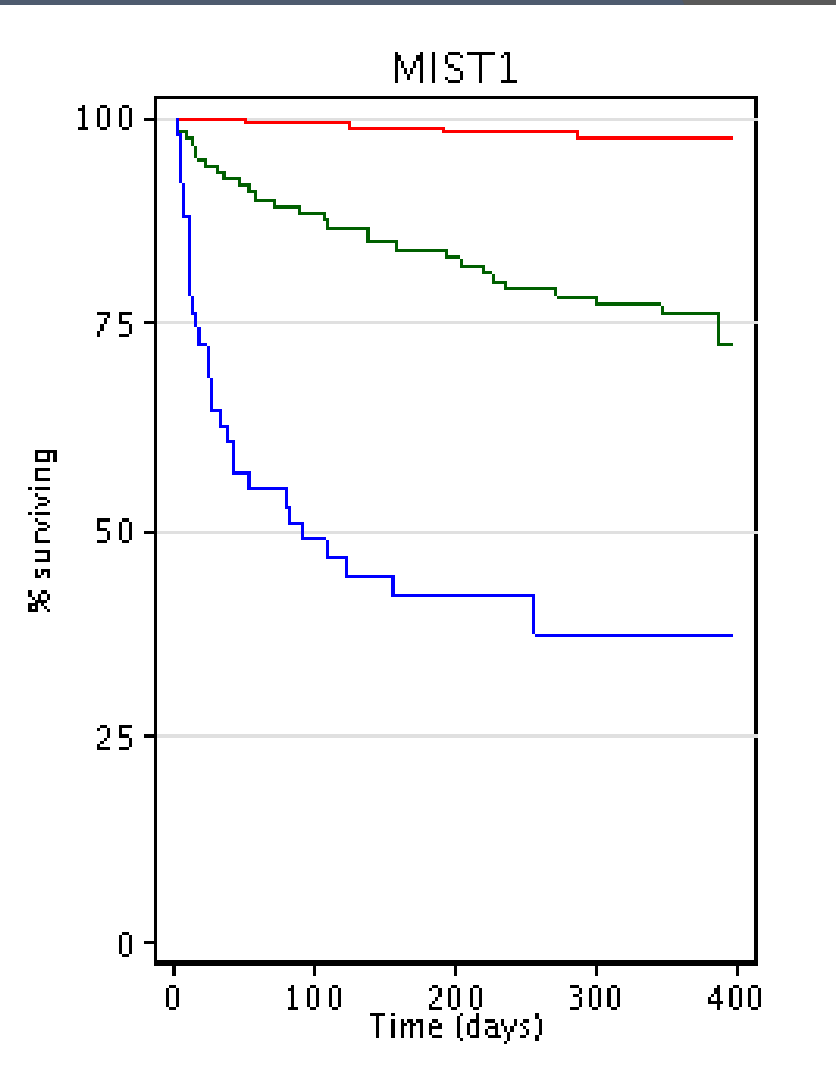
# Prediction of poor outcome in infectious pleurisy

- ⊙ Ultrasound proven loculation (**Chen et al, 2001 J Ultrasound Med 19:837-43**):
  - ✓ Longer hospital stay
  - ✓ More frequent use of intrapleural fibrinolytics
  - ✓ Higher rate of surgical intervention
- ⊙ RAPID score

# RAPID score - MIST 1 a 2 studies

## Outcome prediction in pleural infection RAPID score

Parameter	Measure		Score
<b>R</b> enal	Urea	<5mmol/L 5-8 mmol/L >8 mmol/L	0 1 2
<b>A</b> ge	Age	<50 years 50-70 years >70 years	0 1 2
<b>P</b> urulence of fluid	Purulent Non-purulent		0 1
<b>I</b> nfection Source	Community acquired Hospital acquired		0 1
<b>D</b> ietary Factors	Albumin	> or = 27mmol/L <27mmol/L	0 1
<b>Risk categories</b>	<b>Score 0-2</b> <b>Score 2-4</b> <b>Score 5-7</b>		<b>Low risk</b> <b>Medium-Risk</b> <b>High Risk</b>



