MANAGEMENT OF BRONCHIECTASIS: A TERTIARY HEALTH CARE PERSPECTIVE

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Contents

Declaration

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Abbreviations

ACBT	Active cycle of breathing technique
ANZCTR	Australia New Zealand Clinical Trial Register
BTS	British Thoracic Society
CALHN	Central Adelaide Local Health Network
CF	Cystic fibrosis
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease
CT	Computer Tomography
EMR	Electronic Medical Record
ERS	European Respiratory Society
GEE	Generalised Estimating Equations
HRCT	High Resolution Computed Tomography
ID	Identification
IQR	Interquartile Range
LFA	Lung Foundation Australia
MRSA	Methicillin-resistant staphylococcus aureus
NT	Northern Territory
NTM	Non-tuberculous mycobacteria
OPD	Outpatients Department
PEP	Positive expiratory pressure
PBS	Pharmaceutical Benefits Scheme
RAH	Royal Adelaide Hospital

RNS	Respiratory Nursing Service
SA	South Australia
SD	Standard Deviation
SEPAR	Spanish Society of Pneumology and Thoracic Surgery
STS	Saudi Thoracic Society
TQEH	The Queen Elizabeth Hospital
TSANZ	Thoracic Society of Australia and New Zealand
USA	United States of America
UK	United Kingdom

Peer-reviewed journal publications

Un-submitted (n= 1 related to master's work)

1. **Lawton K**, Carson-Chahhoud KV, Royals K, Veale A, Bronchiectasis management: a clinical audit of respiratory outpatient care in a South Australian hospital.

Published (n= 1 related to master's work)

1. **Lawton K**, Royals K, Carson-Chahhoud KV, Campbell F, Smith BJ. Nurse-led versus doctor-led care for bronchiectasis Cochrane Database Syst Rev 2018; 6: Cd004359 (IF 6.264)

Presentations: (Total number of master's presentations n=7)

Submitted conference abstracts

Oral conference presentations:

1. Lawton K, Royals K, Carson-Chahhoud KV, Veale AJ Management of Bronchiectasis: a health professional perspective. *Thoracic Society of Australia and New Zealand Annual Scientific Meeting,* Gold Coast April 2nd 2019 at the Gold Coast Convention Centre
2. Lawton K, Royals K, Carson-Chahhoud KV, Veale AJ Management of Bronchiectasis: a patient perspective. Thoracic Society of Australia and New Zealand Annual Scientific Meeting, Gold Coast March 30th 2019 at the Gold Coast Convention Centre

Poster conference presentations:

3. Lawton K, Royals K, Carson KV, Smith BJ Management of Bronchiectasis: A review of patient clinical assessment compared to the British Thoracic Society Guidelines TSANZ National Conference; Gold Coast Convention, March 2015, Gold Coast
4. Lawton K, Royals K, Carson KV, Smith BJ. Management of Bronchiectasis: Antibiotic use for the management of non-cystic bronchiectasis: A hospital audit in comparison to British Thoracic Guidelines TSANZ National *Conference; Gold Coast Convention, March 2015, Gold Coast*

Oral presentations on behalf of K Lawton

6. Royals K, Lawton K Bronchiectasis: Moving evidence to practice.
   Royals K presented as invited speaker - New Zealand Thoracic Society Conference, The Heritage Hotel, Queenstown, New Zealand 14/08/2019
7. Jayaingghe H, Lawton K, Royals K, Carson K, Smith B
   British Thoracic Society guidelines for the management of bronchiectasis: A comparison audit of hospital compliance of intravenous antibiotic use
   Jayaingghe H - presented due to scheduling conflict -TSANZ National Conference; Gold Coast Convention, March 2015, Gold Coast

Other (non-conference) invited oral presentations:

8. K Lawton invited to speak at the Thoracic Society SA Branch allied health day (At The Old Lion Hotel, North Adelaide May 9 2020), related to master's research, with a specific focus on the clinical aspects of evidence translation (approximately 45 nurses, scientists and other allied health professionals) Deferred to 2021 due to COVID 19
9. K Lawton invited to present at the Australian and New Zealand Society of Respiratory Science (ANZSRS) SA/NT branch meeting Tuesday 13th July 2021. Held virtually on Zoom.
   'Management of Bronchiectasis: moving evidence to practice'

For education completed during this master's program see Appendix 3

For milestones completed and other significant events see Appendix 4

Summary

Bronchiectasis is a chronic, progressive disease of the airways which is characterised by persistent cough, excessive sputum, difficulty in clearing airway secretions and recurrent infections. In the last decade several guidelines for the management of bronchiectasis have been developed. These guidelines are largely based on expert opinion as there continues to be a paucity of good quality research to guide management recommendations. Management guidelines are a convenient resource for clinicians that summarise the evidence and opinion of guide treatment choices.

As a Respiratory Nurse Consultant working with adult Respiratory Chronic Disease patients, our service only sees approximately 15 bronchiectasis patients a year. When they are referred, they are usually significantly impacted by their health status, with a heavy symptom burden and a poor quality of life. This led me to question how adult bronchiectasis patients are being managed in our hospital and whether management might be improved if our nursing service had a greater role. This thesis focuses on adults with non-cystic fibrosis (non-CF) bronchiectasis and further reference to bronchiectasis within this paper relates to the non-CF bronchiectasis.

An introduction to what is bronchiectasis, a background to how prevalent it is, what the recommended management is, the main guidelines available and how nurse-led care may play a role in management is featured in Chapter one.

Chapter two identifies the overarching aim of this thesis is to identify ways to improve bronchiectasis management in adults. This will be achieved by 1) determine if management of bronchiectasis in outpatients at The Queen Elizabeth Hospital (TQEH) is compliant to the Thoracic Society of Australia and New Zealand (TSANZ) and British Thoracic Society (BTS) guideline, 2) evaluating the efficacy of care through review of exacerbation frequency, hospital and service utilisation, use of multidisciplinary team and 5 year mortality and 3) explore the respiratory nurse-led model of management of bronchiectasis to evaluate the effectiveness of nurse-led care verses doctor-led care in the management of stable bronchiectasis.

In order to identifying ways to improve bronchiectasis management a review of current care was needed. This was achieved by firstly mapping the BTS and TSANZ

guidelines to identify key management recommendations for outpatient care. A data extraction template was developed with the help of two respiratory consultants to assess patient medical records to determine how compliant management was with the recommendations. We then conducted a 3 separate time point retrospective audit each reviewing current bronchiectasis care in an outpatient setting to evaluate adherence to guidelines over a 12-month period in 2011, 2013 and 2016/ 2017 *(Chapter 4)*. This currently unpublished manuscript identified there was incomplete compliance to guidelines with changes for better and worse over time. Improvements were seen in the taking of history for exacerbations, provision of action plans and emergency packs. The use of antibiotics both short and long-term did not have high compliance with recommended care. Vaccination and interval sputum sampling also showed low adherence. Clinical assessments at outpatient review for sputum, cough, breathlessness, and activity tolerance were often omitted in documentation. Breathlessness assessment may be used as an indicator for physiotherapy review. Our cohort of patients had lower referral rates to physiotherapy compared to the BTS 2017 audit. Respiratory Nurse referral increased from 34% in 2011 to 58% in 2016/17, however most of these referrals were for one-off education or coordination of home oxygen not rather than help with bronchiectasis management. This audit concluded that management of bronchiectasis in outpatients could be improved by sharing the audit findings with clinicians and the development of management prompts such as checklists or documentation abbreviated templates such as electronic medical record (EMR) acronyms. It is thought that Respiratory Nurses having a larger role in management of stable patients with bronchiectasis through a protocol/ guideline-based clinic may lead to an improvement in care, but referrals need to be made more consistently to evaluate this.

Evaluation of the effectiveness of respiratory nurses in the management of bronchiectasis occurs in the Cochrane Review “Nurse-led care verses doctor-led care for bronchiectasis” (Chapter 5). This review was an update of an existing published review and updated the available evidence on bronchiectasis management and nurse-led care models. It also revised this Cochrane review to comply with the recommended methodological structure and renamed the review. We found one study, that was 20 years old, which was included in the original review, this study involving 80 participants from the United Kingdom was a single centre randomised control crossover trial. The study concluded that nurse-led care

was not inferior to doctor-led care in stable bronchiectasis. The review concluded that further research was needed to determine 1) cost effectiveness of nurse-led care in bronchiectasis management, 2) if guidelines and protocols for bronchiectasis management are followed and 3) establish if nurse-led management of bronchiectasis was effective in other clinical settings such as inpatient and outreach.

Chapter six discusses the significance and contribution to knowledge of the two manuscripts featured in Chapter four and five of this thesis. It also provides insights into limitations and problems encountered and future directions for ongoing research. Early examination of ongoing research which explores qualitative and quantitative opinions of health professionals working with bronchiectasis patients has identified that there is a lack of knowledge about bronchiectasis guidelines, and this may contribute to some of the inconsistencies in care. Further translational research is needed to explore how future evidence and updates to guidelines are distributed to bridge the gap between resource development and implementation into policy and practice. Evidence in this thesis also suggests there may be value in exploring a greater role for Respiratory Nurses in managing stable disease and further research should be undertaken to evaluate the nurse-led model in bronchiectasis.

In conclusion this thesis confirms there are inconsistencies in bronchiectasis management and that documentation practices and lack of guideline awareness may be contributing factors. We identified that research is needed to determine how best to disseminate future guideline updates. We also confirm that respiratory nurses are underutilised but can safely manage stable bronchiectasis in a nurse-led clinic however more research is required to confirm how a nurse-led clinic would work in a modern setting.

Chapter 1. Introduction

Bronchiectasis was first described by Laennec in 1819 (1, 2), and in 1846 Hasse named it bronchiectasis (3, 4). In 1986 Cole and Stockley proposed the 'vicious cycle hypothesis' (3). This concept described how certain individuals with impaired airway defences are more susceptible to bacterial infection which leads to inflammatory responses and airway damage and an ongoing cycle of infection, inflammation, and airway damage with entry points from either a new infection or inflammatory response to an environmental exposure (3, 5). This knowledge about the role of infection and inflammation in bronchiectasis was thought to have been a turning point in disease management (5). This greater understanding of the role of recurrent infection and inflammation highlighted the importance of use of antibiotics and other preventative strategies such as vaccination and physiotherapy airway clearance (3, 6). The introduction of vaccinations for pertussis in the 1950's, measles in the 1960's (7), and subsequent improvements in living standards improved infection and inflammation exposures (7). Better management of infection and inflammation saw a reduction in numbers of cases worldwide through the 1960's to 80's and at this time bronchiectasis was thought to have been largely "conquered" (1). However the introduction of high-resolution computed tomography (HRCT), in the 1980's, led to an increase in detection of early disease (7) and in the last decade bronchiectasis has been recognised as a common problem which has been largely neglected by health and policy makers (8-10).

There are few evidence-based treatment options for bronchiectasis (11). The increased prevalence of bronchiectasis has driven the development of national and international management guidelines (11), and audits targeting management practices have been conducted (12, 13). Bronchiectasis registries have also been established to inform management and research (11, 14).

Bronchiectasis management is currently based on recommendations in guidelines that were developed relying on low level evidence such as "expert opinion" (15, 16). In Australia the two guidelines most consistently referred to are the BTS and TSANZ bronchiectasis guidelines (15, 17). In 2019 Lung Foundation Australia named bronchiectasis one of eight conditions needing urgent attention because of ongoing poor patient outcomes (18).

1.1 What is Bronchiectasis and what are the causes?

Bronchiectasis is a respiratory condition characterised by a chronic productive cough, and recurrent lower respiratory tract infections (16, 19). Airway inflammation, and difficulty in clearing their excessive sputum are often additional features (1). Diagnosis is confirmed by the finding of abnormal bronchial dilatation on high resolution computer tomography (HRCT) in patients with a compatible history suggestive of bronchiectasis (15). Bronchiectasis is a heterogeneous disease and classified on the basis of cause (1). The causes of bronchiectasis include inherited defects in immunity or mucociliary clearance, autoimmune disorders, past pneumonia (particularly in childhood) and other systemic diseases such as inflammatory bowel syndrome, connective tissue disease and yellow nail syndrome (16, 20). Many patients may never have a cause identified (19).

1.1.1 How common is bronchiectasis

In most countries the available data regarding bronchiectasis prevalence is poor and related to hospital admission data (8, 9). It is believed by many informed experts that this captures the tip of a bronchiectasis “iceberg” (21). It is thought likely that there is a relatively large number of patients in the Primary Care setting with undiagnosed or misdiagnosed bronchiectasis (8, 21) because the presenting symptoms of bronchiectasis such as cough, sputum production and infection are similar to those of other common respiratory diseases (17, 21).

Estimates in Germany have shown a ~10% rise in prevalence of bronchiectasis from 52.5/100,000 in 2009 to 94.8/100,000 in 2017 (9). Similarly, in the United States of America (USA) growth was seen at 8% annually from 52/100,000 in 2001 to 139/100,000 by 2013 (9). In the United Kingdom (UK) there has also been a rise in prevalence of bronchiectasis between 2004 and 2013: Men 301 to 486/100,000 population and women 351 to 566/100,000 population (8, 9). These observations suggest that bronchiectasis is becoming more prevalent in many countries (8, 9).

In Australia 2017 mortality data shows Bronchiectasis was the underlying cause of 398 deaths and the associated cause of death for an additional 573 persons (22). Morbidity data on bronchiectasis shows it was responsible for 7,682 primary and 10,871 secondary admissions in Australia, 2016-17 (22). This accounts for about 0.2% of all Australian hospital separations (22). The prevalence of bronchiectasis in Australia has shown a rise in cases from 20/100,000 in 2007/08 to 28/100,000 in

2016/17 (22). In 2017 the Australian Institute of Health and Wellness statistics identified bronchiectasis as a primary diagnosis has a length of stay of 6.1 days this is higher than the average of all admissions which is 2.8 days (22). In Central Australia prevalence of bronchiectasis is known to be much higher with estimates of 1470/100,000 aboriginal children (23) making it one of the highest in the world (24). There are limited studies in aboriginal adults with bronchiectasis to give an accurate picture of prevalence (25, 26). A comparison study of aboriginal and non-aboriginal bronchiectasis patients of the 'Top End Health Service' referred to Royal Darwin Hospital Respiratory and Sleep service showed 66.5% of these patients were aboriginal (25). The aboriginal patients with bronchiectasis were younger, had higher self-reported smoking and drinking, they were more likely to live in remote and regional communities and had higher rates of comorbidities and significant higher rates of concurrent COPD (25).

This rise in the number of bronchiectasis cases may be because of an increase in diagnosis which could be the result of greater use of HRCT, and increased awareness of bronchiectasis through the establishment of research collaboratives and global disease registries (9).

1.2 Guidelines and their role in bronchiectasis management

Management guidelines for bronchiectasis were first developed in 2008 by the Spanish Society of Pneumology and Thoracic Surgery (SEPAR) (27, 28).These were closely followed by the TSANZ position paper on 'Chronic suppurative lung disease and bronchiectasis in Australia and New Zealand' (29) and the BTS Bronchiectasis Guidelines (30). In 2017 European Respiratory Society (ERS), Saudi Thoracic Society (STS) released guidelines (10, 31). Subsequent updates to these guidelines have been released incorporating the latest research knowledge and clinical expertise to guide clinicians in their decision making in bronchiectasis management (15, 17). Their reliance on expert opinion highlights the need for research to support the evidence base for future recommendations (30). In Australia, clinicians most often refer to either the TSANZ and/or BTS bronchiectasis guidelines (15, 17, 29, 30). The main differences between the BTS and TSANZ guideline relate to how long antibiotics should be used for during exacerbation and when to commence long term antibiotics; with BTS recommending 14-days of use

of oral antibiotics (15) with TSANZ recommending 10-days (17) and long term antibiotics being considered after 3 exacerbations over a period of 12-months in BTS (15) and 6 exacerbations in 12 months for TSANZ (17). Recent updates to BTS bronchiectasis guidelines have included use of quick reference charts to assist clinicians with the management of deteriorating patients (Figure 1) and stepwise management plans for routine visits (Figure 2) (15, 32). A summary of bronchiectasis management will expand on this further in Section 1.3.

Figure 1: Management of deteriorating patient BTS 2019 Guideline (15)

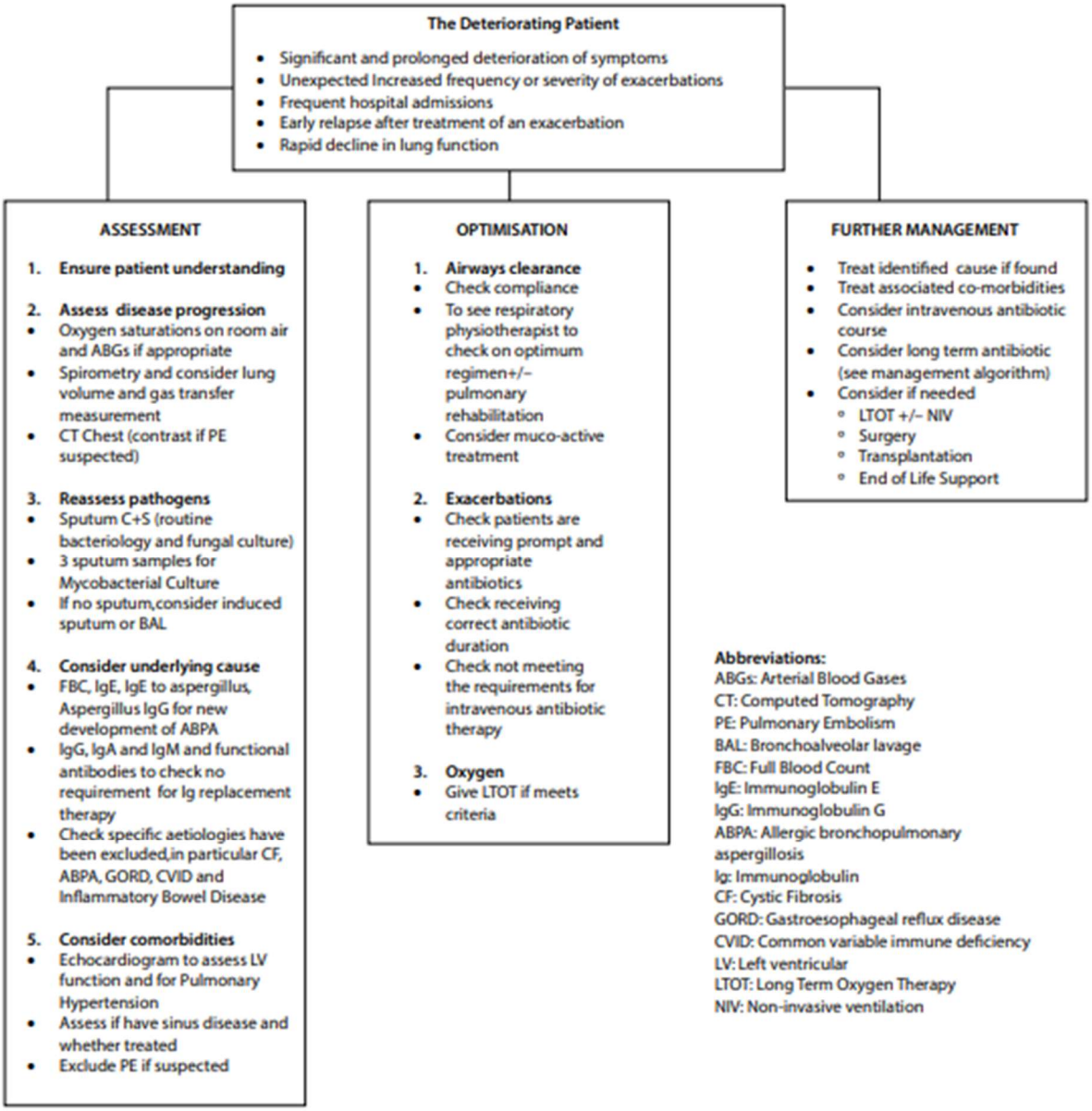
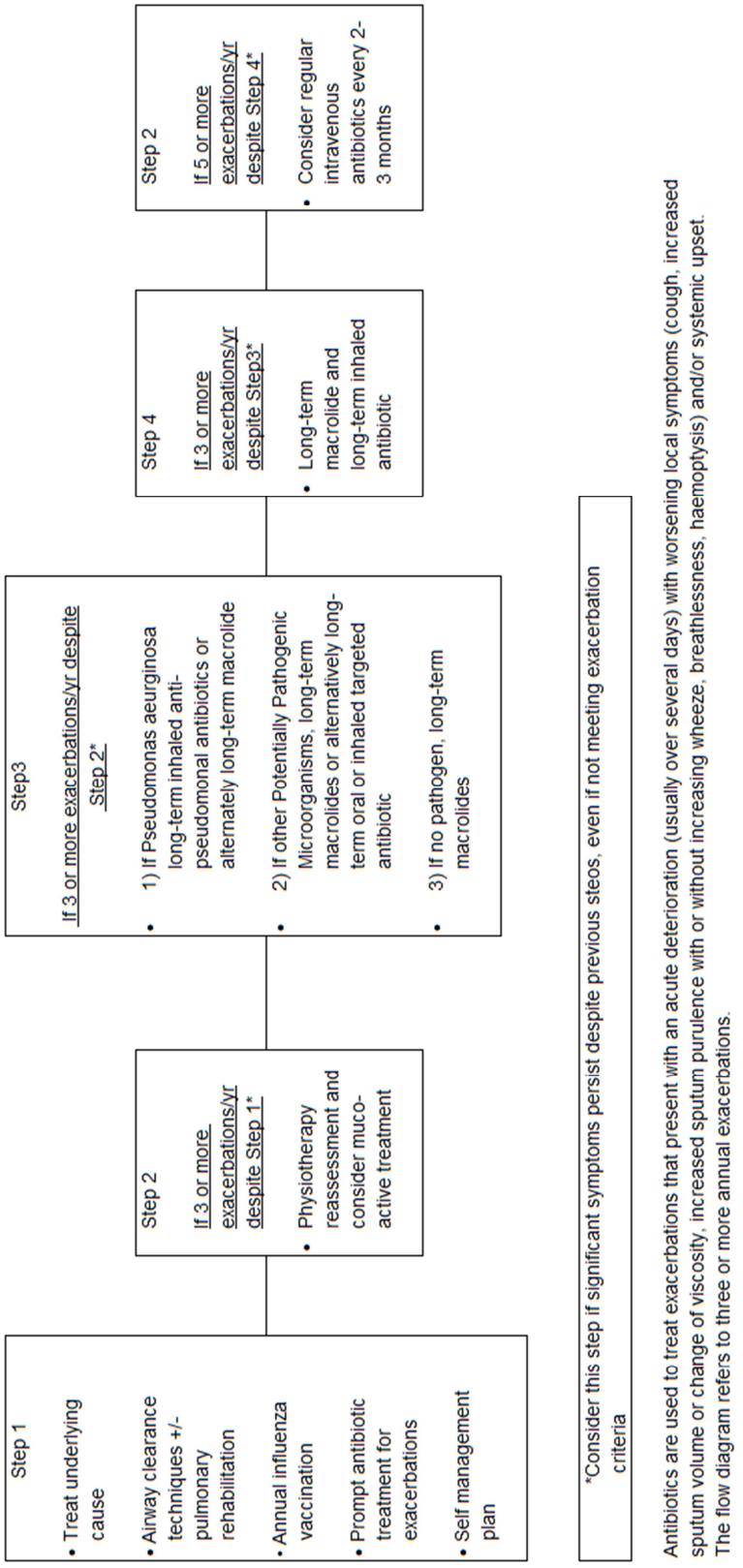


Figure 2: Stepwise management approach BTS 2019 Guideline (15)



It is recognised that although there are guidelines to assist management of patients with bronchiectasis they are not always followed by clinicians (33).

