



OPINION

Comprehensive respiratory assessment in advanced COPD: a 'campus to clinic' translational framework

Michael C Steiner,^{1,2} Rachael A Evans,^{1,2} Neil J Greening,¹ Robert C Free,¹ Gerrit Woltmann,¹ Nicole Toms,¹ Michael D Morgan¹

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¹Leicester NIHR Respiratory Biomedical Research Unit, Institute for Lung Health, Glenfield Hospital, Leicester, UK

²School of Sport Exercise and Health Sciences, Loughborough University, Loughborough, Leicestershire, UK

Correspondence to

Professor Michael Steiner, Leicester NIHR Respiratory Biomedical Research Unit, Institute for Lung Health, Glenfield Hospital, Groby Road, Leicester LE3 9QP, UK; Michael.steiner@uhl-tr.nhs.uk

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INTRODUCTION

COPD is a clinical syndrome representing a spectrum of lung pathologies associated with systemic comorbidities and exacerbations, which contribute substantial morbidity and mortality. The 'umbrella' nature of the syndrome has resulted in the detailed investigation and description of multiple disease phenotypes relating to the heterogeneity of lung pathophysiology but also to other clinical features such as symptom burden, exacerbations, comorbidities, nutritional status and respiratory failure.^{1–5} Phenotype-specific therapies already exist, for example, lung volume reduction therapies, nutritional support and home non-invasive ventilation. Moreover, this may extend to other features such as increased cardiovascular risk and inflammation-directed exacerbation management.^{6,7}

These advances provide an opportunity to make a significant change in the care of patients with COPD both by personalising the management of patient symptoms and future health risk (as embodied in the updated Global Initiative for Chronic Obstructive Lung Disease (GOLD) staging schema⁸) and by the proactive identification and treatment of systemic comorbidities that are known to impact on health outcomes. For these scientific developments to translate to patient care, a more detailed, systematic framework for clinical assessment is needed in routine clinical practice. Such an approach is also required to stratify care across the range of disease severity/complexity so that care can be individualised and services organised accordingly. In keeping with this, the UK National Health Service (NHS) National Outcomes Strategy for COPD recommends that the assessment of disease severity should be based on a 'comprehensive assessment' of clinical characteristics and that services should be integrated to ensure specialist care focuses on more 'complex or unstable' disease.⁹ Currently, however, in the UK and many other healthcare systems, proactive identification and management of complex medical, psychological and social care needs in COPD occurs infrequently and is poorly coordinated.¹⁰ By contrast, a structured approach to managing the multiple care needs of elderly people through a 'comprehensive geriatric assessment' has been shown to be effective in improving health outcomes and reducing healthcare use¹¹ and is now in widespread use.

In this paper, we propose a framework for a structured, systematic and detailed assessment in COPD, which we have termed the 'comprehensive respiratory assessment (CRA)'. We describe the

development and implementation of this tool within a specialist-led COPD service that stratifies patients for advanced/complex disease. We demonstrate the feasibility by presenting data from the CRA over the first 18 months of its use and discuss the potential value of this approach. We propose how a structured assessment with an annualised review could be integrated into commissioned COPD disease management programmes to support shared patient decision-making and self-care, and the establishment and sharing of agreed management plans for scheduled and unscheduled care.

DEVELOPMENT OF THE CRA

The complex COPD service at Glenfield Hospital was established in 2013 with the aim of ensuring thorough and consistent assessment and treatment of patients with complex, advanced COPD in the Leicestershire area (serving approximately one million people). The initiative is supported by the Leicester National Institute for Health Research Respiratory Biomedical Research Unit, which contributes to data collection through an information technology data management platform serving also as an electronic clinical patient record. A bespoke database solution with web-based interface was developed to capture relevant and highly structured data contemporaneously (see online supplement and supplementary figures S1–3) and facilitate population of letter templates.

Accepted, specific criteria for 'advanced' or 'complex' COPD do not exist and our pragmatic stratification approach (box 1) identifies patients with a high symptom burden, high future health risk and potential need for specialist services such as lung volume reduction therapies or home ventilation. Patients accepted to the service provide informed consent for their clinical data to be used for research purposes.

