Introduction

The first set of German guidelines for diagnosis and treatment of patients suffering from acute or chronic cough was published in 2004. [1]. Scientific developments over the past five years necessitate an update. The purpose of this document is to assist in ascertaining underlying causes and treating cough, in order to eliminate or minimize impairments of patients’ health. The guidelines aim to introduce scientifically founded, evidence-based steps for the diagnosis and treatment of cough and optimize cost-effectiveness. Recommendations are assessed through the GRADE system (The Grades of Recommendation, Assessment, Development and Evaluation). Cough as a symptom is categorized as either acute (lasting up to 8 weeks) or chronic (lasting more than 8 weeks) and attributed to distinct diseases. For acute and chronic cough the diagnostic algorithms are updated; cost effectiveness is also taken into account. Additionally, the most frequent diagnostic errors are highlighted. Finally, available therapeutic options are discussed.

Anatomy and physiology of cough

Cough is both an important physiological reflex protecting the airways, and a frequent complaint associated with virtually all pulmonary and several extra-pulmonary diseases. Cough is also a contributing factor in the spreading of infectious disease. The reflex is triggered by physical and chemical stimuli. Irritant receptors and C-fibre receptors are activated in the airways, pleura, pericardium and esophagus. The impulse is then transmitted to the brainstem cough generator circuit via the vagus nerves. There is also a connection to the cortex, allowing voluntary control of both eliciting and - to a limited degree - inhibiting cough [3]. Thus, the reflex is characterized by complexity and plasticity. Diagnostic findings from animal testing are not unconditionally applicable to humans. Efferent innervations reach the effector muscles (diaphragm, abdominal, intercostals, back; as well as muscles of the larynx, and the upper airway) via the vagus.

Kardos P et al. Guidelines of the German Respiratory Society... Pneumologie 2010; 64: 701 – 711
Mucociliary clearance is the primary means of clearing the bronchial system. Cough acts as a secondary mechanism when the primary is either impaired (e.g. by the effects of smoking) or overwhelmed (e.g. by aspiration). The clearing competence of the cough reflex depends on several conditions: obstruction of the airways, bronchial collapsibility, lung volumes, respiratory muscle- and laryngeal function, as well as the amount and viscosity of the mucus [4]. Cough is productive (wet) if the amount of the daily expectoration is at least 30 ml (two tablespoons worth). The phlegm can be mucous, serous, purulent or bloody. Bronchial casts can also be coughed up. The cough reflex arc consists of five parts:
1. Cough receptors
2. Afferent nerves of the reflex arc
3. Brainstem cough generator circuit
4. Efferent nerves of the reflex arc
5. Effector organs (muscles).

Common causes and classification of cough

### Table 1 Classification of clinical causes of cough.

<table>
<thead>
<tr>
<th>Acute (&lt; 8 weeks) Diseases of the Airways:</th>
<th>Chronic (&gt; 8 weeks) Diseases of the Lower Airways/Lungs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Infectious disease of the upper airways: mostly viral infection</td>
<td>- Chronic (non-obstructive) bronchitis, COPD</td>
</tr>
<tr>
<td>- Allergy</td>
<td>- Asthma and other eosinophilic diseases</td>
</tr>
<tr>
<td>- Asthma</td>
<td>- Lung tumors</td>
</tr>
<tr>
<td>- Aspiration: commonly children between the ages of 1 – 3</td>
<td>- Infectious diseases</td>
</tr>
<tr>
<td>- Inhalation intoxication: accidents, fire</td>
<td>- Diffuse parenchymatous lung diseases (DPLD) - Systemic diseases with diffuse lung involvement</td>
</tr>
<tr>
<td>- Postinfectious cough</td>
<td></td>
</tr>
</tbody>
</table>

**Diseases of the Lungs/Plura:**
- Pneumonia
- Pleurisy
- Pulmonary embolism
- Pneumothorax

**Extra Pulmonary Causes:**
- Cardiac disease with acute pulmonary congestion
- Cystic fibrosis
- Diseases of the upper Airways
- Gastroesophageal Reflux Disease
- Drug induced cough:
  - ACE inhibitors
  - others
- Cardiac Diseases:
  - Any including pulmonary congestion
  - Endocarditis

**COPD:** Chronic Obstructive Pulmonary Disease
**RADS:** Reactive Airways Dysfunction Syndrome
**ACE:** Angiotensin Converting Enzyme

### Acute and chronic cough

Diagnosis and treatment of cough depend on whether the patient presents with acute (usual length up to three weeks, possible up to eight weeks) or chronic (more than eight weeks) cough. The natural history of an acute infection of the upper and/or lower airways – the most common cause of cough – is up to three (rarely up to eight) weeks. Medical history and physical examination are usually sufficient in the diagnosis of acute cough.

