



Lung Infection - Community Acquired Pneumonia

Chapter: Definition

Community Acquired Pneumonia

Community-acquired pneumonia (CAP) is an infection of the alveoli, distal airways, and interstitium of the lungs that occurs outside the hospital setting.

Chapter: Epidemiology

Epidemiology

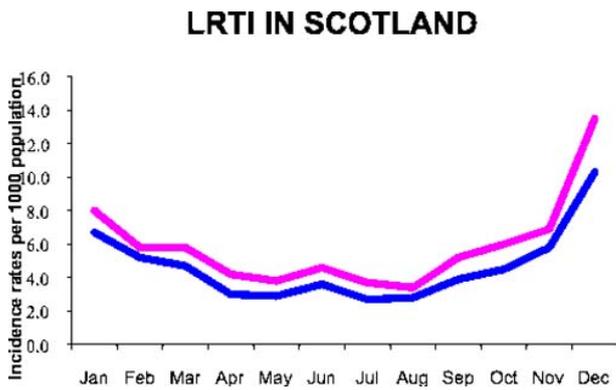
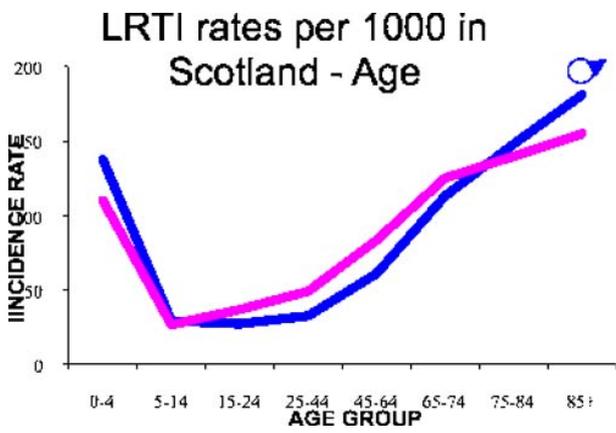
- The annual incidence of community acquired pneumonia in the United Kingdom is 5-11 cases per 1000 adult population.
 - CAP is the fifth leading cause of death in the UK.
 - A recent study found that the organism was an atypical one (e.g. *Mycoplasma pneumoniae*, *Chlamydia pneumoniae* and *Legionella* spp.) in 22% of cases of community acquired pneumonia where an organism was identified.
 - The frequency of pathogens can vary in specific patient groups, e.g. *Mycoplasma* and *Legionella* infections are less frequent in the elderly.
 - Community acquired MRSA is rare in Europe
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Risk factors

Risk factors for CAP include:

- Winter months
 - The very young and the very old
 - Chronic lung, heart, renal and liver disease
 - Diabetes mellitus
 - Immunosuppression
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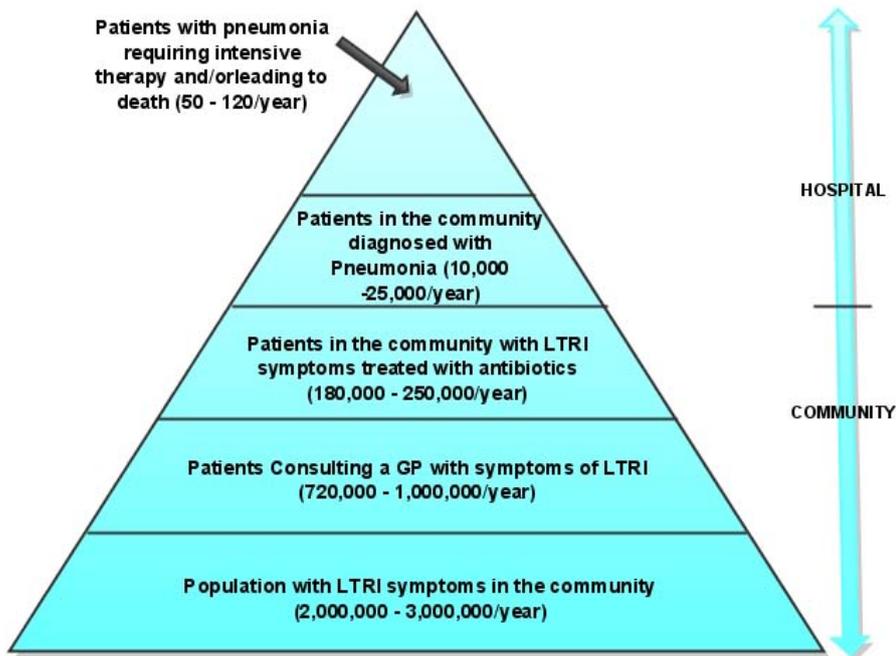
Incidence in Scotland



