Allergologia et immunopathologia
Sociedad Española de Inmunología Clínica, Alergología y Asma Pediátrica
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ORIGINAL ARTICLE

OPEN ACCESS

Pragmatic management of acute cough in children and adolescents: an updated position paper by the Italian Society of Pediatric Allergy and Immunology (SIAIP)

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Received 17 October 2025; Accepted 22 December 2025
Available online 1 May 2026

KEYWORDS
acute cough;
children;
levodropropizine;
management;
natural remedies;
post-viral cough;
position paper

Abstract
Background: Cough is one of the most common and distressing symptoms in pediatric practice and represents a major cause of medical consultation, parental anxiety, and inappropriate medication use. Although most acute cough episodes are benign and self-limiting, they can significantly affect child's sleep, school performance, and quality of life. The COVID-19 pandemic and subsequent changes in infection patterns and immune responses have further highlighted the need to update the existing clinical guidance.
Objective: This joint position paper by the Italian Society of Pediatric Allergy and Immunology (SIAIP) aims to provide a pragmatic, evidence-based update on the management of acute and post-viral cough in children and adolescents, integrating recent scientific advances and real-world clinical experiences.
Methods: A multidisciplinary board of experts from SIAIP critically reviewed the literature published from 2019 to 2025 and updated the previous 2019 SIAIP document. The group achieved consensus on diagnostic and therapeutic recommendations through structured discussion and iterative revision.
Results: The document emphasizes a stepwise approach to pediatric acute cough, starting with careful history-taking, clinical evaluation, and reassurance. Non-pharmacological

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https://doi.org/10.15586/aei.v54i3.1671

measures—hydration, nasal saline irrigation, and avoidance of irritants—remain the first-line management. Pharmacological therapy may be considered in selected cases where cough is particularly distressing or significantly interferes with sleep; peripherally acting, nonsedative antitussives represent a reasonable option in terms of efficacy and safety. Centrally acting antitussives and unnecessary antibiotics should be avoided. Standardized, high-quality natural medical devices—with appropriate supporting evidence—represent a valid option. Honey-based preparations can be considered as complementary options. The paper also discusses new insights into cough pathophysiology, particularly the role of airway sensory hypersensitivity and neurogenic inflammation, which are paving the way for mechanism-based treatments.
Conclusions: This position paper provides an updated, pragmatic framework for the management of acute and post-viral cough in children and adolescents. It promotes rational drug use, integration of non-pharmacological and complementary measures, and awareness of emerging therapeutic targets. A mechanism-driven, individualized, and family-centered approach is advocated to improve clinical outcomes and quality of life for pediatric patients.

Introduction

Cough is both a symptom and a clinical sign, triggered by a reflex mediated through a complex neuronal pathway. It serves a fundamental physiological role in clearing the airways of accumulated material, usually because of overload of secretion (the so-called post-nasal drip), less frequently to foreign body, or inhalation of irritants. Cough may also occur in association with the conditions such as asthma, gastroesophageal reflux disease (GERD), or because of vagal stimulation.

Cough can be classified according to its duration or clinical characteristics. Acute cough, defined as lasting for <1 month, is extremely common in childhood. Clinically, cough may be clinically described as wet, typically associated with mucus hypersecretion, or dry, mainly because of airway irritation. Moreover, its acoustic features may help to differentiate types, such as bitonal, whooping, barking, or hollow cough.

It is important to emphasize that cough generally represents a physiological protective mechanism, allowing the clearance of secretions, irritants, or foreign material from the airways. Therefore, as with fever, it should not be suppressed indiscriminately; in fact, an ineffective cough, especially when centrally inhibited, may be of little clinical benefit or even counterproductive.

From an epidemiological perspective, acute cough represents the most frequent complaint in primary care. The most common cause is upper respiratory tract infection (URTI), usually of viral origin—the so-called post-viral cough.[1] To provide guidance in clinical practice, the Italian Society of Pediatric Allergy and Immunology (SIAIP) in 2019 published a systematic review on the pharmacological management of acute cough in children and adolescents,[2] which also included a diagnostic algorithm. However, that document preceded the COVID-19 pandemic, and substantial new evidence has since become available.

For these reasons, the SIAIP recognized the need to update and expand the previous position paper, involving additional national and international scientific societies. A dedicated scientific board was established to revise the document and provide an updated, evidence-based reference for clinicians. The present position paper aims to summarize the most recent knowledge and offer a practical tool for the management of acute cough in children and adolescents.

Acute Cough: Clinical Aspects

Acute cough affects virtually all children and typically occurs several times per year.[3,4] It represents the most frequent cause of new consultations in primary care and is also a common cause of unscheduled visits to emergency departments and out-of-hours services.[5] However, cough is a nonspecific symptom, and a wide range of etiologies must be considered. In daily practice, the most common triggers of acute cough are respiratory infections, mainly involving the upper airways, inhalation of irritants, foreign bodies, and exposure to allergens in children with asthma (Table 1). Although, in the majority of cases, cough is self-limiting and related to viral infections, it markedly increases parental anxiety and disrupts family sleep.[6] In school-age children, cough interferes with classroom activities and sports, thereby compromising school performance, physical exercise, and rest, and it may even result in school absenteeism.

