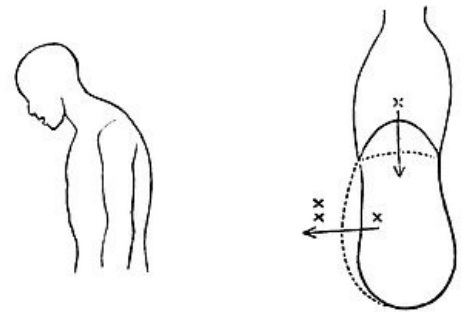


Cough (pediatrics)

Cough is a repeated violent loud exhalation maneuver aimed at clearing the airways or eliminating their irritation. Together with other defensive and protective reflexes of the airways, it helps to physiologically maintain free airway patency. Cough, along with shortness of breath is one of the most common symptoms of respiratory diseases.

Pathophysiology of cough

It is a **nociceptive reflex**, i.e. a physiological response to irritation of nerve endings (receptors) located in **reflexogenic (tussigenic) zones**, the most sensitive of which are in the **larynx** (glottis, vocal cords and subglottis), **trachea** and **bronchi** (most near the branches large bronchi), other zones are in the mucosal areas of the paranasal sinuses, nasopharynx, Eustachian tubes, inner ear, external auditory canal and other localizations. Receptors are located just below the airway epithelium and respond to **mechanical stimuli** (secretion, foreign body), **thermal** (cold or hot air), **chemical** (vapors, gases, acidic gastric juices) and **inflammatory** (edema, hyperemia). The cough reflex is completed in the first six weeks of life.



Increasing intra-abdominal pressure during cough

The cough begins with a deep breath, then when the glottis is closed, the activation of the exhaled muscles increases the pressure in the chest. The high alveolar pressure after opening the glottis leads to a high flow rate of the air exhaled during coughing and thus to the entrainment and expectoration of the airway contents. The cough is accompanied by a sharp fluctuation in intrathoracic pressure, which is transmitted to the circulatory system. **Cough reflex**

1. irritation (chemical, thermal or mechanical);
2. receptors: mucous membranes of the upper and lower respiratory tract, tussigenic zones in the areas of the vagus nerve endings (pleura, spleen, outer ear, stomach, pericardium);
3. afferent fibers: sensitive fibers of the *nervus vagus* (*nervus laryngeus superior*);
4. cough center: elongated spinal cord (*n. ambiguus*, *n. retroambigularis*), cortex (affecting the will);
5. efferent fibers: motor fibers of the *vagus nerve*;
6. effect muscles: respiratory muscles;
7. pressure gradient over 10 kPa;
8. air flow 150–280 m / s (cough).

Cough becomes a pathological phenomenon if, due to its quantity or quality, unfavorable aspects outweigh positive aspects.

Classification of cough

By duration:

- **acute** - regardless of treatment does not last longer than 1 week;
- **subacute** - regardless of treatment does not last longer than 3-4 weeks;
- **chronic** - lasting more than 4 weeks.

By character:

- **dry** (non-productive);
- **moist** (productive);
- **barking** (acute subglottic laryngitis)
- **paroxysmal** (whooping cough).

Clinical picture

- coughing in nasopharyngeal secretion - pharyngeal cough;
- barking cough in the larynx - laryngeal cough;
- coarse, irritating cough - tracheal;
- suffocating cough with or without expectoration - cough from lower respiratory tract disorders..

Warning signs of acute cough: cyanosis, suffocation, sudden onset of symptoms

Warning signs of chronic cough: failure to thrive, vomiting, dyspnea, night cough.