The CRA is structured to address key clinical problems that patients present to clinicians (rather than specific pathophysiologicals) and is conducted in a setting where shared decision-making can be undertaken, support for patient self-management provided and the outcome of the review shared with other clinical and social care teams who manage the patient. The assessment is conducted annually because the nature of the condition (with variable rates of decline, onset of comorbid conditions, exacerbation frequency and uncertain prognosis) requires a system of regular review to be built into the process.



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Box 1 Referral criteria for complex COPD service

FEV₁ <50% predicted plus one of the following:

- ▶ Two or more admissions to hospital for acute exacerbation of COPD
- ▶ Severe disability (Medical Research Council score 4 or worse)
- ▶ Continued smoking
- ▶ Low body mass index (<21 kg/m²) or unexplained weight loss (>5% in 6 months)
- ▶ Candidacy for lung volume reduction therapies
- ▶ Established respiratory failure (PO₂ <8 in stable state)

The CRA is mapped to address patient-centred clinical problems that affect current symptom burden and future health risk; limitations to physical activity and mobility due to breathlessness (exercise/symptom domain), repeated exacerbations and respiratory infection (exacerbation domain), the development of extrapulmonary complications and comorbidities (comorbidity domain) and concerns about shortened life expectancy and end-of-life care (prognostic indicator domain). The content of the CRA in each domain and example treatment outcomes are shown in [table 1](#).

The CRA is conducted as part of a structured annual review. The assessment is performed before the clinic consultation by a specialist respiratory nurse and subsequently discussed with the patient during the physician consultation where a detailed management plan is agreed. The CRA and agreed care plan are recorded in the patient's casefile and discussed with community teams who share responsibility for patient care. The annual review provides the opportunity to involve the multiprofessional team (eg, dietetics, palliative care, pulmonary rehabilitation, psychology, smoking cessation and community support) and to provide supported self-management for the patient (see [figure 1](#)).

The results of the CRA in the first 121 patients (52% men, mean (SD) age: 65 (9) years, FEV₁: 32 (15) % predicted) enrolled over the first 18 months are shown in [table 2](#).

DISCUSSION

The CRA provides a mechanism for systematically encompassing the complexity of COPD and its systemic manifestations in clinical practice and ensuring important features and comorbidities (and their treatment) are not missed or forgotten. The embedding of the CRA in an annual review process provides a platform for shared decision-making with the patient and a resultant care plan that sets out treatment priorities, identifies suitability for tailored interventions (eg, lung volume reduction (LVR) therapy or ventilatory support) and ensures the multiprofessional team are engaged where required. We believe that such a structured approach (which is not in place in most healthcare settings) is a crucial next step for 'campus to clinic' translation of recent and future scientific advances in COPD phenotyping and personalised care.

The data we present from the implementation of the CRA in our complex COPD service demonstrates both feasibility in this setting and the significant symptom burden and high prevalence of extrapulmonary comorbidities among our cohort. Examples of the latter include a notably high exacerbation frequency, substantial cardiovascular risk and high rates of reduced bone mineral density and nutritional depletion. The comprehensive nature of the assessment ensures that patients who may benefit from phenotype-specific therapies are routinely and systematically identified. For example, the prevalence of significant hyperinflation was high, suggesting that lung volume reduction therapies (which are rapidly evolving through the development of bronchoscopic techniques¹³) may be suitable for a higher proportion of this population than is currently offered. Similarly, it is accepted that access to key members of the multiprofessional team (eg, pulmonary rehabilitation, dietetics, palliative care) improves clinical outcomes, but these needs often go

