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The Child with an Incessant Dry Cough

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Educational Aims

The reader will be able to:

- **To highlight the main causes of prolonged dry cough in children**
- **Know how and when to investigate prolonged dry cough**
- **Identify when to use a watchful waiting approach in the absence of any underlying pathology**
- **Know when a trial of inhaled corticosteroids should be used**

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Summary

Cough is a forced expulsive manoeuvre, usually against a closed glottis and is associated with a characteristic sound that is easily recognised. It is a protective reflex against aspiration and to clear airway secretions. In children cough is extremely common and when prolonged it is often a cause for concern for parents, resulting in a high proportion of attendances to primary and secondary care. There are many causes of cough which may be divided into productive or non-productive in character. As there are many guidelines for the management of productive or 'wet' cough the focus of this paper will be to discuss some of the main causes, investigations and management options for 'dry' cough. Dry coughing suggests airways irritation and or inflammation (without excessive extra secretion formation) and is predominantly the result of an acute viral respiratory infection that may last up to 3-4 weeks.

Future directions of research

- Development of markers that predict dry cough responsiveness to inhaled corticosteroids
- More detailed epidemiological studies to investigate the possible separation and causes of persistent dry cough (i.e. non-specific isolated cough, post viral cough and cough variant asthma)
- Further epidemiological studies to explore if or when recurrent acute dry cough becomes a chronic dry cough

Abbreviations

Allergic rhinitis (AR)
Angiotensin converting enzyme (ACE)
British Thoracic Society (BTS)
Bronchoscopic secretion (BS)
Cough receptor hypersensitivity (CRH)
Environmental tobacco smoke (ETS)
European Respiratory Society (ERS)
Forced exhaled nitric oxide (FeNO)
Gastro-oesophageal reflux disease (GORD)
Inhaled corticosteroids (ICS)
Persistent Bacterial Bronchitis (PBB)
Proton pump inhibitor (PPI)
Upper respiratory tract infection (URTI)

What is cough?

Cough is a protective reflex. It is a forced expulsive manoeuvre, usually against a closed glottis and is associated with a characteristic sound that is easily recognised. The importance of having an adequate cough reflex is exemplified in children with severe neuromuscular weakness that have difficulty generating a deep inspiration in order to cough and clear airway secretions. These patients therefore suffer recurrent lower airways infection and lobar collapse.

In general coughing has two main purposes:

- 1] To clear excessive secretions and mucous from the large airways.
- 2] To prevent foreign material from entering the lower airways.

Cough receptor hypersensitivity (CRH) has been shown to occur in adults and children after an upper respiratory tract infection (URTI) or exposure to environmental tobacco smoke (ETS).¹ It is theorised that CRH results in and explains post viral cough which can last for weeks.

What is the epidemiology of cough?

In the UK cough symptoms account for up to 8% of attendances to primary care and the emergency department for children aged 0 to 15 years.^{2,3} A UK population-based prospective cohort study using repeated questionnaires to compare the prevalence of cough in 7670 children aged between 1 and 18 years. The authors used previously validated questions about cough, which allowed comparison with other studies.⁴ They found that 10% 'coughed more than other children', 69% 'coughed usually with a cold', 34% to 55% age-dependently 'coughed without colds', and 25% had 'night-time cough'.⁴ Cough frequency in healthy primary school aged children occurs on average 11.3 times (with a range 1-34) in a 24 hour period.⁵

Chronic cough is associated with more frequent medical reviews. One study reported that 80% of children with chronic cough had five or more medical consultations in a 12-month period.⁶ An Australian study, showed that 20% of children with an URTI coughed for more than 28 days with 19% of these patients having a dry cough and on review by a paediatric pulmonologist were diagnosed with non-specific cough, post viral cough or recurrent URTI.⁷ In the vast majority of children with prolonged non-specific cough it has been shown that the cough will improve and resolve with time.⁸

