ORIGINAL ARTICLE

Gait speed and readmission following hospitalisation for acute exacerbations of COPD: a prospective study

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ABSTRACT

Background Hospitalisation for acute exacerbations of COPD is associated with high risk of readmission. However, no tool has been validated to stratify patients at discharge for risk of readmission.

Aim To evaluate the ability of the 4 m gait speed (4MGS), a surrogate marker of frailty, to predict risk of future readmission in hospitalised patients with an acute exacerbation of COPD (AECOPD).

Methods 213 patients hospitalised with an AECOPD were recruited prospectively. 4MGS was measured on day of discharge. Logistic regression models were used to assess the association between 4MGS and readmission at 90 days after discharge.

Results Baseline characteristics of the cohort: 52% men; mean age 72 years; median FEV_1 35%predicted. Mean (SD) 4MGS at hospital discharge was 0.61 (0.26) ms^{-1}. Significant increased rates of all-cause readmission at 90 days were seen across quartiles of decreasing 4MGS (Q4 fastest: 11.5%; Q3: 20.4%; Q2: 30.2%; Q1 slowest: 48.2%; $p_{trend}<0.001$). Compared with Q4, those in the slowest 4MGS quartile had unadjusted ORs (95% CIs) for 90-day readmission of 7.12 (2.61 to 19.44) for the whole cohort and 11.56 (3.08 to 43.35) in those aged 65 or over. A multivariate model incorporating 4MGS, Charlson Index, hospital admission in past year, FEV_1%predicted and number of exacerbations in past year in those aged 65 or over predicted 90-day readmission with a C-statistic of 0.86.

Conclusions The 4MGS, a surrogate marker of physical frailty, independently predicts the risk of readmission in older patients hospitalised for acute exacerbation of COPD.

Trial registration number NCT01507415.

Key messages

What is the key question?

- Does the 4 m gait speed (4MGS), a simple surrogate marker of physical performance, mobility and frailty, predict readmission following an acute exacerbation of COPD?

What is the bottom line?

- The 4MGS at hospital discharge independently predicts the risk of readmission in those hospitalised for acute exacerbation of COPD in older patients.

Why read on?

- This is the first study in COPD to provide evidence that the 4MGS is a feasible test in patients hospitalised for acute exacerbation of COPD, and may be of value in risk stratifying patients at risk of readmission. This may help clinicians individualise post-discharge care.

INTRODUCTION

Hospitalisations for acute exacerbations of COPD (AECOPD) represent a major event in the natural history of the disease, and account for up to 70% of total COPD costs.[1 2] Hospital admissions are associated with increased mortality, and high readmission rates with 22.6% readmitted within 30 days in the USA[3] and 31.4% readmitted to hospital within 90 days of discharge in the UK.[4] Efforts to reduce hospital readmissions are therefore high on both political and patient agendas.[5] Stratifying patients for risk of readmission may help clinicians individualise post-discharge care, and thus potentially reduce healthcare costs.

Although previous studies have examined potential risk factors for readmissions, some were retrospective analyses of routinely collected datasets, or focused on indices of admission severity or sociodemographic variables that are not amenable to intervention.[6] Physical performance and mobility are of particular interest as they are potentially amenable to intervention through exercise modalities such as early peri-exacerbation pulmonary rehabilitation.[7 8] The 4 m gait speed (4MGS) is a simple measure of physical performance, and a surrogate marker of physical frailty that has been shown to predict adverse outcomes such as future hospitalisations, disability, nursing home admission, falls and mortality in autonomous community-dwelling older people.[9] Due to its simplicity and need for little space, the 4MGS is feasible in most clinical settings,[10] and acceptable to even very frail patients.[11] In patients with COPD, the 4MGS has been recently shown to have excellent test–retest and inter-observer reliability, to correlate significantly with exercise capacity, health

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status and dyspnoea,[12] and to be responsive to both intervention and longitudinal change.[13] Recently, gait speed has been demonstrated to be feasible in the acute setting.[14] In unselected acutely ill older patients, Ostir *et al*[14] showed that gait speed was independently associated with length of hospital stay and odds of discharge to home.

The aim of our study was to evaluate the ability of the 4MGS measured at hospital discharge to predict the risk of readmission in patients hospitalised with an AECOPD. We hypothesised that patients with slower gait speed at hospital discharge would have an increased risk of all-cause non-elective readmission at 90 days.

