Received: 16 March 2024 | Revised: 16 September 2024 | Accepted: 22 October 2024

DOI: 10.1111/apa.17481

ACTA PÆDIATRICA
NURTURING THE CHILD
WILEY

REVIEW ARTICLE

Working group summary of the 2023 full update of the Finnish national guidelines for paediatric lower respiratory tract infections

Katri Backman[1,2] | Merja Helminen[3] | Eliisa Kekäläinen[4,5] | Ilona Mikkola[6,7,8] | Tea Nieminen[9] | Kirsi Nuolivirta[10] | Ville Peltola[11] | Raija Seuri[12] | Satu-Maaria Walle[13] | Terhi Ruuska-Loewald[14,15]

[1]Department of Paediatrics, Kuopio University Hospital, Kuopio, Finland
[2]Department of Clinical medicine, University of Eastern Finland, Kuopio, Finland
[3]Department of Paediatrics, Tampere University Hospital, Wellbeing Services County of Pirkanmaa, Tampere, Finland
[4]Translational Research Program, University of Helsinki, Helsinki, Finland
[5]HUS Diagnostic Center, Clinical microbiology, Helsinki University Hospital, Helsinki, Finland
[6]The Finnish Medical Society Duodecim, Helsinki, Finland
[7]Wellbeing Services County of Lapland, Rovaniemi, Finland
[8]Research Unit of Population Health, University of Oulu, Oulu, Finland
[9]Children's New Hospital, Helsinki University Hospital, Helsinki, Finland
[10]Department of Paediatrics and Adolescent Medicine, Seinajoki Central Hospital, Seinajoki, Finland
[11]Department of Paediatrics and Adolescent Medicine, Turku University Hospital, Turku, Finland
[12]HUS Medical Imaging Center, New Children's Hospital, Helsinki, Finland
[13]Western Uusimaa Wellbeing Services County, West Uusimaa, Finland
[14]Department of Paediatrics and Adolescent Medicine, Oulu University Hospital, Oulu, Finland
[15]Research Unit of Clinical Medicine, University of Oulu, Oulu, Finland

Correspondence
Katri Backman, Department of Pediatrics, Kuopio University Hospital, P.O.Box 100, Kuopio 70029, Finland.
Email: katri.backman@pshyvinvointialue.fi

Abstract

Aim: The first evidence-based Finnish guidelines for paediatric lower respiratory tract infections (LRTIs) were published in 2014 and completely updated in 2023. This paper, by the interdisciplinary working group that developed the 2023 guidelines, summarises the main recommendations.

Methods: The 2023 guidelines were produced after a systematic review. Strong evidence was at least two separate, high-quality studies, moderate evidence was at least one high-quality study and weak evidence was at least one satisfactory study. The authors have now summarised the key points.

Results: There was strong evidence that antitussives and beta-sympathomimetics were not effective for bronchitis-related cough and that laryngitis should be treated with oral corticosteroids, with adrenaline inhalations added in severe cases. Also, that

Abbreviations: CAP, community-acquired pneumonia; LRTI, lower respiratory tract infection; PCR, polymerase chain reaction.

amoxicillin for 5 days provided sufficient treatment for paediatric community-acquired pneumonia and that children with apparent viral pneumonia could be observed without antimicrobial therapy. There was moderate evidence that corticosteroids or inhaled agents were not effective for bronchiolitis and that administering salbutamol with a holding chamber could relieve symptoms of wheezing bronchitis. Also, pertussis should be considered for unvaccinated infants with coughs.

Conclusion: The 2023 guidelines aim to improve acute evidence-based treatment of LRTIs, through appropriate antibiotics, inhaled drugs, corticosteroids, radiology and laboratory testing.

KEYWORDS
bronchiolitis, community-acquired pneumonia, lower respiratory tract infection, paediatric guidelines, viral wheezing

1 | INTRODUCTION

Evidence-based clinical practice guidelines are important, as they harmonise and improve national and international care. The Finnish guidelines for paediatric lower respiratory tract infections (LRTI) were originally published in 2014 to promote evidence-based treatment of these conditions.[1,2] A targeted update that focused on the use of hypertonic saline for bronchiolitis followed in 2015 and the first complete update was finalised in 2023 by an interdisciplinary working group.

The updated clinical practice guidelines are primarily aimed at physicians working in primary care and emergency departments. They aim to improve evidence-based treatment of LRTIs in acute care, by enhancing the appropriate use of antibiotics, inhaled drugs and corticosteroids and radiology and laboratory testing. The guidelines also suggest harmonised criteria for referrals to secondary care.

Key Notes

- This paper summarises the completely updated 2023 evidence-based Finnish guidelines for paediatric lower respiratory tract infections (LRTIs).
- Produced by the working group that developed the guidelines, they include the use of antitussives, beta-sympathomimetics, oral corticosteroids, adrenaline inhalations and antibiotics.
- The guidelines, which replace the first 2014 version, aim to improve acute evidence-based treatment of LRTIs, through appropriate antibiotics, inhaled drugs, corticosteroids, radiology and laboratory testing.

2 | HOW THE MAIN GUIDELINES WERE DEVELOPED

The Finnish guidelines for paediatric lower respiratory tract infections were first issued in 2014. They were completely updated in 2023, by an independent interdisciplinary working group that was established by Duodecim, the Finnish Medical Society. The group, who are also the authors of this paper, consisted of paediatric infectious disease specialists, general paediatricians, a clinical microbiologist, a paediatric radiologist, general practitioners and a methodologist.

A systematic literature search was performed by a research librarian to inform the development of the 2023 guidelines. We used the Medline and Cochrane databases to search for all the studies that had been published in English after the end of the literature search for the original guidelines. This new search covered the period 16 January 2014 to 23 February 2022 and it identified 2482 publications. Studies identified by the previous systematic review, from 1946 to 2014, were also included if they were still relevant or there were no newer studies about the subject. The level of evidence was systematically assessed by the working group and added to the guideline statements that covered the important recommendations that directly affected treatment choices.[3] In this paper, the level of evidence is provided, in brackets, after those recommendations. The categories were: strong evidence if there were at least two separate, high-quality studies, moderate evidence if there was at least one high-quality study and weak evidence if there was at least one satisfactory study. A high-quality study was one that was performed in an appropriate population using a strong study design, such as a randomised controlled trial with a relevant outcome measure. Cases were not regarded as high quality if the literature searches were performed by an expert in that particular field and the detailed results of those searches were not described in their paper.