Approach to the child with chronic cough:

1. Clinical history and examination

The important parts of the clinical assessment are finding out when and how the cough started. What the cough is like i.e. the quality of the cough ('wet' or 'dry')? And is the child an otherwise well child or are their features of an underlying respiratory disorder? Some important questions to ask are summarised in Box 1. Signs of a possible underlying lung disease include:

- Finger clubbing
- Failure to thrive
- Chest shape and chest wall deformities
- Allergic salute (a transverse nasal crease due to recurrent rubbing)
- Eczema [Atopic dermatitis]
- Adventitious lung sounds
- A post nasal drip or palatal abnormalities

If any of the above signs are present then a chest x-ray should be considered and if >5 years old lung function testing should be performed.

2. Cough quality

Once the child has been clinically assessed the first decision is to decide on the quality of the cough. In general, prolonged coughing can be helpfully divided into:

- [1] 'Wet', phlegmy and productive coughing, or
- [2] 'Dry' coughing.

Most parents can accurately differentiate between the two types⁹ Wet cough (with sputum production) is often associated with a rattling chest sound in young children and parents may say they wish the child could do a good cough in order to clear it. At bronchoscopy children with a prolonged wet cough have been shown to have increased secretions throughout the airways which has not been reported in dry cough (Figure 1).⁹ Persistent secretions in the airways with associated bacteria suggests a continuing endo-bronchial infection (Persistent or Protracted Bacterial Bronchitis or PBB). PBB is characterised by an isolated chronic wet or productive cough without signs of another cause, and usually responds to 2 weeks of an appropriate oral antibiotic.¹⁰ For those failing to respond, further investigations are required (see European Respiratory Society (ERS) PBB statement 2017).¹⁰ There are clear guidelines to follow for children with chronic wet productive cough (ERS, British Thoracic Society (BTS) and Chest guidelines).¹⁰⁻¹²

Figure 1. Bronchoscopic secretion (BS) quantification card showing the different grades of secretions. Parental reports of a wet cough were associated with a bronchoscopy secretion grade ≥ 4 . Reproduced with permission.⁹

3. Is the child otherwise healthy and if so what is the normal duration of cough following acute respiratory infections in this group?

The next decision that needs made is whether a child with chronic cough is otherwise well or is there an underlying respiratory condition. With respect to dry cough (the focus of this article) and when deciding that a cough is prolonged and needs investigation it is important to have an understanding regarding how long acute coughing can last in an otherwise healthy child who is suffering from a respiratory tract infection. Dry coughing suggests airways irritation and or inflammation (without excessive extra secretion formation).

The resolution of cough following acute respiratory infection has been studied. In general, resolution is swifter in children where infection is thought to affect the upper respiratory tract alone. True coughing involving a simple URTI is thought to indicate that there is some tracheal and upper bronchial inflammation where the cough receptors are mostly found.¹³ For instance, the symptoms of croup were found to be resolved in 80% by day two but in those with an URTI involving the trachea and upper bronchus cough resolution is typically slower.¹⁴ The cough after acute bronchiolitis in infants is significantly improved by 13 days in 50% and by 21 days in 90%.¹⁴ Thompson *et al.*¹⁴ in their systematic review showed that prospective studies of acute cough in young children in general practice have suggested that about 50% recover by 10 days and 90% by 3 weeks, therefore 10% of children still have cough in the third to fourth weeks.¹⁴⁻¹⁶ It may be possible that informing parents and carers that the cough following an URTI may persist for a few weeks could reduce reattendance rates and reduce anxiety.¹⁷ However, we found no evidence that specifically informing parents about the potential for prolonged cough in an URTI will reduce the need for follow on doctor consultations. A systematic review looking at reconsultation rates in general practice following the supply of patient information leaflets on respiratory tract infections in both adults and children found conflicting evidence for a reduction in reattendance rates.¹⁸ A large study from Macfarlane *et al.*¹⁷ showed a significant reduction (RR 0.70, 95% CI 0.53 to 0.91) in reconsultation rates whilst two other studies by Francis *et al* and Macfarlane *et al.*¹⁹ showed no such reduction for the same illness episode after providing an information leaflet (RR 0.8 (95% CI 0.52 to 1.21) and 0.79 (95% 0.38 to 1.67), respectively).^{17, 19-20} This would be an interesting area for further research.