METHODS

Participants were recruited prospectively from acute medical wards at Hillingdon Hospital, UK. All participants gave written consent and the study was approved by the National Research Ethics Committee (11/LO/1250). The study was registered with the UK Clinical Research Network Portfolio (ID:11212) and ClinicalTrials.gov (NCT01507415).

Inclusion criteria were a diagnosis of COPD according to GOLD guidelines;[15] hospital admission with a primary diagnosis of AECOPD as determined by the duty clinician and confirmed by the local specialist respiratory team; resident in the borough of Hillingdon; and age over 35 years. Need for hospital admission was determined by the duty emergency department clinician. Admission was defined as a medical ward stay outside of the emergency department of greater than 4 h, and expected to be greater than 24 h duration. Patients with known COPD but with chest radiograph changes of consolidation were also included if the admission necessitated a change in or addition to their usual COPD treatment.

Exclusion criteria were patients with unstable cardiac disease; inability to walk 5 m unassisted on day of hospital discharge; predominant neurological limitation to walking (eg, significant hemiplegia); severe cognitive dysfunction (score of 5 or below on 10-item abbreviated mental test score);[16] or poor English such that informed consent could not be obtained.

All patients received a minimum 7 days of oral corticosteroids (prednisolone 30 mg daily), and were treated initially with nebulised bronchodilators. Antibiotics were given for presumed infective exacerbation at the judgement of the supervising clinical team. All patients were supported by a nurse-led COPD outreach team for 2 weeks, who provided telephone support and home visits as necessary.

Measurements

All measurements were carried out within 24 h before hospital discharge. 4MGS was performed as previously described.[12] Participants were allowed to use their normal walking aids (eg, stick or frame) and oxygen if required. Socio-demographic details, smoking pack year history, number of self-reported exacerbations (necessitating change in medication) and hospitalisations (derived from medical records) in the last year and, details regarding the index admission were recorded. FEV_1 was measured[17]; if flow volume loops were non–reproducible or the patient declined spirometry during hospital admission, their last documented FEV_1 was recorded. Other measurements included respiratory disability (Medical Research Council (MRC) Dyspnoea score),[18] help with activities of daily care (Katz Index),[19] self-reported daily physical activity (modified Minnesota Leisure-time Physical Activity Questionnaire),[20] health status (St George's Respiratory Questionnaire, SGRQ),[21] comorbidities (Charlson Index)[22] and a surrogate marker of admission severity (DECAF score incorporating the five strongest predictors of in-hospital mortality (extended MRC Dyspnoea Score, Eosinopenia, Consolidation, Acidaemia, atrial Fibrillation)).[18] Indices of Multiple Deprivation 2010 were derived from home postcodes.[23]

The primary outcome was all-cause non-elective hospital readmission in the 90 days after hospital discharge. Data were obtained from patients and their families and corroborated by hospital and general practice records by a researcher blinded to the measurements made at discharge. The cause of readmission was identified for each episode on the basis of the discharge summary.

Data analysis

Descriptive statistics were used to summarise participant characteristics. We investigated associations between categorical variables using χ^2 tests or, when numbers were low, Fisher's exact test. Between-group differences were assessed using Student t tests or Mann–Whitney U tests (non-normally distributed data) for continuous variables. For comparing more than two groups, ANOVA or Kruskal Wallis was used.

Univariable logistic regression was used to assess the association between 4MGS (and other plausible physiological measures) and all-cause 90-day readmission. 4MGS was considered as quartiles and also as a continuous variable (per 0.1 m/s decline). All variables associated with readmission where $p \leq 0.15$ were considered in the multivariable model. A backwards stepwise procedure was used and variables remained in the model if $p < 0.20$. The interaction between age and 4MGS (both as continuous variables) was considered in the final model; modification was observed ($p = 0.013$) and therefore a subgroup analysis was performed in those aged 65 years or older. This cut-off was chosen as previous large epidemiological studies have validated the prognostic value of the 4MGS in this age category only.[24] To evaluate the ability of 4MGS to predict time to readmission, we used a Kaplan–Meier analysis with significance assessed with the use of the log-rank test for trend. In addition to the univariable and multivariable models, a number of other models were considered and area under the curve (AUC or C-statistic) was used to assess discrimination of models. Hosmer–Lemeshow goodness of fit tests were also conducted on all models. A p value of 0.05 was considered statistically significant. Data analyses and graphical presentations were performed using STATA V.13 (StataCorp LP, Texas, USA).

