



Multidisciplinary care in chronic airway diseases: the Newcastle model

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This review describes a multidisciplinary service for difficult airway disease at a tertiary centre in Australia. The successful model delivers individualised care based on the needs of the patient. <https://bit.ly/3mVa6mz>

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Abstract

Chronic airway diseases including asthma and COPD are prevalent and high-burden conditions with the majority of patients successfully managed in the primary care setting. However, for some patients with more complex disease such as difficult-to-treat or severe asthma, or complex COPD, tertiary care is required. This review provides an overview of the successful tertiary care multidisciplinary respiratory service that operates in Newcastle, New South Wales, Australia, which has been integrated into the tertiary care outpatient clinics for almost three decades. The service is multifaceted in terms of the clinical care it provides; it includes an “Inpatient Service”, “Asthma Management Service”, “Difficult Airways Clinic”, “Drug Administration Clinic”, “Rapid Access Clinic” and “Pulmonary Rehabilitation”, and has an integrated research programme. The core of the multidisciplinary approach to airway diseases is a person-centred model of care, the “Treatable Traits” approach. The staffing of this service comprises consultant physicians, respiratory advanced trainees, respiratory scientists, physiotherapists, speech pathologists, nurse specialists and a nurse consultant. Patients that present to this service undergo an initial assessment and clinical review by team members, synthesis of relevant data, and development of a diagnosis and management plan. Based on this clinical review, specific interventions are determined according to the traits identified. Over time the service has evolved to accommodate the increasing numbers of patients requiring access to the Difficult Airways Clinic assessment and therapies. This has been facilitated by partnering with the Centres of Excellence in Severe Asthma and Treatable Traits to develop educational and practice management tools.

Introduction

Chronic airway diseases including asthma and COPD are prevalent and high-burden conditions worldwide [1–3]. Most patients with asthma and COPD successfully have their disease managed in the primary care setting, by a primary care physician who may be assisted by a practice nurse, with referral to other disciplines as needed. For those patients with more complex disease such as difficult-to-treat or severe asthma, or complex COPD, secondary or tertiary care is frequently required. Within these settings there is an opportunity to provide enhanced multidisciplinary care at a single site in order to optimise outcomes for individuals and reduce the fragmentation of care that is often experienced by patients with complex chronic disease [4].

There have been significant advances in treatment and improved outcomes for people with chronic airway diseases over the last three decades, including the development of new models of care [5–10]. New pharmacological treatments have contributed to the observed improvements, but the more complex treatments require multidisciplinary care in order to be effectively implemented. The value of multidisciplinary care in asthma and COPD is crucial when one considers the increasing complexity of



disease management for patients with complex airway diseases [11], the ongoing burden experienced by patients [12–14] and the focus on person centredness [15]. The need for multidisciplinary teams (MDTs) working seamlessly together and in partnership with patients has never been greater.

Multidisciplinary asthma education clinics began to emerge in Australia in the early 1990s following publication of the Australian Asthma Management Plan [16]. At a similar time, pulmonary rehabilitation programmes were developing, offering multidisciplinary care for people with COPD. Level I evidence confirms that the provision of asthma education, regular review and written asthma plans lead to significant reductions in acute attacks of asthma (hospitalisations (relative risk 0.64 (95% CI 0.50–0.82)), emergency room visits (relative risk 0.82 (95% CI 0.73–0.94)) and unscheduled visits to the doctor (relative risk 0.68 (95% CI 0.56–0.81)), reduced symptoms, and improved quality of life (standard mean difference (SMD) 0.29 (95% CI 0.11–0.47)) [17]. In COPD, multidisciplinary pulmonary rehabilitation leads to improved quality of life and exercise capacity [18], and comprehensive multidisciplinary COPD self-management programmes improve quality of life and may reduce exacerbations [19].

What is multidisciplinary airway disease care?

Multidisciplinary care involves assessment, treatment and supportive care of people with airway disease by a range of different healthcare professionals. For people with airway diseases the team may include physicians, nurses, physiotherapists, speech pathologists, dietitians, psychologists and scientific officers, in addition to other specialties including endocrinologists, allergists, otolaryngologists, gastroenterologists and obstetricians.