BTS audit program assesses, on regular basis, the adherence to its management guideline for bronchiectasis (12, 13, 34). These audits have shown there is a lack of adherence to the guideline by clinicians (12). They suggest that the poor adherence to guidelines may reflect ignorance regarding the existence of the guidelines, the lack of evidence base in the guidelines or attention being diverted to other coexisting lung disease (12, 34). Resourcing issues and accessibility to specialist care may also play a role (12). In Australia the adherence to bronchiectasis guidelines is largely unknown but early data from the Australian bronchiectasis registry suggest compliance with management strategies such as sputum collection is poor (35).

1.3 Management of bronchiectasis

Bronchiectasis management aims to prevent disease progression by managing symptoms and preventing/ reducing the frequency of exacerbations/ infections (16). If an underlying cause such as immune deficiency has been identified then this needs to be addressed (1). Approaches to management involve a combination of both pharmacological and non-pharmacological treatments.

1.3.1 Pharmacological management

Pharmacological management for bronchiectasis is predominately based on timely use of antibiotics for exacerbations (20). Exacerbations of bronchiectasis are determined by symptom changes with particular attention on the volume of sputum, change in consistency and colour (16, 36). Other features of exacerbations include increases in levels of breathlessness, and fatigue (20). Haemoptysis may also be a feature of infection in some patients (37). A sputum culture to identify any organism causing exacerbation is recommended to guide suitable antibiotic treatment (16). Agents such as inhaled mannitol and hypertonic saline are sometimes recommended to assist with sputum clearance (38). Vaccination for influenza and against pneumococcal infections are generally also recommended (39). Inhaled bronchodilators and inhaled or oral corticosteroids are generally not used in the

management of bronchiectasis but may be prescribed for treatment of comorbidities, such as asthma or COPD (16).

1.3.1.1 Short-term antibiotics

Empirical antibiotic use is generally recommended for early treatment for exacerbations (16). Changes may become necessary when sputum culture results and sensitivities become available (40). Recommended duration of oral treatment of antibiotics ranges between 10 days [TSANZ guidelines] to 14 days [BTS guidelines](15, 17). Intravenous antibiotics are used for severe exacerbations or when oral treatments fail to respond (16). These are generally administered in hospital but sometimes there are opportunities for community administration (41).

1.3.1.2 Long-term antibiotics

Long term antibiotics are recommended where patients have frequent exacerbations (16). Thresholds for long term antibiotic commencement vary between guidelines (29, 30). TSANZ guidelines recommend the commencement of long term antibiotics when there have been more than six exacerbations or two hospital admissions in one year or six months of continuous symptoms (17, 29). BTS guidelines recommended commencement of long-term antibiotics with greater than three exacerbations per year or less if significant morbidity is present (15, 30).

Macrolide antibiotics are a common choice for long-term use in bronchiectasis because it is believed they have anti-inflammatory properties (36). Shown to reduce frequency of exacerbations, particularly with pseudomonas colonised patients, macrolides have also improved quality of life (42). Prior to commencement of long-term macrolides sputum testing is recommended to exclude the presence of non-tuberculosis mycobacteria (NTM) as long-term macrolide use may result in the development of drug resistant mycobacteria (16). Monitoring is required to ensure complications do not arise with macrolides as they have the potential to cause hearing loss, tinnitus, and cardiac arrhythmias (37).

Long term nebulised antibiotics may be trialled in cases of high bacterial load, in patients colonised with pseudomonas however the evidence supporting their use lacks numbers and antibiotic stewardship in many organisations means that access to nebulised antibiotics is difficult (11). Commencement requires observation and monitoring to ensure that bronchoconstriction does not occur (15). Dry powder

inhalation of ciprofloxacin has been trialled in two large studies but neither study found sufficient evidence to support their use in bronchiectasis (15).

1.3.1.3 Mucolytic and mucoactive agents

The aim of mucoactive agents (e.g. expectorants to induce cough and mucolytics to thin secretions) is to increase sputum clearance (15). These agents have been advocated in CF but the evidence of effectiveness has not been demonstrated in bronchiectasis (38, 43). Increasing sputum hydration to assist mucociliary clearance is the purpose of nebulised saline and mannitol (16). Nebulised saline in concentrations of either 3%, 6% or 9% may improve quality of life through symptom control achieved by improving expectoration (15). Dry powder mannitol inhalation has been trialled and has shown potential for reducing exacerbations however no improvements in quality of life have been found (16). N-acetylcysteine has been historically used in bronchiectasis and research based on low patient numbers have shown that it may reduce the frequency of exacerbations, but more research is needed (20). There is strong evidence for not using recombinant human deoxyribonuclease (approved for use in CF bronchiectasis) because it is associated with increased exacerbations and hospitalisation (29).

1.3.1.4 Vaccination

Vaccination forms part of a preventative strategy for all respiratory chronic diseases (16). Both influenza and pneumococcal vaccination are generally recommended (15, 17) despite there being limited specific studies addressing their use in patients with bronchiectasis (39).

1.3.2 Non-pharmacological management

Non-pharmacological measures include addressing general lifestyle factors such as: encouraging smoking cessation, encouraging physical activity and good nutrition (16). It also includes the use of chronic disease strategies such empowering patients to self-management (44) and techniques that may be learned to improve airway clearance (45).

1.3.2.1 Sputum clearance

It is common for bronchiectasis patients to cough daily, and many patients produce large volumes of sputum (16). For many years the importance of encouraging

sputum clearance techniques has been emphasised by “experts in bronchiectasis management”, however research continues to be needed as low levels of supporting evidence exists (46). Recommended mucoactive techniques include active cycle of breathing technique (ACBT), and autogenic drainage (20, 45). Physiotherapists are often referred bronchiectasis patients to teach these techniques and they may recommend positive expiratory pressure (PEP) devices such as the Acapella® Choice Vibratory PEP Therapy System assists with sputum mobilisation (20, 45). During acute exacerbations physiotherapists can assist patients with sputum mobilisation thus reducing sputum retention (20).

1.3.2.2 Pulmonary rehabilitation

Pulmonary rehabilitation programs with an exercise and education component are often recommended for patients with bronchiectasis (47). These programs are often delivered in a short program of up to 12 weeks (15). In stable bronchiectasis pulmonary rehabilitation has shown significant short-term benefits for improving exercise capacity and health related quality of life (47). In COPD post-exacerbation pulmonary rehabilitation has been shown to improve activity levels and reduces admission risk (48) but for patients with bronchiectasis rehabilitation has not been shown to reduce the need for admission (47). Ways to maintain benefits gained from rehabilitation programs need research to determine how to best sustain benefits gained beyond 12 months (45).

1.3.2.3 Self-management

Guidelines for management of bronchiectasis recognise the importance of daily airway clearance techniques, healthy lifestyle choices and prompt intervention for exacerbation which include written plans to direct actions (49). Self-management strategies develop the individual’s knowledge and skills to recognise exacerbations and promptly initiate treatment (50, 51). It is believed that early intervention can prevent hospitalisation for exacerbation (50). Ultimately patient engagement and motivation to persist with recommended treatments is required for successful self-management to occur (51).

1.3.3 Monitoring patients with bronchiectasis

In addition to monitoring patients’ wellbeing, it is recommended that Health Professionals follow up with annual pulmonary function testing, and sputum culture

microscopy (15, 16). Sending a sputum for culture between exacerbations can guide treatment in subsequent exacerbations and look for emergence of colonising bacteria such as pseudomonas, fungi (aspergillus) and atypical mycobacteria (15). CT scanning at baseline diagnosis and may be useful in the deteriorating patient or if acute pulmonary haemorrhage doesn't respond to supportive management (15). Monitoring as suggested by BTS guidelines is presented in Table 1 (15).

Table 1 BTS Recommended routine monitoring tests (15)

	Mild-disease severity	Moderate - Severe
Severity Index scoring	baseline	baseline
BMI (Body Mass Index)	annual	annual
Exacerbation History	annual	6 monthly
Sputum Culture	annual	6 monthly
MRC Dyspnoea Score	annual	6 monthly
Spirometry	annual	annual
CT (Radiological Extent)	at diagnosis*‡	at diagnosis*‡
Sputum mycobacterial culture†	baseline‡	baseline‡
Oxygen saturation monitoring (SpO2)	annual	6 monthly
Underlying cause investigations	at diagnosis‡	at diagnosis‡
Comorbidities assessment	at diagnosis‡	at diagnosis‡

*Consider repeat CT scanning in patients with primary immunodeficiency with scan interval of 3-5-years.[380]
†This may need tailored in light of the local prevalence rates of NTM infections and in some centres may need undertaken on a regular basis. Further cultures at exacerbation may be appropriate.
‡Repeat investigations if a deteriorating patient.

1.4 Nursing-led care models and bronchiectasis

Nurse-led care has been shown to produce equal and sometimes better outcomes than doctor-led care in a range of health conditions (52). Health system and patient benefits to nurse-led care include shorter outpatient wait times for Doctor-led clinics, potential for longer consultation time with nurses, improved patient satisfaction, and more personalised care for chronic conditions incorporating behaviour change support (52, 53). Nurses-led services utilise chronic condition/ disease specific guidelines and structured protocols to deliver best practice care (52). The chronic progressive nature of bronchiectasis and the existence of published guidelines makes it a suitable condition for nursing intervention (44, 54). In other respiratory conditions such as asthma, COPD and sleep disorders specialist nurse-led models have been shown to be an effective model for protocol/ guideline-based care (55-58). Evidence to support nurse-led models in bronchiectasis remains limited to one study (59, 60). A review of nurse-led care vs doctor-led care for the management of bronchiectasis is included in Chapter 5.

1.5 Bronchiectasis management: Why is it important?

Improving bronchiectasis management is important because it has the potential to see better control of daily symptoms and a delay disease progression. Disease progression is associated with reductions in quality of life, increased health costs and significant mortality, and morbidity (61, 62). The concept for this thesis was developed while working as a respiratory chronic disease nurse at TQEH. It was postulated, by our Respiratory Nursing Service (RNS) team, that doctor-led bronchiectasis management was seemingly “ad hoc” in our outpatient clinics and that there was potential for improvements in care if nurse-led protocol driven clinics were introduced to assist in patient management. The limited referrals received and the severity of bronchiectasis patients when referred led the RNS to this conclusion.

Chapter 2. Overview of aims

The overarching aim of this thesis is to identify ways to improve bronchiectasis management in adults.

A summary of the aims for each manuscript presented in this thesis are below.

Interventions for 'Bronchiectasis management: a clinical audit of respiratory outpatient care in a South Australian hospital *(Chapter 4)*

The aim of this study is to undertake a clinical audit of outpatient bronchiectasis care to 1) determine how treatment compares to British Thoracic Society (BTS) and Thoracic Society of Australia and New Zealand (TSANZ) guidelines and the BTS bronchiectasis standards. It also aims to 2) evaluate the efficacy of care through review of exacerbation frequency, hospital, and service utilisation, use of multidisciplinary team and 5-year mortality.

Interventions for 'Nurse-led' care vs 'Doctor-led' care for bronchiectasis *(Chapter 5)*

The aim of this Cochrane systematic review is to evaluate the effectiveness of nurse-led care verses doctor-led care in the management of stable bronchiectasis.

Chapter 3. Methods

For the detailed description of methodology for each of the studies presented in this thesis please refer to the individual manuscripts.

These are the manuscript featured in:

Chapter 4 ‘Bronchiectasis management: A clinical audit of respiratory outpatient care in a South Australian hospital’ (Unpublished manuscript)

Chapter 5 ‘Nurse-led versus doctor-led care for bronchiectasis (Review)’.
(Published manuscript)

Chapter 4.

Bronchiectasis management: a clinical audit of respiratory outpatient care in a South Australian hospital

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Chapter Overview

Bronchiectasis management guidelines assist clinicians to provide quality, consistent care for patients by presenting, at a glance, an up-to-date summary of the current recommendations. These are also useful as they highlight where additional research is needed.

Auditing bronchiectasis management in an outpatient setting has been conducted in the United Kingdom by the BTS since the release of the most comprehensive first guideline in 2010. It is only in the last few years other countries have recognised the value in reviewing current practices to determine what is happening in management. In Australia available data remains sparse with the only national publication being of registry data in 2019 and prior to that there are two single centre audits presented at conference (including this study).

Data from the registry presents a pure bronchiectasis picture with much of the coexisting respiratory disease being excluded. This is not the real-world picture because a high proportion of bronchiectasis patients will also have asthma or COPD.

Gaps in care identified in our audit include key management strategies such as antibiotic duration, vaccination, interval sputum sampling, and clinical assessment. Positively, a significant change was seen between 2011 and 2016/17 for the promotion of action plans ($p=0.0479$), and the clinical assessment of history of antibiotics use and exacerbation ($p=0.0224$).

Some of these gaps in care we identified are no doubt secondary to omissions in documentation however a lack of knowledge or trust in guidelines cannot be excluded. Interventions that might improve management compliance to guidelines include sharing findings with clinicians, (i.e., provide feedback regarding their current clinical performance), the development of checklist or electronic medical record (EMR) pre-populated prompt notes (acronyms) or the adoption of a nurse led model of care for stable disease.

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ABSTRACT

Background and Objective: The role of guidelines to assist Bronchiectasis management in Australia is unknown. This study aims to assess the outpatient management of bronchiectasis at The Queen Elizabeth Hospital (TQEH) South Australia (SA) using current "best management guidelines" as the "standard of practice".

Design: A Retrospective audit of medical records in patients receiving specialist follow-up for bronchiectasis at TQEH. A data extraction template developed from bronchiectasis management guidelines commonly accessed in Australia, produced by The Thoracic Society of Australia and New Zealand (TSANZ) and the British Thoracic Society (BTS), was used to assess compliance and hospital resource utilisation during a 12-month observation period.

Results: Guideline compliance was inconsistent across the three years studied. Improvements were seen in documenting the history of exacerbations [F28] in 2011 to 2016/17 (p=0.0224), and provision of action plans [23] 14% in 2011 to 50% in 2016/17 (p=0.0479). The use of long-term antibiotics [F11] increased significantly from 21% in 2011 to 67% in 2016/17 (p=0.0288). Weight assessment [F33] also declined in 2011 to 2016/17 (p=0.0153). Vaccination status between 2011 and 2013 increased for influenza [F16] rising from 17% in 2011 to 33% in 2013 and 2016/17 and the pneumococcus [F17] increasing from 10% in 2011 to 17% in 2013 and 2016/17. Interval sputum sampling when well [F21] increased from 17% to 29% from 2011 to 2013 but returned to 17% in 2016/17. Assessment of breathlessness [F31] at outpatient review was documented in 2011 increasing to 34% in 2016/17. Mortality at 5-years was approximately 50% for 2011 and 2013. Respiratory Nurse referrals increased from 34% of patients in 2011 to 50% by 2016/17. Only 50% of the referrals in 2011 and 43% in 2016/17 were specific requests for assistance with management. The other referrals were for domiciliary oxygen and other support services.

Conclusions: Bronchiectasis management at TQEH is modestly compliant to guidelines for provision of management plan and assessment of exacerbation history at clinic review. It appears however there were gaps in guideline compliance with respect to antibiotic use, sputum interval sampling, and subjective patient assessments undertaken at clinical review. Poor documentation may have

contributed to some of the apparent gaps in compliance to guidelines. Respiratory nurses were underutilised for disease support, further research is needed to determine if a respiratory nurse care model can improve guideline adherence for bronchiectasis, and outcomes for patients and health services.

SUMMARY AT A GLANCE

We found that care for patients with bronchiectasis in respiratory outpatient at TQEH was only modestly compliant with guidelines. Significant shortfalls in care included non-adherence with the recommended duration of short-term antibiotics use, inadequate influenza and pneumococcal vaccination status documentation, low levels of sputum testing for both surveillance between exacerbations and prior to antibiotic use during exacerbations. Documentation of nutritional status and weight was also poor. Omissions in documentation likely contributed to gaps in compliance. Respiratory nurses were underutilised for disease management support, more research is needed to see if guideline adherence and patient / health service outcomes improve with respiratory nursing support.

INTRODUCTION

Bronchiectasis is a chronic respiratory disease characterised by cough, increased sputum production and frequent infections/exacerbations (1).

Management of bronchiectasis seeks to reduce symptoms, improve quality of life, reduce exacerbations, and prevent disease progression (2, 3). Exacerbations are generally secondary to airway infection with viruses or bacteria, recommended management may include the use of an “emergency pack” containing antibiotics (2). Patients are encouraged to monitor their usual symptoms looking for changes in their cough and sputum colour, consistency, and volume that often indicate an exacerbation (2).

The prevalence of bronchiectasis worldwide is thought to be increasing (1), so improving the management of patients with this condition is becoming a higher priority (4, 5). In Australia in 2019 bronchiectasis was identified as “a priority area for action” by the Lung Foundation Australia (4). Concern was expressed that bronchiectasis is both underdiagnosed and undertreated (4, 5). In an attempt to

rectify this, a national disease registry was established by the Lung Foundation Australia in 2015 (4, 6).

Evidence based treatment guidelines have been developed to improve the management of patients with bronchiectasis and to foster a consistent approach to care (1). These guidelines aim to improve the quality of life of patients by reducing exacerbations and preserving or improving lung function and functionality (1, 7). Key recommendations of these guidelines include screening for a cause, managing infection, and exacerbation prevention strategies (3, 7).

In 2010 The British Thoracic Society (BTS) published comprehensive guidelines for the management of patients with bronchiectasis and undertook an audit to understand what changes occurred after their release (8, 9). The audit found that compliance with the guidelines was very variable (8, 10). Subsequent measures to address this variable compliance included the release of a standards of care document in 2012 (11) and the establishment of an ongoing multicentre audit program to evaluate ongoing care.

In 2010 The Thoracic Society of Australia and New Zealand (TSANZ) released a position paper on bronchiectasis management, which was updated to a guideline in 2015 (3, 12). Unlike the UK, where audit evaluations are embedded as part of standard practice, the uptake of guideline recommendations into Australian clinical practice have not been evaluated (1).

The aim of this study was to a) determine how bronchiectasis treatment in outpatients at our hospital compares to the recommended management factors identified from management guidelines typically referred to in Australia; these being TSANZ and BTS bronchiectasis guidelines. We also aimed to evaluate b) the efficacy/outcome of care through review of 1) exacerbation frequency, 2) hospital and service utilisation, (including respiratory physiotherapy and respiratory nursing) and 3) 5-year mortality.

METHODS

Study Cohort

A retrospective audit was conducted to evaluate the outpatient management of adult patients with bronchiectasis. Patients were identified from TQEH emergency department and admission data. Presentations included had either a primary or secondary diagnosis of bronchiectasis during the three 12-month time periods: 2011 and 2013 (January to December) and 2016/17 (July to June). The year was split in 2016/17 July to June because of disruption related to the introduction of an electronic medical record (EMR) system in May 2016. Identification of patients was based on coding of primary or secondary bronchiectasis using ICD 10 code J47.

Inclusion criteria

All patients included in the study had high resolution computerised axial tomography (HRCT) proven bronchiectasis and were attending respiratory specialist outpatients with a physician who was affiliated with the TQEH.

Data Collection

BTS and TSANZ bronchiectasis guidelines are the 2 guidelines most commonly used in Australia (3, 8). The recommendations from each guideline (3, 9, 12) were individually written on an excel spreadsheet, side by side. The key similarities and differences were identified, and the management factor recommendations related to outpatient care were identified. A data extraction template was developed to assess compliance with the management factors. Consultation with 2 respiratory physicians was conducted to ensure the questions in the template were appropriate. The data extraction template was piloted in five patients and minor modifications were made. The final version assessed adherence to 36 key management factors divided under 5-domains (Table 1). These domains were 1. Cause screening, 2. Medication use, 3. Chronic disease management, 4. Other management strategies and 5. Clinical review (which included both objective and subjective assessment).

Table 1: Bronchiectasis management template

Bronchiectasis management factors		
Cause screening		
F1	Was a cause for the bronchiectasis identified?	Yes/No
F2	Had attempts been made to identify a cause?	Yes/No
Medication use		
F3	inhaled bronchodilator	Yes/No
F4	inhaled steroid	Yes/No
F5	oral steroid	Yes/No
F6	hypertonic saline nebulisers	Yes/No
F7	Inhaled Mannitol	Yes/No
F8	Leukotriene receptor antagonists	Yes/No
F9	N-Acetylcysteine nebulisers	Yes/No
Long-term antibiotic use*		
F10	Nebulised	Yes/No
F11	oral	Yes/No
Short term duration of antibiotics		
F12	14 days of treatment (BTS recommendation)	Yes/No
F13	10 days of treatment (TSANZ recommendation)	Yes/No
Chronic Disease Management strategies		
F14	Airway Clearance	Yes/No
F15	Pulmonary Rehabilitation	Yes/No
F16	Influenza vaccination	Yes/No
F17	Pneumococcal pneumonia vaccination	Yes/No
F18	Active smoking avoidance	Yes/No
F19	Passive smoking avoidance	Yes/No
F20	Annual Pulmonary Function Testing (PFT)	Yes/No
F21	Sputum culture when well	Yes/No
F22	Sputum prior to antibiotic use	Yes/No
F23	Action plan	Yes/No
F24	Emergency pack (antibiotics)	Yes/No
Other management strategies		
F25	Any use of non-invasive ventilation (NIV)	Yes/No
F26	Any lung surgery for managing bronchiectasis	Yes/No
Clinical review		
F27	Spirometry	Yes/No
F28	Asked about exacerbation/ use of antibiotics	Yes/No
F29	Asked about Sputum	Yes/No
F30	Asked about Cough	Yes/No
F31	Asked about Breathlessness	Yes/No
F32	Asked about Activity tolerance	Yes/No
F33	Oximetry assessment	Yes/No
F34	Weight assessment	Yes/No
F35	Education provided	Yes/No
F36	Referral made	Yes/No

F Denotes management factor

Bolded headings indicates domains

* Long term antibiotics as defined by BTS (continuous or >28days duration)

The data extraction template was completed using the patients' medical record as the primary data source. For participants in the years 2011 and 2013 the patient's

hospital record and files held by respiratory nurses and physiotherapists were reviewed. Following the introduction of TQEH electronic patient administration system (EPAS) in 2016 this became the sole source of data. This system was later renamed SUNRISE. Additional data collected included demographic information, details regarding comorbidities (including coexisting respiratory conditions) as well as treatments, assessments, education, and referrals.

