Clinical guideline

CHRONIC SUPPURATIVE LUNG DISEASE AND BRONCHIECTASIS IN CHILDREN AND ADULTS IN AUSTRALIA AND NEW ZEALAND

Chang AB,1,2 Bell SC,1,3,4 Torzillo PJ,5,6 King PT,7,8 Byrnes CA,9,10 Maguire GP,11, Holland AE,12,13 O’Mara P,15 Grimwood K;16 and the extended voting group*

1Queensland Children’s Medical Research Institute, Brisbane; and 2Child Health Division, Menzies School of Health Research, Charles Darwin University, Darwin; 3The Prince Charles Hospital; Brisbane and 4School of Medicine, University of Queensland; 5Nganampa Health Council, Alice Springs and 6Royal Prince Alfred Hospital, University of Sydney, Sydney; Departments of 7Respiratory and Sleep Medicine and 8Medicine, Monash Medical Centre, Monash University, Melbourne; 9Department of Paediatrics, University of Auckland; and 10Starship Children’s Hospital, Auckland, New Zealand; 11Baker IDI Aboriginal Health Program, Alice Springs and School of Medicine and Dentistry, James Cook University, Cairns, QLD Australia; 12Dept of Physiotherapy, Alfred Hospital, 13Dept of Physiotherapy, La Trobe University, Melbourne; and 14Institute for Breathing and Sleep, Melbourne; 15Dept of General Practice and The Wollotuka Institute, University of Newcastle; 16Griffith University and Gold Coast University Hospital, Gold Coast.

*The extended voting group (alphabetical order): Jenny Alison (Physiotherapist, University of Sydney), Chris Cull (lay consumer, Brisbane), Bart Currie (Adult Infectious Disease Physician, Menzies School of Health Research, Darwin), Inge Gardner (lay consumer, Darwin), Peter Holmes (Adult Respiratory Physician, Monash Medical Centre, Melbourne), Cameron Hunter (Adult Respiratory Physician, Royal Hobart Hospital, Hobart), John Kolbe (Adult Respiratory Physician, Auckland University), Li Landau (Paediatric Respiratory Physician, Perth), Carolyn Maclennan (General Paediatrician, Flinders Uni, Adelaide) Malcolm McDonald (Adult Infectious Disease Physician, James Cook University, Cairns), Peter Morris (General Paediatrician, Menzies School of Health Research, Darwin), Caroline Nicolson (Physiotherapist, Alfred Hospital, Melbourne), Helen Petsky (Respiratory Nurse Consultant, Royal Children’s Hospital, Brisbane), Naveen Pillarisseti (Paediatric Respiratory Physician, Starship Children’s Hospital, Auckland), Emma Reynolds (Physiotherapist, Starship Children’s Hospital, Auckland), David Serisier (Adult Respiratory Physician, Mater Adult Hospital, Brisbane), Frank Thein (Adult Respiratory Physician, Box Hill Hospital, Melbourne), Peter van Asperen (Paediatric Respiratory Physician, Children’s Hospital at Westmead, Sydney), Lesley Voss (Paediatric Infectious Disease Physician Starship Children’s Hospital, Auckland), Conroy Wong (Adult Respiratory Physician, Middlemore Hospital, Auckland, NZ).
Abbreviations:
c-HRCT  Chest high-resolution computed tomography
CF       Cystic fibrosis
COPD    Chronic obstructive pulmonary disease
CSLD    Chronic suppurative lung disease
FEV\textsubscript{1} Forced expiratory volume in 1 second
ICS     Inhaled corticosteroids
HTLV-1 Human T-cell lymphotrophic virus 1
MDCT    Multi-detector computed tomography
NTM     Non-tuberculous mycobacteria
NTHi    non-typeable \textit{Haemophilus influenzae}
NZ      New Zealand
\textit{Pa} \textit{Pseudomonas aeruginosa}
QoL     Quality of life
RCT     Randomised controlled trial
rhDNase Recombinant human deoxyribonuclease

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ABSTRACT

- Guidelines for managing chronic suppurative lung disease (CSLD) and bronchiectasis in Australian and New Zealand children and adults were updated (latest search date Oct 2013) based on systematic reviews, multi-disciplinary meetings and a modified Delphi process.
- Diagnosis of bronchiectasis requires a chest high-resolution computed tomography scan, preferably using multi-detector scans. Child-specific criteria and protocols are recommended.
- CSLD/bronchiectasis should be diagnosed early and appropriate investigation and treatment instigated. This includes planned coordination of care among healthcare providers, and specialist evaluation to confirm diagnosis, investigate aetiology, assess baseline severity and to develop individualised management plans, including self-management when appropriate.
- Consider a chest CT scan in adults with severe COPD and those with recurrent exacerbations.
- Intensive treatment seeks to improve symptom control, reduce exacerbation frequency, preserve lung function, optimise quality of life and enhance survival.
- All exacerbations require treatment.
- Antibiotic selection is based upon lower airway culture results, local antibiotic susceptibility patterns, clinical severity and patient tolerance. Patients with severe exacerbations and/or not responding to outpatient therapy are hospitalised for more intensive treatments, including intravenous antibiotics.
- Ongoing care requires monitoring for complications and co-morbidities.
- Airway clearance manoeuvres and regular exercise are encouraged, nutrition optimised, environmental pollutants (including tobacco smoke) avoided and vaccines administered following national immunisation schedules.
- Long-term antibiotics, inhaled corticosteroids, bronchodilators and mucoactive agents may be individualised, but are not recommended routine therapy.
- Before starting macrolides in selected patients, collect sputum for mycobacterial cultures and perform an electrocardiogram.
- Although Indigenous people living in rural-remote regions provide particular challenges, the objective of delivering best practice treatment remains paramount.
INTRODUCTION
Since the previous guidelines on managing chronic suppurative lung disease (CSLD) and bronchiectasis,1,2 the increasing trend in the health burden of CSLD/bronchiectasis has been recognised in both Indigenous and non-Indigenous settings in Australia, New Zealand (NZ) and worldwide.2,3,4,5 However, delays in diagnosis still occur in children6 and adults.5,7 It is likely that many with bronchiectasis remain undiagnosed and untreated, risking premature and accelerated pulmonary decline.2 This guideline presents an update from previous recommendations1,2 for managing CSLD/bronchiectasis (unrelated to cystic fibrosis, CF) in children and adults in Australia and NZ, including urban and rural-remote Indigenous people. Readers are referred to the former guideline6 for previously used references and definitions. This update provides an overview, targeted at primary and secondary care, and is not intended for individualised specialist care. As with all guidelines, it does not substitute for sound clinical judgement, particularly when addressing such a phenotypically heterogenous condition as bronchiectasis.8 Table-1 outlines the process undertaken by the writing group. The recommendations are also published in the Medical Journal of Australia.8

