

Pulmonary rehabilitation improves functional capacity in patients 80 years of age or older

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OBJECTIVES: There is limited evidence that pulmonary rehabilitation improves exercise capacity in older patients with chronic respiratory disease. The objective of the present study was to determine whether patients 80 years of age or older gain similar benefits from pulmonary rehabilitation as do younger patients.

DESIGN: Outcomes were compared in 230 consecutive inpatients with moderate to severe lung disease who participated in a comprehensive pulmonary rehabilitation program during a one-year period. Outcomes included 6 min walk test distance (6MWT), the number of stairs completed in 2 min (2MST), Borg dyspnea scores after exertion and objective functional scores.

RESULTS: There were no differences between older (80 to 91 years, n=43) and younger patients (n=187) with respect to sex, forced expiratory volume in 1 s (mean 0.77 L versus 0.72 L) or number of chronic medical diagnoses (2.4 versus 2.7). Older patients were less frequently survivors of mechanical ventilation (2.3% versus 16%). Baseline 6MWT (133 m versus 144 m; P=0.48) and 2MST (5.2 laps versus 6.5 laps; P=0.067) were similar but global function was lower (85 versus 89; P=0.040) in older patients than in younger patients, respectively. After pulmonary rehabilitation, all outcomes improved significantly regardless of age (all before-after comparisons P<0.0001). Younger patients improved with a higher discharge 6MWT (231 m versus 185 m; P=0.004) and similar discharge 2MST (9.3 laps versus 7.9 laps; P=0.070) compared with older patients. Global function at discharge remained lower in older patients than younger patients (91 versus 94; P=0.002). The duration of rehabilitation and length of stay were similar between the two groups.

CONCLUSION: A comprehensive inpatient pulmonary rehabilitation program is beneficial in selected patients 80 years of age or older.

Key Words: Aged; Age factors; Elderly; Lung diseases; Physical therapy; Rehabilitation

Chronic respiratory disease is common and its prevalence is increasing as the life expectancy of the Canadian population is extended by improved medical care. Most of these patients have chronic obstructive pulmonary disease (COPD), which results in functional impairment related to dyspnea and associated muscle deconditioning (1,2). The use of medical resources by patients with COPD is immense (3,4) and will increase due to a doubling in the expected prevalence of chronic lung disease by 2015 (5).

Because many patients remain significantly impaired despite optimal medical management of their chronic respiratory disease,

La réadaptation pulmonaire améliore la capacité fonctionnelle chez les patients de 80 ans ou plus

OBJECTIFS : Selon des éléments probants limités, la réadaptation pulmonaire améliore la capacité à l'exercice chez les patients âgés atteints d'une maladie respiratoire chronique. La présente étude visait à déterminer si des patients de 80 ans ou plus bénéficieraient d'une réadaptation pulmonaire, à l'instar de patients plus jeunes.

MÉTHODOLOGIE : Les issues ont été comparées chez 230 patients hospitalisés consécutifs atteints d'une maladie pulmonaire modérée à grave qui avaient participé à un programme complet de réadaptation pulmonaire pendant une période d'un an. Les issues incluaient la distance du test de marche de 6 minutes (TM6M), le nombre de marches franchies en 2 minutes (MF2M), les échelles de dyspnée de Borg après l'effort et des indices fonctionnels objectifs.

RÉSULTATS : On ne remarquait aucune différence entre les patients âgés (80 à 91 ans, n=43) et plus jeunes (n=187) pour ce qui est du sexe, du volume expiratoire maximal par seconde (moyenne 0,77 L par rapport à 0,72 L) ou du nombre de diagnostics médicaux chroniques (2,4 par rapport à 2,7). Les patients âgés étaient moins souvent des survivants d'une ventilation mécanique (2,3 % par rapport à 16 %). Le TM6M (133 m par rapport à 144 m; P=0,48) et les MF2M (5,2 marches par rapport à 6,5; P=0,067) étaient similaires au départ, mais la fonction globale était plus faible (85 par rapport à 89; P=0,040) chez les patients âgés que chez les patients plus jeunes, respectivement. Après la réadaptation pulmonaire, toutes les issues étaient considérablement plus positives, quel que soit l'âge (toutes les comparaisons avant-après, P<0,0001). L'état des patients plus jeunes s'améliorait, avec de meilleurs résultats du TM6M (231 m par rapport à 185 m; P=0,004) et des résultats similaires de MF2M (9,3 marches par rapport à 7,9; P=0,070) au congé, comparativement aux patients âgés. La fonction globale au congé demeurait plus faible chez les patients âgés que chez les patients plus jeunes (91 par rapport à 94; P=0,002). La durée de la réadaptation et la période d'hospitalisation étaient similaires entre les deux groupes.