© Chest 2015; 145(4): 848

# Intrapleural treatment

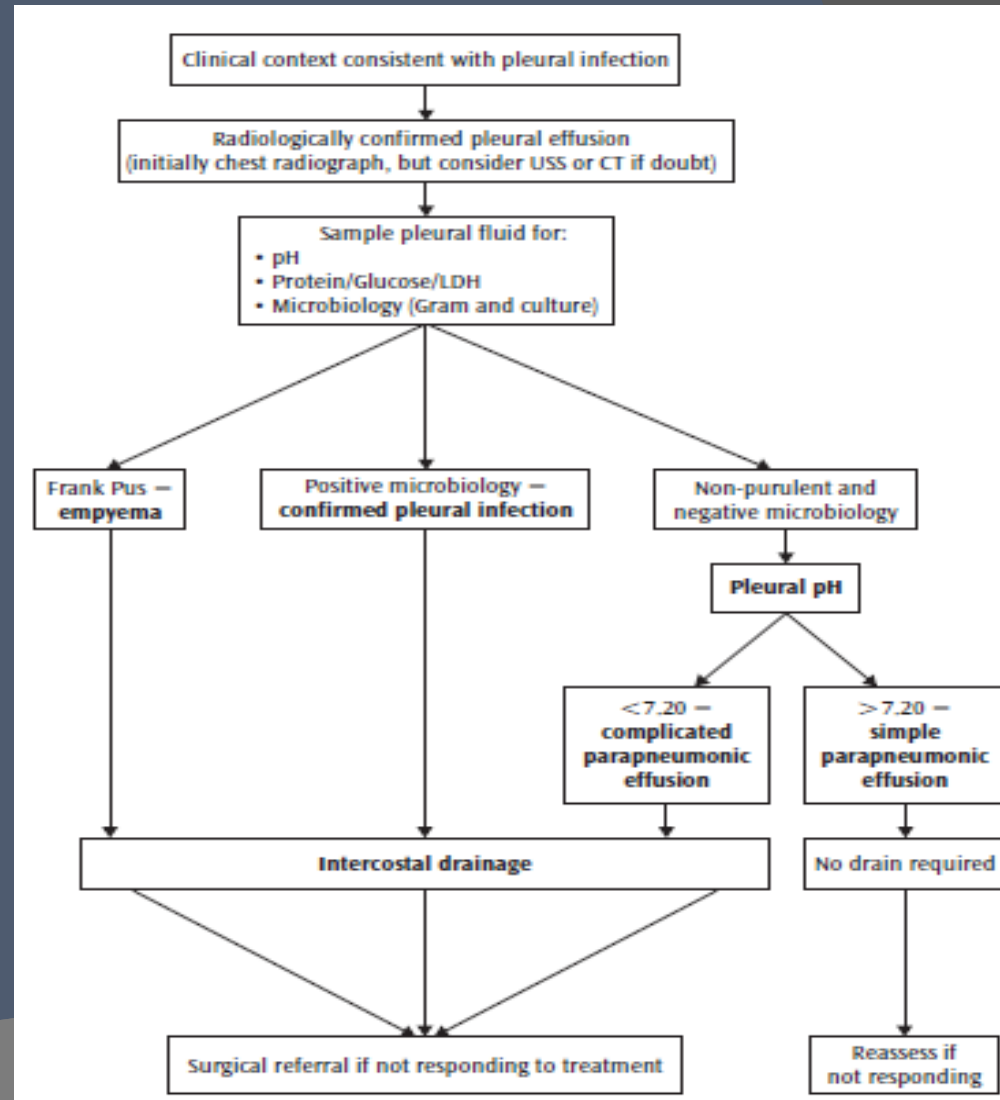
- ⊙ MIST1 study: intrapleural streptokinase not effective (**NEJM; 352: 865-874**)
- ⊙ MIST2 study: t-PA (alteplase) + DNase increase drainage of pleural fluid, decrease the duration of hospital treatment and the rate of surgery (**NEJM; 365: 518-526**), but... high costs
- ⊙ Irrigation by 3x daily 250ml of saline increase drainage of pleural fluid and decrease the need for surgery (**Hooper et al, ERJ 2015**)... low cost treatment
- ⊙ 10/2017 MIST3 initiated: 3 cohorts are randomized > early VATS vs t-PA + DNase vs conservative therapy

