Prim Care Respir J 2011; **20**(3): 269-275

Primary Care RESPIRATORY JOURNAL
www.thepcrj.org

RESEARCH PAPER

Functional status measurement in COPD: a review of available methods and their feasibility in primary care

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Originally submitted 8th December 2010; revised version received 17th January 2011; accepted 18th January 2011; online 26th April 2011

Abstract

Aims: Guidelines advocate that improvement in functional status should be a major goal in COPD treatment. Many tools are available to assess aspects of functional status. This review aims to categorise systematically the available tools based on their construct (i.e. what the tool intends to measure) and to rate the tools for use in the primary care setting.

Methods: PubMed was searched with the keywords 'functional status' or 'physical capacity' or 'functional capacity' and 'COPD'. All tools were categorised and rated on their measurement properties, feasibility, and usage in primary care COPD patients. The tools were divided into four constructs – functional capacity, functional performance, functional reserve, and capacity utilisation – and used the following modes of measurement: laboratory tests; semi-laboratory tests; field tests; and patient-reported outcomes.

Results: The PubMed search resulted in 364 articles. Thirty-two tools were identified and rated.

Conclusions: In primary care, the 6-minute walking distance test is the most reliable semi-laboratory functional capacity test, but is not very practical. The pedometer is the best functional performance field test. The Medical Research Council (MRC) dyspnoea questionnaire and the functional status domain of the Clinical COPD Questionnaire (CCQ) are the best patient-reported outcome tools to assess functional performance.

JWH Kocks, *et al*. *Prim Care Respir J* 2011; **20**(3): 269-275
http://dx.doi.org/10.4104/pcrj.2011.00031

Keywords COPD, management, primary care, functional status, physical capacity, performance, measurement, tools

See linked editorial by Jones on pg 227

Introduction

The amount of physical activity possible and the functional status of COPD patients predict exacerbations,[1,2] hospital admissions,[2] and mortality.[3] Therefore, guidelines advocate the need to designate improvement in functional status as one of the major treatment goals for patients with COPD.[4,5] However, most guidelines do not define "functional status", nor do they define how to assess it.

In routine clinical practice, functional status can be measured by several different methods representing different constructs. The "construct" of a measurement or questionnaire is what the tool intends to measure. Functional status, functional capacity, exercise capacity, and exercise tolerance are terms which are often used interchangeably, but they represent different constructs. Leidy defined a theoretical framework of functional status, exercise capacity and functional capacity,[6] and defined

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functional status as a 'multidimensional concept characterising one's ability to provide for the necessities of life; that is, those activities people do in the normal course of their lives to meet basic needs, fulfil usual roles, and maintain their health and well-being'. The framework labels and clearly defines four distinct, but related, constructs of functional status: *functional capacity*, *functional performance*, *functional reserve*, and *capacity utilisation*. *Functional capacity* is defined as 'one's maximum potential to perform activities' and can be tested, for example, using cycle ergometry. *Functional performance* is defined as the physical, psychological, social, occupational, and spiritual activities people actually do in the normal course of their lives to meet basic needs, fulfil usual roles, and maintain their health and well being. *Functional reserve* is the difference between capacity and performance, and *capacity utilisation* is the effort used to reach the functional performance. This framework is graphically represented in Figure 1.

It is important to keep this framework in mind when selecting tools for research or clinical practice. For research purposes the improvement in functional capacity may be the most important factor and be directly related to the intervention, but for clinical management an indication of the limitations that patients experience in daily life – i.e. their functional performance – is more informative.

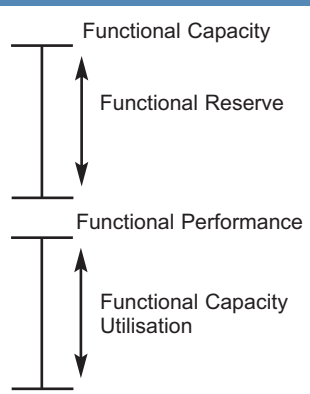
For research purposes, measurement properties such as validity and responsiveness are of great importance in order to detect even the smallest effects of treatment. These high standards often lead to intensive, time-consuming and costly tests. For clinical practice, high measurement standards are equally important, but so too is feasibility. Measurement tools that are not easy to administer will not be used in routine practice,[7,8] and so they should be feasible and easy to interpret.