The latest guidelines comprise 285 references and were peer-reviewed by 15 national experts and clinicians before they were

published in the Finnish Current Care Guidelines series in 2023.[3] The process is described in detail in Finnish and English at: https://www.kaypahoito.fi/hoi50098

3 | SUMMARY OF THE 2023 GUIDELINES

The main content of the full updated guidelines, which have only been published in Finnish and Swedish, can be summarised as follows.

3.1 | Recommendations for microbiological diagnostics

The routine use of multiplex polymerase chain reaction (PCR) testing for respiratory viruses, other than influenza, is not recommended in emergency departments.[4–6]

Bedside viral multiplex PCR and antigen panels, including a broad selection of respiratory pathogens, are widely available for testing respiratory tract viruses. However, testing for viral infections has not had an impact on the time patients spend in emergency departments or antibiotic prescribing practices.[4,5] Despite this, testing is still recommended for hospitalised patients, when it is important for diagnostics, cohorting patients or monitoring viral epidemics.

Influenza testing is recommended for children with LRTIs during the influenza season, particularly if the test is carried out within 48 h of symptom onset, because these children may benefit from antiviral treatment.[6]

Previous studies found that testing for influenza increased the use of antivirals and decreased the use of antibiotics. In addition, the need for laboratory and radiological screening decreased in emergency departments.[6]

Single Mycoplasma pneumoniae antibody detection is not useful for diagnosing acute Mycoplasma pneumoniae infections (moderate).[7,8]

Concordance between *Mycoplasma pneumoniae* antibody tests and PCR testing results has been low.[7,8] Immunoglobulin M antibodies can remain positive for a long time after a mycoplasmal infection.[7] Therefore, a reliable serological diagnosis usually requires paired serum samples, which are not available for acute treatment.[7,8] PCR tests are very sensitive and can detect asymptomatic carriage during epidemics or following a mycoplasmal infection.

Urinary pneumococcal antigen detection is not reliable for diagnosing pneumococcal pneumonia in children (moderate).[9]

Even though pneumococcal urine antigen tests are used in adult patients, pneumococcal nasopharyngeal carriage is common in children, which increases the proportion of false-positive cases.[9] Urinary secretion of pneumococcal antigens decreases in school-aged children, but the reliability of pneumococcal antigen detection in older children remains unclear.

Pertussis should be diagnosed using PCR tests for Bordetella pertussis bacteria (strong).[10,11]

Several high-quality studies have shown that PCR test for *Bordetella pertussis* had good sensitivity and specificity in children[10,11] and was a fast and cost-effective method for diagnosing pertussis. However, the sensitivity of multiplex PCR panels for respiratory pathogens, including pertussis, have been variable. So, if pertussis is strongly suspected, a negative test should be confirmed with a targeted PCR test. Pertussis antibodies are not useful for diagnosing acute pertussis, but can be helpful in the differential diagnosis of chronic cough.

3.2 | Recommendations for laboratory testing and radiology

High C-reactive protein concentrations and blood leucocyte levels increase the probability of bacterial pneumonia, but low levels cannot be used to exclude bacterial pneumonia, particularly at the start of the disease (strong).[12–14]

A high C-reactive protein level, of above 60–80 mg/L, is common in bacterial infections, but low levels can also occur. A blood leucocyte count is not a very reliable way of differentiating between bacterial and viral pneumonia. C-reactive protein may be useful when evaluating the need for hospitalisation, antibiotics or possible complications of pneumonia. However, routine testing for C-reactive protein is not necessary in primary care. A universal problem in studies that have evaluated the usefulness of these laboratory parameters has been the lack of reliable microbiological methods to differentiate bacterial and viral pneumonia.[12]

Most children with LRTIs do not benefit from chest radiography.[15,16]

A randomised controlled trial found that chest radiography did not affect the outcomes in children, but those in the radiography group received more antibiotics. Therefore, a chest radiograph was not needed in non-hospitalised patients with pneumonia who had characteristic clinical findings (Table 1).[15,16] However, a chest radiograph is indicated for severely ill children with fever or suspected pneumonia, as part of the diagnostic work-up or when complicated pneumonia is suspected (Table 1).[15,16]

Obtaining both anteroposterior and lateral images does not add to the sensitivity or specificity of radiological diagnosis of pneumonia in children when compared to just an anteroposterior image (strong).[17]

Lateral images, taken in an emergency department, increased the dose of radiation children were exposed to. However, they did not provide significant diagnostic benefits for patients with pneumonia than just an anteroposterior image.[17]

Alveolar pneumonia can be reliably detected with a chest radiograph (moderate).[18] *Alveolar infiltration in a chest radiograph suggests bacterial pneumonia more often than interstitial infiltration* (weak).[18]

Interpreting a chest radiograph requires expertise and inter-rater agreement tends to be rather poor. According to the World Health Organisation classification, alveolar infiltrates or interstitial infiltrates with pleural fluid can be diagnosed as pneumonia.[18] Peribronchial or peribronchovascular findings in chest radiographs are common during viral infections and can be easily confused with pneumonia.

The usefulness of a lung ultrasound as a diagnostic tool for pneumonia and pleural fluid is debatable.[19]

There is still some debate about how useful lung ultrasounds are as the primary diagnostic tool for pneumonia. The clinical significance of minor ultrasound findings is still unclear and differential diagnostics of pneumonic consolidation and atelectasis is often impossible.[19] Chest radiographs and ultrasound are the primary radiological methods for diagnosing complications of pneumonia or pleural fluid.[19] Computed tomography and magnetic resonance imaging scans are mostly used if surgical interventions are being considered.

TABLE 1 Thorax radiograph in the diagnostics of paediatric LRTIs.