Children with acute cough often require close parental supervision and care, leading to work absence and reduced productivity. This impact is further amplified when younger siblings are also affected or when multiple episodes occur during the same winter season. Consequently, families frequently resort to natural remedies in an attempt to relieve symptoms.[7,8] These practices are not always supported by evidence and may contribute to inappropriate medication use, including unnecessary antibiotics. Overall, acute cough imposes a considerable burden not only on children but also on their families and society because of its direct and indirect costs.[9,10]

The COVID-19 pandemic, while having a devastating impact on global health systems, also provided an unprecedented "natural experiment" for respiratory infections.[11-13] It clearly emphasized that every infectious episode is

Table 1 Causes of acute cough in children.

Causes	Suggestive findings
Environmental pulmonary toxicants	Exposure to tobacco smoke or environmental pollutions
URTIs	Rhinorrhea (anterior and posterior "post-nasal drip"); swollen nasal mucosa; fever; sore throat; nasal discharge; and nasal congestion
Croup	URTI-like prodrome; barky cough; stridor; nasal flaring; chest retractions; and tachypnea
Epiglottitis	Abrupt onset; fever; irritability; marked anxiety; stridor; respiratory distress; drooling; and toxic appearance
Bacterial tracheitis	Stridor; barky cough; fever; respiratory distress; and toxic appearance
Bronchiolitis	Rhinorrhea; first episode of respiratory distress associated with cough; crackles and/or wheezing; dyspnea; polypnea; increased respiratory effort manifested as nasal flaring, grunting, use of accessory muscles or intercostal and/or subcostal chest wall retractions; low oxygen (O_2) saturation levels and apnea; changes in skin color; feeding difficulties; lethargy; and, rarely fever
Pneumonia	Fever; cough; tachypnea; dyspnea; Hypoxemia; increased work of breathing (e.g., chest retractions, nasal flaring, and head bobbing); and decreased or abnormal breath sounds on auscultation (e.g., crackles, rales, crepitation, wheeze, and rhonchi)
Foreign body	Sudden onset of coughing; wheezing; stridor (high-pitched); difficulty in breathing; drooling; gagging; vomiting; and dysphonia or cyanosis
COVID-19	Nasal congestion and rhinorrhea; sore throat; fever; chest tightness; tachypnea; wheezing; crackles; and hypoxia

accompanied by an inflammatory response that underlies the main systemic and respiratory symptoms. Lockdowns, use of masks, hand hygiene campaigns, and social distancing markedly reduced the circulation of common respiratory viruses during the first pandemic phases. This was reflected in the almost complete disappearance of bronchiolitis and a dramatic fall in other acute respiratory infections in many countries.[14,15] As these non-pharmacological interventions were progressively relaxed, a rapid and sometimes pronounced rebound of respiratory infections was observed, often with atypical seasonality and clustering of cases. This phenomenon has been attributed, at least in part, to a "gap" in immune training because of reduced exposure to pathogens, particularly in younger children who had never previously encountered common respiratory viruses.

Within this changing epidemiological landscape, the clinical expression of acute and post-infectious cough appears to be evolving. Children may present with cough associated with different viral patterns and co-infections, and some episodes seem more intense or prolonged than in the pre-COVID era. In addition, heightened parental concern about respiratory symptoms, often driven by fear of SARS-CoV-2 infection, has led to earlier medical consultations and, in some settings, to increased pressure for diagnostic tests and pharmacological treatments. These elements underline the need to reappraise the approach to post-viral cough, considering both inflammatory nature of symptoms and new patterns of viral circulation.[7]

Taken together, these observations reinforce the importance of updated, evidence-based strategies for the assessment and management of acute cough in children and adolescents. Clinicians are now required to balance the reassurance that most acute coughs are benign and self-limited with the recognition of potential red flags, while at the same time avoiding unnecessary investigations and inappropriate pharmacological interventions.

Acute Cough: Practical Management

The present document summarizes and discusses updated knowledge and evidence on the pathophysiology and treatment of acute cough. In addition, it revises the previously proposed practical algorithm for the clinical management of children and adolescents with acute cough. A specific novelty of this position paper is the formal inclusion of selected non-pharmacological remedies. Because the aim was to reflect real-life management, it was not possible to ignore the widespread interest of parents and many physicians in "natural" products, which are often perceived as both effective and safe. Several reviews have re-examined this topic, selecting studies according to predefined evidence-based criteria.[16–18] Overall, the literature shows that only a limited number of substances are supported by sufficiently robust evidence to warrant recommendation in clinical practice. Further well-designed studies, particularly in real-life settings, are therefore needed to provide convincing data on their efficacy and safety.

Causes of Acute Cough in Children

In children, acute cough in children is most commonly caused by acute viral infections, including common colds, acute bronchitis, bronchiolitis, croup, influenza, and

post-viral cough or by exposure to environmental pulmonary toxicants. However, acute cough may also be less common, but leads to potentially serious conditions, such as asthma exacerbations, pneumonia, or foreign body aspiration.