In other chronic diseases, such as diabetes [20], heart failure [21], depression [22] and neurological conditions [23], multidisciplinary care has led to advances in management and improved patient outcomes. In respiratory disease, cystic fibrosis (CF) was perhaps the first pulmonary condition where the importance of specialist MDTs was recognised. Patients attending these specialist multidisciplinary centres achieved better outcomes in terms of lung function, body mass index, chest radiography scores and delayed *Pseudomonas* colonisation than CF patients attending nonspecialised centres [24, 25]. Due to the effectiveness of this approach there was clear recognition early on that the provision of multidisciplinary care in CF was essential for maintaining health and this is now the standard of care [26]. We propose that such multidisciplinary approaches are also essential for patients with complex airway diseases; however, multidisciplinary services have evolved at different rates in different healthcare settings and countries for asthma and COPD, presenting challenges for unified implementation.

In severe asthma, multidisciplinary approaches that involve systematic or multidimensional assessment are recommended by international guidelines [27]. Observational and registry studies, and a meta-analysis, have demonstrated that these approaches to severe asthma management improve asthma control (SMD 0.36 (95% CI 0.23–0.59)) and asthma quality of life (SMD 0.36 (95% CI 0.22–0.50)), reduce acute attacks (SMD –0.34 (95% CI –0.44– –0.23)), and reduce oral corticosteroid (OCS) use (reduction of 11.5 mg on average) [28, 29].

In Newcastle, New South Wales, Australia, multidisciplinary care has been integrated into the tertiary care outpatient/ambulatory care clinics that treat patients with airway diseases for almost three decades [5]. Following the 2021 European Respiratory Society's Precision Medicine in Asthma and COPD symposium we received an invitation to describe our multidisciplinary approach to treating patients with difficult-to-treat and severe asthma within this centre.

The Newcastle multidisciplinary model

The region

Newcastle is a metropolitan city within the state of New South Wales, Australia. The Greater Newcastle region has a population of approximately 575 000 people. It is the second largest city in New South Wales located 150 km north of the State's capital of Sydney. Newcastle sits within the Hunter New England Local Health District. The health district services a population of approximately 920 370 people over a geographical area of 131 785 km², approximately the geographical size of England, UK (www.healthstats.nsw.gov.au). The John Hunter Hospital, located in the Newcastle suburb of New Lambton Heights, is the largest tertiary care hospital within the district and is the base of our multidisciplinary difficult airways services.

The service

The service is multifaceted in terms of the clinical care it provides. The multidisciplinary Difficult Airways Clinic is held twice monthly, providing expert multidimensional clinical review with face-to-face and

telehealth mediums available to patients. In addition there are weekly nurse-led Asthma Management Service clinics, a Rapid Access Clinic for prompt review of deteriorating/exacerbating asthma and COPD patients, and Drug Administration Clinics to provide ancillary assessment and treatment for severe and difficult-to-treat asthma patients who are experiencing challenges to successful treatment, or who require monitoring for initiation and maintenance of biological therapy, other add-on therapies or supported directly observed treatment. There is also an Inpatient Service where people admitted to hospital with acute attacks are reviewed by a nurse specialist, asthma control and management skills are assessed, and asthma education is provided. These patients are then reviewed in the Outpatient Service. Similarly, this Inpatient Service is provided for COPD patients together with an outpatient pulmonary rehabilitation programme. Table 1 describes each aspect of the multidisciplinary airway disease service.

The staffing comprises consultant physicians, respiratory advanced trainees, a respiratory scientist, a physiotherapist, a speech pathologist, nurse specialists and a nurse consultant. The patient numbers through each half-day Difficult Airways Clinic fluctuate, with an average of 34 patients per clinic being seen by the clinical team members.

Who is the population?

The Newcastle model of MDT care for difficult airway disease targets adults with severe asthma or difficult-to-treat asthma. Patients are referred to this service following an assessment by another physician or admission to hospital with acute severe asthma. Our healthcare delivery programme has other components that are available to manage other conditions, such as COPD, bronchiectasis or primary care referrals. These include pulmonary rehabilitation, education and treatment trials.

People managed in the service are over the age of 18 years or have left school and paediatric services. They have symptomatic airway disease despite being prescribed asthma therapy, and the patient and/or their referring physician are seeking other options to manage their symptoms and disease manifestations.