Differential diagnosis of cough in children

- very wide

Acute cough

- Acute cough is most often a manifestation of **an upper respiratory tract infection**. It is usually associated with colds and slightly elevated temperatures. It is **mostly of viral origin** and tends to be uncomplicated. Treatment is not necessary, mucolytics and secretolytics are not suitable because they increase the production of mucus. In newborns and infants, it is important to maintain nasal patency to avoid food intake problems. Excessive swallowing of mucus (especially in young children who cannot blow and cough) can lead to loss of appetite, oral rejection and vomiting. This can lead to dehydration and metabolic breakdown.
- **acute laryngitis;**
 - a sudden, rough, barking cough that develops in a constriction between the subglottic mucosal valleys (dry, unproductive);
 - inspirational stridor, or other signs of dyspnea;
 - it typically begins at night with either full health or a mild respiratory infection;
 - mucus secretion gradually increases and the cough turns wet;
 - predominantly viral etiology;
 - treatment: cold nebulization, inhalation of adrenaline (dilution 1: 4 with saline), administration of corticoids parenterally (dexamethasone 0.4-0.6 mg / kg / dose), oral or rectal administration is not recommended due to the slow onset of action (only in case of impossibility of intravenous administration), careful sedation in case of restlessness of the child, in case of progression of dyspnea, early transfer to the intensive care unit to ensure artificial lung ventilation; administration of antitussives or mucolytics has no therapeutic significance.
- **acute bronchitis;**
- **inhalation of irritants;**
- **inflammation** of the paranasal sinuses;
- **aspiration.**

Chronic cough

The most common causes are **viral cough, rhinitis syndrome, bronchial asthma and gastroesophageal reflux**.

- **Pulmonary causes** – bronchial asthma, cystic fibrosis, primary ciliary dyskinesia, foreign material aspiration, tracheoesophageal fistula, family smoking, post-infection cough, postnasal drip syndrome, tuberculosis, interstitial lung process, tumor, post-infection (RS viruses, parainfluenza, mycoplasmas, chlamydia, cytomegaloviruses, pertussis, parapertussis), nasopharyngeal obstruction (adenoid vegetation), chronic bronchitis, hypotonic tracheal dyskinesia, congenital malformations, unknown aspiration of a foreign body wedged in the bronchial tree.
- **Extrapulmonary causes** – gastroesophageal reflux, cardiac cause, use of ACE inhibitors, psychogenic cough.

Cough with hemoptysis

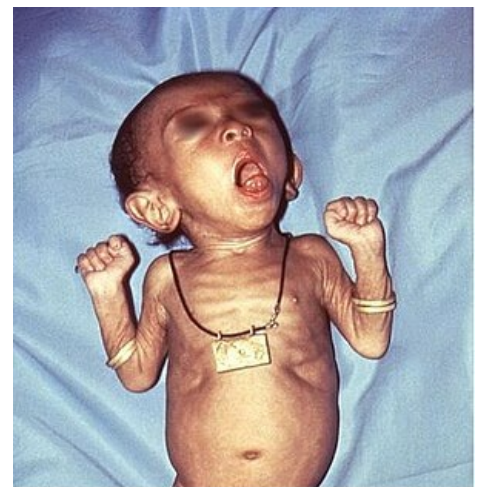
- rarer in children than in adults;
- causes: lung and airway tumors, cardiovascular aneurysms, tuberculosis;
- prodromes of fullness or warmth in the chest and cough irritation;
- the blood is usually bright red, foamy, alkaline.

Pseudo-hemoptysis

- hemorrhagic diathesis, bleeding during anticoagulant treatment, after ENT procedures, most often epistaxis;
- rather coughing, with dark red or brownish and not foamy blood.
- in hematemesis, the blood is dark red to black (coffee grounds color), not foamy, with a sour smell, and leftover food.

The most common causes according to age

Infants: aspiration, obstructive bronchitis, laryngotracheomalacia, compression of the airway vessels (ring loop and. Lusoria - aberrant distance right subclavian artery beyond the distance left subclavian artery - it is usually in the esophagus, but rarely can go well between the esophagus and trachea), cystic fibrosis, viral infections (RSV, parainfluenza, adenoviruses), rarely pertussis, pneumocystosis, tuberculosis (from mother), congenital heart defects with left-sided short circuit, idiopathic cardiac hemosiderosis, influence of passive smoking...



Infant with whooping cough

Children under 5 years of age : aspiration, bronchial asthma, bronchiectasis, cystic fibrosis, primary ciliary dyskinesia, immunodeficiency, acute resp. infection, chronic sinusitis and otitis , tuberculosis...

School children and adolescents: bronchial asthma, bronchiectasis, primary ciliation dyskinesia, immunodeficiency, cystic fibrosis, chronic sinusitis, otitis, active or passive smoking , working environment, lung tumors and mediastinum, psychogenic cough.