References:

1. SIGN guidelines 59 - Community Management of Lower Tract Respiratory Infection in Adults (<http://www.sign.ac.uk/guidelines/fulltext/59/index.html>)

Incidence of LRTI and pneumonia in adults in the community and in hospital in Scotland



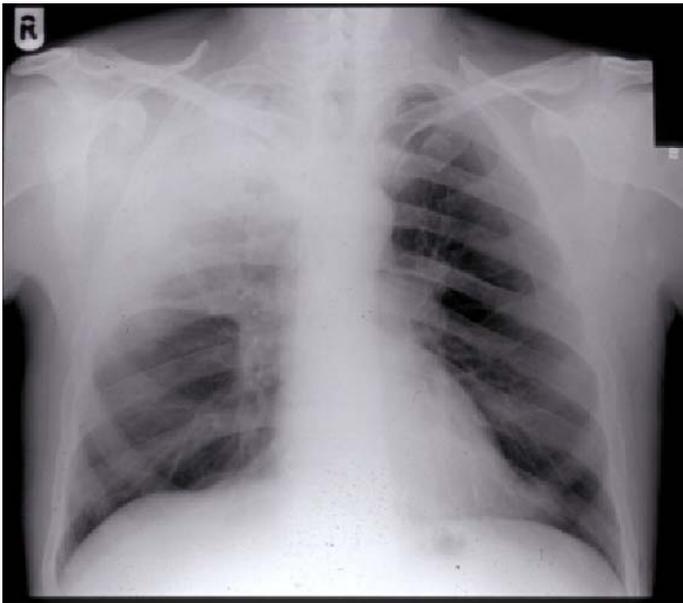
Chapter: Pathophysiology

Pathophysiology

CAP is usually acquired via inhalation or aspiration of pulmonary pathogenic organisms into a lung segment or lobe. Less commonly, CAP results from secondary bacteraemia from a distant source, such as *Escherichia coli* urinary tract infection and/or bacteraemia. CAP due to aspiration of oropharyngeal contents is the only form of CAP involving multiple pathogens.

It manifests as four general patterns.

1. Lobar pneumonia: involvement of an entire lung lobe



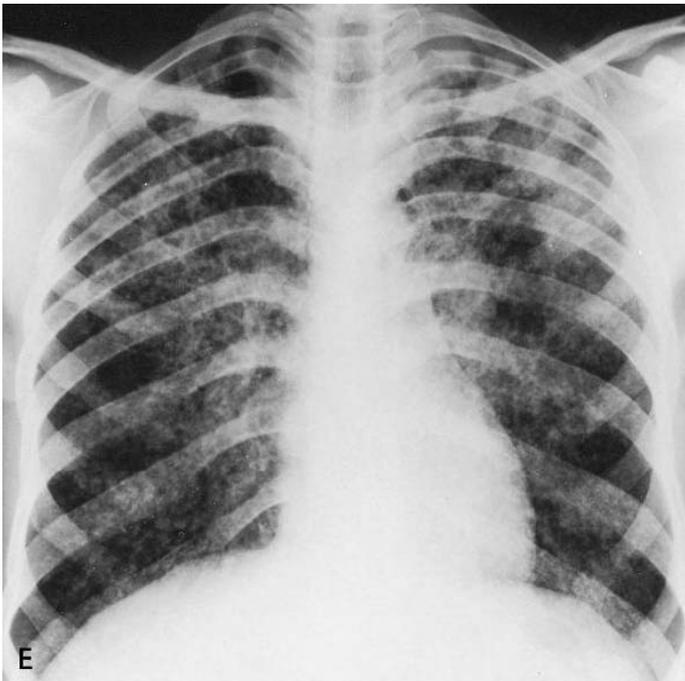
2. Bronchopneumonia: patchy consolidation in 1 or several lobes, usually in dependent lower or posterior portions centered around bronchi and bronchioles



