European Respiratory Society clinical practice guideline for the management of adult bronchiectasis

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Abstract

Background Bronchiectasis is a common lung condition associated with wide range of infectious, immunological, autoimmune, allergic and genetic conditions. Exacerbations and daily symptoms have the largest impact on patients and healthcare systems, and they are the key focus of treatments. Current practice is heterogeneous globally, and bronchiectasis has historically been a neglected disease. Here, we present evidence-based international guidelines for the management of adults with bronchiectasis.

Methods A European Respiratory Society (ERS) Task Force, comprising global experts, a methodologist and patient representatives, developed clinical practice guidelines in accordance with ERS methodology and the GRADE (Grading of Recommendations, Assessment, Development and Evaluations) approach. Systematic literature searches, data extraction and meta-analysis were performed to generate evidence

tables, and recommendations were formulated using the evidence-to-decision framework. A total of eight PICO (Patients, Intervention, Comparator, Outcomes) questions and three narrative questions were developed.

Recommendations The Task Force recommendations include strong recommendations in favour of airway clearance techniques for most patients with bronchiectasis, and pulmonary rehabilitation for those with impaired exercise capacity. We issue a strong recommendation for the use of long-term macrolide treatment for patients at high risk of exacerbations and a strong recommendation in favour of long-term inhaled antibiotics in patients with chronic *Pseudomonas aeruginosa* infection at high risk of exacerbation. Conditional recommendations support the use of eradication treatment or mucoactive drugs in specific circumstances. We suggest not to routinely use long-term oral, non-macrolide antibiotic treatment or inhaled corticosteroids. Additional guidance is also provided on testing for underlying causes, managing exacerbations and managing the deteriorating patient.

Conclusion The ERS bronchiectasis guidelines provide an evidence-based framework for optimal management of adults with bronchiectasis and serve as a benchmark for evaluating the quality of care.

Scope and objectives

The European Respiratory Society (ERS) guidelines for the management of bronchiectasis in adults provide evidence-based recommendations for the care of people with clinically significant bronchiectasis, defined by the presence of permanent dilatation of the bronchi evident on chest computed tomography scan, along with characteristic clinical symptoms [1]. These guidelines are intended for all healthcare professionals involved in the care of adults with bronchiectasis, as well as for policymakers, regulatory authorities and pharmaceutical companies. Bronchiectasis is a complex and heterogeneous disease; therefore, no guideline can be entirely comprehensive or replace clinical judgement. All guideline recommendations must be interpreted within the specific clinical context in which they are applied. Separate ERS guidelines for the management of bronchiectasis in children exist [2]. Bronchiectasis due to cystic fibrosis (CF) has a distinct evidence base; therefore, guidance for the management of CF is provided elsewhere [3]. Some bronchiectasis-associated conditions also have distinct guidelines for investigation and management, such as primary ciliary dyskinesia (PCD) [4], allergic bronchopulmonary aspergillosis (ABPA) [5] and non-tuberculous mycobacterial (NTM) pulmonary disease [6]. While the present guidelines apply for these conditions, they should be interpreted in conjunction with the relevant syndrome-specific recommendations.

Introduction

Bronchiectasis is a chronic inflammatory lung disease characterised by clinical symptoms such as cough, sputum production and recurrent respiratory infections. Bronchiectasis is defined radiologically by the presence of bronchial dilation on chest computed tomography scan [1, 7]. The key goals of bronchiectasis management are to improve quality of life and symptoms, to prevent exacerbations and disease progression [8, 9]. Bronchiectasis is caused by a wide variety of underlying conditions, including infectious, autoimmune, allergic and genetic disorders [10, 11]. Approximately 40% of cases have no identified cause [12].

The disease pathophysiology is conceptualised through the “vicious vortex” concept, in which four interrelated components interact to drive disease progression [13]. These components are airway inflammation, impaired mucociliary clearance, airway infection and structural lung damage [14–16]. Management of bronchiectasis is therefore focused on addressing these four key components, and treatments used can be thought of as primarily targeting one of these four components (figure 1).

Although bronchiectasis is common, it has historically been a neglected and under-researched condition [17]. The first international guidelines for bronchiectasis were published by the ERS in 2017; however, the majority of recommendations were conditional and based on low or very low certainty of evidence, largely due to a lack of high-quality randomised controlled trials (RCTs) [18]. In the past 8 years there has been a notable increase in clinical trials and research activity in bronchiectasis, including extensive data from patient registries [19–22]. In this document we provide new recommendations for the management of bronchiectasis in adults.

Guideline methodology

The ERS guidelines for the management of bronchiectasis in adults were developed by an ERS Task Force in accordance with ERS rules for developing guidelines, which utilise the GRADE (Grading of Recommendations, Assessment, Development and Evaluation) approach. The Task Force was chaired by Professor James D. Chalmers (Dundee, UK) and Professor Stefano Aliberti (Milan, Italy). The Task Force was international, representing 13 countries across four continents. Participants were selected by the chairs based on their expertise and experience, and the Task Force was constituted according to ERS rules. The

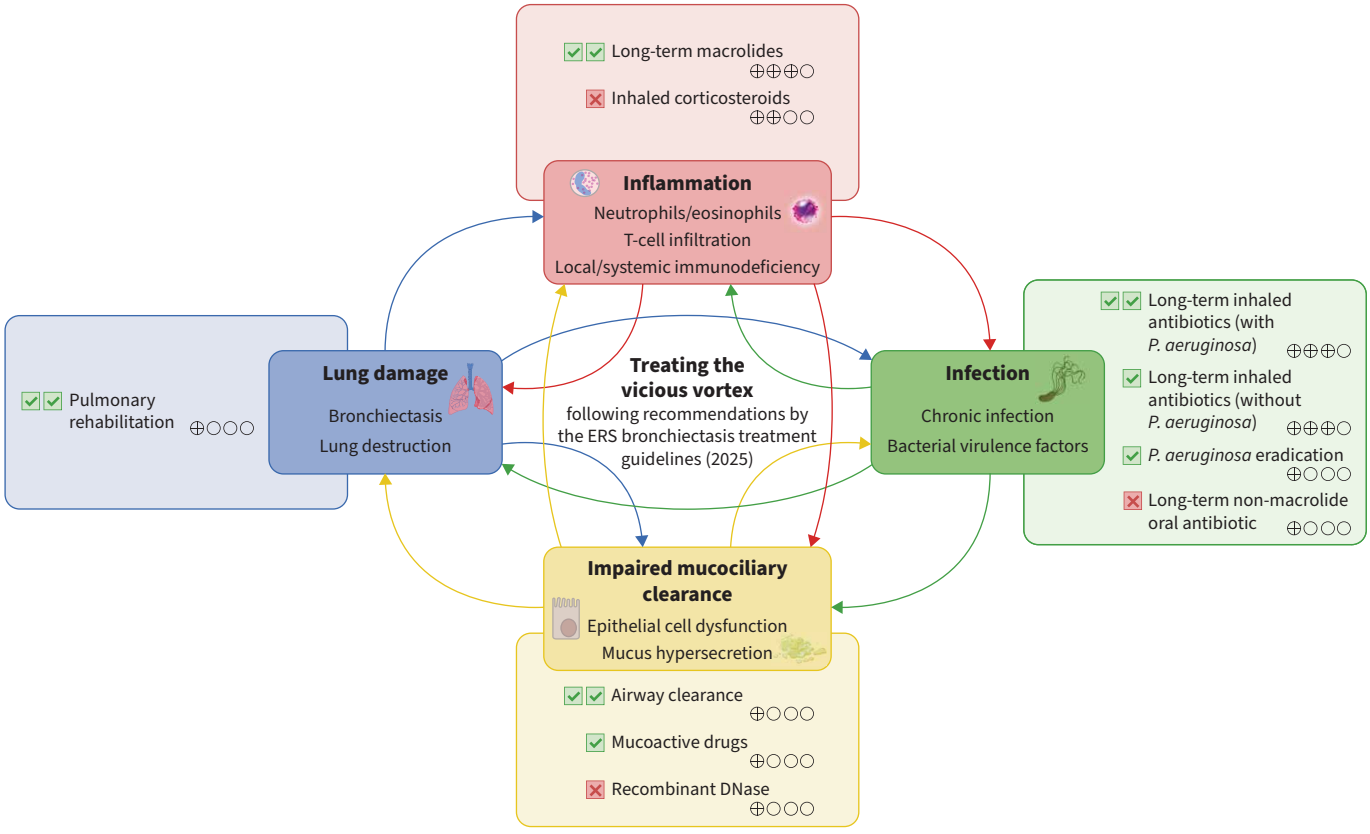

FIGURE 1 The vicious vortex of bronchiectasis with the treatments evaluated in the 2025 European Respiratory Society (ERS) bronchiectasis guidelines. Green indicates treatments that receive a recommendation in favour (two green ticks indicates a strong recommendation for the intervention, one green tick indicates a conditional recommendation for the intervention). Red indicates treatments that receive a recommendation against (a red cross indicates a conditional recommendation against the intervention). The certainty of evidence is indicated by the crossed circles after each topic (1 cross=very low certainty, 2 crosses=low certainty, 3 crosses=moderate certainty, 4 crosses=high certainty). *P. aeruginosa*: *Pseudomonas aeruginosa*.

Task Force also included professional information specialists who supported the literature searches, three patient representatives from the European Lung Foundation/European Multicentre Bronchiectasis Audit and Research Collaboration (EMBARC) Patient Advisory Group with lived experience of bronchiectasis [23] and the ERS lead methodologist. Two members of the ERS guideline methodology network were assigned to the Task Force. Guideline development included virtual and face-to-face meetings, as well as extensive correspondence among voting panel members.

Questions and outcomes

The guideline includes eight PICO (Patients, Intervention, Comparison, Outcomes) questions and three narrative questions [24]. For PICO questions, formal systematic literature searches, meta-analysis and grading were performed. For narrative questions, formal systematic literature searches were also completed. Evidence-to-decision (EtD) frameworks were used to generate EtD tables for both PICO and narrative questions. For each question, relevant outcomes were selected by panel members and patient representatives based on their clinical judgement. Outcomes were then rated on a 9-point scale and classified as critical, important or of limited importance through a panel vote [25]. Only outcomes rated as critical or important based on the average panel score and subsequent discussion and consensus were included. Data for these outcomes were extracted for meta-analysis and considered in the evidence summaries.

Literature searches and systematic literature searches

Literature searches were designed by two independent information specialists in partnership with the chairs, the ERS methodologist and a panel member experienced in methodology. Each question was supported by a systematic literature search of up to five databases (PubMed, Embase, Web of Science Core

Collection, Scopus and Cochrane Central Register of Controlled Trials (CENTRAL)) and two clinical trial databases (ClinicalTrials.gov and International Clinical Trials Registry Platform (ICTRP)). Searches were performed from inception of the databases to between November 2023 and January 2024 (detailed search methodology is shown in the supplementary material). All studies addressing the relevant question were considered, including RCTs and observational studies. Review articles (with the exception of existing systematic reviews), editorials and other papers not containing original data were excluded. The study selection process for each question is presented in PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) flowcharts in the supplementary material. Where RCTs addressing the question were identified, these were considered as the main body of evidence and analyses were limited to those studies. If no RCTs were identified, data from observational studies were extracted and considered as the main body of evidence.

We performed a search for all RCTs related to bronchiectasis (search terms are presented in the supplementary material). As no RCTs were identified addressing PICO Question 6 on eradication and limited data were identified for PICO Question 5 on non-macrolide oral antibiotics, specific searches were performed for these two PICO questions (search terms are presented in the supplementary material). The search strategies for Narrative Question 1 and Narrative Questions 2 and 3 are also presented in the supplementary material. Data from studies that did not meet the criteria for inclusion in the evidence summaries could still be included in the "additional considerations" section of the EtD framework, if they were relevant and informative to the discussions.

The first stage of literature review involved independent screening of titles and abstracts by two reviewers using the Rayyan platform (www.rayyan.ai). Discrepancies in inclusion/exclusion were resolved by an independent third reviewer followed by discussion and consensus among all reviewers. Following full-text review, based on predefined inclusion and exclusion criteria (supplementary material), outcomes of interest were extracted using a predeveloped data extraction form in Microsoft Excel; meta-analyses were performed using Reviewer Manager (RevMan) version 5 (www.cochrane.org). All meta-analyses used random effects models in view of the heterogeneity of patient populations, interventions and study designs identified. Risk of bias for RCTs was evaluated using the Cochrane Risk of Bias tool 2 (RoB 2) for randomised trials embedded within Review Manager software.