An effort was made to determine when the patient was diagnosed with bronchiectasis and to identify if there was a known cause. Management factors [F3-36] were assessed, by case note review, for a 12-month period following the qualifying admission. However, where a patient died during the 12-month follow up period the previous 12-months prior to admission was evaluated (if the data was available). Data extraction was completed by one assessor with a second reviewer validating extraction in a random ten records.

A secondary outcome was to review efficacy of care by evaluation of 1) frequency of exacerbations, 2) hospital service utilisation (including respiratory physiotherapy and respiratory nursing) and 3) 5-year mortality.

Data analysis

Data was entered in Excel and validation of data entry was made by a second reviewer for at least 10% of records. Descriptive statistics were presented for all variables in the analyses: frequency and percentage for categorical variables, mean and standard deviation (SD) for normally distributed continuous variables, and median and interquartile range (IQR) for skewed continuous variables. A P value will be calculated for each comparison, based on a Chi-squared test for categorical variables, using a Fisher's Exact. Test for sparse data used a one-way ANOVA for normally distributed continuous variables and a Kruskal-Wallis test for skewed continuous variables.

Regression models are used to assess differences in various outcomes across the three-year periods: 2011, 2013 and 2016/2017. Binary logistic Generalised Estimating Equations (GEE) models were used for dichotomous outcomes, ordinal logistic GEE models were used for ordinal outcomes and linear mixed-effects models were performed for continuous outcomes, all adjusting for clustering on patient ID as a random effect (some patients appeared in more than one year). Assumptions of a linear model were checked. Bonferroni correction could have been

used to adjust for multiple comparisons however given this research is exploratory the application of the Bonferroni correction is questionable and so is not reported.

The statistical software used was SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Ethics approval

Ethics approval for our study was granted by the Central Adelaide Local Health Network Ethics Committee (HREC/14/TQEHLMH/121). Registration was completed with Clinical trials.gov NCT03550417.

RESULTS

A total of 48 patients with bronchiectasis were identified in 2011, 45 in 2013 and 35 in 2016/17. Following review of inclusion criteria 29 patients from 2011, 24 from 2013 and 12 from 2016/17 were deemed suitable for addition to the study. There were nineteen patients excluded from the 2011 cohort, 21 from 2013 and 23 from the 2016/17 year. The most common reason for exclusion was no recorded follow up. See Table 2 for summary of number of patients identified, included and those excluded with reasons.

Table 2: Inclusion and exclusion criteria

Inclusion and exclusion criteria			
Included patients	2011 (n)	2013 (n)	2016/17 (n)
Identified as bronchiectasis (J47 ICD10 code)	48	45	35
Included (post screening for confirmation)	29	24	12
Excluded patients	19	21	23
Reason for exclusion			
Private patient follow-up	2	5	1
Other hospital follow-up	3	4	6
Traction bronchiectasis	5	6	4
No follow up	7	5	12
Failed to attend appointments		1	
No confirmation bronchiectasis	1		
Other diagnosis	1		

Table 3 presents descriptive statistics for all variables in the analyses including patient characteristics, severity of bronchiectasis [as defined by TSANZ 2010 position paper](12), service utilisation and management factors: n (%), mean (SD) and median (IQR) as appropriate, with associated tests for significance. Those variables that had a statistically significant association with Year are: the patient severity characteristics of Pseudomonas (P value=0.0149), Mycobacteria avium (P value<0.0001), MRSA (P value=0.0066), and the management factors of [F11] long term oral antibiotics (P value=0.0288), [F23] Action plan reference (P value=0.0479), [F25] Additional considerations of NIV (P value=0.0060), [F28] assessment of exacerbation/ antibiotic use (P value=0.0224), [F30] Cough (P value=0.0272), and [F34] Weight (P value=0.0153)

Patient characteristics differed little between the three groups. There were some patients who featured in more than one audit year. We found that 29% of patients in 2013 group were in 2011 group and 25% in 2016/17 group were in either the 2011 or 2013 groups. Analysis in Table 4 accounts for patients appearing in more than one year by adjusting for clustering patient ID as a random effect.

Long-term oral antibiotics use [F11] increased from 21% in 2011 to 67% in 2016/17(p=0.0288). Of those using long term antibiotics 67% of patients were on Macrolides in 2011, 43% in 2013 and 50% in 2016/1 (Appendix 1: Table 5). Other long-term antibiotics used included doxycycline, and ciprofloxacin. In 2013 17% of patients had the duration of their antibiotic treatment recorded, and in 2016/17 this increased marginally to 25%.

Action plans [F23] demonstrated significant increase in their use between 2011 and 2016/17 (p=0.0479).

There was significantly higher use of NIV [F25] in 2016/17 compared to 2011 and 2013 (p=0.0060).

There was a notable decline in weight assessment [F34] (p=0.0153) being completed is likely the result of the impact in the shift of patients from public to private follow up across the 3-time periods. In private clinics there is usually no access to nurses who routinely weigh patients prior to appointment.

Other results of interest that did not produce statistical significance include a general poor compliance to documented duration of short-term antibiotics, with none of these meeting BTS guideline recommendations for 14 days duration of treatment [F12]. Those following the TSANZ recommended duration of 10 days of treatment [F13] were between 14% (2011) and 13% in 2013. In 2016/17 no-one met the TSANZ recommendations for antibiotic duration of treatment with all documented prescriptions for five or seven days. The use of 5-days of antibiotics may reflect the Australian pharmaceutical benefits scheme (PBS) which defaults the supply of many antibiotics to a 5-day course.

A reduction could be seen in the annual pulmonary function testing [F20] 62% 2011 to 33% in 2016/17 and general smoking history taking 45% 2011 to 25% in 2016/17 (Table 4). Sputum sampling pre antibiotics [F24] was low and ranged between13-25%. When well sputum sampling [F23] was also low and ranged between 17-29%. Sputum sampling was mostly done during admission. There was no recorded sputum sampling in 10% 2011, 25% 2013 and 25% 2016/17. Vaccinations for influenza [F18] (17-33%) and pneumococcal infections [F19] (10-17%) was also low.

Table 3. Descriptive statistics of all variables in the analysis

Variable	2011 N=29 n (%)	2013 N=24 n (%)	2016/17 N=12 n (%)	P value
Characteristics				
Age – Median (IQR)	72 (62, 82)	74.5 (69.5, 81)	77.5 (73, 80)	0.7161*
Sex – Female	19 (66)	17 (71)	9 (75)	0.8220***
Charlson Comorbidity Age adjusted score - Mean (SD)	5.2 (2.5)	5.8 (2.2)	5.6 (1.6)	0.7053**
Asthma – COPD	22 (76)	19 (79)	9 (75)	1.0000***
Exacerbation - 12 months period Median (IQR)	2 (1, 4)	2 (1, 4)	4 (1.5, 6)	0.2807*
Less than 5-year mortality	14 (48)	12 (50)	4 (33)	0.6798***
Severity of bronchiectasis				
Pseudomonas	14 (48)	8 (100)	6 (75)	0.0149***
Mycobacteria avium	2 (7)	4 (100)	1 (100)	<0.0001***
MRSA	0 (0)	1 (50)	1 (100)	0.0066***
Significant organism growth	15 (52)	12 (50)	7 (58)	0.8914****
Supplemental oxygen	4 (21)	3 (13)	4 (33)	0.3210***
Pulmonary hypertension	4 (20)	2 (8)	1 (8)	0.5779***
Complication	8 (35)	5 (22)	4 (33)	0.6984***
Respiratory hospital utilisation				
Follow up by Physio	18 (62)	13 (54)	8 (67)	0.8031***
Follow up by Nurse	10 (34)	12 (50)	6 (50)	0.4545****
Respiratory exacerbation – Median (IQR)	2 (1, 4)	2 (1, 4)	4 (1.5, 6)	0.3701*
Respiratory ED – Median (IQR)	1 (0, 1)	1 (0, 2)	1 (0, 2.5)	0.5629*
Respiratory Admission – Median (IQR)	1 (0, 2)	0 (0, 1.5)	1.5 (0, 2.5)	0.3745*
Respiratory OPD – Median (IQR)	2 (2, 3)	2 (1, 3)	3 (2.5, 4.5)	0.0136*

Management factors				
Cause screening				
F1 - PMH cause	12 (41)	10 (42)	-	1.0000***
F2 – Screening	23 (79)	20 (83)	-	1.0000***
Medication use				
F3 - Inhaled bronchodilator	23 (79)	17 (71)	9 (75)	0.8110***
F4 -Inhaled steroid	23 (79)	18 (75)	11 (92)	0.6083***
F5 - Oral steroid	6 (21)	6 (25)	3 (25)	0.9290***
F6 - Hypotonic steroid	-	-	-	N/A
F7 – Mannitol	1 (3)	0 (0)	1 (8)	0.4759***
F8 - Leukotriene receptor	-	-	-	N/A
F9 - Acetyl cysteine	1 (3)	1 (4)	1 (8)	0.7779***
F10 – LT Nebulised antibiotics	5 (17)	4 (17)	2 (17)	1.0000***
F11 – LT Oral antibiotics	6 (21)	7 (29)	8 (67)	0.0288***
F12 - STAbx_EVIDENCE_14days	-	-	-	N/A
F13- STAbx_EVIDENCE_10days	4 (14)	3 (13)	0 (0)	0.5129***
Chronic disease management strategies				
F14 – Airway clearance	15 (52)	10 (42)	7 (58)	0.6007****
F15 - PR program	13 (45)	9 (38)	6 (50)	0.7501****
F16 – Flu	5 (17)	8 (33)	4 (33)	0.3500***
F17 – Pneumonia	3 (10)	4 (17)	2 (17)	0.7135***
F18- Ask about active smoking	12 (41)	11 (46)	3 (25)	0.5367***
F19 - Ask about passive smoking	4 (14)	4 (17)	0 (0)	0.4826***
F20 - Annual PFT	18 (62)	10 (42)	4 (33)	0.1765***
F21 - Sputum when well	5 (17)	7 (29)	2 (17)	0.6041***
F22 - Sputum prior to antibiotics	4 (14)	3 (13)	3 (3)	0.5922***
F23 - Action plan reference	4 (14)	8 (33)	6 (50)	0.0479***
F24 - Emergency pack reference	14 (48)	13 (54)	10 (83)	0.1126***
Other management strategies				
F25- Additional consider NIV	1 (3)	2 (8)	5 (42)	0.0060***
F26 - Surgery as treatment	2 (7)	2 (8)	2 (17)	0.7372***
Clinical Review				
F 27 - Spirometry – Median (IQR)	1 (0, 1)	0 (0, 1)	0.5 (0, 1.5)	0.6686
F28 - Exac Abx – Median (IQR)	1 (1, 3)	2 (1, 2.5)	3 (2, 4)	0.0224
F29 - Sputum – Median (IQR)	1 (1, 2)	1 (0, 1.5)	1.5 (1, 2.5)	0.2644
F30 - Cough – Median (IQR)	1 (1, 2)	1 (0, 1)	2 (1, 2)	0.0272
F31 – Breathlessness, Median (IQR)	1 (0, 1)	0.5 (0, 1)	1 (0, 2)	0.3653
F32 - Activity tolerance, Median (IQR)	1 (0, 2)	1 (0, 1)	1 (0, 1)	0.8467
F33 – Oximetry assessment, Median IQR)	2 (1, 2)	1 (0.5, 2)	2 (0, 3.5)	0.1918
F34 - Weight assessment, Median (IQR)	2 (1, 2)	1 (0, 2)	0 (0, 0.5)	0.0153
F35 - Education – Median (IQR)	0 (0, 1)	0 (0, 1)	0 (0,1)	0.9495
F36 - Referral – Median (IQR)	0 (0, 1)	0 (0, 1)	0 (0,1)	0.6535

*Kruskal-Wallis Test P value

**One-way Anova P value

***Fisher's Exact Test P value

****Chi-Square Test P value

Table 4 presents results from binary logistic GEE models, ordinal logistic GEE models and linear mixed-effects models depending on the outcome and adjusting for clustering on patient ID. It includes Odds Ratios/Mean differences, 95% confidence intervals (CI) and comparison and global P values.

A statistically significant difference was demonstrated using a binary logistic GEE model for long term oral antibiotic use across the 3 Years (global P value=0.0213). In 2011 the odds of long-term oral antibiotic use were 87% less than in 2016/2017 (Odds Ratio=0.13, 95% CI: 0.03, 0.56, comparison P value=0.0062). A further post-hoc comparison made for 2013 versus 2016/2017 also demonstrated significance.

A statistically significant difference was demonstrated using an ordinal logistic GEE model in clinical assessment of cough across the 3 Years (global P value=0.0211). In 2011 the odds of a being asked about cough were 3.21 times higher than in 2013 (Odds Ratio=3.21, 95% CI: 1.23, 8.33, comparison P value=0.0062). A further post-hoc comparison can be made for 2013 versus 2016/2017 (Odds Ratio=0.21, 95% CI: 0.05, 0.78 with comparison P value of 0.02). This means that 0.21 times likely to be asked about cough in 2016/2017 compared to 2013.

Table 4. Univariate Regression results of various outcomes versus Year (2011, 2013, 2016/17)

Outcome	*Predictor*	*Comparison*	*Odds Ratio/Mean Difference (95% CI)*	*Comparison P value*	*Global P value*
Characteristics					
Age**	Year	2011 vs 2013	-2.14 (-2.52, -1.75)	<.0001	<.0001
	Year	2011 vs 2016/2017	-5.47 (-6.07, -4.86)	<.0001	
	Year	2013 vs 2016/2017	-3.33 (-3.93, -2.72)	<.0001	
Sex	Year	2011 vs 2013	1.28 (0.45, 3.66)	0.6477	0.7993
	Year	2011 vs 2016/2017	1.58 (0.36, 6.97)	0.5465	
	Year	2013 vs 2016/2017	1.24 (0.26, 5.78)	0.7884	
Charlson comorbidity age adjusted score**	Year	2011 vs 2013	-0.42 (-1.39, 0.56)	0.3505	0.1804
	Year	2011 vs 2016/2017	-1.21 (-2.57, 0.16)	0.0754	
	Year	2013 vs 2016/2017	-0.79 (-2.17, 0.60)	0.2253	
Asthma COPD	Year	2011 vs 2013	0.83 (0.22, 3.10)	0.7780	0.9515
	Year	2011 vs 2016/2017	1.05 (0.25, 4.35)	0.9489	
	Year	2013 vs 2016/2017	1.27 (0.24, 6.76)	0.7820	
Respiratory Exacerbation**	Year	2011 vs 2013	0.71 (-0.81, 2.22)	0.3127	0.3448
	Year	2011 vs 2016/2017	-0.56 (-2.49, 1.37)	0.5208	
	Year	2013 vs 2016/2017	-1.27 (-3.25, 0.71)	0.1779	
Less than 5year mortality	Year	2011 vs 2013	0.93 (0.34, 2.58)	0.8940	0.5961
	Year	2011 vs 2016/2017	1.87 (0.45, 7.77)	0.3911	
	Year	2013 vs 2016/2017	2.00 (0.52, 7.77)	0.3167	

Outcome	*Predictor*	*Comparison*	*Odds Ratio/Mean Difference (95% CI)*	*Comparison P value*	*Global P value*
Severity of bronchiectasis					
Significant organism growth	Year	2011 vs 2013	1.07 (0.40, 2.85)	0.8903	0.8829
	Year	2011 vs 2016/2017	0.77 (0.21, 2.82)	0.6877	
	Year	2013 vs 2016/2017	0.71 (0.19, 2.71)	0.6205	
Supplemental oxygen	Year	2011 vs 2013	1.87 (0.59, 5.90)	0.2881	0.2330
	Year	2011 vs 2016/2017	0.53 (0.12, 2.33)	0.4037	
	Year	2013 vs 2016/2017	0.29 (0.06, 1.27)	0.0992	
Pulmonary hypertension	Year	2011 vs 2013	2.75 (0.61, 12.32)	0.1861	0.3468
	Year	2011 vs 2016/2017	2.75 (0.27, 27.77)	0.3912	
	Year	2013 vs 2016/2017	1.00 (0.08, 12.12)	1.0000	
Complication	Year	2011 vs 2013	1.92 (0.69, 5.37)	0.2135	0.4306
	Year	2011 vs 2016/2017	1.07 (0.27, 4.29)	0.9276	
	Year	2013 vs 2016/2017	0.56 (0.14, 2.27)	0.4135	
Respiratory hospital utilisation					
Follow up Nurse	Year	2011 vs 2013	0.53 (0.20, 1.39)	0.1937	0.3711
	Year	2011 vs 2016/2017	0.53 (0.14, 1.92)	0.3305	
	Year	2013 vs 2016/2017	1.00 (0.27, 3.69)	1.0000	
Follow up Physio	Year	2011 vs 2013	1.38 (0.52, 3.66)	0.5122	0.7165
	Year	2011 vs 2016/2017	0.82 (0.21, 3.24)	0.7752	
	Year	2013 vs 2016/2017	0.59 (0.14, 2.52)	0.4766	
Respiratory ED**	Year	2011 vs 2013	-0.28 (-1.40, 0.84)	0.5790	0.6331
	Year	2011 vs 2016/2017	-0.59 (-2.01, 0.84)	0.3698	
	Year	2013 vs 2016/2017	-0.31 (-1.77, 1.16)	0.6419	
Respiratory Admission**	Year	2011 vs 2013	-0.10 (-1.15, 0.95)	0.8291	0.5670
	Year	2011 vs 2016/2017	-0.64 (-1.98, 0.71)	0.3073	
	Year	2013 vs 2016/2017	-0.53 (-1.91, 0.85)	0.3980	
Respiratory OPD**	Year	2011 vs 2013	0.16 (-0.55, 0.88)	0.6113	0.0570
	Year	2011 vs 2016/2017	-0.98 (-1.89, -0.07)	0.0386	
	Year	2013 vs 2016/2017	-1.14 (-2.08, -0.20)	0.0229	

Outcome	*Predictor*	*Comparison*	*Odds Ratio/Mean Difference (95% CI)*	*Comparison P value*	*Global P value*
Management factors					
[F1] PMH Cause	Year	2011 vs 2013	0.99 (0.37, 2.63)		0.9811
[F2] Screening	Year	2011 vs 2013	0.77 (0.21, 2.74)		0.6824
[F3] Inhaled bronchodilator	Year	2011 vs 2013	1.58 (0.46, 5.40)	0.4669	0.7607
	Year	2011 vs 2016/2017	1.28 (0.31, 5.35)	0.7373	
	Year	2013 vs 2016/2017	0.81 (0.16, 4.00)	0.7955	
[F4] Inhaled steroid	Year	2011 vs 2013	1.28 (0.36, 4.54)	0.7045	0.5300
	Year	2011 vs 2016/2017	0.35 (0.04, 3.32)	0.3595	
	Year	2013 vs 2016/2017	0.27 (0.03, 2.62)	0.2605	
[F5] Oral steroid	Year	2011 vs 2013	0.78 (0.26, 2.36)	0.6630	0.8938
	Year	2011 vs 2016/2017	0.78 (0.19, 3.28)	0.7373	
	Year	2013 vs 2016/2017	1.00 (0.24, 4.24)	1.0000	
[F9] Acetyl cysteine	Year	2011 vs 2013	0.82 (0.05, 13.66)	0.8909	0.1119
	Year	2011 vs 2016/2017	0.39 (0.02, 6.79)	0.5205	
	Year	2013 vs 2016/2017	0.48 (0.24, 0.96)	0.0381	
[F10] LT Nebulised antibiotics	Year	2011 vs 2013	1.04 (0.34, 3.16)	0.9425	0.9973
	Year	2011 vs 2016/2017	1.04 (0.17, 6.50)	0.9652	
	Year	2013 vs 2016/2017	1.00 (0.19, 5.15)	1.0000	
[F11] LT Oral antibiotics	Year	2011 vs 2013	0.63 (0.19, 2.17)	0.4667	0.0213
	Year	2011 vs 2016/2017	0.13 (0.03, 0.56)	0.0062	
	Year	2013 vs 2016/2017	0.21 (0.05, 0.89)	0.0340	
[F14] Airway clearance	Year	2011 vs 2013	1.50 (0.60, 3.78)	0.3900	0.5628
	Year	2011 vs 2016/2017	0.77 (0.21, 2.82)	0.6877	
	Year	2013 vs 2016/2017	0.51 (0.13, 2.06)	0.3442	
[F15] PR program	Year	2011 vs 2013	1.35 (0.45, 4.10)	0.5916	0.7319
	Year	2011 vs 2016/2017	0.81 (0.21, 3.13)	0.7627	
	Year	2013 vs 2016/2017	0.60 (0.16, 2.29)	0.4546	

