The Effectiveness of Different Combinations of Pulmonary Rehabilitation Program Components*

A Randomized Controlled Trial

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**Study objectives:** To study the short-term and long-term effects of combining activity training or lectures to exercise training on quality of life, functional status, and exercise tolerance.

**Design:** Randomized clinical trial.

**Setting:** Outpatient pulmonary rehabilitation center.

**Participants:** Forty-three outpatients with COPD.

**Interventions:** Patients were randomized to one of three treatment groups: exercise training alone, exercise training plus activity training, and exercise training plus a lecture series. The mean treatment period was 10 weeks.

**Measurement:** The Chronic Respiratory Disease Questionnaire, the modified version of the Pulmonary Functional Status and Dyspnea Questionnaire, and the COPD Self-Efficacy Scale were administered at baseline, and 6, 12, 18, and 24 weeks from the beginning of the rehabilitation program. The 6-min walk test was used to measure exercise tolerance.

**Results:** Benefits of activity training combined with exercise included less dyspnea (p < 0.04) and fatigue (p < 0.01), and increased activity involvement (p < 0.02) and total functional status (p < 0.02) in the short term compared to comparison treatment groups for comparatively older participants. Compared to the lecture series adjunct, the activity training adjunct resulted in significantly higher gains in total quality of life (p = 0.04) maintained at 24 weeks. Significantly worse emotional function and functional status resulted from the lecture series adjunct in the oldest participants (p ≤ 0.03). Treatment groups did not differ significantly on exercise tolerance or self-efficacy.

**Conclusions:** Evidence for additional benefits of activity-specific training combined with exercise was found. A behavioral method emphasizing structured controlled breathing and supervised physical activity was statistically significantly more effective than didactic instruction in facilitating additional gains and meeting participants’ learning needs.

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**Key words:** COPD; dyspnea management; functional status; health-related quality of life

**Abbreviations:** 6MWT = 6-min walk test; CES-D = Center for Epidemiologic Studies Depression Scale; CRQ = Chronic Respiratory Disease Questionnaire; CSES = COPD Self-Efficacy Scale; ETA = exercise training alone; ETAT = exercise training plus activity training; ETLS = exercise training plus a lecture series; MMSE = Mini-Mental State Examination; PFSDQ-M = modified Pulmonary Functional Status and Dyspnea Questionnaire

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Individuals with COPD experience gradual losses in functional status and quality of life. Rehabilitation efforts, however, can minimize and delay these losses. In most pulmonary rehabilitation outcome studies, the effect of a comprehensive pulmonary rehabilitation program as a whole has been studied as opposed to the benefit of particular treatment combinations. The contributions and effect of different treatment combinations in pulmonary rehabilitation are less known.1–5 Such knowledge would help...
to establish the evidence base of these services and to enhance their continued resource allocation in pulmonary rehabilitation programs. Also, few studies to date have compared the effectiveness of different teaching methods and content for patients with pulmonary disease.6

The purpose of this study was to evaluate the benefit of combining lectures or activity training with exercise training on enhancing health-related quality of life, functional status, and exercise tolerance for outpatients with COPD and to determine whether any treatment effects were maintained at 18 and 24 weeks from the beginning of intervention. The study also aimed to investigate the effect of participants’ characteristics such as age and depression (measured by the Center for Epidemiologic Studies Depression Scale [CES-D])7 on treatment effectiveness.

**Materials and Methods**

The research design consisted of one between-subjects factor (treatment group) and one within-subjects factor (time). The treatment group had three levels: exercise training alone (ETA) [standard, usual care], exercise training plus activity training (ETAT), and exercise training plus a lecture series (ETLS). Patients were randomized to one of the three treatment groups. Five quality-of-life and functional status data points were collected for each participant: baseline (preintervention), and 6, 12, 18, and 24 weeks from the commencement of rehabilitation (Fig 1).

**Participants**

The 43 participants were medically stable outpatients with COPD from 60 to 92 years of age referred to the Rusk Institute of Rehabilitation Medicine Pulmonary Rehabilitation Outpatient Program, and were literate and coherent in the English language (Table 1). All participants were white except one who was African American. Twenty-two percent were employed, while the remaining 78% had retired. Eighty-three percent had a college education, and 17% had completed high school (n = 41). Fifty-six percent had depression on CES-D screening (score ≥ 16). Exclusion criteria established a priori were cognitive deficits (score on Mini-Mental State Examination [MMSE] < 24), dementia, blindness, unstable angina, and any other disabling condition that could interfere with participation.