OBJECTIVES
To:
1. Increase awareness of CSLD/bronchiectasis in children and adults;
2. Encourage earlier and improved diagnosis and management of CSLD/bronchiectasis;
3. Present an updated guideline relevant to Australian and New Zealand settings.

BACKGROUND ON BRONCHIECTASIS AND CSLD
There remain little data on the incidence and prevalence of CSLD/bronchiectasis (NZ incidence in children aged ≤14-years=3.7/100,000;10 prevalence in Central Australian Indigenous people: children aged ≤15-years=1470/100,000 based on community data;2 adults=103/100,00 based on adults were hospitalised11) recently published Australian annual hospitalisation rates for bronchiectasis as a principal diagnosis demonstrate a steady increase between 1998–99 to 2011–12 (14 to 21 per 100,000 population respectively) (www.aihw.gov.au/bronchiectasis). The increasing trend is a worldwide phenomenon with some countries reporting childhood fatalities,5 and a growing appreciation of economic cost.3 Recent data in a Central Australian adult hospitalised cohort reported 34.2% of the cohort died (over ensuing 5-10 years) at a median age of 42.5-years.11

Bronchiectasis can be misdiagnosed or co-exist with other chronic respiratory diseases. When present the prognosis is worse e.g. mortality increases in those with both chronic obstructive pulmonary disease (COPD) and bronchiectasis (hazard ratio=2.54; 95%CI 1.16-5.56).4 Since between 29-50% of people with COPD4 and as many as 40% of newly referred patients with difficult to control asthma and a chronic cough have bronchiectasis,11 it is likely that many with chronic respiratory symptoms due to CSLD/bronchiectasis remain undiagnosed. Also, complications and co-morbidities associated with bronchiectasis extend beyond the respiratory system and include cardiac and psychological effects.2

DEFINITIONS AND THEIR LIMITATIONS
The definitions of CSLD and bronchiectasis include overlapping symptoms and signs, which are not specific for each condition and were defined previously.1,2 New evidence and justification for including CSLD are described in recent papers.13,14

Recommendation-1
• 1a. Bronchiectasis is a clinical syndrome in a child or adult with the symptoms and/or signs in Box-1 and presence of characteristic radiographic features on chest high-resolution computed tomography (c-HRCT).
• 1b. CSLD is a clinical syndrome in children with the symptoms and/or signs outlined in Box-1, but who lack a radiographic diagnosis of bronchiectasis.
**GRADE-Strong**

**Box-1**
Recurrent (≥3 episodes) wet or productive cough, each lasting for >4-weeks, with or without other features, e.g. exertional dyspnoea,
- symptoms of airway hyper-responsiveness,
- recurrent chest infections,
- growth failure,
- clubbing,
- hyperinflation or chest wall deformity.

In children, triggers for referral to a specialist include one or more of the following:
(i) persistent wet cough not responding to 4-weeks of antibiotics,
(ii) ≥3 episodes of chronic (>4-weeks) wet cough per year responding to antibiotics,
(iii) a chest radiograph abnormality persisting >6-weeks after appropriate therapy.

**INVESTIGATIONS OF A PATIENT WITH CSLD/BRONCHIECTASIS**

**Radiology**

c-HRCT remains the diagnostic gold standard. However, c-HRCT reconstructed from a multi-detector (MDCT) scan is substantially more sensitive than conventional c-HRCT. As children are at greater risk from radiation-induced cancers later in life, the c-HRCT protocol must ensure the lowest possible radiation exposure to obtain adequate assessment. As the key radiographic criteria of broncho-arterial ratio in people without lung disease is age-dependent, child-specific criteria are recommended.

**Recommendation-2**

- 2a. Patients with symptoms and/or signs suggestive of bronchiectasis require a c-HRCT to confirm the diagnosis and to assess severity and extent of bronchiectasis.
- 2b. In children, seek specialist advice before ordering a c-HRCT and child-specific criteria should be used.
- 2c. In both adults and children, MDCT scans with HRCT reconstruction is the preferred technique to diagnose bronchiectasis.

**GRADE-Strong; Evidence-Moderate**

**Aetiology**

Several causative and associated factors are described for CSLD/bronchiectasis (Table-2). Identifying aetiology (Box-2) and disease severity can influence management, including treatment intensity. Investigations for specific causes of CSLD/bronchiectasis are recommended, even though many patients lack an identifiable aetiology. Bronchoscopy is generally indicated in children who are unable to expectorate and adults with localised disease. Given the implications of bronchiectasis for managing people with COPD, a new recommendation is included.

**Recommendation-3**

Consider a c-HRCT in adults with COPD and either ≥3 exacerbations per year, very severe disease (FEV₁ <30% predicted or requiring domiciliary oxygen) or whose sputum contains organisms atypical for COPD (i.e. Aspergillus species, *Pseudomonas aeruginosa* (Pa) or non-tuberculous mycobacteria, NTM).