# Further remarks

- ⦿ The diameter of pleural catheter (chest tube) has no effect on treatment outcomes (**Chest 2009**)
- ⦿ Purulency of the effusion (macroscopic feature) has no prognostic value (treatment success depends on **pH<7.20** and **the presence of loculation**)
- ⦿ (medical) thoracoscopy – a rising star... 91% success rate in complicated infectious pleurisy treatment (**Brutsche et al, Chest 2005;128:5**)
- ⦿ No study stated when is the ideal timing of surgery (if needed)

# Parapneumonic effusion – main points of care

- Antibiotics – empiric or microbiology-guided
- Thoracentesis – effusions exceeding 300-400ml
- Chest tube insertion – effusion >500ml and pH<7.2
- Intrapleural antiseptic agents (iodopovidone, H<sub>2</sub>O<sub>2</sub>)– each effusion with pH<7.2
- Intrapleural fibrinolytics?
- Surgery – prevent fibrothorax!
- Take care of nutrition
- Respiratory physiotherapy
- Other (oxygen, analgesics...)



# What comes after treatment failure...?

- ◎ ...**fibrothorax** and its characteristics:  
pulmonary restriction,  
respiratory failure,  
decreased mucociliary  
clearance, locus  
minoris resistentiae
- ◎ ...or „**trapped lung**“,  
i.e. inexpandible lung  
covered by fibrocortex  
and effusion



# Case management - malignant/paramalignant effusion

- **Diagnosis:**

- malignant cells present in cytology
- or malignancy present in pleural space
- biochemistry: may be both transudate or exsudate
- often need for surgery to obtain histology... (thoracoscopy, VATS)

- **Treatment:**

- oncological (CHT, RT, biologicals)
- thoracentesis
- thoracic drainage
- pleurodesis – using chemical agents (*talc*, bleomycine, doxycycline)
- pleurodesis - surgical (VATS)
- Indwelling pleural catheter

**Table 46.1** Success rates and relative efficacy of commonly used pleurodesis

Pleurodesing agent	Success rate (CR) (%)
Talc poudrage	68–97
Talc slurry	72–94
Doxycycline	61–88
Tetracycline	47–67
Bleomycin	42–70
Quinacrine	64–91
Iodopovidone	64–92
<i>Corynebacterium parvum</i>	32–76
Silver nitrate	75–90

# Case management - hemothorax

- **Diagnosis:**
  - check recent injury in patient history
  - may be severe thoracic bleeding with anemic shock!
  - if hemothorax suspected, perform thoracentesis immediately!
  - hematocrit effusion/periph.blood  $> 0.5$  or hematocrit in effusion  $> 0.15$
- **Treatment:**
  - thoracic drainage ASAP, use large calibers of chest tube (28-32F)!
  - initial treatment: conservative, but watch for continuous bleeding
  - if bleeding exceeds 200ml/hr for more than 2 hours, call the surgeon - urgent thoracoscopy is needed!



# Case management – TB pleurisy

- **Cytology:** lymphocytes predominant
- Cultivation positive only in 20-50%
- **Histology:** caseating granulomas in 79% (pleural biopsy) up to 100% (thoracoscopy)
- **PCR Myco TB:** sensitivity 60-90%, specificity 80-100%
- **ADA, ADA-2:** sensitivity 75-100%, specificity 80-95%
  
- Patients with *untreated TB* pleurisy develop pulmonary TB within 5 yrs in 65% of cases
- DOTS-short course - 2 months HRZE + 4 months HR
- No evidence for steroids use
- Complete removal of effusion not necessary

# Case management - chylothorax

- **Diagnosis**

- milky effusion
- biochemistry: triacylglyceroles  $> 1.2$  mmol/l or ratio effusion/serum  $> 1.5$
- perform CT scans
- Frequent in malignancy (lymphoma, metastases to mediastinal lymph nodes)

- **Treatment:**

- thoracic drainage + parenteral nutrition 14 days
- surgery (ligation of ductus thoracicus)