Measurement tools can also be categorised according to the methods and resources needed to perform the measurement. In this article we have categorised measurement tools into:

1) laboratory tests – e.g. cycle ergometry[9]
2) semi-laboratory tests – e.g. the 6-minute walking distance test[10]
3) field tests – e.g. the accelerometer[11], and
4) patient-reported outcomes – e.g. the MRC dyspnoea scale[12] and the St George's Respiratory Questionnaire (SGRQ)[13].

Putting measurement tools into a framework based on the construct they measure and the resources needed should help clinicians make better choices regarding the tools they use in routine practice. However, since the number of tools used to measure functional status for patients with COPD is large, and each tool has its own measurement properties, we conducted a literature search to compare the various tools available. This review summarises and rates the tools in a framework – based on the construct they measure and the resources needed – to create an overview of functional status measurements in primary care clinical practice.

Figure 1. Theoretical framework of functional status constructs by Leidy.[6] Reprinted with permission from N. Leidy, Functional status and the forward progress of merry-go-rounds: Toward a coherent analytical framework. *Nurs Res* 1994;43:196-202



Methods

Literature search

We searched PubMed using the following keywords: 'functional status' or 'physical capacity' or 'functional capacity' and 'COPD'. The timeframe for the literature search was the last 15 years, i.e. from 1st January 1995 to 1st July 2010. Studies published in languages other than English were excluded. No attempt to assess the quality of the studies was made as this was beyond the scope of this article.

The resulting titles, abstracts and texts were screened by three authors (JWHK, GMA, TvdM) for tools that were used in patients with COPD to assess exercise capacity, functional status or functional capacity. This resulted in the identification of a set of relevant tools. Following the identification of these tools, the article describing the development or implementation of the corresponding tool was reviewed for further information. To complete the PubMed search, articles that referenced the development article were searched using the "citing articles" function on ISI web of science.

Data collection and scoring of tool properties

For all tools, information was obtained about the time to complete, time for the patient to recover after performing the test, the test properties (reproducibility, reliability, validity, and responsiveness), the existence of the minimal clinically important difference (MCID), and about data in different COPD severity groups.

Based on this information, scoring of the tools was done according to the previously-used International Primary Care Respiratory Group (IPCRG) rating system.[14] This system was developed to compare quickly the usefulness for clinical practice of 'COPD wellness tools'. Tools were attributed the

following scores: ☹ = very poor/unknown; ☹ = Not good enough, if this criterion is important; ☺ = Good enough; ☺ = Recommended; ☺ = Highly recommended.

For all tools, scores were given in the following categories:

Validity/reliability: Articles reporting the development of the tool and further validation of instruments were used to rate the validity and the reliability. For questionnaires, a high Crohnbach's alpha is suggested (> 0.9) for use in individual patient care.[15] If a tool scored highly on these items, preferably in several papers, the rating was "highly recommended".

Responsiveness: if a tool had been shown to be able to measure changes in the patient's situation – for example, during exacerbations or upon efficacious treatment – the tool was rated "recommended". If a tool appeared to be very responsive in multiple events (e.g. exacerbations, smoking cessation, pulmonary rehabilitation), the rating was "highly recommended".

Primary care population: if a tool was developed in patients with mild to moderate COPD, or the tool had successfully been used in this population, the tool was rated "recommended" or "highly recommended" based on the number and size of the studies.

Practical/Easy to administer: a tool was rated "highly recommended" when the application of the tool results in completion within 5 minutes, the scores/values are easy to calculate and interpret, no or very little additional resources are needed (e.g. additional rooms or (electronic) devices), and the patient recovery time is limited.

Tested in practice (COPD): if according to published articles tools are used in clinical practice or if guidelines recommend their use, these tools received "recommended" or "highly recommended" ratings.

MCID known: if the minimal clinically important difference is published, the rating was "highly recommended". If the tool is part of a larger questionnaire, and the total questionnaire's MCID is known, but not the part/domain's MCID, the tool was rated "recommended".

