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Early mobilization with walking aids following hospital admission with acute exacerbation of chronic obstructive pulmonary disease

Abebaw M Yohannes Manchester School of Physiotherapy and **Martin J Connolly** Department of Geriatric Medicine, Manchester Royal Infirmary, University of Manchester, UK

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Objective: We hypothesized that early ambulation with a gutter frame (GF) in elderly patients hospitalized for acute exacerbation of chronic obstructive pulmonary disease (AECOPD) may reduce physical disability and allow earlier discharge.
Design: Blinded, randomized parallel groups trial.
Subjects: One hundred and ten consecutive AECOPD inpatients.
Interventions: Participants were recruited two days post admission and randomly allocated to four groups: GF with supplemental oxygen (GFSO), GF with supplemental air (GFSA), rollator with supplemental air (RSA) and rollator with supplemental oxygen (RSO) (air/oxygen was double-blinded to patients and investigators). Patients exercised three times daily (maximum of 15 minutes per session) with a physiotherapist or nurse.
Outcome measures: Physical disability measured by Barthel Index and perceived respiratory effort by Borg Scale.
Results: After intervention no significant difference was observed between the four groups in length of hospital stay ($F = 0.78$; $p = 0.50$), changes in mean Barthel score ($F = 2.08$; $p = 0.11$) and Borg score ($F = 0.35$; $p = 0.79$). However, improvement in Barthel score (mean 1.22 combined gutter frame group air/oxygen) was greater than the combined rollator group (mean 0.55; $p = 0.003$). Baseline Barthel score and nurses' assessment of compliance were associated with improvement in Barthel score ($p < 0.0001$ and $p < 0.002$). Barthel score was predicted by use of gutter frame ($F = 6.17$; $p = 0.01$), not by use of rollator. Use of air/oxygen group was not related to improvement in Barthel score.
Conclusion: Short-term exercise therapy with gutter frame after AECOPD admission reduces physical disability in older patients but does not affect length of hospital stay. Use of supplemental oxygen during exercise has no additional benefits.

Address for correspondence: Abebaw Mengistu Yohannes, Manchester School of Physiotherapy, Manchester Royal Infirmary, Oxford Road, Manchester M13 9WL, UK. e-mail: Abebaw.Yohannes@cmmc.nhs.uk

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Introduction

Short-term exercise training in younger patients admitted with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) improves exercise capacity.[1] However, the benefits in elderly AECOPD patients is not known. To date only two studies[2,3] have investigated the benefits of supplemental oxygen in conjunction with exercise training in pulmonary rehabilitation (PR) programmes. Their findings were inconclusive. Garrod *et al.*[2] observed in younger COPD patients in exercise training that supplemental oxygen showed a modest benefit in improving dyspnoea, but little added value in enhancing exercise capacity, quality of life or reducing depression. In addition, Rooyackers *et al.*[3] showed that supplementation of oxygen during exercise training had no extra benefit compared with room air in improving quality of life and arterial oxygenation.

Recently, we have demonstrated,[4] in a single blinded study, that a high-wheeled walking frame (gutter frame), which allows patients to brace their arms and therefore use their accessory muscles for respiration when walking, results in improvement in exercise capacity and reduction in oxygen desaturation on exercise. Although the gutter frame is rather bulky, unwieldy and probably unacceptable for long-term use,[5] the present study hypothesized that early ambulation with a gutter frame in elderly patients hospitalized for AECOPD may produce improvements in exercise capacity and thus earlier discharge compared with the use of a rollator. We also wished to investigate the possible additional benefit of supplemental oxygen in such circumstances.

Methods

Subjects

Consecutively admitted patients aged 60 years and above were recruited from inpatients admitted with AECOPD, as diagnosed by their admitting medical consultant in a University Teaching Hospital. Chronic obstructive pulmonary disease was defined by a best one-second forced expiratory volume (FEV_1) <70% predicted together with a <20% improvement in FEV_1 following standard doses of beta agonist by inhalation or nebulization. Three reproducible readings (± 5% FEV_1) were taken at one-minute intervals and the best result recorded.