Certainty of evidence and strength of recommendations

The certainty of evidence for each outcome was evaluated using GRADE methodology as very low, low, moderate or high, taking into account risk of bias, inconsistency, indirectness, imprecision and publication bias for each outcome [26]. For imprecision, certainty of evidence was downgraded if the confidence intervals included the possibility of the lack of a clinically relevant effect using established minimum clinically important differences (MCIDs), where these are available [27–30], and discussion among the panel members where these were not available. GRADE evidence profiles were created in GRADEPro (www.gradepro.org) for each PICO question and are presented in the supplementary material.

Recommendations

EtD frameworks were prepared for each question and discussed during a series of panel meetings. For the PICO questions and Narrative Question 1, evidence was reviewed and new recommendations formulated. For Narrative Questions 2 and 3, which deal with what is already recommended elsewhere, the panel reviewed existing recommendations from clinical guidelines and statements, identified those recommendations with which they agreed, and endorsed those recommendations. For all questions consensus was achieved by considering not only the available evidence, but also patients' values and preferences, as well as practical considerations [31]. Formal voting was performed to agree the final recommendations, with a prespecified threshold: 70% agreement was required to approve recommendations. Voting panel members declared their conflicts of interest and were disqualified from voting on recommendations where they declared a conflict. At least 50% of the panel had to be non-conflicted and eligible to vote for a valid recommendation, in line with ERS rules. Recommendation meetings were held between July 2024 and January 2025. As recommendations were formulated within 12 months of the literature searches, the searches were not updated.

Recommendations are formulated as either strong or conditional. In line with GRADE terminology, we use "we recommend" for strong recommendations and "we suggest" for conditional recommendations.

Additional information to operationalise the recommendations is provided as remarks. The evidence supporting these remarks is discussed and reflects the clinical judgement of the guideline panel.

A summary of the recommendations is shown in table 1.

Narrative Question 1

How can underlying causes of bronchiectasis be identified, and how can the severity, comorbidities and other treatable traits be evaluated?

Recommendation

Management of patients with bronchiectasis should include standardised testing to identify the underlying cause of bronchiectasis, to evaluate disease severity and activity as well as risk of poor outcome, and to identify comorbidities and associated treatable traits. *(Strong recommendation for the intervention, moderate certainty of evidence stemming from narrative review of the evidence.)*

Investigation and management considerations.

The following is based on the evidence from systematic searches, panel discussions, the clinical experience and current practice of the panel, and recommendations in other guidelines (figure 2):

- All patients newly diagnosed with bronchiectasis should be screened for immunodeficiency by measurement of serum immunoglobulins (IgG, IgM and IgA), ABPA by measurement of total IgE, *Aspergillus* specific IgG and IgE, as well as blood eosinophils and NTM by mycobacterial microscopy and culture.
- In patients at high risk of NTM infection based on clinical and radiological features a minimum of three sputum samples or a bronchoalveolar lavage should be obtained.
- Alpha-1 antitrypsin testing should not be performed routinely but should be considered in patients with suggestive clinical and radiological features such as basal emphysema or severe airflow obstruction.
- Patients with symptoms onset during childhood or with specific clinical or radiological features (independent of age of onset) should be screened for CF and PCD.
- Newly diagnosed patients with bronchiectasis should have a Bronchiectasis Severity Index (BSI) calculated to assess the risk of future complications (table 2).
- Patients at higher risk of future complications should be identified. Such patients should be considered for more frequent follow-up and a lower threshold for treatment. High-risk groups include:
  - Patients with COPD, PCD or rheumatoid arthritis (RA)-associated bronchiectasis.
  - Patients with *Pseudomonas aeruginosa* or other enteric Gram-negative infections.
  - Patients with ⩾2 exacerbations per year or ⩾1 severe exacerbation (defined as requiring hospitalisation or intravenous antibiotics) in the previous year.
  - Patients with severe symptoms including high volumes of daily sputum production and sputum purulence.
  - Patients with NTM infection.
  - Patients with ABPA.
- Assessment of comorbid illnesses should be part of the evaluation of all patients with bronchiectasis:
  - Patients at risk should be investigated for associated cardiovascular disease.
  - Patients at risk should be investigated for associated osteoporosis.
  - Patients should be screened for symptoms of anxiety and depression, and appropriate management initiated.
  - Rhinosinusitis and gastro-oesophageal reflux disease are common comorbidities of bronchiectasis that should be identified and managed appropriately.
  - Treatment burden and the impact on associated conditions should be considered as part of treatment decisions when managing bronchiectasis.
  - The assessments described here, including considering the underlying cause, comorbidities, disease activity and treatable traits, should be considered at all patient visits and not just at diagnosis.

Summary of evidence

Evidence supports standardised testing for underlying causes of bronchiectasis, as it may reveal treatable conditions, particularly immunodeficiency, NTM infection, ABPA and CF [4, 10, 11, 32–34]. Identifying these conditions can significantly improve outcomes. Additionally, certain aetiologies, such as COPD, PCD and RA, have treatment and prognostic implications, and can influence follow-up and management strategies [8, 35–37]. Patients themselves often express a strong desire to understand the cause of their bronchiectasis, and this was supported by the patient representatives in the guideline panel [38]. Identifying the underlying cause begins with a thorough history, including childhood history, reviewing high-resolution computed tomography findings, medications, pulmonary function tests and supported by laboratory investigations. Resource implications exist for extensive testing, so the approach should balance cost and benefit. Therefore, testing for immunoglobulin deficiency, ABPA and NTM are reasonable as

TABLE 1 Summary of recommendations

Question	Recommendation(s)	Remarks
Narrative Question 1: ***How can underlying causes of bronchiectasis be identified, and how can the severity, comorbidities and other treatable traits be evaluated?***	Management of patients with bronchiectasis should include standardised testing to identify the underlying cause of bronchiectasis, to evaluate disease severity and activity as well as risk of poor outcome, and to identify comorbidities and associated treatable traits. *(Strong recommendation for the intervention, moderate certainty of evidence stemming from narrative review of the evidence.)*	See the relevant section for the associated detailed investigation and management considerations.
PICO Question 1: ***Should airway clearance techniques be used (compared with no airway clearance techniques) in adults with bronchiectasis?***	We recommend that patients with bronchiectasis should be taught airway clearance techniques. *(Strong recommendation for the intervention, very low certainty of evidence.)*	• Airway clearance techniques (ACTs) are best taught by a respiratory physiotherapy with appropriate experience. • There is no evidence that one technique is superior to another and, therefore, treatment should be personalised. • Airway clearance devices may be used to support manual ACTs. • Previous ERS guidelines limited ACTs to patients with chronic productive cough. The current recommendation acknowledges that some patients with a dry cough, particularly those with mucus plugging on chest computed tomography, may benefit from ACTs. Instruction in ACTs may also assist patients during periods of increased symptoms, such as exacerbations.
PICO Question 2: ***Should mucoactive drugs be used (compared with no mucoactive drugs) in adults with bronchiectasis?***	We suggest to offer mucoactive treatments to patients with bronchiectasis where airway clearance has failed to control symptoms. *(Conditional recommendation for the intervention, very low certainty of evidence.)* We suggest not to offer recombinant DNase to patients with bronchiectasis. *(Conditional recommendation against the intervention, very low certainty of evidence.)*	• The choice of mucoactive treatment should be guided by the patient's comorbidities and concerns around treatment burden and tolerability. • Mucoactive treatments are best delivered as part of a comprehensive airway clearance regimen, which includes personalised airway clearance instruction with or without devices, and regular physical exercise.
PICO Question 3: ***Should long-term inhaled antibiotics be used (compared with no long-term inhaled antibiotics) in adults with bronchiectasis?***	We recommend to offer long-term inhaled antibiotics to patients at high risk of exacerbations and chronic infection with *P. aeruginosa* despite standard care. *(Strong recommendation for the intervention, moderate certainty of evidence.)* We suggest to offer long-term inhaled antibiotics for patients at high risk of exacerbations and chronic infection with pathogens other than *P. aeruginosa* despite standard care *(Conditional recommendation for the intervention, moderate certainty of evidence.)*	• Patients at high risk of exacerbations include patients with a history of ⩾2 exacerbations in the prior year OR ⩾1 severe exacerbation OR 1 exacerbation plus severe daily symptoms. • Inhaled antibiotics should be prescribed for a defined period and treatment response should be formally evaluated. If ineffective or poorly tolerated, it should be discontinued. • Inhaled antibiotics are drug and device combinations; therefore, patients should be provided with an appropriate nebuliser along with the medication. • Many clinicians would perform a supervised test dose of inhaled antibiotics because of the risk of bronchospasm.

Continued

TABLE 1 Continued

Question	Recommendation(s)	Remarks
PICO Question 4: ***Should long-term macrolides be used (compared with no long-term macrolides) in adults with bronchiectasis?***	We recommend to offer long-term macrolides to patients at high risk of exacerbations despite standard care. *(Strong recommendation for the intervention, moderate certainty of evidence.)*	• Macrolides are effective in a broad group of patients with bronchiectasis at high risk of exacerbations, including patients with chronic *P. aeruginosa* infection, patients with airway infection caused by other pathogens, and those without evidence of airway infection. • Macrolides should not be prescribed as monotherapy to patients with NTM infection. NTM should be excluded before initiating macrolide therapy. • The most widely used long-term macrolide is azithromycin, typically at a dose of 250 mg daily or three times per week, or 500 mg three times per week. • In view of the risk of adverse effects, patient education, baseline screening and appropriate follow-up are important when prescribing macrolides.
PICO Question 5: ***Should long-term non-macrolide oral antibiotics be used (compared with no long-term non-macrolide oral antibiotics) in adults with bronchiectasis?***	The panel suggests NOT to offer long-term non-macrolide oral antibiotics as a first-line treatment to adult patients with bronchiectasis and a high risk of exacerbations. *(Conditional recommendation against the intervention, very low certainty of evidence.)*	• Long-term non-macrolide oral antibiotics may have a role in specific situations where patients are at high risk of frequent exacerbations and other options such as long-term macrolides are contraindicated or have proven ineffective.
PICO Question 6: ***Should eradication treatment be used for patients with isolation of a new pathogenic microorganism (compared with no eradication treatment)?***	We suggest to offer eradication treatment to patients with a new isolation of *P. aeruginosa*. *(Conditional recommendation for the intervention, very low certainty of evidence.)*	• A new isolation of *P. aeruginosa* may refer to the first time a patient has *P. aeruginosa* isolated or a further isolation following a prolonged period during which *P. aeruginosa* was not detected. • Eradication practices vary both among panel members and globally. Some clinicians prescribe systemic antibiotics (*e.g.* a 2-week course) followed by a repeat sputum culture, discontinuing antibiotics if the sample is negative. Others would add inhaled antibiotics for 4 weeks to 3 months, without rechecking sputum cultures. The 2017 ERS bronchiectasis guidelines provide examples of different antibiotic strategies [18].

Continued

TABLE 1 Continued

Question	Recommendation(s)	Remarks
PICO Question 7: ***Should long-term inhaled corticosteroids be used (compared with no long-term inhaled corticosteroids) in adults with bronchiectasis?***	We suggest not to offer long-term inhaled corticosteroids to patients with bronchiectasis who do not have coexisting COPD or asthma. *(Conditional recommendation against the intervention, low certainty of evidence.)*	• Patients with bronchiectasis should be evaluated for the presence of coexisting asthma and COPD. The presence of bronchiectasis does not alter the recommendation to use inhaled corticosteroids (ICS) in patients with asthma or in a subset of patients with COPD. Suspected asthma or COPD should be appropriately investigated in patients with bronchiectasis. • There is limited evidence suggesting that ICS may be beneficial in a subgroup of patients with bronchiectasis with elevated blood eosinophil counts who do not have asthma or other eosinophilic conditions. However, no recommendation on ICS use based on blood eosinophils is currently possible, and we recommend further research in this group. • The use of ICS should be re-evaluated in patients without a clear indication. Discontinuation of ICS may be appropriate in some patients.
PICO Question 8: ***Should pulmonary rehabilitation be used (compared with no pulmonary rehabilitation) in adults with bronchiectasis?***	We recommend that patients with breathlessness and/or impaired exercise capacity should be offered pulmonary rehabilitation. *(Strong recommendation for the intervention, very low certainty of evidence.)*	• The educational component of pulmonary rehabilitation should ideally be bronchiectasis specific and include discussion of airway clearance strategies. • Patients with bronchiectasis should be encouraged to undertake regular physical activity, given its multiple health benefits.
Narrative Question 2: ***What diagnostic tests and interventions are currently recommended/used for managing exacerbations?***	See the relevant section for a summary of nine recommendations arising from the narrative review of the evidence.	See the relevant section for the associated detailed recommendations endorsed by the panel.
Narrative Question 3: ***What investigations and treatments are currently recommended in a patient with bronchiectasis who is rapidly deteriorating in terms of symptoms or exacerbations?***	See the relevant section for a summary of 11 recommendations arising from the narrative review of the evidence.	See the relevant section for the associated detailed recommendations endorsed by the panel.

