Respiratory Rehabilitation, Exercise Capacity and Quality of Life in Chronic Airways Disease in Old Age


Summary
Respiratory rehabilitation improves exercise capacity and quality of life in younger patients but is untried in the aged. We aimed to: (a) assess repeatability of the 6-minute walk test, factors affecting it and its relation to quality of life in elderly patients with chronic obstructive airways disease (COAD); (b) assess compliance of such patients with an intensive respiratory rehabilitation protocol; (c) pilot the assessment of the effect of respiratory rehabilitation on the 6-minute walk test in these patients. Seventeen subjects with stable, symptomatic COAD were recruited, 15 (six men), 70–89 (mean 76) years, completed the study. Mean (standard deviation) 1-second forced expiratory volume (FEV₁) = 49 (5)% predicted. Six-minute walk tests were repeated single-blind, 2–10 days apart. Quality of life was measured using Guyatt respiratory questionnaire. Patients underwent 12 weeks incremental respiratory rehabilitation (×4/day step-ups, unweighted arm raises, inflating balloons). Baseline 6-minute walk was repeatable and was correlated with log Guyatt dyspnoea score (r = 0.65, p = 0.006). In multiple regression neither age nor FEV₁ predicted walk distance, but the following were independent predictors of pre-programme 6-minute walk distance: body mass index, maximal expiratory mouth pressure; calorie intake. Mean (SEM) 6-minute walk distance after-rehabilitation was greater than baseline (p = 0.003). Elderly patients with COAD tolerate intensive respiratory rehabilitation and a controlled, blinded study is needed.

Introduction
Respiratory problems are the second commonest cause of severe disability among community-dwelling elderly people [1]. Respiratory rehabilitation attempts to return patients with respiratory disability to as normal life as possible with independence in life activities [2]. It comprises a multidisciplinary comprehensive programme of patient and family education, drug treatment, respiratory muscle training, aerobic exercise, oxygen therapy (for some) and support groups. Exercise training can reduce dyspnoea, and improve exercise tolerance, functional capacity and quality of life in young patients with chronic obstructive airways disease (COAD) [3–5]. Although small numbers of 'young elderly' have been included in such programmes, respiratory rehabilitation has not been studied in very elderly patients with COAD.

Tests measuring distance walked in a designated time are frequently employed in respiratory rehabilitation programmes. They provide objective measures of activity by testing familiar exercise and are more suited to frail elderly patients than bicycle ergometry or other measures requiring sophisticated (and off-putting) monitoring [6, 7]. However, reproducibility and validity of walk tests have not been examined in elderly patients.

Quality of life in COAD is measurable by disease-specific questionnaires including the Guyatt questionnaire [8], which has previously proved useful in subjects as old as 80 years [9] and comprises a battery of questions relating to four dimensions: dyspnoea, fatigue, emotional function and mastery.

The present study aimed to:
1. Assess reproducibility and validity of the 6-minute walk test, factors affecting it and its relation to quality of life in elderly patients with COAD.
2. Assess the ability of frail elderly COAD patients to comply with intensive respiratory rehabilitation.
3. Pilot the assessment of the effect of respiratory rehabilitation on 6-minute walk distance in such patients.

Methods
Patient selection: Subjects comprised men and women aged 70
or above with irreversible COAD defined as 1-second forced expiratory volume \( (FEV_1) \) less than 60% of predicted \([10]\), \( FEV_1/FVC \) (forced vital capacity) ratio less than 60%, and less than 15% increase in \( FEV_1 \) after 5 mg nebulized salbutamol. Patients were clinically stable with no change in medication in the previous month and no hospital admission in the previous 2 months. All received optimal medical therapy.

Age-matched ambulant, community-dwelling controls with normal respiratory function (as demonstrated in a recent previous study in our department \([11]\)) were also recruited for a baseline 6-minute walk distance only. The sole purpose of this was to provide comparative data on 6-minute walk distances for normal elderly persons.