CONCLUSION : Un programme complet de réadaptation pulmonaire pour les patients hospitalisés est bénéfique chez des patients sélectionnés de 80 ans ou plus.

increased attention has focused on pulmonary rehabilitation as a means of improving the chronic dyspnea, limited function and quality of life of these patients (6). However, the use of this modality remains somewhat limited because it is costly and not universally available (7). Where programs do exist, the selection of appropriate patients is an important issue. Generally, as seen in published trials, enrolled subjects tend to be younger than the general population of patients with COPD (2,8-11). This suggests there is an implicit bias against 'older' patients in exercise-based programs. Given that physicians will be faced with increasing numbers of elderly patients with COPD (3-5), it is

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important to know whether age should be an important criteria in the selection process for pulmonary rehabilitation programs.

The objective of the present study was to compare the effectiveness of inpatient pulmonary rehabilitation designed to improve exercise tolerance and functional capacity in patients with chronic lung disease 80 years of age or older with younger patients. Specific outcomes assessed were the 6 min walk distance and the degree of dyspnea at the end of the test; the ability to climb up and down a standard set of stairs and the dyspnea after this test; and a global objective functional score rated by the physiotherapists. Secondary objectives included comparing comorbidity at time of entry and during rehabilitation, as well as the required duration of rehabilitation and total length of stay in older patients with younger patients.

METHODS

Study design

Data were evaluated on 230 consecutive patients who were admitted to the inpatient pulmonary rehabilitation program (IPRP) at Mount Sinai Hospital Center (MSHC) (Montreal, Quebec) between April 1, 1999, and March 31, 2000. To focus on the oldest age group, the population was analyzed comparing those 80 years of age or older ('older patients' [OP]) with all those younger ('younger patients' [YP]). The clinical characteristics of the subjects who enrolled were collected by interview and examination by the health professionals in the program. Patients who did not complete the rehabilitation program as planned because they either developed prohibitive complications or left early for other reasons were included in the analysis. The study was approved by the MSHC Ethics Committee.

Measurements

The following tests were performed systematically on all patients before and on completion of the IPRP program. Quality of life data were incomplete and are not reported.

Six-minute walk test: This standard measure of mobility was performed initially and repeated at weekly intervals, as well as on completion of the IPRP, on all patients according to published standards (12). The patients walked in a measured hallway with neutral encouragement for 6 min. Practice walks were encouraged, yet no practice walk was performed because of the fatigue experienced by many of the patients after this sustained effort. Patients of all ages were observed to be able to walk for total times much shorter than the 6 min opportunity because of severe leg weakness and the requirement for rest. Dyspnea at the end of each trial was rated by the modified Borg visual analog scale (VAS) (13).

Two-minute stair climbing test: This measure of mobility was performed on all patients able to climb stairs. The number of stairs that were climbed and descended in 2 min was counted in a timed evaluation. A set of three steps and a fixed railing was used, with the patient performing as many up and down laps as possible in 2 min. Rests were allowed. Neutral encouragement was given throughout the test. Stair climbing has been used as a measure of disability and impairment of cardiopulmonary function, as well as a predictor of postoperative complications (14). The minimal clinically important difference for this measure has been estimated to be two laps (approximately one-half of a flight of stairs).