The main causes of acute cough in childhood are summarized in Table 1.

Algorithm-Based Approach to Acute Cough

Algorithm for the management of acute cough provides a structured framework to guide clinical reasoning and ensure an evidence-based, stepwise evaluation. The approach begins with a detailed medical history, a thorough physical examination, and an assessment of cough quality (Figure 1).

In most cases, acute cough in children results from viral URTIs and resolves spontaneously without complications. Nevertheless, a meticulous history remains essential to avoid missing or delaying the diagnosis of potentially serious underlying disorders. Key aspects to investigate include the child's age, the duration and onset of cough, its qualitative features, possible triggers, associated symptoms or signs, and particular attention on red flags as outlined in Figure 2.

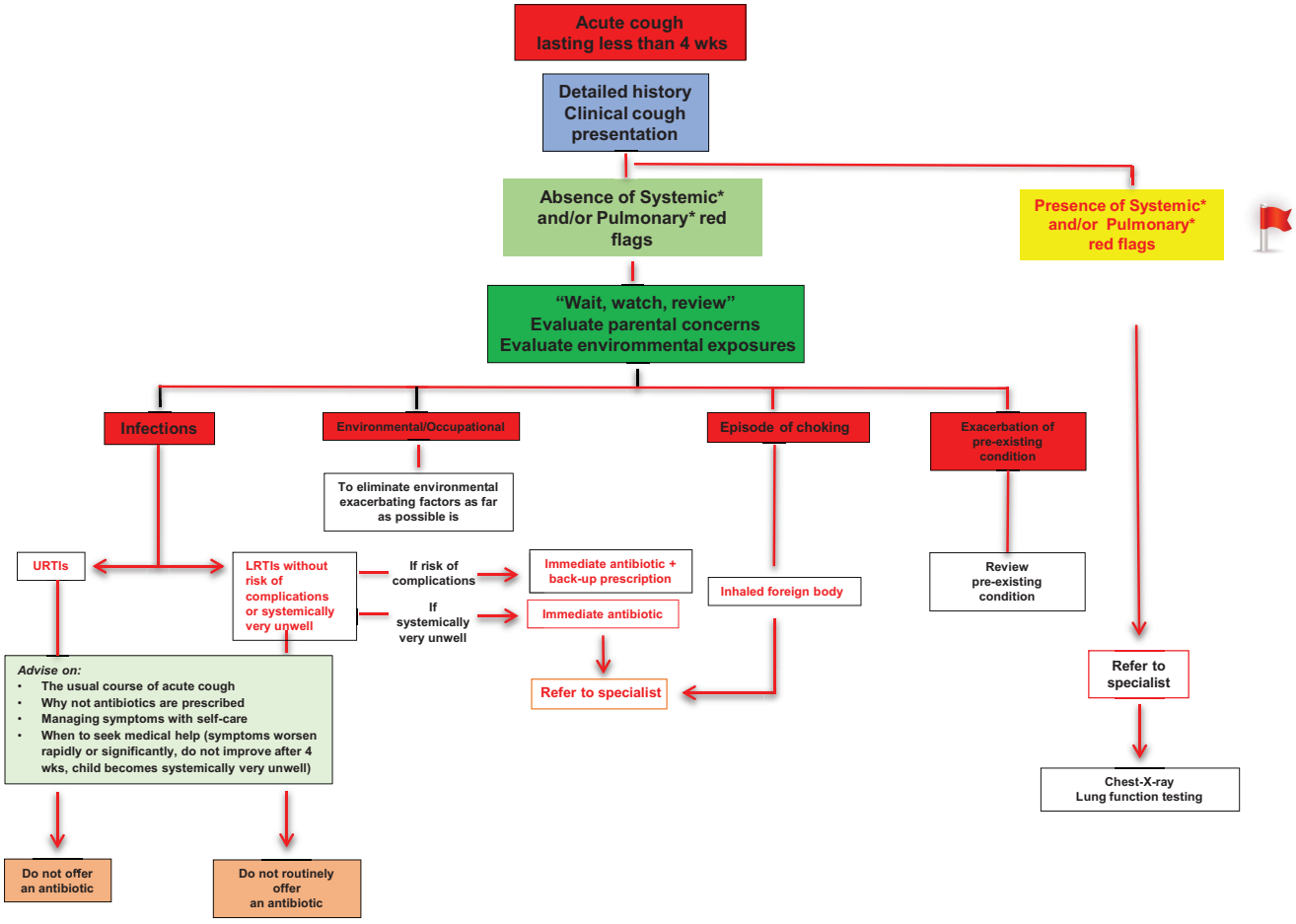

Figure 1 Flow chart of acute cough assessment for children in absence of systemic and/or pulmonary flags.