As opposed to acute cough, a chest x-ray and lung function test should be performed immediately in the case of chronic cough. If the chest x-ray proves inconclusive, the lung function test is unremarkable and cough is the only presenting symptom it will always be difficult to establish the diagnosis. Throughout English-language publications [5–9], these cases are called chronic cough or chronic persistent cough focusing the possible diagnosis on the three most common causes: upper airways cough syndrome, cough variant asthma and gastroesophageal reflux disease [5, 10 – 15]. It is therefore imperative to note the distinction between the definitions of “chronic cough” in these guidelines vs. the use of the term in international publications. In this document, chronic cough is defined just as lasting over eight weeks, while acute cough is defined as lasting up to eight weeks.

### Recommendation: R1

- **Diagnostic tests for acute cough due to common cold:**
  - History and physical examination only
- **Grade:** strong 🆙�
- **Evidence:** none

Special circumstances requiring immediate full diagnosis of acute cough are listed in **Table 2** below.

<table>
<thead>
<tr>
<th>Circumstances requiring an immediate investigation of acute cough.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoptyis</td>
</tr>
<tr>
<td>Thorax pain</td>
</tr>
<tr>
<td>Dyspnea</td>
</tr>
<tr>
<td>High fever</td>
</tr>
<tr>
<td>Stay in countries with high prevalence of Tb, contact with a person, stricken with Tb, homeless</td>
</tr>
<tr>
<td>History of malignant tumor</td>
</tr>
<tr>
<td>Immune deficiency, HIV infection, immune suppressive therapy</td>
</tr>
<tr>
<td>Heavy smoker</td>
</tr>
</tbody>
</table>

**Tb:** tuberculosis, **HIV:** Human Immunodeficiency Virus

### Recommendation: R2

- **Likely causes of chronic cough without conclusive chest x-ray and lung function:**
  - Upper airway cough syndrome
  - Cough variant asthma
  - Gastroesophageal reflux
- **Grade:** strong 🆙�
- **Evidence:** moderate

### Recommendation: R3

- **Distinction between acute and chronic cough:**
  - Acute cough: lasting up to 8 weeks
  - Chronic cough: lasting longer than 8 weeks
- **Grade:** strong 🆙�
- **Evidence:** none
Acute cough

**Recommendation: R4**

- **Appropriate diagnostic tests for acute cough:**
  In most cases history and physical examination suffice in absence of special circumstances (see Table 2)
- **Grade:** strong
- **Evidence:** low

- **Acute viral infections** [16] of the upper and lower airways (common cold) are the most common cause of cough and usually subside spontaneously after three weeks.
- **Upper airways allergic disease** (Hay fever, intermittent or persistent allergic rhinitis), often in combination with sinusitis, conjunctivitis, pharyngitis and laryngitis, can also trigger acute cough. Itchy eyes and throat are usually characteristic [17].
- **Intermittent asthma: allergic or due to infection** can cause acute cough
- **Aspiration:** Aspiration of a foreign body, most commonly in 1–3 year-old children, as well as in elderly, fragile patients triggers acute cough with expectoration of the foreign body or permanent bronchial obstruction with consecutive chronic cough.
- **Acute inhalative intoxication** (workplace accidents, fires, solvent- or glue-sniffing) can lead to a toxic lung edema, acute interstitial pneumonia and bronchiolitis with re-emergence of cough, often after a discomfort- and cough-free interval of 6–48 hours. Information on treatment of inhaled substances is available in German at: www.medknowledge.de/patienten/notfaelle/vergiftungszentralen.htm

**Recommendation: R5**

- **Treatment of cough due to acute inhalative intoxication:**
  High dose inhalative corticosteroid
  Additional systemic corticosteroid, if necessary
- **Grade:** strong
- **Evidence:** none

- **Postinfectious cough:** persists >3 weeks after an acute, often viral airway infection and resolves after <8 weeks. Epithelial damage after B. pertussis or M. pneumoniae infection or a transient increase in bronchial hyper-responsiveness (BHR) - later subsiding spontaneously - are responsible for post-infectious cough. In the latter case a short course of asthma treatment (inhaled corticosteroids [18] or beta2-adrenergics [10]) is effective.
  (We describe persistent BHR with consequent chronic cough without airflow obstruction as cough type asthma, see below under chronic cough).