Radiograph usually unnecessary	Radiograph necessary
Viral cough (Bronchitis)	Child with high fever and poor general condition with suspected pneumonia or unclear focus of infection
Laryngitis, bronchiolitis, wheezing bronchitis	Quiet breathing sounds in lung auscultation.
Clinically diagnosed community-acquired pneumonia in a child with good general condition	Patient with diagnosed pneumonia has fever 48 h after the beginning of antibiotics. Differential diagnostics of rare cardiac causes like myocarditis, heart failure Suspected foreign body of respiratory tract[a,b]

[a]In case of a strong/evident foreign body, bronchoscopy may be performed without radiography, depending on the patient's clinical condition.

[b]If radiograph is conducted PA and side projections should be performed.

Controlling chest radiographs after pneumonia is not usually necessary.[12]

It is not usually necessary to control a chest radiograph after pneumonia if the patient makes a good recovery. They should only be used if the primary findings indicate significant atelectasis, a large amount of pleural fluid or if there is suspicion of an underlying illness.[12]

4 | TREATMENT OF LOWER RESPIRATORY TRACT INFECTIONS

4.1 | Viral bronchitis

4.1.1 | Definition and symptoms

Acute cough in children is usually caused by a viral infection and usually resolves within 4 weeks.[20]

TABLE 2 Glucocorticoids and sympathomimetics in paediatric lower respiratory tract infections.

Diagnosis	Glucocorticoids	Sympathomimetics
Laryngitis	Betamethasone 0.25–0.4 mg/kg/day p.o. (up to 7 mg) as a single dose or dexamethasone 0.15–0.6 mg/kg p.o. (up to 8 mg) as a single dose. If needed in addition nebulised Budesonid 2000 µg as a single dose	Nebulised racemic adrenaline[a] 4–5 kg 0.2 mL (4.5 mg). 6–7 kg 0.3 mL (6.8 mg). 8–9 kg 0.4 mL (9.0 mg). >10 kg 0.5 mL (11 mg)
Acute bronchitis (cough)	No glucocorticoids	No betasympathomimetics
Bronchiolitis	No glucocorticoids	No betasympathomimetics or racemic adrenaline
Wheezing bronchitis	No glucocorticoids	Salbutamol 0.1 mg inhalation aerosol with spacer[b]: • In emergency: 6 doses (one dose at a time[c] to spacer) with 20 min pauses three times. • At home: At least 2 doses 3–6 times per day for 2–4 days
Pneumonia	No glucocorticoids	No betasympathomimetics
Pertussis	No glucocorticoids	No betasympathomimetics

[a]Racemic adrenaline is diluted in 2–3 mL of isotonic (0.9%) natriumchloride before the inhalation. If racemic epinephrine is not available Adrenaline 1 mg/mL can be inhaled 0.2 mg/kg up to 5 mg. Doses less than 2 mL are diluted like racemic adrenaline 1 mg/mL.

[b]This guideline does not include treatment options for paediatric asthma.

[c]Bioavailability probably is higher when dosed one inhalation at a time to spacer (Csonka).

4.1.2 | Recommendations

Antitussive and beta-sympathomimetic drugs are ineffective in relieving acute coughs in children and antitussives may cause serious adverse events (*strong*) (Table 2).[21–23]

Studies have found that dextromethorphan was ineffective in children with coughs and the efficacy of mucolytic agents were insufficiently studied.[21] In addition, oral beta-sympathomimetics were ineffective in children with coughs in the absence of breathing difficulties.[22,23]

Short-term treatment with oral honey products is likely to relieve acute nocturnal coughs during a LRTI better than no treatment or a placebo in children older than 1 year of age (*moderate*).[23,24]

Oral honey was efficient in reducing cough frequency compared to a placebo or no treatment,[23] and may also have reduced cough duration.[23]

Antibiotics are ineffective in relieving acute coughs in children.[20]

An acute viral cough typically lasts less than 4 weeks.[20] In children, these were usually caused by a viral infection and antibiotics were ineffective in relieving symptoms (Table 3).[20]

Chronic wet coughs are much rarer in children than acute viral coughs. Antibiotics may have been efficient for wet coughs lasting over a month.[25] However, in these cases, it was important to take into account other diagnostic possibilities and consult a specialist.[25]

4.2 | Laryngitis

4.2.1 | Definition and symptoms

Laryngitis is a viral infection of the larynx and voice box and is most commonly seen in children of 6–36 months of age. Characteristic symptoms include a barking cough, hoarseness and, in more severe cases, inspiratory stridor.

4.2.2 | Recommendations

Glucocorticoids are effective in relieving the symptoms of laryngitis (*strong*).[26]

The effectiveness of glucocorticoids in relieving symptoms and reducing the risk of recurrent inspiratory stridor in children with laryngitis has been proved by several studies (Table 2).[26] Oral glucocorticoids seemed to be as efficient as intramuscular glucocorticoids.[26] Nebulised budesonide may have provided additional efficacy in children who had already received oral corticosteroids and had remaining symptoms (Table 2).[27]

Nebulised adrenaline is effective in relieving the symptoms of severe laryngitis (*strong*).[28,29]

Nebulised adrenaline proved to be effective in relieving laryngitis symptoms in several studies.[28,29] The effect of nebulised adrenaline is short and lasts from 1 to 2 h. Patients receiving this should be monitored in the emergency department for 1–2 h for recurrence of symptoms.

Inhaled mist is not effective in relieving the symptoms of laryngitis (*strong*).[30]

A good-quality randomised controlled trial showed that an inhaled mist did not offer any relief for laryngitis symptoms and concluded that it should not be used.[30]

4.3 | Bronchiolitis

4.3.1 | Definition and symptoms

Most international guidelines state that bronchiolitis can be diagnosed in children under 2 years of age.[31] However, bronchiolitis is most prevalent in the first year of life during respiratory syncytial virus epidemics. According to the Finnish definition, bronchiolitis is diagnosed in infants under 12 months of age who exhibit characteristic symptoms or findings, like coughs, tachypnoea, chest recession and wheezing or crackles on chest auscultation.