**GRADE-low; Evidence-low**

**Severity**

In addition to routine clinical data (cough, sputum, exacerbation rate, well-being, etc) and radiological assessment, objective tests provide information about disease severity and prognosis.
Lung function: Although spirometry is classically obstructive, a restrictive pattern is also recognised. Spirometry and lung volume measurements should be assessed at diagnosis and spirometry performed at each review, even though they can be relatively insensitive in mild disease and in children. Accelerated deterioration in lung function may occur. If serial pulmonary function measurements indicate disease progression, a step-up in therapy is recommended. Paediatric studies show that spirometric volumes can stabilise and even improve, while in adults with moderate-severe bronchiectasis, mortality risk is associated with degree of lung function impairment. Other assessments, including complex pulmonary function and the 6-minute walk tests, are sometimes used for determining functional impairment, but these are not discussed further.

Microbiology: Surveillance of airway or sputum microbiology helps guide antibiotic therapy in CSLD/bronchiectasis, especially if there is deterioration or inadequate response to current treatment. The most common pathogens in children are non-typeable *Haemophilus influenzae* (NTHi), *Streptococcus pneumoniae* and *Moraxella catarrhalis*. In adults, *Pa* and NTHi predominate. About 25-45% of airway samples fail to grow pathogenic bacteria. As disease progresses the microbiota change, often with *Pa* appearing in more advanced disease and predicting a worse prognosis. Aspergillus and NTM species are detected in some adults with bronchiectasis, although their pathogenic role is uncertain. Nonetheless, NTM has been implicated in exacerbations and pulmonary deterioration. Readers are referred to new diagnostic and classification guidelines for aspergillosis-related issues. Molecular and sequencing based-studies have highlighted the abundance (up to 83%) of anaerobic bacteria and the complexity of the pulmonary microbiome, but the clinical implications remain uncertain. Meanwhile in Central Australian Indigenous adults, when compared with non-infected individuals, human T-cell lymphotrophic virus (HTLV)-1 is associated with both an increased risk of developing bronchiectasis and a worse outcome. While the background prevalence of HTLV-1 in the Central Australian Indigenous population is 7.2-13.9%, 18 (72%) of 25 patients with bronchiectasis tested in the Alice Springs Hospital were HTLV-1 seropositive.

Other tests: Pulmonary arterial hypertension complicates severe bronchiectasis. In advanced disease, chronic or nocturnal hypoxemia is common and selected patients require arterial blood gas, an echocardiogram and overnight oxygen assessment.

**Recommendation-4**
Obtaining further history for specific underlying causes may determine subsequent investigation and management. History should include:
- History suggestive of cystic fibrosis (family history, pancreatitis, chronic gastrointestinal symptoms, male infertility);
- Underlying immune deficiency or ciliary dyskinesia (recurrent sinusitis, extrapulmonary infections, including discharging ears and severe dermatitis, and male infertility);
- Recurrent aspiration (cough and/or choking with feeds/meals, post-bariatric surgery, may be occult); and
- Inhaled foreign body

**GRADE-Strong; Evidence-Moderate**

**Recommendation-5**
Perform or refer for baseline investigations (Box-2).

**GRADE-Strong; Evidence-Moderate**
Minimum investigations are:
- Full blood count and major immunoglobulin classes G, A, M, E
- Sweat test in all children and selected adults - (see below)
- Culture airway secretions, including specialised cultures for mycobacteria, particularly non-tuberculous mycobacteria (NTM) in sputum-producing patients
- Spirometry and lung volumes (when aged >6-years)
- Aspergillus serology.

In addition consider the following after discussion with a specialist:
- Exhaled fractional nasal nitric oxide, nasal ciliary brushings and/or genetic testing for primary ciliary dyskinesia
- Sweat test and/or extended CFTR gene mutation testing (adults aged <50 years or in those with episodes of pancreatitis, bowel obstruction, heat prostration and in patients with co-existent liver disease or male infertility)
- Bronchoscopy for foreign body, airway abnormality and specimens for culture of respiratory pathogens, including mycobacteria
- Assessment for aspiration (primary or secondary)
- Additional immunological tests (neutrophil function tests and lymphocyte subsets, IgG subclasses, antibody responses to vaccines)
- HIV, HTLV-1
- Echocardiogram especially in adults (when concerned about pulmonary hypertension).

Recommendation-6
Obtain further history to determine markers of severity, impact of illness, co-morbidities and modifiable risk factors. History should include: frequency of exacerbations and hospitalisations, degree of effort limitation, exposure to tobacco smoke and other pollutants, childhood history and housing.

GRADE-Strong; Evidence-low

MANAGEMENT (TABLE-3)
Early and effective management reduces short and long-term morbidity.\(^\text{23,31}\) In children, airway injury is superimposed upon the physiological changes involving lung growth and development.\(^\text{32}\) With appropriate treatment, lung disease complicating primary immunodeficiency should not deteriorate.\(^\text{23,33}\) In a Melbourne adult cohort, longer duration of chronic productive cough was related to poorer lung function,\(^\text{8}\) while in children longer duration of wet cough before treatment was associated with worse c-HRCT scores.\(^\text{34}\)

Recommendation-7
Aim to optimise general well-being, symptom control, lung function, quality of life (QoL), and reduce exacerbation frequency and prevent excessive decline in lung function. This may require intensive medical therapy.

GRADE-Strong; Evidence-High

Exacerbations
Exacerbations impair QoL,\(^\text{23}\) increases airway and systemic inflammation,\(^\text{35}\) result in hospitalisation, and are an independent predictor of lung function decline.\(^\text{22,36}\) Symptoms include >72-hours of increased cough, change in sputum (volume, viscosity, purulence), breathlessness, haemoptysis
and/or constitutional upset (malaise, tiredness). In children, exacerbations are defined clinically (increased cough, altered cough and/or sputum characteristics) with or without elevated serum biomarkers (e.g. C-reactive protein).

Recommendation-8
Develop treatment plans for exacerbations for each patient, linking them to primary healthcare and specialist or hospital facilities. When appropriate, this includes individualised and self-initiated management action plans.