Sample size

Sample size was based on receiver operating characteristic (ROC) analysis and the area under the ROC curve with 90-day readmission status as a binary outcome predicted by a multivariable model incorporating 4MGS. Assuming a 25% readmission rate (ie, 3 non-admitted controls for every admitted case), 204 patients (51 cases and 153 controls) would be needed to show that the C-statistic is above 0.6 where the true value is 0.73.[7] Assuming a potential 10% lost to follow-up, the recruitment target was 225 patients.

RESULTS

A recruitment flowchart is shown in figure 1. Three hundred and seventy-eight patients were screened for eligibility, of whom 226 patients consented to take part in the study. Six patients were discharged before 4MGS was performed, four withdrew their consent, one died in hospital on the day of discharge, and one became acutely confused. A further patient died suddenly and unexpectedly at home 18 h after discharge. Therefore 213 patients were included in the final analysis (figure 1).

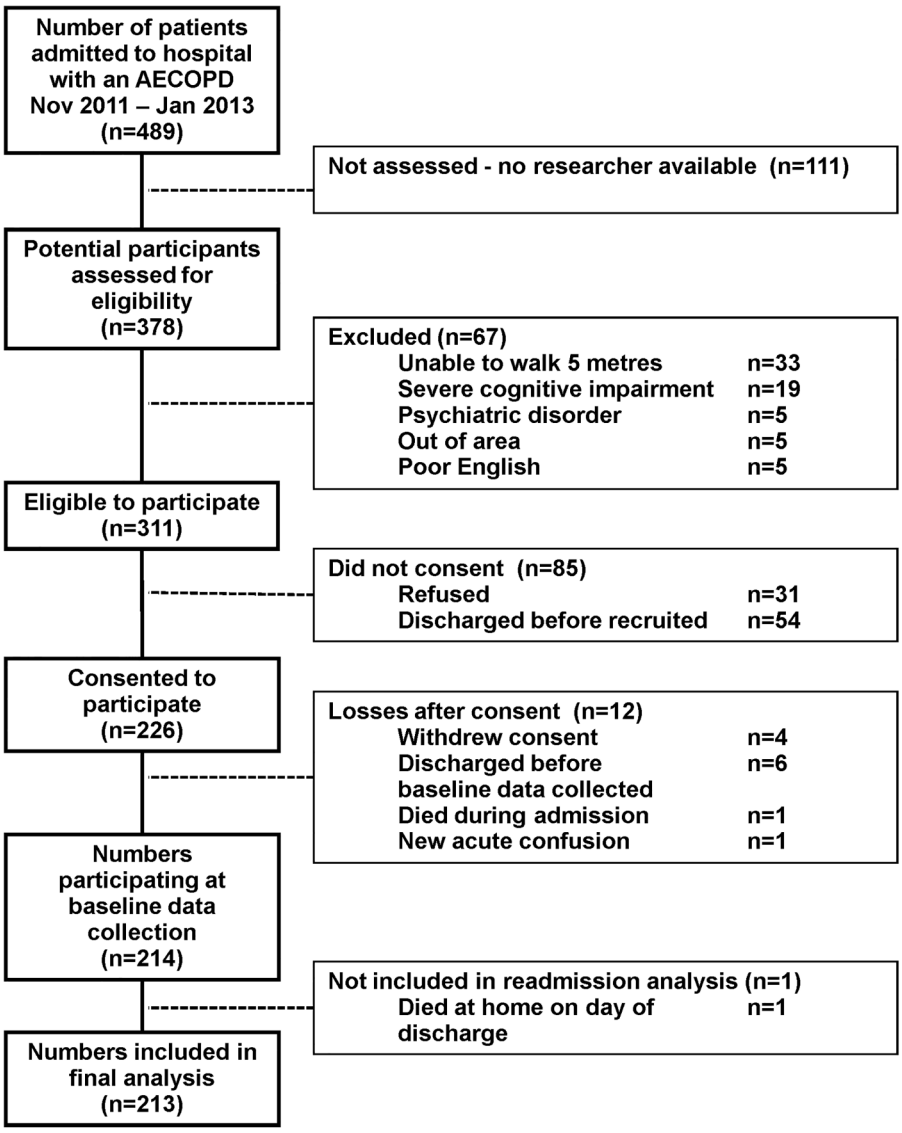

Figure 1 CONSORT diagram of patient flow through the study. AECOPD, acute exacerbation of COPD.