Global Functional Score: Certified dedicated physiotherapists systematically evaluated all patients entering and ending the

pulmonary rehabilitation program and computed the Global Functional Score (GFS). This structured objective assessment was developed between 1990 and 1994 and follows a standard flow sheet. This was developed using the World Health Organization's *International Classification of Impairments, Disabilities and Handicaps* (15) with an approach similar to the Functional Independence Measure in neurological patients (16). A complete assessment scores multiple mental, physical and functional domains. This included a basic evaluation of mental status and motivation (10 points), physical mobility with respect to the bed and room (20 points), independence with activities of daily living (17 points), 6 min walk distance (4 points), number of stairs climbed and descended in 2 min (4 points), graded muscle strength of extremities (12 points per side for arms; 9 points per side for legs). Function was assessed (16 points per arm; 12 points per leg). Finally, balance was assessed. If necessary, the Berg balance scale was performed seated, while standing and then with movement (12 points). The sum scores per individual divided by the maximum possible multiplied by 100 are reported, where, as a result, a score of 100 indicates normal function.

Validation of the GFS in the study population was performed. When retested after three months, a correlation coefficient $\rho=0.84$ was found within individuals. This scale correlated with patient quality of life as measured by the St George's Respiratory Questionnaire (17) (ρ with impact domain scores of 0.25). The GFS was lower in patients surviving mechanical ventilation and improved over time with recovery and rehabilitation. In the study patients, improvements in the 6 min walk test (6MWT) and 2 min stair climbing test (2MST) (reported separately) generally accounted for a 0.6 to 1.8 point improvement in the GFS. The minimal clinically important difference for GFS has been estimated to be 2 out of 100 (equivalent to a change in a category in at least three domains).

IPRP

The IPRP at MSHC employs a multidisciplinary team working to optimize physical ability, functional autonomy and social performance. Admission to the program is by referral from community physicians and pulmonary specialists. Age is not a factor in admission to the IPRP. The IPRP encompasses the components of education, physical exercise and psychosocial adjustment to severe chronic respiratory illness. The professionals on this team include physical and occupational therapists, physicians, specialized nurses, a social worker, dieticians, inhalation therapists, recreation therapists, psychologists and music therapists.

Patients are admitted for an anticipated three-week period. However, if intercurrent medical conditions exist or become apparent, the length of stay may be longer. The program includes therapies to strengthen both upper and lower extremity muscle groups (treadmill and bicycle exercise, weight training, stair climbing and hall walking). Teaching includes breathing techniques to improve voluntary breathing and to control and reduce dyspnea. Energy conservation during daily activities is emphasized. Patients receive education regarding medications and inhalation techniques. The structured time for each patient per week is at least 5 h training with a physiotherapist, 3 h with an occupational therapist and 2 h with a psychologist.

The exercise prescription includes supervised dyspnea-limited or fatigue-limited daily exercise training. This includes treadmill

TABLE 1
Baseline characteristics of patients

	Age		P
	<80 years	80+ years	
Number	187	43	
Male (%)	46 (39 to 53)	37 (22 to 52)	0.24
FEV ₁ (L)	0.72 (0.67 to 0.78)	0.77 (0.67 to 0.87)	0.36
FVC (L)	1.36 (1.27 to 1.49)	1.48 (1.29 to 1.68)	0.74
BMI (kg/m ²)	25.9 (24.8 to 27.0)	23.4 (21.6 to 25.3)	0.025
PaCO ₂ (mmHg)	48 (46 to 50)	46 (43 to 49)	0.21
COPD (%)	89 (84 to 94)	93 (84 to 100)	0.86
LTOT (%)	34 (27 to 40)	37 (22 to 52)	0.73
Recent mechanical ventilation (n)	16 (11 to 21)	2.3 (0 to 7)	0.018
Number of chronic diseases	2.7 (2.5 to 2.9)	2.4 (2.0 to 2.8)	0.19
Cardiac disease (%)	40 (12 to 23)	35 (2 to 22)	0.53
Depression (%)	21 (15 to 27)	9 (0 to 18)	0.070

Means or percentages of each age group are presented. 95% CI are in parentheses. P values are for comparisons between age group with an F test for frequencies and Student's t test for continuous variables. BMI Body mass index; COPD Chronic obstructive pulmonary disease; FEV₁ Forced expiratory volume in 1 s; FVC Forced vital capacity; LTOT Long-term O₂ therapy; PaCO₂ Partial pressure of carbon dioxide in arterial blood

walking, stationary cycling and/or free-walking. This is supervised by physiotherapists who set initial goals that substantially improve or overcome any handicaps the patients may currently face in their lives at home (2,9,15). Supplemental O₂ is used during training in patients with exercise-induced O₂ desaturation (end-exercise oxygen saturation measured by pulse oximetry less than 90%) and in patients who are already using home O₂. The training intensity is adjusted at least weekly based on the level of dyspnea and heart rate, as well as adverse symptoms, including dizziness, fatigue and discomfort of the chest or legs. When dyspnea is determined to be the major limiting factor to effort, the exercise intensity is targeted to a Borg score of 5 or more.