Systemic and/or Pulmonary red flags

Systemic Red flags	Neonatal onset of cough	Digital clubbing	Failure to thrive	Use of medications or drugs	Palatal abnormalitis	Fever	Pallor	Sweating	Dehydration	Features suggestive of immunedeficiency
Pulmonary Red flags	Chest pain	Daily moist or productive cough	Hemoptysis	Abnormal cough characteristics	Tachycardia	Hypoxiac yanosis	History of previous lung disease or predisposing causes	Dyspnea tachypnea Respiratory distress	Chest shape and chest wall deformities	Adventitious lung sounds

Figure 2 Red flags for severe acute cough.

Children should always be examined for systemic or pulmonary abnormalities (Table 2). The absence of such findings supports the likelihood of a benign, self-limiting cause, whereas the presence of fever, respiratory distress, abnormal auscultatory findings, or systemic involvement warrants further investigation. In addition, parental expectations and modifiable exacerbating factors, such as exposure to tobacco smoke, biomass fuels, indoor allergens, or outdoor air pollution, should also addressed, regardless of the suspected etiology.

When "cough pointers" are identified, they may indicate specific acute disorders requiring targeted investigation and management (Figure 2). Importantly, in children, the quality and temporal pattern of cough often provide valuable diagnostic clues. As a pragmatic rule, dry cough usually reflects an irritative or inflammatory process involving the airways or adjacent structures, whereas wet cough is more consistent with productive cough because of postnasal drip, or less frequently a mucus hypersecretion, or impaired mucociliary clearance (Table 3).

Dry cough frequently accompanies infections such as pertussis, pertussis-like illness, post-viral cough syndrome, *Mycoplasma pneumoniae* or *Chlamydia pneumoniae* infections. These conditions are typically characterized by a paroxysmal, sometimes spasmodic cough, often associated with other features of respiratory infection, including pharyngitis. An infectious cause should be particularly suspected when there is a history of close contact with symptomatic individuals. Pertussis and pertussis-like illness must be considered even in fully immunized children, as partial vaccine failure is a recognized phenomenon.

Dry and paroxysmal cough, in the absence of wheeze, chest tightness, or dyspnoea may represent the predominant manifestation of cough-variant asthma (CVA). Episodes commonly occur in response to typical asthma triggers, such as cold air, weather changes, exercise, and exposure to outdoor or indoor pollutants. Because patients with CVA often exhibit variable expiratory airflow limitation and bronchial hyperresponsiveness, they tend to benefit from standard asthma therapies, particularly inhaled corticosteroids.[18] Early diagnosis and appropriate treatment may delay progression to classic asthma in predisposed individuals. Conversely, children who have experienced CVA but have never wheezed and have no other evidence of atopy appear to have a very low risk of developing asthma.[19]

A barking or brassy cough, particularly when associated with stridor and hoarseness, is highly suggestive of croup. In contrast, a sudden onset of cough accompanied by wheeze, stridor, respiratory distress, or additional symptoms, such as drooling, gagging, vomiting, and dysphonia, or cyanosis raises strong suspicion of foreign body aspiration, which requires urgent assessment.

A dry cough present since birth should prompt consideration of congenital airway malformation, such as tracheomalacia, especially when associated with failure to thrive, stridor, dyspnea, respiratory distress, recurrent lower respiratory tract infections (LRTI), or dysphagia.[19]

Habit cough (also referred to as habit-tic cough, psychogenic cough, somatic cough disorder, or functional cough) occurs when psychological distress manifests as a cough. It is typically a dry, often harsh cough that usually begins after a viral URTI.[20] It is predominantly a daytime

Table 2 List of systemic and pulmonary red flags.

Systemic red flags	Neonatal onset of cough	Digital clubbing	Failure to thrive	Use of medications or drugs	Craniofacial, palatal abnormalities	Fever	Pallor	Sweating	Dehydration	Features suggestive of immune deficiency	Neuromuscular disorder
Pulmonary red flags	Chest pain	Coughing is progressive, daily moist or productive cough	Hemoptysis	Abnormal cough characteristics	Tachycardia	Hypoxia cyanosis	History of previous lung disease or predisposing causes	Dyspnea tachypnea respiratory distress	Chest shape and chest wall deformities	Adventitious lung sounds	Coughing initiates suddenly with a choking episode, swallowing difficulties

Table 3 Quality of cough and suggested underlying causes or contributing factors.

Quality of cough	Suggested underlying causes or contributing factors
Barking or brassy cough or honking	Croup, tracheomalacia, and habit cough
Paroxysmal (with/without whoop)	Pertussis and parapertussis
Staccato, dry cough	*Mycoplasma pneumoniae*, *Chlamydia pneumoniae*; post-viral cough syndrome, cough variant asthma
Wet cough	Protracted bacterial bronchitis, pneumonia, bronchiectasis, cystic fibrosis, primary ciliary dyskinesia

phenomenon, occurring many times per minute with a strikingly regular pattern, and it tends to diminish when the child is distracted or asleep, although complete absence at night is relatively uncommon. The frequent presence of additional somatic complaints, such as throat or chest pain, breathlessness, hyperventilation, palpitations, headache, nausea, or vomiting, may lead to extensive (and sometimes unnecessary) investigations.[20]

Similarly, vocal tics can manifest as a dry cough, often accompanied by throat-clearing and and other stereotyped vocalizations, and may form part of a generalized tic disorder.[20]