PICO: Patients, Intervention, Comparator, Outcomes; ERS: European Respiratory Society; *P. aeruginosa*: *Pseudomonas aeruginosa*; NTM: non-tuberculous mycobacteria.

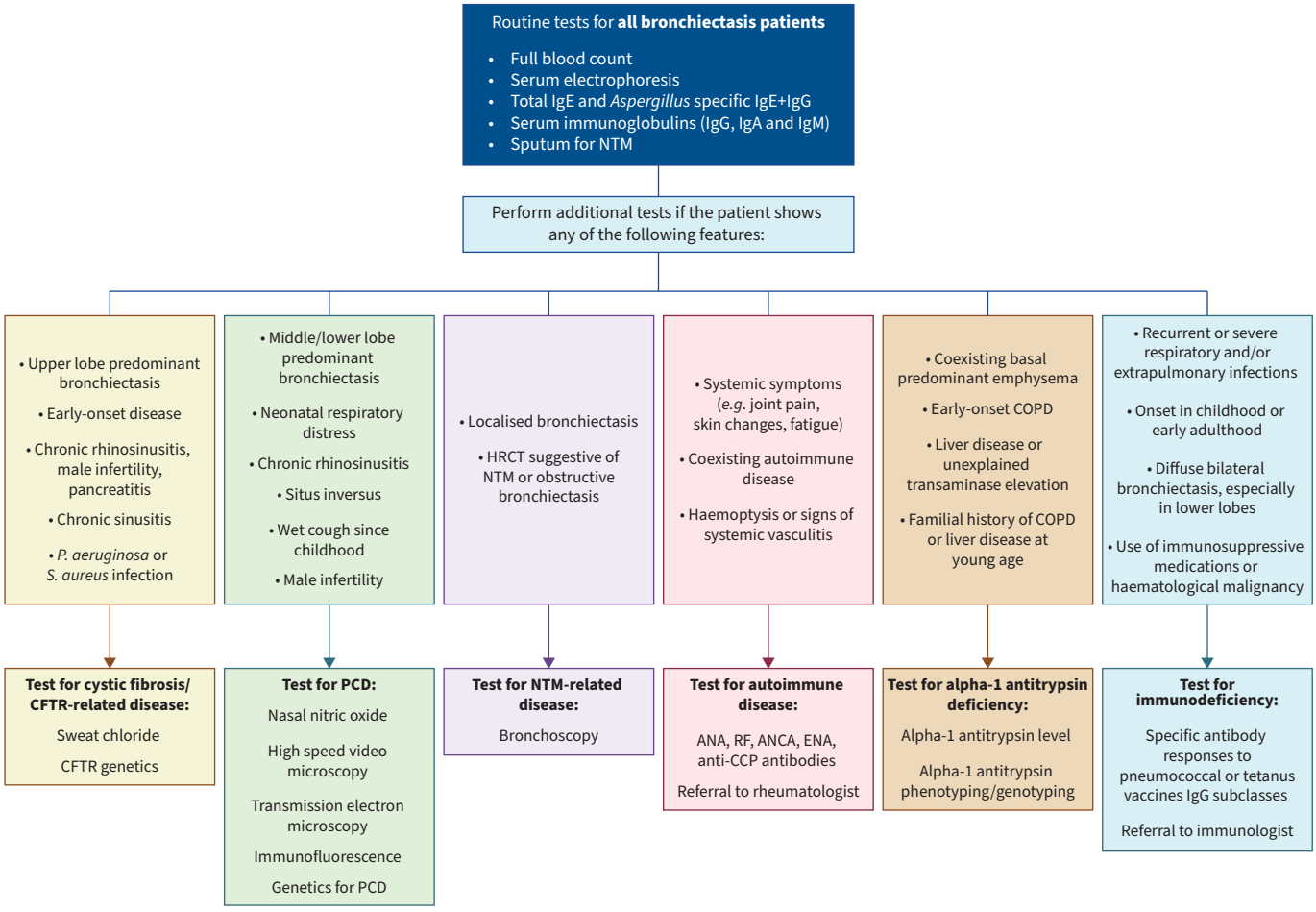

FIGURE 2 Investigation and management considerations for initial assessment and subsequent aetiological testing for adults with bronchiectasis. The core components (dark blue box) are routine for all patients. This figure summarises the investigation and management considerations described in the text based on the systematic searches, panel discussions and current practices. These do not constitute separate recommendations. In a deteriorating bronchiectasis patient a comprehensive aetiological workup should be repeated and guided by clinical, radiological and demographic clues to identify any missed, evolving or newly relevant causes. NTM: non-tuberculous mycobacteria; *P. aeruginosa*: *Pseudomonas aeruginosa*; *S. aureus*: *Staphylococcus aureus*; HRCT: high-resolution computed tomography; CFTR: cystic fibrosis transmembrane conductance regulator; PCD: primary ciliary dyskinesia; ANA: antinuclear antibody; RF: rheumatoid factor; ANCA: anti-neutrophil cytoplasmic antibody; ENA: extractable nuclear antigen; CCP: cyclic citrullinated peptide.

they are not prohibitively expensive, each are common (up to 10% depending on the series and even higher in certain populations) and they change management [10, 39]. Studies have found alpha-1 antitrypsin screening in unselected bronchiectasis patient populations to have a low positive rate [40, 41], and so routine screening is not recommended. Screening for rarer conditions like CF and PCD is important but carries significant cost and logistical challenges. The majority of patients with these genetic causes will have symptoms in childhood, but additional features that may suggest CF include upper lobe bronchiectasis, gastrointestinal symptoms (malabsorption/pancreatic insufficiency/pancreatitis, intestinal obstruction), chronic rhinosinusitis with or without nasal polyps, male infertility and infection with *Staphylococcus aureus*, *P. aeruginosa* or NTM. Although not all patients with bronchiectasis require screening for CF, a low threshold for testing should be adopted in view of the availability of specific CF transmembrane conductance regulator (CFTR) modulator treatments [42–44]. Diagnosis of PCD should follow the ERS/American Thoracic Society (ATS) guidelines [45]. No cost-effectiveness data were identified in the analysed studies. Bronchiectasis aetiology varies globally, with post-tuberculosis bronchiectasis more common in Asia, Africa and some parts of Europe [46], CF is less prevalent in Asia, and ABPA is reported less common in Southern than Northern Europe [11].

Bronchiectasis has a highly variable clinical course [47, 48]. Severity assessment aims at identifying patients at risk of progression, exacerbations and mortality. The BSI is the most widely used standardised

TABLE 2 The Bronchiectasis Severity Index

Severity marker	Score
Age, years	
<50	0
50–69	2
70–79	4
⩾80	6
BMI, kg·m^{-2}	
<18.5	2
18.5–25	0
26–29	0
⩾30	0
FEV_1 % pred	
>80	0
50–80	1
30–49	2
<30	3
Previous hospital admission	
No	0
Yes	5
Number of exacerbations in previous year	
0	0
1–2	0
⩾3	2
MRC breathlessness score	
1–3	0
4	2
5	3
***Pseudomonas* colonisation**	
No	0
Yes	3
Colonisation with other organisms	
No	0
Yes	1
Radiological severity: ⩾3 lobes involved or cystic bronchiectasis	
Yes	1
No	0

Patients receive a score out of a maximum of 24 points. 0–4 points is considered mild or low risk of mortality and hospitalisation, 5–8 points is considered moderate or intermediate risk of mortality and hospitalisation, and ⩾9 points is considered severe or high risk of mortality and hospitalisation. BMI: body mass index; FEV_1: forced expiratory volume in 1 s; MRC: Medical Research Council.

severity assessment tool, although others exist [47, 49, 50]. Use of such tools may help to identify patients most likely to experience complications. Nonetheless, severity scores have limitations, and potential misclassification of patients could lead to under- or overtreatment; therefore, features such as frequent exacerbations [8], severe daily symptoms [51], *P. aeruginosa* infection [52], and some aetiologies and associated conditions [53] should guide clinicians toward more intensive monitoring and management.

The concept of severe daily symptoms and sputum purulence relies on clinical judgement and can be pragmatically defined as symptoms which have a severe impact on patients' day-to-day functioning or quality of life [54]. Objective tools such as the Quality of Life-Bronchiectasis (QoL-B) questionnaire respiratory symptoms score or St George's Respiratory Questionnaire (SGRQ) score may support identification of severe symptoms [27]. In a recent study using the EMBARC registry in nearly 10 000 patients, mean QoL-B respiratory symptoms score was 60 points and mean SGRQ score was >52 points [55]. An objective sputum colour chart is available to identify sputum purulence [56, 57].

Comorbidities are frequently observed in patients with bronchiectasis, and are associated with increased mortality and reduced quality of life [53]. Cardiovascular diseases [58], osteoporosis, depression, anxiety [59], chronic rhinosinusitis [60], and low body weight and malnutrition [47] are common, and have available treatment or preventive strategies that could yield desirable benefits [61].

Justification of recommendation

The recommendation to test for underlying causes in bronchiectasis is justified by the potential benefits of identifying treatable conditions that can improve patient outcomes. Although such testing may increase healthcare costs and introduce diagnostic complexity, the prioritisation of diagnosing treatable aetiologies outweighs these concerns. The recommendation to limit testing for alpha-1 antitrypsin deficiency, CF and PCD to patients with suggestive clinical features reflects a targeted diagnostic approach that balances the need for comprehensive evaluation while minimising unnecessary testing, healthcare costs and patient burden.

Assessing disease severity is essential to ensure a standardised evaluation of bronchiectasis, facilitating appropriate management strategies. Additionally, the identification and management of comorbidities support a holistic approach to patient care, ultimately improving clinical outcomes.

The treatable traits concept emphasises the importance of a personalised approach to bronchiectasis management. Effective treatment strategies targeting the underlying cause, associated comorbidities and key disease features (infection, impaired mucociliary clearance, inflammation, *etc.*) depend on comprehensive patient assessment to identify treatable traits.

Implementation considerations

Implementing testing for underlying causes in bronchiectasis requires a structured approach to address several practical challenges, including regional disparities in diagnostic capacity, variability in disease aetiology across populations, and the lack of standardised follow-up and management protocols. Testing for certain underlying causes (particularly PCD) may be difficult to implement in many regions due to limited access to specialised diagnostic facilities. While evidence exists to support treatment of some treatable traits (*e.g.* cardiovascular disease secondary prevention), other areas lack clear therapeutic data. It is important to note that the screening strategies described here are considered first-line investigations. In patients with strong clinical suspicion of a particular condition, additional testing may be appropriate. An example of this is immunodeficiency. For example, although low immunoglobulin levels and functional antibody testing (*e.g.* measurement of pneumococcal antibody followed by pneumococcal vaccination if low and repeat antibody measurement 6 weeks later) can identify many immunodeficiencies, referral to an immunologist should be considered for patients with suggestive features, even when initial immunoglobulin levels are normal.

Monitoring/evaluation

Aetiological testing is typically undertaken at the time of diagnosis; however, this should be viewed as an ongoing process. If patients' clinical features change in a way that raises suspicion for a new diagnosis, further testing should be undertaken. Although formal severity assessment is recommended at diagnosis, it should not be limited to that time-point. Assessment of future risk should be a key part of every clinical review.