[F16] Flu vaccination	Year	2011 vs 2013	0.42 (0.11, 1.63)	0.2084	0.3850
	Year	2011 vs 2016/2017	0.42 (0.09, 1.89)	0.2567	
	Year	2013 vs 2016/2017	1.00 (0.24, 4.17)	1.0000	
[F17] Pneumonia vaccination	Year	2011 vs 2013	0.58 (0.11, 2.99)	0.5124	0.7748
	Year	2011 vs 2016/2017	0.58 (0.08, 3.92)	0.5738	
	Year	2013 vs 2016/2017	1.00 (0.16, 6.29)	1.0000	
[F18] Ask about active smoking	Year	2011 vs 2013	0.83 (0.30, 2.34)	0.7301	0.4719
	Year	2011 vs 2016/2017	2.12 (0.46, 9.82)	0.3378	
	Year	2013 vs 2016/2017	2.54 (0.57, 11.27)	0.2205	
[F20] Annual PFT	Year	2011 vs 2013	2.29 (0.74, 7.08)	0.1497	0.1752
	Year	2011 vs 2016/2017	3.27 (0.81, 13.22)	0.0961	
	Year	2013 vs 2016/2017	1.43 (0.35, 5.80)	0.6177	
[F21] Sputum when well	Year	2011 vs 2013	0.51 (0.14, 1.83)	0.2991	0.5149
	Year	2011 vs 2016/2017	1.04 (0.16, 6.84)	0.9661	
	Year	2013 vs 2016/2017	2.06 (0.34, 12.53)	0.4331	
[F22] Sputum prior to antibiotics	Year	2011 vs 2013	1.12 (0.22, 5.79)	0.8924	0.5927
	Year	2011 vs 2016/2017	0.48 (0.09, 2.63)	0.3974	
	Year	2013 vs 2016/2017	0.43 (0.07, 2.49)	0.3448	
[F23] Action plan reference	Year	2011 vs 2013	0.32 (0.09, 1.11)	0.0716	0.0482
	Year	2011 vs 2016/2017	0.16 (0.03, 0.75)	0.0203	
	Year	2013 vs 2016/2017	0.50 (0.11, 2.17)	0.3554	
[F24] Emergency pack reference	Year	2011 vs 2013	0.79 (0.27, 2.29)	0.6644	0.1357
	Year	2011 vs 2016/2017	0.19 (0.04, 0.97)	0.0463	
	Year	2013 vs 2016/2017	0.24 (0.04, 1.27)	0.0929	
[F25] Additional consider NIV	Year	2011 vs 2013	0.39 (0.03, 4.68)	0.4598	0.0057
	Year	2011 vs 2016/2017	0.05 (0.00, 0.50)	0.0108	
	Year	2013 vs 2016/2017	0.13 (0.03, 0.64)	0.0121	
[F26] Surgery tx	Year	2011 vs 2013	0.81 (0.19, 3.54)	0.7848	0.6443
	Year	2011 vs 2016/2017	0.37 (0.05, 2.95)	0.3484	
	Year	2013 vs 2016/2017	0.45 (0.05, 4.02)	0.4783	

[F27] Spirometry*	Year	2011 vs 2013	1.60 (0.62, 4.09)	0.3309	0.6231
	Year	2011 vs 2016/2017	1.23 (0.34, 4.49)	0.7505	
	Year	2013 vs 2016/2017	0.77 (0.20, 2.99)	0.7089	
[F28] Exac Abx*	Year	2011 vs 2013	0.67 (0.27, 1.63)	0.3754	0.0258
	Year	2011 vs 2016/2017	0.18 (0.05, 0.62)	0.0071	
	Year	2013 vs 2016/2017	0.26 (0.08, 0.88)	0.0308	
[F29] Sputum*	Year	2011 vs 2013	1.50 (0.58, 3.89)	0.4056	0.2788
	Year	2011 vs 2016/2017	0.51 (0.15, 1.76)	0.2885	
	Year	2013 vs 2016/2017	0.34 (0.09, 1.28)	0.1112	
[F30] Cough*	Year	2011 vs 2013	3.21 (1.23, 8.33)	0.0168	0.0211
	Year	2011 vs 2016/2017	0.66 (0.19, 2.30)	0.5189	
	Year	2013 vs 2016/2017	0.21 (0.05, 0.78)	0.0200	
[F31] Breathlessness*	Year	2011 vs 2013	1.17 (0.42, 3.24)	0.7681	0.3515
	Year	2011 vs 2016/2017	0.43 (0.12, 1.56)	0.2002	
	Year	2013 vs 2016/2017	0.37 (0.09, 1.51)	0.1659	
[F32] Activity tolerance*	Year	2011 vs 2013	1.34 (0.48, 3.74)	0.5744	0.8541
	Year	2011 vs 2016/2017	1.17 (0.32, 4.21)	0.8153	
	Year	2013 vs 2016/2017	0.87 (0.24, 3.11)	0.8289	
[F33] Oximetry*	Year	2011 vs 2013	2.31 (0.97, 5.45)	0.0572	0.1278
	Year	2011 vs 2016/2017	0.93 (0.24, 3.53)	0.9099	
	Year	2013 vs 2016/2017	0.40 (0.10, 1.57)	0.1887	
[F34] Weight*	Year	2011 vs 2013	1.86 (0.76, 4.54)	0.1734	0.0172
	Year	2011 vs 2016/2017	9.32 (1.92, 45.25)	0.0056	
	Year	2013 vs 2016/2017	5.02 (1.01, 24.92)	0.0487	
[F35] Education*	Year	2011 vs 2013	0.94 (0.33, 2.66)	0.9109	0.9493
	Year	2011 vs 2016/2017	1.18 (0.30, 4.70)	0.8167	
	Year	2013 vs 2016/2017	1.25 (0.32, 4.84)	0.7470	
[F36] Referral*	Year	2011 vs 2013	0.68 (0.25, 1.90)	0.4661	0.6423
	Year	2011 vs 2016/2017	0.54 (0.13, 2.28)	0.3986	
	Year	2013 vs 2016/2017	0.78 (0.20, 3.12)	0.7308	

*Ordinal logistic GEE model with associated Odds Ratio (95% Confidence Interval)

**Linear mixed-effects model with associated Mean Difference (95% Confidence Interval

Efficacy of care

Efficacy of care was evaluated based on exacerbations, service utilisation (including respiratory physiotherapists and respiration nurses) and 5-year mortality. Results are presented in Table 3 and 4.

Exacerbations frequency rose from a median IQR of two exacerbations in 2011 and 2013 to four exacerbations in 2016/17 (p= 0.3701). Hospital service utilisation of Respiratory OPD also rose from a median IQR of two OPD doctor visits in 2011 and 2013 to three in 2016/17 (p value=0.0136). Hospital admissions in 2011 had a median IQR of one admission rising to one and a half by 2016/17.

A physiotherapist had seen 64% of patients at least once in the last 5-years in 2011, 54% in 2013 and 67% in 2016/17. Respiratory nurse involvement increased over the years from 34% of patients in 2011 to 50% in 2013 and 58% in 2016/17. Of those referred to a respiratory nurse many were seen for short episodic care with one off education or home oxygen coordination. Chronic disease management with bronchiectasis patient treatment support occurred in 50% of those referred to Respiratory Nurses in 2011 and 2013. In 2016/17 43% of those having respiratory nursing received chronic disease management (Appendix 1: Table 5).

Our cohort of patients had significant morbidity and mortality associated with their bronchiectasis based on their comorbid conditions, hospital admission frequency and their survival post 5-years, which was around 50%. Recruitment from a hospital admission as a qualifying factor for inclusion has no doubt influenced this as hospital admission is a known risk factor for 5-year mortality in bronchiectasis patients (3, 13).

Patients were likely sicker in the 2016/17 cohort with a higher percentage of significant organism growth, more frequent exacerbations, an increased number of visits to Respiratory OPD and a slight increase in respiratory related hospitalisations.

DISCUSSION

This study has shown that TQEH outpatient management of bronchiectasis is modestly compliant with the published guidelines used in Australia. Areas for potential improvement are: 1. Antibiotic use. We found low adherence to the guidelines with respect to F12-13 (9, 12) and poor documentation of how long antibiotics were being used for. We saw high use of long-term antibiotics including ciprofloxacin and doxycycline but only moderate compliance to TSANZ & BTS recommended treatments such as macrolides (3, 9, 12). 2. Vaccination. We found low adherence and poor documentation for Influenza and pneumococcal vaccination. Both are recommended by TSANZ and BTS to assist in prevention of exacerbations and pneumococcal pneumonia (9, 12). 3. Outpatient clinical assessments. We saw low to moderate compliance with the recommendation of asking patients/assessing for impacts on exercise tolerance [F32] and breathlessness [F31] (9, 12). This may mean that opportunities for referral to physiotherapy were missed.

It needs to be recognised however that some perceived gaps in management may be the result of poor documentation rather than poor management. Either way the study findings suggest that outpatient management of bronchiectasis could be easily improved if the findings of the study were shared with clinicians. Other options for improving the management of patients might be the introduction of nurse-led protocol driven bronchiectasis clinics. Such clinics could occur concurrently with traditional clinics and have been shown to be effective in managing stable patients for bronchiectasis and other respiratory conditions (14-17).

Documentation omission or gaps in guideline knowledge

The recommended use of antibiotics to treat infections varies between the guidelines with TSANZ suggesting 10 days (3, 12) and BTS saying 14 days (7, 9). Our audit, like the guidelines, revealed inconsistencies with the duration of antibiotic use with regimes ranging between 5 to 10 days. Fourteen percent of patients in 2011 and 13% of patients in 2013 were compliant to the TSANZ recommendation of 10 days duration. In 2016/17 no one met the TSANZ recommendations. No one in all three years studied met the duration of 14 days of antibiotic treatment as recommended by the BTS (7). This may reflect a lack of familiarity with the guidelines, or it may reflect clinician reservations regarding the importance of

adhering to this recommendation and the influence of PBS dispensing quantities. Documentation regarding antibiotic use was in general very poor with just 21% of patients in 2011, 17% of patients in 2013 and 25% of patients in 2016/17 having any recent history of antibiotic use recorded. Documentation omissions have been the subject of quality improvement research in the past because they can adversely influence health care outcomes (18). One reason why documentation may poor is the time pressure in overcrowded/ busy clinics (18). Documentation check lists, acronyms and care bundles have been used to improve documentation in a variety of settings (18, 19) such interventions could improve the outpatient management of bronchiectasis at TQEH.

Sputum sampling prior to antibiotic use for exacerbations [F24] showed low compliance with at least 75% of patients not having sputum prior to antibiotic use. Sputum testing when well [F23] was done at least once during the 12 months in only 17% of patients in 2011 and 2016/17, with an increase to 25% in 2103. Of greater concern was the 10% in 2011 and 25% in 2013 and 2016/17 who had no sputum testing during admission or in the follow up 12 months. Sputum sampling allows the identification of infecting or colonising organisms and provides antibiotic sensitivity data that can also guide future care (7, 20). The high prevalence of significant organism growth in our study (50%) has highlighted the importance of guideline recommendations for sputum testing. This should be a priority for translation into practice.

Further research is needed to determine the barriers and enablers for guideline compliant management of outpatients with bronchiectasis (20). Development of supportive models of care that embed guidelines into practice, e.g., nurse led clinics should be explored. Protocol driven nurse-led clinics have been shown to potentially improve care in other respiratory diseases (15-17).

Coexisting respiratory disease and impact on outpatient review

Cardiac and respiratory comorbidities make symptom assessment and treatment of patients with bronchiectasis challenging (8, 21). In the present study the use of inhaled bronchodilator, steroid medications, NIV and the action plans details were likely influenced by the presence of comorbid COPD, obstructive sleep apnoea and asthma (9). This highlights the potential for adverse patient outcomes if patients with bronchiectasis don’t receive optimal care.

Consistency in care with guideline use

Guidelines have the potential to improve patient care especially when multiple service providers are involved because they provide a stable platform upon which a management plan can be formulated and reviewed (22). In a hospital setting it is not uncommon for junior doctors who change regularly to be managing complicated patients. It is likely the apparent short falls we found in patient care in the present study could be improved by better adherence to guidelines.

Multi-disciplinary team (MDT) care

BTS bronchiectasis guidelines of 2010 suggested that the MDT at a minimum should consist of the respiratory physician, a respiratory physiotherapist and specialist respiratory nurse (9). Much of what we know about the value of the MDT has been extrapolated from COPD management research (23). All patients included in our study had respiratory physician follow up, an incidental finding showed by 2016/17 83% of patients were seen in private Medicare clinic, likely for follow up with the same clinician.

Physiotherapy has a well-recognised role in the management of people with bronchiectasis, but patients are not always referred (20). In our study we found that physiotherapy referral in the previous 5 years ranged between 54% in 2013, 62% in 2011 and 67% in 2016/17. Specific referral during the three years studied for pulmonary rehabilitation ranged between 39-50% and for airway clearance ranged between 42-58%. Both airway clearance and pulmonary rehabilitation have been shown to have positive impact in bronchiectasis management including reducing exacerbations and improvements in quality of life and function (20, 24). Why more people in the present study were not referred for physiotherapy was not apparent.

In bronchiectasis management guidelines, the role of respiratory nursing remains undefined (9). In our study respiratory nurse involvement in the previous 5-years increased from 34% of patients in 2011 and 58% by 2016/17. Of those with respiratory nurse involvement only 43-50% were for chronic disease support. There is one randomised control trial specifically assessing a nurse-led clinic for bronchiectasis management (14). The study found there were few differences in outcome between nurse and doctor-led care for the outpatient management of bronchiectasis in a stable population (14, 25). In other disease cohorts, such as COPD, asthma and sleep, respiratory nurse-led clinics have used evidence-based

management protocols and demonstrated their capabilities to provide equal care outcomes (15). Nurses often have the flexibility to spend more time with patients and provide more frequent follow up these factors improve patient satisfaction (26). A recent systematic review of nurse-led services in ambulatory care concluded expansion of community models had potential to create a safer, more accessible, and productive healthcare system (27). Nurse-led clinics for bronchiectasis should be further investigated.

Limitations of this study

This audit used ICD 10 coding data to identify patients with bronchiectasis. Hospital admission is the primary source of known data related to bronchiectasis (28). Numbers identified for our study were low, there is potential that documentation may have led to incorrect coding and missed inclusion. Identification of bronchiectasis patients from hospital admission meant patients included tended to have more severe disease and increased frequency of exacerbations.

This study relied on what was written in the medical record. It is well recognised that health professionals frequently omit writing all care provided to save time. We adopted the approach that if something was not written down it was not done. This may have exaggerated the proportion of patients whose management deviated from the guideline recommendations. For completion private patient files kept by the respiratory nurses and respiratory physiotherapists were examined. These notes contained additional detail not in hospital case notes. From a medicolegal perspective health professionals know documentation is a critical part of our care provision and omissions in documentation are viewed as care not preformed. Care performed needs to be documented and actions to improve the way we document should be a priority.

The 2016/17 retrospective audit recruited patients between July 2016 to June 2017. The EMR system started in June 2016. Staff familiarisation with system and changes to the way staff document may have influenced completeness of early records. This will have affected 16% of this cohort. With the remaining 84% of included patients admitted after at least 6 months of use. Staff would have been more familiar with EMR and may have adopted time saving strategies such as use of acronyms to edit pre-populated notes and letter templates.

In summary bronchiectasis management at our institution was found to be only modestly compliant with guideline recommended care for the three time periods studied. We suspect poor clinician documentation may have contributed to some of the apparent gaps in adherence to guidelines. Development of an acronym or checklist may assist in completeness of documentation and assist clinicians to better manage bronchiectasis. A repeat of audit following any introduced changes should occur.

We found respiratory nurses were underutilised for the management of bronchiectasis patients. Respiratory nurses have a demonstrated ability to manage patients with respiratory conditions other than bronchiectasis. Further research is needed to determine if a nurse led clinic utilising a protocol would improve compliance to guidelines and improve bronchiectasis patient care in a public hospital outpatient setting.

The knowledge of the existence of guidelines within our hospital and their utilisation remains unclear. More research is required to determine why there are gaps in care and identify what are the barriers and facilitators to bronchiectasis management, documentation and guideline use from both a clinician and patient perspective.

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Appendix 1: Table 5

Additional Data: Long term antibiotic use, sputum sampling and Respiratory Nursing review.

Additional Data	Number (2011) n=29	%	Number (2013) n=24	%	Number (2016/17) n=12	%
Long term antibiotic use	6	21%	7	29%	8	67%
Macrolides	4	67%	3	43%	4	50%
Quinolones	1	17%	1	14%	2	25%
Tetracyclines	0		2	29%	2	25%
Other	1	17%	1	14%	0	
Sputum sampling						
Any	26	90%	18	75%	9	75%
Admission	26	90%	17	71%	9	75%
Before antibiotics	4	14%	3	13%	3	25%
When well	5	17%	7	29%	2	17%
No sampling	3	10%	6	25%	3	25%
Respiratory Nurse Review	10	34%	12	50%	7	58%
Chronic Disease Management	5	50%	6	50%	3	43%
O2 Coordination	3	30%	4	33%	1	14%
One off education	2	20%	2	17%	3	43%

Chapter 5.

Nurse-led versus doctor-led care for bronchiectasis (Review)

(Literature review, update of existing review and analysis)

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Statement of authorship for jointly authored papers within the thesis

Statement of authorship

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Author contributions:

By signing the Statement of Authorship, each author certifies their stated contribution to the publication is accurate and that permission is granted for the publication to be included in the candidate's thesis.

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Contribution to the paper	Invited to update the review, conceived, and designed the manuscript, analysed the data, wrote the first draft, contributed to writing the manuscript, agree with manuscript results and conclusions, jointly developed the arguments and structure for the paper, made critical revisions and approved final version.		
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Signature		**Date**	21 / 10 /2020

Name of co-author	Fiona Campbell		
Contribution to the paper	Previous author of review, contributed to writing the manuscript, agree with manuscript results and conclusions, made revisions, approved final version prior to publication.		
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Contribution to the paper	Contributed to writing the manuscript, agree with manuscript results and conclusions, approved final version and supervised the process.		
Signature		**Date**	22 / 10/2020

Chapter Overview

Nurse-led models of care for disease management of stable patient cohorts have been utilised for over 30 years ago. They have been shown to be successful in managing a range of diseases including respiratory conditions. Nurse-led models utilise guidelines to form the foundations of the care delivered. The role of respiratory nurses in the management of bronchiectasis has not been defined in guidelines but is recognised by the BTS that nurses have a role in management provided they are suitably trained and prepared for their role. In Chapter 4 the retrospective audit of three separate years identified that bronchiectasis management at the QEH was modestly compliant to guideline recommended care, it is postulated that these gaps in current care may be improved through the utilisation of a nurse-led model. Evidence to explore the role of the nurse in the management of bronchiectasis may be found in the Cochrane library which is a trusted source of evidence-based medical research. In 2003 a Cochrane review was published titled 'Nurse specialist care for bronchiectasis'.

The Cochrane Database of Systematic Reviews are a source that is frequently used to provide evidence for policy, influence current practice and present recommendations for future evaluations and research. The Cochrane Database is widely respected for its rigorous methodology of systematic appraisal of the available published and unpublished evidence. It searches a broad cross-section of resources to identify relevant studies for inclusion. Its methodology provides a framework which protects the quality of evidence with a risk of bias evaluation alongside each study which further assists to identify any possible issues with interpretation of results. It brings together the most up-to-date evidence and establishes if the intervention is effective, ineffective and makes recommendations based on available data.

In 'Nurse-led versus doctor-led care for bronchiectasis' we were invited to provide an update to the previous review 'Nurse specialist care for bronchiectasis'(63) This new review explores the current literature and applied the updated Cochrane review format. New to this review is a detailed description of what is bronchiectasis and how it is managed, what is nurse-led care, how it is expected to work based on available literature and why it was important to do the review. Only one randomised

control cross over trial involving 80 participants was identified as meeting the eligibility criteria for inclusion in this review, this trial was identified in the previous review. The study from the United Kingdom was published in 2002 and is now over 18 years old. This review found no difference between nurse-led care and doctor-led care for in terms of patient lung function, exacerbations, or quality of life. In the first year of the study nurse-led care had increased costs from hospital admission and the use of more intravenous antibiotics these were reduced in the second year suggesting costs over time may be reduced through a learning effect.

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TABLE OF CONTENTS

[Intervention Review]

Nurse-led versus doctor-led care for bronchiectasis

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ABSTRACT

Background

Specialist nursing roles to manage stable disease populations are being used to meet the needs of both patients and health services. With increasing cost pressures on health departments, alternative models such as nurse-led care are gaining momentum as a substitute for traditional doctor-led care. This review evaluates the safety, effectiveness, and health outcomes of nurses practising in autonomous roles while using advanced practice skills, within the context of bronchiectasis management in subacute, ambulatory, and/or community care.

Objectives

To compare the effectiveness of nurse-led care versus doctor-led care in the management of stable bronchiectasis.

Search methods

We searched the Cochrane Airways Group Specialised Register and bibliographies of selected papers in addition to grey literature such as electronic clinical trials registries. Searches were current as of March 2018.

Selection criteria

Randomised controlled trials were eligible for inclusion in the review.

Data collection and analysis

Two reviewers extracted and entered data from included studies. Primary outcomes were numbers of exacerbations requiring treatment with antibiotics, hospital admissions, and emergency department attendances.

Main results

We included one United Kingdom (UK) study in the review. In this randomised controlled trial, a total of 80 participants, with a mean age of 58 years, were treated for 12 months by a specialist nurse or doctor, then were crossed over to the other clinician for the next 12 months. Two participants died during the study period. Six participants failed to cross over to nurse-led care because of unstable bronchiectasis. Overall, the level of study completion was high.

Data show no difference in the numbers of exacerbations requiring treatment with antibiotics (rate ratio 1.09, 95% confidence interval (CI) 0.91 to 1.30, 80 participants, moderate-certainty evidence). Investigators reported more hospital admissions in the nurse-led care group (rate ratio 1.52, 95% CI 1.04 to 2.23, 80 participants, moderate-certainty evidence) and did not report emergency department attendance.

For secondary outcomes, participants in the nurse-led care group used more healthcare resources during the first year of the trial. Increased admissions and greater use of resources made treatment costs for nurse-led groups' higher. Total costs for both years of the study were £8,464 and £5,228 for nurse-led care compared with doctor-led care. However, by the second year, treatment costs were almost equitable between the two groups, which may reflect the nurses' learning of how to better treat people with bronchiectasis. No statistically significant changes were observed in quality of life, exercise capacity, mortality, or lung function. Wide confidence intervals led to uncertainty regarding these results. Adverse events were not an outcome for this review.

Authors' conclusions

This update of the review shows that only one trial met review criteria. Review authors were unable to demonstrate effectiveness of nurse-led care compared with doctor-led care on the basis of findings of a single study. The included study reported no significant differences, but limited evidence means that differences in clinical outcomes between nurse-led care and usual care within the setting of a specialist clinic remain unclear. Further research is required to determine whether nurse-led care is cost-effective, if guidelines and protocols for bronchiectasis management are followed does this increases costs and how effective nurse-led management of bronchiectasis is in other clinical settings such as inpatient and outreach.

