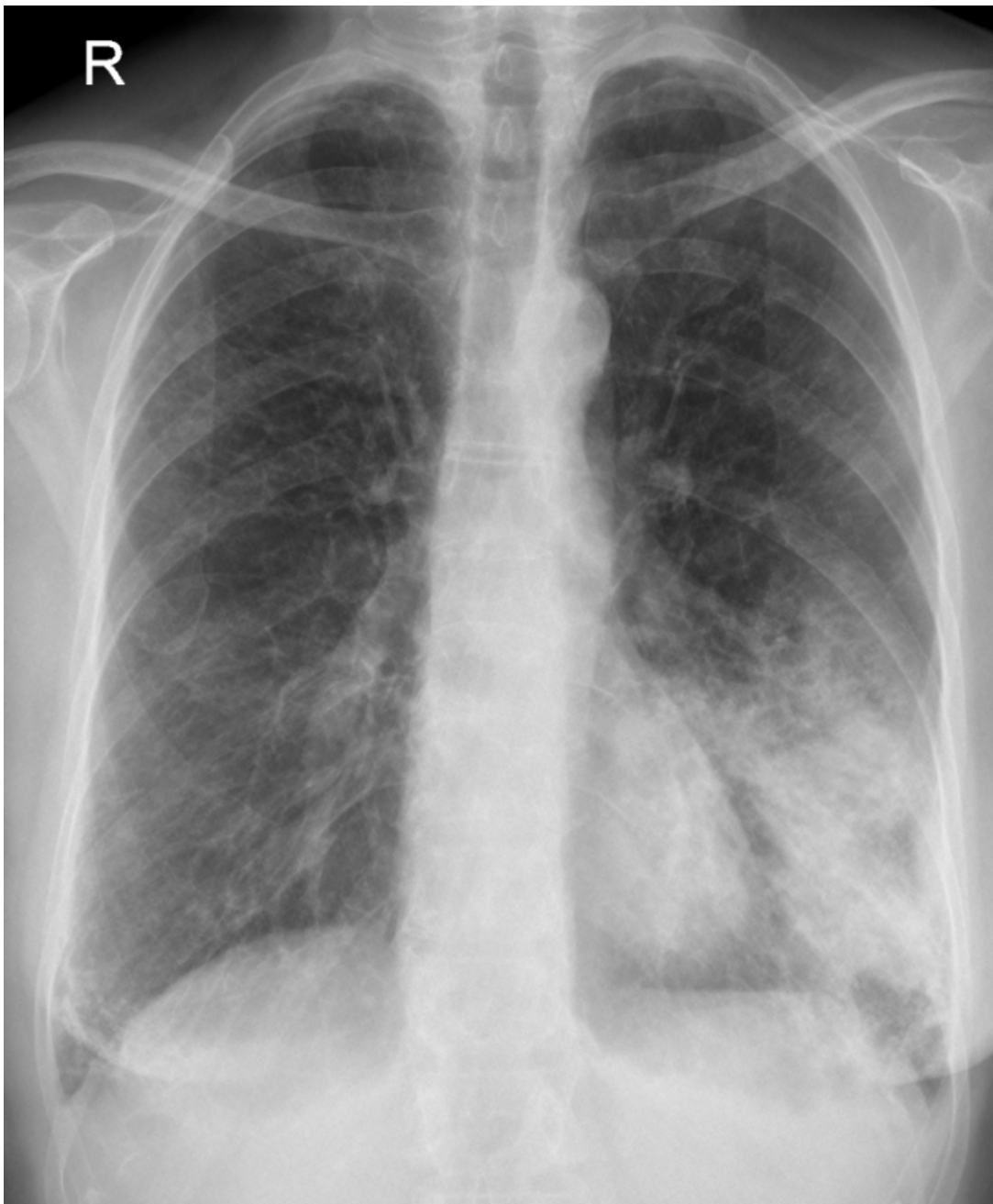


Pneumonia — Classification, Diagnosis and Treatment

[See online here](#)

Its high morbidity and mortality make pneumonia one of the major infectious diseases worldwide. Learn about the pathogenic causes as well as the individual types of pneumonia, in order to be able to reliably differentiate and treat it in clinical practice.