**Recommendation: R6**

- **Treatment of cough due to postinfectious BHR:**
  Inhalative corticosteroid or beta2-adrenergic
- **Grade:** strong
- **Evidence:** moderate

- **Pneumonia**
- **Pleurisy**
- **Pulmonary embolism:** 50% of patients with acute pulmonary embolism present with a cough [19].
- **Pneumothorax:** all forms can be accompanied by dry cough.
- **Acute heart failure with pulmonary congestion:** Acute left heart failure (up to lung edema) can trigger both cough and bronchial obstruction [20,21]. Bradycardia associated with acute emerging AV block II-III can greatly reduce stroke volume eliciting pulmonary congestion and cough [22].

**Recommendation: R7**

- **Acute cough and heart failure:**
  Breathlessness, palpitation and acute cough is indicative of left heart failure and/or AV block
- **Grade:** strong
- **Evidence:** low

**Chronic cough**

- **Chronic Bronchitis and COPD:**
  The WHO defines chronic (non-obstructive) bronchitis as presence of cough and phlegm on most days over a period of at least three months during two consecutive years without other causes. Many patients suffering from chronic cough meet these criteria. For patients complaining chronic cough this diagnosis is only therapeutically useful, if the cause of their chronic bronchitis (i.e. smoking, work-related exposures) can be identified, cessation is possible and other causes of chronic cough have been excluded. Because smokers rarely complain of cough and phlegm, chronic bronchitis is seldom a reason to attend a cough clinic. Consequently they can rarely be included in diagnostic and therapeutic trials (5 to 14%) [11,13,14,23,24].
  - COPD: by definition patients with the chronic obstructive bronchitis phenotype of COPD are suffering from cough and phlegm. Chronic cough is a common symptom of COPD.
- **Asthma and other eosinophilic respiratory disease:**
  - Asthma: often responsible for chronic cough [25]. Dry cough can elicit or worsen an asthma attack.

**Recommendation: R8**

- **Persistent cough despite controlled asthma:**
  Additional antitussive up to 4 weeks duration indicated
- **Grade:** weak
- **Evidence:** none

  - Cough type (variant) Asthma is characterized by dry cough and bronchial hyperresponsiveness (BHR). Wheezing, dyspnea and bronchial obstruction are absent. Chronic cough with proven BHR can only be confirmed as variant asthma if asthma treatment (inhaled corticosteroids or beta2 adrenergics) eliminates the cough [10,13–15,26–30].
**Recommendation: R9**
- **Chronic cough due to BHR:**
  If responsive to inhaled corticosteroid, montelukast or beta2-adrenergics: cough variant asthma
- **Grade:** strong
- **Evidence:** moderate

**Recommendation: R10**
- **Prevention of progression from variant asthma to asthma:**
  Early treatment with inhaled corticosteroid
- **Grade:** strong
- **Evidence:** low

**Recommendation: R11**
- **Chronic cough with sputum eosinophilia w/o BHR:**
  Eosinophilic bronchitis, responsive to inhaled corticosteroid
- **Grade:** strong
- **Evidence:** moderate

**Recommendation: R12**
- **Primary work-up of chronic cough:**
  Perform chest x-ray at first consultation
- **Grade:** strong
- **Evidence:** none

**Recommendation: R13**
- **Stepwise work-up of chronic cough w/o conclusive chest x-ray:**
  Before performing HR-CT or bronchoscopy consider asthma, COPD, upper airway cough syndrome and gastroesophageal reflux
- **Grade:** strong
- **Evidence:** moderate

**Recommendation: R14**
- **Bronchoscopy for chronic cough:**
  Indicated for every patient at the end of the diagnostic algorithm, if cough remains unexplained
- **Grade:** strong
- **Evidence:** none

**Recommendation: R15**
- **Treatment of chronic cough due to multiple underlying causes:**
  Treat all conditions appropriately, if present (e.g. asthma, rhinitis, reflux)
- **Grade:** strong
- **Evidence:** moderate

**Recommendation: R16**
- **Pharmacologic treatment of chronic cough due to reflux:**
  Use double standard dose proton pump inhibitor
  Duration of treatment: 2–3 months
- **Grade:** strong
- **Evidence:** moderate