Baseline characteristics of patients as a whole and stratified by quartiles of 4MGS are shown in table 1 and online supplementary table E1. Mean (SD) 4MGS was 0.61 m/s (0.26). Patients with lower gait speed at discharge were significantly older, had longer lengths of stay, worse respiratory disability (MRC), higher comorbidity burden (Charlson Index), poorer health status (SGRQ), and higher DECAF scores (table 1). Only 7% of patients underwent early post-hospitalisation pulmonary rehabilitation (see online supplementary table E1), which had no significant effect upon subsequent analyses of readmission.

Readmission risk

In total, 59 patients (27.7%) were readmitted within 90 days of hospital discharge (47 for respiratory and 12 for non-respiratory causes). Baseline characteristics of those admitted and not admitted within 90 days are summarised in table 2.

For the primary outcome, the risk of 90-day all-cause readmission decreased as 4MGS increased (Q1 (slowest) 48.2%, Q2 30.2%, Q3 20.4%, Q4 (fastest) 11.5%; $p_{trend}<0.001$) (see online supplementary figure E1). In those ineligible for the study due to inability to walk 5 m unaided (n=33), 90-day readmission rate was 54.5% (n=18).

For the secondary outcome, Kaplan–Meier curves (figure 2) demonstrated reduced time to 90-day all-cause non-elective readmission with slower 4MGS quartiles (log-rank test for trend: $p<0.001$).

In total, the cohort occupied 601 emergency hospital bed days in the 90 days after hospital discharge with decreasing cumulative hospital bed days with faster gait speeds (Q1 (slowest) 316; Q2 157; Q3 106; Q4 (fastest) 22 days).

Univariable analysis for risk of 90-day readmission in the whole cohort is demonstrated in online supplementary table E2. Compared with those with the fastest 4MGS (Q4), those in the slowest 4MGS quartile (Q1) had an unadjusted OR (95% CI) of 7.12 (2.61 to 19.44). Using gait speed as a continuous measure, there were increasing odds of readmission at 90 days for each 0.1 m/s decline in gait speed (OR 1.30 (1.14 to 1.48); $p<0.001$)). Results of the multivariable analysis for the whole cohort confirmed that 4MGS was an independent risk factor for 90-day readmission. The interaction term between age and 4MGS was added to the final model and was significant ($p=0.013$) and therefore subgroup analysis was performed.

In patients aged 65 years or over, 53 (32.3%) patients were readmitted within 90 days. Univariable analysis in this subgroup demonstrated decreasing risk of 90-day readmission with faster

Table 1 Baseline characteristics of the total sample and stratified by quartiles of gait speed

Baseline characteristic	Total population All (n=213)	Quartiles of gait speed Q1 <0.40 m/s (n=54)	Q2 0.40–0.59 m/s (n=53)	Q3 0.60–0.79 m/s (n=54)	Q4 ≥0.80 m/s (n=52)	p Value
Age (years)	72.1 (10.8)	76.2 (9.8)	76.5 (9.0)	69.2 (10.1)	66.0 (10.7)	<0.001
Male, n (%)	111 (52.1)	25 (46.3)	25 (47.2)	27 (50.0)	34 (65.4)	0.170
Smoking pack year history	44 (30)	46 (32)	43 (33)	47 (26)	39 (29)	0.510
Lives alone	91 (42.7)	28 (54.9)	23 (42.6)	25 (46.3)	15 (27.8)	0.040
BMI (kg/m^2)	25.6 (22.1, 29.6)	26.1 (21.7, 31.3)	25.4 (20.7, 30.0)	25.5 (21.9, 29.9)	25.5 (23.3, 28.2)	0.771
FEV_1% pred.	35 (26, 49)	41 (30, 52)	30 (24, 43)	36 (22, 54)	35 (26, 48)	0.085
One or more admissions in last year, n (%)	79 (37.1)	18 (33.3)	20 (37.7)	18 (33.3)	23 (44.2)	0.615
Number of exacerbations in previous year	2 (1, 4)	3 (1, 4)	1.5 (0.75, 4)	2 (1, 4)	2 (1, 4)	0.544
Length of stay (days)	3 (1, 5)	4 (2, 5)	3 (2, 6)	2 (1, 4)	1 (1, 3)	<0.001
DECAF	1 (1, 2)	2 (1, 3)	2 (1, 3)	1 (1, 2)	1 (0, 2)	<0.001
Total number of comorbidities	3 (2, 5)	4 (3, 5)	3 (2, 4)	3 (2, 4)	2 (1, 3)	<0.001
Charlson Index	1 (1, 2)	2 (1, 4)	2 (1, 3)	2 (1, 3)	1 (1, 2)	0.005
MRC 1–3	65 (30.5)	8 (14.8)	13 (24.5)	16 (29.6)	28 (53.9)	<0.001
MRC 4	42 (19.7)	6 (11.1)	8 (15.1)	15 (27.8)	13 (25.0)	
MRC 5	106 (49.8)	40 (74.1)	32 (60.4)	23 (42.6)	11 (21.2)	
SGRQ total	56.7 (16.5)	65.2 (13.3)	57.5 (16.6)	56.5 (15.2)	47.4 (15.9)	<0.001
Katz Index						
1–4	18 (8.5)	11 (20.4)	4 (7.7)	3 (5.6)	0 (0.0)	0.001
5–6	194 (91.5)	43 (79.6)	48 (92.3)	51 (94.4)	52 (100.0)	
Daily energy expenditure (kcal/day)	68 (11, 141)	11 (0, 90)	51 (7, 96)	63 (22, 185)	124 (70, 268)	<0.001
4MGS, m/s	0.61 (0.26)	0.28 (0.10)	0.50 (0.05)	0.69 (0.60)	0.95 (0.15)	<0.001