GRADE-Strong; Evidence-Low

Antibiotics
High bacterial loads in the airways of patients with CSLD/bronchiectasis are associated with increased respiratory symptoms, more frequent exacerbations and elevated inflammatory markers. Consequently, antibiotic therapy to reduce bacterial load has a central management role. A recent review of the use of antibiotics in people with bronchiectasis is available.

(i) Acute exacerbations
Depending upon the severity, short-term oral antibiotics and ambulatory care are usually tried first for acute exacerbations. More severe episodes require intravenous antibiotics combined with intensified physiotherapy and other airway clearance methods, including nebulised therapy. While robust evidence is lacking, a 2-week antibiotic course is generally recommended. Response to therapy includes reduced sputum volume and purulence, and improved cough character (wet to dry or cessation of cough), general well-being, QoL and markers of systemic inflammation (C-reactive protein), microbial clearance, and ‘return to baseline’ state.

(ii) Pseudomonas aeruginosa eradication
Chronic Pa infection in CSLD/bronchiectasis is associated with advanced disease and deteriorating clinical outcomes. A small retrospective study reported that when first isolated, Pa can be eradicated with intravenous antibiotics followed by 3-months of oral and inhaled anti-pseudomonal antibiotic therapy. While eradication was accompanied by reduced exacerbation rates, additional studies are needed to demonstrate any sustained clinical benefit.

(iii) Long-term suppression
The goal of long-term oral or inhaled antibiotic therapy is to reduce bacterial load and airway inflammation when sustained eradication of lower respiratory pathogens is not possible. Trials of long-term oral beta-lactam and inhaled antibiotics provide conflicting results for a clinical benefit, with the best evidence being provided for benefit by a randomised controlled trial (RCT) on inhaled gentamicin. In contrast, recent randomised placebo-controlled trials of macrolides for 6-24 months duration report exacerbations were reduced by 33-64% and in some instances improved QoL and lung function. Nevertheless, additional studies are required to establish their overall role and safety in CSLD/bronchiectasis, particularly concerning the clinical implications of developing antibiotic resistance. Macrolides should be avoided in those receiving Class IA/III anti-arrhythmic agents, if there is a prolonged QTc interval or as a single agent when NTM are cultured. New inhaled antibiotic formulations (e.g. ciprofloxacin, amikacin) are currently undergoing clinical trials to determine if they have a role in managing non-CF bronchiectasis.

Recommendation-9
Base antibiotic selection (Box-3) on lower airway culture results [sputum, bronchoscopy washings (adults and older children) or bronchoalveolar lavage (young non-expectorating children)] when available, local antibiotic susceptibility patterns, clinical severity and patient tolerance, including allergy.

GRADE-Strong; Evidence-Moderate
### Box 3

<table>
<thead>
<tr>
<th>Mild-moderate exacerbation (oral therapy)^</th>
<th>Moderate to severe exacerbation (IV therapy)^</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial empiric therapy</strong>*</td>
<td></td>
</tr>
<tr>
<td>Children: amoxycillin, amoxycillin-clavulanate</td>
<td>Children and adults: ampicillin, cefotaxime or ceftazidime (amoxycillin-clavulanate, or cefuroxime‡)</td>
</tr>
<tr>
<td>Adults: amoxycillin, amoxycillin-clavulanate or doxycycline†</td>
<td>Children and adults: piperacillin-tazobactam, ticarcillin-clavulanate, or ceftazidime + tobramycin§ if severe or <em>P. aeruginosa</em> in recent cultures.</td>
</tr>
<tr>
<td>Children and adults: ciprofloxacin if <em>P. aeruginosa</em> in recent cultures.</td>
<td></td>
</tr>
</tbody>
</table>

**Specific pathogens**

<table>
<thead>
<tr>
<th><strong>H. influenzae</strong></th>
<th><strong>amoxycillin</strong></th>
<th><strong>ampicillin (amoxycillin†)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>β-lactamase–ve</strong></td>
<td>amoxycillin-clavulanate or doxycycline†</td>
<td>cefotaxime or ceftazidime (amoxycillin-clavulanate or cefuroxime‡),</td>
</tr>
<tr>
<td><strong>β-lactamase +ve</strong></td>
<td>amoxycillin</td>
<td>benzylpenicillin G, ampicillin (amoxycillin†)</td>
</tr>
<tr>
<td><strong>S. pneumoniae</strong></td>
<td>amoxycillin</td>
<td>cefotaxime or ceftazidime (amoxycillin-clavulanate, or cefuroxime‡)</td>
</tr>
<tr>
<td><strong>M. catarrhalis</strong></td>
<td>amoxycillin-clavulanate</td>
<td>cefotaxime or ceftazidime (amoxycillin-clavulanate, or cefuroxime‡)</td>
</tr>
<tr>
<td><strong>S. aureus</strong></td>
<td>di-/flucloxacillin</td>
<td>flucloxacillin</td>
</tr>
<tr>
<td><strong>MRSA</strong></td>
<td>seek specialist advice¶</td>
<td>seek specialist advice¶</td>
</tr>
<tr>
<td><strong>P. aeruginosa</strong></td>
<td>ciprofloxacin (max 14 days)</td>
<td>Children and adults: piperacillin-tazobactam, ticarcillin-clavulanate, or ceftazidime + tobramycin§ if severe or <em>P. aeruginosa</em> in recent cultures.</td>
</tr>
<tr>
<td><strong>NTM</strong></td>
<td>seek specialist advice¶</td>
<td>seek specialist advice¶</td>
</tr>
</tbody>
</table>

*In addition to clinical severity, initial empiric therapy is also guided by previous lower airway culture results (sputum, BAL/bronchoscopy washings), local antibiotic susceptibility patterns and prior responses to antibiotic treatments. In children too young to expectorate sputum and when no previous lower airway culture results are available, prescribed empiric antibiotic therapy should be active against *H. influenzae*, *S. pneumoniae* and *M. catarrhalis.*

