ORIGINAL ARTICLE

Which Chronic Obstructive Pulmonary Disease Patients Will Be Likely to Attend Consistently a Pulmonary Rehabilitation Program?

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Abstract

Introduction: Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death in the United States, and millions of COPD patients are disabled and unable to work. Pulmonary rehabilitation (PR) programs are available to assist with disability, but it is not clear who is likely to consistently participate in them. The purpose of this study was to determine which participants were likely to consistently attend a PR program.

Methods: A retrospective medical record review was used to assess 104 community-dwelling adults with COPD who completed the PR program at a Midwest medical center between 2000 and 2005.

Sample: The sample consisted of 32 men and 72 women with a mean age of 59.9 years (±19.10 years), mean predicted one-second forced expiratory volume (FEV_1) of 46.45% (SD = 20.1), mean percent forced vital capacity (FVC%) of 67.61 (SD = 16.61), mean FEV_1/FVC% ratio of 51.15% (SD = 18.17), and mean residual volume (RV) of 150.66% (SD = 67.01).

Results: Contextual variables of current smoking (beta = -.36), male sex (beta = .19), not having emphysema (beta = -.27), and FVC% (beta = .32) were significant predictors of attendance at (a dose of) PR. The number of selected comorbidities significantly predicted the dose of PR (beta = -.20).

Conclusion: These findings support the ability to identify factors that predict attendance at a PR program. Nurses can assess patients at risk for lack of consistent PR attendance and implement interventions to improve attendance. Specifically, smoking cessation prior to or as an integral part of PR programs may improve attendance.

Introduction

According to the American Thoracic Society (ATS) and the European Respiratory Society, chronic obstructive pulmonary disease (COPD) is a "preventable and treatable disease state characterized by airflow limitation that is not fully reversible."[1] COPD is the fourth leading cause of death in the United States; the total estimated cost of COPD in 2002 was $32.1 billion. Millions of patients with COPD live for many years but are disabled and unable to work.[2] Pulmonary rehabilitation (PR) programs can improve functional status and quality of life in these individuals. The ATS has identified the need to determine at initial assessment which patients with COPD are likely to improve with a PR program. The purpose of this study was to determine which participants were likely to attend a PR program consistently.

ATS statements emphasize that the level of disability and handicap, not the severity of physiologic impairment of the lungs, dictates the need for pulmonary rehabilitation. The economics of health care result in limited availability of PR programs, making it imperative to have selection criteria. Characteristics that may influence health-promoting behaviors and outcomes include demographics, individual patient characteristics, and lung disease characteristics.[3] Relevant individual characteristics include smoking, nutritional status, level of education achieved, social support systems, and other psychosocial traits. Disease characteristics include severity of illness (percent of predicted one-second forced expiratory volume [FEV_1%]),[4] activity level,[5,6] and type of disease. Severity of illness, measured in our study as the FEV_1% and the residual volume (RV), is viewed as an indirect influence on outcomes in PR programs.

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Methods

Study Subjects and Data

Appropriate institutional review board approvals were obtained. This study was a retrospective record analysis of 104 individuals (32 men and 72 women) with diagnosed chronic lung disease, chronic bronchitis, or emphysema who were participating in PR programs at a Midwest medical center. Other sources of data included pulmonary function test results and records of maximum ventilation per unit of time (V_{max}). Patient and disease factors studied included sex, baseline age, **s**moking status (current, former, or never), body mass index (BMI), level of education achieved (number of years), living status (alone or with someone), self-reported anxiety or depression, total number of five selected self-reported comorbidities, and predicted FEV_1% and FVC%.

Study Endpoint

The PR participation "dose" was defined as the number of sessions multiplied by the number of weeks attended (eg, 12 sessions multiplied by six weeks equals a PR dose of 72).

Statistical Analysis

Analysis was performed using the statistical software package SPSS for Windows, version 13 (SPSS, Chicago, IL). Descriptive statistics were obtained for each variable, and plots were made to ascertain the shapes of the distributions of the variables. Hierarchical multiple-regression models were used to predict the amount of the shared variance and effects of the predictor variables.

