

Pneumonia (pediatrics)

Pneumonia is the acute or chronic **inflammation of the lung parenchyma** due to **infectious, allergic, physical, or chemical noxious agents**. It usually represents an acute inflammation **at the level of the respiratory bronchioles, alveolar spaces, and interstitium**. Pneumonia is the third leading cause of death worldwide. The causative agent is usually recognized in up to 50% of cases.^{[1][2][3]}

Pneumonias occur particularly **often in the first year of life**, after which their incidence decreases. In the Czech Republic, 80,000 to 150,000 pneumonia cases with a lethality of 10-20% are reported every year. The rise in cases is due to increasing age of the population and related polymorbidities, new agents (SARS), population migration, AIDS, drug addiction, air conditioning,...^[2]

Pneumonia cases are most often of infectious origin and are transmitted by **respiratory droplets**. They usually begin with an infection of the upper respiratory tract. Then, the infection spreads to the bronchi and alveoli. Hematogenous spread is rare.^[1]

Pneumonia is a **febrile** illness whose most common manifestation is cough. Other signs (which may not manifest at first) are tachypnea, respiratory insufficiency, and crackling sounds during lung auscultation. Infiltrates in lung tissue are a typical finding on a skiagram.^[4]

There are no specific symptoms that would allow pneumonia to be diagnosed. The probability of diagnosis is increased by the presence of the above symptoms. We must take into account that younger children in particular are more likely to have **non-specific symptoms** such as lethargy, vomiting, and reluctance to eat or exercise.^[4]



X-ray examination of a patient with pneumonia with inflammatory infiltrates visible.

Pathophysiology

The pathophysiological basis is inflammatory infiltration of lung tissue and alveolar exudation. **Risk factors** for pneumonia are *hypoventilation due to pulmonary causes* (chronic respiratory insufficiency, foreign body aspiration, bronchiectasis, stenoses, ciliary epithelial dysfunction, interstitial pulmonary fibrosis, cystic fibrosis), *hypoventilation due to extrapulmonary diseases* (postoperative conditions, conditions with impaired consciousness, neuromuscular diseases), and *immune disorders* (congenital immunodeficiency in children).^[4]

Classification of pneumonia

According to the course

- Acute
- Chronic - inflammation lasting more than 3 months
- Recurrent - recurrent inflammation in the same location;
- Migrating - pulmonary infiltrates migrate, appearing at different times in different parts of the lungs.

According to etiology

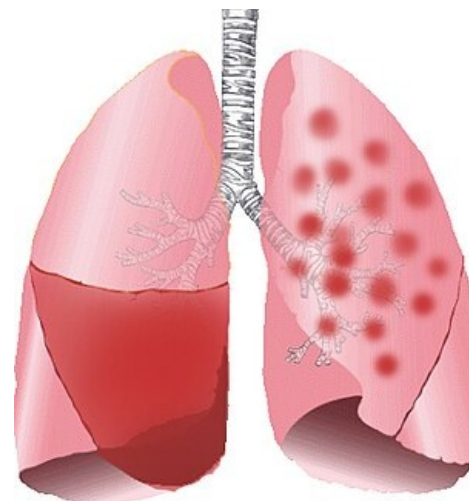
- **Infectious:** bacterial, atypical (viral, etc...), fungal, parasitic
- **Non-infectious** (so-called "pneumonitis"): aspiration, inhalation, post-radiation, post-drug administration, hypersensitivity (allergic)

By location of acquisition and epidemiology

- **Community pneumonia**
 - This is the most common type of pneumonia, up to 90%, obtained in a normal environment outside a hospital facility
 - Occurs outside the hospital or was diagnosed within 48 hours of admission (the child was hospitalized during the incubation period). The child had not been hospitalized or stayed in a medical facility in the previous two weeks.
 - They are usually treated on an outpatient basis and usually bacterial causative agents are sensitive to common ATB.
 - originators: G +: *Str. pneumoniae*, *Str. pyogenes*, *Staph. aureus*; G-: *H. influenzae*, *Klebsiella pneumoniae*
- **Nosocomial pneumonia**
 - Infection occurs aerogenically (contamination of the respiratory airways), hematogenously (translocation of microbes in the blood), or via microaspiration of oropharyngeal secretions that contain the original airway flora, colonizing microbes from the environment, or GIT flora.
 - Therapy must be initiated empirically (each workplace knows at least approximately its epidemiological