Statistical analysis

Descriptive statistics (means, SDs, counts and frequencies in per cent) were used to present patients' baseline characteristics. The analysis focused on the comparisons of the changes in scores associated with rehabilitation in the two groups (OP versus YP) with an unpaired Student's t tests. Analysis of the admission and discharge scores were performed in a similar manner. Confounding variables were examined between the two groups using an F test or with unpaired Student's t test where appropriate. Multivariate analysis (18) adjusting for significant confounders (survivors of mechanical ventilation, body mass index [BMI] and depression, all with a univariate P<0.1) was performed for all of the outcomes. The study population was examined for trends across age groups through inspection of histograms and any significance of a trend was tested using the χ^2 test for trend. Per cent predicted values for forced expiratory volume in 1 s were calculated with respect to equations for normal values published by Crapo et al (19). Statistical significance was at the two-sided 0.05 level, and 95% CIs were calculated.

TABLE 2
Six-minute walk distance after pulmonary rehabilitation

	Age		P (YP vs OP)
	<80 years	80+ years	
6 min walk (m)			
Admission	144 (131 to 157)	133 (108 to 158)	0.48
Discharge	231 (231 to 244)	185 (159 to 211)	0.004
P (admission versus discharge)	<0.0001	<0.0001	
Dyspnea at end of 6 min walk (Borg scale)			
Admission	4.2 (3.9 to 4.5)	3.4 (2.8 to 4.1)	0.038
Discharge	3.5 (3.3 to 3.8)	3.1 (2.7 to 3.4)	0.033
P (admission versus discharge)	<0.0001	0.13	

Means with 95% CI in parentheses. P values are for comparisons between age groups with an unpaired Student's t test, and within age groups with a paired Student's t test. OP Older patients; YP Younger patients

RESULTS

Patient population

The mean age of the 230 patients evaluated by the pulmonary rehabilitation team was 70.0±10.0 years, of whom 102 (44%) were men. The oldest patient was 91 years and the youngest patient was 39 years. There were 39 patients younger than 60 years, 62 patients aged 60 to 69 years, 86 patients aged 70 to 79 years and 43 patients aged 80 years of age or older (OP); of the 43 OP, 11 were aged 85 years or older. Data comparing YP with OP are presented in Table 1. BMI and mechanical ventilation within the past three months were the only variables that showed significant differences with age. The number of chronic diseases, as well as the prevalence of depression and chronic stable heart disease were not significantly different. In addition, during the rehabilitation period, a similar fraction of patients suffered acute coincident illnesses, occurring in eight of 43 (19%) in the OP group compared with 39 of 187 (21%) patients in the YP group (P=0.74). These ranged in severity from oral thrush to acute respiratory failure.

6MWT

At admission, 6MWT was similar in the OP and YP groups, with very low values compared with results in other populations with COPD (Table 2). The distance walked improved significantly in both age groups after pulmonary rehabilitation (admission versus discharge P<0.001). Those in the YP group improved more in absolute terms with a longer mean discharge 6MWT. However, the per cent improvement in 6MWT by the OP group was 40% (95% CI: -29% to 108%) which was similar to the YP group who improved, on average, by 60% (95% CI: 13% to 108%; P=0.17). Dyspnea was lower in the OP group at admission and discharge, although the absolute reduction in dyspnea with rehabilitation was similar between age groups (OP -0.4; 95% CI: -1.0 to -0.2 versus YP -0.7; 95% CI: -1.0 to -0.4; P=0.40). Adjusted analysis found that admission 6MWT did not differ with age (OP versus YP; P=0.57), but was shorter on discharge for the OP group (P=0.017), with similar levels of dyspnea at the end of the test for both groups.