3. Interstitial pneumonia: inflammation of the interstitium, including the alveolar walls and connective tissue around the bronchovascular tree



4. Miliary pneumonia: numerous discrete lesions due to hematogenous spread



Chapter: Risk Factors for Developing Pneumonia

CAP

Risk factor include:

- Alcoholism (relative risk [RR] 9)
- Asthma (RR 4.2)
- Immunosuppression (RR 1.9)
- Institutionalization

- Age > 70 years (RR 1.5 vs 60–69 years)
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Pneumococcal pneumonia

Risk factors for pneumococcal pneumonia include:

- Dementia
 - Seizures
 - Congestive heart failure
 - Cerebrovascular disease
 - Tobacco smoking
 - Alcoholism
 - Chronic obstructive pulmonary disease (COPD)
 - HIV infection
 - ~ Risk up to 40 times that in age-matched patients not infected with HIV.
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Invasive pneumococcal disease

Risk factors for invasive pneumococcal disease include:

- Male gender
 - African-American race
 - Chronic illness
 - Current tobacco smoking (strongest independent predictor among immunocompetent young adults)
 - Passive exposure to tobacco smoke
 - Immunologic defects
 - ~ Multiple myeloma
 - ~ Nephrotic syndrome with low serum immune globulin levels
 - ~ Splenectomy
 - ~ HIV infection
 - ~ Others
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Legionnaires' disease

Risk factors for Legionnaires' disease include:

- Male gender
 - Current tobacco smoking
 - Diabetes
 - Hematologic malignancy
 - Cancer
 - End-stage renal disease
 - HIV infection
 - Recent hotel stay or ship cruise
-

Gram-negative bacterial pneumonia

Risk factors for gram-negative bacterial pneumonia (including that caused by *Pseudomonas aeruginosa*)

- Probable aspiration
 - Previous hospital admission
 - Previous antimicrobial treatment
 - Bronchiectasis
 - Neutropenia
 - Comorbidities such as alcoholism, heart failure, or renal failure
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Alcohol use

Heavy drinkers

- Higher incidence of gram-negative bacterial pneumonia
 - ~ Worse clinical symptoms
 - ~ Require longer courses of IV antibiotic therapy than do nondrinkers
 - More prolonged fever, slower resolution, and a higher rate of empyema have been noted in pneumococcal pneumonia patients with chronic alcoholism than in their nondrinking counterparts.
 - The clinical entity designated ALPS—alcoholism, leukopenia, and pneumococcal sepsis—is associated with a mortality rate of 80%.
 - Excessive alcohol use is an independent risk factor for the development of acute respiratory distress syndrome (ARDS).
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Epidemiological risk factors

Epidemiological risk factors suggesting possible causes of CAP

- Alcoholism
 - ~ Streptococcus pneumoniae, oral anaerobes, Klebsiella pneumoniae, Acinetobacter spp., Mycobacterium tuberculosis
 - COPD and/or smoking
 - ~ Haemophilus influenzae, Pseudomonas aeruginosa, Legionella spp., S. pneumoniae, Moraxella catarrhalis, Chlamydomphila pneumoniae
 - Structural lung disease (e.g., bronchiectasis)
 - ~ P. aeruginosa, Burkholderia cepacia, S. aureus
 - Dementia, stroke, decreased level of consciousness
 - ~ Oral anaerobes, gram-negative enteric bacteria
 - Lung abscess
 - ~ Oral anaerobes, endemic fungi, M. tuberculosis, atypical mycobacteria
 - Stay in hotel or on cruise ship in previous 2 weeks
 - ~ Legionella spp.
 - Local influenza activity
 - ~ Influenza virus, S. pneumoniae, S. aureus
 - Exposure to birds
 - ~ Chlamydomphila psittaci
 - Exposure to sheep, goats, parturient cats
 - ~ Coxiella burnetii
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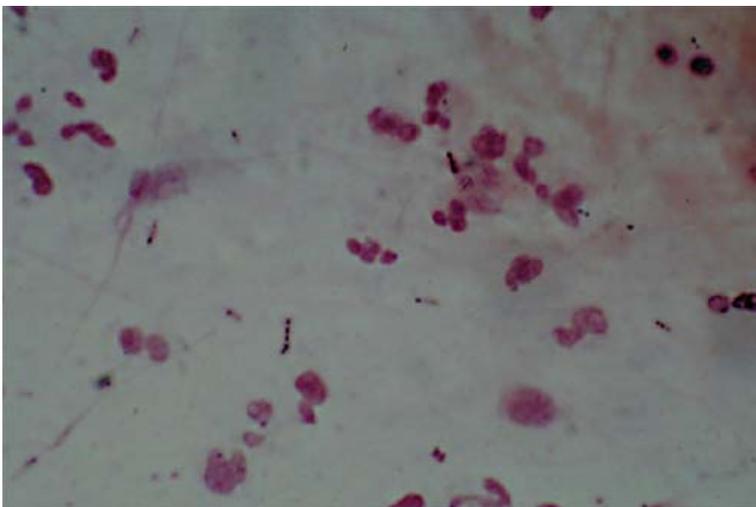
Chapter: Microbiology