TABLE 1 Service components of the multidisciplinary airways service

Service component	Description
Inpatient Service	Patients who are admitted to hospital with acute attacks of asthma or COPD are cared for by the admitting respiratory team who refer them to a specialist airway diseases nurse. The nurse will assess the patient's past control, triggers and self-management skills. They conduct an education session in the inpatient setting, address adherence, optimise inhaler technique, and provide each patient with a crisis management plan and follow-up appointment in the outpatient clinic.
Asthma Management Service	Patients with asthma are referred to this clinic, and are reviewed by a respiratory physician and have several visits with an asthma nurse specialist. Patients are usually referred directly back to their primary care physician once treatment and asthma management skills are optimised. If assessment deems that the individual's asthma is difficult to treat or severe, they are referred into the Difficult Airways Clinic for further assessment and targeted treatment.
Difficult Airways Clinic	This multidisciplinary clinic conducts a multidimensional assessment of the airways, behavioural/risk factors and comorbidities. The team agree on the appropriate targeted treatment for traits within these domains. Patients' inflammatory profiles are phenotyped and care is delivered within the service. Communication with the primary care team is crucial, particularly for those commenced on biologic therapies.
Drug Administration Clinic	This clinic is held weekly and staffed by an asthma nurse specialist or clinical nurse consultant. It provides an environment to initiate new add-on therapies including biologic therapy under supervision. It also facilitates the opportunity to provide education on treatment and administration techniques. Government-mandated follow-up assessments may also be conducted in these clinics.
Rapid Access Clinic	Held Monday to Friday afternoons, this clinic provides people with severe disease who are known to the service access to the team for assessment by an asthma nurse specialist and medical staff in the event of adverse treatment effects or exacerbations of severe disease. This is not a primary care service, but a facility provided to avert hospitalisation.
Pulmonary Rehabilitation	An 8-week outpatient pulmonary rehabilitation programme is offered to patients with reduced exercise capacity and symptoms. Exercise classes are held twice per week, and are supervised by a physiotherapist and nurse specialist. A multidisciplinary team provides weekly group education.
Research	The service is closely aligned with our asthma and COPD research programme, offering patients the opportunity to be involved in world class research and access to novel interventions. This also provides multidisciplinary clinicians with the opportunity to embed research into their clinical practice and receive training in research.

The model of care paradigm: “Treatable Traits”

At the core of our multidisciplinary approach to airway diseases is a person-centred model of care. Our service achieves this using a Treatable Traits approach. Treatable Traits is a model of care that facilitates an assessment of individual patients to identify traits according to the airway, behavioural/risk factor and comorbidity domains [10, 25, 30, 31]. Once traits are identified an individualised treatment plan is developed to deliver targeted treatments according to the identified traits. These interventions are delivered in partnership with the patient and the various members of the MDT. Multidimensional assessment can provide important disease-related factors that drive severe asthma symptoms and/or inhibit treatment responses highlighting treatable disease factors. The traits that are assessed within the Difficult Airways Clinic are based on those that are prevalent [32], that cause a symptom and exacerbation burden on the patient, that are most treatable, and that pose a future risk to the patient [25, 32]. A list of the traits assessed in our clinic and their associated targeted treatments is outlined in table 2. This is not an exhaustive list of traits or treatments, but what can be achieved within our current resources. Further information on traits and treatments is outlined in prior publications [10, 25, 31].

This approach has been tested in a randomised controlled trial and resulted in significant improvements within the intervention group in asthma quality of life (mean increase in Asthma Quality of Life Questionnaire of 0.86 (95% CI 0.49–1.23) units), asthma control (mean decrease in Asthma Control Questionnaire-5 of –0.72 (95% CI –1.25––0.18) units) and reduced primary care visits for acute asthma attacks (incident rate ratio 0.14 (95% CI 0.02–0.93)) [10].

How do we do it?

The approach of the MDT service is to review the symptoms and their likely causes, to review the diagnosis of asthma and other relevant diseases, to assess current treatment and asthma self-management skills, to assess the airway disease phenotype using relevant biomarkers, and to assess relevant

TABLE 2 The traits and their associated targeted treatments that form part of the multidimensional assessment