Results

The PubMed search resulted in 364 articles. Thirty-two tools were identified. The tools were divided into four categories:

1. laboratory tests
2. semi-laboratory tests
3. field tests, and
4. patient-reported outcomes.

The tools and ratings are presented in Table 1. References mentioned in the table are development articles, further validation articles, manuals or reviews describing the properties of the tools.

Discussion

This review is the first that has systematically organised tools measuring functional status in COPD within a framework by assessing the exact construct that they measure as well as the resources needed for their use. The measurement properties of each tool were graded based on the existing literature, and feasibility was graded on predefined criteria.

To assess functional status in COPD patients, this study revealed that although there is a variety of tools to assess functional status in COPD no one tool meets all the criteria for it to be highly recommended for primary care use. The 6-minute walking distance test is the most reliable, but not a very practical semi-laboratory functional capacity test. The pedometer is the best functional performance field test, and the MRC and the

Table 1. Measurements and scores

Category	Dimension of functional status	Tool	Validity/ Reliability	Responsive	Primary Care Population	Practical/ Easy to Administer	Tested in Practice (COPD)	MCID known
1. Lab	Cap	Cycle ergometry[9]	☺	☺	☺	☹	☺	☺
1. Lab	Cap	Shuttle walk test[9]	☺	☺	☺	☺	☺	☹
1. Lab	Cap	Treadmill test[9]	☺	☺	☺	☹	☺	☹
1. Lab	Per	Direct video observation	☹	☹	☺	☹	☹	☹
2. Semi	Cap	6 MWD[10]	☺	☺	☺	☺	☺	☺
2. Semi	Cap	Master 2 step test[16]	☹	☹	☹	☺	☹	☹
2. Semi	Cap	Sit to stand test[17]	☺	☹	☺	☺	☹	☹
2. Semi	Cap	Stair climbing[18]	☹	☹	☹	☺	☺	☹

Table 1. Measurements and scores continued

Category	Dimension of functional status	Tool	Validity/ Reliability	Responsive	Primary Care Population	Practical/ Easy to Administer	Tested in Practice (COPD)	MCID known
2. Semi	Cap/per	Glittre ADL[19]	😡	🙁	😟	😟	😟	😠
3. Field	Cap/per	Energy Expenditure [20]	😡	😡	😡	😠	😠	😠
3. Field	Per	Pedometer[21]	😡	🙁	🙁	🙁	🙁	😠
3. Field	Per	Accelerometer[11]	😡	😡	🙁	😐	🙁	😠
3. Field	Per	Heart rate monitoring[22]	😠	😠	🙁	😠	😠	😠
4. PRO	Per	Activity Self Efficancy Questionnaire (ASEQ)[23]	😠	😟	😡	😡	😟	😠
4. PRO	Per	COPD Activity Rating Scale (CARS)[24]	😐	😟	😟	😐	😟	😠
4. PRO	Per	Clinical COPD Questionnaire functional status domain (CCQfun)[25,26]	😡	😡	😡	😡	😡	🙁
4. PRO	Per	Capacity of Daily Living during the Morning questionnaire (CDLM)[27]	😡	🙁	😡	🙁	😐	😡
4. PRO	Per	Canadian Occupational Performance Measure COPM[28,29]	🙁	🙁	😐	🙁	🙁	😡
4. PRO	Per	CRQ - dyspnoea domain[30,31]	😡	🙁	😡	🙁	😡	🙁
4. PRO	Per	Daily record cards[32]	🙁	🙁	😡	🙁	🙁	😠
4. PRO	Per	Nottingham Extended Activities of Daily Living Questionnaire (EADL)[33,34,35]	😐	😟	😟	🙁	😟	😠
4. PRO	Per	Functional Performance Inventory (FPI)[36]	🙁	😟	🙁	🙁	😐	😠
4. PRO	Per	Functional Status Questionnaire (FSQ)[37]	😐	😟	😟	😐	😟	😠
4. PRO	Per	General Practice Physical Activity Questionnaire GPPAQ[38]	🙁	😟	😡	😡	😟	😠
4. PRO	Per	London Chest Activity of Daily Living scale (LCADL) [35]	😟	😟	😟	😡	😟	😠
4. PRO	Per	Modified Activity Record Questionnaire (MARQ)[39]	😠	😟	😡	🙁	😟	😠
4. PRO	Per	Manchester Respiratory Activities of Daily Living Questionnaire (MRADLQ)[40]	😡	😡	😐	😡	😟	😠
4. PRO	Per	Medical Research Council dyspnoea questionnaire (MRC)[12]	🙁	🙁	😡	😡	😡	😡
4. PRO	Per	Pulmonary Functional Status and Dyspnea Questionnaire (PFSDQ)[41,42]	🙁	🙁	🙁	😐	🙁	😠
4. PRO	Per	Pulmonary Functional Status Scale (PFSS)[43]	😐	🙁	🙁	😐	🙁	😠
4. PRO	Per	SGRQ - activity domain[13]	😡	😡	😐	😐	🙁	🙁
4. PRO	Per	Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH)[44]	😐	🙁	🙁	🙁	🙁	😠