Postive cultures

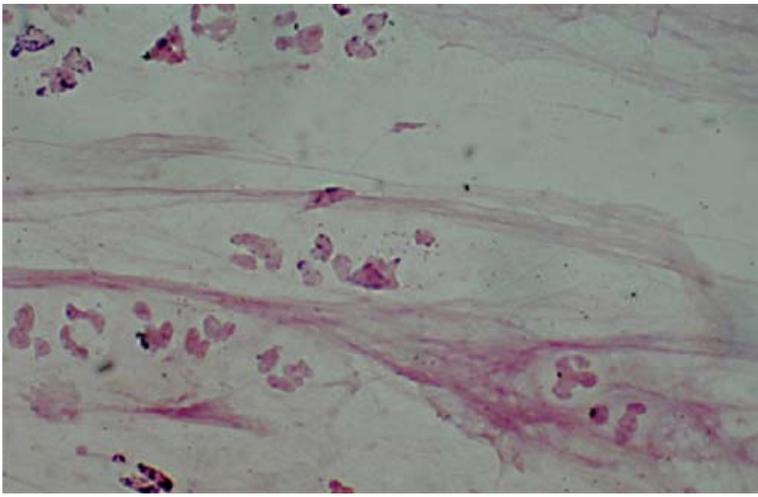
Positive cultures from CAP patients in UK studies.

Studies	Community 1 (n=236)	Hospital 4 (n=870)	ICU 4 (n=185)
Strep. pneumoniae	36%	36.1%	21.6%
H. influenzae	10.2%	4.5%	3.8%
Legionella spp	0.4%	3.7%	17.8%
Staph. aureus	0.8%	2.1%	8.7%
M. pneumoniae	1.3%	13.1%	2.7%
C. pneumoniae	?	?	?
Gram -ve enterobacteria	1.3%	1%	1.6%
Viruses	13.1%	9.1%	9.7%
Influenza A & B	8.1%	8.1%	5.4%
None found	45.3%	32.4%	32.4%

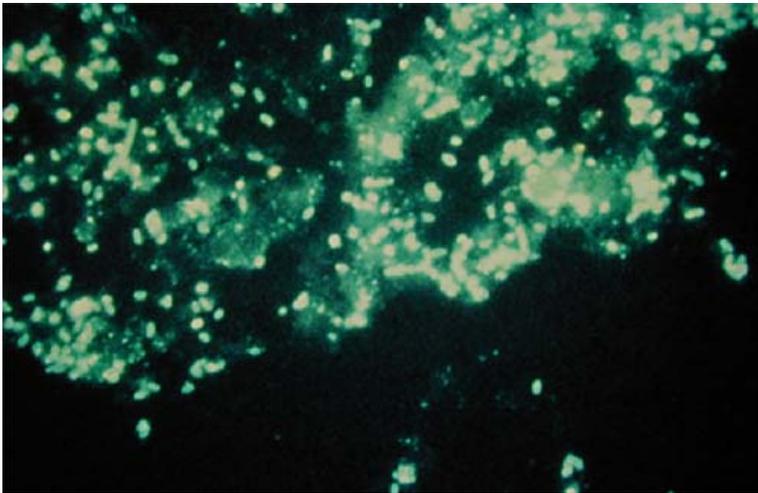
Gram stain Strep. pneumoniae



Gram stain Haemophilus influenzae



Sputum direct fluorescent antibody stain showing Legionella infection.