PLAIN LANGUAGE SUMMARY

Nurse specialist care for bronchiectasis

Background

Bronchiectasis is a long-term lung disease. The main symptom is cough that produces phlegm and results in recurrent chest infections. As the disease gets worse, people have poor quality of life and eventually may develop respiratory failure - a condition in which the body is not able to control oxygen and carbon dioxide levels properly.

Review question

We wanted to find out if nurses are able to manage the care of people with bronchiectasis as well as doctors. We looked for randomised controlled trials comparing nurse-led care with doctor-led care.

Study characteristics

We found one study from the United Kingdom involving 80 people with bronchiectasis. The study was completed in 2002, when management of bronchiectasis was different from today. Participants were divided into two groups: One group of outpatients was observed for a 12-month period under the care of the specialist nurse, and the other under care of the doctor. After 12 months, these participants swapped groups.

Key results

We found no significant differences between nurse-led and doctor-led care in terms of lung function, infective flareups (exacerbations), or quality of life. In the first year of the study we noted increased costs for nurse-led care with more hospital admissions and greater use of antibiotic injections.

Certainty of evidence

The certainty of evidence in the one included study was satisfactory, given that the study design meant participants knew which group they belonged to.

Bottom line

More research is required to determine how nurse specialists compare with doctors in providing safe and effective treatment for patients with stable bronchiectasis.

This Cochrane plain language summary was up-to-date as of March 2018.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Nurse-led care compared with doctor-led care for management of bronchiectasis

Nurse-led care compared with doctor-led care for management of bronchiectasis

Patient or population: management of bronchiectasis
Setting: outpatient
Intervention: nurse-led care
Comparison: doctor-led care

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No. of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with doctor-led care	Risk with nurse-led care				
Exacerbations requiring treatment with antibiotics (per patient per year) Assessed by clinician identified or participant self-reported Follow-up: 12 months	Mean rate of infective exacerbations was 3.1 per patient per year.	0.28 per patient per year higher (95% CI 0.28 lower to 0.97 higher)	1.09 (95% CI 0.91 to 1.30)	80 (1 RCT)	⊕⊕⊖⊖ LOW[a,b]	
Hospital admissions (per patient per year). Follow-up: 12 months	Mean admission per patient per year was 1.02.	1.55 per patient per year higher (1.06 higher to 2.27 higher)	1.52 (95% CI 1.03 to 2.23)	80 (1 RCT)	⊕⊕⊖⊖ LOW[a,b]	More admissions in nurse-led care. All nurse-led care admissions approved by consultant. Protocol followed by nurse regarding management
Emergency department attendance	See comment.	See comment.	See comment.	See comment.	See comment.	Not reported
Mortality	Two participants died - 1 from each care group - after 12-month assessment.			See comment.	⊕⊕⊖⊖ LOW[a,b]	
Cost-effectiveness Total cost for duration of study and	Total costs £5428 Cost difference £274 higher in second year	Total costs £8464 Cost difference £1940 lower in second year			⊕⊕⊖⊖ LOW[a,b,c]	Costs may be reduced over time through a learning effect.

difference in cost for first and second years Cost scale: £ per participant					
Quality of life, measured with SGRQ - total scores Lower scores indicating improved respiratory health Scale from 0 to 100 Follow-up: 12 months	Unreported	MD 1.7 higher (4 lower to 0.6 higher)	79 (1 RCT)	⊕⊕⊖⊖ LOW[a,b]	Participants reported fewer symptoms and less impact on daily life with nurse-led care, but data show no clinical or statistically significant differences between nurse-led and doctor-led care.
Exercise capacity: 12MWT Assessed with distance, metres Follow-up: 12 months	Mean exercise capacity: 12MWT was 746 m.	MD 18 m greater (13 lower to 49 higher)	80 (1 RCT)	⊕⊕⊖⊖ LOW[a,b]	No significant differences in distance walked between nurse-led and doctor-led care
FEV_1 assessed with % predicted Scale from 0 to 100 Follow-up: 12 months	Mean FEV_1 was 69.5% predicted.	MD 0.2% predicted higher (1.6% predicted lower to 2% predicted higher)	80 (1 RCT)	⊕⊕⊖⊖ LOW[a,b]	Nil significant differences in percentage predicted FEV_1 between nurse-led and doctor-led care

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

12MWT: 12-minute walk test; CI: confidence interval; FEV_1: forced expiratory volume in one second; MD: mean difference; RCT: randomised controlled trial; SGRQ: St. George's Respiratory Questionnaire.

GRADE Working Group grades of evidence.
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect.

[a]Cannot rule out carryover effects from cross-over trial. No reported information at first 12-month time period before cross-over. May have had a learned effect that resulted in fewer exacerbations and hospitalisations and better quality of life. This may have led to better lung function and exercise capacity. Marked down one point for risk of bias.
[b]Age of study, small number of participants, and uncertainty, with some results based on wide confidence intervals. Marked down one point for imprecision.
[c]Cannot rule out selective reporting with the decision not to cross-over 6 participants after first 12 months. No longer considered stable bronchiectasis. Already marked down for risk of bias previously, so not downgraded again based on this reason.

BACKGROUND

Description of the condition

Bronchiectasis is a lung condition characterised by the radiological finding of permanent abnormal dilatation of one or more bronchi (Boyton 2012; Kim 2012; King 2011). Patients with bronchiectasis have a persistent productive cough and recurrent infection and often develop airway colonisation with opportunistic micro-organisms (Abo-Leyah 2017; McShane 2013).

Diagnosis of bronchiectasis is confirmed by high-resolution computed tomography (HRCT) (King 2010). Diagnosis is based on this radiological finding along with presenting clinical symptoms of cough and sputum production (Abo-Leyah 2017; Feldman 2011).

Many causes of bronchiectasis are known. These include damage to the airway associated with foreign body, past significant respiratory infections, genetic disorders, abnormal host defences, and autoimmune disease (Katzenstein 1982; Kim 2012). The underlying cause may also be idiopathic (Boyton 2012).

Clinically, patients present with symptoms of increased sputum production and recurrent infections (Kim 2012; King 2010). Other symptoms may include shortness of breath, mild to moderate airflow limitation, and haemoptysis. As the condition progresses, patients may experience poorer health status and quality of life and increased functional disability (Boyton 2012; Wong 2012). This may result in weight loss and increased airflow obstruction and may lead to further complications of respiratory failure and right-sided heart failure (Boyton 2012).

Prevalence

Previously referred to as an orphan disease and thought to be uncommon, bronchiectasis may be more common than was previously thought, but its true incidence remains unclear (Chalmers 2017; Chang 2008). In the past, global incidence data for bronchiectasis were derived from hospital admission coding (McShane 2013; Ringshausen 2013). Disease registries have been established globally over the past five years; these provide a more accurate picture of bronchiectasis populations around the world (Chalmers 2017). In the UK, the incidence of bronchiectasis in 2013 was 35.17/100,000 women and 26.92/100,000 men (Quint 2016). Point prevalence data for the same year show that cases of bronchiectasis in women (566.1/100,000) and men (485.5/100,000) younger than 40 remain uncommon and reach higher prevalence in older age (Quint 2016). In the United States bronchiectasis prevalence appears to have an 8.74% annual increase with the number of aging bronchiectasis patients reported to be contributing to this rise (Aksamit 2017). Sex and age may contribute to the pathogenesis of bronchiectasis, and more females and elderly individuals are given the diagnosis (King 2010).

Bronchiectasis occurs independently of other respiratory diseases but may coexist and may have similar features to other respiratory chronic diseases, leading to a possible delay in diagnosis (Chang 2015; King 2010). Researchers have noted overlap of chronic obstructive pulmonary disease (COPD) and bronchiectasis, and phenotyping in both diseases has become a topic of discussion. Additional investigations are required to determine the underlying relationships and interactions of coexisting respiratory diseases (Liu 2014: Martinez-Garcia 2017).

Bronchiectasis prevalence is higher in indigenous population groups, and bronchiectasis has been identified as an important cause of childhood morbidity (Chang 2010). Indigenous examples of higher prevalence include Aboriginal Australians (1470 cases/100,000 population), Alaskan Natives (1400 cases/100,000 population), and Canadian Inuit in the Qikiqtani Region (202/100,000) (Boyton 2012; Chang 2010; Das 2015). Higher mortality rates have been reported among Pacific (17.8/100,000) and Maoris children (4.8/100,000) than among New Zealand children of European and other ethnicity; however significant mortality does not seem to begin until adulthood (Twiss 2005). Childhood lower respiratory tract infections and environmental factors of tobacco exposure and overcrowding in the home are thought to contribute to higher rates of bronchiectasis (Das 2015).

Management

There remains a lack of certain evidence from large clinical research trials to support bronchiectasis management (Chalmers 2017). Development and evolution of guidelines for the management of bronchiectasis have continued since the release of the Spanish guideline in 2008 (Chalmers 2017; Martinez-Garcia 2018). Guidelines based on available evidence and expert opinion have been produced by the British Thoracic Society (BTS) and The Australian and New Zealand Thoracic Society (TSANZ) (Chang 2015; Pasteur 2010), and, more recently, the European Respiratory Society, the Spanish Society of Pulmonology, and the Saudi Thoracic Society (Al-Jahdali 2017; Martinez-Garcia 2018; Polverino 2017). Management includes symptom control, prevention of acute exacerbations/infections, and limitation of disease progression (Feldman 2011; King 2010; Lavery 2007), and aims to support a healthy lifestyle incorporating good nutrition, non-smoking, and regular exercise including referral to available pulmonary rehabilitation programmes (Scullion 2013). Other preventative strategies such as immunisation and infection control practices can minimise future infection risk (King 2010).

Research

The development of new treatments and targeted therapies for bronchiectasis has been slow; research trials have struggled with recruitment numbers because of coexisting conditions in a rare disease, and effectiveness of treatment for individuals with coexisting conditions remains unknown (Chalmers 2016). Duration of antibiotic treatment has been the focus of research and guideline recommendations; difficulties surround consensus, but agreement has been reached regarding the value of sputum testing at the beginning of antibiotic use (Polverino 2017). Use of long-term antibiotics, particularly macrolides with 'antibiotic' and 'anti-inflammatory' properties, has shown promise for reducing the frequency of exacerbations; however care in screening for non-tuberculous mycobacteria (NTM) is needed to avoid issues of macrolide resistance in NTM (Abo-Leyah 2017). Specific tools have been developed to assess the severity of bronchiectasis these include the FACED score (forced expiratory volume in one second (FEV_1) % predicted (F), age (A), chronic colonisation by *Pseudomonas aeruginosa* (C), extension of the disease by radiological assessment (E), and dyspnoea (D)), eFACED (FACED score including significant exacerbations(e)), and Bronchiectasis Severity Index (BSI) and a quality of life measure (Quality of Life - Bronchiectasis questionnaire); additional trials are required to validate their wider use (Chalmers 2015; Minov 2015).

Description of the intervention

Traditionally, disease management has been a medically co-ordinated activity encompassing diagnosis, clinical assessment, medication prescription, radiography, and pathology and other investigative testing, with goals of optimising treatment and monitoring disease (Nathan 2006).

It has been over 50 years since the introduction of specialist nursing roles in the United States; Canada and the United Kingdom were close behind in introducing similar models that have since been rolled out across the world (Donald 2014). Reference to these nurses encompasses different names across the world, including specialist nurse, nurse practitioner, clinical specialist nurse, and nursing consultant (Brodsky 2008). Different countries have required varying levels of skill and education to support these roles (Brodsky 2008; Niziol 2008). Nursing extended practice roles are predominantly complementary to, or are used to substitute for, the usual (medical) model of care (Donald 2014).

Within respiratory medicine, the respiratory nurse specialist role evolved in the early 1980s, initially to meet the needs of patients in terms of rehabilitation and medication support, and have targeted disease-specific areas such as cystic fibrosis, asthma, COPD, and occupational lung disease (Fletcher 2007; Niziol 2008).

Specialist nurses have advanced through additional education and training to encompass roles previously within the domain of the physician, resulting in blurring of professional boundaries and provision of alternative models of care to the traditional medical model (Niziol 2008). These initiatives have been embraced by nurses, their medical colleagues, and health funders (Brodsky 2008).

How the intervention might work

Nurse-led consultation involves the specialist nurse taking on the management role for stable disease as an alternative to the traditional doctor-led care model. This is not a new concept within chronic disease, and disease specialties are reviewing cost-effectiveness and equivalency of care with nurse-led models (Kilpatrick 2014). Studies specific to nurse-led care in bronchiectasis are limited; studies in respiratory medicine are presented below.

For asthma, a six-month randomised controlled trial saw 154 participants randomised to doctor-led or nurse-led care (Nathan 2006). Outcomes studied included numbers of exacerbations, changes in peak flow, quality of life (Asthma 20) questionnaire scores, and clinic attendance (Nathan 2006). Follow-up asthma care provided by the nurse specialist was as safe and effective as that provided by the physician when a suitably trained nurse used structured interventions including similar outpatient clinic timing and access to independent prescribing (Nathan 2006).

For COPD, a review of types of nurse-led consultations showed nurses in advanced practice roles recommending both pharmacological and non-pharmacological treatment and autonomously functioning in diagnostic and follow-up roles (Fletcher 2013). A randomised controlled trial involving 187 participants looked at the effects on patient outcomes of transferring outpatient doctor care to a respiratory nurse for stable patients with COPD (Vrijhoef 2007). This study showed that nurses working under a protocol were effective in improving patients' subjective knowledge and satisfaction. Nurse-led and doctor-led care were comparable for FEV_1, body mass index (BMI), smoking status, health status, objective knowledge, and compliance, but cost increases for additional consultations were noted (Vrijhoef 2007).

For moderate to severe obstructive sleep apnoea, a multi-centre randomised controlled non-inferiority trial compared health outcomes of nurse-led care versus doctor-led care. The nurse-led approach used a simplified diagnostic and management model to initiate in-home sleep study and treatment and to manage follow-up. Data showed that nurse-led care was not inferior to physician-led care in continuous positive airway pressure (CPAP) adherence, quality of life, and patient satisfaction (Antic 2009), but offered an effective strategy to reduce wait times for sleep study and to free up physician clinics; also, costs were reduced and access to treatment and devices was improved for trial participants (Antic 2009).

Specialist nurses in the role of alternative providers of usual (medical) care have previously proved mostly equivalent for outcomes related to patients and health systems (Kilpatrick 2014). Evidence suggests that cost savings and resource use may be improved through the use of specialist nurses in an outpatient context (Kilpatrick 2014).

Why it is important to do this review

Specialist nursing roles are gaining traction within the current health service climate, but little is known about outcomes of nurse-led care compared with outcomes of care delivered by doctors and the cost implications of using either model. Systematic reviews examining specialist nursing roles in a variety of healthcare settings and specialisations are amassing a growing body of knowledge (Donald 2014). To date, inconsistencies in reporting of study methods and differences in nursing education, roles, and experiences have made it difficult to discern any formal conclusions, other than that more rigorous research is required (Donald 2014). This systematic review seeks to evaluate currently available evidence from randomised controlled trials exploring management of bronchiectasis - both chronic and acute episodes - within the context of a nurse-led model.

OBJECTIVES

To compare the effectiveness of nurse-led care versus doctor-led care in the management of stable bronchiectasis.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) of parallel and cross-over design. We considered papers published in all languages.

Types of participants

We included studies in which adult or child participants had computed tomography-defined bronchiectasis.

Types of interventions

Interventions include specialist care managed or delivered by a nurse who provides chronic disease management for bronchiectasis through a minimum of two contacts over separate days. Excluded were studies solely focused on inpatient or immediate postprocedural care. This systematic review compared nurse-led care versus the usual care delivery model of doctor-led care.

Types of outcome measures

Primary outcomes

1. Exacerbations requiring treatment with antibiotics* (self-reported and physician/specialist nurse reported)
2. Hospital admissions
3. Emergency department attendance

Secondary outcomes

1. Cost-effectiveness
2. Quality of life measures
3. Satisfaction (patient and general practitioner (GP))
4. Exercise capacity
5. Mortality
6. Lung function, such as FEV_1 and forced vital capacity (FVC)

*Nurse was accredited to prescribe antibiotics; post-clinic review nurse met with consultant regarding all clinical decisions.

Patients were taught signs and symptoms that indicate when antibiotics for exacerbation of bronchiectasis should be initiated. They self-reported their use of antibiotics between clinic appointments.

Search methods for identification of studies

Electronic searches

We identified trials using the Cochrane Airways Trials Register, which is maintained by the Information Specialist for the Group. The Cochrane Airways Trials Register contains studies identified from several sources.

1. Monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL), through the Cochrane Register of Studies Online (crso.cochrane.org).
2. Weekly searches of MEDLINE Ovid SP 1946 to date.
3. Weekly searches of Embase Ovid SP 1974 to date.
4. Monthly searches of PsycINFO Ovid SP.
5. Monthly searches of Cumulative Index to Nursing and Allied Health Literature (CINAHL) EBSCO.
6. Monthly searches of Allied and Complementary Medicine (AMED) EBSCO.
7. Handsearches of the proceedings of major respiratory conferences.

We identified studies contained in the Trials Register using search strategies based on the scope of Cochrane Airways. We have provided details of these strategies, as well as a list of handsearched conference proceedings, in Appendix 1. See Appendix 2 for search terms used to identify studies for this review.

We conducted the latest search in March 2018.

Searching other resources

We searched the bibliography of the included study for relevant trials that were not identified by the search strategy. We searched online clinical trials registries, including the International Standard Registered Clinical/social sTudy Number (ISRCTN) Registry from Controlled Clinical Trials (www.controlled-trials.com), government registries (clinical trials.gov), and the International Clinical Trials Registry Platform (ICTRP) search portal of World Health Organization (WHO) registries (www.who.int/trialsearch), for completed and ongoing studies.

Data collection and analysis

Selection of studies

Two review authors (KL and KR) independently scanned the titles, abstracts, and keywords of papers identified from the searches. We retrieved articles of potential relevance and reviewed the full text for consideration of inclusion.

We reached consensus (after discussion) on whether all independently classified citations and full-text studies obtained should be included or excluded.

Both review authors (KL and KR) then applied inclusion criteria to determine which papers should be included in the review and should undergo data extraction. Inclusion criteria were developed on the basis of types of studies, participants, interventions, and outcomes identified.

Data extraction and management

One of the two review authors extracted all study data, the second review author verified the data. KL and KVC independently performed the risk of bias assessment.

Assessment of risk of bias in included studies

Two review authors (KL and KVC) independently assessed the included study for risk of bias related to:

1. sequence generation;
2. allocation sequence concealment;
3. blinding of participants and personnel;
4. blinding at outcome measurement;
5. incomplete outcome data;
6. selective outcome reporting; and
7. other reporting biases.

Measures of treatment effect

We extracted continuous and dichotomous outcome data and would have analysed them using standard statistical techniques with a fixed-effect model had we identified a sufficient number of included studies for pooling in the meta-analysis. If significant heterogeneity was found, we would have used a random-effects model. For continuous outcomes, we would have calculated mean differences (MDs) with 95% confidence intervals (CIs) and would have pooled values as MDs or standardised mean differences (SMDs) for rates presented as rate ratios. For dichotomous outcomes, we would have calculated risk ratios (RRs) with 95% CIs.

We would have performed a narrative synthesis for each study had we included more than one. We would have combined all trials using Review Manager software.

Unit of analysis issues

We considered a mixture of cross-over and parallel studies for inclusion in the review, with the potential for unit of analysis issues to occur had we found sufficient studies for pooling of results. We planned to use the generic inverse variance (GIV) method (by entering effect estimates and their standard errors) to adjust for unit of analysis errors when meta-analysing the data, as per Section 7.7.7 of the *Cochrane Handbook for Systematic Reviews and Interventions,* had we found more than one study to allow for meta-analysis (Higgins 2011).

Dealing with missing data

We evaluated missing information regarding participants on an available case analysis basis, as described in Chapter 16.2.2 of the *Cochrane Handbook for Systematic Reviews and Interventions* (Higgins 2011). If statistics essential for analysis were missing (e.g. group means and standard deviations for both groups were not reported) and could not be calculated from other data, we planned to contact the study authors to request missing data. We considered loss of participants that occurred before baseline to have no effect on eventual outcome data provided by the study. We assessed and discussed on an intention-to-treat basis any losses that occurred after baseline measurements had been taken.

Assessment of heterogeneity

Had we identified sufficient studies, we would have assessed statistical heterogeneity using a combination of tests, including an I^2 statistic and visual inspection of the data. If we had included 10 or more studies, we would have also used funnel plots. We would have considered the Der-Simonian and Laird method of analysis presented with a P value less than 0.05 as statistically significant. In the presence of significant heterogeneity, we would have re-analysed data using both fixed-effect and random-effects models.

Assessment of reporting biases

We planned to examined reporting biases by using a funnel plot, if we were able to meta-analyse 10 or more studies.

Data synthesis

We analysed trial data using RevMan 5.1.

Subgroup analysis and investigation of heterogeneity

If we had included a sufficient number of studies, we would have performed the following subgroup analyses.

1. Hospital versus community-based nursing care.
2. Adults versus children.

Sensitivity analysis

We planned to perform a sensitivity analysis to explore effects of bias derived from study methods on review findings. However, we did not conduct a sensitivity analysis because we included only one study, which we did not judge to be at high risk of bias for sequence generation and allocation concealment.