Table 1 The domains and content of the comprehensive respiratory assessment

| | Assessment | Diagnostic | Outcome |
|-----------------------------|--|--|---|
| Exercise/symptom domain | <ul style="list-style-type: none"> ▶ MRC scale ▶ Drug therapy ▶ Attendance at PR ▶ CAT score | <ul style="list-style-type: none"> ▶ Lung function ▶ Hyperinflation ▶ Exercise desaturation ▶ Exercise testing ▶ Muscle strength | <ul style="list-style-type: none"> ▶ Prescription, eg, bronchodilator ▶ Referral for PR ▶ Consider LVR ▶ Ambulatory oxygen |
| Exacerbation domain | <ul style="list-style-type: none"> ▶ Exacerbation frequency ▶ Hospital admission ▶ Vaccination history ▶ Drug therapy | <ul style="list-style-type: none"> ▶ Sputum microbiology ▶ Blood eosinophilia ▶ CT imaging | <ul style="list-style-type: none"> ▶ Exacerbation management strategy ▶ Prescription, eg, ICS/mucolytic ▶ Antibiotic prophylaxis ▶ Vaccination |
| Comorbidity domain | <ul style="list-style-type: none"> ▶ Medical history ▶ Weight loss ▶ History of anxiety or depression ▶ Fracture history | <ul style="list-style-type: none"> ▶ BMI ▶ Bone mineral density (DEXA) ▶ Vitamin D ▶ FFMI and SMI (DEXA) ▶ ECG/BNP ▶ Framingham risk score ▶ Serum testosterone ▶ HADS | <ul style="list-style-type: none"> ▶ Osteoporosis secondary prevention ▶ CV risk reduction ▶ Nutritional therapy ▶ Hormone replacement ▶ Psychological therapies |
| Prognostic indicator domain | <ul style="list-style-type: none"> ▶ Smoking status ▶ Home oxygen use ▶ NIV use (acute and home) ▶ Oedema ▶ 'Surprise' question | <ul style="list-style-type: none"> ▶ Blood gases ▶ iBODE | <ul style="list-style-type: none"> ▶ Smoking cessation ▶ Home oxygen or ventilation ▶ EoL/advance care planning ▶ Palliative care referral |

'Surprise' question indicates 'would you be surprised if your patient died in the next year'; iBODE, see Williams *et al.*¹²

BMI, body mass index; BNP, brain natriuretic peptide; CV, cardiovascular; DEXA, dual emission X-ray absorptiometry; EoL, end of life; FFMI, fat-free mass index; HADS, hospital anxiety and depression score; iBODE, Body mass index, airflow Obstruction, Dyspnoea, and Exercise; ICS, inhaled corticosteroid; LVR, lung volume reduction therapy; MRC, Medical Research Council; NIV, non-invasive ventilation; PR, pulmonary rehabilitation; SMI, skeletal muscle index.

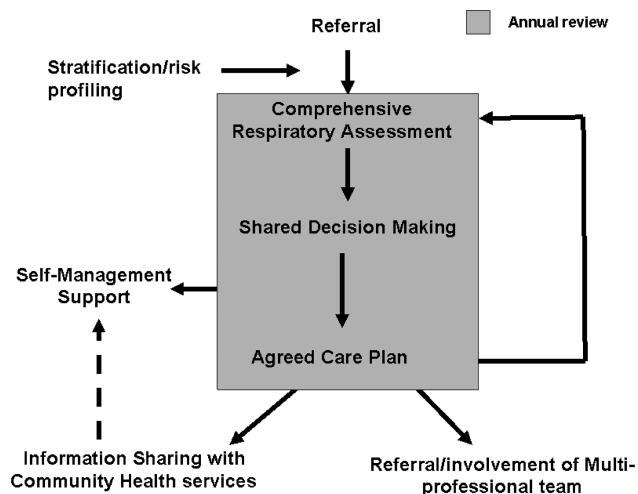


Figure 1 Proposed components and organisation of a structured annual review for patients with complex COPD.

unrecognised in routine primary and secondary care practice and referral rates are highly variable. The CRA provides the necessary clinical and diagnostic information together with management prompts to ensure these therapeutic opportunities are considered. The assessment also offers the potential to personalise exacerbation management; for example, a third of patients had a blood eosinophilia and a third had positive sputum bacteriology, suggesting that individualised exacerbation self-management strategies could result in improved outcomes and reduced harm and healthcare costs.³

The updated GOLD staging system incorporating symptom burden, exacerbation frequency and lung function impairment⁸ is the first step towards a more sophisticated clinical assessment of COPD but has prompted questions about its applicability in clinical practice. Others have suggested categorisation in terms of 'severity, activity and impact'^{14 15} or 'best current control versus future risk'.¹⁶ We extended these concepts by developing a framework with sufficient detail that can be implemented 'in the field'. We have structured the CRA around four key clinical problems encountered in routine practice to ensure the clinic consultation remains 'patient centred' while ensuring phenotype-specific therapies can be appropriately offered. However, we do not intend to be prescriptive about the specific components of the CRA and recognise that some of the assessments/diagnostics proposed could justifiably be included in more than one domain (eg, frequent exacerbation or hospitalisation is an indicator of poor prognosis).¹⁷