The following patients were excluded: refusal of informed consent; terminal illness; current participation in any other research project; uncontrolled heart failure, major cardiac arrhythmia (except controlled atrial fibrillation); history of nondepressive psychotic illness; history of poor compliance with medical therapy; acute/chronic confusion (Hodkinson Abbreviated Mental Test score <7/10)[6]; carbon dioxide retention judged by the patient's supervising consultant to be severe enough to prevent oxygen supplementation; limitation of exercise capacity by nonrespiratory disability (e.g., musculoskeletal problems); inability to use co-ordinate frame; intolerance of oxygen mask or nasal cannulae.

All subjects gave written informed consent. The study was approved by the local medical ethics committee.

Study design

Eligible patients were identified by contacting admitting medical teams each morning, and were approached no sooner than two days after admission and only when the acute phase of their illness had passed (i.e., 24 hours without pyrexia, no longer needing supplemental oxygen (in the opinion of admitting medical team), not breathless at rest). Following verbal and written explanation and the obtaining of witnessed, written informed consent, patients were randomized (by tossing a coin) twice. The research physiotherapist and nurse were blinded to group allocation for oxygen or air but administered the Barthel Index and Borg Scale independently. A coin was tossed first for supplemental air/oxygen (heads oxygen and tails air) and the second time for the rollator or gutter frame (heads gutter frame and tails rollator). Nursing staff were blinded for both to group allocation and assessment of patients pre and post programme. Patients were then assigned to one of four groups: group A – gutter frame with supplemental oxygen (GFSO); group B – gutter frame with supplemental air (GFSA); group C – rollator with supplemental oxygen (RSO); group D – rollator with supplemental air (RSA). Use of supplemental oxygen or com-

pressed air was fully blinded during the study by use of cylinders covered with colour-coded plastic sheeting (by the central cylinder supplies department) marked 'Research – not for clinical use'. (Envelopes containing a key to the code (oxygen versus compressed air) used were kept in a file on the ward nursing station.)

Protocol

Mobilization exercise was supervised by a research physiotherapist or nurse using a gutter frame with supplemental oxygen or air and rollator with supplemental oxygen or air. Oxygen or air was delivered by 24% Venturi facemask or, if the patient found this uncomfortable, by nasal cannulae at 2 litres per minute. Patients were permitted to use oxygen or air supplement by the method already clinically in use for that patient (Venturi mask or nasal cannulae) which had been clinically validated in terms of improvement in oxygenation (saturation measurements or blood gases). Oxygen or air was supplied from wheeled cylinder not attached to the frame with assistance of a research physiotherapist or nurse. No subject had previously used a gutter frame or rollator. The research physiotherapist or the nurse demonstrated how to use the walking aids (gutter or rollator) prior to the session. This was to ensure that the patient was aware how to use the walking aid, and to ensure safety.

All patients received three sessions per day of mobilization 'training' on the ward within the limits of their tolerance with a maximum duration of 15 minutes per session. The amount of time covered at the end of the walk was noted. In addition, if patients were deemed capable by the nursing staff of doing so, and within their tolerance they walked to and from the toilet when required using the frame and cylinder as above. The protocol continued up to and including the day of discharge from hospital. All other standard clinical treatment remained unaffected. Sociodemographic characteristics were obtained by structured verbal questioning.