**Instrumentation**

All study instruments had evidence of good reliability and validity. The Chronic Respiratory Disease Questionnaire (CRQ) was used to measure health-related quality of life.9 Two instruments were used to measure functional status: the modified Pulmonary Functional Status and Dyspnea Questionnaire (PFSDQ-M),10 and the COPD Self-Efficacy Scale (CSES).11 Exercise tolerance was measured using the 6-min walk test (6MWT).12 Verbal cueing was limited to two standardized prompts: “you’re half way done” and “you have one minute to go.” The 6MWT was administered twice at baseline to control for practice effects, and once at discharge.13 Adequate restorative rest was allowed between tests.

**Data Collection Procedures**

Ethics approval was obtained from the New York University Human Subjects Committee and the cooperating hospital Institutional Board of Research Associates before commencing the study. Sixty-seven patients consecutively admitted to the outpatient pulmonary rehabilitation program met the selection criteria and were invited to participate in the study. Forty-three participants gave written informed consent. Consenting participants were randomly assigned into one of three treatment groups using a biased coin design and probability table.14,15

The instruments were counterbalanced in the evaluation packets in order to control for any order effects of the questions and participant fatigue. Physical therapists administered the 6MWT.
Treatment intensity using the Borg scale of perceived exertion, maintain each session duration. Therapists individualized exercise physical therapists, consisted of 15 sessions held twice a week, Participants needed to attend using supplemental oxygen if needed during exercise training). Participants were disqualified from the study if they received for follow-up evaluations. All re-evaluations were completed within a 3-week time period from the planned follow-up date. Participants were not told their scores of any prior evaluation. Study procedures regarding attrition were established a priori. Participants were disqualified from the study if they received more than the standard 15 physical therapy sessions and they did not follow-through with treatment recommendations (such as not using supplemental oxygen if needed during exercise training). Participants needed to attend >50% of the rehabilitation sessions.

Treatment

Exercise Training: The exercise training implemented by physical therapists, consisted of 15 sessions held twice a week, each session 1 h in duration. Therapists individualized exercise intensity using the Borg scale of perceived exertion, maintaining perceived exertion between 11 (fairly light) and 13 (somewhat hard). Patients were encouraged to exercise for 20 to 30 min each session, mostly walking on a treadmill at a comfortable pace with speed and incline gradually upgraded. Upper-body training using hand weights was occasionally used for a one fourth of the session. Patients with hypoxemia (arterial oxygen saturation <90%) were administered supplemental oxygen to manage arterial oxygen deficiency, which was necessary to prevent secondary neural and cognitive deficits. Chest physical therapy, avoiding environmental irritants, and prevention and management of respiratory infections. Controlled breathing strategies were not taught in the lectures, except diaphragmatic breathing, which was only briefly mentioned by the psychologist and practiced as a means to manage stress.

Data Analysis

Statistical software (SAS 8.2; SAS Institute; Cary, NC; and SPSS 10.0 for Windows; SPSS; Chicago, IL) were used for the analyses. For patients with re-evaluation data, their characteristics were compared using one-way analysis of variance. Baseline quality-of-life, functional status, and walk distance group scores were compared using multivariate analysis of variance. Mixed linear models, repeated-measures analyses were used to examine any differences in scores for quality of life and functional status. The greater robustness and power of mixed linear models analyses, compared to multivariate analysis of variance, allowed them to handle an unbalanced design and to include data from subjects with an incomplete set of measurements.

Table 1—Baseline Characteristics and Scores of the Complete Group of Patients Recruited

<table>
<thead>
<tr>
<th>Variables</th>
<th>Participants Reevaluated at 6 Weeks</th>
<th>Participants Who Dropped Out Prior to 6-Week Reevaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>No.</td>
</tr>
<tr>
<td>Age, yr</td>
<td>74.2</td>
<td>6.6</td>
</tr>
<tr>
<td>Female/male gender</td>
<td>22/11*</td>
<td></td>
</tr>
<tr>
<td>Body mass index</td>
<td>26.04</td>
<td>6.5</td>
</tr>
<tr>
<td>Maximum smoking amount, packs/d†</td>
<td>1.55</td>
<td>1.1</td>
</tr>
<tr>
<td>Long-term oxygen therapy (0 = no, 1 = yes)‡</td>
<td>0.21</td>
<td>0.42</td>
</tr>
<tr>
<td>Time since diagnosis, yr</td>
<td>4.62</td>
<td>5.27</td>
</tr>
<tr>
<td>MMSE‡</td>
<td>28.3</td>
<td>1.3</td>
</tr>
<tr>
<td>CES-D</td>
<td>15.8</td>
<td>8.6</td>
</tr>
<tr>
<td>FEV₁, L</td>
<td>1.23</td>
<td>0.43</td>
</tr>
<tr>
<td>FEV₁ % predicted</td>
<td>0.55</td>
<td>0.18</td>
</tr>
<tr>
<td>6MWT, feet</td>
<td>900.31</td>
<td>346.37</td>
</tr>
<tr>
<td>CRQ total</td>
<td>16.8</td>
<td>3.8</td>
</tr>
<tr>
<td>PFSDQ-M total</td>
<td>7.3</td>
<td>6.1</td>
</tr>
<tr>
<td>CSES total</td>
<td>16.0</td>
<td>4.1</td>
</tr>
</tbody>
</table>