Research priorities

Large-scale studies performing genetic testing for PCD, CF and primary immunodeficiencies in adults with bronchiectasis, with appropriate downstream testing to confirm the diagnoses, are required to determine the true prevalence of these conditions and to inform the development of optimal screening strategies. Studies implementing comprehensive aetiological testing approaches across different regions/countries are required to determine if the recommended screening strategies are globally applicable and cost-effective.

PICO Question 1: Airway clearance

Should airway clearance techniques be used (compared with no airway clearance techniques) in adults with bronchiectasis?

Recommendation

We recommend that patients with bronchiectasis should be taught airway clearance techniques. *(Strong recommendation for the intervention, very low certainty of evidence.)*

Remarks

- Airway clearance techniques (ACTs) are best taught by a respiratory physiotherapy with appropriate experience.
- There is no evidence that one technique is superior to another and, therefore, treatment should be personalised.
- Airway clearance devices may be used to support manual ACTs.

- Previous ERS guidelines limited ACTs to patients with chronic productive cough. The current recommendation acknowledges that some patients with a dry cough, particularly those with mucus plugging on chest computed tomography, may benefit from ACTs. Instruction in ACTs may also assist patients during periods of increased symptoms, such as exacerbations.

Summary of evidence

We included two RCTs (a 12-month RCT and a 3-month crossover trial) that evaluated ACTs in 39 participants *versus* 40 receiving standard care or placebo exercises. These studies showed no significant difference overall in the percentage of participants with ⩾1 exacerbation during follow-up (OR 0.58 (95% CI 0.21–1.58)) [62, 63], while the 12-month RCT by Munoz *et al.* [63] showed a significant reduction in exacerbation rate over 12 months. Improvements in health-related quality of life were clearly demonstrated with ACTs, with a statistically significant mean total Leicester Cough Questionnaire (LCQ) score improvement of 2.81 (95% CI 0.72–4.9) and a mean difference (MD) in SGRQ score of −12.51 (95% CI −22.39– −2.62) [62, 63]. Both of these exceed the reported MCIDs for these measures. Our meta-analysis also indicated a significant reduction in breathlessness with a MD in the modified Medical Research Council (mMRC) dyspnoea scale of −1.36 (95% CI −2.14– −0.58) points and significant increase in 24-h sputum volume (MD 6.2 (95% CI 0.46–11.95) mL).

The overall certainty of evidence was rated as very low, primarily due to a high risk of bias and imprecision. No studies reported on hospitalisation rates, adverse effects or treatment burden.

Justification of recommendations

ACTs are associated with improved quality of life and symptoms, and may reduce exacerbations [62, 63]. Airway clearance is a key component of daily bronchiectasis management [64]. Despite the very low certainty of evidence, the panel issued a strong recommendation based on the following: 1) ACTs are self-administered, low-cost and accessible; 2) patients widely recognise their benefits; and 3) the recommendation was strongly supported by patient representatives. Although adverse effects and harms were not systematically reported or collected, ACTs are widely believed to be safe and low risk for adverse events. These factors outweigh the limitations of the evidence base and highlight a need for broader implementation. Airway clearance is underutilised in clinical practice, and this recommendation should encourage increased uptake among healthcare professionals and policy [65].

Implementation considerations

Patients should receive appropriate training and personalised guidance in selecting the most suitable ACTs for their individual needs by a specialist respiratory physiotherapist. It is acknowledged that not all patients will have access to a respiratory physiotherapist and that other healthcare professionals may be involved in teaching airway clearance. Although direct comparative studies are lacking, clinical experience from the panel members suggests starting treatment with independent ACTs (defined as methods used to clear mucus and secretions from the airways that can be performed by an individual without the need for assistance from another person or specialised equipment). Adjuvant airway clearance devices may be considered to enhance sputum properties, facilitate consistent treatment, and increase adherence and tolerability [64]. These devices may not be equally accessible in low- and middle-income settings, and patients typically bear the costs due to limited coverage by health systems. Although the acceptability of remote delivery for this intervention is uncertain, it may offer an opportunity to enhance accessibility. Additionally, the panel supports implementing ACTs alongside an educational approach that identifies the benefits of this intervention and addresses barriers and facilitators to promote long-term adherence [66]. Finally, when inhaled mucoactive agents or bronchodilators are administered alongside ACTs, the timing of administration in relation to ACTs should be carefully managed to maximise treatment synergy.

There are no head-to-head studies comparing different ACTs, and the consensus is that no one technique is superior to others [18, 64]. Therefore, techniques should be chosen based on individual preference and effectiveness.

Monitoring/evaluation

Patients trained in ACTs should be periodically reviewed to ensure the techniques are still performed correctly, are suitable for patient needs and/or to modify techniques if the disease changes.

Research priorities

Large RCTs of ACTs in bronchiectasis would be desirable, although controlled trials of ACTs are complex since ACTs are standard of care and there are ethical considerations in withholding this treatment. Key research priorities in this area include:

1) Long-term impact of ACTs on exacerbation frequency (*e.g.* ⩾12 months).
2) Optimal strategies for delivering ACT training.
3) Effectiveness of virtual methods such as online training or video/remote training to deliver ACTs.
4) Additional benefits provided by airway clearance devices.
5) Whether exercise alone is as effective as ACTs in improving respiratory symptoms, and whether patients performing regular exercise also require ACTs [67].
6) The role, effectiveness and adaptability of ACTs during exacerbations, especially in relation to exacerbation severity and individual patient characteristics.

PICO Question 2: Mucoactive drugs

Should mucoactive drugs be used (compared with no mucoactive drugs) in adults with bronchiectasis?

Recommendations

We suggest to offer mucoactive treatments to patients with bronchiectasis where airway clearance has failed to control symptoms. *(Conditional recommendation for the intervention, very low certainty of evidence.)*

We suggest not to offer recombinant DNase to patients with bronchiectasis. *(Conditional recommendation against the intervention, very low certainty of evidence.)*

Remarks

- The choice of mucoactive treatment should be guided by the patient's comorbidities and concerns around treatment burden and tolerability.
- Mucoactive treatments are best delivered as part of a comprehensive airway clearance regimen, which includes personalised airway clearance instruction with or without devices, and regular physical exercise.

Summary of evidence

We included nine randomised trials investigating mucoactive treatments, including 12–52 weeks of inhaled mannitol [68, 69], 15 days of oral erdosteine [70], 2–24 weeks of aerosolised recombinant human DNase I [71, 72], 3–12 months of inhaled hypertonic saline (6% or 7%) [73–75] and 12 months of oral *N*-acetylcysteine [76]. In three randomised trials, testing mannitol, hypertonic saline and *N*-acetylcysteine, we found no significant difference overall in exacerbation frequency (MD −0.28 (95% CI −0.63–0.07)). We found no difference in exacerbation frequency rate ratio (0.99 (95% CI 0.80–1.23)) from two trials and no difference in the proportion of patients free of exacerbations during follow-up (OR 1.48 (95% CI 0.88–2.51)) from three trials [68, 74–76]. One study reported time to first exacerbation that was significantly prolonged with 400 mg inhaled mannitol compared with low-dose mannitol control twice daily for 52 weeks (hazard ratio (HR) 0.78 (95% CI 0.63–0.96)) [68]. There were no differences found in the odds of participants remaining free from hospitalisation during follow-up (OR 3.35 (95% CI 0.32–35.36)). Regarding quality of life measurements, in three studies overall there was a 2-point improvement in SGRQ total score with treatment (MD −2 (95% CI −3.6– −0.4)) and in one study a large improvement in the QoL-B respiratory symptoms domain was observed (MD −11.42 (−20.38– −2.46)). In one trial of 12 months of *N*-acetylcysteine, 24-h sputum volume was significantly lower, with a MD of −11.82 (95% CI −19.31– −4.33) mL between the treatment and placebo groups [76]. Across four studies, we found no significant differences in the percentage of participants experiencing at least one adverse event related to study medication in the treatment groups (OR 1.4 (95% CI 0.96–2.04)). No studies reported on impact on activities of daily living.

Justification of recommendation

Mucus in bronchiectasis is typically hyperconcentrated and viscous, impairing mucociliary clearance [77]. Mucus plugging, a common radiological feature, is associated with exacerbation risk and disease severity [15]. Oral mucoactive agents, such as carbocisteine or *N*-acetylcysteine, reduce mucus viscosity, although evidence is limited [12]. Nebulised hypertonic saline and inhaled mannitol hydrate mucus and stimulate cough to facilitate clearance. Mucoactive treatments may improve symptom burden and quality of life when used in addition to airway clearance and exercise. Despite limited evidence, our recommendation

prioritises improvements in quality of life and symptoms, and is supported by the lack of significantly increased adverse events. One study assessing inhaled mannitol suggests greater benefit in patients with more severe symptoms [51]. Highly symptomatic patients with poor quality of life could therefore be considered for mucoactive treatment. Inhaled mucoactive treatments may cause wheezing or bronchospasm. The use of pre-treatment bronchodilators can mitigate this risk. Notably, recombinant human DNase was ineffective and reduced forced expiratory volume in 1 s (FEV_1) in a previous trial; therefore, its use is not recommended [72].

Implementation considerations

An individualised approach should be adopted, taking into account symptom and treatment burden, feasibility, tolerability, and patient preferences. As nebulised hypertonic saline can cause bronchospasm, a test dose and pre-treatment with a bronchodilator, especially in patients with asthma or severe airflow limitation, are recommended. Issues related to device availability, cleaning requirements and replacement costs may increase treatment burden of inhaled therapies, as emphasised by patient representatives among the Task Force [78]. In this regard, high-efficiency, easy-to-clean nebulisers may be advantageous in resource-rich setting. Importantly, ACTs should be introduced before mucoactive therapy to ensure maximum treatment effectiveness [64].

Monitoring/evaluation

Mucoactive treatments are primarily prescribed to improve symptoms and quality of life. If no clinical benefit is evident after a reasonable trial period (*e.g.* 3 months), treatment should be discontinued.

Research priorities

Large RCTs using precision medicine approaches to target mucoactive treatments based on symptom burden and/or particular sputum characteristics (*i.e.* abnormal mucins, mucus properties or DNA content) are needed. Although recombinant human DNase proved ineffective in a trial published in 1998 [72], new insights into neutrophil extracellular traps and poor disease outcomes [79], as well as bronchiectasis endotypes [80], suggest that further research is needed to clarify whether specific subgroups of adults with bronchiectasis may benefit from recombinant human DNase. Mucociliary clearance targeting treatments, in contrast to antibiotics and anti-inflammatory treatments, have been neglected and the development of novel mucoactive agents should be a research priority in future.

PICO Question 3: Inhaled antibiotics

Should long-term inhaled antibiotics be used (compared with no long-term inhaled antibiotics) in adults with bronchiectasis?

Recommendations

We recommend to offer long-term inhaled antibiotics to patients at high risk of exacerbations and chronic infection with *P. aeruginosa* despite standard care. *(Strong recommendation for the intervention, moderate certainty of evidence.)*

We suggest to offer long-term inhaled antibiotics to patients at high risk of exacerbations and chronic infection with pathogens other than *P. aeruginosa* despite standard care. *(Conditional recommendation for the intervention, moderate certainty of evidence.)*

Remarks

- Patients at high risk of exacerbations include patients with a history of ⩾2 exacerbations in the prior year OR ⩾1 severe exacerbation OR 1 exacerbation plus severe daily symptoms.
- Inhaled antibiotics should be prescribed for a defined period and treatment response should be formally evaluated. If ineffective or poorly tolerated, it should be discontinued.
- Inhaled antibiotics are drug and device combinations; therefore, patients should be provided with an appropriate nebuliser along with the medication.
- Many clinicians would perform a supervised test dose of inhaled antibiotics because of the risk of bronchospasm.