Exclusions for subjects and controls comprised: respiratory exacerbation within the previous 6 weeks; acute/chronic confusion (a score of less than AMT 7/10 on the Abbreviated Mental Test \([12]\)); psychiatric disease; unstable angina; uncontrolled heart failure; major cardiac arrhythmia (except controlled atrial fibrillation); retinal detachment or previous pneumothorax (contra-indications to balloon inflation); exercise limitation by factors other than dyspnoea; previous experience with walk test or respiratory rehabilitation programmes; terminal illness.

Subjects and controls gave written informed consent. The study was approved by the local Ethical Committee.

**Study design:** Patients attended the geriatrics day hospital for 14 weeks. For the first 2 weeks, they were seen weekly for assessment including history, examination, venesection and anthropometric measurement. Body mass index (BMI) was calculated as weight/height\(^2\). Spirometry was performed using a Compact C Spirometer (Vitalograph Ltd, Buckingham, UK). Three reproducible readings (±5% \( FEV_1 \)) were taken at 1-minute intervals and the best recorded. Maximal and mean inspiratory and expiratory mouth pressures (which reflect overall respiratory muscle strength) were measured using an MPM mouth pressure meter (Precision Medical Ltd, Pickering, North Yorkshire, UK \([13]\)). Three reproducible readings (±5% maximal values) were taken at 1-minute intervals and the best recorded. Spirometry and mouth pressures were performed after 1 hour’s rest, no earlier than 10 h 00, and at least 2 hours after food and 30 minutes after nebulized salbutamol (5 mg) and ipratropium (500 \( \mu \)g). Considerable effort was taken to obtain maximum values for both spirometric and mouth pressure indices.

Six-minute walk tests were conducted over 29 metres on a level, enclosed, warm (22–24\(^\circ\)C) corridor with vinyl flooring, 30 minutes (seated at rest) after respiratory function tests. Patients and controls were transported to the start of the course by wheelchair. They were asked to walk as far as possible within 6 minutes up and down the course. They were told they could vary their speed and/or rest when necessary but should aim to cover as much distance as possible within 6 minutes. Any mobility aid usually employed was used. The second walk test was repeated at 2–10 days, under identical conditions. Investigators acted as time-keepers, following (not leading) the patient, and not providing encouragement. Repeat walk tests were monitored by different ‘blinded’ investigators in randomized order. Controls attended only once for a single walk test and did not undergo any form of exercise training or reassessment.

Patients completed the Guyatt Questionnaire with the help of a nurse unaware of the results of other assessments. A dietitian, also unaware of other findings performed a 7-day dietary assessment, from which mean daily energy and protein intakes were calculated.

Patients were then enrolled into 12 weeks of incremental home exercise training. They had an initial supervised physiotherapy session to teach them how to perform the exercises safely and to assess their capabilities. A patient-specific programme was then planned. Patients were told that exercise should be of sufficient intensity to produce moderate dyspnoea. They were advised to exercise four times daily, half-an-hour after inhaled/nebulized bronchodilators and at least 2 hours after food. All received written instructions and a simple exercise diary card. Patients were seen individually twice weekly in the day hospital to ensure compliance, supervise exercise increment and provide encouragement. At each of these sessions, which lasted 20–30 minutes per patient, patients were observed performing their exercises. Exercise increments were patient-specific and decided upon after observation and discussion with the patient. Increments were generally made at weekly intervals (range 3–14 days).

The training programme comprised:

1. Unsupported, unweighted arm exercise: repetitive bilateral shoulder flexion from neutral, synchronized with breathing, followed by repetitive, bilateral shoulder abduction from neutral, synchronized with breathing. This may improve exercise capacity by training accessory muscles of respiration \([14]\), and by improving cardiovascular fitness.

2. Aerobic leg exercise: stair-climbing using the bottom step of their home staircase. If the patient’s home had no stairs or he/she was assessed as unsafe performing this exercise, unweighted straight-leg-raising (lying) and knee extension (sitting) were substituted.

3. Inflating party balloons to the size of melons. This improves expiratory muscle strength in young patients \([15]\).

Walk tests and all other assessments were repeated blindly after 12 weeks training.