Trait assessed	Treatment
Airways	
Airflow limitation	Bronchodilators (maintenance: LABA/LAMA; rescue: SABA/SAMA/rapid-acting LABA)
Airway hyperresponsiveness	Increase ICS, LABA
Mucus hypersecretion	Mucociliary clearance techniques with a physiotherapist, inhaled hypertonic saline, macrolides
Type 2 airway inflammation	Corticosteroids, anti-IL-5, -13 and -4 monoclonal antibody therapy
Frequent exacerbation	Written action plans, vaccination, education
Bronchiectasis	Physiotherapy, mucociliary clearance techniques, macrolides, pulmonary rehabilitation, vaccination
Emphysema	Smoking cessation, endobronchial valves, lung transplantation
Pathogen colonisation	Antibiotics and tailored antibiotic written action plan for infections
Oxygen desaturation	Domiciliary oxygen therapy assessment
Dyspnoea	Pulmonary rehabilitation, breath retraining
Systemic allergic inflammation	Anti-IgE monoclonal antibody therapy
Comorbidities	
Dysfunctional breathing	Breath retraining
Vocal cord dysfunction	Speech pathology intervention, gabapentin/pregabalin, psychology/psychiatry
Anaemia	Haematinic (iron/B12) supplementation
Obstructive sleep apnoea	Continuous positive airway pressure, mandibular advancement splint, positional therapy, weight loss
Obesity	Caloric restriction, exercise, bariatric surgery, pharmacotherapy
Depression and/or anxiety	Cognitive behavioural therapy, pharmacotherapy
Osteopenia/osteoporosis	Pharmacotherapy based on osteoporosis guidelines, vitamin D supplementation, resistance training
Risk factors/behaviours	
Suboptimal adherence	Self-management education
Inadequate inhaler technique	Self-management education, including demonstration and assessment
Inhaler device polypharmacy	Asthma self-management education
No written asthma action plan	Provide written action plan with education and shared decision making
Smoking	Smoking cessation counselling, nicotine replacement therapy, pharmacotherapy
Underweight and sarcopenia	Nutrition and resistance training
Exercise intolerance	Pulmonary rehabilitation and physical activity
LABA: long-acting β -agonists; LAMA: long-acting muscarinic antagonists; SABA: short-acting β -agonists; SAMA: short-acting muscarinic antagonists; ICS: inhaled corticosteroids; IL: interleukin.	

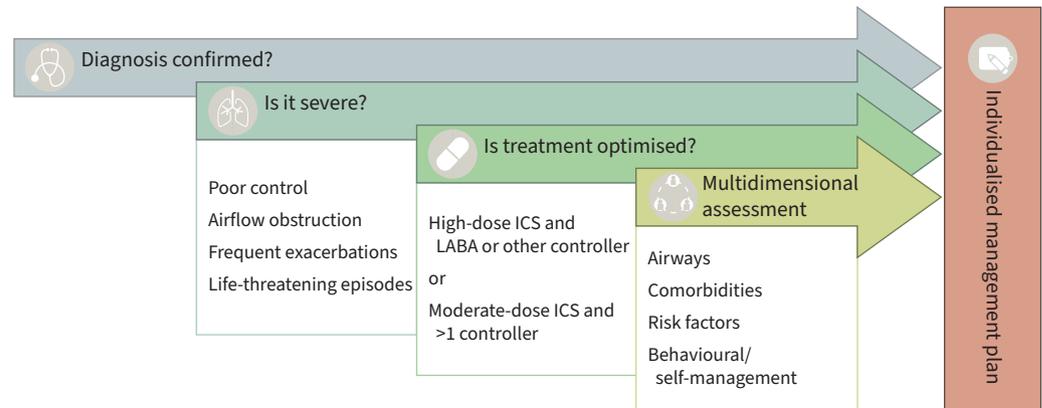


FIGURE 1 Management model. ICS: inhaled corticosteroids; LABA: long-acting β -agonists. Content reproduced with permission from the Centre of Excellence in Treatable Traits, originally developed as part of the Centre of Excellence in Treatable Traits (<https://treatabletraits.org.au>).

comorbidity. The model is summarised in figure 1 and a checklist used in the clinic is presented in figure 2. We consider each of these steps integral to achieving the optimal outcome.

The initial assessment involves clinical review by team members, synthesis of relevant data, and development of a diagnosis and management plan by the team members. This will then lead to specific interventions based on the traits identified. Interventions are delivered in a range of care environments. For example, biologic therapy is initiated by the service, first administered in the Drug Administration Clinic and then continued either in a primary care setting or by self-administration, with 6-monthly review as required by Australian Government regulations.

Nonpharmacological interventions are provided by medical and nursing clinic staff, allied health professionals, and primary care physicians as appropriate. The need for these interventions is elicited through the multidimensional assessment; the types of intervention and the clinicians delivering the treatments are shown in figure 3.

The assessment tools used to identify the individual's traits, and hence need for intervention, include clinical and biological markers, and patient-reported outcomes measures. The assessment tools used in our clinic for the traits within the airway, behavioural/risk factors and comorbidity domains are accessible via the Severe Asthma Toolkit repository (<https://toolkit.severeasthma.org.au/resources/systematic-multidimensional-assessment-resources/>). The Severe Asthma Toolkit is discussed further in the Leadership and training section of this review.