Definition of Pneumonia

Pneumonia—an inflammation of the lungs with various causes

Pneumonia or (pulmonary inflammation) is an **acute or chronic inflammation of lung tissue**. Causes include infection with **bacteria, viruses or fungi**. In more rare cases, pneumonia can also be caused through toxic triggers through inhalation of toxic substances, immunological processes or in the course of radiotherapy.

Note: Pneumonia, also known as pulmonary inflammation, is an inflammation of the lung parenchyma, caused by infectious agents.

Classification of pneumonia

Classification of pneumonia in literature is not uniform and is determined either by the location of its occurrence, the site of infection, etiology or its underlying pathogenic causes.

The Primary Pneumonia ist pneumonia of a healthy lung with the Pathogens:

- Pneumococci
- Staphylococci
- [Haemophilus influenzae](#)
- Mycoplasma
- [Chlamydia](#)
- Legionella
- Adenovirus and parainfluenza viruses

The Secondary Pneumonia is pneumonia as a secondary infection or as a super propagated infection of the bronchi. Involved pathogens are:

- [Herpes viruses](#)
- [Fungi](#)
- Protozoa
- Anaerobes

Classification of pneumonia according to the site of infection

Since the germ reservoir varies from place to place, knowledge of the place of the infection can often be of immanent importance for the diagnosis and treatment. We, therefore, make the following distinctions:

Community-acquired pneumonia (CAP)

Pneumonia acquired outside of hospitals with the pathogens streptococcus pneumoniae, haemophilus influenzae, chlamydia pneumoniae, legionella.

Hospital-acquired pneumonia (HAP)

Pneumonia acquired during hospitalization with the pathogens Pseudomonas aeruginosa, enterobacter, E. coli, Proteus, Serratia, klebsiella pneumoniae.

Pneumonia under immunosuppression

Pneumonia due to congenital or acquired immune deficiencies. Common variable immunodeficiency (CVID): granulocyte macrophage defects and immunosuppressive therapy for HIV infection, neutropenia, organ transplantation.

Classic classification of pneumonia according to the location of its occurrence in the lung

Lobar pneumonia

Pneumonia of a single pulmonary lobe with possible involvement of the pleura.

Symptoms: fever, cough, dyspnea, tachypnea, rust brown sputum (red hepatization), hemoptysis, fever blisters. **Involved pathogens are:**

- Pneumococcus (*Streptococcus pneumoniae*)
- Staphylococcus
- Haemophilus influenzae
- Klebsiella

Interstitial pneumonia

Inflammation of large areas of the lung under the restriction of interstitial lung scaffold; symptoms: cough, tachypnea, dyspnea. Involved pathogens are viruses, intracellular proliferating bacteria such as chlamydia, mycoplasma, legionella.

Bronchial pneumonia

Propagated from bacterial bronchitis, usually only affecting individual segments of a pulmonary lobe. Involved pathogens are bacteria.

Classification of pneumonia according to its underlying pathogenic cause

Significant **pathogenic causes** for the occurrence of pneumonia are **bacteria, viruses, and fungi**. It is customary to conceptually combine typical pneumonia, which is caused by bacteria, with **lobar pneumonia**, therefore it is often referred to as typical lobar pneumonia in literature. The same applies to **atypical pneumonia** which is usually induced virally or by a fungus and which is conceptually combined with **interstitial pneumonia**. An estimated 20 % of occurring pneumonia is atypical pneumonia.