Outcome measures

Physical disability was assessed by the Barthel Index[7] and self-completed by the patients pre and post-programme. The scoring range for the Barthel Index is from 0 to 20 with a score of 20 indicating no physical disability. Patient's perceived exertion (respiratory effort) was assessed by the Borg Scale.[8] Patients completed the Borg Scale presented to them on an A4 size sheet for perceived breathlessness before and after the exercise programme with a minimum score of 6 (rate of perceived exertion (RPE) very light) and a maximum score of 19 (RPE very very hard). In addition, they also completed the Borg Scale immediately prior to and immediately after on the second walk of the each day. Most of the subjects completed the Barthel Index or the Borg Scale independently of the investigators. Those who had difficulties reading or writing were assisted by the research physiotherapist or nurse who read out the questions and recorded their responses, but gave no advice either directly or indirectly that might influence the subjects' response to the questions.

Compliance of patients with the ward nurse's assessment and treatment regime was ascertained by asking the nurse responsible for the care of the patient (excellent/good/fair/poor). Re-admission to hospital after discharge within one month was monitored by contacting the patient's GP.

Statistical analysis

The data were analysed with SPSS version 10.1 for Windows. The results were generally expressed as means ± SD. Differences between the four intervention groups and between the gutter frame group as a whole (with or without supplemental oxygen) and the rollator frame group as a whole (with or without supplemental oxygen) were compared using a 2×2 factorial analysis of ANCOVA, which controls for difference baseline levels. The significance level used was $p < 0.05$.

Results

We approached 135 subjects. 15 subjects declined to participate in the programme. Two patients withdrew from the programme because of intolerable dyspnoea. Two patients died with worsening respiratory problems. Six patients discontinued the programme: one had thoracotomy, four patients had methicillin-resistant *Staphylococcus aureus* skin contamination and

one patient had open TB. This is summarized in Figure 1. Thus the following data represent analysis of the 110 subjects who completed the programme.

Nursing staff graded compliance as excellent in 60 (55%); good in 33 (30%); fair in 8 (7%) and poor in 9 (8%).

Table 1 shows the demographic characteristics. The majority of the patients had severe respiratory impairment. No difference was observed in baseline FEV_1 (SD) between the four groups: GFSO = 0.72 (0.3); GFSA = 0.81 (0.3); RSA = 0.74 (0.3); RSO = 0.84 (0.3) litres.

Table 2 shows pre- and post-programme Barthel and Borg Scales. No statistically significant change in improvement was observed between groups in both Barthel and Borg Scale in the four groups. However, when data from the gutter frame group (with or without supplemental oxygen; $n = 54$) were compared with data from the combined rollator frame group (with or without supplemental oxygen; $n = 56$), it was found that the gutter frame group had a larger increase in Barthel score (gutter frame group mean increase 1.22 ± 1.77; rollator frame group mean increase 0.55 ± 0.91; $p = 0.003$). Change in Barthel scores was negatively correlated with change in Borg Scale ($r = -0.27$; $p < 0.005$).

Table 3 reveals that there was no significant difference between the four groups in length of hospital stay, time to start of the programme post hospitalization, time (days) of the exercise pro-