4. The characteristic sound of the cough

The characteristic sound of the cough is helpful and for experienced clinicians it will often confirm a diagnosis. In many instances the child will spontaneously cough during a clinic visit, however, if this does not happen then we find it helpful to ask a child to voluntarily cough. The parents may have recordings on their smartphones of the cough and these should also be reviewed. YouTube video clip examples of dry cough including the [whoop of pertussis](#), [the seal like bark of croup](#), [the honking cough of a somatic cough](#) or the [tic like cough of a psychogenic cough](#) can currently be found in the reference section.²¹⁻²⁴

What are the possible causes of a mostly dry persistent cough?

1. Post viral and pertussis like infections

Post viral cough syndromes, atypical and pertussis infections likely cause most prolonged acute coughing that linger on after an URTI. The BTS cough in children guidelines included an algorithm for the management of children with prolonged acute coughing and allows a period of observation to determine whether natural resolution will occur while giving red flag alerts.⁸ Figure 2 includes a new modification of this algorithm to illustrate what to do in the case of prolonged cough without any specific indicators for the cough.

Bordetella pertussis typically causes a paroxysmal cough associated with vomiting or apnoeas in infants. Studies in primary care have shown that 20-37% of school aged children with cough for more than 2 weeks that seek medical review are positive for pertussis despite being fully vaccinated.^{8,25} The cough resolved over time in virtually all children, although the median time to recovery was longer for pertussis positive children (median 112 days, range 38-191) than for pertussis negative children (median 58 days, range 24-192).⁸ The pertussis negative group likely had either an atypical bacterial infection or a post viral cough syndrome.

It is thus important to note that if a trial of treatment such as inhaled corticosteroids (ICS) had been started the ICS would have appeared to have worked but the resolution would have been due to the natural resolution that occurs (Figure 3).

Figure 3. Proportion of children continuing to cough each day after onset according to serology. Reproduced with permission.⁸

Confirming the diagnosis of pertussis can be helpful as it gives an explanation for the severity and duration of cough. Treatment is with a macrolide antibiotic ideally in the first two weeks of the illness to reduce infectivity. *Mycoplasma pneumoniae*, adenovirus, and respiratory syncytial virus can mimic pertussis.^{26, 27}

2. Cough variant or predominant asthma

Although children with asthma cough and increased coughing may precede an asthma exacerbation it is the wheezing (due to airways obstruction) and shortness of breath that are the most important diagnostic features of asthma. Evidence suggests that in most children, isolated cough (no wheezing) does not represent asthma.^{28,29} Children who have problem coughing but have never wheezed and have no other clinical atopy have a very low probability of having asthma.³⁰ However, in our experience we find that a subset of children with persistent dry cough (especially children with a dry night time cough) benefit from treatment with ICS. As in the Davies et al. [1999] study this perceived improvement to ICS could represent a placebo effect.³¹ The mechanism underpinning this response is unclear and children probably have a range of underlying pathologies. It is possible that a small number may have eosinophilic airways inflammation without airways obstruction or the wheezing has gone undetected because they have not undergone medical review at the peak of the illness.