Our initial data demonstrate an unmet need for proactively addressing complexity and multimorbidity in COPD, and evidence from other models of care (eg, the comprehensive geriatric assessment) suggests that improved health outcomes do follow.¹¹ We propose that the CRA and annual review needs to result in a care plan, which is agreed with the patient and includes components of scheduled and unscheduled care. It is desirable that the process incorporates support for self-management to ensure the patient understands the care plan and is able to actively participate in its delivery (see figure 1). However, unless the process is incorporated in a coordinated disease management programme where the care plan can be executed, improvements in the quality and outcome of care may not be realised.

We have developed the CRA in the setting of a specialist-led complex COPD service, which requires the establishment of

referral (or stratification) criteria. Should this be applied across the whole COPD population or solely to those with advanced or complex disease (however that might be defined)? Our proposed CRA is likely to be most profitable in those with more complex disease where symptom burden and future risk is highest, risk of comorbidities greatest and the need for specialised intervention more likely, but we believe the principles are applicable to all patients whether managed by primary care or specialist physicians with the content modified according to the burden of disease and the healthcare setting. We suggest that scheduled annual reviews should be provided for all patients, and indeed in the UK this is mandated in the NHS contract for primary care providers.

In the UK, it is notable that health policy is increasingly focused on containing healthcare costs by moving care of long-term conditions away from hospitals into community settings.

Table 2 Results from the comprehensive respiratory assessment over the first 18 months

| Exercise/symptom domain | | Exacerbation domain | |
|-------------------------|-------------|---------------------------|-----------|
| RV/TLC (%) | 64 (11) | COPD-related admissions | 0.9 (1.4) |
| RV (% predicted) | 213 (27) | Antibiotics courses | 5.1 (4.4) |
| Hyperinflation* | 59% | Oral steroid courses | 5.0 (4.4) |
| TLCO (% predicted) | 38 | Blood eosinophilia† | 33% |
| ISWT (m) | 140 | Sputum culture positive | 38% |
| QMVC (% predicted) | 45 (24) | Flu vaccination | 94% |
| MRC dyspnoea score | 4 (IQR 4–4) | Pneumonia vaccine | 84% |
| Previous PR attendance | 71% | Maintenance oral steroids | 11% |
| Exercise desaturation‡ | 51% | Maintenance antibiotics | 21% |
| CAT score | 25.5 (6.3) | | |

| Comorbidity domain | | Prognostic indicator domain | |
|---------------------------|------------|-----------------------------|-----------|
| Other comorbidity | 76% | Pack years (years) | 39 (16) |
| Abnormal BNP§ | 22% | Current smokers | 25% |
| Framingham risk score | | Long-term oxygen therapy | 35% |
| Low (<10%) | 46% | 'Surprise' question (% no) | 23% |
| Intermediate (11–20%) | 36% | BMI <21 kg/m ² | 32% |
| High (>20) | 18% | Nutritional depletion¶ | 53% |
| Sarcopenia** | 64% | iBODE†† | 7.3 (1.1) |
| Osteoporosis‡‡ | 14% | | |
| BMI (kg/m ²) | 25.3 (7.4) | | |
| BMI ≥30 kg/m ² | 25% | | |
| HADS anxiety >10§§ | 33% | | |
| HADS depression >10§§ | 27% | | |

Figures for events refer to the preceding 12 months. Bone mineral and lean mass measured from DEXA. Lung volume measurements measured using body plethysmography (n=71).

*Residual volume >150% predicted and RV/TLC >55% (calculated as proportion of total population of 121 subjects).

†Blood eosinophil count >0.4×10⁹.

‡≥4% desaturation on exertion.

§>95% upper limit of CI.

¶Nutritional depletion: FFMI <15 kg/m² (women)/<17 kg/m² (men) or BMI <21 kg/m² (5).

**SMI calculated as the height normalised sum of appendicular lean mass.

Sarcopenia defined as SMI <7.23 (men) or <5.67 (women) (5).