A monthly MDT meeting is held to review and discuss difficult cases to seek group input and reflection, and further develop a management plan. The other key aim of this meeting is educational. Aspects of the cases are discussed in detail, such that only a small number of cases, *e.g.* two or three cases, are discussed in each meeting, and new developments in severe asthma management or service delivery are also discussed. The MDT meeting provides an educational and training function for MDT staff, including respiratory physicians in training who are rotating through the service. The case discussion is modelled on Case Conference reviews with each specialty having input into the assessment and recommendations. A letter with findings and recommendations of the assessment and discussions is generated and sent to the referring and treating teams.

The MDT: who are the key players?

Within the MDT, the members have key responsibilities related to their areas of expertise and discipline, but they also work together to deliver clear and consistent messages to each patient. Key members of the airway disease MDT include consultant physicians, physicians in training, specialist and consultant respiratory nurses, speech pathologists, dietitians, psychologists, physiotherapists, respiratory scientists, and pharmacists. Not all these team members will be core within the day-to-day clinic environment, but access to these professionals is beneficial. Similarly, referral to other medical disciplines is key to a well-functioning clinic. For patients with difficult-to-manage and severe asthma, referral to

Clinical assessments	Questions	Notes
1. Has the diagnosis of asthma been confirmed?	Compatible history and objective evidence of variability in symptoms and lung function over time; either spontaneously, with treatment or following bronchial provocation testing	
2. Is it severe?	Poor control: airflow obstruction; frequent exacerbations; life-threatening episodes	
3. Is treatment optimal?	High-dose ICS and LABA or other controller	
4. Are self-management skills optimal?	Optimised: inhaler device techniques; adherence; self-monitoring; disease knowledge; written action plan	
5. Are trigger factors identified and managed?	Allergens; cigarette smoke; respiratory viral infection; emotional stress; mould and dampness; patient-reported triggers	
6. Is comorbidity identified and managed?	Sino-nasal disease; dysfunctional breathing; paradoxical vocal fold movement; obstructive sleep apnoea; anxiety and/or depression; gastro-oesophageal reflux disease; obesity	
7. What is the pattern of airway inflammation?	Eosinophilic (sputum assessment, F_{ENO} , blood eosinophils); neutrophilic (sputum assessment); mixed (sputum assessment); paucigranulocytic (sputum assessment)	
8. What is the optimal individualised management plan?	Developed with evidence-based interventions that target clinical issues identified during a systematic and multidimensional assessment in partnership with patients and clinicians, considering patient preferences	

FIGURE 2 Severe Asthma Assessment Checklist developed by the Centre of Excellence in Severe Asthma. The checklist is intended to provide a practical structure which can be used to inform the diagnosis and characterisation of severe asthma in the clinic. ICS: inhaled corticosteroids; LABA: long-acting β -agonists; F_{ENO} : exhaled nitric oxide fraction. Content reproduced with permission from the Centre of Excellence in Severe Asthma (www.severeasthma.org.au).

endocrinologists, allergists and gastroenterologists is common. Within our Difficult Airways Clinic, our core staff are consultant physicians, physicians in training, specialist and consultant respiratory nurses, speech pathologists, and respiratory scientists, with access to other disciplines as required.

Each member of the MDT has a specific role. Figures 3 and 4 demonstrate the expertise and functions of the team members. Some roles may overlap between disciplines, *e.g.* breath retraining may be performed by either a suitably trained nurse, physiotherapist or speech pathologist. Communication between team members is also imperative and is facilitated by the clinicians being colocated in the same clinic area for the same clinic times with the MDT meetings before the clinics.

How to set up a multidisciplinary service

The setup of any multidisciplinary service will depend on the local environment, access to resources, existing infrastructure and clinical need. Developing a business case can be a useful first stage in justifying the establishment of a multidisciplinary service and facilitating engagement with health service management [5]. It also can provide a helpful structure for planning the parameters and the implementation of the service. The steps involved in developing a business case are outlined in the following paragraphs.

Step 1 is to define the problem. This can include the current burden or lack of effective management of the disease which adversely impacts the healthcare system, the patients or the clinicians' workload.