Summary of evidence

We included 18 randomised trials for this question, noting that some manuscripts reported more than one trial within a single paper. Across 13 trials, inhaled antibiotics reduced exacerbation frequency by 20% compared with controls (rate ratio 0.80 (95% CI 0.70–0.92)) [20, 81–87]. Across 18 studies, there was a significant 15% reduction in the number of patients with ⩾1 exacerbation (risk ratio 0.85 (95% CI 0.76–

0.94)) [20, 81–92], frequency of severe exacerbations was reduced by 43% in eight studies (rate ratio 0.57 (95% CI 0.35–0.94)) [20, 81, 83, 91, 93, 94] and time to first exacerbation was prolonged in pooled data from 14 studies (HR 0.81 (95% CI 0.71–0.93)) in those receiving inhaled antibiotics. Regarding quality of life and symptoms, there was no significant improvement in the QoL-B respiratory symptoms score (MD 2.14 (95% CI 0.28–4.57)) [81–87] or SGRQ total score (MD −2.63 (95% CI −5.37–0.1)) [20, 84, 85, 90–93] with inhaled antibiotic treatment overall in 11 and eight studies, respectively. In 18 studies, an increase in antimicrobial resistance was found with a 1.96-fold higher risk of identifying bacterial isolates with antibiotic minimum inhibitory concentrations indicative of resistance in those receiving antibiotics (rate ratio 1.96 (95% CI 1.55–2.48)). There were no differences in numbers of participants reporting treatment-emergent adverse events in 15 studies (OR 1.04 (95% CI 0.81–1.35)) [20, 81–85, 87, 88, 90–93] and no differences in all-cause mortality (OR 1.04 (95% CI 0.57–1.89)) from 15 studies.

The certainty of evidence was rated as moderate overall. The majority evidence of comes from studies that included patients infected with *P. aeruginosa*, whereas evidence for patients without *P. aeruginosa* infection remains more limited.

Justification of recommendation

A strong recommendation was made for patients chronically infected with *P. aeruginosa*, based on clinically relevant reductions in exacerbation frequency, including severe exacerbations. A conditional recommendation was made for patients with other chronic infections, given the predominance of *P. aeruginosa* in the available meta-analysis and the availability of effective treatments, including long-term macrolides, in these patients. The recommendation prioritises the clinically relevant improvements in exacerbation outcomes, in the context of the poor outcomes experienced by patients with chronic *P. aeruginosa* infection, and is also informed by the lack of any significant increase in adverse events. The panel acknowledged the risk of antimicrobial resistance, which is important at the population level but is of uncertain significance for the individual patient in the context of inhaled antibiotics. Feedback from patients also supported a strong recommendation.

Previous guidelines recommended the use of long-term treatments such as inhaled antibiotics for patients with ⩾3 exacerbations per year [18]. The current wording of the recommendation reflects the understanding that the number of exacerbations in the previous year is an important risk factor for future exacerbations but is not the only risk factor [8, 46, 47, 51, 95]. Patients with a high burden of daily symptoms are also at high risk of future exacerbations, and the threshold to commence long-term treatments may be lower in patients with other important prognostic features [51, 55]. Clinical features associated with a higher risk of future exacerbations include *P. aeruginosa* infection, PCD, COPD, RA and sputum purulence [35, 36, 52, 57, 96]. The present recommendation, therefore, suggests that patients with ⩾2 exacerbations are likely to be at high risk of future exacerbations, but that some patients with a lower number of exacerbations with a high symptom burden may also benefit from preventative treatment. The threshold to commence treatment should be individualised taking into account the key risk factors in each individual patient as well as considerations around the risk–benefit balance, availability, cost and the burden of treatment.

Antimicrobial stewardship is a key consideration. Long-term antibiotic treatment should be used after other aspects of treatment have been optimised; therefore, other options such as airway clearance, vaccination against respiratory pathogens, treatment of underlying causes and comorbidities have been addressed.

Practical considerations

Inhaled antibiotic treatments have historically been given 1 month on and 1 month off by some clinicians. There is some evidence that continuous use of antibiotics provides sustained symptomatic benefit compared with cyclical treatment and no evidence that resistance is different [20, 81, 97, 98]. Some clinicians advocate the continuous use of antibiotics on this basis, but availability and cost considerations may also influence this.

Treatment burden is an important consideration for patients prescribed inhaled antibiotics, particularly in relation to administration time and cleaning of equipment, which may affect adherence [99]. In line with antimicrobial stewardship principles, inhaled antibiotics should be used where other measures have been ineffective to prevent exacerbations. There should be clear evidence of chronic bacterial infection of the airways and that other potential drivers of frequent exacerbations have been considered and addressed. Other important practical considerations are included in the remarks above. In addition to being provided with an appropriate nebuliser, patients and/or caregivers should be appropriately trained in its use and cleaning. Inhaled antibiotics are often taken alongside with other medications. The recommended sequence

of treatments, as described in the 2017 ERS bronchiectasis guidelines [18], would be to take bronchodilators first, followed by nebulised/inhaled mucoactive drugs, followed by performing airway clearance and then taking inhaled antibiotics to optimise deposition.

Monitoring and evaluation

Treatment should be prescribed for a defined period and re-evaluated. If no clear benefit is observed, inhaled antibiotics should be discontinued, and alternative strategies should be considered to reduce exacerbations. If benefit is observed treatment may be continued with monitoring for adverse effects. Long-term treatment is defined as a minimum of 3 months but most available data is over 12 months. The optimal period for evaluating response is not known, but as the primary benefit is on exacerbations many clinicians would re-evaluate efficacy after 1 year.

Research priorities

Although long-term inhaled antibiotics show efficacy in studies, predicting individual response remains a challenge, as reflected by inconsistent results across RCTs. The panel, therefore, recommends studies that should focus on precision approaches to optimise treatment selection. Key research questions include:

1) Can inflammatory or microbial biomarkers predict patients' response to inhaled antibiotics?
2) What is the best way of identifying patients at risk of future exacerbations?
3) What is the impact of inhaled antibiotics on antimicrobial resistance, and what, if any, are the clinical consequences of resistance on treatment efficacy and future outcomes.

PICO Question 4: Macrolides

Should long-term macrolides be used (compared with no long-term macrolides) in adults with bronchiectasis?

Recommendation

We recommend to offer long-term macrolides to patients at high risk of exacerbations despite standard care. *(Strong recommendation for the intervention, moderate certainty of evidence.)*

Remarks

- Macrolides are effective in a broad group of patients with bronchiectasis at high risk of exacerbations, including patients with chronic *P. aeruginosa* infection, patients with airway infection caused by other pathogens and those without evidence of airway infection.
- Macrolides should not be prescribed as monotherapy to patients with NTM infection. NTM infection should be excluded before initiating macrolide therapy.
- The most widely used long-term macrolide is azithromycin, typically at a dose of 250 mg daily or three times per week, or 500 mg three times per week.
- In view of the risk of adverse effects, patient education, baseline screening and appropriate follow-up are important when prescribing macrolides.

Summary of evidence

We included nine RCTs. Meta-analysis found a significant and highly clinically relevant 52% reduction in exacerbation frequency/rate (HR 0.48 (95% CI 0.37–0.62)) in those receiving macrolides compared with those who did not from four randomised trials [100–104]. In five randomised trials, a significant 36% lower risk of having exacerbations (risk ratio 0.64 (95% CI 0.46–0.89)) was found [100–103, 105, 106]. Two trials reported a significantly longer time to first exacerbation (HR 0.32 (95% CI 0.21–0.47)) [101, 102]. A clinically meaningful, significant improvement in SGRQ total score was found in seven studies, with an average improvement of 7.26 (MD −7.26 (95% CI −10.94– −3.59)) [100–102, 104, 106–108] in participants receiving long-term macrolides *versus* those in the comparator groups. There were no differences in the frequency of identification of antimicrobial-resistant organisms between participant groups across two studies (OR 1.08 (95% CI 0.22–5.19)) or in the odds of isolating a new pathogen (OR 0.82 (95% CI 0.41–1.63)) within two trials. In data from six studies, there was no significant increase in adverse events in those receiving macrolides (OR 0.86 (95% CI 0.53–1.39)) [100–102, 105, 107, 108]. In three smaller studies, reported mortality overall was low, with no differences between groups and one study also reported no differences in incidence of hospitalisation (OR 0.45 (95% CI 0.04–5.19)).

Justification of recommendations

A strong recommendation is supported by a highly clinically relevant reduction in exacerbations and a highly meaningful improvement in quality of life with long-term macrolide treatment [103]. The trials show no major safety concerns, and in studies of 6–12 months duration, antimicrobial resistance was not

identified as a significant issue. The largest studies included patients with ⩾1 exacerbation per year, and benefit was demonstrated across multiple patient subgroups, including those with low exacerbation frequency and the subgroup of patients with *P. aeruginosa* infection [103].

While previous guidelines recommended the use of long-term treatments such as macrolides for patients with ⩾3 exacerbations per year [18], the current wording of the recommendation reflects the recognition that past exacerbation frequency is a key, but not exclusive, predictor of future risk [8, 46, 47, 51, 95]. Patients with a high burden of daily symptoms are also at high risk of future exacerbations and, in such cases, the threshold for initiating long-term treatments may be lower [51, 55]. Clinical features associated with a higher risk of future exacerbations include *P. aeruginosa* infection, PCD, COPD, RA and sputum purulence [35, 36, 52, 57, 96]. The present recommendation therefore suggests that patients with ⩾2 exacerbations are likely to be at high risk of future exacerbations, but that some patients with a lower number of exacerbations with a high symptom burden or other risk factors may also benefit from preventative treatment. The threshold to commence treatment should be individualised, based on patient-specific risk factors, risk–benefit balance and treatment burden.

Practical considerations

Although no major safety concerns were identified in the trials, macrolides are not without risks and most studies carefully excluded patients at high risk of macrolide-related adverse events [100–102]. Prior to starting macrolide maintenance therapy, patients should be screened for NTM infection, QT time abnormalities and liver/kidney function abnormalities [109]. Patients should be warned about the possibility of ototoxicity, which usually manifests as tinnitus, hearing loss and vestibular dysfunction. Treatment should be discontinued if these symptoms occur. Many clinicians will perform ECG, urea and electrolytes, and liver function tests 2–3 weeks after initiation of macrolide maintenance treatment to monitor QT interval and liver/kidney function. However, the optimal monitoring strategy is not yet defined due to a lack of studies.

The optimal macrolide dosage has not been established. The largest trials used either azithromycin 250 mg daily or 500 mg three times per week, or erythromycin [100–102]. The observed efficacy of erythromycin suggests a class effect, although azithromycin is preferred due to better tolerability and the possibility of intermittent dosing [12]. Adverse effects appear larger in studies that use higher doses [101, 110] and clinicians may consider starting at the lowest effective dose (*e.g.* azithromycin 250 mg daily or three times per week, or 500 mg three times per week) [109].

Monitoring and evaluation

Patients on long-term macrolide therapy should be reviewed on an individualised basis to assess efficacy (*e.g.* number of exacerbations, symptoms) and side-effects. The optimal duration of macrolide therapy is unknown, with the longest studies being up to 12 months. Discontinuation may be considered after 1 year if no clear benefit is observed or, alternatively, if remission of exacerbations and symptoms is reached. In such cases, a careful discussion about the risks and benefits of discontinuation is needed due to the risk of relapse.

Research priorities

Key research questions in the field of long-term macrolide use include:

1) What is the long-term safety profile of macrolides beyond 12 months, including impacts on antimicrobial resistance, emergence of new pathogens and adverse effects?
2) Can macrolide treatment prescribed at early disease stage (*e.g.* mild bronchiectasis with non-frequent exacerbations but risk factors for progression) result in slowing disease progression or even in achieving remission?
3) What is the optimal monitoring strategy for adverse events? Do all patients require ECGs before and after macrolide initiation? Is NTM screening required for all patients or only for patients with high-risk clinical features? What is the value of baseline or follow-up audiology screening?
4) Can macrolides be safely discontinued in clinically stable patients with a low symptom and exacerbation burden?

PICO Question 5: Oral antibiotics

Should long-term non-macrolide oral antibiotics be used (compared with no long-term non-macrolide oral antibiotics) in adults with bronchiectasis?

Recommendation

The panel suggests NOT to offer long-term non-macrolide oral antibiotics as a first-line treatment to adult patients with bronchiectasis and a high risk of exacerbations. *(Conditional recommendation against the intervention, very low certainty of evidence.)*

Remarks

- Long-term non-macrolide oral antibiotics may have a role in specific situations where patients are at high risk of frequent exacerbations and other options such as long-term macrolides are contraindicated or have proven ineffective.