**Statistical analysis:** Coefficient of repeatability was used to assess reproducibility of the 6-minute walk test \([16]\). Relationship between pre-programme 6-minute walking distance and Guyatt questionnaire measures were assessed by linear regression. Relationship between walk test, lung function indices, dietary intakes, BMI and mouth pressures was assessed by multiple regression. Significance was defined at the 5% level.

**Results**

Seventeen subjects were recruited. Fifteen (six men) completed the study. One withdrew at 4 weeks because of difficulty committing herself to attendance and another was excluded after initial assessment showed that her exercise tolerance was not significantly impaired. Twelve of the 16 recruited subjects were essentially housebound because of respiratory problems. The mean age of those 15 subjects completing the programme was 76 (range 70–89) years and mean \( FEV_1 \), 49% [standard deviation (SD) = 5%] of predicted. In addition to COAD, subjects suffered the following: ischaemic heart disease 3; controlled left ventricular failure 2; peripheral vascular disease 2; osteoarthritis of knees 1; Parkinson’s disease 1; symptomatic spinal osteoporosis 1. One of those completing the programme did not (in error) have a second (pre-programme) walk distance measured. Thus reproducability data of pre-programme walk distance are only available for 15 of the 16 patients entered
initially into the programme. Controls comprised 25 persons (12 men) with a mean age of 77.6 years (range 71–91) years.

Mean calorie intake was 1518 kcal/day (range 1051–1959 kcal/day), and mean BMI was 23.1 kg/m² (range 18.0–31.9 kg/m²).

Mean [standard error of mean (SEM)] 6-minute walking distances for subjects (n = 15) on days 1 and 2 were 196 (25.3) and 195 (24.7) m respectively. Figure 1 shows the difference of the 6-minute walk distances on days 1 and 2 plotted against their mean. The difference (0.65 m) did not differ significantly from zero (t = 0.081; p = 0.94). The mean of the ratios of 6-minute walk distances on the two days was 1.01 (with 95% confidence limits for this mean 0.93 to 1.09). Coefficient of repeatability for the 6-minute walk distance was 63.0 m.

The 95% confidence limits for repeat 6-minute walking distance in the subject group were -62.35 m to 63.65 m (Figure 1). Mean (SEM) 6-minute walk distance for controls was 409 (13.9) m.

Guyatt dyspnoea scores were not normally distributed and were log transformed to achieve normal distribution. A further subject was unable to complete reliable Guyatt questionnaires and data for this subject were excluded from the analysis, again leaving evaluable data for 15 subjects. Six-minute walk distance was significantly correlated with pre-programme log Guyatt dyspnoea score (r = 0.65, p = 0.006; Figure 2). Multiple regression showed neither age nor FEV₁ (percentage of predicted levels or absolute value) predicted pre-programme 6-minute walking distance, but that pre-programme 6-minute walk distance was independently predicted by maximal expiratory mouth pressure (t = 2.54, p = 0.039), calorie intake (t = 2.52, p = 0.040) and (negatively) BMI (t = -3.1, p = 0.018). Overall R² was 0.70. BMI alone accounted for 32.5% of the variance in pre-programme 6-minute walk distance. In multiple regression height was not an independent predictor of walk distance, did not affect predictive value of BMI and did not alter overall R². Separate multiple regression analysis revealed that calorie intake, protein intake, age, and lung function indices did not predict BMI.

Mean pre-programme 6-minute walk distance (day 1) in those 15 subjects completing the programme was 203 (SEM = 26.0) metres. Mean 6-minute walking distance after exercise training was 260 (SEM = 28.3) m, which was significantly higher than on day 1 (t = 3.9, p = 0.003).

**Discussion**

This study, the first to examine respiratory rehabilitation in very elderly patients with COAD, has demonstrated repeatability and validity of the 6-minute walk test in such patients and confirmed that elderly, frail COAD patients tolerate intensive, incremental exercise programmes aimed at improving exercise capacity. This latter aspect of the study was unblinded, and not controlled, and therefore does not prove the value of exercise programmes in increasing exercise capacity in such patients. However, results were encouraging with a 30% increase in the 6-minute walk test.