Images sourced from www.medscape.com

Chapter: Clinical: History/Examination Presentation

History

- Breathlessness
- Cough – usually productive of purulent sputum
- Occasional haemoptysis
- Pleuritic chest pain
- Fever / sweats
- Travel history
- Smoking history

Examination



Percussion



Respiratory examination

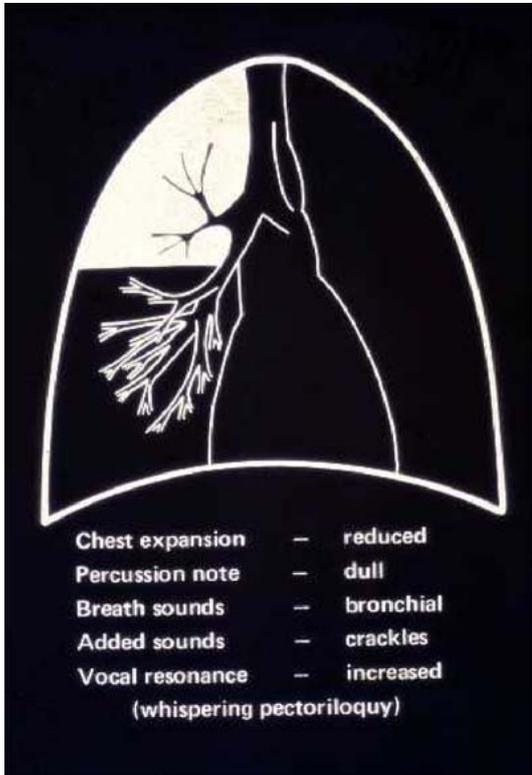
- Fever
- Tachypnea
- Tachycardia

- Chest examination (Have a look at this resource on Lung Sounds and the Stethoscope)
 - ~ Dullness to percussion
 - ~ Vocal fremitus
 - ~ Increased tactile fremitus: reflects underlying consolidated lung
 - ~ Decreased tactile fremitus: reflects pleural fluid
 - ~ Aegophony: an increased resonance of voice sounds heard when auscultating the lungs due to enhanced

transmission of high-frequency noise across fluid, such as in abnormal lung tissue, with lower frequencies filtered out.

- ~ Whispering pectoriloquy: similar to aegophony but whispered.
- ~ Bronchial breathing: sound of turbulent airflow of a harsh or blowing quality made by air moving in large bronchi that have surrounding consolidation. (Compare with auscultating over the trachea).
- ~ Crackles
- ~ Pleural friction rub

Diagram: The findings that would be present in a patient with purely consolidation and no effusion.



- Elderly
 - ~ May initially display new-onset or worsening confusion and few other manifestations
- Severely ill patients who have septic shock secondary to CAP
 - ~ Hypotension and evidence of organ failure

Differential diagnosis

- Congestive Heart Failure and Pulmonary Oedema
- Chronic bronchitis
- Myocardial infarction
- Asthma
- Tracheobronchitis
- SLE pneumonitis
- Acute drug hypersensitivity reactions
- Pulmonary embolus or infarction
- Bronchogenic carcinoma

Chapter: Investigations

Chest radiograph

- Obtain chest radiography to exclude conditions that mimic CAP and to confirm the presence of an infiltrate compatible with the presentation of CAP.
 - Patients presenting very early with CAP may have negative findings on chest radiography. In these patients, repeat chest radiography within 24 hours.
 - Chest radiography assists with the differentiation of viral pneumonias from non-viral pneumonias. Viral pneumonias display few or no infiltrates on chest radiography, but, when present, infiltrates are almost always bilateral, peri-hilar, symmetric, and interstitial. Bacterial pneumonias have a predominantly focal segmental or lobar distribution.
 - In contrast, typical or atypical pathogens produce a lobar or segmental pattern on chest radiography, with or without consolidation or pleural effusion.
 - Chest radiographic findings should be negative in patients with asthma who do not have CAP. Chest radiography findings are also negative in patients with chronic bronchitis.
 - The infiltrates observed with CHF appear as increased interstitial markings and vascular redistribution to the upper lobes. Patients with pre-existing heart failure usually have cardiomegaly.
 - Rapid cavitation is not a typical feature of CAP.
 - Aspiration pneumonitis may develop cavitation 1 week after aspiration. Signs of cavitation are absent on the initial chest radiograph in patients with CAP due to aspiration.
 - Cavitating CAP can be caused by *S. aureus* which usually follows on from influenza.
 - Rapidly progressive asymmetric infiltrates suggest the possibility of Legionnaires disease.
 - Chest radiographic findings worsen rapidly and require a significant period to improve. Clinical resolution occurs long before radiologic resolution.
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Other investigations