Summary of evidence

Two trials were included, investigating the use of amoxicillin, penicillin and oxytetracycline in patients with bronchiectasis [111, 112]. Meta-analysis was not possible and so the results of the individual studies are reported narratively. After adjusting for exacerbation frequency in the year before the study, no statistically significant difference in exacerbation rates was observed between the amoxicillin and placebo groups [111]. Furthermore, no clinically meaningful reduction in mortality was reported [112]. Some reductions in breathlessness and sputum volume were noted, although these effects were limited. Currie *et al*. [111] showed a 58% reduction in sputum volume after 32 weeks in the amoxicillin group compared with 19% in the placebo group. The Medical Research Council [112] found a 26% reduction in sputum volume in the penicillin group, 36% reduction in the oxytetracycline group and 24% reduction in the placebo group after 1 year. Finally, a slight increase in adverse events and the emergence of potentially pathogenic organisms, as well as a modest rise in antibiotic resistance, were observed in the treatment arms. However, meta-analyses were not feasible due to limited and inconsistently reported data. The trials are also hampered by small population size, questionable inclusion criteria and, sometimes, a low number of outcome events, resulting in very low certainty of evidence.

Justification of recommendation

The overall risk–benefit balance of long-term non-macrolide oral antibiotics appears to be unfavourable, given the lack of a clear reduction in exacerbations and other clinically relevant outcomes. The available studies are, however, hampered by small populations, unclear reporting of data, questionable inclusion criteria and, sometimes, a low number of events, resulting in very low certainty of evidence. Therefore, routine use of non-macrolide oral antibiotics is not recommended, as there is limited evidence, a risk of adverse effects and more effective first-line alternatives exist.

There are exceptional circumstances where non-macrolide maintenance antibiotics may be an appropriate treatment for patients with bronchiectasis. This includes in patients at high risk of NTM or regions with high NTM prevalence [16], or in patients unable to take macrolides due to adverse effects. Therefore, in cases where macrolides are contraindicated or ineffective, and there is clear evidence of infection in respiratory cultures, a trial of long-term, targeted non-macrolide antibiotic therapy may be justified.

Implementation considerations

Physicians and healthcare workers should be advised on the current lack of evidence supporting the use of non-macrolide, long-term antibiotics in bronchiectasis. These treatments should only be considered in patients unable to receive macrolides, with the understanding by healthcare professionals that current data only show limited reduction in shortness of breath and sputum volume.

Monitoring/evaluation

As with any long-term treatment, a formal evaluation of efficacy is recommended and therapy should be discontinued if ineffective.

Research priorities

RCTs on long-term, non-macrolide oral antibiotics are needed to establish if they reduce exacerbations and improve symptoms, and which patient populations are most likely to benefit.

Algorithm for long-term antibiotic treatment in patients with bronchiectasis

Figure 3 shows an algorithm for long-term antibiotic use in patients with bronchiectasis. The algorithm first emphasises antimicrobial stewardship, and that alternative treatments and optimisation of management should occur before long-term treatments are considered. Identification of patients at high risk of exacerbations include those with frequent prior exacerbations, severe symptoms, as well as severe exacerbations, while also considering additional risk factors for poor outcomes. In view of the greater

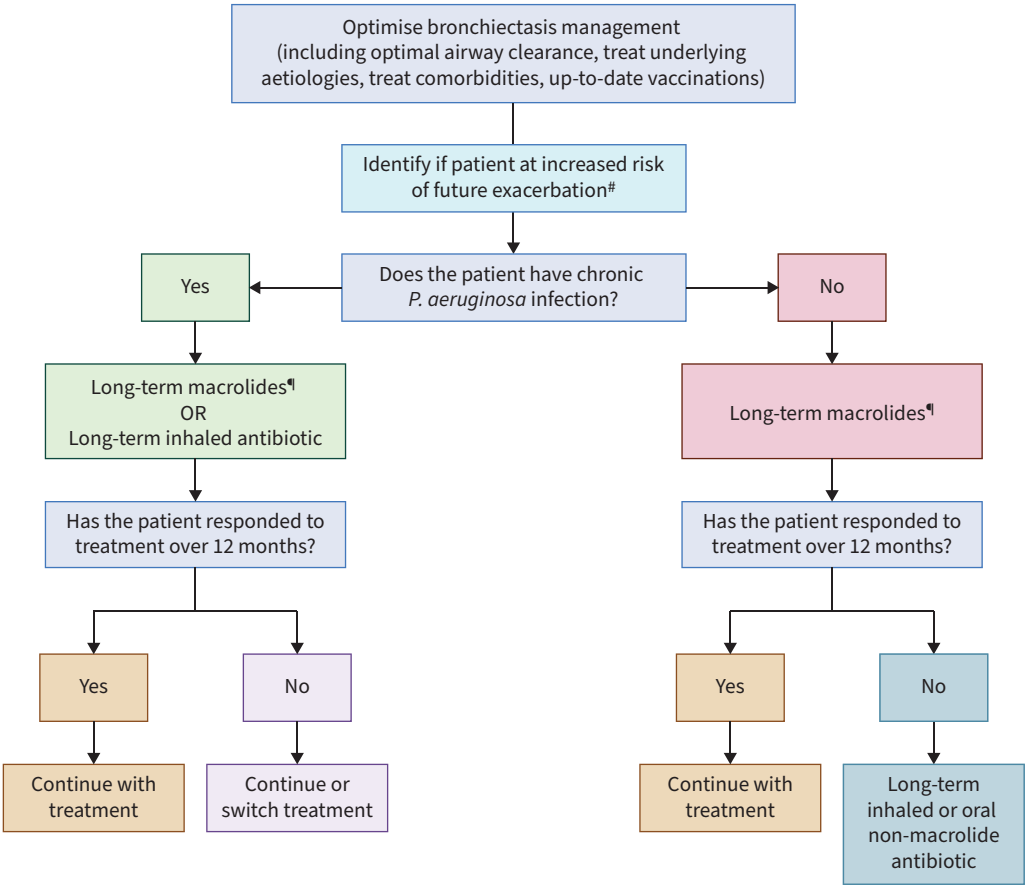

FIGURE 3 European Respiratory Society algorithm for long-term antibiotic treatment in patients with bronchiectasis. The identification of high-risk individuals is addressed in Narrative Question 1. Recommendations on long-term inhaled antibiotics and macrolides are addressed PICO Questions 2 and 3, respectively. Long-term oral antibiotics are also addressed in PICO Question 5. Note that while 12-month re-evaluation is suggested as justified in the text, earlier reassessment is needed, particularly in the case of adverse events or clinical deterioration. #: patients at high risk of future exacerbation if experiencing ⩾2 exacerbations per year, 1 exacerbation per year plus severe symptoms or ⩾1 severe exacerbation requiring hospitalisation per year; ¶: following exclusion of non-tuberculous mycobacteria. *P. aeruginosa*: *Pseudomonas aeruginosa.*

evidence for inhaled antibiotics in patients with *P. aeruginosa*, we recommend a different approach for patients with and without *P. aeruginosa* infection. Patients with *P. aeruginosa* may receive either a long-term macrolide or long-term inhaled antibiotic as first-line treatment, with the choice based on patient preference and an individualised assessment of risks. For patients without *P. aeruginosa* infection, macrolides are a clear first-line option (figure 3).

PICO Question 6: Eradication

Should eradication treatment be used for patients with isolation of a new pathogenic microorganism (compared with no eradication treatment)?

Recommendation

We suggest to offer eradication treatment to patients with a new isolation of *P. aeruginosa*. *(Conditional recommendation for the intervention, very low certainty of evidence.)*

Remarks

- A new isolation of *P. aeruginosa* may refer to the first time a patient has *P. aeruginosa* isolated or a further isolation following a prolonged period during which *P. aeruginosa* was not detected.

- Eradication practices vary both among panel members and globally. Some clinicians prescribe systemic antibiotics (*e.g.* a 2-week course) followed by a repeat sputum culture, discontinuing antibiotics if the sample is negative. Others would add inhaled antibiotics for 4 weeks to 3 months, without rechecking sputum cultures. The 2017 ERS bronchiectasis guidelines provide examples of different antibiotic strategies [18].

Summary of the evidence

No randomised trials comparing eradication with no eradication treatment were identified. The only available evidence comes from before-and-after observational studies assessing eradication success and clinical outcomes before and after the intervention. All studies examined *P. aeruginosa* eradication treatment. Six studies were identified: five observational studies and one randomised trial which evaluated two different eradication regimens; the randomised trial was treated as a before-and-after observational study for the purposes of analysis [113–118]. Pooled data from these studies indicate that eradication was achieved in ∼40% of patients at 12 months [119]. Three studies reported a reduction in exacerbations and/or hospitalisations during the year following the eradication intervention [113, 117, 118]. The certainty of evidence is considered very low, due to the observational nature of the studies, the lack of a control group and other limitations.

Justification of the recommendation

Despite limited available data, there is overwhelming evidence that chronic infection with *P. aeruginosa* is associated with increased mortality, exacerbations, hospitalisations and worse quality of life [52, 96, 120, 121]. Preventing chronic *P. aeruginosa* infection is, therefore, of high benefit to patients, and this was confirmed by our panel members with lived experience. The conditional recommendation reflects both the very low certainty of evidence and the concern that while 40% achieve eradication with the current treatments, it is unknown how many patients would achieve spontaneous clearance due to the lack of control groups across studies. The eradication treatment carries burden, particularly if inhaled antibiotics are used, and antibiotic use is associated with a risk of antimicrobial resistance and side-effects.

No evidence was identified for the eradication of organisms other than *P. aeruginosa* and implicit in the recommendation is that eradication is not recommended routinely for pathogens other than *P. aeruginosa*

Implementation considerations

The 2017 ERS bronchiectasis guidelines provide examples of antibiotic regimens for eradication which typically consist of 2 weeks of oral or intravenous antibiotics followed by 6 weeks to 3 months of inhaled antibiotics [18]. Practice varies in terms of the antibiotics used, and whether some clinicians will check sputum cultures after the systemic antibiotic phase and discontinue treatment if sputum is negative, while some clinicians will use inhaled antibiotics regardless of whether initial culture conversion is achieved after systemic antibiotics.

Monitoring and evaluation

Patients undergoing eradication treatment should have sputum cultures performed after the completion of therapy and at 1 year to confirm whether eradication was successful. Patients in whom eradication is not achieved should be managed as having chronic *P. aeruginosa* infection.

Research priorities

An RCT comparing *P. aeruginosa* eradication therapy *versus* symptomatic treatment only is needed to establish the long-term efficacy and safety of this practice. Studies utilising molecular techniques to detect *P. aeruginosa* should be performed to identify if the organism is truly eradicated or merely suppressed following treatment.

PICO Question 7: Inhaled corticosteroids

Should long-term inhaled corticosteroids be used (compared with no long-term inhaled corticosteroids) in adults with bronchiectasis?

Recommendation

We suggest not to offer long-term inhaled corticosteroids to patients with bronchiectasis who do not have coexisting COPD or asthma. *(Conditional recommendation against the intervention, low certainty of evidence.)*

Remarks

- Patients with bronchiectasis should be evaluated for the presence of coexisting asthma and COPD. The presence of bronchiectasis does not alter the recommendation to use inhaled corticosteroids (ICS) in patients with asthma or in a subset of patients with COPD. Suspected asthma or COPD should be appropriately investigated in patients with bronchiectasis.
- There is limited evidence suggesting that ICS may be beneficial in a subgroup of patients with bronchiectasis with elevated blood eosinophil counts who do not have asthma or other eosinophilic conditions. However, no recommendation on ICS use based on blood eosinophils is currently possible, and we recommend further research in this group.
- The use of ICS should be re-evaluated in patients without a clear indication. Discontinuation of ICS may be appropriate in some patients.

Summary of evidence

Six randomised trials were identified: one crossover study of beclomethasone dipropionate 1500 µg per day [122], RCTs of 400 µg budesonide twice daily, fluticasone 500 µg twice daily (two trials) [123–125], beclomethasone/formoterol 200/12 µg twice daily [126] and a randomised trial of 250 or 500 µg fluticasone propionate [127]. Three studies reported no overall differences in average number of exacerbations or number of participants with an exacerbation in the groups receiving ICS compared with those receiving no treatment or placebo (MD −0.2 (95% CI −0.57–0.16) and OR 0.89 (95% CI 0.24–3.26), respectively) [123, 125, 127]. There were no significant differences in 24-h sputum volume across three trials (MD −3.37 (95% CI −8.18–1.43) mL) [122–124, 127] or in FEV_1 in four trials (MD 0.03 (95% CI −0.19–0.12) L) [122, 124, 125, 127]. There were no significant effects identified for health-related quality of life: in two trials there were no differences in SGRQ total score (MD −3.54 (95% CI −8–0.92)) [125, 127] and in one study there was no change in QoL-B score (MD 3.7 (95% CI −9.59–16.99)) [126]. There was a significant increase in adverse events in four studies (OR 3.19 (95% CI 1.34–7.61)) in those receiving ICS compared with the respective control groups. There was no significant impact on the incidence of hospitalisation in one study (OR 0.20 (95% CI 0.02–1.90)) and no effect on mortality. No studies reported on occurrence of pneumonia or new NTM isolation.