Data expressed as mean (SD) or median (25th, 75th centiles).
4MGS, 4 m gait speed; BMI, body mass index; DECAF score, extended MRC Dyspnoea Score, Eosinopenia, Consolidation, Acidaemia, atrial Fibrillation; MRC, Medical Research Council Dyspnoea Score; SGRQ, St George's Respiratory Questionnaire.

gait speed (OR (95% CI): Q1 11.56 (3.08 to 43.35); Q2 4.38 (1.15 to 16.70); Q3 2.8 (0.69 to 11.41); Q4 1 (reference); p<0.001) (table 3). In the multivariable model (table 4) 4MGS remained an independent risk factor for 90-day readmission (OR 1.43 (1.13 to 1.80) per 0.1 m/s decline in 4MGS). The association between 4MGS (0.1 m/s decline) and all cause readmission was not significant in those aged below 65 (OR (95% CI) 0.90 (0.67 to 1.22), p=0.490), although numbers of readmissions were low (n=6 (12.2%)) and therefore no further analysis was performed.

Predicting readmission

ROC plots and C-statistic of various models to predict hospital readmission at 90 days, in those 65 or over, are shown in figure 3. A model incorporating 4MGS and hospital admissions in the last year had a C-statistic of 0.78 (acceptable discrimination). The full model incorporating all independent risk factors identified in the multivariable analysis had excellent discrimination with a C-statistic of 0.86. The C-statistic of the full model without gait speed was 0.82, implying that 4MGS adds value as a predictive marker.

DISCUSSION

This is the first study to prospectively test whether objectively measured physical performance at discharge predicts all-cause readmission in patients hospitalised with AECOPD. We have demonstrated that slower usual 4MGS on the day of discharge is associated with significantly increased odds of all-cause non-elective hospital readmission at 90 days, increased post-discharge hospital bed days and reduced time to readmission. Consistent with our findings, those ineligible for the study due to inability to complete the 4MGS had even higher readmission rates. Given the simplicity of the 4MGS, this is a potentially useful tool to risk stratify older patients with COPD in the acute setting, and individualise discharge planning and post-discharge care.

Due to the high readmission rates associated with hospitalisations for AECOPD,[3 4] there is considerable interest in stratifying patients at increased risk of readmission, and then intervening effectively to reduce that risk. Several lines of indirect evidence suggest that surrogate markers of poor physical functioning and frailty may increase the risk of readmission following hospitalisation for AECOPD. Previous studies have demonstrated that functional limitation (need for help with self-care prior to admission) is an independent risk factor for increased risk of hospital readmission in patients with COPD.[25 26] Similarly, Garcia-Aymerich and colleagues[20] demonstrated that self-reported higher level of usual physical activity in patients admitted for AECOPD were associated with reduced risk of readmission. In a small cohort of patients with COPD discharged from hospital (n=21), Emtner *et al*[27] demonstrated that exercise capacity as measured by the incremental shuttle walk (ISW) at 4–6 weeks after discharge was a reliable predictor of subsequent hospital readmission over 12 months.