Medical examination

- **Anamnesis**
 - family anamnesis: atopy, bronchial asthma, eczema or immunodeficiency;
 - personal anamnesis: neonatal period, type of nutrition, previous illness, incidence of eczema;
 - current diseases: cough duration, its daily variability, exercise tolerance, the effect of temperatures on cough, the occurrence of previous infections, the occurrence of rhinitis, snoring in the child's sleep, the effect of food on the onset of cough;
 - the child's social environment and overall regime may affect the onset and duration of the disorder.
- Clinical examination.
- Basic laboratory tests: sedimentation of red blood cells (FW), blood count with differential budget , C reactive protein .
- Serology: chlamydia, mycoplasma, pertussis, viruses - adenoviruses.
- Sweat test - to rule out cystic fibrosis.
- Mantoux II test - to rule out tuberculosis.
- 24-hour esophageal pH measurement, or X-ray contrast examination of the esophagus - to exclude GER.
- Bronchomotor tests .
- **Skiagram of the chest**
 - indicated for both acute and chronic cough;
 - anterior and possibly lateral projection, in case of suspicion of foreign body aspiration, focal finding (abscess, cyst, pneumocele,...), atelectasis, focal pneumonia,...
- **Spirometry** - functional examination of the lungs
 - indicated for chronic cough;
 - requires patient cooperation, is performed on children from about 3 years of age;
 - baby co-plethysmography may be performed on non-cooperating children;
 - it is performed at rest;
 - flow-volume curve determines ventilation parameters (functional vital capacity, one second expiratory capacity, maximum expiratory rate,...).
- **CT / HRCT of the chest**
 - allows the assessment of the structural integrity of small airways;
 - the disadvantage is the high radiation exposure, which carries the risk of malignancy;
 - indicated in case of suspicion of interstitial lung process, pulmonary embolism, congenital defect of lungs, respiratory tract, mediastinum or heart, suspicion of tumor event. evidence of metastases of extrathoracic malignancies, pathological processes of the mediastinum, complicated pneumonia (necrotizing, abscessing).
- Bronchoscopy - endoscopy of the lower respiratory tract
 - the range of the flexible bronchoscope is at the level of 6-8. bronchial branching order from a total of 23-24 (depending on the device used);
 - indicated for diagnostic reasons in chest skiagram abnormalities (atelectasis, atypical and unclear infiltrates), airway obstruction (stridor, persistent wheezing, localized hyperinflation), chronic cough (suspected foreign body aspiration, hemoptysis);
 - indicated for therapeutic reasons in the presence of a mucus and blood plug and to clear the airways;
 - special bronchoscopic methods: bronchoalveolar lavage, brush or mucosal biopsy, transbronchial biopsy, drug administration, endoscopic intubation.
- Otorhinolaryngological examination (paranasal sinuses, adenoid vegetation);
- Allergy examination;
- Immunological testing;
- Cardiac examination;
- Psychological examination.

Therapy

- **Basic treatment.**
 - Symptomatic adenoid vegetation - adenotomy.
 - Persistent bronchial asthma - inhaled corticosteroids (in more severe forms in combination with long-term β_2 -agonists or montelukast).
 - Cystic fibrosis - complex treatment: mucolytics, antibiotics, pancreatic enzymes, inhalation - amiloride and recombinant DNase, vitamins, respiratory rehabilitation and nutrition with increased intake of nutrients and minerals).
 - Primary ciliary dyskinesia - antibiotics, mucolytics, respiratory rehabilitation.
- **Antibiotic treatment** is indicated for bacterial rhinosinusitis and bronchitis, pneumonia and pertussis. Initial antibiotic therapy is empirical in community-acquired pneumonia, so if the clinical condition does not improve after 48 hours of antibiotic treatment, a change in pharmacotherapy should be considered.

- Children up to 6 years:
 - most often oral penicillin with a broad antibacterial spectrum and β lactamase inhibitor (ampicillin / sulbactam and amoxicillin / clavulanic acid);
 - or cephalosporins stable to β -lactamases (cefuroxime)
 - a macrolide (clarithromycin or azithromycin) is used if mycoplasma or chlamydial pneumonia is suspected.
- Children aged 6-15:
 - macrolide antibiotics (eg clarithromycin for 14 days) due to the high prevalence of mycoplasma pneumonia..
- Symptomatic treatment: **expectorants, antitussives.**