- Sputum culture (prior to antibiotic therapy)
- Blood cultures (particularly if pyrexial) – will often pick up *S. pneumoniae* and *H. Influenzae*. Take a look at this video on how to take blood cultures video
- Arterial blood gas analysis – tells you if patient has type 1 (hypoxia only) or type 2 (hypoxia with hypercapnoea) respiratory failure as well as any degree of metabolic acidosis from superadded sepsis i.e. how 'sick' the patient is. Take a look at this video on how to take ABG.
- Full blood count – to assess white blood cell count (high OR low important)
Urea and electrolytes – deranged renal function is an important indicator of severity (see severity scoring)
- Liver transaminases – rise may suggest Legionella, psittacosis or Q-fever
C-reactive protein (CRP) – a non-specific inflammatory marker. More useful if normal to exclude infection.
- Serology for atypical pathogens (*Legionella*, *mycoplasma*): may be negative in the early stages of these infections
- *Legionella* urinary antigen: applicable only for the *Legionella pneumophila* serogroup type I, which accounts for approximately 80% of infections. The urinary antigen test remains positive for *Legionella* for long periods but may be negative early in the infection.
- Pneumococcal urinary antigen

- Throat swab for viral PCR (particularly in severe pneumonia)
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Severity assessment

There are many severity scoring systems used to risk stratify patients with pneumonia. The most important stratification is to decide if a patient is non-severe (can be treated at home) or severe (must be aggressively treated in hospital). The scoring system most commonly used in the UK is the CURB-65 score. It is scored 0-5. Patients who score 3 or more have a 21-fold greater risk of death than those scoring less than 3.

CURB65

Confusion (new): Mental State Questionnaire (MSQ¹) score <8/10.

Urea: > 7 mmol/L

Respiratory rate 30 /min

Blood pressure: Systolic 90 mmHg, and/or Diastolic 60 mmHg

Age > 65 years

Other Indices of Severity

- Hypoxia: $paO_2 < 8Kpa$ or $saO_2 < 90\%$ with or without oxygen.
 - Bilateral or multi-lobar shadows on chest radiograph
 - Please note: fever, WCC and CRP are NOT related to prognosis
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Footnote

1. Mental State Questionnaire (MSQ)

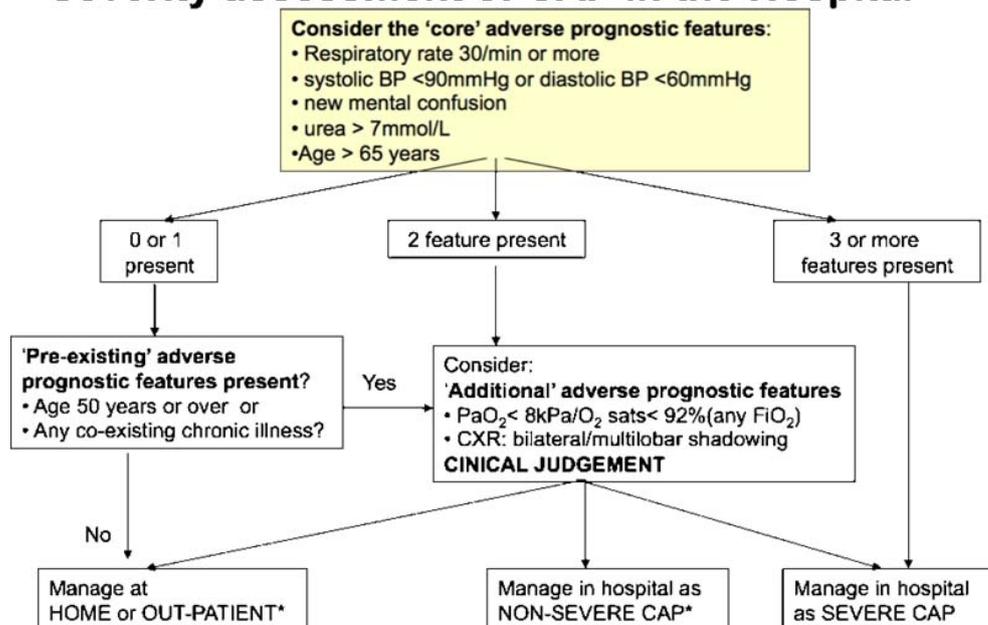
Item	Score
Today's DATE	1
Today's MONTH	1
Today's YEAR	1
This TOWN	1
Present SITUATION	1
AGE	1
MONTH of BIRTH	1
YEAR of BIRTH	1
PRIME MINISTER	1
PREVIOUS PRIME MINISTER	1