To our knowledge, this is the first study to prospectively determine the prognostic value of physical performance objectively measured at hospital discharge in patients with COPD. Although field walking measures, such as the ISW and 6-min walk (6MW), have been well validated in patients with COPD,[28] these tests are performed at or close to peak oxygen consumption. They have to be repeated after adequate rest due to learning effect, and the 6MW requires a quiet, uninterrupted

Table 2 Baseline characteristics stratified by readmitted or not readmitted within 90 days

Data at hospital discharge	All-cause readmission at 90 days		
	Not readmitted (n=154)	Readmitted (n=59)	p Value
Age (years)	70.5 (11.1)	75.9 (9.2)	0.001
Male, n (%)	78 (50.6)	33 (55.9)	0.490
Social deprivation index	21 (10)	21 (10)	0.532
Smoking pack year history	44 (31)	44 (29)	0.877
Lives alone, n (%)	62 (40.3)	29 (49.2)	0.240
Hospital admission in previous year, n (%)	47 (30.5)	32 (54.2)	0.001
Number of exacerbations in previous year	2 (1, 4)	3 (1, 6)	0.006
Length of stay (days)	2 (1, 4)	4 (2, 7)	0.001
Requiring non-invasive ventilation, n (%)	12 (7.8)	10 (16.9)	0.049
Requiring intubation and ventilation, n (%)	1 (0.6)	1 (1.7)	0.478
DECAF	1 (1, 2)	2 (1, 3)	<0.001
Completed post-hospitalisation early pulmonary rehabilitation	8 (5.2)	7 (11.9)	0.130
MRC 1–3	52 (31.8)	13 (22.0)	0.142
MRC 4	33 (21.4)	9 (15.3)	
MRC 5	69 (44.8)	37 (62.7)	
eMRC 5a	56 (36.4)	27 (45.8)	
eMRC 5b	13 (8.4)	10 (16.9)	
BMI (kg/m^2)	25.6 (22.6, 29.9)	25.1 (20.9, 29.4)	0.277
FEV_1% pred.	38 (27, 51)	30 (23, 42)	0.290
SGRQ total	56.0 (17.0)	58.5 (15.1)	0.310
Total number of comorbidities	3 (2, 4)	4 (2, 5)	0.004
Charlson Index	1 (1, 2)	2 (1, 4)	<0.001
Cardiovascular comorbidity (ischaemic heart disease or congestive cardiac failure)	26 (16.9)	20 (33.9)	0.007
Katz Index			
1–4	9 (5.9)	9 (15.3)	0.587
5–6	144 (94.1)	50 (84.7)	
Daily energy expenditure (kcal/day)	73 (22, 185)	51 (0, 90)	0.013
4MGS, m/s	0.65 (0.25)	0.49 (0.25)	<0.001

Data expressed as mean (SD) or median (25th, 75th centiles).
4MGS, 4 m gait speed; BMI, body mass index; DECAF score, extended MRC Dyspnoea Score, Eosinopenia, Consolidation, Acidaemia, atrial Fibrillation; eMRC, extended Medical Research Council; MRC, Medical Research Council; SGRQ, St George's Respiratory Questionnaire.

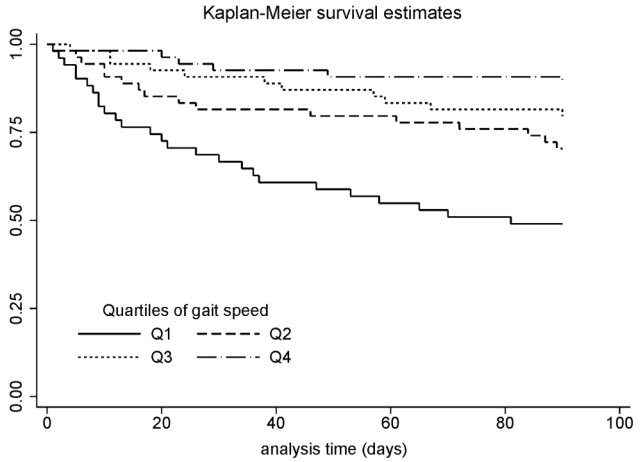

Figure 2 Kaplan–Meier curve demonstrating time to 90-day all-cause non-elective readmission according to 4MGS quartile (Q1≤0.40 m/s; Q2=0.40–0.59 m/s; Q3=0.60–0.79 m/s; Q4≥0.80 m/s). 4MGS, 4 m gait speed.