^Seek local specialist advice if a history of antibiotic hypersensitivity or severe adverse antibiotic effects exists and when serious drug interactions may occur. Aminoglycosides, macrolides and fluoroquinolones in particular should be used with care in the elderly. †Doxycycline is used only in adults and adolescents; ‡Available only in New Zealand; §Although treating *P. aeruginosa* bacteraemia with combined beta-lactam and aminoglycoside antibiotic therapy provides no additional clinical benefit and is associated with more adverse events than using a single beta-lactam agent, the role of single beta-lactam therapy for non-bacteraemic *P. aeruginosa* pneumonia and other respiratory infections is unproven. Combination therapy should still be used when multi-resistant *P. aeruginosa* strains are detected. ¶Specialist advice is required for treating MRSA in accordance with local susceptibility patterns and infection control policies. The decision of when to treat NTM and what agents to use is complicated by the high levels of antibiotic resistance shown by these strains and the need for prolonged therapeutic courses involving multiple drug combinations that risk serious toxicity and drug interactions.
Recommendation-10
When Pa is first detected, consider discussion with a specialist in this field regarding suitability for eradication.
GRADE-Weak; Evidence-Low

Recommendation-11
In patients not requiring parenteral antibiotics for an acute exacerbation, oral antibiotics are prescribed for at least 10-days based on available airway microbiology results. Close follow-up to assess treatment response is necessary.
GRADE-Strong; Evidence-Low

Recommendation-12
Inadequate response should prompt repeat of lower airway cultures and assessment of whether parenteral antibiotic therapy and hospitalisation are needed.
GRADE-Strong; Evidence-Moderate

Recommendation-13
Patients failing oral antibiotic therapy for an acute exacerbation should receive intensive airway clearance strategies and parenteral antibiotics based upon the latest lower airway culture results. Close follow-up is required.
9a. In children, this requires supervised treatment for at least 10-14 days.
9b. In adults, IV antibiotics should be for at least 5-days and often followed by oral antibiotics. Conversion from IV to oral antibiotics depends upon appropriate oral alternatives and if effective adjunct therapies, such as airway clearance strategies can be maintained in an ambulatory care setting and ongoing outpatient review.
GRADE-Strong; Evidence-Moderate

Recommendation-14
Long-term oral antibiotics should not be prescribed routinely. Macrolides (or other antibiotics) can be considered for a therapeutic trial over a limited period (e.g. up to 12-24 months) in selected patients [e.g. frequent exacerbations (≥3 exacerbations and/or ≥2 hospitalisations in the previous 12-months)]. Before commencing macrolides; (a) Seek respiratory/infectious diseases specialist advice, (b) ensure NTM infection is excluded in patients capable of providing a sputum specimen, and (c) perform an ECG in adults for assessment of QTc.
GRADE-Strong; Evidence-Moderate

Recommendation-15
Long-term nebulised antibiotics should not be prescribed routinely. Consider a therapeutic trial in children and adults with frequent exacerbations and/or Pa infection.
GRADE-Strong; Evidence-Moderate

Bronchodilators and Corticosteroids
Those with CSLD/bronchiectasis may have co-existent asthma with wheeze and/or dyspnoea responsive to beta-2 agonist medications. Reports on asthma symptoms in those with CSLD/bronchiectasis vary from 11 to 46%. While some studies ascribe asthma as a cause of bronchiectasis, it is more likely asthma was misdiagnosed initially or co-existed with CSLD/bronchiectasis. When present, asthma therapies should be used in accordance with asthma guidelines.

Inhaled corticosteroids (ICS) provide, at best, a modest benefit in CSLD/bronchiectasis. A study published after the current Cochrane review also found no significant differences between those receiving ICS compared to placebo. Combined ICS-long acting beta-agonist (compared to high-dose
ICS) improved dyspnoea and cough with no effect on exacerbations.\textsuperscript{50} Furthermore, ICS in adults with chronic respiratory disease risk NTM infection.\textsuperscript{51}

**Recommendation-16**
Inhaled and oral corticosteroids should not be prescribed routinely unless there is an established diagnosis of co-existing asthma or COPD.

*GRADE- Strong; Evidence-Low for oral corticosteroids, moderate for ICS*

**Recommendation-17**
Inhaled bronchodilators should not be prescribed routinely and used only on an individual basis.

*GRADE- Strong; Evidence- Low*

**Mucolytics and mucoactive agents**
Mucolytic agents include mannitol, iso- and hyper-tonic saline. While early short-term trials were promising, longer-term RCTs found that both hypertonic saline\textsuperscript{52} and mannitol\textsuperscript{53} conferred little advantage over isotonic saline and placebo respectively. In contrast, recombinant human deoxyribonuclease (rhDNase), a widely used mucolytic in CF, is harmful in adults with CSLD/bronchiectasis and is associated with increased exacerbations and hospitalisations, and more rapid FEV\textsubscript{1} decline.\textsuperscript{54}

**Recommendation-18**
rhDNase is contraindicated in CSLD/bronchiectasis.

*GRADE- Strong; Evidence-High*

**Recommendation-19**
Mucoactive agents, including hypertonic saline and mannitol, are currently not recommended routinely. Consider a therapeutic trial in children and adults with frequent exacerbations. *GRADE- Weak; Evidence-Moderate*

**Airway clearance techniques, exercise and pulmonary rehabilitation**
Despite lacking a robust evidence-base, airway clearance techniques are standard treatment in people with CSLD/bronchiectasis. Available studies suggest airway clearance techniques are beneficial, with improved QoL and exercise capacity, and reduced cough and sputum volumes.\textsuperscript{55,56} Given the variety of airway clearance techniques and increased efficacy when individualised therapy is utilised,\textsuperscript{57} specific respiratory expertise should be sought.

Pulmonary rehabilitation is a multidisciplinary treatment, including exercise training, self-management education, psychosocial and nutritional intervention.\textsuperscript{58} Small short-term RCTs including whole body exercise training have shown improvements in symptoms, exercise tolerance and QoL.\textsuperscript{59} Unless specific contraindications exist, physical activity should be encouraged.