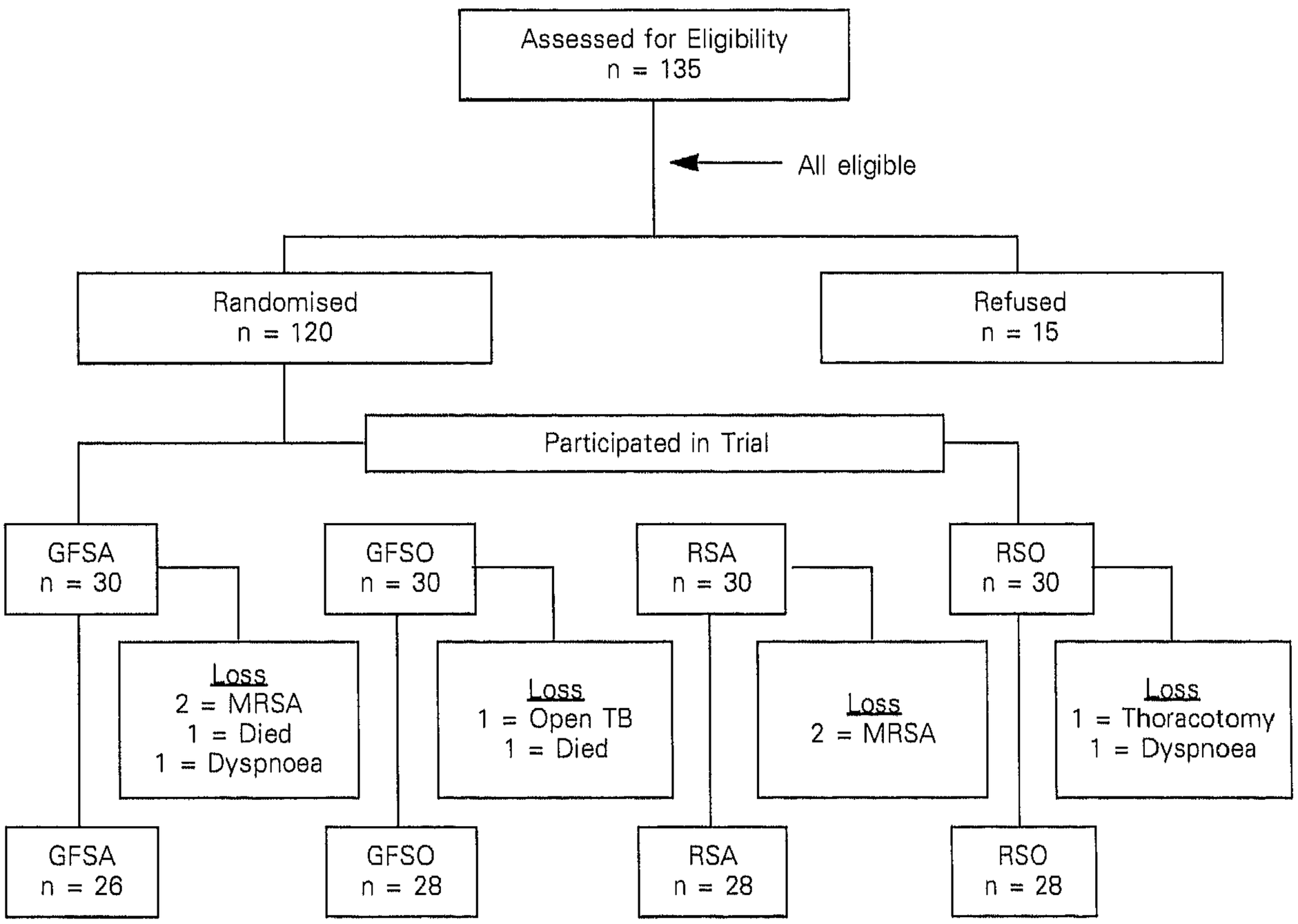

Figure 1 Flowchart showing the various stages of the trial, including the flow of participants and withdrawals. GFSA, gutter frame with supplemental air; GFSO, gutter frame with supplemental oxygen; RSA, rollator with supplemental air; RSO, rollator with supplemental oxygen; MRSA, multiple resistant *Staphylococcus aureus.*

gramme or duration of exercise in minutes or the time taken to make a discharge decision ($F = 0.61$; df = 3, $p = 0.57$). There was no statistically significant difference in the length of stay between the two groups of combined gutter frame versus rollator ($t = 0.475$, $p = 0.49$) and air versus oxygen ($t = 0.01$; $p = 0.90$). For the whole group mean total length of stay was 9.96 days.

Within one month after discharge, in total (20 (18%), 10 male) elderly COPD patients were re-admitted because of acute exacerbation. GFSO group = 6 (30%) patients; GFSA group = 4 (20%) patients; RSO group = 6 (30%) patients and RSA group = 4 (20%) patients.