A wet cough is usually indicative of productive cough due to postnasal drip or less frequently a mucus hypersecretion, or impaired mucociliary clearance.[21] Persistent wet secretions associated with bacterial infection may suggest protracted bacterial bronchitis (PBB), which is characterized by: (i) chronic wet cough lasting for more than 4 weeks; (ii) absence of specific pointers to alternative causes of wet cough; and (iii) resolution of symptoms following a 2–4-week course of appropriate oral antibiotics. The most common pathogens are *Haemophilus influenzae*, *Streptococcus pneumoniae,* and *Moraxella catarrhalis*.[22]

Whenever possible, clinicians should directly listen to, and, when feasible, record the cough during the visit to corroborate the history. It is important to remember that cough quality and pattern can change over time; for example, a dry cough may evolve into a wet cough as airway secretions increase.

A cautious interpretation is therefore essential, as cough characteristics alone are not sufficiently specific to distinguish reliably between common causes of acute cough in children.[23] Cough description should always be integrated with the overall clinical context and considered as one component, rather than the sole determinant, of diagnostic decision-making.

Therapeutic Management of Acute Cough

The therapeutic management of acute cough in children should be pragmatic and evidence-based, with the primary goal of relieving discomfort and improving quality of life (QoL) while avoiding unnecessary or potentially harmful treatments. Since most cases are of viral and self-limiting origin, reassurance, parental education, and symptom severity monitoring remain the cornerstones of care. Non-pharmacological measures, such as adequate hydration, nasal saline irrigation, humidified air, and avoidance of irritants, such as tobacco smoke, should always represent the first-line approach.[8]

The inappropriate use of antibiotics or systemic corticosteroids should be strongly discouraged, as these agents provide no benefit in uncomplicated viral coughs and may contribute to antimicrobial resistance or adverse effects.[24] Likewise, centrally acting antitussives, such as codeine, dextromethorphan, or cloperastine, have limited efficacy and safety concerns, including sedation and respiratory depression, and should not be used in children.[25]

The main therapeutic strategies are summarized in Table 4.

Pharmacological Management of Acute and Post-Viral Cough

The pharmacological management of acute cough in children should be reserved for selected cases, such as where the symptom significantly interferes with sleep, feeding, or daily activities. As cough is a physiological reflex essential for airway clearance, the goal of therapy is not suppression *per se*, but modulation of excessive or distressing cough that persists beyond the acute viral phase.[25]

Pharmacological intervention becomes appropriate when cough is frequent, and disturbing, especially at night, and when the physical examination and clinical context exclude serious underlying conditions. In these cases, treatment may be aimed at reducing cough reflex hypersensitivity, which can persist after viral infections because of residual airway inflammation and neurogenic activation. Post-viral cough is often sustained by peripheral sensory nerve hyperexcitability, leading to exaggerated cough responses to minimal stimuli.[26]

In this setting, peripherally acting antitussives, are preferable to central cough suppressants. Unlike codeine or dextromethorphan, which inhibit the cough center and may depress respiratory drive, peripheral agents act by modulating afferent C-fiber activity in the airways, thereby reducing cough frequency without abolishing the protective reflex.[24] This mechanism allows for symptom control while preserving airway defense, a key consideration in pediatric patients.

Recent Italian real-world studies have offered preliminary support to this approach. In a large observational multicenter primary-care study, children with post-viral

Table 4 Therapeutic options for the management of acute and post-viral cough in children.

Therapeutic category	Examples of active substances	Mechanism of action	Evidence and indications	Comments/safety considerations
Non-pharmacological measures	Hydration, humidified air, nasal saline irrigation, environmental control	Maintain mucosal hydration and mucociliary clearance; reduce cough triggers	First-line in all children with acute viral cough	Simple, safe, cost-effective; universally recommended
Peripheral antitussives	Levodropropizine	Inhibits cough reflex via modulation of peripheral sensory (C-fiber) activity	Suggested efficacy in acute post-viral cough by real word evidence; improves sleep and QoL	Nonsedative; well-tolerated; suitable from age ≥2 years
Central antitussives	Codeine, dextromethorphan, cloperastine, butamirate	Suppress cough center in medulla	No consistent benefit in children; potential toxicity	Contraindicated or not recommended for children aged <12 years; risk of sedation, respiratory depression
Mucolytics/ expectorants	Ambroxol, acetylcysteine, carbocysteine, guaifenesin	Alter mucus viscosity or secretion	Insufficient evidence in children; may induce vomiting or paradoxical cough	Avoid in children aged <2 years; limited role overall
Anti-inflammatory therapy	Corticosteroids (systemic or inhaled)	Reduces airway inflammation	Only indicated for specific conditions (asthma, croup)	No role in simple viral cough
Natural/plant-based medical devices	*Plantago lanceolata*, *Grindelia robusta*, *Thymus vulgaris*, *Helichrysum italicum*, *Althea officinalis*, *Hedera helix*	Forms a protective mucosal barrier; demulcent, antioxidant effects	May reduce cough frequency and throat irritation; modest benefit in post-viral cough	Variable quality and standardization; use only certified formulations
Medical devices containing complex botanical substances with honey	*Grindelia, Helichrysum, Plantago Biological honey*	Demulcent, antioxidant, anti-inflammatory, and reduces reflex sensitivity	Evidence of reducing cough duration and severity	Contraindicated in infants aged <12 months (for honey)
Honey and glycerol-based products	Honey, honey + glycerol syrups	Demulcent and antioxidant; soothes throat and reduces reflex sensitivity	Limited or no clinical evidence supports honey- and glycerol-based products in children aged >1 year	Contraindicated in infants aged <12 months (risk of botulism); adjunctive role only
Emerging pharmacological agents	P2X3 antagonists (gefapixant, eliapixant), transient receptor potential (TRP) channel modulators, NK1 receptor antagonists	Target vagal afferent hypersensitivity and neurogenic inflammation	Promising results in adults with chronic refractory cough	Not yet approved for pediatric use; potential future options