††Mean (SD) iBODE score.¹²

‡‡T score ≤−2.5.

§§HADS anxiety or depression scores >10.

BMI, body mass index; BNP, brain natriuretic peptide; CAT, COPD assessment test; DEXA, dual emission X-ray absorptiometry; FFMI, fat-free mass index; HADS, hospital anxiety and depression score; iBODE, Body mass index, airflow Obstruction, Dyspnoea, and Exercise; ISWT, incremental shuttle walking test; MRC, Medical Research Council; PR, pulmonary rehabilitation; QMVC, reduced maximum voluntary quadriceps contraction strength; RV, residual volume; SRS, skeletal muscle index; TLC, total lung capacity; TLCO, transfer factor of the lung for carbon monoxide.

This is at odds with the above-mentioned developments in disease phenotyping and personalised care in COPD because there may be inadequate expertise or diagnostic infrastructure in community settings to allow these developments to be implemented. We suggest that this dilemma can only be solved by commissioning whole disease management pathways that includes the provision of specialist assessment where individual patient needs are complex. This is in line with newer integrated commissioning models for patients with long-term conditions (eg, capitated budget approaches such as 'Year of Care' (<http://www.nhs.uk/ltcyoc>)) and also with the recently published NHS 'Five Year Forward View' (<http://www.england.nhs.uk/2014/08/15/5yfv/>). Moreover, expert, comprehensive assessment in those with complex/advanced disease may reduce healthcare costs, for example, by implementing cutting-edge individualised exacerbation management strategies and tailored end-of-life care.

In summary, we have developed a structured comprehensive assessment for patients with COPD, which we have embedded in an annual review process as part of a complex COPD service. We believe that the principles underpinning this approach (disease stratification structured assessment, annual review and shared decision-making) are fundamental in the planning and commissioning of whole disease management pathways. Structuring care in this way is the only way to ensure that scientific developments in disease phenotyping and personalised care are translated into clinical practice in a cost-effective manner.

Contributors All authors contributed to the writing of the article.

Competing interests None declared.

Ethics approval NRES Committee East Midlands—Derby.

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Online supplement

Bespoke database for CRA

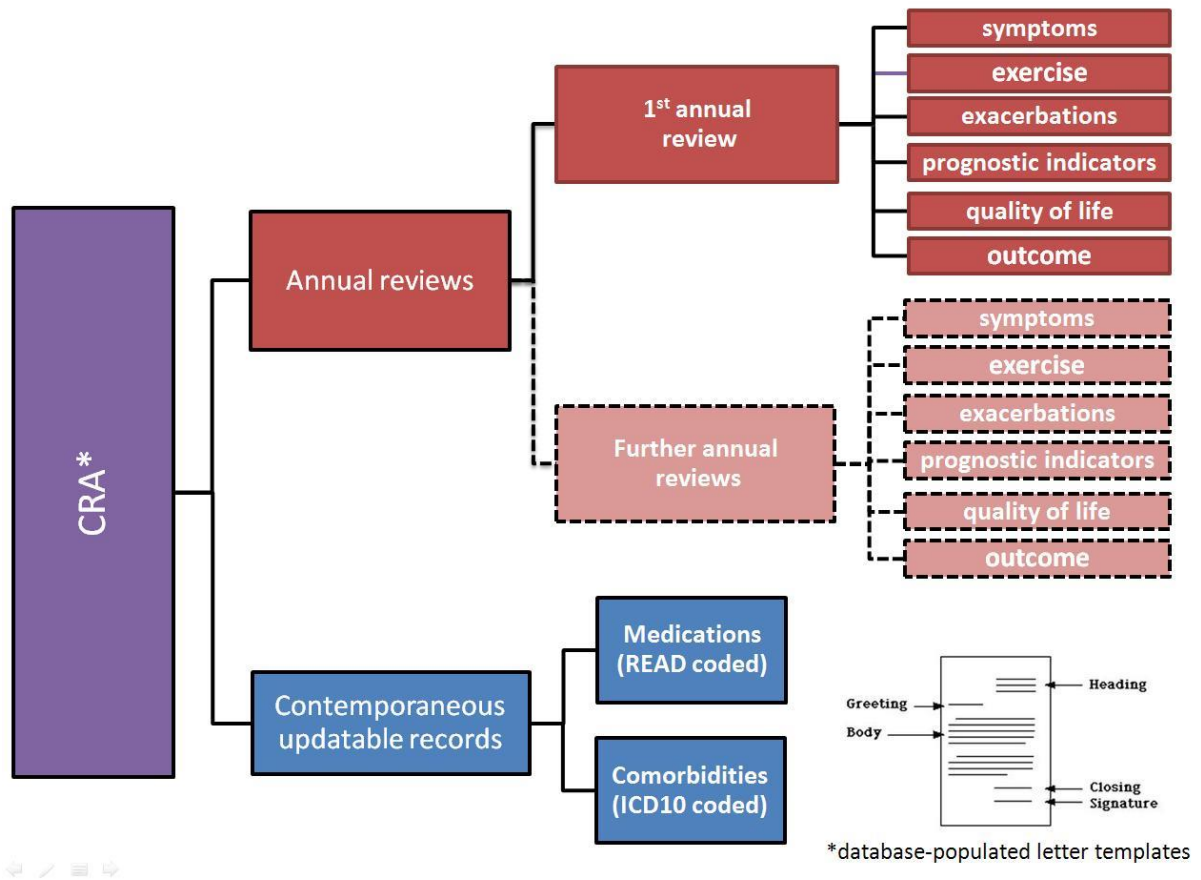
The Airways Disease Database (ADD) was designed within the IT section of the Leicester NIHR Respiratory biomedical research unit (BRU) for clinical research data management and to support clinical phenotyping in specialist multi-disciplinary respiratory clinics. The web based interface was designed through dialogue with clinicians, specialist nurses and other staff within the unit to meet both staff role and clinic specific needs. The platform and clinic specific modules were designed employing software available in the public domain (open source tools including PHP, MySQL).