**Recommendation-20**
Airway clearance techniques are recommended and respiratory physiotherapist’s advice should be sought. Individualise airway clearance therapy.

*GRADE-Strong; Evidence-Moderate*

**Recommendation-21**
Adults with bronchiectasis and exercise limitation should receive pulmonary rehabilitation.

*GRADE-Strong; Evidence-Moderate*
**Recommendation-22**
Regular physical activity is recommended for children and adults with CSLD/bronchiectasis.

*GRADE-Strong; Evidence-Low*

**Nutrition**
Poor nutrition (both macro and micro-nutrition) compromises innate and adaptive immunity. Studies in other chronic respiratory diseases\(^6\) indicate that poor nutrition may be a risk factor for respiratory exacerbations in CSLD/bronchiectasis. Vitamin-D deficiency has been associated with poorer outcomes\(^6\), but the evidence for this is low.

**Recommendation-23**
Assess and optimise nutritional status.

*GRADE-Strong; Evidence-Moderate*

**Minimise further lung injury**
Environmental pollutants\(^6\), including tobacco smoke, exacerbate chronic respiratory disorders and constitute an additional risk factor for those with CSLD/bronchiectasis.

**Recommendation-24**
Promote elimination of smoking, including second-hand smoke exposure.

*GRADE-Strong; Evidence-High*

**Recommendation-25**
Promote avoidance of environmental airborne pollutants.

*GRADE-Strong; Evidence-Low*

**Co-morbidities**
Patients with CSLD/bronchiectasis have increased rates of co-morbidities, including chronic sinusitis, gastro-oesophageal reflux, ‘asthma-like’ disease and depression. It is unknown whether these co-morbidities increase the frequency and/or severity of exacerbations or worsen lung injury.

**Recommendation-26**
Regularly monitor and manage complications and co-morbidities (Box-4). When present, these are managed following standard guidelines.

*GRADE-Strong; Evidence-Moderate*

**Box-4**

**Regular review consists of:**
At least an annual review in adults and 6-monthly in children. A multi-disciplinary team is preferable, especially at the initial evaluation. The review includes assessment of:

(a) severity, which includes oximetry and spirometry
(b) sputum culture (when available) for routine bacterial and annual mycobacterial culture
(c) management of possible complications and comorbidities, particularly for gastro-esophageal reflux disease/aspiration, reactive airway disease/asthma, COPD, otorhinolaryngeal disorders, urinary incontinence, mental health and dental disease. Less commonly patients require assessments for sleep disordered breathing and cardiac complications.
(d) Adherence to therapies and knowledge of disease processes and treatments
Other treatments
Various other treatments are available, but with little supportive data (Table-3). Current management strategies have reduced the need for surgical interventions, which carry a small but significant risk of morbidity and mortality. Lung transplantation should be considered in those with end-stage lung disease.

Recommendation-27
Although surgery is not indicated normally, there may be circumstances requiring assessment by a multi-disciplinary team expert in CSLD/bronchiectasis care.
GRADE-Strong; Evidence-moderate

Public health issues, prevention and appropriate health care delivery
The socioeconomic determinants of health, including their impact upon CSLD/bronchiectasis cannot be addressed adequately here. Immunisations that prevent acute respiratory infections, such as pertussis, influenza and pneumococcal vaccines, are recommended despite the lack of specific high-level evidence for CSLD/bronchiectasis.63

Delivery of chronic disease programmes requires comprehensive and highly-skilled primary healthcare services. Education of primary healthcare providers should focus upon identifying children and adults for appropriate referral and high-quality local management. Like other chronic illnesses, individualised and multi-disciplinary case management operating within an inter-professional framework is optimal.64 Clinical deterioration should prompt early referral for specialist care. Those with moderate or severe disease are best managed by a multi-disciplinary approach to chronic care. In a pilot RCT, a self-management programme (within a multidisciplinary team) improved QoL and health-management elements.65

Indigenous children and adults with CSLD/bronchiectasis who live in rural-remote regions provide particular challenges for the delivery of care. In asthma, including local Indigenous workers improves outcomes,66 but there are no data specific for bronchiectasis.

Recommendation-28
Immunise according to National Immunisation Schedules. Ensure timely annual influenza immunisation and that pneumococcal vaccines are administered following national guidelines.
GRADE-Strong; Evidence-Moderate

Recommendation-29
Coordinated care by health care providers is necessary. Specialist evaluation is recommended if bronchiectasis is suspected to confirm diagnosis, investigate aetiology, assess severity and to develop management plans. Those with moderate or severe disease are best managed using a multi-disciplinary approach to chronic care with individualised case management. Clinical deterioration should prompt early referral to services with CSLD/bronchiectasis expertise.
GRADE-Strong; Evidence-low

Recommendation-30
Specialist review should be undertaken for patients with moderate disability or progressive lung disease. This includes consideration for lung transplantation.
GRADE-Strong; Evidence-Low
Recommendation-31
Providing healthcare for Indigenous people in rural-remote regions requires flexible and adaptive arrangements. However, it should not alter the objective of delivering best practice treatment to this population.
GRADE-Strong; Evidence-Low

Recommendation-32
Given the high prevalence of CSLD/bronchiectasis in Indigenous Australians, Māori and Pacific Island children and adults, a high index of suspicion with early diagnostic investigation and institution of best practice treatment should be established. Interpreters and local health-workers should be available for education regarding disease and management.
GRADE-Strong; Evidence-Moderate
Table 1: Methods

Recommendations were based upon the available evidence (Table-3). Principles of evidence-based medicine and the revised GRADE\(^67\) approach to guideline development were used to categorise recommendations into: strong, weak, or no specific recommendation.\(^67\)

The implications of a strong recommendation are:
- **For patients**—most people in your situation would want the recommended course of action and only a small proportion would not; request discussion if the intervention is not offered.
- **For clinicians**—most patients should receive the recommended course of action.
- **For policy makers**—the recommendation can be adopted as a policy in most situations.