4.3.2 | Recommendations

Nebulised adrenaline is likely to be ineffective in reducing the need for hospitalisation in infants with bronchiolitis (*moderate*) (Table 2).[32,33]

Several randomised controlled trials found that inhaled adrenaline was ineffective in reducing the need for hospitalisation in patients with bronchiolitis.[32,33] A network meta-analysis found that adrenaline inhalations reduced admission rates during the first day of the disease, but no effect was seen on day 7.[33]

Inhaled beta-sympathomimetics do not improve oxygenation, reduce the need for hospitalisation or reduce the length of hospitalisation in bronchiolitis, compared to placebos (*moderate*) (Table 2).[34]

According to a 2014 Cochrane review that summarised 30 randomised studies, beta-sympathomimetics did not reduce the need for hospitalisation or length of stay in bronchiolitis.[34] Most of the studies included in the Cochrane review showed no significant symptom relief in hospitalised patients.[34]

Systemic or inhaled glucocorticoids are likely to be ineffective in relieving symptoms or reducing hospitalisation rates or the duration of hospitalisation (*moderate*) (Table 2).[35]

A 2013 Cochrane Review summarised 17 randomised studies and concluded that systemic or inhaled glucocorticoids did not reduce the need for hospitalisation or length of hospital stay in children under 2 years of age.[35]

Nebulised hypertonic saline may be ineffective in reducing the length of hospital stay compared to no inhalations (*weak*).[36,37]

It has been suggested that hypertonic saline inhalations reduced the length of hospital stay in bronchiolitis when compared to saline 0.9% inhalations or standard care.[37] However, when nebulised hypertonic saline was compared with minimal handling in a randomised setting, no difference was found between the groups in terms of being

TABLE 3 Antibiotic treatment in paediatric lower respiratory tract infections.

Diagnosis	Recommendation
Laryngitis	No antibiotics
Acute bronchitis (cough)	No antibiotics
Bronchiolitis	No antibiotics
Wheezing bronchitis	No antibiotics
Community-acquired pneumonia	
Outpatients	Amoxicillin: • Normal dose: 40–45 mg/kg/day p.o. in three doses for 5 days. • High dose (if penicillin resistant pneumococcus suspected): 80–90 mg/kg/day p.o. (up to 4000 mg/day) in three doses usually for 5 days. Allergy for penicillin: Macrolides[a]: • Azithromycin 10 mg/kg/day (up to 500 mg/day) once a day for 3 days. • Clarithromycin 15 mg/kg/day (up to 1000 mg/day), usually for 7 days. Doxycycline (children >8 years old) p.o. 2.2–4.4 mg/kg/day (up to 200 mg/day) divided in two doses usually for 7 days Mycoplasma pneumonia: Macrolide or doxycycline (children >8 years old) alone or combined with amoxicillin.
Inpatients	Penicillin[b] 100 000–300 000 U/kg/day i.v. divided in 4–6 doses (up to 24 000 000 U/day) Allergy for penicillin[c]: Cefuroxime 100–150 mg/kg/day i.v. divided in three doses (up to 6000 mg/day). Ceftriaxone 100 mg/kg/day i.v. divided in 1–2 doses (up to 4000 mg/day) Mycoplasma pneumonia. Add macrolide or doxycycline (children >8 years old)
Influenza	Oseltamivir (for 5 days) p.o.[d] • <12 months 6 mg/kg/day. • Over 12 months and less than 15 kg 30 mg twice a day. • 16–23 kg 45 mg twice a day. • 24–40 kg 60 mg twice a day. • Over 40 kg 75 mg twice a day p.o.
Pertussis	Azithromycin 10 mg/kg/day (up to 500 mg/day) once a day for 5 days. Clarithromycin 15 mg/kg/day (up to 1000 mg/day), usually for 7 days

Abbreviations: i.v. intravenously; p.o. per orally.

[a]Severe pneumonia should not be treated with macrolides as a monotherapy.

[b]*Staphylococcus aureus* pneumonia is a rare, but potentially severe condition. *S. aureus* is not covered with penicillin. Penicillin combined with clindamycin is recommended in *Streptococcus pyogenes* pneumonia.

[c]*5% of patients with severe penicillin allergy are at risk for cross reactions with first-generation cephalosporins, but severe reactions are rare.*

[d]Influenza prophylaxis for children >3 months after family exposure is one dose for 10 days.

fit for discharge or length of stay. So, at the moment there is no clear evidence to support the use of nebulised hypertonic saline over standard care.[36]

High-flow nasal cannulas are likely to reduce the need to escalate treatment, compared to ordinary oxygen supplementation (moderate).[38,39]

High-flow nasal cannula treatment is likely to reduce the need to escalate treatment and provide intensive care for bronchiolitis patients, compared to low-flow oxygen supplementation.[38,39] However, a large proportion of children can be treated with standard low-flow oxygen,[38,39] which is also a more cost-effective and easier treatment option than a high-flow nasal cannula. High-flow nasal cannula treatment seems to be safe[38,39] and is widely used in many hospitals for bronchiolitis patients.

High-risk infants may need referrals to hospitals.[31]

All infants under 3 months of age are prone to severe disease. So are infants with a history of prematurity, chronic lung disease, haemodynamically significant congenital heart disease, neuromuscular disorders or immunodeficiency.[31] These patients need to be monitored carefully and may need referrals to secondary care (Table 4).

4.4 | Wheezing bronchitis

4.4.1 | Definition and symptoms

In Finland, wheezing bronchitis is defined as episodic wheezing during an acute viral respiratory infection or repeated wheezing in children aged 12–36 months. Characteristic symptoms and findings include acute expiratory wheezing and respiratory distress during viral infections. Diagnoses are clinical and there is no need for routine laboratory testing or radiology if the diagnosis is clear.

Approximately, 30% of children experience wheezing during viral infections before 3 years of age.[40] However, the prognosis is good, with two-thirds of these children becoming asymptomatic after 3 years of age.[40]

4.4.2 | Recommendations

Inhaled beta-sympathomimetics may relieve symptoms in wheezing bronchitis (weak) (Table 2).[41]

Inhaled beta-sympathomimetics are generally used to relieve symptoms in children over 1 year of age, who experience wheezing. They are also recommended by the most important international guidelines.[41] However, the evidence of efficacy in wheezing bronchitis is limited in young children.

Dosing salbutamol via a holding chamber (spacer) is likely to be more efficient in relieving wheezing symptoms and has fewer side effects than administering salbutamol via a nebuliser (moderate) (Table 2).[42]

Studies have reported that providing salbutamol doses via a holding chamber was at least as efficient as administering via a nebuliser. Some studies reported that it was actually more efficient in relieving symptoms in children with wheezing exacerbations and asthma[42] and preventing hospitalisation for these conditions. Fewer side effects

TABLE 4 Indications for secondary care referral in paediatric lower respiratory tract infections.