Results

Baseline Characteristics of the Sample

Table 1 provides a summary of the sample characteristics for the study subjects. The mean age was 60 years (range, 34–82 years), mean FEV_1% was 46%, and mean FVC% was 68%. All participants were unemployed or retired; this factor was eliminated from further analysis. Almost the entire sample (99%) used supplemental oxygen. The mean BMI was 30 kg/m^2, indicating that most study subjects were either overweight or obese. Smoking history averaged 42 pack-years (= 20 cigarettes per day per year). Not in the table are data showing that activities of daily living were substantially impaired (eg, 45% reported inability to walk a block, 52% inability to keep up with others the same age, and 53% inability to walk up a slight hill). The mean average of total activity was used in analysis. The mean number of total years of education was 10.1; 35% reported living alone, and 75% reported having depression.

Pulmonary Rehabilitation Program Participation

The mean number of program weeks attended was 6.8 (range, 1–8) and the mean number of sessions was 20.3 (range, 4–24); thus, the mean calculated dose for PR participation was 144.4 (range, 4–192).

Patient Characteristic Predictors

Table 2 shows the predictive patient characteristics. A three-step hierarchical multiple regression was used to examine the influence of selected predictors in specific orders. In model 1, age and sex were regressed on the dependent variable dose of participation in PR. Model 2 added the predictors of smoking status (current vs never) and BMI. Model 3 added severity of illness (FEV_1%, FVC%, RV%, and activity level) and type of disease characteristics (bronchitis and emphysema). The models accounted for 31% of the variance on the dose of participation. The final model was statistically significant ($F = 5.70$; $p < 0.001$); sex, current smoking, FVC% predicted, and a diagnosis of emphysema were statistically significant predictors of PR dose.

Predicting Resources and Barriers

Table 3 displays the results of multiple regressions used to predict the effect of education level and living status on PR participation. The second model of the

Table 1. Demographic and clinical characteristics of study subjects (N = 104)

Variable	X (SD); Range N (%)
Age (years)	59.9 (10.2); 34–82
Sex	
Female	72 (69.2%)
Male	32 (30.8%)
Smoking status	
Current	46 (44.2%)
Former	43 (41.3%)
Never	15 (14.4%)
Smoking history (pack-years[a])	41.7 (34.3); 0–200
Nutritional status (body mass index)	30.2 (9.19); 16–59.5
Disease characteristics	
Emphysema	85 (81.7%)
Bronchitis	88 (84.6%)
Disease severity	
FEV_1%	46.45 (20.1); 15.0–97.0
FVC%	67.61 (16.61); 30.0–107.0
FEV_1/FVC ratio %	51.15 (18.17); 21.00–92.00
RV%	150.66 (67.01); .56–7.92

FEV_1% = percentage of predicted one-second forced expiratory volume; FVC% = percentage forced vital capacity; RV% = percentage residual volume.
[a] pack-years = 20 cigarettes per day per year

Table 2. Summary of predictors of contextual factor and dose of PR

Dose of PR	Predictors	Beta	R	R^2	Adjusted R^2	Model significance
Model 1	Age Sex (male)	0.22[a] 0.18	0.32	0.10	0.09	F = 5.8[b]
Model 2	Age Sex Current smoking BMI	0.21[a] 0.17 0.40[c] 0.08	0.52	0.27	0.24	F = 9.4[c]
Model 3	Age Gender Current smoking BMI FEV1% FVC% RV% Total activity level Emphysema Bronchitis	0.17 0.19[a] 0.36[c] 0.03 0.26 0.32[b] 0.02 0.07 0.27[b] 0.03	0.61	0.38	0.31	F = 5.7[c]

[a] $p \leq .05$; [b] $p \leq .01$; [c] $p \leq .001$
BMI = body mass index; FEV_1% = percentage of predicted one-second forced expiratory volume; FVC% = percentage forced vital capacity; PR = pulmonary rehabilitation; RV% = percentage residual volume.
Beta weights are the standardized regression coefficients used to create a predication equation of the standardized variable and represent the amount of beta weight of each variable to predict the dependent variable (the dose of PR).
R is the Pearson correlation coefficient between the predictors and actual scores of the dose of participation in PR.
R^2 is the squared multiple regression and represents the degree of variance accounting for the combinations of the predictors.
Adjusted (R^2) is the unbiased estimate of R^2.
Model significance is the F test, which examines the degree to which the relationship between predicators and dose of participation in PR is linear. If the F test result is significant, then the relationship between predictors and dose of participation in PR is linear and therefore the model significantly predicts the dependent variable.

It is noteworthy that we found that men had better attendance at PR programs.

analysis added the presence of anxiety, depression, and comorbidities. Only the number of comorbidities was statistically significant in predicting the dose of PR.