Respiratory problems are rated by elderly persons themselves as the second commonest cause of severe disability, and are the third commonest cause of overall disability in the community [1]. Much of this disability results from inadequately treated airways obstruction that would respond in some degree to drug therapy. However, there remain many patients whose disability cannot be fully alleviated by drugs. Comprehensive respiratory rehabilitation programmes, as applied to younger patients, comprise full medical assessment, optimal pharmacological treatment, nutritional assessment, advice and supplementation, and patient education, and do not simply concentrate on exercise training [2].

Elderly patients (more particularly the younger elderly) are often included in these programmes but have never been studied as a separate group. There is little or no information on selection of elderly patients, ability of the ‘average’ elderly patient to undergo intensive training programmes, or the validity of measures of exercise performance in this age group.

Previous studies of reproducibility and validity of walk tests have concentrated exclusively on younger patients [6, 7]. Indeed, reproducibility of 2- and 6-minute walk tests was examined in patients whose mean age was 51 years [7], whilst the age range of those in whom reproducibility of the 12-minute walking test
was assessed was unreported [6]. More recently Knox et al. examined reproducibility in slightly older patients, whose mean age however was still less than 65 years [17].

The present study was not restrictive in its selection criteria. Patients with multiple diseases were included, provided they considered the chief limitation to exercise to be their respiratory condition. They were significantly disabled by their respiratory problems, most being housebound, and their baseline 6-minute walk distance was less than half that of age-matched controls.

Aside from respiratory status, many variables affect walking speed and distance for elderly patients. All our patients walked on a vinyl floor [18]. In contrast to the findings of others [19], walk distance was unrelated to age. This suggests that pathology rather than ageing is more important. The fact that walk distance was unrelated to degree of airways obstruction (FEV₁) has been previously reported in younger patients [6, 20]. In contrast, the relationship between walk distance and dyspnoea score in the present study is further evidence for the validity of measurement of walk distance in elderly people. The independent relationship between walk distance and maximal expiratory mouth pressure (reflecting global respiratory muscle strength) suggests the importance of secondary pathology in severe COAD. Conversely respiratory muscle strength may be merely (or largely) a reflection of overall muscle strength, and predictive of baseline walking distance for this reason. We specifically chose not to investigate whether expiratory muscle training improved mouth pressures as we felt that assessing the effect of an uncontrolled, unblinded treatment on a variety of potentially interacting variables would be of questionable utility.

The relationship between nutritional factors and respiratory disability in COAD is complex especially in elderly subjects. The present study has shown that BMI (across a range from low/normal to moderately overweight) is the single most important predictor of walk distance (heavier patients walk less far). That this is not related to height (taller patients with longer legs walking faster) is shown by the fact that height was not an independent predictor in the analysis. However calorie intake was a further independent predictor of walk distance (those with higher intake walked further). This is perhaps not surprising as calorie intake ranged from 'very low' to 'low—normal' and it is conceivable that low intake may be a surrogate for greater disability (and consequent inability to shop and/or prepare food). BMI in COAD however is not simply a result of intake, as confirmed in this study, but relates to excess energy expenditure of laboured breathing.

The present study employed a ‘battery’ of techniques, including aerobic (conditioning) training (step exercises and possibly arm exercises), respiratory muscle training (balloon inflation), and upper-limb/accessory muscle training. All aspects of the battery have been successfully employed in younger patients [4, 13, 14, 21]. The study has shown that elderly, frail patients can complete an intensive training programme. Indeed only one of 16 suitable patients defaulted, a withdrawal rate less than expected from studies of younger patients [9]. This may in part reflect the intensive, personalized, one-to-one nature of the programme.

The study has not shown conclusively that exercise training programmes improve walking distance in elderly patients with COAD. A learning effect of repeated walk tests has been described [17], although this is small when tests are repeated at infrequent intervals (as in our study), and we observed no training effect in our pre-programme repeatability testing. The study, however, was not placebo controlled, and although it seems unlikely that a 30% improvement in walk distance was a placebo effect, a randomized placebo-controlled trial is needed. The present study has been valuable in confirming validity of walk tests in elderly subjects, together with the ability of elderly patients to comply with exercise regimes, and provides further stimulus to undertake a randomized controlled study.

References


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