Diagnosis	Indications for secondary care referral (any of the following).
Laryngitis	Breathing difficulty after delivered primary care (racemic adrenaline, corticosteroids) or decreased oxygen saturation.
Bronchiolitis	Apnoea or high risk for apnoea (infants less than 1 month of age or preterm young infants). Tachypnoea (especially in infants less than 3 month of age). Respiratory distress (chest recession, nasal flaring). Persistent oxygen saturation of less than 95%. Problems with feeding. Patient at risk for severe bronchiolitis due to other condition or illness
Wheezing bronchitis	Remaining respiratory distress after salbutamol inhalations or persistent oxygen saturation of less than 95%
Pneumonia	Poor general condition or respiratory distress. Persistent oxygen saturation of less than 95%. Suspected pneumonia complication. Failure in implementing per oral medication. Age less than 6 months. Patient at risk for severe pneumonia due to other condition or illness
Pertussis	Suspected pertussis in unvaccinated or only once vaccinated infant

Note: Referral to secondary care can also be performed for other reasons.

were reported in most studies when doses were delivered via a holding chamber.[42]

Maintenance glucocorticoid inhalations are ineffective in preventing viral-induced wheezing episodes in young children.[43]

There is no evidence to support the use of maintenance inhaled glucocorticoids to prevent viral-induced wheezing episodes that require oral glucocorticoid treatment or hospital admission.[43]

4.5 | Community-acquired pneumonia

4.5.1 | Aetiology and symptoms

Pneumonia can be caused by bacteria, viruses or both. A viral aetiology is particularly common in young children and viruses have been detected in 60% of young pneumonia patients.[44] The most common bacteria responsible for community-acquired pneumonia (CAP) are *Streptococcus pneumoniae* and *Mycoplasma pneumoniae*.[44] *Mycoplasma pneumoniae* is a more common cause of pneumonia in school-aged children.[44] Other less common causative agents are *Chlamydia pneumoniae*, *Streptococcus pyogenes*, *Staphylococcus aureus* and, in neonates, *Chlamydia trachomatis*.

The most common symptoms include fever, cough, tachypnoea and respiratory distress. Fine crackles or locally silenced breathing sounds are characteristic findings during lung auscultation.

4.5.2 | Recommendations

The primary treatment for CAP is amoxicillin for 5 days (*strong*) (Table 3).

Amoxicillin is the primary regimen for CAP when pneumonia is not severe and a bacterial aetiology is suspected.[15,45,46] A short course of antibiotics is non-inferior to a long course of treatment lasting 7–10 days, for paediatric CAP.[45–48]

Children with clinical viral pneumonia do not require antibiotics.[49]

A viral aetiology is particularly common in young children with CAP.[44] One study of children aged 3 months to 18 years of age with non-severe CAP did not detect any difference between those who did and did not receive antibiotics.[49]

Macrolides may improve the clinical outcome in Mycoplasma pneumoniae CAP (*weak*) (Table 3).

According to most studies, there is not enough evidence to support the use of macrolides in *Mycoplasma pneumoniae* LRTI, but one placebo-controlled trial demonstrated improvements in the clinical outcomes of the macrolide group.[50,51] Most patients with *Mycoplasma pneumoniae* respiratory tract infections recover without treatment and the use of macrolides is not encouraged if the child is clinically well or already recovering.

Complications of pneumonia should be considered if the fever continues and the child's general condition does not improve within 48 h of starting antimicrobial therapy (Table 4).[52]

Children who do not become afebrile 48 h after starting antibiotic treatment, or those whose condition does not improve, should be examined for complications like empyema, lung abscesses or necrotising pneumonia. If these conditions are suspected, they should be referred to secondary care. Ultrasound is the primary radiological tool in diagnosing complications of pneumonia. Computed tomography and magnetic resonance imaging scans are usually carried out before surgical interventions.[12]

4.6 | Influenza

4.6.1 | Recommendations

Neuraminidase inhibitors are effective for treating the symptoms of influenza in children, if the treatment begins within 48 h of the initial symptoms (*strong*) (Table 1).[53–55]

Antivirals are recommended for children with influenza if they seek medical care within the first 48 h of symptoms starting. If the child is severely ill and hospitalised, antivirals may be beneficial even if the symptoms have lasted longer than 48 h.

Other treatment options include oral baloxavir marboxyl and intravenous peramivir for children over 2 years of age and tsanamivir for children over 6 months of age. Neuraminidase inhibitor prophylaxis reduces the risk of influenza after influenza exposure in households and can be prescribed for children with an increased risk for severe influenza.

4.7 | Pertussis

4.7.1 | Recommendations

Pertussis should be suspected in young infants with a paroxysmal cough (*moderate*).[56]

These children should be referred to secondary care for diagnostics. Symptoms may resemble bronchiolitis and, in addition to a cough, the infants may suffer from apnoea.[56] Unvaccinated infants face the highest risk of severe disease (Table 4). However, one-third of pertussis cases are diagnosed among adults. In many countries, pertussis immunisation is recommended for young adults or pregnant women, in order to protect young infants.

Macrolide prophylaxis is likely to be effective in preventing pertussis among exposed family members (*moderate*).[57]

It has been reported that providing macrolide chemoprophylaxis for the household contacts of children with acute pertussis infection was effective in preventing pertussis among exposed family members.[57]

Azithromycin and clarithromycin are effective in eradicating Bordetella pertussis bacteria (*strong*) (Table 1).[58,59]

Several studies have proved that azithromycin and clarithromycin were effective in eradicating *Bordetella pertussis*.[58,59]

Symptomatic treatment of a pertussis-related cough is generally ineffective (*moderate*).[60]

Various agents have been studied in the symptomatic treatment of whooping cough, but none of these significantly relieved symptoms and therefore cannot be recommended.[60]

5 | CONCLUSION

These updated 2023 clinical practice guidelines summarise the current research evidence on the appropriate use of antibiotics, inhaled drugs, corticosteroids, radiology and laboratory testing in paediatric LRTIs. They aim to improve the evidence-based treatment of these conditions in acute care. The guidelines recommended that a child with an LRTI should always be referred to secondary care if they have a poor general condition or poor oxygenation (Table 4). Children should also be referred if they have suspected complications of pneumonia. Young infants with bronchiolitis, who are at risk for severe diseases, and young unvaccinated infants with suspected pertussis should also be referred to secondary care.