**Recommendation: R17**
- **Surgical treatment of chronic cough due to reflux:**
  Should only be performed if preoperative pharmacological reflux treatment for cough is successful
- **Grade:** weak
- **Evidence:** moderate

**Recommendation: R18**
- **Surgical treatment of chronic cough due to weak acid reflux:**
  Initiate surgical treatment if proton pump inhibitor fails:
  no general recommendation
  **Grade:** none
  **Evidence:** none

**Recommendation: R19**
- **Drug induced cough:**
  Approximately 10% of women and 5% of men cough while taking ACE-inhibitor medication [40]. The therapeutic (antihypertensive, cardiac or nephroprotective) effects of an ACE treatment can be replaced by angiotensin II receptor antagonists, which do not cause cough more frequently than placebo. For further drugs inducing cough updated information is available on www.pneumotox.com.

**Upper airway cough syndrome includes:**
- Chronic rhinitis and sinusitis, often with postnasal drip [33]
- Chronic pharyngitis and laryngitis [34]
- Chronic affections of the external auditory canal [7]

**Lung tumors:** Cough is the most common initial symptom of lung tumors [32]. If a patient presenting with chronic cough is not taking an ACE inhibitor, a chest x-ray should be done at the first consultation. Furthermore, in order to exclude a lung tumor each patient with unexplained chronic cough should have a bronchoscopy at the end of the diagnostic algorithm (Fig. 2).

**Eosinophilic bronchitis:** characterized by chronic cough and sputum eosinophilia in absence of BHR. Eosinophilic bronchitis is invariably responsive to inhaled corticosteroid treatment [31].

**Gastroesophageal reflux disease:** Cough is triggered either by reflex or through reflex to pharynx and larynx (laryngopharyngeal reflex) and micro-aspirations [36]. Cough due to reflux can occur with or without heartburn [6], and not necessarily coincides with reflux oesophagitis (non-erosive reflux disease). Thus the gold standard of the reflux diagnosis is a triple sensor 24-hour pH probe and impedance pH-probe. The latter allows diagnosing both acid and weak acid reflux. Since pH-probes are frequently not available and poorly tolerated, high dose (2 × 40 mg) proton pump inhibitor treatment over the course of up to three months can alternatively be carried out, thereby confirming or excluding the diagnosis of reflux cough [37]. In distinct cases surgical treatment (fundoplication) can be performed [38, 39], yet no evidence-based selection criteria for surgery are available.

**Vocal cord dysfunction:** recurrent voluntary inspiratory (sometimes also expiratory) adduction of the vocal cords eliciting throat clearing, dry cough, wheezing and dyspnea. VCD can mimic asthma and often affects younger women [35].

**Kardos P et al. Guidelines of the German Respiratory Society ... Pneumologie 2010; 64: 701 – 711**
Therapeutic implications for patients suffering from chronic cough

Infections:
- Pertussis in adults is a rare cause of chronic cough, but has been described even without a preceding phase of acute infection. Particularly patients with recent contact to persons suffering from acute pertussis infection should be checked for antibodies. However, interpretation of the results is difficult. After the acute exudative phase of infection (taking up to ten days) a direct culture of Bordatella is no longer possible and antibiotics will have no effect on cough or on the natural history of the infection.

Infections:
- Tuberculosis: chronic cough is a typical symptom, and was one of its key diagnostic criteria in the pre-x-ray era.

Infections:
- Chronic cough due to heart diseases: Aside from chronic left heart failure (cough generally occurs upon physical exertion or prone position), cardiac drugs including ACE inhibitors, beta-blockers (only in patients with BHR), Amiodarone (eliciting Alveolitis), AV – block II – III, endocarditis [41] and cardiac arrhythmia [42, 43] can cause chronic cough.

Infections:
- Diffuse parenchymatous lung diseases (DPLD) – Systemic diseases with diffuse lung involvement:
  - DPLD: In addition to dyspnea, dry cough is the most common symptom. Some forms of diffuse parenchymatous lung disease (Table 3) cause cough at such an early stage that the DPLD can be missed by conventional chest x-ray. Thus, an apparently “normal” chest x-ray and spirometry do not rule out early lung disease with cough. A high resolution CT scan can establish the diagnosis.
  - Most systemic autoimmune disease can develop lung involvement and cause cough (e.g. Sjögren’s syndrome, systemic lupus erythematosus, rheumatoid arthritis, systemic sclerosis and vasculitides).