Chapter: Management of CAP

Management

As previously mentioned treatment is based on the severity of the patient's illness. See the following flow chart.

Severity assessment of CAP in the Hospital



* Also consider social circumstances and patient wishes

References:

1. SIGN guideline 59 (<http://www.sign.ac.uk/guidelines/fulltext/59/index.html>)

General management

- High flow oxygen - usually 35% or greater
- Aim to maintain paO₂>8Kpa or saO₂> 92%
- Monitor ABGs in COPD - look for pH?, pCO₂? as often need to give controlled oxygen therapy (aim for saO₂ between 88-92%)
- IV fluids should be given to all with severe pneumonia
- Paracetamol for pleuritic pain
- Consider nutritional supplements in prolonged illness
- May need intensive care input for mechanical ventilation if oxygen saturations not maintained

Antibiotic therapy

Antibiotic Man

Download and take a look at the antibiotic man, which gives guidelines on treating infection, from the download link above.

Early administration of antibiotics in patients with pneumonia is essential. It is recommended that this should occur within 4 hours of a patient being admitted to hospital with a pneumonia.

- Non-severe (CURB65 0 or 1)
 - ~ Oral Amoxicillin 1g tds or Doxycycline 100mg bd (if penicillin allergic)
- Severe (CURB 3-5)
 - ~ Intravenous Co-Amoxiclav 1.2g tds PLUS IV Clarithromycin 500mg bd
- When to use IV antibiotics

- ~ Severe Pneumonia
 - ~ Impaired consciousness
 - ~ Loss of swallowing reflexes
 - ~ Functional or anatomical reasons for malabsorption
- Remember to step down when IV therapy no longer required
- Duration of therapy (days)
- | | |
|--------------------------------------|-------|
| ~ Home treated, non-severe | 7 |
| ~ Hospital treated, non severe | 7 |
| ~ Hospital treated, severe pneumonia | 10 |
| ~ Pneumococcal (uncomplicated) | 7 |
| ~ Staphylococcal infection | 14-21 |
| ~ Legionella infection | 14-21 |
| ~ Gram negative enteric bacilli | 14-21 |
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Follow-up

Patients over the age of 55 years and who have been smokers should have a follow-up chest radiograph at 6 weeks after their initial presentation. This is to ensure clearance of the pneumonia but more importantly to ensure there has been no underlying bronchial neoplasm as the cause.

Chapter: Complications

General complications

Because most patients hospitalized with pneumonia are elderly and have multiple comorbid conditions, complications during the hospital stay are not uncommon.

The most common complications are:

- Respiratory failure
- Congestive heart failure
- Shock
- Atrial dysrhythmias
- Myocardial infarction
- GI bleeding
- Renal insufficiency

Other complications include:

- Multiorgan failure
- Bleeding diatheses
- Exacerbation of comorbid conditions

Only ~30% of patients hospitalized for the treatment of pneumonia have no complications.

Major systemic complication is bacteremia.

- Can lead to metastatic infection, including septic arthritis or meningitis
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Complicated pleural effusion

- Pleural effusion is seen in ~40% of patients hospitalized for CAP.
- All patients with a pleural effusion should have ultrasound imaging of the affected side.