walking course of 30 m.[28] Although these tests are feasible in stable patients with COPD, even in those with respiratory failure, they may be less acceptable to unwell hospitalised patients and may not be logistically possible in some acute hospital settings. Consequently, we used the 4MGS, which is well established in gerontology as a simple surrogate marker of physical performance, mobility, sarcopenia and frailty.[29–31] In our study, more than 90% of potentially eligible patients with COPD were able to perform a 4MGS on the day of discharge. The results from our current study also corroborate recent findings in older patients admitted with a wide range of medical diagnoses to an acute care elderly unit. Ostir *et al*[14] demonstrated that a faster usual gait speed (measured over 8 ft on the day of admission) was strongly associated with shorter length of stay, whilst the inability to complete the walk, or a gait speed less than 0.40 m/s, had significantly decreased odds of discharge to home. In a large multicentre cohort of acutely ill, hospitalised male veterans, each 0.10 m/s increase in baseline gait speed (measured over 50 ft) was associated with fewer hospitalisation days and healthcare costs in the following year.[32]

In the management of people with long-term conditions such as COPD, there has been much interest in identifying those who would benefit from more targeted care approaches from those who do not, thus enabling health planners to channel both financial and clinical resources appropriately. The FEV_1 was similar across all quartiles of gait speed, suggesting that readmission was more closely related to multi-morbidity and frailty than to severity of the underlying disease. Therefore gait speed may provide a more holistic viewpoint of a patient's current status.

Existing risk stratification models for long-term conditions have a major disadvantage in that the results are not available to practitioners to use for real-time clinical decisions. The simplicity of the gait speed means it could be incorporated easily into routine clinical practice, allowing clinicians to identify a phenotype associated with increased healthcare usage. We observed a more than 14-fold increase in hospital bed days in the slowest 4MGS quartile group compared with the fastest quartile (316 vs 22 days) in the 90 days following discharge. Recognising frail patients at increased risk of adverse outcomes may aid the initiation of palliative care discussions as part of individualised post-discharge care. Tailoring post-discharge health and social support may pave the way for a paradigm shift from existing reactive care models to a more preventative/proactive care strategy.

Cummings *et al*[31] recently postulated that routine identification of 'dismobility' defined as a slow 4MGS may help improve the clinical care, research and regulatory approval of pharmacological interventions to improve mobility, including anabolic agents.[33] As well as stratifying patients for trial entry, 4MGS is a continuous measure that is a potentially useful outcome marker.[34] We recently demonstrated that 4MGS is responsive to the effects of outpatient pulmonary rehabilitation.[13] Unlike baseline lung function severity, comorbidity burden, or previous hospital admissions, physical performance is potentially amenable to treatment.[13] By demonstrating the association between

Table 3 Univariable logistic regression predicting all-cause readmission at 90 days in patients 65 years or older (n=164)

	OR (95% CI)	p Value
Gait speed (quartiles)		
1 (median 0.32 m/s)	11.56 (3.08 to 43.35)	<0.001
2 (median 0.50 m/s)	4.38 (1.15 to 16.70)	
3 (median 0.69 m/s)	2.8 (0.69 to 11.41)	
4 (median 0.91 m/s)	1	
Gait speed continuous per 0.1 m/s decline	1.37 (1.17 to 1.60)	<0.001
One or more admissions (last year)	3.37 (1.70 to 6.67)	<0.001
Exacerbations	1.32 (1.13 to 1.54)	<0.001
Charlson Index	1.50 (1.14 to 1.96)	0.003
DECAF	1.55 (1.16 to 2.08)	0.003
Katz Index	0.55 (0.36 to 0.83)	0.004
Length of stay	1.10 (1.02 to 1.19)	0.011
Daily energy expenditure	1.00 (1.00 to 1.00)	0.058
Total comorbidities	1.18 (0.99 to 1.42)	0.068
MRC		
1–3	1	0.071
4	0.98 (0.35 to 2.78)	
5	2.16 (0.97 to 4.64)	
Age	1.04 (0.99 to 1.09)	0.097
FEV_1% pred.	0.98 (0.96 to 1.00)	0.102
SGRQ total	1.02 (1.00 to 1.04)	0.110
Lives alone	1.17 (0.61 to 2.26)	0.636
BMI	0.99 (0.93 to 1.04)	0.659
Male	1.05 (0.55 to 2.02)	0.883

BMI, body mass index; DECAF score, extended MRC Dyspnoea Score, Eosinopenia, Consolidation, Acidaemia, atrial Fibrillation; MRC, Medical Research Council; SGRQ, St George's Respiratory Questionnaire.