Infections:
- Cough due to inhalative events:
  - Aspiration: Chronic cough is caused if the foreign body becomes trapped in the bronchial system (usually in children between 1 – 3 years old), or due to chronic recurrent aspiration of food (liquids) resulting from dysphagia in underlying neurological conditions (e.g. bulbar paralysis, Parkinson’s disease [44], myasthenia gravis). Other causes: tracheoesophageal fistula, malformations, neck dissection (head and neck cancer), regurgitation in heavy gastroesophageal reflux disease.
  - RADS (reactive airways dysfunction syndrome) occurs following short-term, intense inhalation of vapors, smoke or gases [45] (usually due to accidents in the workplace) and often develops into difficult asthma.

Infections:
- Bronchiectasis and tracheobronchomalacia
  - Bronchiectasis can be missed on chest x-ray. Gold standard of the diagnosis is a high resolution CT scan. Usually causes productive cough with voluminous secretion, often hemoptysis.

Infections:
- Surgical treatment of chronic cough due to bronchiectasis:
  - Complete surgical resection of localized bronchiectasis is also effective for cough

Infections:
- Antitussive treatment of chronic cough due to bronchiectasis:
  - Central active cough suppressants contraindicated

Infections:
- Physiotherapy for tracheobronchomalacia:
  - Use cough - preventing physiotherapy techniques

Table 3  Diffuse parenchymatous lung diseases with cough as an early symptom.

<table>
<thead>
<tr>
<th>DPLD</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amiodarone induced DPLD</td>
<td>Cough can be the sole early manifestation</td>
</tr>
<tr>
<td>Methotrexat induced DPLD</td>
<td>The autoimmune disease itself or the methotrexat treatment can cause the cough.</td>
</tr>
<tr>
<td>Sjögren’s syndrome</td>
<td>9% pulmonary involvement, cough is rarely the presenting symptom...</td>
</tr>
<tr>
<td>Giant cell arteritis</td>
<td>Cough indicates lung involvement</td>
</tr>
<tr>
<td>Wegener’s disease</td>
<td>Airway involvement can cause cough even when chest x-ray is negative</td>
</tr>
<tr>
<td>Inflammatory bowel disease</td>
<td>Bronchiectasis, bronchial narrowing. COP* or even treatment (sulfasalazine) can trigger cough</td>
</tr>
<tr>
<td>Sarcoidosis</td>
<td>Airway involvement can cause cough</td>
</tr>
</tbody>
</table>

* COP: Cryptogenic organizing pneumonia
Isolated orphan airways disease: usually emerges in patients over 40 years old. Can lead to expiratory bronchial collapse, irreversible central obstruction of the airways. Coughing is frequently the main symptom. (Table 4)

Cystic fibrosis: CF is an autosomal recessive inherited disease. Abortive forms can manifest in adulthood for the first time through cough, bronchial infections and bronchiectasis [48].

Chronic cough and sleep apnea: Sleep apnea patients often complain of chronic cough.

Psychogenic (habit or tic) cough: By definition the sensitivity of the cough reflex is not increased in patients with psychogenic cough, but difficulty to measure reliably. There is always a risk of misdiagnosis of multicausal or idiopathic cough as being psychogenic cough.

Chronic idiopathic cough: Despite extensive diagnostic procedures, underlying causes of cough cannot be determined in up to 18% of patients with chronic persistent cough (ratio female/male = 2:1). Capsaicin or citric acid sensitivity of the cough reflex is increased in these patients [49].

Recommendation: R25
- Chronic idiopathic cough:
  - Do not perform diagnostic cough provocation test with capsaicin according to standardized provocation protocol
  - Grade: weak ⬤
  - Evidence: low

Recommendation: R26
- Chronic idiopathic cough:
  - Treatment with inhaled off label local anaesthetics
  - Grade: weak ⬤
  - Evidence: very low

Diagnosis of cough

Applying the algorithms frequently allows for a provisional diagnosis, which must be confirmed by successful treatment. Failure can therefore require continued investigation based on the algorithm. Multicausal cough requiring combination treatment also has to be considered.

Recommendation: R27
- Stepwise diagnostic workup of cough:
  - Use algorithms for acute and chronic cough, respectively
  - Grade: strong ⬤ ⬤
  - Evidence: none

Cough can persist up to eight weeks after subsiding of an acute infection (postinfectious cough). Except for special circumstances (Table 2), further examination according to the algorithm for chronic cough is only necessary after eight weeks (box 12).