Description of label: 😠 = very poor/unknown; 🙁 = Not good enough, if this criterion is important; 😐 = Good enough; 🙂 = Recommended; 😡 = Highly recommended.

Lab = laboratory tests; semi = semi-laboratory tests; field = field tests; PRO = patient-reported outcomes; cap = functional capacity; per = functional performance.

References refer to manuals, development or validation studies.

CCQ functional status domain are the best patient-reported outcome tools.

The number of published studies measuring functional status in COPD patients has increased rapidly in the past years. In 2000, 18 articles were found using our search strategy, whereas in 2009 there were 40. This increase in publications reflects the increasing awareness that something more than lung function is impaired in COPD patients, and that functional status is one of those impaired dimensions. There are only two conceptual frameworks currently available in which functional status is described – Leidy's model,[6] and a model described by Larson.[45] Given the increased attention on functional status, it is likely that more conceptual frameworks will be developed. An example is the new conceptual framework being developed as part of the PROactive program (personal communication M. Puhan, www.proactivecopd.com).

The framework we created is based on an existing framework developed by Leidy,[6] and we extended this by adding aspects on the resources needed to perform the test. Leidy *et al*. divided functional status into functional capacity, functional performance, functional reserve and capacity utilisation. Since functional reserve is the difference between capacity and performance, no specific tests have been developed to measure this theoretical construct. Capacity utilisation – which represents the effort that the patient needs to reach the functional performance – might be one of the most important constructs but it is not represented as a separate tool in the literature. We therefore ended up dividing the measurement tools into "functional capacity" and "functional performance" tools. However, two tools – the Glittre ADL[19] and Energy Expenditure[20] – were categorised as being both capacity and performance tests. The 6-minute walking distance test (6MWD) shows characteristics of both functional capacity and functional performance, although it is considered a test for functional capacity.[10] The 6MWD has shown good correlation with functional performance measures such as motion sensors[46,47] and is indeed more related to functional performance – measured with patient reported outcomes – than exercise capacity, as measured by cycle ergometry in patients with severe emphysema.[48]

In addition to the categorisation into constructs, we divided the tools into methods according to the resources needed – i.e. laboratory tests, semi-laboratory tests, field tests, and patient-reported outcome tests. Using this framework we rated the most important measurement features which include validity and reliability, responsiveness, the validation in primary care COPD patients, the feasibility, the usage in primary care, and the availability of the MCID.

Despite the difficulty in categorising certain tests, the combination of Leidy's framework[6] and our resources framework gives a good overview of available current functional status measurement tools and a guide for choosing tools which are feasible for use in primary care.

This study focussed on tools for patients with mild to moderate COPD, and in Table 1 the rating for this patient group is shown. Internationally, there is considerable variation between countries in terms of where patients are treated – either in primary or in secondary care. In some countries, all stages of COPD are treated mainly in primary care, whereas in others – such as in The Netherlands – most patients with severe COPD are managed in secondary care. Most tools have been developed in more severe COPD patients, and therefore we explicitly focussed in our rating system on mild to moderate COPD; in milder patients the measurement properties are more difficult to obtain from the literature. Nevertheless, within the group of mild patients (as defined by lung function), patients with more impaired functional status may benefit most from interventions.[49]