Typical pneumonia

Acute inflammation, concerning one or more lung lobes. Symptoms are fever, chills, painful cough, purulent mucus, possibly pleural effusion. Involved pathogens are pneumococcus (*Streptococcus pneumoniae*), staphylococcus, klebsiella, pseudomonas, proteus.

Atypical pneumonia

Inflammation of the interstitial lung tissue with the symptoms possible moderate fever, dry cough. Involved pathogens are viruses, chlamydia, rickettsia, mycoplasma, legionella, pneumocystis jirovecii, coxiella burnetii.

Classification of pneumonia according to its etiology

Sometimes pneumonia is defined in terms of its etiology. **Possible etiological causes are:**

- Etiological definition of pneumonia
- Pneumonia in chronic lung disease

- Pneumonia in other underlying diseases
- Pneumonia after aspiration
- Pneumonia due to allergic causes

Epidemiology of Pneumonia

Pneumonia, the second leading infectious disease worldwide

With community-acquired pneumonia being the second most commonly detected infectious disease worldwide, it is of great economic as well as socio-economic importance. In Germany, there are approximately **400,000 to 600,000 cases per year**. The incidence rate is estimated to be approximately one to eleven cases per 1,000 inhabitants per year while the rate in retirement homes is much higher and rockets to 68 to 114 cases per 1,000 people.

The main pathogens are:

- Pneumococci (25—45 %)
- Haemophilus influenzae (5—20 %)
- Mycoplasma pneumoniae (5—15 %), the most common pneumonia pathogen in adolescents and young adults
- [Viruses, fungi and other bacteria](#) (5—25 %)

Note: Community-acquired pneumonia (CAP) is the second most commonly detected infectious disease worldwide. In Germany, approximately 700,000 cases of the disease are estimated per year. Hospital-acquired pneumonia is the most important hospital-acquired infectious disease.

Etiology of Pneumonia

The most common causes of pneumonia

Common causes of pneumonia generally are pathological changes of the airways and lung tissue, local or systemic immunodeficiency, bed confinement and age.

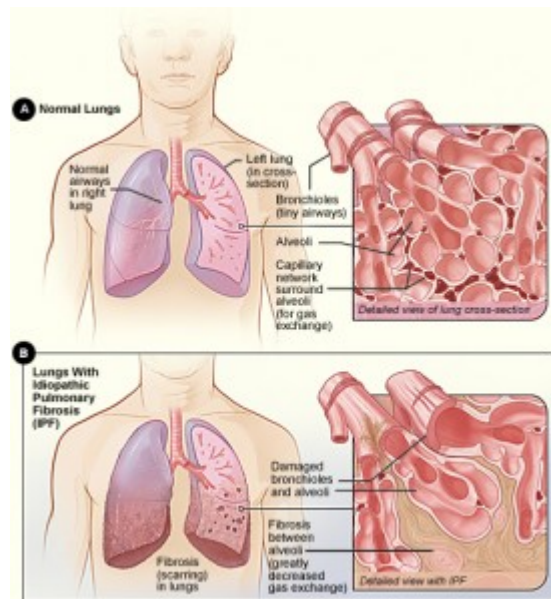


Image: “pulmonary fibrosis” by National Heart Lung and Blood Institute (NIH). License: [Public Domain](#)

The main pulmonary pre-existing conditions that increase the risk of pneumonia are:

- [COPD](#)
- [Pulmonary fibrosis](#)
- [Bronchiectasis](#)
- [Cystic fibrosis](#)

Other predisposing factors that increase the risk of pneumonia due to general immune deficiency are:

- [HIV infection](#)
- [Leukemia](#)
- Lymphomas
- Tumors ([lung cancer](#))
- Therapy with corticosteroids and immunosuppressants
- [Diabetes mellitus](#)
- Renal insufficiency

In addition to pre-existing medical conditions that weaken the immune system, often other trigger events favor the emergence of pneumonia:

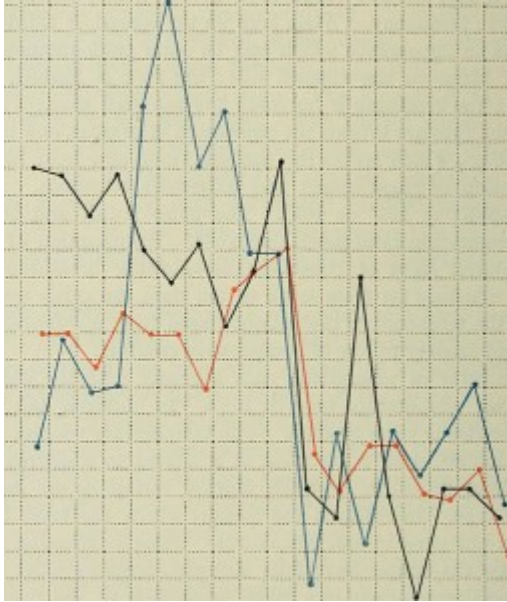
- Aspiration of gastric content and food
- [Pulmonary embolism](#)
- Pulmonary congestion with left ventricular failure
- Basal hypoventilation (bed confinement/shallow breathing)

Note: The most common cause of pneumonia is a pneumococcal infection. Typical lobar pneumonia is caused by bacteria, atypical interstitial pneumonia usually by viruses and intracellular proliferating bacteria.

Pathogenesis of Pneumonia

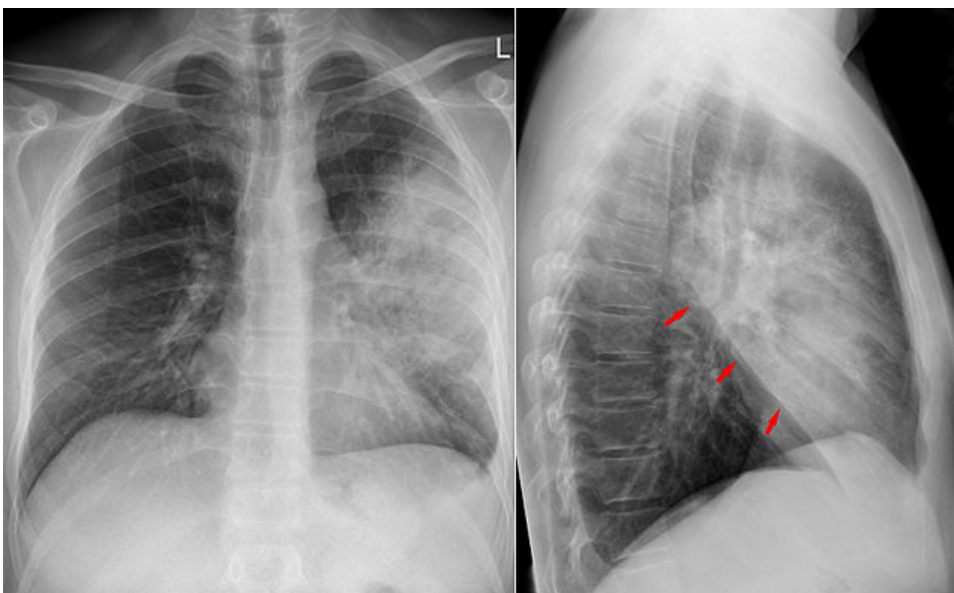
Pathogenesis of typical lobar pneumonia

Approximately 90 % of all pneumonia cases are caused by bacteria. Untreated, the majority of these cases display the course of typical lobar pneumonia. This usually starts acutely and suddenly, with chills and is followed by rapidly rising fever. Further symptoms that develop during the course are:



Fever Chart pulse (red) and breathing (blue) in lobar pneumonia

- Painful [cough](#)
- [Dyspnea](#)
- Tachypnea
- [Tachycardia](#)
- Purulent sputum
- [Pleural effusion](#)
- [Hemoptysis](#)