situation), then adjusted based on cultivation

1. **Early** nosocomial pneumonia - develops after 48 hours after admission to hospital, agents: G-: *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*., *E. coli*, *Proteus vulgaris* .; G+ : *Staph. aureus*; anaerobes
2. **Late** nosocomial pneumonia - develops after 4 days, associated with G- bacteria more often.
3. **Ventilator-associated pneumonia**
 - it is a nosocomial pneumonia caused by microaspiration of microorganisms from the oropharynx and stomach in patients connected to a mechanical ventilator
 - **Pneumonia in immunocompromised patients**
 - Immunocompromised patients include patients treated with cytostatics or radiation therapy, and patients after a transplantation, and HIV positive patients.
 - in addition to classical pathogens responsible for pneumonia (klebsiella, enterobacteria), opportunistic pathogens (RSV, CMV, herpes zoster virus, pneumocystis jirovecii, mycobacteria) become important pneumonia causative agents.
 - **Pneumonia in social care institutions**
 - Elderly polymorbid patients, who often visit medical facilities, are more likely to experience infections with resistant strains^{[5][4]}



Scheme of lobar pneumonia and bronchopneumonia.

According to the clinical and X-ray image

- **typical (bacterial)**
 - classic symptoms of pneumonia (fever, cough, and shortness of breath)
 - caused by bacterial pathogens
 - lobar pneumonia or lobular pneumonia (bronchopneumonia), with exudate formation in the alveoli
 - there is usually leukocytosis
- **atypical**
 - have atypical symptoms (nonspecific "flulike" symptoms - headaches, muscles, joints, also nausea, vomiting)
 - radiological findings correspond to a disseminated pulmonary process
 - characterized by intracellular parasitism
 - interstitial inflammation, at the level of the alveolar wall and the interstitium itself
 - leukopenia with relative lymphocytosis

According to the mechanism of origin

- primary (isolated lung disease)
- secondary (complication of other systemic diseases)

Acute pneumonia: mostly a primary disease because it arises in previously healthy lung tissue that was previously normally ventilated. **Secondary pneumonia:** occurs in children with altered health status or in children predisposed to the development of a respiratory infection.^[4]

According to the pathological-anatomical picture

1. Lobar
 - There is limited inflammatory involvement of the pulmonary alveoli. Gradually, a productive cough with expectoration of purulent sputum (more likely in older children who can cough more readily). Sometimes, there is also pleural pain on top of the rapidly increasing temperature.
2. Lobular (bronchopneumonia)
 - There is inflammation of the lung parenchyma, which occurs secondary to an infection of the bronchial tree whereby inflammation spreads to adjacent lung tissue.
3. Interstitial^[4]

According to the X-ray finding

- Allar - the entire pulmonary wing is affected
- Lobar - one lobe is affected
- Segmental - segment impairment
- Bronchopneumonia - the infiltrate does not respect the anatomical arrangement of the lungs (boundaries of lobes and segments).^{[2][6]}

According to severity

1. Light
 - Only **cough** is present, without tachypnea or dyspnea, but with colds or pharyngitis.
2. Moderate
 - Cough and **tachypnoea** without dyspnea

3. Heavy
 - Cough, tachypnoea, and **dyspnea** with involvement of auxiliary respiratory muscles. **Inability to drink** in infants.^[4]

According to age

This division takes into account the most frequently encountered etiologic agents of pneumonia according to the age of the child.