Over diagnosis of asthma may be a problem in children with isolated cough. In the under 5's (who are unable to perform spirometry), a trial of treatment (typically ICS for 6-8 weeks) is often undertaken.³² In the absence of other features suggestive of asthma we advise that the results of such clinical trials of treatment are interpreted cautiously. If the cough resolves, then the anti-asthma medication should be stopped and only restarted if the cough returns. A second response to therapy would lend support to a potential asthma diagnosis but could also be a second placebo response. This significantly reduces the risk that children are committed to a long-term unnecessary treatment. If the cough returns following cessation of ICS and abates again following reintroduction, then a cautious and provisional diagnosis of asthma can be made but this should be revisited regularly and confirmed with spirometry and/or age appropriate pulmonary function tests as soon as the child is able to perform these investigations.

3. Isolated non-specific dry cough

A small number of children with dry cough have persistent intrusive symptoms and are referred either for further investigations or an opinion. In some cases they have already had careful, sequential investigation. Isolated non-specific dry cough is therefore a diagnosis of exclusion and should only be made in an otherwise well child with no features of underlying respiratory disorders. Providing the child is otherwise well and has no red flag symptoms the most appropriate approach may be one of watchful waiting in anticipation of natural resolution of the cough.³³ These children should be followed up until there is resolution of the cough.

4. Allergic rhinitis (AR) or upper airways cough syndrome

Although some have questioned whether AR is a cause of true coughing – there is no doubt that some children with AR have a 'clearing the throat' type cough but this typically has a 'wet' loose phlegmy character and may not be classified as a dry cough. Despite this it is our impression that some children with AR do have periods of dry coughing (in addition to the typical eye and nasal symptoms) especially at the start of the pollen season. Older children may also describe the sensation of nasal secretions dripping into the posterior pharynx.

AR is associated with an allergic salute and inflammation of the nasal passages on examination. Allergy testing should be considered to common aeroallergens such as grass

or tree pollen, house dust mite, cat and dog dander as well as any other allergens which the parents or child feel may be contributing. It may require a trial of treatment with nasal steroids or an antihistamine to determine if the cough is a result of the AR.

5. Gastro-oesophageal reflux

Gastro-oesophageal reflux disease (GORD) can stimulate the afferent limb of the cough reflex by irritating the upper respiratory tract without aspiration (e.g. larynx) and by irritating the lower respiratory tract by micro-aspiration or macro-aspiration, there is evidence that strongly suggests that GORD also can cause chronic cough by stimulating an oesophageal bronchial cough reflex.^{34, 35} It is unclear if cough is the chicken or the egg in GORD. The most recent Cochrane review on the treatment of prolonged non-specific cough in children secondary to GORD found that proton pump inhibitors (PPI) should not be used empirically and there was insufficient evidence for milk modification in cough related to GORD.³⁶ Ghezzi et al. [2013] showed that weak acid gastro-oesophageal reflux caused a significant amount of cough episodes in young children with persistent cough and theorised that this may explain the inconsistent effects of anti-acid treatments on respiratory symptoms in GORD.³⁷ A 2-4 week trial of anti-reflux treatment, either thickeners or PPI can be helpful but any response needs to be carefully re-evaluated and long term use of PPI in particular needs to be balanced against their risks.

6. Somatic cough (previously termed Psychogenic cough) or Tic cough (previously termed habit cough)

Many experienced clinicians when hearing the cough and seeing the child will instantly be able to make a diagnosis based on the characteristic history and their gut feeling and normal physical examination.^{38, 39} The somatic cough may sound so ridiculously exaggerated and loud that it is hard to believe the child looks non-perplexed by it. Although somatic or tic cough characteristically disappears during sleep this is not always the case. In a systematic review the most common cough feature was a non-productive explosive barking or honking cough with 5% of patients having cough during sleep and the initial triggers for the cough were URTI's and social distress.⁴⁰

A diagnosis of tic cough should be made when the child manifests the core clinical features of tics that include suppressability, distractibility, suggestibility, variability, and the presence of a premonitory sensation whether the cough is single or one of many tics.⁴¹ Again many experienced paediatricians will be able to make the diagnosis of tic cough instantly on seeing the child and hearing the cough.