Certainty of evidence was low as most critical outcomes, including exacerbations, quality of life and adverse events, were rated as low due to downgrading for factors including imprecision and biases, such as lack of blinding and premature trial termination.

Justification of the recommendation

The panel considered there is a lack of evidence of benefit of ICS and a risk of harms associated with this treatment. Adverse events of ICS are well known, and include an increased risk of pneumonia and NTM infection as well as a small but significant increase in systemic adverse effects of corticosteroids [128]. Between 20% and 30% of people with bronchiectasis have comorbid asthma or COPD [35, 129]. Treatment with ICS is recommended for most individuals with asthma, and for a subset of people with COPD who have elevated blood eosinophils and frequent exacerbations [130, 131]. There is no clear evidence that bronchiectasis should influence the decision to prescribe ICS in these groups [132].

Blood eosinophils require further investigation in bronchiectasis as a predictor of ICS efficacy. Around 20% of patients with bronchiectasis have blood eosinophil counts >300 cells·µL^{-1} in the absence of asthma or other eosinophilic conditions [133]. There are reports suggesting that in a subset of individuals with elevated blood eosinophils, ICS may be beneficial in improving quality of life and reducing exacerbations, but these data are from *post hoc* analyses and observational studies only, and prospective trials are needed [134].

Practical considerations

The use of ICS, with or without long-acting β_2-agonists, is widespread in patients with respiratory symptoms, and misdiagnosis of bronchiectasis as asthma or COPD is not uncommon [35, 129, 135, 136]. Many newly diagnosed patients with bronchiectasis are already receiving ICS, and the decision to continue or withdraw ICS when bronchiectasis is diagnosed requires consideration [137]. Factors supporting ICS withdrawal include absence of asthma or COPD, supported by established criteria, and low blood eosinophils [138]. Conversely, every effort should be made to correctly identify asthma in patients with bronchiectasis as ICS have demonstrated benefit in this group [129]. Misdiagnosis of COPD is also common in bronchiectasis, and the ROSE criteria, which define COPD–bronchiectasis associated in the presence of Radiological bronchiectasis, FEV_1/forced vital capacity <0.7 (Obstruction), appropriate Symptoms and appropriate Exposures (typically smoking), may support in appropriate diagnostic labelling [138].

Monitoring and evaluation

If ICS are used, treatment effectiveness should be formally evaluated after a defined period of time, and ICS discontinued if ineffective or if adverse events outweigh potential benefits.

Research priorities

An RCT of ICS in bronchiectasis is needed to establish if it can reduce exacerbation frequency and whether blood eosinophil counts predict treatment response. Since ICS is widely used in bronchiectasis, it may be possible to perform an RCT of withdrawal of ICS. Further studies are required to understand the role of type 2 inflammation in bronchiectasis (not exclusively limited to blood eosinophils) and whether type 2 biomarkers can guide treatment.

PICO Question 8: Pulmonary rehabilitation

Should pulmonary rehabilitation be used (compared with no pulmonary rehabilitation) in adults with bronchiectasis?

Recommendation

We recommend that patients with breathlessness and/or impaired exercise capacity should be offered pulmonary rehabilitation. *(Strong recommendation for the intervention, very low certainty of evidence.)*

Remarks

- The educational component of pulmonary rehabilitation should ideally be bronchiectasis specific and include discussion of airway clearance strategies.
- Patients with bronchiectasis should be encouraged to undertake regular physical activity, given its multiple health benefits.

Summary of evidence

We included seven studies. Compared with usual care, the group of patients with bronchiectasis undergoing pulmonary rehabilitation showed a significant improvement in exercise capacity after the intervention measured by distance covered during the 6-min walk test (6MWT) in three studies (MD 41.13 (95% CI 28.74–53.53) m) [139–141] and measured by the incremental shuttle walk test (ISWT) in four studies (MD 72.83 (95% CI 51.44–94.23) m) [141–144]. These differences exceed the MCID. At follow-up, one study showed no difference in 6MWT distance (MD −6.74 (95% CI −29.61–16.13) m) [141] and two trials found no difference in ISWT distance (MD 39.41 (95% CI −33.02–111.83) m) [141, 144]. After the intervention, in two studies participants undergoing pulmonary rehabilitation achieved a significantly higher number of steps per day than those in the usual care groups (MD 1443 (95% CI 176–2709)) [140, 142], although in one study there was no difference in steps at the end of follow-up (MD 18.1 (95% CI −2284.05–2320.25)) [142]. In two studies, breathlessness measured using the mMRC scale was significantly reduced after the intervention (MD −0.85 (95% CI −1.42– −0.28)) [139, 140]. Health-related quality of life measured by SGRQ total score was significantly improved with pulmonary rehabilitation; in two studies on average the SGRQ score was 9.21 points lower (95% CI −13.2– −5.22 points) after the intervention [139, 144], and in one study 8.6 points lower (95% CI −14.34– −2.86 points) in the rehabilitation group compared with the usual care group at the end of follow-up [144]. There was no difference in quality of life measured by the LCQ in two studies after the intervention (MD 1.2 (95% CI −0.95–3.35)) or at the end of follow-up (MD 0.98 (95% CI −0.32–2.29)) [141, 144], and no difference in QoL-B respiratory domain score in one study after the intervention (MD 3.6 (95% CI −3.18–10.38)) [142]. In one study, there was a significant 74% reduction in the odds of a participant experiencing ⩾1 exacerbation during follow-up in the pulmonary rehabilitation group compared with the usual care group (OR 0.26 (95% CI 0.08–0.81)) [141]. No significant impact on mortality was observed. No studies reported on occurrence of severe exacerbations.

Overall, there is a substantial benefit of pulmonary rehabilitation in the short term, but most benefits are not sustained during follow-up distant from the intervention.

The certainty of evidence was rated very low due to downgrading based on risk of bias, inconsistency and imprecision for many key outcomes.

Justification of recommendation

The recommendation is justified by consistent evidence of improvements in quality of life and exercise capacity. Despite the very low certainty of evidence, the strong recommendation is supported by the unequivocal improvement in functional capacity, and consistent results despite small sample sizes.

Implementing pulmonary rehabilitation requires substantial investment in resources and trained health professionals, which significantly increases the overall programme costs.

Implementation considerations

Effective implementation of pulmonary rehabilitation requires a multifaceted approach to tackle the many implementation pitfalls such as geographic inaccessibility, infrastructure, funding and standardisation [145, 146]. Many rehabilitation programmes are designed primarily for COPD, and the educational component may not be optimised for patients with bronchiectasis. As bronchiectasis becomes increasingly recognised, the feasibility of tailoring programmes to patients with bronchiectasis is expected to improve. Previous guidelines address the delivery of pulmonary rehabilitation [147–149].

Monitoring/evaluation

In order to monitor rehabilitation quality and patient evolution, an official ATS/ERS policy statement advises that clinical outcomes must be measured for individual patients and include a standardised assessment of a patients' functional exercise capacity, dyspnoea and health status [147, 148]. Additionally, evaluations of other outcomes are suggested, such as the impact pulmonary rehabilitation has on psychological comorbidity and measurement of the patient's experience.

Research priorities

Future studies should explore how to individualise pulmonary rehabilitation across different settings (home-based, outpatient clinics, hospital-based, community-based and tele-rehabilitation) as well as to evaluate digital tools that could replace face-to-face rehabilitation. Research should also try to assess the impact of initiating pulmonary rehabilitation during or immediately after an exacerbation. Finally, pragmatic strategies to sustain the benefits of pulmonary rehabilitation should also be a research priority.

Narrative Question 2

What diagnostic tests and interventions are currently recommended/used for managing exacerbations?

We suggest the following diagnostic tests be performed during exacerbations. *(Conditional recommendation for the intervention, very low certainty of evidence based on a narrative review of evidence.)*

Recommendations in current guidelines regarding diagnosis and treatment of exacerbations endorsed by the panel:

- An exacerbation is defined as a worsening of symptoms that exceeds day-to-day variability and requires a change in management. Core symptoms of exacerbation include a change in cough, sputum volume and/or consistency, sputum purulence, dyspnoea and/or exercise intolerance, fatigue or malaise, and haemoptysis [150]. Addition clinical features are fever, wheezing, general discomfort, anorexia, weight loss, pleuritic chest pain and changes on chest examination [18, 95, 150].
- Features of a severe exacerbation (defined as requiring hospitalisation or intravenous antibiotic treatment) may include tachypnoea, acute or acute-on-chronic respiratory failure, a significant decline in oxygen saturation or respiratory function, hypercapnia, haemoptysis, new onset of cyanosis, new signs of cor pulmonale, haemodynamic instability and/or impaired cognitive function [18, 95, 151].
- At the onset of an exacerbation, a sputum sample for microbiology should ideally be obtained before initiating antibiotic treatment [18, 95, 151].
- Sputum culture should be repeated, where possible, if there is no response to the initial antibiotic treatment [95, 151, 152].

We suggest the following interventions to be performed during exacerbations. *(Conditional recommendation for the intervention, very low certainty of evidence based on a narrative review of evidence)*:

Recommendations in current guidelines regarding interventions endorsed by the panel:

- Antibiotics should be prescribed for an exacerbation, guided by previous microbiology results, local susceptibility patterns and clinical severity [18, 95, 151, 152].
- An adult bronchiectasis self-management plan should include guidance on recognising exacerbations. Providing selected patients the ability to self-administer antibiotics at home with appropriate instruction and education may allow more prompt treatment [18, 95, 151, 152].
- Patients not responding promptly to oral antibiotics or showing signs of a severe exacerbation should be reviewed to determine if there is a need for a change in treatment, intravenous antibiotic treatment and/or hospitalisation [95].

- Airway clearance regimens may need to be adapted in frequency, intensity and technique during an exacerbation [64, 95].
- In general, a 14-day antibiotic course is considered standard, especially in severe exacerbations or in patients with *P. aeruginosa* infection. Shorter courses may be appropriate in patients with mild bronchiectasis, those with infection due to pathogens more sensitive to antibiotics (*e.g. Streptococcus pneumoniae*) or patients with a rapid return to baseline symptoms during treatment [18, 95, 151].

Summary of evidence

Exacerbations are a major cause of morbidity, diminished quality of life and increased mortality in bronchiectasis, making their prevention and management a clinical priority [150]. The inherent complexity in defining an exacerbation complicates its diagnosis and management. Moreover, the evidence supporting diagnostic approaches and interventions in current guidelines is largely based on expert opinion and established clinical practice rather than high-quality trials, resulting in an overall low certainty of evidence [18, 150, 152–154]. Evidence suggests that in most exacerbations there is no change in airway pathogens from stable state and antibiotic treatment is aimed to reduce symptoms, presumably by reducing the bacterial load rather than an attempt to eradicate the chronic infection [80, 120]. Viruses are a common cause of bronchiectasis exacerbation [80, 155]. Routinely screening for viruses in bronchiectasis has not been recommended by any guideline to date. Testing, particularly in inpatients presenting with acute respiratory tract infections, is common and may influence management if severe acute respiratory syndrome coronavirus 2 or influenza is detected [156, 157].

Supplementary table S1 lists documents that contributed to the review of the evidence.

Justification of recommendation

Despite the very low certainty of evidence, the recommendations are justified as many of the suggested practices are already routinely implemented in clinics and hospitals managing patients with bronchiectasis. While specific antibiotic regimens are not detailed due to variations in local practice and resistance patterns, general principles for management of exacerbations can still be established to guide clinical decision making.

Implementation considerations

The implementation of these recommendations is expected to be straightforward, as they are generally inexpensive and already widely integrated into clinical practice. Given their broad acceptance and routine use in most settings, additional resource allocation or infrastructural changes are unlikely to be necessary for widespread adoption.