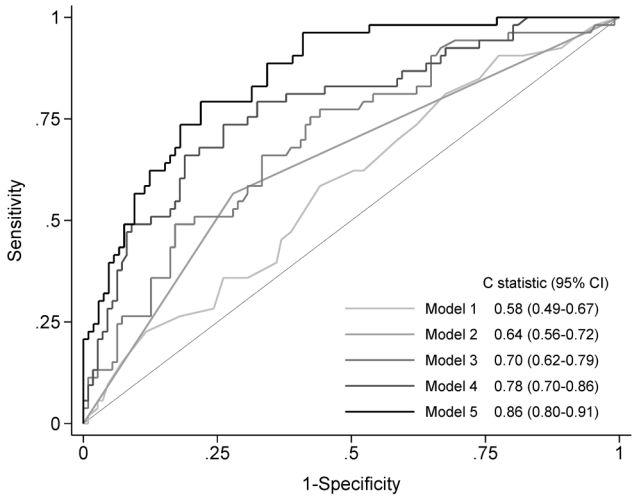

Figure 3 Receiver operating characteristic curves demonstrating the ability of univariable and multivariable models to predict 90-day readmission in patients 65 years or older. Model 1=age; Model 2=one or more admissions in last year; Model 3=4 m gait speed; Model 4=4 m gait speed+one or more admissions in last year; Model 5=multivariable model (see table 4; gait speed, Charlson Index, one or more admissions in the previous year, number of exacerbations in the previous year, length of stay, physical activity and health status).

poor physical performance, frailty and increased readmission risk, this may encourage clinicians and healthcare planners to recommend interventions that improve or maintain physical performance, such as physical activity interventions,[35] supervised exercise training in the form of pulmonary rehabilitation,[7] or comprehensive geriatric assessment.[36] It was noteworthy that only 7% of our cohort underwent peri-hospitalisation pulmonary rehabilitation, in line with recent data from a systematic audit.[37]

There were limitations associated with our study. First, this was a single-centre study and the findings need to be corroborated by further studies in COPD-specific populations in different healthcare systems. However, we believe that the recruiting hospital was typical of many other UK hospitals, and observed readmission rates were similar to those seen in national audits in the UK and the USA. Second, as 4MGS was the measure of interest, patients unable to walk 5 m independently were excluded, and hence our study focused only on ambulatory patients. However, we did observe high readmission rates in those ineligible for the study due to inability to complete a 4MGS, in line with the study of Ostir *et al*.[14] Third, our cohort had only a small number of younger patients hospitalised with COPD, and larger studies will be needed to demonstrate whether 4MGS also has prognostic value in younger patients. Finally, 4MGS was only measured in the 24 h before hospital discharge—we were unable to comment on whether regular measurement of 4MGS during a hospital admission could influence medical decision to discharge, an area amenable to further research.

In summary, the 4MGS at hospital discharge, a simple surrogate marker of physical performance, mobility and frailty, independently predicts the risk of readmission in those hospitalised for AECOPD, especially in older patients.

Table 4 Multivariable logistic regression predicting all-cause readmission at 90 days in patients 65 years or older (n=164)

Variable	OR (95% CI)	p Value
Gait speed continuous per 0.1 m/s decline	1.43 (1.13 to 1.80)	0.002
Charlson Index	1.50 (1.07 to 2.09)	0.018
One or more admissions (last year)	6.75 (2.60 to 17.51)	<0.001
Exacerbations in the last year	1.52 (1.20 to 1.92)	0.001
Length of stay	1.14 (1.01 to 1.29)	0.033
Daily energy expenditure	1.00 (0.99 to 1.00)	0.104
SGRQ total	0.98 (0.95 to 1.01)	0.198

Data expressed as OR (95% CI).
SGRQ, St George's Respiratory Questionnaire.

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