Categorisation can help to select the most appropriate measurement in specific situations. In clinical settings, it is important that physicians realise what they measure in a patient, why they measure it, and how valid this measurement is. For example, a capacity test like cycle ergometry is very valid and can reveal true (limitations in) maximum capacity. In COPD, the limitation of capacity can be linked to the loss of pulmonary function. When the capacity limitation cannot be explained by pulmonary function loss, this might be a reason to re-examine the patient for co-morbidities. Although laboratory capacity tests might be very useful in hospital-based clinical settings, for primary care the field tests and patient-reported outcomes (PROs) are more feasible. However, field tests and PROs always test performance and not capacity. Clinical conclusions drawn from these tests might therefore differ from conclusions based on (laboratory-based) capacity tests. An additional complication of functional status PROs is that although categorised as performance tests, most PROs measure patient-perceived performance limitations and/or symptom burden during performance. Correlations between motion sensors measuring actual performance and functional status PROs are therefore moderate.[11] Only the SQUASH measures the amount of physical activity; the MRADLQ measures whether or not activities are performed (with or without help). But both show poor measurement properties.

Not all tests are standardised, making it difficult to compare them between settings and between studies. For example, the stair climbing test was performed in a hospital setting with 16 flights of stairs and was stopped after exhaustion or chest pain and conducted at the patient's own pace[18] or at maximal speed[50] or after 35 seconds counting the maximum number of stairs.[51] Although the test is cheap (and if you have stairs in your practice, can easily be performed), it lacks standardisation. However, for individual follow-up of patients in the same setting it might be useful.

Standardised health status questionnaires with a separate functional status domain were included in this review (SGRQ, CRQ, CCQ). These domains are often separately described in studies. However, it is not advisable to create a "new" questionnaire that only uses the separate domain, because that creates new tests and alters the validity.[52] The advantage of a domain within a health status scale is that with one tool, different aspects of the health impairment caused by the disease are measured.

Like many medical tests, functional status examination tests can be used to support the diagnostic trajectory but can also be used for monitoring purposes only. In clinical practice, capacity tests like cycle ergometry are often used as a diagnostic tool,[9] whereas PROs are suggested as evaluation tools. Since patient-reported outcomes are "precision instruments",[52] and instruments are being developed[26,53] and validated[54] for use in daily clinical practice, these instruments are more often used for evaluation purposes. Although information gleaned from questionnaires is often more comprehensive and more reliable than from oral history-taking, the benefits in terms of clinical practice have yet to be established.

A limitation of this study is that the grading of the tools was done based on the literature review by JWHK and GMA. Although we had pre-defined criteria to rate the measurements, it was difficult on several occasions to rate according to the 5 "smilie" grades. For example, when a measurement was used in a large study population which included a low number of GOLD I and II patients, we discussed between the authors if "primary care population" should be rated as "good enough", or "recommended". This resulted in a less objective rating (for example, "MCID known"), but the agreement between the authors improved the validity in scoring. Where JWHK and GMA disagreed on the scoring, TvdM reviewed the literature as well and discrepancies were discussed. The ratings on "Practical/ Easy to Administer" and "Tested in Practice (COPD)" are based on the literature and not on real life experience. Our method was different from that used in an overview of COPD wellness tools for the IPCRG where researchers and clinicians were asked to rate the several COPD wellness tools. The latter method might have resulted in different scoring because of unpublished experiences.

In addition, we limited our search to PubMed, which will have resulted in most, but not all available articles.[55] We have used our search to identify tools, not to review individual studies. Nevertheless, we are confident that important tools that are used in scientific work were included in this review.

In conclusion, for primary care, the 6-minute walking distance test is the most reliable, but not very practical, semi-laboratory functional capacity test. The pedometer is the best functional performance field test. And the MRC and the CCQ functional status domain are the best patient-reported outcome tools to measure functional performance in primary care.

Acknowledgements

We would like to thank Milo A. Puhan, MD, PhD for his comments on the manuscript. We thank Dr. Candida Delgatty, Family/General Practitioner for her kind contribution in linguistically checking and editing this manuscript..

Conflicts of interest

GMA is an employee of Boehringer Ingelheim, The Netherlands.

Funding

Unrestricted research grant from Boehringer Ingelheim.

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