Step 2 is a survey of the local environment. This establishes if there are any existing or alternative solutions. For example, there may be a MDT service that already operates that can be adapted, enhanced or expanded. This was the case in our service when we established the Difficult Airways Clinic. Redesign of

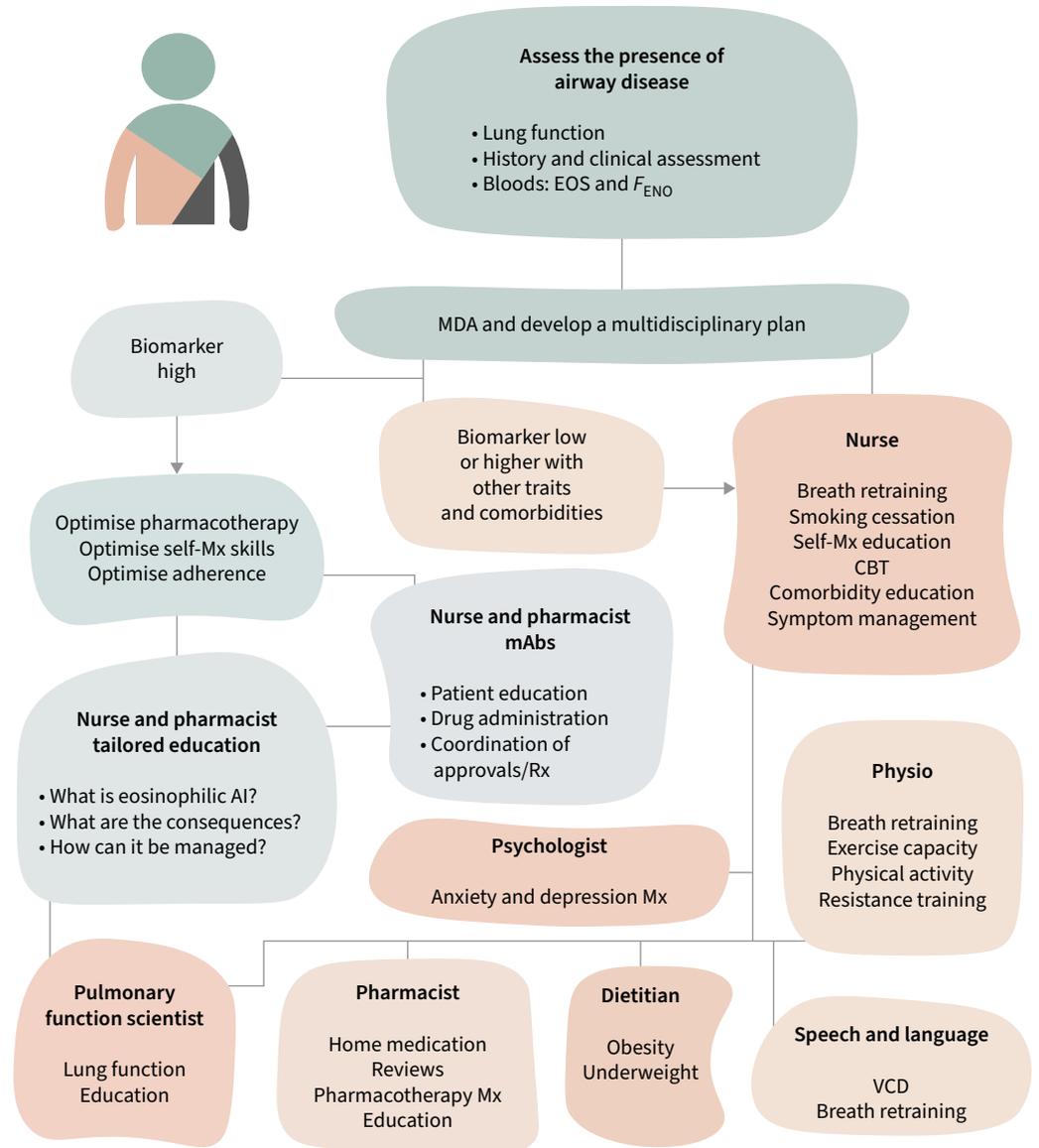


FIGURE 3 Example of a patient’s journey and how different members of the multidisciplinary team are involved in the patient’s care. AI: airway inflammation; CBT: cognitive behavioural therapy; EOS: eosinophils; F_{ENO} : exhaled nitric oxide fraction; MDA: multidisciplinary assessment; mAb: monoclonal antibody; Mx: management; Rx: prescription; VCD: vocal cord dysfunction. Content reproduced with permission from the Centre of Excellence in Treatable Traits, originally developed as part of the Centre of Excellence in Treatable Traits (<https://treatabletraits.org.au>).

the existing Asthma Management Service enabled the initial development of this new clinical service without an increase in cost.

Step 3 in defining the multidisciplinary service is outlining the specific detail of the service. Some key elements here include identifying crucial team members that can provide the multidisciplinary service, the scope of the service and the intended recipients of the service. In terms of the key members of the MDT, this will depend on the personnel available within the local environment, although McDONALD *et al.* [5] suggest the minimum staff required for a severe asthma service includes a specialist physician, a specialist nurse and a pulmonary function scientist, if available. However, with this minimal level of staffing, referral to other allied health and medical disciplines is necessary. Given the increased use of telemedicine over the past few years, MDT members may be more accessible in areas when they previously have not been available.