[Image](#): "Typical X-ray image of lobar pneumonia in the left upper lobe. The arrows point to the border

In addition to these symptoms, the expected course of a typical case of lobar pneumonia is divided into three stages:

Stage 1: **Engorgement** (accumulation of serous fluid in the alveoli)

Stage 2: **Red hepatization** (russet colored sputum due to the admixture of blood)

Stage 3: **Yellow hepatization** (liquefaction of the secretion and subsequent resorption)

Pathogenesis of atypical interstitial pneumonia



Image: “AP chest x-ray of a patient with pneumocystis jiroveci pneumonia, showing reticular interstitial markings in all lung fields. Released into public domain on permission of patient.” by Samir. License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

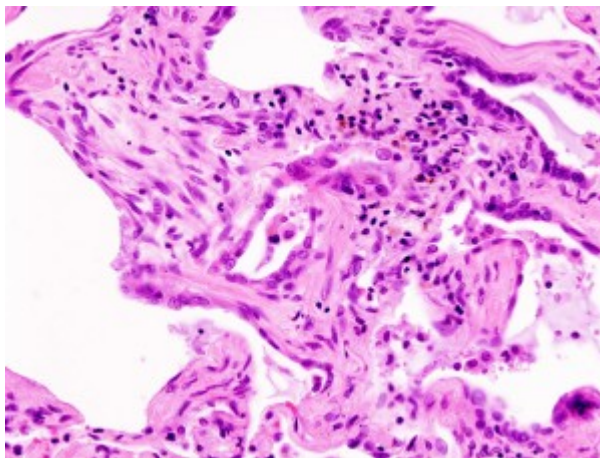


Image: “Histopathological image of pulmonary fibrosis representing usual interstitial pneumonia (UIP).” by KGH. License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

Atypical pneumonia begins insidiously. A cough is dry. The patient complains of a headache and aching limbs with moderate fever. Overall, the symptoms of atypical interstitial pneumonia are less clear and acute than those of typical lobar pneumonia.

Diagnosis of Pneumonia

Note: The nature of the diagnosis depends on the severity of pneumonia. Primary, typical community-acquired pneumonia usually only requires clinical examination. The diagnosis of secondary, atypical, hospital-acquired pneumonia, on the other hand, is achieved by the clinic, pathogen detection, and laboratory findings. The most important diagnostic measure is a chest X-ray.