Monitoring/evaluation

Exacerbations are common and important events in the natural history of bronchiectasis. Monitoring and evaluation should prioritise assessing their frequency, severity and response to interventions. Prevention of exacerbations is a major priority; therefore, in addition to the acute management of exacerbations, patients should be reviewed to determine if they are at high risk of future exacerbations, and preventative measures implemented to reduce future risk.

Research priorities

Future research should be focused on the following topics:

1) Assessing the presence, severity and evolution of bronchiectasis exacerbations.
2) Determining the optimal antibiotic management, especially regarding monotherapy *versus* dual antibiotics and evaluating the role of inhaled antibiotics during exacerbations.
3) Investigating the role of non-antibiotic treatments and identifying causes of exacerbations other than bacterial infection.
4) Establishing the optimal duration of antibiotic treatment particularly for outpatients.
5) Identification of biomarkers that can allow shortening or individualising of antibiotic treatment duration.

Narrative Question 3

What investigations and treatments are currently recommended in a patient with bronchiectasis who is rapidly deteriorating in terms of symptoms or exacerbations?

We suggest the following investigations and management in a deteriorating patient. *(Conditional recommendation for the intervention, very low certainty of evidence based on a narrative review of evidence.)*

Recommendations in guideline literature on investigations in the deteriorating patient endorsed by the panel:

- Clinical deterioration, including increasing exacerbation frequency and/or severity, worsening of symptoms and/or rapid decline in lung function, should result in a comprehensive re-evaluation of the patients and their treatment [18, 95].
- Adherence to both ACTs and/or pharmacological treatment should be evaluated [18, 64, 95].
- Underlying diseases other than bronchiectasis should be reviewed to ensure they are being adequately treated [18, 95].
- Investigation for specific conditions known to be associated with deterioration (*e.g.* ABPA, NTM infection or infection with a new pathogen) should be considered [5, 18, 95].
- Early diagnosis of bronchiectasis, accurate identification and treatment of its underlying cause, adequate management of chronic airway infection, and interventions to prevent exacerbations and control disease may delay disease progression [2, 18, 95, 151].
- Repeat chest computed tomography imaging can help to identify several potential causes of deterioration [95].
- Repeat testing for NTM should be performed when there are suggestive clinical or radiological features of NTM infection, particularly in those who deteriorate despite appropriate antibiotics [6, 95].

Recommendations in guideline literature on treatments endorsed by the panel:

- Deteriorating patients who are not already under the care of a bronchiectasis specialist should be referred to a respiratory clinic with expertise in bronchiectasis [95].
- Current treatment should be reviewed and optimised using a "treatable traits" approach. This includes, but is not limited, to treatment directed at the underlying aetiology of the patient's bronchiectasis, airway clearance and mucoactive treatments, vaccination status, long-term (inhaled or oral) antibiotic treatment, *P. aeruginosa* eradication treatment, long-term inhaled bronchodilator and corticosteroid treatment, pulmonary rehabilitation, oxygen therapy and non-invasive ventilatory support where appropriate [2, 18, 95, 151, 152].
- Lung resection may be considered in highly selected patients with localised disease whose symptoms are not controlled by medical treatment optimised by a bronchiectasis specialist [18].
- Early referral for lung transplantation is essential in patients with progressive disease despite optimal medical management. This may include rapidly declining FEV_1 or FEV_1 <30% predicted and/or arterial carbon dioxide tension (P_{aCO_2}) >50 mmHg [18, 95].

Summary of evidence

Deterioration in patients with bronchiectasis is a critical concern associated with substantial morbidity and mortality, making its management a high priority. While previous guidelines did not explicitly define or address rapidly deteriorating patients, they provided indirect guidance on managing patients with worsening symptoms [18, 95]. Given the serious clinical implications, ensuring that these patients receive timely investigation, treatment adjustments and specialist referrals is a fundamental aspect of care.

Current practice for deteriorating patients remains heterogeneous across healthcare providers, as no globally uniform definition of "deterioration" or "disease progression" exists. Typically, patients experiencing rapid worsening of symptoms are referred to a specialist clinic, where their treatment regimen is re-evaluated and critically assessed. Key aspects of current care include baseline testing such as chest imaging, lung function and sputum microbiology, re-evaluation of aetiology, and adjustment of current treatments and preventive strategies. However, important gaps in current practice include treatment adherence assessment, which should be a routine component of patient evaluation, and a shared definition of "deterioration", which is currently inconsistent and variable among healthcare providers [18, 95].

Supplementary table S1 lists documents that contributed to the review of the evidence.

Justification of recommendations

Rapid deterioration in patients with bronchiectasis represents a critical aspect of the disease spectrum, necessitating timely recognition and appropriate management. While most current guideline literature, with the exception of the British Thoracic Society guidelines [95], does not provide specific guidance for the deteriorating patient, many existing recommendations are applicable to those experiencing increasing exacerbations or worsening symptoms and we therefore extracted these recommendations. These include guidance on follow-up strategies, treatment optimisation and prevention measures to mitigate disease progression [18, 95, 152].

The accumulated evidence supports early investigation and proactive treatment of patients who have deterioration. By applying these general principles from existing guidelines, clinicians can ensure that deteriorating patients receive timely and individualised management, potentially reducing morbidity and improving long-term outcomes.

Implementation considerations

As with all aspects of bronchiectasis care, the approach to the deteriorating patient should be personalised and adapted based on the nature of the deterioration, the presenting signs and symptoms, and patients' treatable traits. The approach to deteriorating symptoms and reduced lung function may be different, as will specific situations, such as a marked increase in haemoptysis, worsening shortness of breath requiring oxygen or non-invasive ventilation and recurrent exacerbations due to chronic bacterial infections. Figure 4 shows a general approach to the deteriorating patient (the RAPID approach), which needs to be adapted to each individual patient's situation.

Monitoring/evaluation

Monitoring and evaluation should focus on early identification and timely intervention for patients experiencing disease deterioration, as this is a common feature of bronchiectasis. Regular clinical assessment, symptom tracking and objective investigations should be prioritised to detect worsening conditions and guide appropriate treatment. Key aspects of monitoring include evaluating exacerbation frequency, response to treatment, microbiology, respiratory function decline and increased need for oxygen or ventilatory support.

R **Recognise and refer**
- Recognise the deteriorating patient#
- Refer to or consult with a bronchiectasis specialist

A **Assess**
- History and physical examination
- Adherence to airway clearance and/or pharmacological treatment
- Newly developed or worsening comorbidity
- The presence of new or evolving treatable traits

P **Perform**
- A review of airway clearance by an experienced respiratory physiotherapist
- A high-resolution computed tomography scan of the chest
- Sputum culture for bacteria, fungi and mycobacteria
- Bronchoscopy if sputum cannot be obtained or culture results are inconclusive
- Tests to reassess underlying causes such as allergic bronchopulmonary aspergillosis
- A full pulmonary function assessment

I **Initiate**
- Antibiotic treatment for infection
- Eradication therapy for *Pseudomonas aeruginosa* where appropriate
- Targeted treatment for non-tuberculous mycobacteria or fungal lung infections
- Disease-specific therapy for newly diagnosed causes of bronchiectasis
- Updated strategies for airway clearance and exercise tolerance
- New long-term maintenance treatments (*e.g.* inhaled antibiotics, macrolides) when indicated by the present guidelines

D **Deal with complications**
- Malnutrition: referral to a dietician; supplemental feeding
- Haemoptysis: bronchial artery embolisation or surgical resection in selected cases, following multidisciplinary discussion with a thoracic surgeon experienced in bronchiectasis
- Persistent or high-burden infections unresponsive to antibiotics: detailed imaging
- Respiratory failure: supplemental oxygen; non-invasive ventilation; referral for lung transplantation

FIGURE 4 RAPID: the rapidly deteriorating patient treatment algorithm [2, 5, 6, 18, 64, 95, 150–152]. #: persistent symptom worsening, increased frequency and/or severity of exacerbations/hospitalisations, progressive lung function decline, worsening radiological findings, and a substantial impairment in quality of life.

Research priorities

Future research should focus on:

1) Improving diagnostic tools to enable faster identification, severity assessment and objective follow-up of deteriorating patients with bronchiectasis.
2) Determining the optimal time-point for hospitalisation referral, as well as referral for surgery or lung transplantation.
3) Establishing strategies for measure end-of-life care and palliative management in patients with advanced bronchiectasis.

Other treatments

At the time of writing, a novel anti-inflammatory treatment targeting neutrophilic inflammation, dipeptidyl-peptidase-1 (DPP-1) inhibition, has shown reduced exacerbations and reduced lung function decline in a 12-month phase 3 trial [158], building on the results of several positive phase 2 trials [159–162]. The phase 3 trial enrolled patients with bronchiectasis and a history of ⩾2 exacerbations in the previous year. DPP-1 inhibition is likely to have a role in the future management of patients with bronchiectasis at high risk of exacerbations. As this therapy is not available and has not been approved by regulatory authorities at the time of writing, no recommendation is currently possible but this treatment is planned to be addressed in an update of the ERS bronchiectasis guidelines in 2026.

Discussion

Bronchiectasis remains a disease with a high unmet need. The evidence base has progressed significantly since the last ERS bronchiectasis guidelines in 2017 facilitated a number of important changes in recommendations [18]. New recommendations are issued for the first time on severity of disease, comorbidities and treatable traits, and provide detailed summaries of existing guidance on exacerbation management and the deteriorating patient. Substantial changes are made to other aspects of management. Testing for underlying causes, airway clearance, macrolide antibiotics and inhaled antibiotics were all given a conditional recommendation in 2017, and are given a strong recommendation in the present guidelines. This reflects a strengthened evidence base, and should result in changes in clinical practice to more proactively use these interventions. For patients with chronic *P. aeruginosa* infection, macrolides were a second-line treatment after failure of an inhaled antibiotic in the 2017 guidelines, but are a first-line treatment alongside inhaled antibiotics in the 2025 guidelines as a result of improved evidence for both interventions [97, 103]. A key change in the 2025 guidelines is the introduction of individualised risk assessment of patients, where the previous guidelines suggested initiating treatments in patients with ⩾3 exacerbations per year. Registry data suggests that preventative treatments are generally underutilised in people with bronchiectasis [12, 21, 137, 163, 164]. The burden of disease is high, and many patients, including those with <3 exacerbations per year, are at high risk of exacerbation and deterioration. Although it is essential to avoid indiscriminate use of antibiotics, frequent exacerbations promote disease progression and place patients at risk of antimicrobial resistance due to frequent systemic antibiotic treatments. The present guideline promotes a more proactive, patient-centred approach to preventative treatment based on identifying patients with high disease activity, and therefore at high risk of progression, and treating before severe deterioration occurs. Elements contributing to the perception and evaluation of disease activity, by both clinicians and patients, usually include the frequency, severity and impact on quality of life of daily symptoms and exacerbations, the trajectory of lung function over time, as well as some clinical or radiological features such as sputum purulence and the presence of mucus plugs on imaging. Establishing clear definitions of disease activity and disease control will be helpful in future to guide treatment strategies.

Bronchiectasis is a rapidly developing field and it is hoped there will be effective new therapies in the next few years. At present, the 2025 guidelines emphasise the importance of “doing the simple things well” and focusing on identifying the underlying cause, airway clearance and appropriate pharmacotherapy. Adherence to these guideline recommendations should be evaluated in future through collecting data on the proportion of patients receiving appropriate testing and treatment [65], to achieve the ultimate goal of this document which is to promote improved treatment for patients with bronchiectasis worldwide.

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This document was endorsed by the ERS Executive Committee on 5 September 2025.

A lay summary of this guideline can be found at https://europeanlung.org/en/information-hub/guidelines/managing-bronchiectasis-in-adults-2025/.

The guidelines published by the European Respiratory Society (ERS) incorporate data obtained from a comprehensive and systematic literature review of the most recent studies available at the time. Health professionals are encouraged to take the guidelines into account in their clinical practice. However, the recommendations issued by this guideline may not be appropriate for use in all situations. It is the individual responsibility of health professionals to consult other sources of relevant information, to make appropriate and accurate decisions in consideration of each patient's health condition and in consultation with that patient and the patient's caregiver where appropriate and/or necessary, and to verify rules and regulations applicable to drugs and devices at the time of prescription.

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