In the univariate analysis of the four study groups (total of 110) between subjects a change

Table 1 Sociodemographic characteristics, spirometry and arterial blood gases of four groups of COPD 110 subjects

Variable	GFSO Mean (SD)	GFSA Mean (SD)	RSO Mean (SD)	RSA Mean (SD)
Age	75 (7)	75 (7)	74 (8)	74 (7)
Gender M/F	13/15	15/11	12/16	19/9
BMI	23 (5)	24 (6)	24 (6)	23 (4)
FEV_1 (litres)	0.72 (0.2)	0.81 (0.4)	0.84 (0.3)	0.74 (0.2)
% FEV_1	38 (11)	38 (15)	35 (11)	39 (10)
PaO_2 (mmHg)	80 (23)	72 (18)	76 (18)	77 (22)
$PaCO_2$ (mmHg)	41 (9)	41 (8)	38 (9)	43 (10)
pH value	7.4 (0.06)	7.4 (0.07)	7.4 (0.07)	7.4 (0.06)
HCO_3 (mmol/l)	27 (5)	26 (5)	24 (4)	27 (6)

GFSO, gutter frame with supplemented oxygen; GFSA, gutter frame with supplemental air; RSO, rollator with supplemental oxygen; RSA, rollator with supplemental air; BMI, body mass index; FEV_1, forced expiratory volume in one second; % FEV_1, percentage of forced expiratory volume in one second; PaO_2, arterial oxygen tension; $PaCO_2$, arterial carbon dioxide tension; HCO_3, arterial bicarbonate.

Table 2 Mean pre- and post-exercise Barthel ADL index score and perceived effort Borg score

Group = number	Pre Barthel score	Post Barthel score	Pre Borg score	Post Borg score
GFSO = 28	16.2 (2.4)	17.4 (2.2)	14.2 (3.3)	13.4 (3.5)
GFSA = 26	16.3 (2.4)	17.9 (2.2)	14.1 (2.7)	12.6 (3.2)
RSO = 28	18.4 (1.3)	19 (1.2)	13.7 (2.5)	12.1 (2.6)
RSA = 28	17.9 (1.8)	18.5 (1.5)	12.2 (2.8)	13.0 (3.1)
ANOVA		$F = 3.88$; df = 3 $p = 0.01$		$F = 0.90$; df = 3 $p = 0.44$

GFSO, gutter frame with supplemental oxygen; GFSA, gutter frame with supplemental air; RSO, rollator with supplemental oxygen; RSA, rollator with supplemental air.

Table 3 Mean duration (SD) of exercise, length of stay and start days of exercise

Group	Duration of exercise (min)	Length of stay	Start time of exercise (days)
GFSO	44 (32.5)	11.7 (12.1)	3.21 (2.4)
GFSA	54 (95.6)	10.04 (11.4)	3.51 (3.5)
RSO	48 (37.6)	9.96 (12.5)	3.64 (4.3)
RSA	48 (47.4)	8.89 (12.5)	3.81 (3.0)
ANOVA	$F = 0.14$; df = 3 $p = 0.93$	$F = 0.78$; $df = 3$ $p = 0.50$	F = 0.15; df = 3 $p = 0.93$

GFSO, gutter frame with supplemental oxygen; GFSA, gutter frame with supplemental air; RSO, rollator with supplemental oxygen; RSA, rollator with supplemental air.

in Barthel score (as dependent variable) was associated with baseline Barthel score ($F = 117.7$; df = 3, $p < 0.0001$) and nurses' assessment of compliance ($F = 5.4$; df = 3, $p < 0.002$). Similarly, improvement in prior to discharge post-exercise Borg Scale as (dependent variable) was related to baseline Borg Scale post exercise ($F = 46.7$; df = 3, $p < 0.003$) and compliance of nursing assessment ($F = 4.9$; $p < 0.003$). Age, sex, use of gutter frame or rollator, use of air or oxygen, smoking status, oxygen saturation on air, pH and pCO_2 were not associated with improvement. Further univariate analysis was performed to look at the combined gutter frame group versus the combined rollator group and air versus oxygen. Change in Barthel score was predicted by use of gutter frame ($F = 6.17$; df = 1, $p = 0.01$), but not by use of rollator frame. Use of air or oxygen was not related to improvement in Barthel score.