Clinic of pneumonia

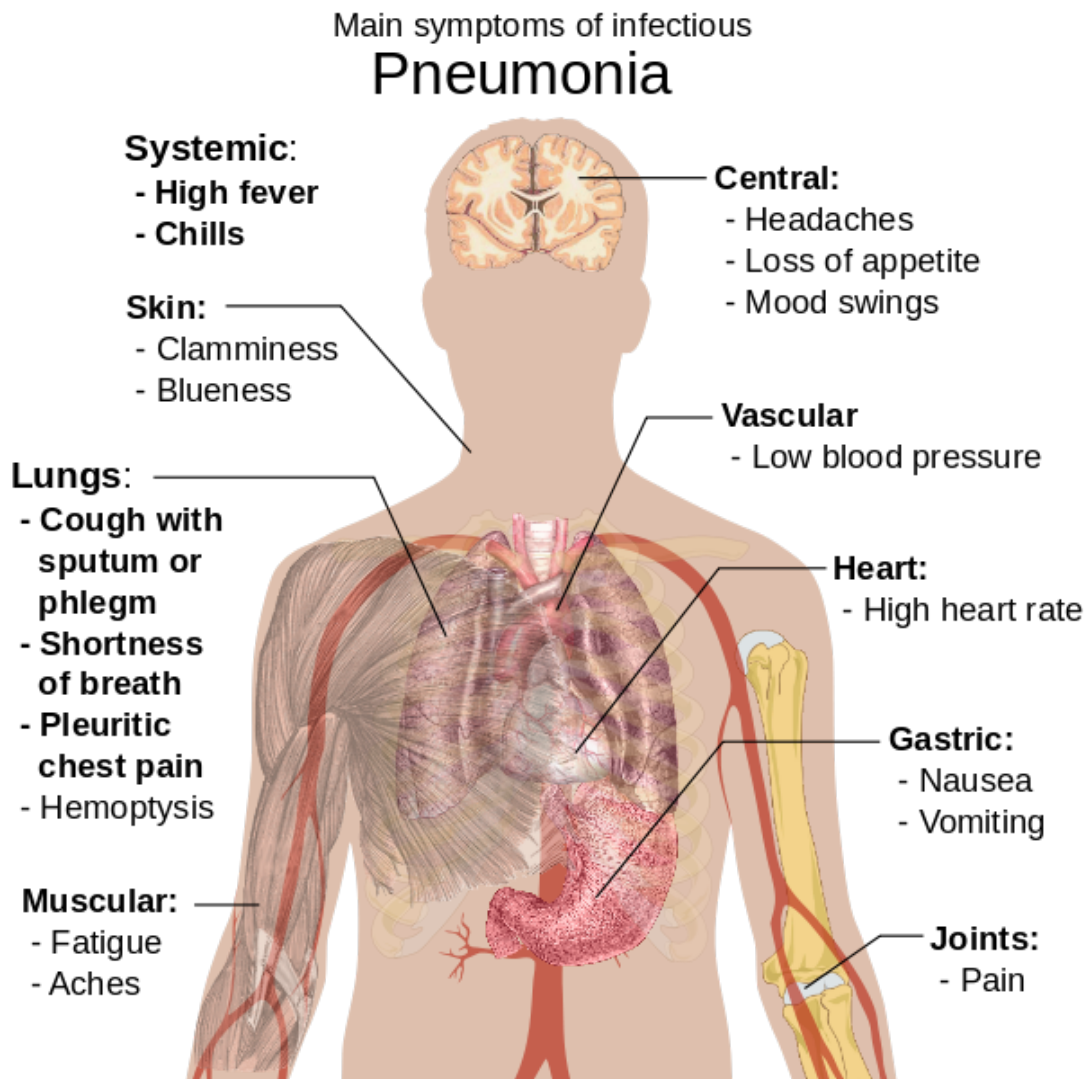


Image: "Main symptoms of infectious pneumonia." by Mikael Häggström. License: [Public Domain](#)

Primary, community-acquired pneumonia (CAP) is generally diagnosed clinically in uncomplicated cases. **Physical examination shows:**

- On percussion damping above the affected area
- Increased vocal fremitus in the affected area
- Bronchial respiration
- Fine bubble rales
- In case of additional, accompanying pleuritis: coarse bubbling, bronchial sounds

Cases of severe, secondary, hospital-acquired pneumonia (HAP) usually require targeted

therapeutic intervention consisting of a three-step approach of the clinic, laboratory tests, and pathogen detection. Pathogen detection is achieved from sputum. Apart from a possibly intensified breathing sound (bronchial breathing), little diagnostic evidence can be detected clinically. The sensitivity and specificity only are around 60 %. Typical laboratory parameters are:

CRP ↑

BSG ↑

leucocytes ↑

Chest X-ray for diagnosis of pneumonia



Image: "Pneumonia in chest X-ray" by Hellerhoff.
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The **most important diagnostic measure** to diagnose pneumonia is the **chest X-ray**. For a detailed investigation of pneumonia, two X-ray images are made. Less ventilated lung areas show up light in the radiograph. Amongst other things, this can be observed with massive immigration of leukocytes (infiltration).

Typical lobar pneumonia can be characterized by homogeneous shading, possibly several lobes or lobe segments in a row affected simultaneously. The **atypical interstitial pneumonia** has increased interstitial markings; distributed throughout the lungs or accentuated nuclear shadowing.