AUTHOR CONTRIBUTIONS

Katri Backman: Writing – review and editing; writing – original draft; conceptualization; investigation; methodology; validation; visualization; project administration; formal analysis. **Merja Helminen:** Conceptualization; investigation; writing – review and editing; visualization; validation; methodology; project administration; formal analysis. **Eliisa Kekäläinen:** Conceptualization; investigation; writing – review and editing; visualization; validation; methodology; formal analysis; project administration. **Ilona Mikkola:** Conceptualization; investigation; writing – review and editing; visualization; validation; methodology; formal analysis; project administration; resources. **Tea Nieminen:** Conceptualization; investigation; methodology; validation; visualization; writing – review and editing; formal analysis; project administration. **Kirsi Nuolivirta:** Conceptualization; investigation; methodology; validation; visualization; writing – review and editing; formal analysis; project administration. **Ville Peltola:** Conceptualization; investigation; methodology; validation; visualization; writing – review and editing; project administration; formal analysis. **Raija Seuri:** Conceptualization; investigation; methodology; validation; visualization; writing – review and editing; formal analysis; project administration. **Satu-Maaria Walle:** Conceptualization; investigation; methodology; validation; visualization; writing – review and editing; formal analysis; project administration. **Terhi Ruuska:** Conceptualization; investigation; writing – original draft; methodology; validation; visualization; writing – review and editing; formal analysis; project administration; supervision.

FUNDING INFORMATION

No external funding.

CONFLICT OF INTEREST STATEMENT

Katri Backman: member of Sanofi Advisory Board, congress fee from CSL Behring. Eliisa Kekäläinen: congress fee from Roche Diagnostics, member of AstraZeneca Advisory board, lecture honorariums from AbbVie, Pfizer and Janssen. Tea Nieminen: member of MSD, Pfizer and Sanofi Advisory board. Ville Peltola: member of the National Immunisation Technical Advisory Group, Finland (Chair, until 2023), member of the Vaccine Purchase Working Party, Ministry of Social Affairs and Health, Finland, until 2023. The other authors have no conflict of interests to declare.

ORCID

Katri Backman https://orcid.org/0000-0001-5683-407X
Kirsi Nuolivirta https://orcid.org/0000-0002-2612-9449

REFERENCES

1. Tapiainen T, Aittoniemi J, Immonen J, et al. Finnish guidelines for the treatment of community-acquired pneumonia and pertussis