- If the effusion is > 1 cm, the fluid should be aspirated.
 - If the fluid has a pH of < 7.2, a glucose level of < 2.2 mmol/L, and an LDH content of > 1000 units and is positive on Gram's staining or culture, it should be drained.
 - If frank pus is aspirated, insertion of a large-bore chest tube is recommended.
 - The goal is eradication of the collection.
 - ~ Follow-up with postdrainage imaging is required to confirm adequate catheter placement and complete pleural fluid drainage.
 - Thoracotomy and decortication may be necessary.
 - All patients with a complicated pleural effusion, as defined above, should have a consultation with a thoracic surgeon.
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Lung abscess

Incidence of lung abscess

- Uncommon; 4–5 cases/10,000 hospital admissions

Risk factors

- Conditions associated with impaired cough reflex and/or aspiration, such as alcoholism, anesthesia, drug abuse, epilepsy, and stroke
- Dental caries
- Bronchiectasis
- Bronchial carcinoma
- Pulmonary infarction

Etiology

- Most aspiration-associated lung abscesses are due to a combination of aerobic and anaerobic bacteria.
 - On average, 6 or 7 bacterial species are identified in an individual case.
 - In HIV-infected patients, lung abscesses can be due to *Pneumocystis*, *Rhodococcus equi*, and *Cryptococcus neoformans* as well as the bacteria noted above.
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Recurrent pneumonia

- Of patients hospitalized for the treatment of CAP, 10–15% have another episode within 2 years.
 - If the recurrence affects the same anatomic location as the previous episode, the most likely cause is an obstructed bronchus due to either a tumor or a foreign body.
 - COPD and repeated macroaspiration are the most common causes of recurrent pneumonia.
 - Persons without COPD, with pneumonia in a different location from the previous episode, and with no risk factors for aspiration should undergo evaluation for immunodeficiency (including HIV testing), immunoglobulin determination, protein electrophoresis, and enumeration of T and B cells.
 - CT of the chest often detects pulmonary anatomic defects (e.g., bronchiectasis) that might be the cause of the recurrence.
-

Chapter: Prognosis

Prognosis of CAP

- The severity and prognosis of CAP depends primarily on host factors, such as the status of the cardiopulmonary system and splenic function. Obviously, when all other factors are equal, older patients do not fare as well as younger adults.
- Patients with CAP who have impaired splenic function may develop overwhelming pneumococcal sepsis, potentially

leading to death within 12-24 hours, regardless of the antimicrobial regimen used.

- Negative prognostic factors include pre-existing lung disease, underlying cardiac disease, advanced age, multilobar involvement, and delayed initiation of appropriate antimicrobial therapy.

Chapter: Prevention

Influenza & pneumococcal immunisations

The severity and prognosis of CAP depends primarily on host factors, such as the status of the cardiopulmonary system and splenic function. Obviously, when all other factors are equal, older patients do not fare as well as younger adults. Patients with CAP who have impaired splenic function may develop overwhelming pneumococcal sepsis, potentially leading to death within 12-24 hours, regardless of the antimicrobial regimen used.

Influenza vaccine is prepared each year using viruses similar to those considered most likely to be circulating in the forthcoming winter. The UK Departments of Health recommend that the influenza vaccine is given to all people aged 65 years or older and to people of any age

- with chronic respiratory disease including asthma
- with chronic heart disease
- with chronic renal disease
- with immunosuppression due to disease or treatment
- with diabetes mellitus
- in long stay residential care
- health and social care workers of all ages who have regular direct contact with high risk patients or clients.

Influenza vaccine is contraindicated for those with hypersensitivity to hen's eggs.

Pneumococcal polysaccharide vaccine (PPV) should be given to all those aged two years or older in whom pneumococcal infection is likely to be more common or more serious in terms of increased morbidity and mortality (those with chronic lung disease, underlying medical conditions or severely immunocompromised).

PPV should be given to all people over the age of 65 years, on a one-off basis, to be administered when patients receive their routine annual influenza vaccine.

Pneumococcal and influenza vaccines can safely be given concurrently at different sites.

PPV should not be given during acute infection and is not recommended during pregnancy.

Revaccination with PPV within three years is contraindicated but revaccination after five years should be considered in those at increased risk including asplenic, hyposplenic and nephrotic patients.

Smoking cessation

It is essential that patients who smoke be given advice to stop smoking as well as information on methods that may help to do so.

Chapter: External references

References

References:

1. British Thoracic Society - CAP guidelines

(<http://www.brit-thoracic.org.uk/ClinicalInformation/Pneumonia/PneumoniaGuidelines/tabid/136/Default.aspx>)

2. SIGN guidelines (<http://www.sign.ac.uk/guidelines/fulltext/59/index.html>)