Recommendation: R28
- Diagnostic work-up of acute cough:
  - Usually taking history and physical exam are sufficient
  - Grade: strong ⬤ ⬤
  - Evidence: low

Recommendation: R29
- Antibiotic treatment in otherwise healthy patients suffering of acute cough:
  - Not necessary
  - Grade: strong ⬤ ⬤
  - Evidence: moderate

Every patient with unexplained chronic cough must have a bronchoscopy performed by the end of the diagnostic algorithm. If a patient complains of cough lasting over eight weeks, diagnostic workup should be initiated immediately. The first steps consist of collecting the patients' medical history and a physical exam (box 1). If a (primarily) cardiac or neurological cause of cough is suspected, appropriate diagnostic workup must be initiated (box 3).

Establishing the cause of chronic cough is challenging if neither the chest x-ray nor the lung function test prove conclusive. If BHR can be established by nonspecific inhalative provocation test (box 11) the cough can be treated as probable variant asthma.

In smokers with inconclusive chest x-ray and normal lung function, smoking related chronic, non-obstructive bronchitis is the most likely cause of cough. Therefore a period of smoking cessation is recommended before further diagnostic workup is initiated (Box 14). If smoking cessation fails, or abstention remains unsuccessful after four weeks, diagnostic workup according to the algorithm should be continued.

Provided their chest x-ray proves negative, patients with cough and heartburn can be provisionally diagnosed with suspected gastroesophageal reflux and PPI treatment can commence. In case of remarkable gastroenterological history, one should proceed according to current gastroenterological recommendations. If after three months at the latest high-dose PPI treatment proves unsuccessful, and the cause of cough is not determined at the end of the algorithm (including CT and bronchoscopy), extensive and targeted gastroenterological diagnosis should be performed. This includes endoscopy, esophageal manometry, triple sensor pH-probe (or impedance for both acid and weakly acid reflux). At this point the indication for surgery (fundoplicatio) can be assessed as well.
Also the most common diagnostic and therapeutic shortcomings should be considered: early-stage, diffuse parenchymatous lung disease not yet evident on chest x-ray, eosinophilic bronchitis (eosinophile cell count in the sputum > 3%) and a psychogenic cough (rare in adults) all should be taken account of. In some patients, the cause of chronic cough will remain unclear despite exhausting available diagnostic tools. In this case the patient suffers from chronic idiopathic cough where the source of an increased sensitivity of the cough reflex cannot be established (Box 26).

**Recommendation: R30**

- **Cost-effective diagnostic work-up of cough:**
  - Follow algorithms
- **Grade:** strong
- **Evidence:** none

The most frequent shortcomings in diagnosis of cough

- Trivialization of cough in smokers without diagnostic workup.
- Change of the established sequence of examinations without reason.
- Extrapulmonary causes (ENT, gastric, neurological, cardiac) are disregarded.
- No bronchoscopy though cause of cough was not determined.
- Multiple causes overlooked.

**Symptomatic treatment of cough**

Causal treatment should always be sought. However, if this approach is impossible (e.g. acute viral respiratory infection) or would only prove effective in a delayed manner (e.g. tuberculosis), symptomatic treatment can be considered instead or in addition to causal treatment of cough. Symptomatic treatment targets one or several of the five parts of the cough reflex arc. Effects can be protussive (increasing cough and expectoration) or antitussive.

**Physiotherapy of cough:** Despite being clinical routine in both hospital and outpatient care [51] as well as in rehabilitation, evidence for the physiotherapy of cough is very low. Physiotherapy aims to:
- increase expectoration using effective coughing techniques for patients with productive but ineffective cough
- suppress voluntarily non-productive cough
- instruct patient in the use of physiotherapeutic equipment improving expectoration such as Acapella®, Flutter® and RC Cornet®.

![Fig. 1 Clinical algorithm for the diagnosis of acute cough.](image-url)
Fig. 2  Clinical algorithm for the diagnosis of chronic cough.

0. patient with chronic cough

1. history/physical exam

2. cardiac or neurological cause likely? yes → targeted diagnosis and treatment  no → cough explained by result? yes → further diagnosis and treatment  no → chest x-ray PA and lateral

3. targeted diagnosis and treatment

4. success? yes → no further action  no →

5. further diagnosis and treatment

6. chest x-ray PA and lateral

7. cough explained by result? yes → further diagnosis and treatment  no → lung function test

8. lung function test

9. normal lung function? yes → is non-specific provocation pathological? yes → cough due to BHR  no → smoking or exposure to hazardous material? yes → abstinence*  no → normal ENT exam? yes → reflux? yes → treatment  no → further ENT diagnosis and treatment

10. normal lung function?