cough treated with levodropropizine experienced a rapid improvement in cough intensity, sleep quality, and the overall well-being. Benefits were generally observed within 5–7 days, and the treatment was well tolerated, with only mild, self-limited adverse events.[17,24] The study offers real-world evidence that is consistent with the efficacy and safety of peripheral, non-opioid antitussives in pediatric acute and post-viral cough, although confirmation from controlled trials is needed. Centrally acting antitussives, including codeine, cloperastine, butamirate, and dextromethorphan, lack robust evidence of efficacy in children and carry unfavorable safety profiles (sedation, respiratory depression, and risk of misuse). Their use is strongly discouraged by international agencies, such as European Medicines Agency (EMA) and Food Drug Administration (FDA), in the pediatric population.[17]

Other classes of agents, such as mucolytics and expectorants, have not demonstrated consistent benefit in

randomized pediatric studies and may cause paradoxical worsening of cough or vomiting in young children. Their use should be avoided, particularly in children aged <2 years, where the cough reflex and mucociliary clearance are still immature.

Overall, when pharmacological treatment is indicated, peripherally acting nonsedative agents represent the most appropriate choice. Their use should always be individualized, considering age, symptom burden, and tolerance, and integrated with non-pharmacological measures and environmental control. Such a targeted approach ensures both symptom relief and physiological protection, aligning with the principles of rational, evidence-based pediatric respiratory care.[24]

Emerging Perspectives in Pharmacological Cough Modulation

Recent advances in cough pathophysiology have highlighted the complex interplay between airway inflammation, epithelial injury, and neurogenic sensitization, leading to persistent cough even after the resolution of infection. This condition, often referred to as post-viral, is characterized by a transient hypersensitivity of vagal afferent pathways, resulting in an exaggerated cough response to otherwise innocuous stimuli, such as talking, cold air, or mild irritants.[24] In children, prolonged cough may be in rare cases neurogenic (sensory neuropathic) in origin.[27]

Mucosal dehydration and mechanical stimuli, caused by pharyngeal dripping of viscous nasal mucus, viruses, bacteria, inflammatory mediators, and irritant substances, play a decisive role in triggering the urge to cough and sustaining URTI-associated acute cough.[28]

Viral respiratory infections induce the release of pro-inflammatory cytokines, prostaglandins, and neuropeptides (such as substance P and calcitonin gene-related peptide), which enhance the excitability of sensory nerve endings in the airways. This leads to upregulation of transient receptor potential (TRP) channels, particularly transient receptor vannilloid 1 (TRPV1), TRPA1, and transient receptor melastatin 8 (TRPM8), on vagal afferents. These receptors serve as molecular "sensors" for chemical and mechanical stimuli, and their heightened activation contributes to cough reflex hypersensitivity. Understanding these mechanisms has paved the way for innovative targeted pharmacological approaches.[29,30]

Among these, P2X3 receptor antagonists (e.g., gefapixant and eliapixant) have emerged as a new class of neuromodulatory agents capable of suppressing pathological cough hypersensitivity by selectively blocking adenosine 5′-triphosphate (ATP)-mediated activation of vagal sensory fibers. In adults with refractory or unexplained chronic cough, gefapixant has shown significant reduction in cough frequency and severity, although its use is currently limited by dose-related taste disturbance.[31] Pediatric data are still lacking, but these compounds represent a promising future direction for the management of chronic or post-infectious cough unresponsive to conventional therapy.

Other research efforts are focusing on TRP channel modulators, neurokinin-1 (NK1) receptor antagonists, and neuromodulators of the vagal pathway, aiming to restore normal cough threshold without impairing airway defense. Experimental compounds targeting TRPV1 and TRPA1 channels have demonstrated antitussive potential in preclinical studies by reducing sensory neuron excitability and inflammatory signaling.[32]

Although these approaches are not yet approved for pediatric use, they illustrate a paradigm shift in cough treatment, from empirical symptom suppression toward pathophysiology-driven modulation of cough reflex hypersensitivity. Future studies in children and adolescents will be essential to clarify the safety, dosing, and long-term impact of these agents as well as their integration into multimodal treatment strategies that combine pharmacological, environmental, and behavioral interventions.