in children. Acta Paediatr. 2016;105(1):39-43. doi:10.1111/apa.13177
2. Tapiainen T, Aittoniemi J, Immonen J, et al. Finnish guidelines for the treatment of laryngitis, wheezing bronchitis and bronchiolitis in children. Acta Paediatr. 2016;105(1):44-9. doi:10.1111/apa.13162
3. The Finnish Medical Society Duodecim. Current care guidelines. https://www.terveysportti.fi/xmedia/ccs/process/Suositus.html
4. Rao S, Lamb MM, Moss A, et al. Effect of rapid respiratory virus testing on antibiotic prescribing among children presenting to the emergency department with acute respiratory illness: a randomized clinical trial. JAMA Netw Open. 2021;4(6):e2111836. doi:10.1001/jamanetworkopen.2021.11836
5. Mattila S, Paalanne N, Honkila M, Pokka T, Tapiainen T. Effect of point-of-care testing for respiratory pathogens on antibiotic use in children: a randomized clinical trial. JAMA Netw Open. 2022;5(6):e2216162. doi:10.1001/jamanetworkopen.2022.16162
6. Abanses JC, Dowd MD, Simon SD, Sharma V. Impact of rapid influenza testing at triage on management of febrile infants and young children. Pediatr Emerg Care. 2006;22(3):145-9. doi:10.1097/01.pec.0000202454.19237.b0
7. Copete AR, Vera C, Herrera M, Aguilar YA, Rueda ZV, Vélez LA. Mycoplasma pneumoniae in children with and without community-acquired pneumonia. What do PCR and serology say? Pediatr Infect Dis J. 2020;39(7):e104-e108. doi:10.1097/INF.0000000000002636
8. Wang L, Feng Z, Zhao M, et al. A comparison study between GeXP-based multiplex-PCR and serology assay for mycoplasma pneumoniae detection in children with community acquired pneumonia. BMC Infect Dis. 2017;17(1):518. doi:10.1186/s12879-017-2614-3
9. Esposito S, Bosis S, Colombo R, et al. Evaluation of rapid assay for detection of *Streptococcus pneumoniae* urinary antigen among infants and young children with possible invasive pneumococcal disease. Pediatr Infect Dis J. 2004;23(4):365-7. doi:10.1097/00006454-200404000-00021
10. Abu Raya B, Bamberger E, Gershtein R, Peterman M, Srugo I. The laboratory diagnosis of *Bordetella pertussis* infection: a comparison of semi-nested PCR and real-time PCR with culture. Eur J Clin Microbiol Infect Dis. 2012;31(4):619-22. doi:10.1007/s10096-011-1327-6
11. Nunes MC, Soofie N, Downs S, et al. Comparing the yield of nasopharyngeal swabs, nasal aspirates, and induced sputum for detection of *Bordetella pertussis* in hospitalized infants. Clin Infect Dis. 2016;63(suppl 4):S181-S186. doi:10.1093/cid/ciw521
12. Harris M, Clark J, Coote N, et al. British Thoracic Society guidelines for the management of community acquired pneumonia in children: update 2011. Thorax. 2011;66(Suppl 2):ii1-ii23. doi:10.1136/thoraxjnl-2011-200598
13. Bhuiyan MU, Blyth CC, West R, et al. Combination of clinical symptoms and blood biomarkers can improve discrimination between bacterial or viral community-acquired pneumonia in children. BMC Pulm Med. 2019;19(1):71. doi:10.1186/s12890-019-0835-5
14. Don M, Valent F, Korppi M, Canciani M. Differentiation of bacterial and viral community-acquired pneumonia in children. Pediatr Int. 2009;51(1):91-6. doi:10.1111/j.1442-200X.2008.02678.x
15. Bradley JS, Byington CL, Shah SS, et al. The management of community-acquired pneumonia in infants and children older than 3 months of age: clinical practice guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. Clin Infect Dis. 2011;53(7):e25-e76. doi:10.1093/cid/cir531
16. Bowen SJM, Thomson AH. British Thoracic Society Paediatric Pneumonia Audit: a review of 3 years of data. Thorax. 2013;68(7):682-3. doi:10.1136/thoraxjnl-2012-203026
17. Soudack M, Plotkin S, Ben-Shlush A, et al. The added value of the lateral chest radiograph for diagnosing community acquired pneumonia in the pediatric emergency department. Isr Med Assoc J. 2018;20(1):5-8.
18. Elemraid MA, Muller M, Spencer DA, et al. Accuracy of the interpretation of chest radiographs for the diagnosis of paediatric pneumonia. PLoS One. 2014;9(8):e106051. doi:10.1371/journal.pone.0106051
19. Orso D, Ban A, Guglielmo N. Lung ultrasound in diagnosing pneumonia in childhood: a systematic review and meta-analysis. J Ultrasound. 2018;21(3):183-95. doi:10.1007/s40477-018-0306-5
20. Bergmann M, Haasenritter J, Beidatsch D, et al. Coughing children in family practice and primary care: a systematic review of prevalence, aetiology and prognosis. BMC Pediatr. 2021;21(1):260. doi:10.1186/s12887-021-02739-4
21. Smith SM, Schroeder K, Fahey T. Over-the-counter (OTC) medications for acute cough in children and adults in community settings. Cochrane Database Syst Rev. 2014;2014(11):CD001831. doi:10.1002/14651858.CD001831.pub5
22. Becker LA, Hom J, Villasis-Keever M, van der Wouden JC. Beta2-agonists for acute cough or a clinical diagnosis of acute bronchitis. Cochrane Database Syst Rev. 2015;2015(9):CD001726. doi:10.1002/14651858.CD001726.pub5
23. Waris A, Macharia M, Njeru EK, Essajee F. Randomised double blind study to compare effectiveness of honey, salbutamol and placebo in treatment of cough in children with common cold. East Afr Med J. 2014;91(2):50-6.
24. Oduwole O, Udoh EE, Oyo-Ita A, Meremikwu MM. Honey for acute cough in children. Cochrane Database Syst Rev. 2018;4(4):CD007094. doi:10.1002/14651858.CD007094.pub5
25. Chang AB, Oppenheimer JJ, Weinberger MM, et al. Management of children with chronic wet cough and protracted bacterial bronchitis: CHEST guideline and expert panel report. Chest. 2017;151(4):884-90. doi:10.1016/j.chest.2017.01.025
26. Gates A, Gates M, Vandermeer B, et al. Glucocorticoids for croup in children. Cochrane Database Syst Rev. 2018;8(8):CD001955. doi:10.1002/14651858.CD001955.pub4
27. Klassen TP, Watters LK, Feldman ME, Sutcliffe T, Rowe PC. The efficacy of nebulized budesonide in dexamethasone-treated outpatients with croup. Pediatrics. 1996;97(4):463-6.
28. Bjornson C, Russell K, Vandermeer B, Klassen TP, Johnson DW. Nebulized epinephrine for croup in children. Cochrane Database Syst Rev. 2013;10:CD006619. doi:10.1002/14651858.CD006619.pub3
29. Eghbali A, Sabbagh A, Bagheri B, Taherahmadi H, Kahbazi M. Efficacy of nebulized L-epinephrine for treatment of croup: a randomized, double-blind study. Fundam Clin Pharmacol. 2016;30(1):70-5. doi:10.1111/fcp.12158
30. Scolnik D, Coates AL, Stephens D, Da Silva Z, Lavine E, Schuh S. Controlled delivery of high vs low humidity vs mist therapy for croup in emergency departments: a randomized controlled trial. JAMA. 2006;295(11):1274-80. doi:10.1001/jama.295.11.1274
31. NICE. Bronchiolitis in children: diagnosis and management NICE guideline [NG9]. 2021 Available: https://www.nice.org.uk/guidance/ng9
32. Skjerven HO, Hunderi JOG, Brügmann-Pieper SK, et al. Racemic adrenaline and inhalation strategies in acute bronchiolitis. N Engl J Med. 2013;368(24):2286-93. doi:10.1056/NEJMoa1301839
33. Elliott SA, Gaudet LA, Fernandes RM, et al. Comparative efficacy of bronchiolitis interventions in acute care: a network meta-analysis. Pediatrics. 2021;147(5):e2020040816. doi:10.1542/peds.2020-040816
34. Gadomski AM, Scribani MB. Bronchodilators for bronchiolitis. Cochrane Database Syst Rev. 2014;2014(6):CD001266. doi:10.1002/14651858.CD001266.pub4
35. Fernandes RM, Hartling L. Glucocorticoids for acute viral bronchiolitis in infants and young children. JAMA. 2014;311(1):87-8. doi:10.1001/jama.2013.284921