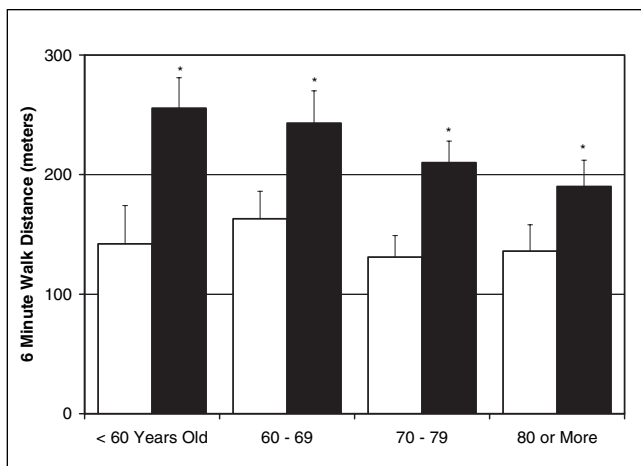


Figure 1) Changes in 6 min walk distance according to age group. Mean admission distance (open bars) and discharge distance (black bars) shown with 95% confidence upper limits. All four groups improved significantly ($P < 0.0001$) from admission to discharge. χ^2 tests for age-related trend were $P = 0.16$ at admission and $P < 0.001$ at discharge

2MST

At admission, patients in the OP group were able to perform almost as well as those in the YP group when tested for their ability to climb and descend three-stair laps ($P = 0.067$; Table 3). Improvement was observed in both groups with an increased ability to climb and descend stairs at discharge ($P < 0.0001$). The OP group improved after the IPRP by a mean 51% (18% to 84%) which was similar to the YP group who improved by a mean 41% (10% to 73%; $P = 0.46$). Dyspnea after 2MST was, on average, lower in the OP group than in the YP group at admission and discharge ($P = 0.004$ at admission and $P = 0.014$ at discharge). Despite these differences, the reduction in dyspnea after IPRP was significant in both groups. In an adjusted analysis, no differences were found in stair climbing ability at admission, at discharge or for per cent improvement (all $P > 0.10$).

GFS

GFS was lower in the OP group than in the YP group at admission and discharge (Table 4). GFS improved significantly in both groups after pulmonary rehabilitation (both $P < 0.001$). The per cent improvement in GFS for the OP group was 7.9% (95% CI: 4.2% to 7.9%), similar to the improvement observed in the YP group who improved by a mean of 7.0% (95% CI: 5.3% to 8.6%; $P = 0.61$). Because GFS contains the 6MWT and 2MST as part of the global score, the subscores within the GFS were analyzed. Graded muscle strength and function improved, as did measures of functional physical mobility and balance. After adjusting for confounding variables, GFS remained lower in the OP group both at admission ($P = 0.0013$) and discharge ($P = 0.009$) with a similar per cent improvement ($P = 0.37$).

Duration and complications during the program

The time spent admitted to the pulmonary physiotherapy program was similar for both age groups (Table 5). When including the total time required while admitted to hospital, including medical evaluation, as well as any interruptions of

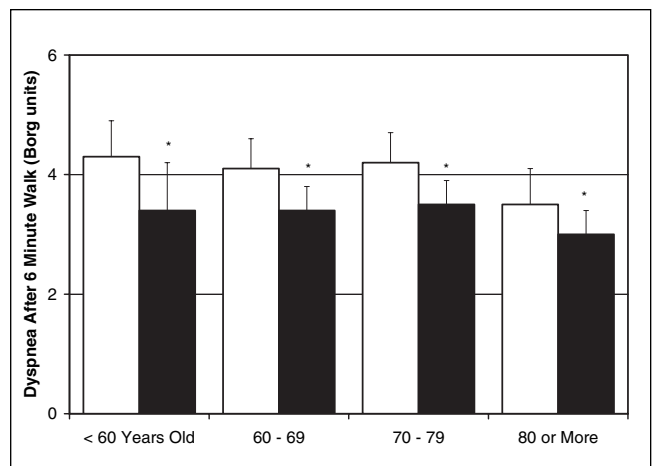


Figure 2) Changes in Borg dyspnea scores after 6 min walk according to age group. Mean admission (open bars) and discharge (black bars) dyspnea scores presented with 95% confidence upper limits. All four groups improved significantly ($P < 0.0001$) from admission to discharge. Dyspnea was significantly lower in patients 80 years of age or older at admission and discharge. χ^2 tests for age-related trend were $P = 0.22$ at admission and $P = 0.35$ at discharge