Taken together, these advances reinforce the concept that the management of cough, especially post-viral, should evolve from a symptomatic to a mechanism-based approach, aimed at restoring airway sensory homeostasis and preventing chronicity.

Non-Pharmacological and Natural Remedies

In pediatric clinical practice, non-pharmacological and natural remedies are frequently used to manage acute and post-viral cough. Their popularity reflects both parental preference for "natural" therapies and the desire to avoid unnecessary pharmacological interventions. However, despite their widespread use, the scientific evidence supporting these treatments remains limited, and many available products differ widely in formulation, concentration, and quality.[8]

Non-pharmacological management includes a range of simple yet effective supportive measures, such as ensuring adequate hydration, maintaining ambient humidity, promoting nasal patency through saline irrigation, and eliminating environmental irritants (e.g., tobacco smoke, biomass fuels, and air pollutants). These interventions help to maintain mucociliary clearance and reduce cough reflex activation, and should be universally recommended as the first step in management for all children with acute cough.[24]

Beyond these general measures, numerous herbal extracts and natural products have been investigated for their potential soothing, demulcent, or mucosal protective effects. The SIAIP Task Force on Nutraceuticals and Medical Devices has recently reviewed the most commonly used natural preparations for pediatric cough, such as formulations based on *Plantago lanceolata, Grindelia robusta, Helichrysum italicum, Thymus vulgaris, Althea officinalis, Hedera helix*, and honey.[25] These compounds often act via non-pharmacological mechanisms, forming a protective film over the inflamed mucosa, thus reducing irritation and local inflammation. In URTI-associated acute cough, mucosal dehydration and mechanical stimuli from viscous postnasal drip, pathogens, and inflammatory mediators play a decisive role; the barrier action of these agents helps to counteract exactly these processes. Many are classified as medical devices rather than drugs, as their action is primarily physical, rather than systemic.

Among these natural options, honey is the best studied and most consistently effective. Several randomized controlled trials (RCTs) and meta-analyses have shown that a

single evening dose of honey can reduce nocturnal cough frequency and improve sleep quality in children aged >1 year.[8] Honey exerts a demulcent and antioxidant effect, stimulating salivary secretion and coating the upper airway mucosa, thereby diminishing cough reflex sensitivity. However, it is important to emphasize that honey must not be administered to infants aged <12 months because of the risk of infant botulism.

A high-quality specific polysaccharide-resin-saponins-honey-based medical device, specifically formulated for the treatment of post-viral acute cough, has been demonstrated in a pediatric RCT to be superior to placebo in nocturnal and more intense cough, and to carbocysteine in all the items of the cough score adopted in the study to evaluate night and day cough.[28]

There are other medical devices based on combinations of plant extracts (e.g., *Thymus vulgaris* L., *Althaea officinalis* L., and *Hedera helix* L.), and some of these products are often combined with glycerol, malt extract, or hyaluronic acid, which provide additional emollient and humectant effects, facilitating mucosal hydration and comfort. However, differences in botanical source, extraction process, and degree of standardization among products can significantly influence clinical outcomes. Thus, standardization, quality control, and transparency of composition are essential prerequisites for their rational use.[17] The remark on "transparency of composition" does not apply to substance-based medical devices because their full qualitative and quantitative composition is already disclosed to the competent notified body during the certification process. Adequate quality is a mandatory prerequisite for product choice.

It is also important to stress that "natural" does not always mean "safe." Adverse effects are rare but can occur, as is the case with medicines, particularly in children with allergies. In addition, effectiveness is not guaranteed. For this reason, natural products should be recommended only when documented literature evidence supports their use. As a result, in the case of acute URTI-related cough, only high-quality products with sound evidence of efficacy may be a valuable therapeutical option. When selected appropriately, they can reduce symptom perception, improve family satisfaction, and limit unnecessary use of synthetic drugs. Their integration into standard care should follow the same evidence-based criteria applied to conventional treatments: correct indication, appropriate dosing, defined treatment duration, and ongoing monitoring of response.[17]

Ultimately, non-pharmacological and natural remedies represent a valuable component of a holistic, patient-centered approach to pediatric cough management. Their judicious use, guided by evidence, safety, and parental expectations, can complement pharmacological options within a rational, tiered treatment strategy designed to minimize overtreatment while maintaining patient comfort and airway protection.

Conclusions and Future Directions

Cough remains one of the most frequent and distressing symptoms in pediatric practice, representing a leading cause of medical consultation, parental anxiety, and inappropriate medication use. Although most cases are benign and self-limiting, acute cough may significantly impair sleep, school performance, and the overall family well-being.