	Staff	Role	Facility
	Consultant physician	Expertise, leadership, assessment, education, optimisation, diagnosis, research	Clinic, MDT meeting
	Senior respiratory trainee doctor (advanced trainee)	Assessment, diagnosis, medical management, experience, case presentation, research	Clinic, RAC, MDT meeting
	Respiratory scientist	Assess diagnosis, education, research	Pulmonary function laboratory, MDT meeting
	Physiotherapist	Optimisation of patient, comorbidities, sputum management	Clinic, PRP
	Speech pathology	VCD diagnosis and intervention, dysfunctional breathing diagnosis and intervention, research	Clinic, MDT meeting
	Nurse specialists	Assessment, patient education, treatment coordination, risk factor and comorbidity optimisation, research	Clinic, RAC, inpatients, phone support, DAC, PRP, AMS
	Researcher	Promotion, recruitment into and of clinical research	MDT meeting

FIGURE 4 The multidisciplinary team (MDT) of the difficult airway disease service. VCD: vocal cord dysfunction; RAC: Rapid Access Clinic; PRP: pulmonary rehabilitation programme; DAC: Drug Administration Clinic; AMS: Asthma Management Service. Content reproduced with permission from the Centre of Excellence in Treatable Traits, originally developed as part of the Centre of Excellence in Treatable Traits (<https://treatabletraits.org.au>).

Step 4 involves the rationale for the service. The rationale should draw a link between the problem, established in Step 1, and detail how the proposed service will address this problem.

Step 5, the implementation plan, outlines the specific requirements and resources needed to set up a service, *e.g.* the physical location, availability of technology and equipment [33], and defining the referral pathways [5]. Defining referral pathways is a critical step in setting up a multidisciplinary service. Additionally, in Step 5, the frequency of the MDT meetings, the team governance, leadership [34] and the structure should be considered [33]. In addition to identifying team members, clarification of team member roles should also be clearly established, *e.g.* who will coordinate the patient's care [35], who will facilitate the meeting and who will present the clinical cases.

Step 6 is to calculate the budget for the multidisciplinary service. This will include the costing to staff the service, facilities and resources, as well as any proposed funding sources that may be available. Funding sources will be context specific, but can include activity-based funding, which is where hospitals receive

funding based on the complexity of the patients they treat, or government-funded or -subsidised remuneration systems (e.g. Medicare in Australia and the NHS in the UK).

Step 7 requires articulation of the benefits of the proposed service. The key parameters of interest will be context dependent; however, some examples include a reduction in the number of admissions, a reduction in the number of days in hospital, reduced burden from OCS use and reduced cost to the healthcare system *via* more efficient use of resources.

Finally, in Step 8, a risk assessment should be undertaken to determine if there are any risks associated with the proposal for a multidisciplinary service. For example, will this service impede the current clinical workload, will the service be financially viable, is the support and infrastructure available to support the service or will the service have adequate patient uptake [5, 34]. Identifying risks and barriers to the proposal can assist in developing strategies and solutions to overcome them.

Evolution of the service: changing scope with capacity

Our service has continually evolved over several decades to meet the needs of the population and offer advances in airway disease management. The initial service began in the early 1990s targeting patients with uncontrolled asthma who had recently attended the hospital for management of an exacerbation [36]. The key focus was on providing optimal pharmacotherapy and optimising self-management skills, using collaborative input of a respiratory physician and nurse specialist. At the time the service began, Australia was experiencing an epidemic of asthma deaths. This model of care, the Asthma Management Service, served as a model of how to implement the newly developed asthma guidelines in a regional setting [16]. The Asthma Management Service continues; however, with the advent of biologic therapies and insights into severe asthma, an additional difficult airway disease MDT service was developed in 2000. This difficult airway disease MDT was developed to offer specific care for patients with severe asthma and difficult-to-treat asthma using systematic assessment, and was based on similar interventions described in the USA and UK [37, 38]. The service structure remains similar to that described earlier and is also described in detail in McDONALD *et al.* [5].

A key change has been to evolve the service to accommodate the expanding numbers of patients receiving biologic therapy for severe asthma. Our initial service model was to administer the treatment injections and provide post-administration observation at an outpatient visit. We reached service capacity once we had approximately 30 patients on biologic therapy. Maintenance biologic administration was then transferred to primary care. The Difficult Airways Clinic staff provided the education, training and support for primary care staff to administer the biologic therapy. Further developments to support biologic administration are services funded by specific pharma companies and self-injection options for patients. At the present time, supervised biologic administration by the MDT is provided for initiation of biologic therapy and uncommon situations where directly observed biologic therapy is required.