The implications of a weak recommendation are:
- **For patients**—most people in your situation would want the recommended course of action, but many would not
- **For clinicians**—you should recognise that different choices will be appropriate for different patients and that you must help each patient to arrive at a management decision consistent with her or his values and preferences
- **For policy makers**—policy making will require substantial debate

The level of evidence provided by GRADE is:
- **High**=Further research is very unlikely to change our confidence in the estimate of effect.
- **Moderate**=Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
- **Low**=Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
- **Very low**=Any estimate of effect is very uncertain.

When relative risk was not available in publications, the decision to upgrade the evidence was based primarily on the likelihood of whether further research would have an effect on the recommendation.

An updated search (from a previous search in July 2009\(^9\)) was conducted in Aug-Oct 2013. This was undertaken by the writing group (for assigned recommendations) and independently performed by AC using the text-word ‘bronchiectasis’ or ‘suppurative lung disease’ and ‘controlled trials’ in the Pubmed and Cochrane Central Library databases. Only full papers published in English were retrieved. Recommendations were updated and finalised by complete agreement by the writing group. The assigned evidence level (defined above) of recommendations was also agreed in consensus. This document and a summary table were then circulated to the entire group for assessment using the GRADE descriptors.\(^67\) Strength of recommendations were assigned by formal voting rules\(^68\) and agreement with a statement by >75% of the group was defined \textit{a priori} as consensus.

This document and a truncated version (for publication in the MJA) were then submitted to the TSANZ education committee led by Prof Peter Wark and reviewed externally. After amendments, the truncated version was submitted to the MJA(5764) where it also underwent external independent reviews, in accordance with this Journal’s processes. Further minor amendments were made and reviewed by the writing group. As the recommendations were unaltered, we did not repeat the GRADE process with the expanded group. The writing group has no financial conflicts of interest and thus responds to the eight items of guideline panel review outlined by Lenzer and colleagues.\(^70\)
Table 2 - Aetiologies and factors associated with bronchiectasis (in alphabetical order)

- Congenital causes (eg. Monier-Kuhn, Young’s syndrome)
- COPD/smoking
- Cystic fibrosis
- Mucociliary dysfunction (eg. primary ciliary dyskinesia)
- Immune deficiency (primary or secondary eg. hypogammaglobulinaemia, lung and bone marrow transplantation, malignancy, HIV/AIDS)
- Pulmonary fibrosis and pneumoconiosis (eg. silicosis) – causes traction bronchiectasis
- Post obstructive (eg. foreign body)
- Post-infectious (eg. tuberculosis, adenovirus, recurrent pneumonia)
- Recurrent small volume aspiration (from upper airway secretions or gastric contents)
- Systemic inflammatory diseases (eg. rheumatoid arthritis, sarcoidosis)
<table>
<thead>
<tr>
<th>Evidence type/study</th>
<th>Summary of results</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Antibiotics (by type)</strong></td>
<td></td>
<td></td>
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<tr>
<td>General</td>
<td>Cochrane review, other systematic review*</td>
<td>Generally beneficial. See text</td>
</tr>
<tr>
<td>Macrolides</td>
<td>DB RCTs for 6-24 months(^{13,37,38,44})*</td>
<td>Exacerbations reduced significantly in Rx arm (by 33-64%). Also, improvement in weight in children,(^{11}) and QoL,(^{37}) sputum(^{44}), PFT parameters(^{37}) and lung function decline(^{44}) in some, but not all studies, in adults(^{38})</td>
</tr>
<tr>
<td>Nebulised aminoglycosides</td>
<td>Cross-over DB RCT (tobramycin, 30 patients with (Pa), 6-months each).* New RCT (single blinded 12-month gentamicin 80mg bd)(^{71})*</td>
<td>Reduced number and days of hospitalisation in tobramycin arm. Improved exercise capacity, sputum purulence, QoL, reduced exacerbations in gentamicin arm. No effect on lung function or sputum volume.(^{71})</td>
</tr>
<tr>
<td>Nebulised ciprofloxacin</td>
<td>DB RCT (42 adults with (Pa), mixture of liposomal and free ciprofloxacin, alternating 28-day cycles on and off therapy for 6 mths(^{72}) DB RCT (144 adults with (Pa), colistin 1 million units bid for up to 6mths).(^{73})</td>
<td>Reduced the odds of an antibiotic treated exacerbation by 80%</td>
</tr>
<tr>
<td>Nebulised colistin</td>
<td></td>
<td>Reduced sputum (Pa) load, improved QoL after 6 mths</td>
</tr>
<tr>
<td>Evidence type/study</td>
<td>Summary of results</td>
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<tr>
<td><strong>Antibiotics</strong> (by duration)</td>
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<tr>
<td>Short term (&lt;1 month)</td>
<td>Several cohort studies,* Cochrane review&lt;sup&gt;74&lt;/sup&gt; General clinical improvement. No RCTs (but studies in progress&lt;sup&gt;75&lt;/sup&gt;)</td>
<td></td>
</tr>
<tr>
<td>Medium term (1-11 months)</td>
<td>Cochrane review*, (+ see macrolide section) Improvement with amoxycillin and macrolides (see above). Adults with <em>Pa</em>-reduced hospitalisation but no change in QoL*</td>
<td></td>
</tr>
<tr>
<td>Long term (≥ 12 months)</td>
<td>RCTs (+ see macrolide section) Adults with <em>Pa</em> had reduced hospitalisation frequency and days.* Reduced general disability in those taking tetracycline compared to placebo*</td>
<td></td>
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<tr>
<td><strong>Anti-inflammatories</strong></td>
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<tr>
<td>Oral NSAIDs</td>
<td>Cochrane review* No RCTs Cohort study, 25mg tds indomethacin for 28 days reduced neutrophil chemotaxis, but no change in sputum albumin, elastase, MPO</td>
<td></td>
</tr>
<tr>
<td>Inhaled indomethacin</td>
<td>Cochrane review* RCT in 25 adults (some had CSLD). Reduced sputum and improved dyspnoea score</td>
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<tr>
<td><strong>Mucolytics</strong></td>
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<tr>
<td>Bromhexine</td>
<td>Cochrane review* Studies only in acute phase Not universally available</td>
<td></td>
</tr>
<tr>
<td>rhDNAse</td>
<td>Systematic review* Increased exacerbation rate and accelerated FEV&lt;sub&gt;1&lt;/sub&gt; decline</td>
<td></td>
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<tr>
<td><strong>Airway clearance</strong></td>
<td></td>
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<tr>
<td>Respiratory physiotherapy (Airway clearance techniques)</td>
<td>Cochrane review&lt;sup&gt;55&lt;/sup&gt; 5 small cross-over short term studies (4 in adults, one in children). Improvements in QoL, cough-related measures and sputum. No harm detected</td>
<td></td>
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<tr>
<td>Evidence type/study</td>
<td>Summary of results</td>
<td>Notes</td>
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<tr>
<td>Inhaled hyperosmolar agents</td>
<td>Cochrane review, RCTs using 6% HS (uni-centre) and mannitol (multi-centre), and systematic review</td>
<td>No paediatric RCT. Adults: Mannitol conferred minimal benefit at 12-weeks, sputum expectoration in the placebo-group was significantly less than mannitol group. No effect on exacerbation frequency, QoL, spirometry, microbiological and inflammatory parameters. 6% HS over 12-months provided no advantage over isotonic saline in exacerbation, QoL, FEV1. 82 had HRCT scans showed reduced mucous plugging in mannitol group.</td>
</tr>
</tbody>
</table>