Bronchial pneumonia can be characterized by scattered focal, confluent infiltrates possibly scattered throughout the lungs and the **alveolar pneumonia** is marked through alveolar space filled with exudate.

Further diagnostic measures for pneumonia

If the findings remain unclear after the clinic, laboratory, chest X-ray and pathogen detection, the following diagnostic measures can be added:

- Sonogram for determination of pleural effusion

- [Computer tomography](#) for a more precise evaluation of the location and extent of inflammation

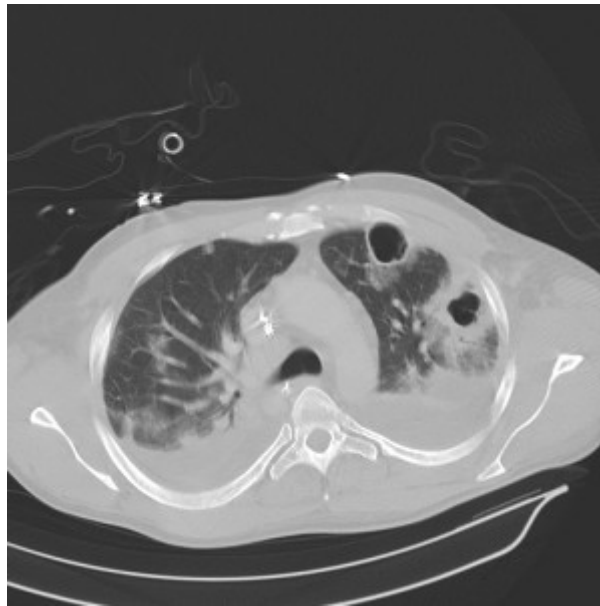


Image: "Computed tomography (CT) scan of chest showing bilateral pneumonia with abscesses, effusions, and caverns. 37-year-old male." by Charitaras A. License: [CC BY-SA 3.0](#)

- A lung perfusion scintigraphy to study the blood flow to the lungs for suspected [pulmonary embolism](#)
- A bronchoscopy to detect foreign bodies or tumors in the airways
- A bronchial lavage for targeted sampling of pathogenic liquids

Note: The main symptoms are cough, dyspnea, and fever.

Differential Diagnosis

Similar diseases to pneumonia

The following diseases can display similar symptoms and test results to pneumonia:

- [Bronchial carcinoma](#)
- Pulmonary [tuberculosis](#)
- [Pulmonary embolism](#) with infarction
- [Pulmonary fibrosis](#)

Therapy of Pneumonia

Different therapeutic strategies for the treatment of pneumonia

Treatment of pneumonia depends on the respective underlying pathogens, the severity of the disease and individual risk factors to be assessed for each patient such as age, comorbidities, and previous antibiotic treatments. If risk factors are present, the patient should be hospitalized, in severe clinical cases possibly in the ICU.

Therapeutic measures for community-acquired pneumonia (CAP)

Since the majority of pneumonia has a bacterial origin, community-acquired pneumonia is treated with a **carefully selected antibiotic therapy** without prior pathogen detection. Uncomplicated cases are usually treated with aminopenicillins. The duration of therapy lies around 7–10 days.

Therapeutic measures in hospital-acquired pneumonia (HAP)

Prior to the initiation of antibiotic therapy, pathogen detection is essential in hospital-acquired pneumonia. Depending on the severity of the clinical picture, a calculated antibiotic therapy can subsequently be introduced intravenously, which upon a characterization of the pathogen, can then be adapted if necessary. The duration of the therapy lies around 7 days.

Complications of Pneumonia

In case of late treatment or protraction, pneumonia can lead to serious complications that affect the pulmonary parenchyma or even go beyond that and affect the entire organism. Frequently affected body parts are blood, brain, and heart. One of the major complications is a **lung abscess**.