RESULTS

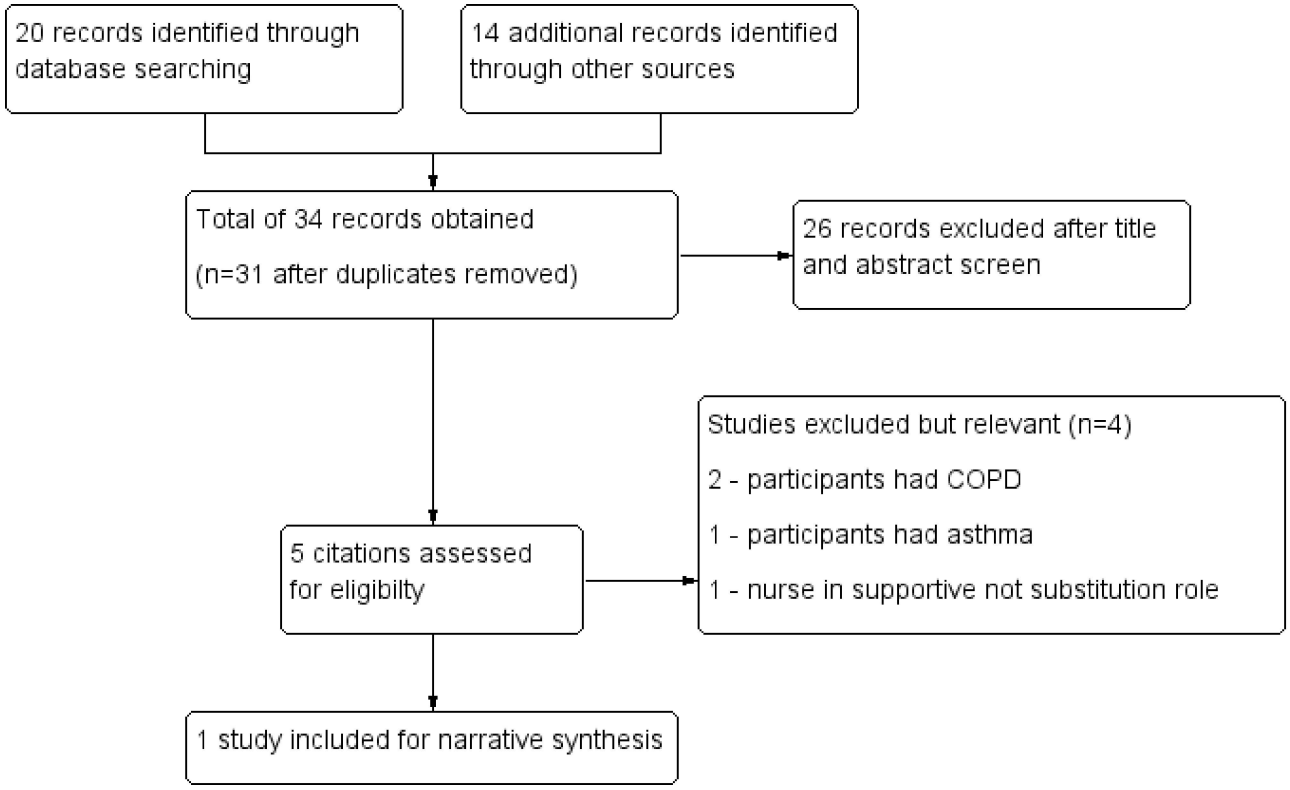
Description of studies

Characteristics of included studies and Characteristics of excluded studies are reported in the respective tables.

Results of the search

We identified 34 studies using search methods - 20 citations from the literature search, and 14 through other source searches. A total of 31 studies remained when we had removed duplicates. We excluded 26 records after title and abstract screening. We considered five studies relevant and screened them for eligibility, then excluded four studies. Only one study met review inclusion criteria (Sharples 2002; see Figure 1).

Figure 1. Study flow diagram.



Included studies

We have reported details of the included study in the Characteristics of included studies table and reasons for exclusion of four studies in the Characteristics of excluded studies table.

Study design

The included study - Sharples 2002 - investigated the efficacy of nurse specialist care in bronchiectasis using a randomised, single-centre, cross-over design. This study was conducted in the United Kingdom and was published in 2002.

Participant characteristics

A total of 149 patients with bronchiectasis from the Lung Defence Clinic were identified, 40 of whom were unsuitable for inclusion; seven additional participants declined or did not participate in the recruitment process. From the remaining 102 eligible participants, investigators randomised the first 80 participants to attend the clinic. All participants were ≥ 18 years of age, and mean participant age was 58.3 ± 13.3 years. The study included 55 female participants, and the diagnosis of bronchiectasis was confirmed for all participants by high-resolution computed tomography (HRCT). Participants were recruited from a bronchiectasis outpatient clinic. Trials included only stable patients with an established management plan*. Exclusion criteria comprised a life expectancy of less than two years, expected transplant listing within the two-year study period, FEV_1 < 30% predicted, and other significant comorbidities that would modify the management of bronchiectasis. Data were obtained for 77 participants following two deaths and inability of one participant to complete tests.

Investigators allocated 39 participants to nurse-led care in the intervention arm and the remaining 41 participants to doctor-led care during the year-long treatment period.

*The management plan was not specifically defined but was inclusive of best practice recommendations including physiotherapy, medication compliance, and use of antibiotics (Sharples 2002).

Intervention characteristics

Patients, on arrival to the outpatient clinic, received routine testing followed by consultation with a nurse practitioner or a doctor. Consultation involved clinical assessment, review of history, physical examination, and discussion of a treatment management plan for bronchiectasis. Appropriate changes to the management plan were made, and additional tests such as X-ray and blood testing performed. The nurse practitioner or the doctor had the discretion to determine frequency of follow-up appointments on the basis of a protocol that included weekly appointments for those given intravenous antibiotics at home, fortnightly appointments to assess results of antibiotic courses, and appointments every three to six months for routine monitoring of the patient's disease. When participants were randomised, they were assigned their appropriate contact person (nurse practitioner or doctor) and were encouraged to telephone that contact person with disease or management queries. The nurse practitioner had the same autonomy as the doctor to bring patient appointments forward and to recommend general practitioner review or emergency medication commencement. The nurse practitioner did not have authority to manage other systemic problems outside management of bronchiectasis, and admission to hospital for these issues was referred to the

consultant. Additional education, referrals, and use of specific sputum clearance techniques were not reported.

To ensure patient safety, a supervision mechanism was included as part of the study design whereby the nurse practitioner had a detailed discussion with a consultant within 24 hours of the clinic to detail management decisions. If the consultant would have made a different management decision, the patient was contacted regarding a change in treatment.

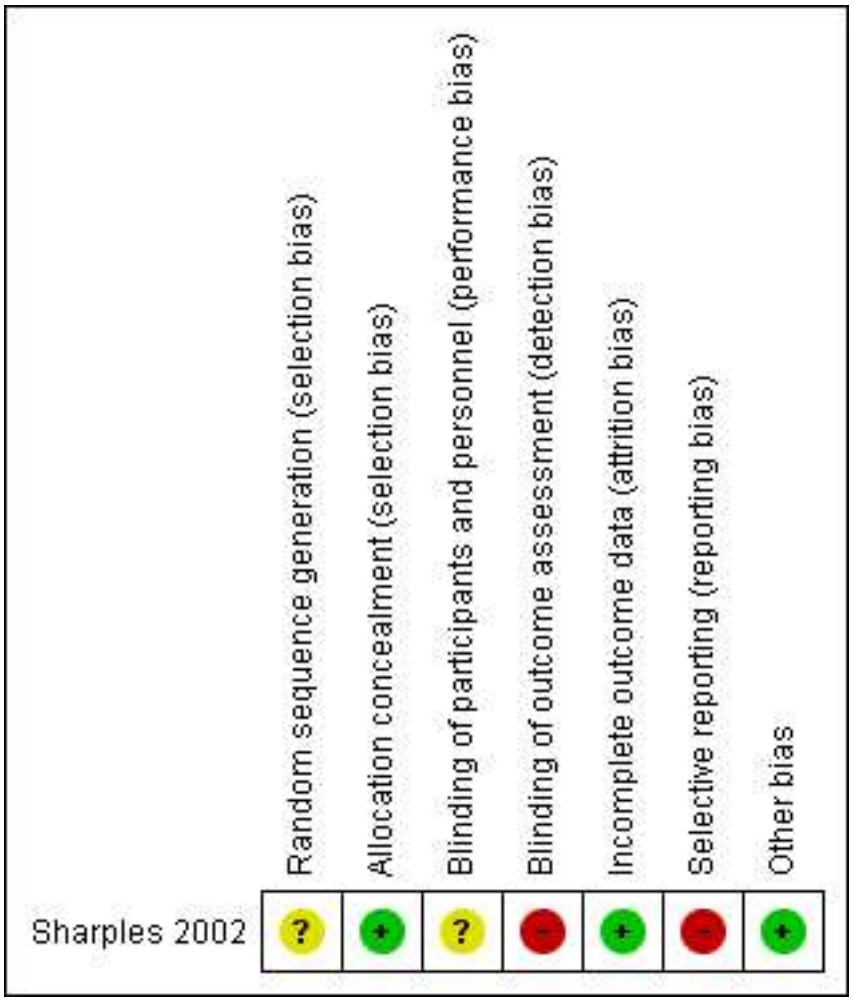
Excluded studies

Four studies appeared relevant from the initial screening process; however on further investigation, they did not meet all criteria for inclusion. We excluded these studies from analysis for the following reasons. Two studies were randomised controlled trials involving patients with COPD (Bergner 1988; Cockcroft 1987). Both studies looked at home care nursing as the intervention, with nurses in a supportive role. Levy 2000 was a randomised controlled trial in which participants had asthma. The intervention patient education provided by a respiratory nurse was compared with no education and standard follow-up with the general practitioner. Maa 2007 met criteria for inclusion in that this was a randomised controlled trial with participants who had bronchiectasis; however this was not a nurse-led care comparison study. The nurse played a complementary role in supervising acupressure treatment.

Risk of bias in included studies

Full details of our risk of bias judgements can be found in the "Risk of bias" section at the end of each Characteristics of included studies table and in Figure 2. Overall, the methodological certainty of the study was satisfactory. Two independent review authors (KL and KC) reached agreement regarding assessment of study certainty.

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

Review authors considered generation of randomisation sequence as having unclear risk in Sharples 2002. Investigators mentioned but did not describe randomisation. Review authors considered allocation concealment to be adequately reported in Sharples 2002. This presented low risk of bias with the use of numbered opaque envelopes.

Blinding

Blinding of participants and personnel did not occur; this was considered to confer unclear risk of bias because the design of

this intervention made blinding impossible. The effect of knowing which groups the participant was assigned to and crossed over to is unknown.

Lack of blinding of assessment outcomes led to the conclusion of high risk of detection bias.

Incomplete outcome data

Overall the level of study completion was high. Two patient deaths had occurred after the first 12 months of the study; a patient given nurse-led care died from perforated bowel, and a patient receiving doctor-led care died from respiratory failure. Most participants completed clinical assessment. One patient was unable to complete lung function and exercise testing owing to a rib fracture not related to his bronchiectasis. Two other patients did not complete the exercise test; one at 12 months had a fractured toe, and one at 24 months was too sick to complete testing. Both of these participants had received doctor-led care before the time of their assessment. Quality of life was not assessed in two different participants, one at 12 months and one at 24 months; both had received nurse-led care during the assessment period. Six participants did not cross over to nurse-led care in the second year, as they were no longer considered to have stable bronchiectasis. These participants were still included in the trial on an intention-to-treat basis. Trialists reported that a secondary analysis excluding participants produced almost identical results. These results were not published in the original article, and trial authors did not respond to attempts to contact them. They reported attrition with reasons and a high completion rate; therefore we judged this domain as having low risk of bias.

Selective reporting

Investigators tested changes between time periods; however, they observed effects with changes in the economic analysis in the second year of the trial and mentioned these results in the discussion but did not report them in the results. Owing to the cross-over design with no washout period, we could not exclude the presence of a carryover effect. This may have an impact on data pertaining to exacerbations and hospital admissions in particular, but could also effect FEV_1 and exercise capacity. Trialists performed post hoc analysis for carryover of clinical outcomes but stated that these results were non-significant and did not report further on them. Attempts to seek clarification from study authors of post hoc analysis and first year data were unsuccessful. Cost changes between the first and second years of the study could be related to learned effect or selection effect, given that six participants did not cross over to nurse-led care (Sharples 2002). For all of these reasons, we judged this domain as having high risk of bias.

Other potential sources of bias

We did not identify other potential sources of bias in this study.

Effects of interventions

See: **Summary of findings for the main comparison** Nurse-led care compared with doctor-led care for management of bronchiectasis

See Summary of findings for the main comparison for the main comparison of nurse-led care versus doctor-led care for management of stable bronchiectasis.

No meta-analysis or sensitivity analysis was possible because only a single study was identified (Sharples 2002). To eliminate questions regarding carryover effects of doctor-led/nurse-led care, we attempted to contact the authors of this study to request data from the first 12 months of the study. We received no response, so we reviewed outcomes over the 24-month study period including the 12-month crossover time periods. We have presented narrative data from the published paper.

Exacerbations requiring treatment with antibiotics

Infective exacerbations were reported by patients and were not verified by the physician or nurse. The number of infective exacerbations experienced by participants during nurse practitioner-led care was 262 in 79.4 patient-years of follow-up, compared with 238 in 77.8 years during doctor-led care (rate ratio 1.09, 95% CI 0.91 to 1.30; low-certainty evidence; Analysis 1.1).

Hospital admissions

During doctor-led care, investigators reported 42 admissions to hospital compared with 66 during nurse-led care (rate ratio 1.52, 95% CI 1.04 to 2.23; low-certainty evidence; Analysis 1.2). Of these, 23 and 43 re-admissions, respectively, were attributable to bronchiectasis (rate ratio 1.59, 95% CI 0.75 to 3.39; P = 0.22; Sharples 2002). Data show a statistically higher proportion of hospital admissions in nurse-led care over the trial period.

Emergency department attendance

This was not reported.

Cost-effectiveness

Researchers assessed hospital admission, use of medication, and clinic visits to determine cost-effectiveness of nurse-led versus doctor-led care. Three drugs accounted for more than 80% of the difference in antibiotic utilisation, namely, intravenous meropenem and ceftazidime and nebulised colistin. These drugs are infrequently used but are costly; this meant that the slight increase in use among participants being cared for by the nurse was economically important. Most intravenous antibiotics were prescribed for treatment of patients with *Pseudomonas* infection, as per a well-defined protocol. Medical staff pre-authorised all hospital admissions and determined length of stay of these participants (Table 1). Nurse-led care resulted in significantly higher costs per patient compared with doctor-led care, largely owing to differences in the number of hospital admissions and increased use of intravenous and nebulised antibiotics. Total cost of nurse-led care per patient in the first year was £5202, and total cost was £3262 in the second year. Costs of doctor-led care per patient in the first year were £2577 and in the second year £2851 (Sharples 2002).

Nurse-led clinic appointments lasted on average 26 minutes compared with 20 minutes for doctor-led care (Sharples 2002). Nurses averaged 5.06 clinic visits per patient compared with 4.48 for doctors (Table 1).

Quality of life measures

Triaists administered St. George's Respiratory Questionnaire (SGRQ). Results show no significant differences but significant uncertainty because of wide confidence intervals for each of the scores for symptoms, control, or impact, or for total score (Analysis 1.3; Analysis 1.4; Analysis 1.5; Analysis 1.6). One patient in a nurse-

led care group refused to complete quality of life interviews at 12 months.

Satisfaction (patient and GP)

Study authors asked participants to rate their satisfaction with nurse-led and doctor-led care and analysed 12 individual statements related to the consultation. Statistically significant differences favoured the nurse practitioner in terms of communication and time spent with patients (Table 2).

Exercise capacity

Results on exercise capacity were unclear owing to wide confidence intervals in distance walked during a 12-minute walking test (12MWT) between people receiving nurse-led care and those given doctor-led care (low-certainty evidence; Analysis 1.7).

Mortality

Two patients died after the 12-month follow-up. The patient given nurse-led care died from a perforated bowel, and the patient receiving doctor-led care died from end-stage respiratory failure (low-certainty evidence; Sharples 2002).

Lung function

Results show no statistically significant differences in FEV_1/FVC percent predicted or distance walked between nurse-led and doctor-led care in the two treatment periods (low-certainty evidence; Analysis 1.8; Analysis 1.9).

DISCUSSION

Summary of main results

The primary aim of this review was to assess the effectiveness of nurse specialist care compared with traditional doctor-led care for people with bronchiectasis. The evidence presented in this review is insufficient to show if nurse-led or doctor-led care is better, worse, or the same.

Sharples 2002 randomised 80 people with stable bronchiectasis to receive care from either the nurse practitioner or a physician for one year. After one year, the group crossed over to the other practitioner. This trial is now old, and since it was published, bronchiectasis guidelines have been produced for the first time. Outcome data related to infective exacerbation rate, quality of life, exercise capacity, and lung function show little between-group difference but do not demonstrate equivalence. Patient satisfaction showed significant differences in favour of the nurse practitioner - which trial authors postulated may be due to improved communication and increased time spent with patient (Sharples 2002). An increase in hospital admissions for nurse-led care was evident when paired data from both arms of the trial were considered. Nurse-led care in the first year of the study incurred increased costs from hospital admissions and use of antibiotics (Sharples 2002). A paucity of data contributed to wide confidence intervals for all outcomes, reflecting uncertainty in the results and low certainty of evidence.

The cross-over design as applied to temporary effects such as the patient review is a suitable evaluation when directed to a stable chronic condition such as bronchiectasis. Advantages of this design include that each patient acts as his or her own control (eliminating participant variation amongst participants), fewer participants are required for assessment, and all participants receive the intervention (Higgins 2011). The potential for a carryover effect without a washout period between treatments cannot be excluded as a potential bias (Higgins 2011).

Overall completeness and applicability of evidence

Despite an extensive literature search and increasing utilisation of nursing specialist roles in health care, only one study conducted within this 15-year time frame met the inclusion criteria for this review. Since 2002, bronchiectasis guidelines have been introduced and practices have changed. Additional research into classification of bronchiectasis through use of severity scores, as well as new inhaled antibiotic agents and successful use of macrolides as treatment options, have added to management strategies. Future development of targeted therapies in line with underlying causes of bronchiectasis are under investigation (Chalmers 2015).

Additional costs

Sharples 2002 reports significant additional resource use in nurse-led care related to increased hospital admissions during the first year of the trial. However, the difference between nurse-led care and doctor-led care was substantially less in the second year of nurse specialist care. Study authors suggest this may be a learned effect, as the nurse became more familiar with the outpatient clinic management role. After receiving additional training, it was the nurses' first year of managing people in a clinic, but the doctors leading care groups had at least three years' experience. Trial authors postulated that further modification to the protocol may reduce the cost difference further (Sharples 2002). Few studies of good certainty have effectively shown that disease management can affect healthcare utilisation and costs (Ofman 2004). A broad systematic review of nurse-led clinics did show some favourable results in terms of nurse-led care cost-effectiveness; however limited studies in this area have reduced the generalisability of these results (Randall 2017). Case management in nurse-led clinics was also shown to increase cost-effectiveness and to reduce hospital admission (Randall 2017).

Antibiotic stewardship

The role of stewardship in the use of antibiotics is to maximise clinical success and reduce unplanned consequences such as antibiotic resistance (Garau 2014). People with bronchiectasis who experience frequent exacerbations should have antibiotic choice guided by sputum testing for microscopy, culture, and sensitivity (Pasteur 2010; Polverino 2017). Colonisation with opportunistic organisms such as *Pseudomonas* can occur in bronchiectasis, and the decision to treat an individual with infection should be made using clinically objective measures (i.e. presence of temperature, general malaise) and, when possible, blood results indicating raised C-reactive protein (CRP) or white cell count (WCC) (Brink 2016; Garau 2014).

The role of non-pharmacological interventions such as self-management/chronic disease support and review of sputum clearance techniques should be considered to optimise care (Garau 2014; Pasteur 2010).

Protocol use

Use of a protocol by the nurse may have led to increased costs through compliance with the recommended management pathway. No evidence suggests that doctor-led care followed

the same protocol. Variance in decision making between the three doctors involved in the study cannot be excluded (Sharples 2002). A management protocol would have been used in Sharples 2002 in the absence of bronchiectasis guidelines, which were not released until 2008 (Martinez-Garcia 2018). Auditing of British Thoracic Society (BTS) guidelines for bronchiectasis management has revealed lack of adherence to the guideline (Hill 2012; Hill 2014). Few economic evaluations were reported before guideline release (Garrison 2016); however it is expected that better management through adherence to guidelines should lead to better health outcomes (Polverino 2017). Further evaluation of protocol use/guideline adherence by clinicians is recommended to determine whether costs reduce overtime and health outcomes are improved.

Hospital admissions

Hospital admissions were higher for the group receiving nurse-led care. All admissions in nurse specialist care had to be authorised by a consultant, and all admissions were considered appropriate (Sharples 2002). This increase in cost may be attributed to the experience of the nurse compared with that of the doctor. The nurse practitioner had been trained to practice at an advanced level but required additional training in the specialist aspect of this disease before participating in the study. The doctor-led care group included physicians with a minimum of two to three years of consultative experience in caring for patients with respiratory disorders.

Nurse training

The nursing role or its level of specialisation is not defined within the BTS guideline for bronchiectasis nor in the European Respiratory Society (ERS) monograph, but the BTS guideline suggests that nurses should be suitably trained to fulfil their role in the management of bronchiectasis (Floto 2011; Pasteur 2010). The advanced practice role of a specialist nurse in a tertiary setting in Sharples 2002 was acknowledged in the guideline (Pasteur 2010). Little has been written about nurses and their training in recent guideline releases. The Spanish guideline has identified some of the key nursing responsibilities, which include control of treatment adherence, assessment of medication tolerance, inhaled medication education, maintenance of equipment, intravenous antibiotic administration, disease monitoring with spirometry, and sputum clearance (Martinez-Garcia 2018). Introduction of guidelines for management assists nurses in advanced or extended practice roles to provide translational health care through integration of guidelines into current practice when clinically judged appropriate (Branham 2014). The costs of nurse training were also included among study expenses.

Patient satisfaction

Patient satisfaction was greater for communication and time spent with patient when nurse-led care was provided (Sharples 2002). Nurse interventions in complementary roles to doctor-led care often include review of patient needs, education, self-management, and additional referral to healthcare professionals (Kilpatrick 2014). This approach is likely to be incorporated into nurse-led care models, accounting for some of the extra time that nurses spent with their patients (Vrijhoef 2007).

The generalisability of results presented in Sharples 2002 is limited to the Lung Defence Clinic because no similar studies have been conducted.

Quality of the evidence

The overall quality of the included study was low, but because review authors identified only one study during the literature, we have limited ability to conclude, beyond this study, that nurse-led care in the management of stable bronchiectasis is more effective than doctor-led care.

Potential biases in the review process

No significant biases were expected, or and none were found to occur during the review process. Criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* were strictly followed to limit potential biases during screening, data extraction, and data analysis (Higgins 2011). Two review authors independently assessed risk of bias and resolved conflicts by discussion with a third review author.

We attempted to correspond with study authors but received no reply. None of the authors of this review reported conflicts of interests, financial or otherwise.