Discussion

Our study group's composition of 32 men and 72 women was not congruent with the current worldwide prevalence of COPD in more males than females; it does parallel the higher initial enrollment of women in PR activities and programs. Also, more US women than men died from COPD since 2000.[7] It is noteworthy that we found that men had better attendance at PR programs. It would be important to know why women did not have as large a PR dose. The pulmonary function test results and type of disease results could be indicators of health status, with healthier patients attending PR more frequently. Emphysema inversely predicted the dose of PR, indicating that patients without emphysema but with moderate COPD showed better adherence to PR attendance than those with more severe disease.

Smoking is the most common cause of COPD.[7] A history of current or former smoking is the risk factor most often associated with developing COPD. Our study revealed that being a current smoker had an adverse effect on participation in PR programs, suggesting that participants who had not stopped smoking had lower doses of PR than those who had quit or had never smoked. This study strongly supports the principle that smoking cessation should be an integral part of PR programs.

We were surprised that none of the resource variables were statistically significant in predicting PR program attendance. We are not aware of comparable attempts to examine the influence of education, living status, and insurance coverage. Because patients' self-reports of anxiety and depression when entering a rehabilitation program were the only data available on the records, the nonsignificant results may not be valid or of clinical value. PR programs need valid and reliable standardized measures of anxiety and depression to examine how they relate to outcomes. The finding in this study that the comorbidity score was related to lower participation seems plausible, because greater numbers of comorbidities would be a deterrent to completion of a PR program and would likely have a negative impact on physical functioning.[8] Little research has been done to determine the optimal means of managing COPD with related comorbidities.[9]

In summary, the patients most likely to benefit from a PR program have these initial characteristics: male sex, not currently smoking, higher predicted FVC%, and a diagnosis of emphysema alone. This study suggests that patient selection criteria should be as follows: 1) symptomatic chronic lung disease stabilized by standard therapy, 2) functional limitations from COPD that have

Table 3. Summary of multiple regressions of predictors of resources and barriers on dose of PR

Dose of PR	Predictors	Beta	R	R^2	Adjusted R^2	Model significance
Model 1	Education	.17	.17	.030	.011	F = 1.562
	Living alone	-.030				
Model 2	Education level	.18	.29	.089	.043	F = 1.907
	Living alone	-.055				
	Number of comorbidities	-.20[a]				
	Psychological barriers—anxiety	-.031				
	Psychological barriers—depression	-.068				

[a] $p \leq .05$
PR = pulmonary rehabilitation.
Beta weights are the standardized regression coefficients used to create a predication equation of the standardized variable and represent the amount of beta weight of each variable to predict the dependent variable (the dose of PR).
R is the Pearson correlation coefficient between the predictors and actual scores of the dose of participation in PR.
R^2 is the squared multiple regression and represents the degree of variance accounting for the combinations of the predictors.
Adjusted (R^2) is the unbiased estimate of R^2.
Model significance is the F test, which examines the degree to which the relationship between predicators and dose of participation in PR is linear. If the F test result is significant, then the relationship between predictors and dose of participation in PR is linear and therefore the model significantly predicts the dependent variable.

the potential to be decreased by exercise, 3) existence of few comorbid conditions, and 4) current nonsmoking status. There are no arbitrary lung function or age criteria. It has been recommended that certain patients with severe COPD should have specialized inpatient PR.[10] Patients with disabling lung disease require individualized assessment of needs, individualized attention, and a PR program designed to meet realistic individualized goals. All potential participants should have an opportunity to complete smoking cessation prior to initial enrollment in PR or as an integral activity within the PR program.

Studying the combinations of factors that can affect attendance expands our knowledge about the potential for PR. Patient assessment can play a key point in assisting patients to be in the best condition to benefit from participation in PR programs. Screening and reviewing patients can also help the patient with COPD to set realistic individual and program goals. The evaluation process for PR programs should include assessment of impairment and disability and judicious enrollment of high-risk patients, with determination based on evidence as to who is most likely to benefit from PR.

There were limitations to our study. This study was completed over a two-year period to obtain an adequate sample size, resulting in potential historical bias, although there were no major changes in the PR program during the course of the study. Existing records are an economical source of information but limit researchers' ability to apply validity and reliability testing to the selection of measures and limit data collection to study variables that have already been collected. ❖

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