A rational, evidence-based approach should therefore guide management, as schematically represented in Figures 2-4 for the general overview and management of post-viral and non post-viral acute cough. Careful clinical assessment and parental reassurance are often

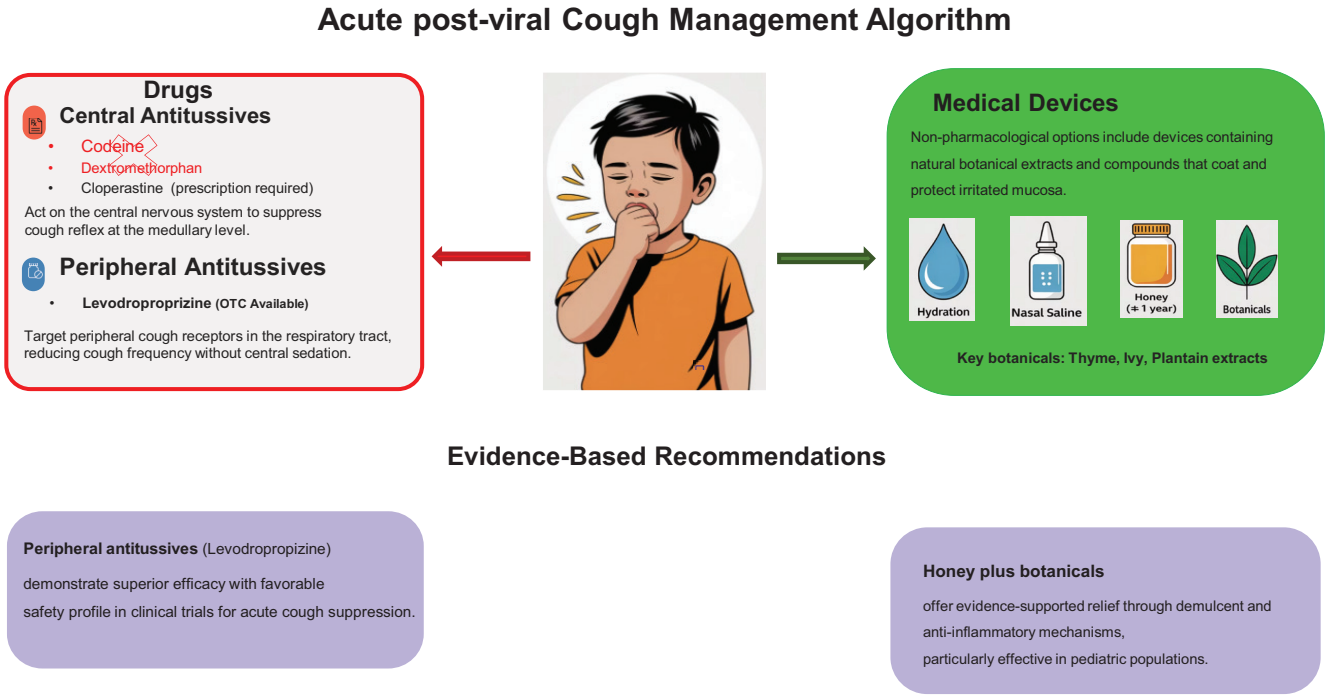

Figure 3 Algorithm for managing children with post-viral acute cough.

sufficient, with non-pharmacological measures, such as adequate hydration, nasal saline irrigation, and avoidance of irritants, constituting the first therapeutic step. Pharmacological therapy may be considered in selected cases in which cough becomes particularly distressing or interferes with sleep; in this context, peripherally acting, nonsedative antitussives can represent a reasonable option in terms of efficacy and safety. Centrally acting agents and unnecessary antibiotics should be avoided. In parallel, the use of standardized natural medical devices or honey-based preparations may be contemplated, with careful consideration of their composition and supporting evidence.

Beyond symptomatic control, there is growing awareness that post-viral cough often involves airway sensory hypersensitivity and neurogenic inflammation. This evolving concept opens new perspectives for mechanism-based treatments, including modulators of vagal afferent pathways, such as P2X3 antagonists or TRP channel inhibitors, which could represent future therapeutic options once adequately validated for pediatric use.

To advance the field, large multicenter real-world studies are needed to assess the efficacy, safety, and long-term outcomes of current pharmacological and non-pharmacological strategies. The development of validated clinical tools, including objective cough monitoring systems and parent-reported outcome measures, will allow more accurate evaluation of treatment effects in children.

Ultimately, the management of acute and post-viral cough in childhood should evolve from an empirical, symptom-based approach toward a mechanism-driven, individualized model that combines scientific evidence, clinical judgment, safety profile, and family-centered care. Such an approach will ensure not only more rational use of medicines but also improved QoL and better health outcomes for children and their families. In this context, natural remedies also could be a useful and safe approach but only if using medical device and products with adequate scientific evidence, as documented for a multicomponent medical device containing honey, *Plantago lanceolata*, *Grindelia robusta*, and *Helichrysum italicum*.[33,34]

In conclusion, the management of children with acute cough should be personalized and based on safe, mainly concerning sedative effects, and effective drugs and medical devices with well-documented literature.

Mandatory Disclosure on Use of Artificial Intelligence

The authors declare that no AI-assisted tools were used in the preparation of this manuscript. All references have been manually verified for accuracy and relevance.

Author Contributions

This study was a collaboration of all the authors.

Conflicts of Interests

The authors declared that they had no competing interests.

Funding

The publication was supported by the Italian Society of Pediatric Allergy and Immunology (SIAIP).

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