Agreements and disagreements with other studies or reviews

We did not identify any new studies via updated searches; therefore our conclusions have not substantively changed in this update. We have updated the background section to present a contemporary picture of bronchiectasis and to provide examples of respiratory nurse-led care versus doctor-led care for a variety of respiratory diseases. Cochrane methods have changed since the review was last completed, and we have updated this review to bring it in line with current recommendations.

Respiratory specialist nurses may focus on a specific single disease or may have a broader chronic disease scope of practice (Fletcher 2013). For other respiratory conditions such as asthma, chronic obstructive pulmonary disease (COPD), and sleep disorders, specialist nurses have been shown to be comparable to doctors caring for stable patient groups (Antic 2009; Fletcher 2013; Nathan 2006). Expanding the scope of this review to make it inclusive of respiratory specialist nurses functioning in an alternative role to doctors in providing care may improve the yield of suitable studies and improve the body of evidence to permit a determination about specialist nurse care.

AUTHORS' CONCLUSIONS

Implications for practice

This review has been unable to demonstrate the clinical and cost effectiveness of nurse specialist care when compared with doctor-led care for management of stable bronchiectasis, based on findings of a single study. Uncertainty remains owing to the paucity of evidence surrounding nurse-led care in the management of bronchiectasis. The study showed uncertainty related to outcomes of exacerbation, quality of life, exercise, mortality, and lung function. Patient satisfaction improved with nurse-led care; however costs increased owing to admissions and use of medication. It is unknown whether costs reported in the study conducted in 2002 are a true reflection of the average cost of providing care for people living with bronchiectasis at the current time, according to updated guidelines and clinical practice.

Implications for research

Widespread use of nurse-led care models in health care still lacks the research rigour needed to show cost-effectiveness, and findings in current research are unclear (Lopatina 2017). Issues surrounding the uniqueness of practice roles and specificity for disease groups make it difficult to know how cost-effective they are beyond the group tested (Lopatina 2017). A standard approach based on a validated economic evaluation tool may facilitate generalisation.

In Sharples 2002, the nurse followed a protocol developed from recommended management practices of the day. Wider adherence to the protocol by the nurse or by the doctor was not reported. Future studies must measure compliance with protocols to determine efficacy with exacerbations and hospital admissions.

Long-term studies of nurse specialist care in bronchiectasis are required to determine:

1. cost-effectiveness of nurse-led care in bronchiectasis;
2. whether bronchiectasis guidelines are followed and whether this contributes to an increase in cost; and
3. whether bronchiectasis management in other clinical settings such as inpatient and outreach nursing is effective.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Sharples 2002

Methods	Country: United Kingdom Design: randomised controlled trial, single centre, cross-over study. No washout phase Study objective: to assess feasibility and safety of nurse-led outpatient clinic and to compare cost-effectiveness of nurse-led vs doctor-led care Methods of analysis: paired student's t tests, means, confidence intervals Exacerbation and admission: Poisson distribution and modes of care comparison using likelihood ratios Patient satisfaction: Wilcoxon signed rank test, McNemar test Cost analysis: paired non-parametric bootstrap analysis Clustering adjustments made: not relevant
Participants	Eligible for study: 80 Randomised: 39 nurse-led care, 41 doctor-led care Completed: 37 nurse-led care, 40 doctor-led care Age, years: nurse/doctor 63.7, doctor/nurse 53.1; mean age 58.3 ± 13.3 years Gender: male/female 25/55 Bronchiectasis diagnosis: confirmed by high-resolution computed tomography Recruitment: outpatient clinic attendance with established management plan Comorbidities: no detail provided regarding comorbid conditions Exclusion criteria: life expectancy < 2 years, need for transplant listing within 2 years, FEV_1 < 30% predicted, other significant pathology that would modify the management of bronchiectasis
Interventions	Intervention description: nurse specialist-led care Control description: doctor-led care Duration of intervention: two 1-year care blocks Setting: outpatient
Outcomes	Prespecified outcomes: FEV_1, FVC, exacerbation rates, hospital admissions, quality of life, cost-effectiveness, exercise capacity, 12MWT, withdrawals and dropouts, nurse autonomy, participant and GP satisfaction; consultation: type, length, and venue; participant compliance Follow-up period: 1 year, then cross-over
Notes	Funding: NHS R&D Health Technology Assessment Programme

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation mentioned but methods not described
Allocation concealment (selection bias)	Low risk	Numbered opaque envelopes used

Sharples 2002 *(Continued)*

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Blinding did not occur; blindness was not possible, given it is part of the intervention. Impact of knowing group assignment is unclear. Carryover effects from first year of study may have occurred when crossed-over.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Blinding did not occur.
Incomplete outcome data (attrition bias) All outcomes	Low risk	High level of completion; attrition reported with reasons
Selective reporting (reporting bias)	High risk	Changes between time periods were tested; however effects were observed in the economic analysis during the second time period; post hoc analyses occurred for carryover of clinical outcomes but were not reported. Selection effect cannot be ruled out, given that 6 participants did not cross-over to nurse-led care.
Other bias	Low risk	No other biases identified

12MWT: 12-minute walk test; FEV_1: forced expiratory volume in one second; FVC: forced vital capacity; GP: general practitioner; NHS: National Health Service; R&D: Research and Development.

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Bergner 1988	Randomised controlled trial - participants had a confirmed diagnosis of chronic obstructive pulmonary disease
Cockcroft 1987	Randomised controlled trial - participants with chronic obstructive airways disease were recruited
Levy 2000	Randomised controlled trial of specialist nurse education in asthma
Maa 2007	Randomised trial of nurse in complementary alternative medicine role utilising acupressure as treatment for participants with bronchiectasis

DATA AND ANALYSES

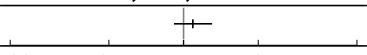
Comparison 1. Nurse-led versus physician-led care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Infective exacerbations (per patient per year)	1		Rate Ratio (Fixed, 95% CI)	Totals not selected
2 Admissions per patient per year	1		Rate Ratio (Fixed, 95% CI)	Totals not selected

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3 SGRQ - symptoms	1		Mean Difference (Fixed, 95% CI)	Totals not selected
4 SGRQ - control	1		Mean Difference (Fixed, 95% CI)	Totals not selected
5 SGRQ - impact	1		Mean Difference (Fixed, 95% CI)	Totals not selected
6 SGRQ - total scores	1		Mean Difference (Fixed, 95% CI)	Totals not selected
7 Exercise capacity: 12-minute walk distance, metres	1		Mean Difference (Fixed, 95% CI)	Totals not selected
8 FEV_1 (% predicted)	1		Mean Difference (Fixed, 95% CI)	Totals not selected
9 FVC (% predicted)	1		Mean Difference (Fixed, 95% CI)	Totals not selected

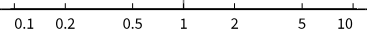
Analysis 1.1. Comparison 1 Nurse-led versus physician-led care, Outcome 1 Infective exacerbations (per patient per year).

Study or subgroup	Experimental N	Control N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
Sharples 2002	39	41	0.1 (0.09)		1.09[0.91,1.3]



Analysis 1.2. Comparison 1 Nurse-led versus physician-led care, Outcome 2 Admissions per patient per year.

Study or subgroup	Experimental N	Control N	log[Rate Ratio] (SE)	Rate Ratio IV, Fixed, 95% CI	Rate Ratio IV, Fixed, 95% CI
Sharples 2002	39	41	0.4 (0.196)		1.52[1.04,2.23]

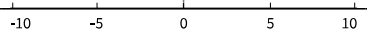


Analysis 1.3. Comparison 1 Nurse-led versus physician-led care, Outcome 3 SGRQ - symptoms.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	38	41	-1.4 (2.347)		-1.4[-6,3.2]

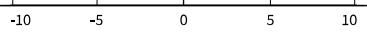
Analysis 1.4. Comparison 1 Nurse-led versus physician-led care, Outcome 4 SGRQ - control.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	38	41	-1.7 (1.398)		-1.74[-4.48,1]



Analysis 1.5. Comparison 1 Nurse-led versus physician-led care, Outcome 5 SGRQ - impact.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	38	41	-1.8 (1.429)		-1.8[-4.6,1]



Analysis 1.6. Comparison 1 Nurse-led versus physician-led care, Outcome 6 SGRQ - total scores.

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	38	41	-1.7 (1.174)		-1.7[-4,0.6]

Analysis 1.7. Comparison 1 Nurse-led versus physician-led care, Outcome 7 Exercise capacity: 12-minute walk distance, metres.

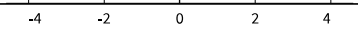
Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	39	41	18 (15.817)		18[-13,49]

Analysis 1.8. Comparison 1 Nurse-led versus physician-led care, Outcome 8 FEV_1 (% predicted).

Study or subgroup	Nurse-led N	Doctor-led N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	39	41	0.2 (0.918)		0.2[-1.6,2]

Analysis 1.9. Comparison 1 Nurse-led versus physician-led care, Outcome 9 FVC (% predicted).

Study or subgroup	Experimental N	Control N	Mean Difference (SE)	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
Sharples 2002	39	41	-0 (0.725)		-0.02[-1.44,1.4]



ADDITIONAL TABLES

Table 1. Cost-effectiveness

Resource	Nurse-led care (mean visits per participant)	Nurse-led care (mean cost per participant, £)	Doctor-led care (mean visits per participant)	Doctor-led care (mean cost per participant, £)	Difference (SD, £)
Nurse-led clinics	4.61	180	0	0	180 (158)
Doctor-led clinics	0.45	25	4.48	217	-192 (199)
Procedures	0.13	61	0.11	54	7 (376)
Imaging	1.14	47	0.76	45	1 (112)
Other tests	24.58	260	18.94	222	37 (257)
Antibiotics (intravenous)	23 (days)	879	16 (days)	523	356 (1452)
Antibiotics (oral)	222 (days)	684	201 (days)	524	161 (695)
Bronchodilators	461 (days)	213	435 (days)	193	20 (179)
Corticosteroids	238 (days)	278	219 (days)	258	20 (181)
Other drugs	212 (days)	180	190 (days)	155	25 (194)
Inpatient	6.46 (days)	1338	2.36 (days)	477	861 (2755)
Day case	0.11	43	0.05	16	27 (170)
GP visits	1.11	20	1.40	26	-6 (33)
Total		**4208**		**2711**	**1498 (688 to 2674)**

SD: standard deviation.

Table 2. Participant satisfaction with consultation

Comments	Nurse practitioner better, number, (%)	Doctor better, number (%)	P value
It was sometimes difficult to discuss your problems with the doctor/nurse practitioner.	11/76 (14.5)	1/76 (1.3)	0.006
The doctor/nurse practitioner explained clearly what is wrong.	7/74 (9.5)	0/74 (0)	0.016
The doctor/nurse practitioner examined you thoroughly when necessary.	6/70 (8.6)	0/70 (0)	0.031
The doctor/nurse practitioner should tell you more about your illness/condition and treatment.	7/59 (11.9)	3/59 (5.1)	0.344
The doctor/nurse practitioner made you feel at ease.	2/75 (2.7)	1/75 (1.3)	1.000
There was not enough time to discuss your problems with the doctor/nurse.	10/74 (13.5)	1/74 (1.4)	0.012
You felt confident the doctor/nurse practitioner knew about your medical history and your care.	7/74 (9.5)	1/74 (1.4)	0.070
Sometimes you felt that the doctor/nurse practitioner should listen more to what you said.	5/69 (7.2)	2/69 (2.9)	0.453
The doctor/nurse practitioner gave clear explanation about any tests that you needed.	4/75 (5.3)	1/75 (1.3)	0.375
You often came away from your appointment wishing you'd asked more questions.	13/72 (18.1)	9/72 (12.5)	0.523
You felt you were given a chance to have an active part when discussing your illness/condition.	4/73 (5.5)	0/73 (0.0)	0.125
There were frequent interruptions during your consultation.	6/73 (8.2)	3/73 (4.1)	0.508

APPENDICES

Appendix 1. Sources and search methods for the Cochrane Airways Register of Trials

Electronic searches: core databases

Database	Frequency of search
CENTRAL (the Cochrane Library)	Monthly
MEDLINE (Ovid)	Weekly
Embase (Ovid)	Weekly
PsycINFO (Ovid)	Monthly
CINAHL (EBSCO)	Monthly

(Continued)

AMED (EBSCO)	Monthly

Handsearches: core respiratory conference abstracts

Conference	Years searched
American Academy of Allergy, Asthma and Immunology (AAAAI)	2001 onwards
American Thoracic Society (ATS)	2001 onwards
Asia Pacific Society of Respirology (APSR)	2004 onwards
British Thoracic Society Winter Meeting (BTS)	2000 onwards
Chest Meeting	2003 onwards
European Respiratory Society (ERS)	1992, 1994, 2000 onwards
International Primary Care Respiratory Group Congress (IPCRG)	2002 onwards
Thoracic Society of Australia and New Zealand (TSANZ)	1999 onwards

MEDLINE search strategy used to identify trials for the CAGR

Bronchiectasis search

1. exp Bronchiectasis/
2. bronchiect$.mp.
3. bronchoect$.mp.
4. kartagener$.mp.
5. (ciliary adj3 dyskinesia).mp.
6. (bronchial$ adj3 dilat$).mp.
7. or/1-6

Filter to identify RCTs

1. exp "clinical trial [publication type]"/
2. (randomized or randomised).ab,ti.
3. placebo.ab,ti.
4. dt.fs.
5. randomly.ab,ti.
6. trial.ab,ti.
7. groups.ab,ti.
8. or/1-7

9. Animals/

10. Humans/

11. 9 not (9 and 10)

12. 8 not 11

The MEDLINE strategy and RCT filter are adapted to identify trials in other electronic databases.

Appendix 2. Search strategy to identify relevant studies from the Cochrane Airways Register of Trials

#1 BRONCH:MISC1
#2 MeSH DESCRIPTOR Bronchiectasis Explode All
#3 bronchiect*
#4 #1 or #2 or #3
#5 MeSH DESCRIPTOR Ambulatory Care
#6 MeSH DESCRIPTOR Nurses Explode All
#7 MeSH DESCRIPTOR Nursing
#8 "ambulatory care"
#9 nurs*
#10 doctor*
#11 "medical staff"
#12 specialis*
#13 #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12
#14 #4 and #13

[In search line #1, MISC1 denotes the field in the record where the reference has been coded for condition, in this case, bronchiectasis]

WHAT'S NEW

Date	Event	Description
5 March 2018	New citation required but conclusions have not changed	Review structure and methods updated to match current Cochrane standards. Background/discussion updated. New review author team. Order of outcomes changed
5 March 2018	New search has been performed	Literature search run. No new suitable studies found

HISTORY

Protocol first published: Issue 2, 2001
Review first published: Issue 3, 2003

Date	Event	Description
3 July 2008	New search has been performed	Update search run in July 2008; no new studies found
3 July 2008	Amended	Converted to new review format
4 September 2002	New citation required and conclusions have changed	Substantive amendments made

CONTRIBUTIONS OF AUTHORS

KL and KR wrote the protocol with additional input from KVC. KL and KR assessed search results. KL and KVC-C entered data and developed the discussion. FC and BJS contributed comments to the final draft of the manuscript before submission to editorial.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- The review authors declare that no such funding was received for this systematic review, Other.

External sources

- The review authors declare that no such funding was received for this systematic review, Other.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

This review includes a new review author team.

Outcome measures include the following.

1. The new review author team reordered primary and secondary outcomes and included data on patient satisfaction and cost-effectiveness not previously reported.
2. Hospital admission was changed to a primary outcome, in addition to exacerbations.
3. Lung function was changed to a secondary outcome, as it is unlikely to show significant differences in stable bronchiectasis.

New methods include the following.

1. Since the last review, changes to search methods and standard airways protocol have occurred; these have been included in this update.
2. Assessment of risk of bias has been updated. Results have been presented in the 'Summary of findings' table.

In the previous review, the first review author and Diana Bilton were involved in the only trial analysed in the review.

INDEX TERMS

Medical Subject Headings (MeSH)

Bronchiectasis [*nursing]; Randomized Controlled Trials as Topic

MeSH check words

Adult; Child; Humans

Chapter 6. Discussion

6.1 Significance and contribution to knowledge

This thesis presents evidence from published and unpublished manuscripts to identify areas where changes to practice could improve bronchiectasis management in an outpatient setting. It also explores if nurse-led care could be used as an effective model for bronchiectasis management. Results from this research can be used to underpin current practice, inform policy makers and provide direction for design of future research to improve bronchiectasis management in our institution and may contribute to a broader understanding in South Australia of what is happening in bronchiectasis management in our state.

Currently, globally, we continue to see an increasing number of bronchiectasis cases and as yet we have no medications specifically designed for its treatment (11). We do however have guidelines to support how we manage this condition. These guidelines are a mix of mainly low-level evidence and expert opinion (15, 30). In Australia it is not known how well the TSANZ or BTS guidelines are utilised. Audits into practice compliance with guidelines are becoming popular around the world (34, 64) but in Australia we have been slow to pursue audits of guideline compliance (11). This thesis attempts to address this need and provides insights into current practices regarding bronchiectasis management in one local hospital. BTS and TSANZ guidelines were used as the benchmark for care. It has collated up-to-date evidence on what management is, what a nurse led model is and how it compares to doctor led care. As a result, this thesis has identified ways bronchiectasis management could be improved in one clinical setting.

How we manage bronchiectasis needs to be investigated to ensure that we remain contemporary to recommended treatments so that when new developments occur, they can be incorporated quickly into everyday practice.

6.1.1 Retrospective Audit on 'Bronchiectasis management: A clinical audit of respiratory outpatient care in a South Australian hospital'

In this unpublished manuscript of a retrospective audit exploring three separate years of outpatient treatment at TQEH shows that bronchiectasis management was only modestly compliant to guidelines. It identified that areas for potential improvement included 1. How we use both episodic (short-term) and long-term

antibiotics. 2. Asking or documenting preventative strategies such as influenza and pneumococcal vaccination status or interval sputum sampling. 3. How we document the outpatient clinical assessment of patients and how we make treatment choices and referrals. Simply sharing the present study with clinical colleagues may influence individuals to change their practice and improve care. Changes in individual's documentation practices may, for example, change the outcomes of future retrospective audits. Documentation omissions are a risk to health outcomes (65) and may occur because of the time pressures in busy clinics (65). The development of prompts from checklists or acronyms [used as templates to write electronic medical records (EMR) notes] may assist in clinicians providing guideline recommended care in the future (65, 66).

In this study we saw a high prevalence (50%) of significant organism growth with low levels of sputum testing. Guidelines recommend both interval sputum testing and testing during infection to assist in identification of infection or colonised organisms (17, 29, 30). Lack of knowledge of this recommendation should be a priority to highlight with clinicians so it can lead to practice change ensuring organisms are identified earlier and sensitivities recorded which can guide decision making for antibiotics choice for future care (11, 15). Further research is needed into barriers and enablers of the compliance with use of bronchiectasis management guidelines in outpatients (11).

Guidelines enable consistency in care by providing a standardised approach to the development of a management plan. This is especially important in settings with multiple providers or where providers may rotate through the service (67). This study highlighted that care may be improved through a more consistent use of the guidelines.

Other options for improving patient care include the introduction of guideline/ protocol driven nurse-led clinics which have been shown to be effective in managing stable patients with bronchiectasis and other respiratory condition (55, 59, 60). Nurses clinics often have high satisfaction rates because they generally have the ability to spend adequate time with patients and can provide timely follow up (57). Nurse-led services can be provided in ambulatory settings making medical outpatient services potentially more accessible for other patients (52).

6.1.2 Nurse-led care versus doctor-led care for bronchiectasis (review)

This update of the Cochrane review 'Nurse specialist care for bronchiectasis' (63) had the primary aim of assessing the effectiveness of Nurse-led care versus doctor-led care. Only one study was found to meet the criteria for inclusion, this study was identified in the previous review. In Sharples 2002, 80 participants with stable bronchiectasis were randomised to receive either doctor or nurse-led care in outpatients. This study was a randomised control crossover trial where after a year of care the participant swapped to the other clinician. Outcome data showed little difference between groups for infection rate, quality of life, exercise capacity and lung function. Patient satisfaction was significantly higher in favour of nurse practitioner the study authors postulated that this may have been due to the additional length of time afforded patients and improved communication. The study also showed an increase in hospital admissions for nurse-led care and use of antibiotics particularly in first year of study. The difficulty in making conclusions about this one study was due to the wide confidence intervals for all outcomes which led to some uncertainty about results and low certainty of the evidence.

Additional costs for health care were seen in nurse-led care arm in the first year of the study but there was less of a cost difference in the second year. Modifications to the study protocol were thought to be able to control costs further (60). Few studies in healthcare have had success in showing that improving disease management will affect both healthcare utilisation and costs (68). Disease management can improve outcomes however there are too few studies that focus on cost to make generalisations about improving disease managed care with reduced costs (53). Case management as part of a nurse-led clinic has been shown to reduce costs by hospital avoidance and increase cost effectiveness (53).

The use of a protocol by the nurse may have led to increase costs by compliance to the recommended pathway. Nurse-led clinics use guidelines/ protocols as the foundation for care. In this study the pathway was developed for the nurse with no evidence to say the 3 doctors involved complied with the same protocol (60). Audits into guideline use for bronchiectasis have shown that guidelines are not always followed by clinicians (12, 34). Our audit in Chapter 4 also found poor guideline compliance.

Nurse-led care in its first year let to more admissions and was more costly than doctor-led care. Although hospital admissions where higher in the nurse-led group the nurse's actions to admit were deemed appropriate with all nurse actions overseen by a consultant (60) Cost increases in the first year of nurse-led care clinic was likely due to experience of the nurse who was trained to work at the advanced level prior to commencement of the study (60). A nurse-led clinic can provide less than expected care if a nurse is inexperienced or lacks confidence/ judgement in clinical decision making this can leading to outcomes that are less favourable including increased costs or higher admissions (69). Few disease management studies have shown to have a positive affect healthcare utilisation and costs (68). A systematic review of nurse-led care clinics did show favourable outcomes for cost effectiveness but limited research in this area has reduced the generalisability of the results (53). Case management in nurse-led clinics seemed the common factor to increase cost effectiveness and reduce hospital admission (53).

Patient satisfaction was higher with nurse-led care than doctor-led care. This was possibly because of the extra time spent with the patient by the nurse. This affords greater time to educate, listen to management issues and develop engagement in management plans to enable better outcomes (57, 70).