Treatment of somatic or tic cough disorders should firstly include reassurance that serious underlying disease is unlikely.³⁸ If simple reassurance and explanation doesn't lead to cough resolution behaviour modification strategies such as sipping on a hot drink of lemon or honey when the patient has the urge to cough should be implemented. If this fails to work then trials of hypnosis, counseling, and referral to a psychologist and or psychiatrist may be considered.⁴¹ Or even the "bed sheet technique" which involves wrapping a bed sheet tightly around the chest and not removing it until there is cough cessation may be considered.⁴²

7. Congenital malformation of the airway

A cough present from birth increases the likelihood of a congenital airway malformation. Typically, these coughs are associated with failure to thrive, stridor, dysphagia, dyspnoea,

respiratory distress and recurrent respiratory tract infections. Patients in whom this is suspected should undergo fibre-optic bronchoscopy and further detailed imaging. Examples include:

- I. Severe congenital vascular anomalies within the mediastinum causing compression of the airways and these are usually diagnosed in the neonatal period. Milder forms may present as chronic dry cough characteristically described as a seal-like bark.
- II. Tracheomalacia or tracheo-oesophageal fistula cough sound characteristically brassy. Malacia may also affect the bronchi (bronchomalacia) by themselves or in conjunction with the trachea (tracheobronchomalacia). It is difficult to know the true incidence of TM as it is underreported but one study found it affects around 1 per 1,445 infants.⁴³ For mild to moderate tracheomalacia treatment may not be required as the cartilage gradually strengthens with age. However, in severe cases noninvasive ventilation should be considered and occasionally aortopexy may be required if dying spells occur. A tracheo-oesophageal fistula will require surgical correction.

8. Exhaled Tobacco smoke

Exposure to environmental tobacco smoke has been shown to have a detrimental effect on the respiratory health of children since the 1970's.^{44,45} It has a negative effect on lung development and has been shown to lead to reduced lung function in infants and children.⁴⁶⁻⁴⁹ A meta-analysis published in 2011 found that smoking by either parent or other household members significantly increased the risk of lower respiratory infections.⁵⁰ It is also well documented that there is a link between chronic cough and exposure to ETS.⁵¹ Adolescents who develop a recurrent or persistent cough should be questioned about cigarette smoking.¹¹ They should be given age appropriate information on smoking cessation and offered help and advice to stop. If there is a history of parental smoking then parents should also be advised to stop and be given appropriate information on smoking cessation.

9. Other rarer causes of persistent dry cough in children include:

- a. Children's interstitial lung disease
- b. Tuberculosis
- c. Medications such as angiotensin converting enzyme (ACE) inhibitors used to treat congestive heart failure
- d. Ear wax (via Arnold's nerve reflex)

Conclusions

Prolonged dry cough is a common and frequent cause for referral to secondary and tertiary care paediatric centres. There are many causes and the characteristic of the cough as well as the presence, or absence, of associated symptoms are important in arriving at a diagnosis. In the absence of any underlying pathology, a watchful waiting approach may be the most appropriate action.

Box 1.

Important questions to ask include:

- Age of onset and duration?
- Was the onset sudden (foreign body inhalation) or associated with an intercurrent illness?
- Is the cough dry or wet?
- What does it sound like? (honk, brassy, bark)
- Does it occur every day?
- Is it progressive?
- Is it present during sleep?
- Are there any associated symptoms? (wheeze, dyspnoea, vomiting)
- Are there any exacerbating factors?
- Relieving factors including a trial of bronchodilators?
- Exposure to aero-irritants (e.g. ETS)
- Effect of the cough on the child and others?
- Underlying conditions (e.g. neuromuscular disease, GORD, asthma, etc.)?
- Medication history (ACE inhibitors)
- Family history of atopy and respiratory disease?

Figure 2. A revised algorithm of the simplified overview of the assessment and management of the common causes of chronic cough. Derived from the BTS guideline recommendations for the assessment and management of cough in children.¹¹

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