Lung abscesses as a complication of pneumonia

A lung abscess is a purulent fusion of the lung tissue (necrosis). **Pneumonia pathogens that frequently cause a lung abscess are:**

- Staphylococcus
- Klebsiella
- Anaerobes

Other possible non-infectious causes for the formation of a lung abscess are:

- Aspiration of foreign bodies or gastric acid
- Local reduced perfusion, e.g. due to a pulmonary infarction
- [Bronchial carcinoma](#)

The clinic of lung abscesses is dominated by symptoms such as **cough, dyspnea, fever and chest pain**. If the abscess collapses into a bronchus this is clinically displayed clearly in a sudden occurrence of severe purulent sputum (**two-layer sputum**). The ejected material is partly purulent, partly putrid. Hence, the evil putrid mouth-and breath odor which can occur concomitantly (halitosis).

Therapeutically, a calculated long-term treatment with antibiotics and if appropriate, simultaneous postural drainage or direct abscess drainage should be performed. In the worst case, surgical intervention is required (resection).

More complications of pneumonia to be aware of

- Pleurisy
- [Pleural empyema](#)

- Pneumogenic sepsis
- [Acute progressive respiratory failure \(ARDS\)](#)
- An endogenous inflammatory response of the whole organism ([SIRS](#))
- Pneumatoceles

If signs of pneumonia are still visible in the X-ray after six to eight weeks, it must be assumed that the disease has become chronic. In general, this usually affects patients with a weak immune system and existing chronic diseases.

Note: The main complications of pneumonia are lung abscesses, pleurisy, pleural empyema and pneumogenic sepsis.

Prognosis of Pneumonia

Different types of pneumonia have different prognoses

The prognosis highly depends on the type of pneumonia. While primary community-acquired pneumonia has a good prognosis with a fatality rate below 1 %, the mortality rate in secondary hospital-acquired pneumonia is about 20 %. Cases of pneumonia that require hospitalization have a mortality rate of > 10 %.

Note: CAP: mortality < 1 %; HAP: mortality about 20 %; pneumonia requiring hospitalization: fatality rate > 10 %

Prevention

Pneumococcal vaccination for pneumonia prevention

Risk groups such as infants, diabetics, patients with the weakened immune system, patients older than 65 with recurrent respiratory diseases and patients after splenectomy are advised to get vaccinated against pneumococcus.

Flu vaccination for the prevention of pneumonia

An annual flu shot is recommended for people over 60 years who are in close contact with many people occupationally (nurses, kindergarten staff, retailers). **Furthermore, people with the following underlying diseases are encouraged to get a basic flu shot:**

- People with cardiovascular diseases such as [hypertension](#) or [angina](#)
- People with lung disease such as [asthma](#) or [chronic bronchitis](#)
- People with metabolic disorders such as [diabetes mellitus](#)
- People with [kidney disease](#)
- [HIV](#)-infected patients
- [Leukemia](#) patients

Other preventive measures against pneumonia:

- [Haemophilus influenza vaccination](#)
- Strict abstinence from smoking
- Wearing respirators in occupations with exposure to dust

Review Questions

The answers are below the references.

1. In microscopic slides of the sputum of suspected pneumonia patients, rounded up lancet-shaped bacteria, mounted in pairs, is often observed. It most likely involves:

- A. Treponemes
- B. Vibrios
- C. Clostridia
- D. Staphylococci
- E. Pneumococci

2. Mycoplasma is...

- A. ...bacteria without cell walls.
- B. ...capsule-forming bacteria.
- C. ...animal viruses.
- D. ...bacteria formed under the influence of penicillin.
- E. ...bacteria treated with lysozyme.

3. Alveolar epithelial...

- A. ...has kinocilia.
- B. ...is superimposed by surfactant on the surface.
- C. ...has goblet cells, amongst others.
- D. ...is underlaid by smooth muscle.
- E. ...cannot regenerate.

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Correct answers: 1E, 2A, 3D

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