Although there remains a paucity of evidence related to nurse-led bronchiectasis care beyond this study some positive developments in nurse-led models for other diseases give us hope that nurse-led care can be considered a viable alternative in a stable bronchiectasis patients freeing up outpatient clinic space for the unstable and providing a level of consistency in care (58). Further research into nurse-led care for management of bronchiectasis is required to confirm its contemporary use.

6.2 Limitations and problems encountered

6.2.1 Bronchiectasis management: A clinical audit of respiratory outpatient care in a South Australian hospital

This retrospective study identified patients for inclusion based on past hospital admission so it is biased towards patients at the severe end of the bronchiectasis spectrum (71).

It should be noted that some patients were common (i.e., appeared in two audit periods) between 2011, 2013 and 2016/17. This meant that the characteristics were more similar with 29% of patients in 2013 and 25% of patients in 2016/17 featuring in an additional audit. Most management factors were not affected by the inclusion of patients over multiple years as they were assessed over a 12-month period from inclusion. Management factors that were assessed over a greater period-of-time were more likely to be influenced these were [F1-2] cause screening, pulmonary rehabilitation [F16], airway clearance [F17] and surgery use pre OPD [F4].

This audit was retrospective and relied on existing documentation as the source of truth. It is however well recognised that health professionals may omit writing all the particulars of care in an effort to save time. This may have influenced the findings of the study.

Adoption of an electronic patient record occurred prior to the final audit period. Lack of staff familiarisation with the new technology may also have contributed to some gaps in care during this period.

6.2.2 Cochrane systematic review:

The Cochrane systematic literature review identified current management recommendations for bronchiectasis and evaluated the effectiveness of nurse-led vs doctor-led care. Although all attempts were made to ensure that the search strategies were as comprehensive as possible there remains a possibility that some relevant citations may have been missed. Our search strategy was supported by the Cochrane Airways Trial Register who assisted in identification of suitable studies from multiple health databases as outlined in methodology in Chapter 5. An additional search was conducted to include grey literature via screening of bibliographies for included studies, review of online clinical trial registries and author contact. Despite best efforts there is still a possibility that relevant citations may have been missed.

6.3 Future directions/ Next steps

6.3.1 Qualitative research: perspectives in bronchiectasis management

Research has been undertaken to collect both quantitative and qualitative information to determine what health professionals and patients with bronchiectasis thought the important management issues were. The theoretical domains framework was the framework utilised to underpin thematic analysis of qualitative responses. The protocol was completed, ethics approval obtained, study was registered with Australian New Zealand Clinical Trials Registry (ANZCTR). Refer to approval letter from SA Health ethics committee in Appendix 2. This study involved the development of a semi-structured interview questionnaire for health professionals and another for patients and the undertaking of interviews to determine barriers and enablers to bronchiectasis management. Recruitment was limited to health professions working with bronchiectasis patients in an outpatient setting, within Central Adelaide Local Health Network (CALHN) TQEH and Royal Adelaide Hospital (RAH) campuses, for at least 12 months. Recruitment of patients with moderate or severe bronchiectasis, as classified by 2 clinicians, using judgement from results of a combination of bronchiectasis severity score (72) and Bronchiectasis Quality of Life Questionnaire (73).

We reached data saturation after interviewing 14 patients and 14 health professions. Health professionals included 6 Respiratory Doctors, 5 Respiratory Physiotherapists and 3 Respiratory Nurses. Early analysis of quantitative data identified that 50% of health professionals did not know that guidelines exist for bronchiectasis. Further analysis is ongoing with plans to publish these findings in the future.

6.3.2 Bronchiectasis outpatient census

A future plan is to undertake a ‘Bronchiectasis Patient Census’ over at least 3 years of respiratory outpatient appointments in TQEH outpatients to establish the number of patients being treated for bronchiectasis and to determine feasibility of replicating a similar nurse-led versus doctor-led trial as was featured in the Cochrane review. Currently outpatients do not code individual patient encounters hence a manual review of patient records to determine primary respiratory condition for management needed to be undertaken.

6.3.3 Development of acronym or checklist for bronchiectasis outpatients

Another future plan is to develop a Sunrise EMR acronym or checklist to assist in guideline compliant care of bronchiectasis patients and to allow auditing of that care to determine if the checklist is an effective tool to improve compliance with guidelines.

6.3.4 Nurse-led care for management of stable bronchiectasis

Future plans to replicate nurse-led vs doctor-led care for bronchiectasis to validate it in todays' health care system are being discussed. Opportunities for collaboration in research within networks established during this masters' study may enable the replication of a similar randomised control study to Sharples 2002. Collaboration with other services will be required to enable this study to demonstrate beyond a single setting or service that it can be an effective model to produce outcomes similar to doctor-led care. It may also be required due to a potential low yield of patients attending general outpatients which will be informed by the undertaking of the census detailed above.

Chapter 7. Conclusions

This thesis has shown that bronchiectasis management within our hospital is only mildly compliant to BTS and TSANZ guidelines. It is possible that inadequate documentation explained some of our findings. Development of checklists or EMR acronyms may support guideline compliant care.

A lack of knowledge of guidelines amongst health professionals was identified. How future updates to guidelines are disseminated is critical to ensure clinicians are aware of recommended care.

This audit determined that nurses are underutilised in bronchiectasis management and postulates that a nurse-led care model could enhance compliance with guidelines potentially improving patient outcomes. Further research is required to determine this.

The Cochrane review and retrospective clinical audit identified the key interventions required for bronchiectasis management and the updated Cochrane review described a nurse-led model of care. Although there is only one published study of nurse-led care of patients with bronchiectasis, Sharples 2002 this study demonstrated similar outcomes to doctor-led care across infective exacerbation rates, quality of life, exercise capacity and lung function. Nurse-led care has been shown to be effective in other respiratory settings. Replication of the above nurse vs doctor-led trial in bronchiectasis care in a collaborative multicentre study may improve the use of guidelines and patient care. Nurse-led care has the potential to improve access to outpatient services for unstable patients with bronchiectasis, ensuring timely appointment by utilising an existing resource in Respiratory Nurses to manage stable disease.

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Appendices

Appendix 1 Ethics approval letter for Bronchiectasis management audit

Appendix 2 Ethics approval letter for barriers and enablers for management from a health professional and patient perspective.

Appendix 3 Education completed while undertaking masters' program.

Appendix 4 Milestones completed and other significant events during masters' program.

Appendix 1 Ethics approval letters/ emails: Evaluation of management of bronchiectasis in an outpatient setting.

RE: Addition of another year to audit protocol modification

Dear Kathy,

Date: 27 June 2018

HREC reference number: HREC/14/TQEHLMH/121

Project title: Evaluation of management for bronchiectasis in an outpatient setting

CPI: Ms Kathryn Lawton

Please accept this e-mail as **Acknowledgement of Receipt , Review and APPROVAL** of the document(s), on behalf of **Central Adelaide Local Health Network Human Research Ethics Committee (CALHN HREC) and CALHN Research Governance**, and retain a copy for your records.

For multi-centre studies a copy of this email must be forwarded to Principal Investigators at every site approved by the CALHN HREC for submission to the relevant Research Governance Officer along with a copy of the approved documents.

Document	*Version*	*Date*
OPD Bronchiectasis Management Protocol (tracked and clean)	5	06 June 2018

This approval is subject to the conditions outlined in the original ethics approval letter.

Should you have any queries about this matter please contact the Executive Officer of the HREC on 08 7117 2229 or 08 8222 6841 or Health.CALHNResearchEthics@sa.gov.au

Yours sincerely,

Eloise Spooner
Research Administration Officer
On behalf of:

Mr Ian Tindall
Chair,
Central Adelaide Local Health Network Human Research Ethics Committee (CALHN HREC)
CALHN Research Office
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http://www.basilhetzelinstitute.com.au/research/information-for-researchers/human-research-ethics-committee/

Government of South Australia
SA Health
Central Adelaide Local Health Network Inc.

RE: Ammendment to HREC/14/TQEHLMH/121 to include mortality in outcomes

Dear Kathy,

Date: 16 April 2018

HREC reference number: HREC/14/TQEHLMH/121

Project title: Evaluation of management for bronchiectasis in an outpatient setting

CPI: Kathryn Lawton

Please accept this e-mail as **Acknowledgement of Receipt , Review and APPROVAL** of the document(s), on behalf of **Central Adelaide Local Health Network Human Research Ethics Committee (CALHN HREC) and CALHN Research Governance**, and retain a copy for your records.

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Document	*Version*	*Date*
OPD Bronchiectasis Management Protocol (tracked and clean)	4	12 April 2018

This approval is subject to the conditions outlined in the original ethics approval letter.

Should you have any queries about this matter please contact the Executive Officer of the HREC on 08 7117 2229 or 08 8222 6841 or Health.CALHNResearchEthics@sa.gov.au

Yours sincerely,

Eloise Spooner
Research Administration Officer
On behalf of:

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Government of South Australia
SA Health
Central Adelaide Local Health Network Inc.

RE: Updated protocol and attachments HREC/14/TQEHLMH/121 - Amendment Approval

Dear Kathy

Date: 08 August 2017

HREC Number: HREC/14/TQEHLMH/121

Project Title: Evaluation of medical and nursing management for Bronchiectasis

CPI: Mrs Kathryn Lawton

Please accept this e-mail as **Acknowledgement of Receipt , Review and APPROVAL** of the document(s), **on behalf of TQEH/LMH/MH Human Research Ethics Committee and Central Adelaide CALHN Research Governance**, and retain a copy for your records.

For multi-centre studies a copy of this email must be forwarded to Principal Investigators at every site approved by the TQEH/LMH/MH HREC for submission to the relevant Research Governance Officer along with a copy of the approved documents.

Document	***Version***	***Date***
Protocol	3	17 July 2017
Attachment 1 - extraction template page 3-5	4	2017
Attachment 2 - Letter request for letters and supplementary notes	1	
Template page 3	1	-
Charlson co-morbidity index	-	-

This approval is subject to the conditions outlined in the original ethics approval letter.

Should you have any queries about this matter please contact the Executive Officer of the HREC on 08 82226841 or Health.CALHNResearchEthics@sa.gov.au

Yours sincerely
Lisa Barrie
On behalf of:

Professor Richard E Ruffin
Chairman,
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Ground Floor, Basil Hetzel Institute for Translational Health Research, The Queen Elizabeth Hospital, 28 Woodville Road, Woodville South SA 5011

Government of South Australia
SA Health
Central Adelaide Local Health Network Inc.

RE: Amendment to ethics HREC/14/TQEHLMH121 - Amendment Approval

Dear Kathy

Date: 17 November 2016

HREC reference number: HREC/14/TQEHLMH121

Project title: Retrospective evaluation of Bronchiectasis Patient Care

Please accept this e-mail as **Acknowledgement of Receipt , Review and APPROVAL** of the document(s), **on behalf of TQEH/LMH/MH Human Research Ethics Committee and Central Adelaide CALHN Research Governance**, and retain a copy for your records.

Document	***Version***	***Date***
Cover letter		01 November 2016
Template new pag3	-	-
Table Charlson Comorbidity Index	-	-
Data extraction template	3	2016

This approval is subject to the conditions outlined in the original ethics approval letter.

Should you have any queries about this matter please contact the Executive Officer of the HREC on 08 82226841 or Health.CALHNResearchEthics@sa.gov.au

Yours sincerely
Lisa Barrie
On behalf of:

Professor Richard E Ruffin
Chairman,
CALHN Research Office
Phone: 08 8222 6841 | DX: 465101 | Email: Health.CALHNResearchEthics@sa.gov.au | Web: www.basilhetzelinstitute.com.au/research/
Ground Floor, Basil Hetzel Institute for Medical Research, The Queen Elizabeth Hospital, 28 Woodville Road, Woodville South SA 5011

Government of South Australia
SA Health
Central Adelaide Local Health Network Inc.

Government of South Australia
SA Health

Human Research Ethics Committee (TQEH/LMH/MH)
Basil Hetzel Institute DX465101
The Queen Elizabeth Hospital
28 Woodville Road
Woodville South SA 5011
Telephone: 08 8222 6841
Email: qeh.ethics@health.sa.gov.au

14 August 2014

Ms Kristin V. Carson
DX 465154; The Clinical Practice Unit
The Queen Elizabeth Hospital
28 Woodville Road
Woodville South SA 5011

Dear Ms Carson

HREC reference number: HREC/14/TQEHLMH/121
Project title: Evaluation of medical and nursing management for Bronchiectasis

RE: HREC/14/TQEHLMH/121 - Ethics Application Approval

The Human Research Ethics Committee (TQEH/LMH/MH) Chairman has expedited the approval of your protocol under Section 5.1.19 of the National Statement on Ethical Conduct in Human Research.

I am pleased to advise that your protocol has been granted full ethics approval and meets the requirements of the *National Statement on Ethical Conduct in Human Research*. The documents reviewed and approved include:

Document	*Version*	*Date*
Covering Letter	-	18 June 2014
Application: LNR Proposal for Research	-	17 June 2014
Data extraction template	1	17 May 2013
Protocol	*unknown*	*undated*

Sites covered by this approval:

- **The Queen Elizabeth Hospital, SA**

HREC approval is valid from **14 August 2014 to 14 August 2015.**

Please note the following conditions of approval:

1. Researchers are required to immediately report to this HREC anything which might warrant review of ethical approval of the protocol, including:
    a. proposed changes in the protocol; and
    b. unforseen events that might affect continued ethical acceptability of the project.
2. Protocols are approved for up to twelve months only and a report is required at the end of the study or 12 month period. Extensions will not be granted without a report to the Committee.
3. Confidentiality of the research subjects shall be maintained at all times as required by law.
4. All research subjects shall be provided with a Participant Information Sheet and Consent Form, unless otherwise approved by the Committee.
5. The Participant Information Sheet and Consent Form shall be printed on the relevant site letterhead stating the contact details for the researchers.
6. A report and a copy of any published material should be forwarded to the Committee at the completion of the project.

This Committee is constituted in accordance with the NHMRC's *National Statement on the Ethical Conduct of Human Research (2007).*

You are reminded that this letter constitutes ethical approval only. You cannot commence this project until you receive site authorisation from the CEO or delegate, even if ethics approval is received.
To obtain site authorisation, a separate Site Specific Assessment (SSA) application should be made to each public health site involved in the study, through the Site's Research Governance Officer. For more information, please visit: http://www.basilhetzelinstitute.com.au/research/research-ethics-governance/governance-site-specific-assessments-ssa-

If University personnel are involved in this project, the Principal Investigator should notify the University before commencing their research to ensure compliance with University requirements including any insurance and indemnification requirements.

Should you have any queries about the HREC's consideration of your project please contact Ms Melissa Kluge on 08 8222 6841 or qeh.ethics@health.sa.gov.au

The HREC wishes you every success in your research.

Yours sincerely

A/Professor Timothy Mathew
Chairman, Human Research Ethics Committee (TQEH/LMH/MH)
TM:mk

Appendix 2 Ethics approval letter: Management of bronchiectasis: What are the barriers and enablers to bronchiectasis management and the use of guidelines in outpatient care.

Government of South Australia
SA Health

Central Adelaide Local Health Network
Human Research Ethics Committee
Level 3, Roma Mitchell House
North Terrace, Adelaide SA
Australia 5000

Ground Floor, Basil Hetzel Institute for Translational Research
28 Woodville Road, Woodville SA
Australia 5000

T : 08 7117 2229
T : 08 8222 6841
E : Health.CALHNResearchEthics@sa.gov.au

Approval Date: 27 March 2018

HREC Reference number: HREC/18/CALHN/176

CALHN Reference number: R20180324

Mrs Kathryn Lawton
Respiratory Nursing Service
The Queen Elizabeth Hospital

Dear Mrs Lawton,

Project Title: Management of bronchiectasis: What are the barriers and enablers to bronchiectasis management and the use of guidelines in outpatient care?

Thank you for submitting the above project for ethical review. This project was considered by the Chairman of the Central Adelaide Local Health Network Human Research Ethics Committee. I am pleased to advise that your protocol has been granted full ethics approval and meets the requirements of the *National Statement on Ethical Conduct in Human Research* (2007) incorporating all updates. The documents reviewed and approved include:

Document	*Version*	*Date*
Covering Letter	-	20 March 2018
LNR Ethics and Governance Application Form	-	-
Bronchiectasis Management Guideline Interview Protocol	4	22 March 2018
Participant Information Sheet Bronchiectasis Health Professional	3	22 March 2018
Participant Information Sheet Bronchiectasis Patients	3	22 March 2018
Health Professionals Recruitment Flyer	1	17 January 2018
Patient Recruitment Flyer	1	17 January 2018
Heads of Unit Recruitment Script, Letter, Email Health Professional	1	15 January 2018
Recruitment Script, Letter, Email Health Professional	1	15 January 2018
Recruitment Script, Letter, Email Patient	1	15 January 2018
Bronchiectasis Questionnaire: Respiratory Physicians	1	22 December 2017
Bronchiectasis Questionnaire: Respiratory Nurses	1	22 December 2017
Bronchiectasis Questionnaire: Respiratory Physiotherapists	1	17 January 2017
Bronchiectasis Questionnaire: Patient	1	05 January 2017
The E-FACED score severity	-	2017
Quality of Life Questionnaire: Bronchiectasis	3.1	2012
Interview Moderator Guide (Respiratory Physicians)	1	05 March 2018
Interview Moderator Guide (Respiratory Nurses and Physiotherapists)	1	17 January 2018
Moderator Guide (Bronchiectasis Patients)	1	17 January 2018
Master Sheet: Protocol Numbers	-	-
Data Collection Template: Patients	1.1	18 January 2018

Sites covered by this approval:

- Royal Adelaide Hospital, SA : Mrs Kathryn Lawton
- The Queen Elizabeth Hospital, SA : Mrs Kathryn Lawton

HREC approval is valid from **27 March 2018 to 27 March 2023**

GENERAL TERMS AND CONDITIONS OF ETHICAL APPROVAL:

1. This HREC is the South Australian 'lead HREC' for the purpose of this ethics approval. Any study sites that are not listed on this letter are not covered by this ethics approval. For any SA study-sites within the public health system that are proposed to be added, the CPI must write formally to this HREC requesting the additional study site and a separate formal letter will be issued.
2. Adequate record-keeping must be maintained in accordance with GCP, NHMRC and state and national guidelines. The duration of record retention for all clinical research data is 5 years from the date of publication.
3. Researchers are required to immediately report to this HREC anything which might warrant review of ethical approval of the study, including:
   (a) adverse events which warrant protocol change or notification to research participants;
   (b) changes to the protocol;
   (c) changes to the safety or efficacy of the investigational product, device or method;
   (d) premature termination of the study.
4. The Committee must be notified within 72 hours of any Urgent Safety Measures (USMs) occurring at this or any approved sites.
5. Confidentiality of the research participants shall be maintained at all times as required by law.
6. Approval is valid for 5 years from the date of this letter, after which an extension must be applied for.
7. Investigators are responsible for providing an annual review to the CALHN HREC Executive Officer each anniversary of the above approval date, within 10 workings days, using the Annual Review Form available at: https://www.rahresearchfund.com.au/rah-research-institute/for-researchers/human-research-ethics/
8. The REC must be advised with a report or in writing within 30 days of completion.

Should you have any queries about the HREC's consideration of your project, please contact Ms Heather O'Dea on 08 8222 4139, or Health.CALHNResearchEthics@sa.gov.au.

You are reminded that this letter constitutes ethical approval only. You must not commence this research project at a SA Health site until governance authorisation at that site has been obtained. Please contact the CALHN Research Office Health.CALHNResearchLNR@sa.gov.au

This Committee is constituted in accordance with the NHMRC's *National Statement on the Ethical Conduct of Human Research* (2007).

The HREC wishes you every success in your research.

Yours sincerely

Ian Tindall
CHAIRMAN
CALHN HUMAN RESEARCH ETHICS COMMITTEE
27 March 2018

Appendix 3 Education completed during master's program

Date	Course	Venue
30/04/2015	Get smarter with your data: Data management planning workshop	University of Adelaide, Waite Campus
14/05/2015	SA Nurses and Midwifery Research Symposium	South Australian Health and Medical Research Institute (SAHMRI), City
8/7/2015	Endnote training session – Beginner level	University of Adelaide, City Campus
25/5/2016	Statistics and evidence-based health care.	Joanna Briggs Institute, Grenfell St
20-24 /6/2016	Basic statistics and research methods	University of Adelaide, City Campus
22/9/2016	HDR/RHD Workshop: Ethics and Integrity in Research with Humans	University of Adelaide, City Campus
3/5/2017	Managing publication in Aurora	Basil Hetzel Institute, Woodville South
3/5/2017	Create your Research Profile	Basil Hetzel Institute, Woodville South
9/5/2017	NVIVO basics	University of Adelaide, City Campus
31/5/2017	Analysing data with pivot tables in excel- Lecture (demonstration only)	University of Adelaide, City Campus
8/6/2017	Managing an HDR Thesis with Word	University of Adelaide, City Campus
17/05/2018	SA Nursing and Midwifery Research Symposium	SAHMRI, City
23/5/2019	SA Nursing and Midwifery Research Symposium	SAHMRI, City
18/06/2019	The Imposter Syndrome	Online CaRST
23/06/2019	Turbocharge our writing	Online, CaRST

Appendix 4 Milestones completed and other significant events during master's program

Date	Milestone	Comments
30/04/2015	Induction	Basil Hetzel
01/01/2016	Change in supervisor details	Added Kristin Carson as co-supervisor
02/03/2016	Presentation and discussion with supervisory panel review	BHI / 5B TQEH
18/03/2016	Approval letter for Core Component of the structure program completion	
23/03/2017	Presentation / Completion of major review	BHI
4/4/2017	Major Review Completion acknowledgement letter	
25/12/2017	Annual Review Completion acknowledgement letter	Form completed following
19/11/2018	Annual Review Completion acknowledgement letter	Online process / following discussion
01/02/2019	Change in supervisor details email	Dr Brian Smith removed as primary supervisor, Dr Antony Veale steps into primary supervisor role, Mark Nottle added.
09/05/2019 16/05/2019	Final presentation	5B TQEH, Respiratory Medicine Unit
10/2019	Submitted annual review prior to moving to writing out of candidature	Student completed, not sent to supervisors as not required
24/07/2020	Intention to submit form lodged	
08/2020	Examiners appointed	
8/09/2020	Emails sent to graduate centre extending submission of thesis. Acknowledged and approved request	
18/12/2020	Thesis submitted for examination	
/06/2021	Thesis returned, for minor changes	Primary supervisor to approve for final submission
29/09/2021	Final thesis submission sent	