Expectorants

- facilitate the removal of thick mucus from the airways;
- according to the mechanism it is divided into **mucolytics, secretolytics and secretomotorics**:
 - mucolytics reduce the viscosity of bronchial secretion by influencing its physicochemical properties - by breaking down chemical bonds, they reduce the viscosity of mucus and sometimes have anti-inflammatory and anti-infective effects;
 - secretomotorics (beta-sympathomimetics, essential oils) facilitate the transport of mucus and its expectoration by increasing the activity of the ciliated epithelium.
- **Acetylcysteine** - a mucolytic that reduces disulfide bonds in mucus proteins;;
 - effect up to 2-3 days after administration;
 - side effects: gastrointestinal problems, headache, allergic skin reactions.
- **Carbocysteine** - more favorable pharmacokinetic properties and higher stability than acetylcysteine;
 - contraindication: children under 2 years of age, acute ulcer disease, acute cystitis and acute glomerulonephritis.
- **Erdostein** - mucolytic and mild anti-inflammatory effect, acts as a scavenger of free oxygen radicals;
 - contraindication: children up to 15 kg;
 - Currently considered the most effective mucolytic, its effectiveness has been confirmed by controlled clinical trials, which have shown antioxidant and anti-inflammatory effects, increased immunoglobulin A, lysozyme and lactoferrin in bronchial secretion, reduced bacterial adhesion and potentiation of antiasthmatics salbutamol and budesonide and antibiotics.
- **Ambroxol** - a metabolite of bromhexine, which has a mucolytic and significant secretomotor effect, accelerates the formation and secretion of surfactant and thus reduces the adhesion of mucus to the airway surface; supports the activity of alveolar macrophages and has an antioxidant effect and an indirect anti-inflammatory effect; increases the penetration of antibiotics into lung tissue and probably also contributes to the reduction of bronchial hyperreactivity
 - side effects: gastrointestinal problems.
- **Bromhexine** - is metabolized to the active substance ambroxol;
 - long-term application leads to excessive stimulation of goblet cells, and thus ultimately to their atrophy.
 -
- **Desoxyribonuklease**- an enzyme that cleaves extracellular DNA, which is responsible for the high viscosity of mucus in patients with cystic fibrosis;
 - contraindication: children under 5 years of age, during pregnancy and lactation;
 - side effects: allergic skin reactions..
- Guaifenezin, mesna.

Expectorants should not be given concomitantly with antitussives due to possible accumulation and stasis of mucus in the bronchi.

Antitussives

- **suppress the cough reflex;**
- indicated in persistent conditions of dry, irritating cough, when previous expectorant administration was ineffective;
- there is a risk of addiction with long-term usage
- according to composition: **codeine x non-codeine**;
- according to the mechanism of action: central x peripheral ;
 - **codeine-type antitussives** have a central mechanism of action; non-codeine can have both central and peripheral effects.
- **central antitussives**: codeine, dihydrocodeine, ethylmorphine and dextromethorphan;
 - inhibit or suppress the cough reflex by attenuating the cough center in the elongated spinal cord or higher centers;
 - adverse effects of morphine antitussives: possible respiratory depression and development of constipation;
 - **Codeine** - methyl morphine derivative; a very effective antitussive with analgesic effects
 - contraindication: children under 12 years of age and with difficult expectoration in COPD
 - side effects: nausea, vomiting, constipation, respiratory depression, urinary retention, palpitations,

possibly miosis.

- **Pholcodine** - a codeine derivative with more advantageous properties than codeine - has a stronger antitussive effect, fewer side effects and a lower risk of addiction..
- **Dextrometorphan** - a synthetic antitussive that is very well tolerated, has no analgesic effect, does not dampen the respiratory center, the risk of addiction is minimal, does not cause constipation:
 - contraindication: children under 2 years and bronchial asthma.
- peripheral antitussives: butamirate, dropropizine and levodropropizine;
 - suppresses the reflex zones of cough in the airways and conduction of excitations in the afferent and efferent pathways of the cough reflex, does not suppress the respiratory center and does not lead to drug dependence
 - **Butamirate** - central and peripheral effects (mild bronchodilator effects);
 - a well-acting and well-tolerated antitussive with minimal side effects..

Many studies have not shown a clinical effect of antitussives in children..

Comment:

- Antihistamines have minimal or no effect in the treatment of cough.
- Most children with acute cough recover spontaneously without medical intervention.
- Treatment of the symptom itself can lead to an unnecessary delay in the correct diagnosis, and even to severe damage to the airways and lung parenchyma..

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