11. is non-specific provocation pathological? yes → cough due to BHR  no → smoking or exposure to hazardous material?

12. smoking or exposure to hazardous material? yes → abstinence*  no → normal ENT exam?

13. normal ENT exam?

14. reflux? yes → treatment  no → further diagnosis and treatment

15. abstinence successful, cough subsided?

16. reflux? yes → treatment  no → further diagnosis and treatment

17. further ENT diagnosis and treatment

18. further diagnosis and treatment

19. chronic idiopathic cough due to increased sensitivity of the cough reflex

20. are HRCT scan and bronchoscopy normal? yes → eosinophilia in sputum? yes → eosinophilic bronchitis  no → in-depth reflux diagnostic workup

21. in-depth reflux diagnostic workup

22. in-depth reflux diagnostic workup

23. in-depth reflux diagnostic workup

24. pathological? yes → appropriate reflux therapy  no → in-depth reflux diagnostic workup

25. pathological?

26. pathological?

27. pathological?

28. pathological?

29. pathological?

* based on clinical suspicion, changes in severity and/or characteristics of cough may require immediate bronchoscopy therefore ignoring the steps of the algorithm.
Physiotherapy for chronic productive cough with and w/o bronchiectasis: 
Prescribe physiotherapy  
Grade: weak  
Evidence: very low

Physiotherapy for chronic dry cough: 
Prescribe physiotherapy for voluntary cough suppression  
Grade: None  
Evidence: none

Use of physiotherapeutic equipment for chronic productive cough with and w/o bronchiectasis: 
Prescribe physiotherapeutic equipment  
Grade: Weak  
Evidence: low

Pharmacotherapy

Expectorants reduce irritation of the cough receptors by accumulated mucus through “coughing up”, and represent the most common medication used for respiratory diseases in Germany (e.g. ambroxol and N-acetylcysteine, in the USA guaifenesin and iodinated glycerol.). Because of the lack of appropriate methods effectiveness is difficult to assess. Regarding relative effectiveness of different expectorants, conflicting or inconsistent evidence exists throughout the published literature [52, 53]. Symptomatic use of expectorants is recommended to ease cough in cases with production of viscous secretions (COPD, bronchiectasis). Many patients also report positive subjective effectiveness using self-medication for acute bronchitis.

Prescription of expectorants to ease cough: 
In symptomatic COPD and bronchiectasis patients  
Grade: weak  
Evidence: very low

Use of fixed combination phytopharmaca (ivy, thyme, primerose) for acute cough due to common cold: 
Prescribe fixed combination  
Grade: strong  
Evidence: moderate

In cystic fibrosis bronchiectasis inhaled dornase alfa eases cough [56].

Cystic fibrosis bronchiectasis: 
Use dornase alfa  
Grade: strong  
Evidence: moderate

Bronchiectasis with persistent cough: 
Use inhaled antibiotics (i.e. tobramycine, colistin)  
Grade: weak  
Evidence: high

Drugs that reduce mucus production
Inhalative anticholinergics (i.e. ipratropium and tiotropium) are thought to reduce mucus production; however their antitussive effect is not consistent [57].

Drugs that increase mucociliary clearance
Theophylline and beta2-adrenergics do increase mucociliary clearance but are not effective relieving cough [58].

Drugs for the reduction of irritation of cough receptors
By “coating” cough receptors in the throat, demulcents are thought to have an antitussive effect. Cough syrups, lozenges, cough drops and honey, share sugar as the common ingredient. Effectiveness, if any, is limited in time to the contact of the sugar with the receptor, usually 20 – 30 minutes.

Drugs that affect mucosal oedema
Systemic alpha-adrenergics for nasal decongestion are popular in the US but virtually not in use in Germany. Fixed combinations with anticholinergic and central effective antihistamines clorpheniramine or dексбrompheniramine are not available. Antibiotics are only effective against cough caused by a bacterial infection characterized by purulent phlegm (i.e. suppurative bronchitis, bronchiectasis, exacerbation of COPD, purulent rhinitis and sinusitis). Antibiotics are not indicated in acute bronchitis. Anti-inflammatory therapy: inhalative and nasal corticosteroids (oral leukotriene antagonists and probably topical nedocromil) alleviate cough in asthma, eosinophilic bronchitis, postinfectious cough due to BHR and rhinitis. Local anesthetics: Local anesthetics disable electrophysiological activity in the receptors and afferent nerves [59] (e.g. during bronchoscopy). They are increasingly used off label for idiopathic cough and in palliative medicine [60].