1. Neonatal pneumonia
 - Gram-negative bacteria (*Escherichia coli*, *Klebsiella pneumoniae*), group B streptococci.
2. Infant pneumonia (2-11 weeks of age)
 - *Chlamydia trachomatis*, *Ureaplasma urealyticum*, *Mycoplasma hominis*, cytomegalovirus, *Pneumocystis carinii*.
3. Pneumonia in children aged 3 months to 5 years
 - Viruses (respiratory syncytial virus, parainfluenza, adenoviruses, rhinoviruses), less often bacteria (pneumococci, staphylococci, streptococci, *Hemophilus influenzae*).
4. Pneumonia in children older than 6 years
 - Most often *Mycoplasma pneumoniae*, viruses (parainfluenza, influenza), bacteria (pneumococci, *Hemophilus influenzae*, streptococci).^[4]

Epidemiology

The incidence of pneumonia in EU countries is 1000 children/year. This is 2-3 million cases of childhood community-acquired pneumonia in absolute numbers per year. Pneumonia is the most common fatal infectious disease in children in developed countries. In uncomplicated pneumonia without other risk factors, mortality is less than 0.5%. In the presence of certain risk factors, this figure rises to 30%.^[4]

Risk factors

Factors that increase the likelihood of pneumonia and increase complications and mortality during treatment include:

- Young age
- prematurity
- comorbidities (other lung diseases, heart disease, kidney or liver diseases, malignancies)
- severe general condition
- extrapulmonary manifestations coexisting with pneumonia
- severe X-ray findings (multilobar infiltrates, bilateral infiltrates, cavitation, pleural effusion)
- hyposaturation
- severe leukopenia or leukocytosis
- signs of renal failure
- non-compliant family^[4]

Anamnesis

- **Personal history:** perinatal condition, age, risk factors, vaccination, stay in a facility where they could have been exposed with infected individuals
- **Epidemiological anamnesis:** contact with infection, contact with animals
- **Travel anamnesis:** stays abroad, contact with persons at risk (migrants).^[4]

Clinical picture

In the case of typical pneumonia, the following symptoms develop rapidly:

- Cough
- fever
- tachypnea
- dyspnea
- involvement of auxiliary respiratory muscles

Auscultation findings

- initially auscultation of breathing sounds can be negative for any abnormality, but as the pneumonia progresses, one can hear weakened breathing and even bronchial breathing (in the case of consolidation of lung tissue), wheezing, and crepitation.

Other symptoms

- abdominal pain (should be distinguished from appendicitis in right-sided pneumonia)
- vomiting
- meningeal irritation with high fever

- signs of pleural irritation and chest pain.^[4]

Indications for hospitalization

The key indications for hospitalization are **hypoxia** (SaO₂ <92%) and cyanosis. Other indications include:

- The inability of the family to provide appropriate care for the child
- if the infant is under the age of two months
- respiratory rate > 70 breaths per minute, dyspnea, intermittent apnea, wheezing, inspiratory stridor at rest, exhaustion with labored breathing
- eating disorder, signs of malnutrition
- impaired consciousness
- non-compliance of the child's family
- outpatient treatment failure^[4]

Indications for the transfer of a child to a pediatric intensive care unit (ICU)

- The ability to keep the patient's SaO₂ above 92% fails
- if resting respiratory and pulse rates increase with clinical signs of respiratory failure
- recurrent apnea or slow, irregular breathing^[4]

Radiological diagnostics

A typical X-ray of pneumonia shows **opacities**, which is due to the presence of **infiltrate** in the lung parenchyma. According to the extent of the infiltrate, we can infer the severity of the pneumonia. In an uncomplicated course, the infiltrate is perihilar and peribronchial. An infiltrate that has spread into the interstitium is a sign of the spread of inflammation into the lung tissue. If alveolar effusion is present, pneumonia is often of viral etiology. Atelectasis develops in severe inflammatory disease, pneumonia due to a foreign body obstruction, or lung tissue compression (e.g., due to pleural effusion).^[4]

Imaging methods

- posterior (possibly lateral) chest X-ray
- when pleural effusion is suspected, US imaging can be used^[4]

The X-ray finding may be false negative in some cases, such as:

- at the onset of the disease
- in significant dehydration
- in patients experiencing leukopenia, agranulocytosis, or immune disorders
- in infiltration of an area that is not visible in the anterior image (effusion retrocardially or retrodiaphragmatically).^[4]