To provide contemporaneous electronic data capture for the CRA, a bespoke 'complex COPD' ADD module was created to facilitate structured data entry on symptoms, exercise, exacerbations, prognostic indicators, quality of life and outcome. In addition generic modules within the database framework provide the ability to capture related data such as longitudinal medication records (supplement figure 1) and ICD10 coded comorbidity recording. CRA letter templates are populated from the completed data set, thereby saving substantial admin time associated with specialist clinic delivery.


Example screenshots from the database are shown in supplement figures 2 and 3.

Supplement Figures

Supplement Figure 1: Overview diagram of web based CRA clinic data collection tool.



Supplement Figure 2: Representative screenshot of CRA data collection interface (dummy patient).



Patient: JOHN SMITH
DOB: 03/04/1936 **S-number:** S1234567

[Edit Demographics..](#)

[Options](#) [Logout Admin](#)

Enter patient no

[New patient](#) [Blank reports](#)

Add patient to complex COPD - > annual assessment (20/03/2015) - Generic info

x Generic info

x Exercise/symptom

x Exacerbations

x Co-morbidities

x Prognostic indicator

x Quality of Life

x Outcome

Generic info (Annual assessment)

• There are 4 required observations missing in the 'Generic info' record x

✓ Save Data

↻ Recalculate

✔ Verify

Date of assessment [clear..](#)

20/03/2015

General

Smoking/drink

Home circumstances

Consent

Oxygen at home* [clear..](#) [clear..](#)

Yes No l/min

Assessment for ambulatory O₂ (last 12 months) [clear..](#)

Yes No

NIV at home [clear..](#)

Yes No

Known to have alpha-1 antitrypsin deficiency [clear..](#)

Yes No

Chest X-ray in last 12 months [clear..](#)

Yes No

Supplement Figure 3: Screenshot of prognostic indicator recording fields.

Prognostic indicator (Annual assessment)

- Please enter '% predicted FEV₁', 'ISWT', 'MRC dyspnoea scale' in 'Exercise/symptom' page to calculate the IBODE score ✕

✓ Save Data

IBODE

Oedema [clear..](#)

Yes No

Prev. need for acute

NIV* [clear..](#)

Yes No

Would you be surprised if patient died in next year?* [clear..](#)

Yes No

End of life discussion [clear..](#)

Yes No