the rehabilitation program due to intercurrent complications, the length of stay in hospital was similar for the two groups. Adjusted analysis found that length of stay and time spent in physiotherapy remained similar in both groups. A similar fraction of patients suffered complications in all age groups, with 18.6% of the OP group and 20.9% of the YP group having had at least one complication during their hospitalization.

Trends across age categories

When the data were analyzed using four age categories, no significant trend was found for 6MWT at admission ($P = 0.16$). There was a significant trend with age toward lower distance walked at discharge with older age ($P < 0.001$) (Figure 1). No trend was seen across age groups for per cent improvement in 6MWT. The absolute reduction in dyspnea with rehabilitation was not significantly different across age categories (Figure 2).

Stair climbing ability demonstrated no statistically significant trend across age groups at admission. After rehabilitation, there was strong trend to lower stair climbing ability with older age ($P = 0.002$). Dyspnea after the 2MST demonstrated a trend to lower dyspnea with older age both at admission ($P = 0.043$) and at discharge ($P = 0.009$). No trend with age was seen in GFS at admission, but at discharge there was a tendency to lower functional scores in the older age categories ($P = 0.0025$).

DISCUSSION

We have shown improvement in dyspnea, functional capacity with respect to walking and climbing steps, and global function in patients with chronic severe lung disease following a comprehensive pulmonary rehabilitation program. Furthermore, these improvements occurred in all measures to a similar extent regardless of age. With a similar intervention in all patients, at discharge, the OP group had lower absolute scores measured for 6MWT and global function, but similar degrees of relative improvement. The absolute improvement in the OP group is in the range of minimal clinical significance for the 6MWT (20). The likelihood of other chronic diseases

TABLE 3
Two-minute stair test before and after pulmonary rehabilitation

	Age		P YP vs OP
	<80 years	80+ years	
2 min stair test (laps)			
Admission	6.5 (5.9 to 7.1)	5.2 (4.0 to 6.4)	0.067
Discharge	9.3 (8.6 to 9.9)	7.9 (6.6 to 9.2)	0.070
P (admission versus discharge)	<0.0001	<0.0001	
Dyspnea at end of 2 min stair test (Borg scale)			
Admission	4.8 (4.6 to 5.1)	3.9 (3.4 to 4.4)	0.0008
Discharge	4.0 (3.7 to 4.2)	3.2 (2.8 to 3.6)	0.0016
P (admission versus discharge)	<0.0001	<0.0079	

Means with 95% CIs in parentheses. P values are for comparisons between age groups with an unpaired Student's t test, and within age groups with a paired Student's t test. OP Older patients; YP Younger patients

and coincident acute medical illnesses was similar in all age groups. The time needed for pulmonary rehabilitation, with regard to physiotherapy intervention or total length of stay, was also similar across all age groups.

The study population was, in general, severely affected in their functional capacity at admission. This is exemplified by the very low scores on the 6MWT at admission. This is the result of the selection of the most functionally disabled patients by referral sources, because the IPRP is unique in the area by serving severely disabled patients who would be incapable of regularly attending an outpatient program. The fact that the functional measures of walk distance in 6 min and stair climbing improved after the program with less dyspnea demonstrates an improved ability to do external work for the same degree of dyspnea and is evidence of a training effect of the program.

Our findings of lower discharge exercise capacity and functional ability in older patients is in keeping with previous studies of elderly subjects (21,22). This has been explained physiologically by a combination of factors, including skeletal muscle atrophy (sarcopenia) with lower muscle fibre size and number (23-25). Sarcopenia is even more pronounced in patients with COPD (1). Intrinsic muscle function is also reduced in healthy older individuals, with a reduced amount of sarcoplasmic reticulum calcium release (26). Studies (23,27-29) examining the effect of endurance and strength training on healthy older subjects have shown positive effects with improvements similar to those observed in younger subjects. For example, low intensity strength training in healthy older subjects, on average, more than doubled pretraining force production (30).