Drugs affecting central mechanism for cough (antitussives) are systemically applied morphine or codeine as well as natural and synthetic derivatives (i.e. dextromethorphan, dihydrocodeine, noscapine and pentoxyverin). Some non-addictive herbal remedies (thyme, ribwort, sundew) claim central antitussive properties, though this is not proven by clinical studies. Opiates are recommended for symptomatic treatment of dry cough [61]. They have limited efficacy in the treatment of cough resulting from common cold [62].
Complications of cough

Case reports are available for most complications of cough, listed below.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Complications of cough.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Urinary incontinence (in women)</td>
</tr>
<tr>
<td></td>
<td>Hoarseness</td>
</tr>
<tr>
<td></td>
<td>Pungent thorax pain</td>
</tr>
<tr>
<td></td>
<td>Triggering of asthma attacks in patients with bronchial asthma</td>
</tr>
<tr>
<td></td>
<td>Conjunctival ecchymosis</td>
</tr>
<tr>
<td></td>
<td>Epistaxis</td>
</tr>
<tr>
<td></td>
<td>Gastroesophageal reflux</td>
</tr>
<tr>
<td></td>
<td>Petechial hemorrhage</td>
</tr>
<tr>
<td></td>
<td>Rib fracture</td>
</tr>
<tr>
<td></td>
<td>Mediastinal emphysema</td>
</tr>
<tr>
<td></td>
<td>Cough Syncope</td>
</tr>
<tr>
<td></td>
<td>Seizure initiated by cough</td>
</tr>
<tr>
<td></td>
<td>Headaches</td>
</tr>
<tr>
<td></td>
<td>Inguinal herniation</td>
</tr>
<tr>
<td></td>
<td>Rupture of the rectus abdominis muscle</td>
</tr>
</tbody>
</table>

Conflict of interest

According to the rules of the Association of the Scientific Medical Societies in Germany, http://www.uni-duesseldorf.de/AWMF/, the conflict of interest statements were reported on the appropriate AWMF form and assessed by all authors. According to the subject of the guideline no conflict of interest was detected.1

Institutions

1 Group Practice & Allergy, Respiratory and Sleep Medicine Centre, Red Cross Maingau Hospital, Frankfurt am Main, Germany
2 Patients Airway League, Dienheim, Germany
3 Markus Krankenhaus, Department of Surgery, Frankfurt am Main, Germany
4 St. George Medical Center, Robert-Koch-Hospital, Leipzig, Germany
5 Center for Rhinology and Allergology Heidelberg University, Mannheim Faculty of Medicine, Wiesbaden, Germany
6 Nassaustraße 15, Weilburg, Germany
7 Physiotherapy Clinic S. Röske, Wuppertal, Germany
8 Occupational Accident Insurance, Bergmannsheil, University Hospital, Department of Internal Medicine III, Pneumology, Allergology, and Sleep Medicine, Bochum, Germany
9 Institute of Surgical Research, Philipps-University Marburg, Germany
10 Hospital Bethanien, Pulmonology, Allergy, Sleep Medicine Moers, Germany
11 Hospital Fürth, University Erlangen-Nürnberg, Fürth, Germany

References

11 Poe RH, Harder RV, Israel RH et al. Chronic Persistent Cough, Experience In Diagnosis and outcome using an anatomic diagnostic protocol. Chest 1989; 95: 723–728
19 Stein PD, Willis PW, DeMets DL. History and physical examination in acute pulmonary embolism in patients without preexisting cardiac or pulmonary disease. Am J Cardiol 1981; 47: 218–223
22 Brandon N. Premature atrial contraction as an etiology for cough. Chest 2008; 133: 828
33 Corsico AG, Villani S, Zoa MC et al. Chronic productive cough in young adults is very often due to chronic rhino-sinusitis. Monaldi Arch Chest Dis 2007; 67: 90–94
49 McGarvey LP. Does idiopathic cough exist? Lung 2008; 186 Suppl 1: S78 – S81