### Asthma therapies

<table>
<thead>
<tr>
<th>Therapy</th>
<th>Summary of results</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICS</td>
<td>Cochrane review* plus new RCT</td>
<td>Cochrane: No difference in any outcome when only placebo RCTs were included. Reduced exacerbation rate occurred in adults with Pa. RCT: 400 mcg budesonide conferred no benefit.</td>
</tr>
<tr>
<td>ICS-LABA</td>
<td>Cochrane review</td>
<td>In stable state, ICS-LABA (compared to high dose ICS), improved dyspnoea and cough-free days, but no effect on QoL, exacerbations or lung function</td>
</tr>
<tr>
<td>Oral corticosteroids</td>
<td>Cochrane review*</td>
<td>No RCTs</td>
</tr>
<tr>
<td>Anti-cholinergics</td>
<td>Cochrane review*</td>
<td>No RCTs</td>
</tr>
<tr>
<td>Beta2 agonist</td>
<td>Cochrane review*</td>
<td>No RCTs</td>
</tr>
<tr>
<td>LTRA</td>
<td>Cochrane review*</td>
<td>No RCTs</td>
</tr>
<tr>
<td>Evidence type/study</td>
<td>Summary of results</td>
<td>Notes</td>
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<td>-------------------------------------------------------</td>
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<tr>
<td>Physical training and pulmonary rehabilitation</td>
<td>Pulmonary rehabilitation improved shuttle test results and QoL. No additional ADV advantage of simultaneous inspiratory muscle training</td>
<td></td>
</tr>
<tr>
<td>Oxygen (domiciliary)</td>
<td>No data as sole therapy*</td>
<td>Consider data from COPD showing benefit in survival*</td>
</tr>
<tr>
<td>Surgery</td>
<td>Cochrane review*</td>
<td>No RCTs. Cohort studies suggest a benefit in selected cases.*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reduced exacerbation rate similar to medically treated group.*</td>
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<tr>
<td></td>
<td></td>
<td>Adverse events of surgery*</td>
</tr>
<tr>
<td>Ventilation for acute respiratory failure</td>
<td>Comparison of non-invasive ventilation (NIV) to mechanical ventilation. NIV failure rate of 33%. Mortality of 25%.</td>
<td></td>
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<tr>
<td>Vaccines</td>
<td></td>
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<tr>
<td>Pneumococcal conjugate and polysaccharide vaccines</td>
<td>Cochrane review*</td>
<td>No RCTs. Advocated as vaccines pneumococcal and influenza reduce infection risk.</td>
</tr>
<tr>
<td>Influenza vaccines</td>
<td>Cochrane review*</td>
<td>No RCTs.</td>
</tr>
<tr>
<td>Acupuncture</td>
<td>RCT*</td>
<td>Improved QoL, but not in sputum or 6 min walking test.</td>
</tr>
<tr>
<td>Model of follow-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurse led</td>
<td>Cochrane review*</td>
<td>No difference in exacerbations, but increased hospital admissions in nurse led compared to doctor led care.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased health care cost implications.</td>
</tr>
<tr>
<td>Evidence type/study</td>
<td>Summary of results</td>
<td>Notes</td>
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<td>------------------------------------------------</td>
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<tr>
<td>Self-management program within a multi-disciplinary model</td>
<td>Uni-centre RCT.</td>
<td>Intervention group</td>
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<tr>
<td></td>
<td></td>
<td>improved elements of self-care (eg exercise, medications) and QoL, no effect on lung function $^65$</td>
</tr>
</tbody>
</table>

*No new data based on updated searches on Pubmed (Sept-Oct 2013)-see paper$^7$ for references ie only new references are included here; COPD=chronic obstructive pulmonary disease; DB=double blind; FEV$_1$=forced expiratory volume in 1-second; HS=hypertonic saline; ICS=inhaled corticosteroids; LABA=long-acting beta-agonist; LTRA=leukotriene receptor antagonist; MPO=myeloperoxidase; NSAIDs=non-steroidal anti-inflammatory drugs; Pa=Pseudomonas aeruginosa; QoL=quality of life; RCT=randomised controlled trial; Rx=treatment.
References


30 Holland AE, Wadell K, Spruit MA. How to adapt the pulmonary rehabilitation programme to patients with chronic respiratory disease other than COPD. Eur Respir Rev 2013; 22(130):577-586.