36. Everard ML, Hind D, Ugonna K, et al. SABRE: a multicentre randomised control trial of nebulised hypertonic saline in infants hospitalised with acute bronchiolitis. Thorax. 2014;69(12):1105-12. doi:10.1136/thoraxjnl-2014-205953
37. Zhang L, Mendoza-Sassi RA, Wainwright C, Klassen TP. Nebulised hypertonic saline solution for acute bronchiolitis in infants. Cochrane Database Syst Rev. 2013;7:CD006458. doi:10.1002/14651858.CD006458.pub3
38. Franklin D, Babl FE, Schlapbach LJ, et al. A randomized trial of high-flow oxygen therapy in infants with bronchiolitis. N Engl J Med. 2018;378(12):1121-31. doi:10.1056/NEJMoa1714855
39. Kepreotes E, Whitehead B, Attia J, et al. High-flow warm humidified oxygen versus standard low-flow nasal cannula oxygen for moderate bronchiolitis (HFWHO RCT): an open, phase 4, randomised controlled trial. Lancet. 2017;389(10072):930-9. doi:10.1016/S0140-6736(17)30061-2
40. Taussig LM, Wright AL, Holberg CJ, Halonen M, Morgan WJ, Martinez FD. Tucson Children's Respiratory Study: 1980 to present. J Allergy Clin Immunol. 2003;111(4):661-75. doi:10.1067/mai.2003.162
41. Global Initiative for Asthma. Global strategy for asthma management and prevention. 2022 Available from http://www.ginasthma.org/
42. Payares-Salamanca L, Contreras-Arrieta S, Florez-García V, Barrios-Sanjuanelo A, Stand-Niño I, Rodriguez-Martinez CE. Metered-dose inhalers versus nebulization for the delivery of albuterol for acute exacerbations of wheezing or asthma in children: a systematic review with meta-analysis. Pediatr Pulmonol. 2020;55(12):3268-78. doi:10.1002/ppul.25077
43. McKean M, Ducharme F. Inhaled steroids for episodic viral wheeze of childhood. Cochrane Database Syst Rev. 2000;2000(2):CD001107. doi:10.1002/14651858.CD001107
44. Jain S, Williams DJ, Arnold SR, et al. Community-acquired pneumonia requiring hospitalization among U.S. children. N Engl J Med. 2015;372(9):835-45. doi:10.1056/NEJMoa1405870
45. Bielicki JA, Stöhr W, Barratt S, et al. Effect of amoxicillin dose and treatment duration on the need for antibiotic re-treatment in children with community-acquired pneumonia: the CAP-IT randomized clinical trial. JAMA. 2021;326(17):1713-24. doi:10.1001/jama.2021.17843
46. Pernica JM, Harman S, Kam AJ, et al. Short-course antimicrobial therapy for pediatric community-acquired pneumonia: the SAFER randomized clinical trial. JAMA Pediatr. 2021;175(5):475-82. doi:10.1001/jamapediatrics.2020.6735
47. Kuitunen I, Jääskeläinen J, Korppi M, Renko M. Antibiotic treatment duration for community-acquired pneumonia in outpatient children in high-income countries-a systematic review and meta-analysis. Clin Infect Dis. 2023;76(3):e1123-e1128. doi:10.1093/cid/ciac374
48. Williams DJ, Creech CB, Walter EB, et al. Short- vs standard-course outpatient antibiotic therapy for community-acquired pneumonia in children: the SCOUT-CAP randomized clinical trial. JAMA Pediatr. 2022;176(3):253-61. doi:10.1001/jamapediatrics.2021.5547
49. Lassi ZS, Padhani ZA, Das JK, Salam RA, Bhutta ZA. Antibiotic therapy versus no antibiotic therapy for children aged 2 to 59 months with WHO-defined non-severe pneumonia and wheeze. Cochrane Database Syst Rev. 2021;1(1):CD009576. doi:10.1002/14651858.CD009576.pub3
50. Gardiner SJ, Gavranich JB, Chang AB. Antibiotics for community-acquired lower respiratory tract infections secondary to mycoplasma pneumoniae in children. Cochrane Database Syst Rev. 2015;1:CD004875. doi:10.1002/14651858.CD004875.pub5
51. Esposito S, Bosis S, Faelli N, et al. Role of atypical bacteria and azithromycin therapy for children with recurrent respiratory tract infections. Pediatr Infect Dis J. 2005;24(5):438-44. doi:10.1097/01.inf.0000160949.99560.8d
52. Lahti E, Peltola V, Virkki R, Alanen M, Ruuskanen O. Development of parapneumonic empyema in children. Acta Paediatr. 2007;96(11):1686-92. doi:10.1111/j.1651-2227.2007.00511.x
53. Jefferson T, Jones MA, Doshi P, et al. Neuraminidase inhibitors for preventing and treating influenza in adults and children. Cochrane Database Syst Rev. 2014;2014(4):CD008965. doi:10.1002/14651858.CD008965.pub4
54. Venkatesan S, Myles PR, Bolton KJ, et al. Neuraminidase inhibitors and hospital length of stay: a meta-analysis of individual participant data to determine treatment effectiveness among patients hospitalized with nonfatal 2009 pandemic influenza a(H1N1) virus infection. J Infect Dis. 2020;221(3):356-66. doi:10.1093/infdis/jiz152
55. Malosh RE, Martin ET, Heikkinen T, Brooks WA, Whitley RJ, Monto AS. Efficacy and safety of oseltamivir in children: systematic review and individual patient data meta-analysis of randomized controlled trials. Clin Infect Dis. 2018;66(10):1492-500. doi:10.1093/cid/cix1040
56. Gökçe Ş, Kurugöl Z, Şöhret Aydemir S, Çiçek C, Aslan A, Koturoğlu G. Bordetella pertussis infection in hospitalized infants with acute bronchiolitis. Indian J Pediatr. 2018;85(3):189-93. doi:10.1007/s12098-017-2480-4
57. Alvarez J, Godoy P, Plans-Rubio P, et al. Azithromycin to prevent pertussis in household contacts, Catalonia and Navarre, Spain, 2012–2013. Emerg Infect Dis. 2020;26(11):2678-84. doi:10.3201/eid2611.181418
58. Altunaiji S, Kukuruzovic R, Curtis N, Massie J. Antibiotics for whooping cough (pertussis). Cochrane Database Syst Rev. 2007;2013:CD004404. doi:10.1002/14651858.CD004404.pub3
59. Langley JM, Halperin SA, Boucher FD, Smith B. Azithromycin is as effective as and better tolerated than erythromycin estolate for the treatment of pertussis. Pediatrics. 2004;114(1):e96-e101. doi:10.1542/peds.114.1.e96
60. Wang K, Bettiol S, Thompson MJ, et al. Symptomatic treatment of the cough in whooping cough. Cochrane Database Syst Rev. 2014;2014:CD003257. doi:10.1002/14651858.CD003257.pub5

How to cite this article: Backman K, Helminen M, Kekäläinen E, Mikkola I, Nieminen T, Nuolivirta K, et al. Working group summary of the 2023 full update of the Finnish national guidelines for paediatric lower respiratory tract infections. Acta Paediatr. 2024;00:1–10. https://doi.org/10.1111/apa.17481