The finding that global function measure at admission and discharge were significantly lower in the OP group was not surprising. General disability increases with age in epidemiological studies (31) and likely results from both the increasing prevalence and severity of chronic disease, and the behavioural and social factors that result in less regular physical activity in older age groups.

Rehabilitation programs have found great success and utility in older patients (32,33). Programs tailored for rehabilitation after acute medical illness or for chronic musculoskeletal conditions have been proven to be effective in older populations

TABLE 4
Global functional score before and after pulmonary rehabilitation

	Age		P YP vs OP
	<80 years	80+ years	
Global functional score (max 100)			
Admission	89 (87 to 90)	85 (81 to 89)	0.040
Discharge	94 (93 to 95)	91 (88 to 93)	0.002
P (admission versus discharge)	<0.0001	<0.0001	

Means with 95% CIs in parentheses. P values are for comparisons between age groups with a Student's t test, and within age groups with a paired Student's t test. OP Older patients; YP Younger patients

TABLE 5
Length of program and stay in hospital

	Age		P
	<80 years	80+ years	
Days in rehabilitation	23.1 (21.9 to 24.3)	23.1 (20.3 to 26.0)	0.98
Days in hospital	28.7 (28.0 to 31.3)	32.2 (27.1 to 37.3)	0.35

Means of each measure per group are presented. 95% CIs are in parentheses. P values are for comparisons between age groups with a Student's t test

(34). Cardiac rehabilitation programs have shown physiological benefits which occurred regardless of age (35-37). Observations of small numbers of patients in other centres have found that older patients improve substantially with pulmonary rehabilitation (38,39) and that age was not a significant determinant of response to exercise training compared with measures of muscle weakness (40). All of these programs shared the same general goals of improved functional status, improved quality of life and empowering the patients to be more able to meet their own needs. Our population was severely compromised at entry, which was demonstrated by the very low 6 min walk distances. Whether the age effects observed here are applicable to pulmonary rehabilitation in the outpatient setting requires further study. Subgroup analysis of smaller numbers in other centres provided evidence that age is not a factor in response to outpatient pulmonary rehabilitation (40).

King et al (41) have observed a bias against referring older patients for rehabilitation. In their review of all patients participating in a regional, publicly funded cardiac rehabilitation program, implicit selection against older patients was evident. Patients who were 70 years of age or older were 58% less likely to undergo rehabilitation regardless of important comorbid conditions.

In the present study population, the OP group showed differences compared with the YP group. On average, they had a lower BMI and were less likely to be referred after mechanical ventilation. This may reflect the selection biases in acute medical care operating in other centres, as well as the lower likelihood of older patients to receive and survive mechanical ventilation.

Exercise-induced improvements in functional capacity and mobility with an increased tolerance to dyspnea have been reported following low intensity exercise training that did not result in changes in cardiorespiratory function or peripheral

muscle adaptations (42,43). The symptom-limited training in our study also resulted in similar improvements across all age groups. We cannot generalize our results to the potential effects of cardiopulmonary exercise test-directed training in older age groups.

One limitation of our study was that the patients were selected before admission and were not representative of all patients with chronic severe respiratory disease. Our patients were selected based on their likelihood to benefit from rehabilitation. Referring physicians spanning a wide spectrum ranging from outpatient general practice to critical care send applications for admission. Applications are refused if substantial impediments to rehabilitation are suspected to exist, such as severe or unstable cardiac disease, cognitive dysfunction, untreated depression or severe musculoskeletal disease.

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CONCLUSIONS

We found that older patients with chronic respiratory disease may benefit significantly from pulmonary rehabilitation. The relative improvements in 6 min walk distance, stair climbing ability and global functional capacity were similar to those in the younger patients of the study population. Therefore, we conclude that age alone should not be a contraindication to entry into a comprehensive pulmonary rehabilitation program for individuals who appear to be medically stable and capable of participating in an exercise program.

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