Indications for performing a chest X-ray

- pneumonia not responding to standard outpatient treatment
- complicated pneumonia
- high inflammatory parameters (CRP, procalcitonin, FW, leukocytosis)
- suspected aspiration
- suspected complications
- febrile unclear cause
- tachypnea
- suspected TB^[4]

Diagnosis of the etiological agent

The possible causative agents can be narrowed by taking into account the age of the child, the epidemiological situation, and the course of the disease. This is complemented with the use of specific diagnostic methods:

- blood culture (before ATB administration)
- cultivation of biological material (sputum, upper respiratory tract swab, thoracocentesis)
- antigen in urine - Streptococcus pneumoniae, Legionella pneumophila (in patients over 14 years of age)
- direct detection in nasopharyngeal secretion - viruses (immunofluorescence, agglutination, PCR)
- serology^[4]

Auxiliary examinations

- Oxygen saturation
- FW, CRP, complete blood count
- blood gases (P_aO₂, P_aCO₂)
- ionograms, urea, aminotransferases
- in severe condition with suspected sepsis: platelets and coagulation examinations.^[4]

Therapy

- penicillin, tetracycline and macrolide antibiotics (for typical pneumonias at least 10 days, for atypical 14 days to 3 weeks; intravenously 2 to 5 days); in nosocomial infections cephalosporins III., IV. generation (cefotaxime, ceftazidime, cefepime), higher generation penicillin antibiotics (ticarcillin, piperacillin/tazobactam, etc...), fluoroquinolones, carbapenems (imipenem, meropenem) or in combination with aminoglycosides for example.
- symptomatic treatment:
 - expectorants, mucolytics, antitussives for irritating dry cough
 - antipyretics
 - analgesics for pleural pain
 - oxygen therapy for respiratory insufficiency
 - nebulization therapy
- regime measures:
 - sufficient supply of fluids, calories, vitamins
 - respiratory rehabilitation
- Functional lung examination is indicated 6 weeks after the pneumonia has subsided^[3]

Complication

- respiratory insufficiency, pleural effusion, empyema, pulmonary abscess, pulmonary gangrene, and atelectasis and subsequent bronchiectasis
- sepsis with dissemination of infection to other sites (arthritis, otitis, nephritis, endocarditis, meningitis, peritonitis), possibly leading to septic shock^[3]

Comparison table for typical and atypical pneumonia

PARAMETER	TYPICAL PNEUMONIA	ATYPICAL PNEUMONIA
Basic characteristics	significant physical findings	poor physical findings
Agents	(extracellular) <i>Streptococcus pneumoniae</i> , <i>Haemophilus influenzae</i> <i>Haemophilus parainfluenzae</i> , <i>Staphylococcus aureus</i> , <i>Klebsiella pneumoniae</i> , <i>Escherichia coli</i> and <i>Pseudomonas aeruginosa</i>	(intra/paracellular) <i>Mycoplasma pneumoniae</i> , <i>Chlamydomphila pneumoniae</i> , <i>Chlamydomphila psittaci</i> , <i>Legionella pneumophila</i> <i>Coxiella burnetii</i> , viruses - RSV, influenza, <i>Pneumocystis carinii</i>
Onset	sudden	slow
Extrapulmonary symptoms	infrequent	common - headache and muscle pain, vomiting, diarrhea
Fever	febrile	subfebrile
Cough	productive	dry, irritating
Heart rate	possibly tachycardia	normal
The patient looks	sick	calm, unaffected
Physical examination	crepitus, bronchial breathing	isolated rales
X-ray	segmental/lobar opacities(alveolar involvement)	Reticulonodulation (interstitial involvement)
Sedimentation	high	slightly increased
Inflammatory parameters	high	slightly increased
Blood count	leukocytosis	lymphocytosis
Therapy	penicillins	macrolides

Links

Related articles

- Pneumonia • Pneumonia in infants • Pneumonia in older children
- Bacterial pneumonia • Atypical pneumonia • Abscessive pneumonia • Aspiration pneumonia
- X-ray examination in lower respiratory tract inflammation • Clinical evaluation of the severity of pneumonia

Reference

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