The service now has over 300 patients receiving regular biologic therapy for severe type 2 (T2)-high asthma. An emerging issue is that of monitoring adherence, regular follow-up and managing the requirement for ongoing government approval for biologic use. Ongoing therapy requires demonstration of a continued response to therapy and submission of this data to a central government agency, who then issues approval for a further 6 months of therapy. These processes are currently tracked manually or with simple data management programmes. Future developments will see the introduction of an automated system of reminders and appointment management.

The service also needs to accommodate the increasing numbers of patients requiring access to the Difficult Airways Clinic assessment and therapies. To do this, the service has partnered with the national Centre of Excellence in Severe Asthma and Centre of Excellence in Treatable Traits to develop educational and practice management tools to facilitate the assessment and management of severe asthma in different settings. These tools and training sessions have supported the development of severe asthma assessment and management in different sites, as well as ambulatory settings outside of the hospital and in specialist private practices.

Leadership and training

The MDT members within our service are international leaders in the field of severe and difficult-to-treat asthma and COPD. Our team members work in partnership with the national Centre of Excellence in Severe Asthma (www.severeasthma.org.au) and Centre of Excellence in Treatable Traits (<https://treatabletraits.org.au>) to build the capacity of clinicians and researchers within the field. We have developed the Severe Asthma Toolkit (<https://toolkit.severeasthma.org.au>) [39], an interactive online

training resource for multidisciplinary clinicians that provides evidence-based and up-to-date resources for use in the clinic. It is free to use, and resources can be downloaded and printed. The Severe Asthma Toolkit was launched in 2018 and is now used in over 200 countries (based on ISO 3166 standard codes) across the world.

We have also developed and deliver postgraduate courses through our national society (Thoracic Society of Australia and New Zealand) and offer an educational webinar series on severe asthma *via* our website (www.severeasthma.org.au/tools-resources/past-webinars/).

Challenges

The service we have described is embedded within a tertiary care hospital in a high-income country. This model of care has been developed for patients with complex airway diseases, who present with heterogeneous needs. This is not the approach that all patients with airway diseases require, and implementation in other settings such as secondary and primary care would require personalisation to those settings [40]. We acknowledge that the resources we have access to would not be available in low- and middle-income countries or even rural and remote regions of high-income countries. However, the use of a Treatable Traits approach that addresses core traits within primary care, rural and remote regions, and low- and middle-income countries, such as T2-high inflammation, airflow limitation, self-management skills and adherence, smoking, physical inactivity, and obesity [41], could be more feasible. We have previously described how this could be achieved [41]. This approach could also enable referral into more complex services, such as that described, if patient need determines. The use of telehealth has significantly increased within the last couple of years and this technology can be used to improve access to services for patients who may be otherwise disadvantaged.

Resources are clearly a challenge to implementing and continually improving our multidisciplinary service, and to the best of our knowledge there are no cost-effectiveness analyses of multidisciplinary airway disease clinics such as the one we have described. However, we do know that this approach is associated with significantly improved health outcomes, including halving OCS requirements [29], reduced exacerbations, and improved quality of life and asthma control [28, 29]. All these outcomes lead to increased healthcare utilisation when not addressed or controlled. Despite these proven benefits, most multidisciplinary clinics continue to operate with limited resources [42]. This proves difficult particularly when staff are on planned and unplanned leave, and when there are competing demands on the specialty area (coronavirus disease 2019 (COVID-19) and influenza pandemics/epidemics), and can create excessive waiting times for patients to be reviewed. Furthermore, the application process for biologic therapies through the Australian Pharmaceutical Benefits scheme is time consuming and impacts resourcing [42].

Conclusions

We have described the multidisciplinary service we provide for patients with difficult airway disease. The care model is multipronged in terms of the services it offers. It is person centred, as we individualise care based on the needs of the patient and the specific traits that are causing symptoms and impacts. Our team work seamlessly together (mostly) due to the structure of the service and the opportunity for collaborative care and ongoing training. The success of the service is due to continued quality improvement and the enabling of change with new treatments and changing capacity. A multidisciplinary approach is integral to addressing the complexity and heterogeneity of people with complex airway diseases. In concluding we leave you with a quote from a patient within our service:

“There is hope. That’s the message. There is an answer ... it lies in recognising that you are part of a partnership with a team of people that can support you.”

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