Pneumonia — Classification, Diagnosis and Treatment

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Pneumonia is one of the major infectious diseases worldwide due to its high morbidity and mortality. 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 by 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

The 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 is the 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. The 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 imminent 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*, and *legionella*.

Hospital-acquired pneumonia (HAP)

Pneumonia acquired during hospitalization with the pathogens *Pseudomonas aeruginosa*, enterobacter, *Eschericia coli*, proteus, serratis, and *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, and fever blisters. The involved pathogens are:

- *Pneumococcus* (*S. pneumoniae*)
- *Staphylococcus*
- *H. 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 and intracellular proliferating bacteria such as chlamydia, mycoplasma, and 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 the 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 the occurring pneumonia is atypical pneumonia.

Typical pneumonia

Acute inflammation, associated with 1 or more lobes of the lungs. Symptoms are fever, chills, painful cough, purulent mucus, and possibly pleural effusion. Involved pathogens are *pneumococcus* (*S. pneumoniae*), *staphylococcus*, *klebsiella*, *pseudomonas*, and *proteus*.

Atypical pneumonia

Inflammation of the interstitial lung tissue with the symptoms of possible moderate fever and dry cough. The involved pathogens are viruses, *chlamydia*, *rickettsia*, *mycoplasma*, *legionella*, *Pneumocystis jirovecii*, and *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 2nd-most commonly detected infectious disease worldwide, it is of great economic as well as socio-economic importance.

**The main pathogens are:**

- *Pneumococci* (25–45%)
- *H. influenzae* (5–20%)
- *M. 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. 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:

- Chronic obstructive pulmonary disease (COPD)
- Pulmonary fibrosis
- Bronchiectasis
- Cystic fibrosis

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

- Human immunodeficiency virus (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 and atypical interstitial pneumonia is usually caused by viruses and intracellular proliferating bacteria.

Pathogenesis of Pneumonia

Pathogenesis of typical lobar pneumonia

Approx. 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:

- Painful cough
- Dyspnea
- Tachypnea
- Tachycardia
- Purulent sputum
- Pleural effusion
- Hemoptysis
In addition to these symptoms, the expected course of a typical case of lobar pneumonia is divided into 3 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

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.
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 and bronchial sounds

Cases of severe, secondary, hospital-acquired pneumonia (HAP) usually require targeted therapeutic intervention consisting of a 3-step approach of the clinic, laboratory tests, and pathogen detection. Pathogen detection is achieved from the 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↑
The **most important diagnostic measure** to diagnose pneumonia is the **chest X-ray**. For a detailed investigation of pneumonia, 2 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 the 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
Lung perfusion scintigraphy to study the blood flow to the lungs for suspected pulmonary embolism
- Bronchoscopy to detect foreign bodies or tumors in the airways
- 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](https://www.cancer.gov/types/lung/hp/pdq/patient/overview-professional-use#section-5)
- Pulmonary [tuberculosis](https://www.cdc.gov/tuberculosis/index.html)
- 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 intensive care unit (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 is 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 the 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 (**2-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 6–8 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 CAP has a good prognosis with a fatality rate below 1%, the mortality rate in secondary HAP is approx. 20%. Cases of pneumonia that require hospitalization have a mortality rate of > 10%.

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

### Prevention

#### Pneumococcal vaccination for pneumonia prevention

Risk groups such as infants, diabetics, patients with 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, and 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:

- *H. influenza* vaccination
- Strict abstinence from smoking
Wearing respirators in occupations with exposure to dust

References


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