Difficulties encountered during the study

The majority of the patients were compliant with the exercise programme and nursing treatment regime. However, some patients ($n = 8$ in total) were reluctant to use the gutter frame with supplemental oxygen or air or to comply with the exercise programme. Six patients missed a few sessions of the exercise programme as they were attending other medical investigations.

Discussion

To our knowledge this is the first study to investigate early mobilization with walking aids (gutter frame/rollator) with supplemental oxygen or air in elderly patients admitted with AECOPD. Our findings suggest that short-term exercise therapy with the gutter frame or rollator reduces physical disability but not length of stay in older patients with COPD but that the addition of supplemental oxygen has no further benefit in these circumstances.

Clinical messages

- Short-term exercise therapy in older patients after acute exacerbation of chronic obstructive pulmonary disease reduces physical disability but not length of hospital stay.
- Use of supplemental oxygen has no additional benefit in such circumstances.

There are several possible explanations for the lack of any effect on length of stay. First, discharge is a complex process dependent not only upon medical recovery but also on the skill and experience of the multidisciplinary team and availability of community resources. Lack of immediate community support may have resulted in delay in discharge of a minority of our patients, although 88 (80%) were discharged on the same day a discharge decision was made. Furthermore, our further analysis revealed no intergroup differences in hospitalization time before a medical discharge decision was arrived at.

Secondly, physicians do not regularly use either the Barthel physical disability measure or the Borg Scale to assist them when they make a decision to discharge a COPD patient. The Barthel Index has been use in inpatient rehabilitation programmes for stroke patients.[7,9] However, it suffers from the ceiling and floor effects that may lead to an underestimation of patients' problems[9,10] and also has poor discriminating ability when used to compare elderly COPD outpatients with healthy controls.[11] Its use in this study was dictated by the lack of suitability of extended (community-based) ADL scales for use in an inpatient population at the time the study was conducted.

The Borg Scale is an appropriate scale to measure patient-perceived exertion effort pre and post exercise, for example, 6-minute walk test in patients with COPD.[8] Furthermore, dyspnoea correlates with oxygen desaturation, physical activities and quality of life.[12] Our findings add further evidence to this in that change in physical disability score was negatively correlated with change in dyspnoea score. Further study is required to ascertain the use of the Borg Scale in acute exacerbation of COPD, especially in old age.

Previous studies[2,3] have found little added value of supplemental oxygen in hypoxaemic COPD patients in pulmonary rehabilitation programmes. The COPD populations studied in both previous studies were very small and type 2 error

may have compromised their findings. In the present study it is possible the duration of exercise training was too short and may have thus had limited ability to produce major benefit (Table 3). Further studies are required to ascertain the benefits of gutter frames and supplemental oxygen in AECOPD patients, especially in relation to intensity and frequency of the treatment.

Our analysis is complicated by the difference in baseline Barthel scores between groups. However, 2 × 2 factorial ANCOVA analysis controls for such differences.

Further caution has to be exercised in the interpretation of our findings. Although the improvement in Barthel score seen in the gutter frame group was statistically greater than that seen in the rollator group, the absolute improvement was small and in the group as whole it was probably not clinically significant. However, such an improvement may be of value in some individual subjects.

Conclusion

In this study short-term exercise therapy in AECOPD reduces physical disability but does not affect length of stay in older patients with COPD. In addition, use of supplemental oxygen produced no additional benefit in this situation. Further studies are required to confirm or refute the benefits of walking aids with supplement of oxygen/air in this setting. Increasing the duration and/or frequency exercise in this situation may be beneficial and merits further study. Patient-perceived respiratory effort measured by RPE may not be an important criterion used clinically to assess whether a patient with AECOPD is ready for discharge.

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