*Data are presented as No. (mean not shown).
†p < 0.1.
‡p < 0.05, significant difference between the two groups.
flexibility was also allowed in the construction of within-subjects covariance structures. The covariance structures applied to each dependent variable analysis and selected based on quality of fit included compound symmetry, autoregressive, antedependence, Huynh-Feldt, and Toeplitz.

The covariate depression was used for emotional function and mastery, total quality of life, and self-efficacy based on preliminary multiple linear regression analyses and theoretical support. To analyze any effect of treatment group on discharge 6MWT scores, univariate analysis of covariance was used. All residual scores were checked for normality and outliers. The scores of the CSES were squared to normalize the data; Box-Cox analysis was conducted to determine the optimal transformation function.

RESULTS

The recruitment period of the study was from January 2001 to March 2002. Sixty-four percent (n=43) of invited patients were recruited for the study (Fig 2). This sample size was chosen based on the number of participants that could feasibly be recruited within a 15-month period. A priori power analysis was difficult because of limited literature available to estimate means and SDs, size of interaction, and main treatment group effects, and covariance effects of different treatment combinations.

Six patients were only evaluated once because of hospitalization, low motivation, illness, and not agreeing to treatment group randomization. During the rehabilitation treatment phase, seven patients (19% of patients who began treatment) dropped out, four of them by the 6-week evaluation. A further nine patients (43% in total of patients who began treatment) dropped out by the 24-week follow-up. Attrition was attributed mostly to COPD-related surgery, illness, injury, finding the intensity of the program too great, and being unreachable or unwilling to be re-evaluated. Patients who had a COPD exacerbation were kept in the study provided that they did not receive additional physical therapy treatment. A COPD exacerbation was defined as significantly increased fatigue, cough, dyspnea, pulmonary secretions, and functional limitations, often due to a pulmonary infection. Scores on the MMSE were significantly lower for patients who dropped out of the study compared to patients who had not by the 6-week reevaluation (p=0.02; Table 1), suggest-

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**Figure 2. Flowchart of data collection.**

- 67 patients considered
- 43 patients randomized
  - 18 randomized to the ETAT group
    - 14 commenced treatment
    - Reevaluated at 6 weeks (n=11) 10 received treatment > 50%
    - Reevaluated at 12 weeks (n=9) 10 received treatment > 50%
    - Reevaluated at 18 weeks (n=8) 11 received treatment > 50%
    - Reevaluated at 24 weeks (n=6)
  - 10 randomized to the ETLS group
    - 10 commenced treatment
    - Reevaluated at 6 weeks (n=10) 10 received treatment > 50%
    - Reevaluated at 12 weeks (n=10)
    - Reevaluated at 18 weeks (n=9)
    - Reevaluated at 24 weeks (n=8)
  - 15 randomized to ETA group
    - 13 commenced treatment
    - Reevaluated at 6 weeks (n=12) 11 received treatment > 50%
    - Reevaluated at 12 weeks (n=11)
    - Reevaluated at 18 weeks (n=8)
    - Reevaluated at 24 weeks (n=7)
ing that patients with higher cognitive function are better candidates for pulmonary rehabilitation.

Patient baseline demographics did not differ significantly between the three treatment groups \((p > 0.10)\), except for age: \(F(2,29) = 5.5\) \((p = 0.009)\) [Table 2]. Despite randomization and related to attrition, participants in the ETLS group were younger than the ETA group, with a mean difference of 7 years \((p = 0.008)\). FEV\(_1\) as a measure of airflow obstruction severity was not compared between the groups because of missing data for 49% of participants. Mean baseline scores of groups also differed significantly for mastery: \(F(2,29) = 5.97\) \((p = 0.01)\); emotional function, \(F(2,30) = 4.18\) \((p = 0.03)\); and CRQ total, \(F(2,29) = 5.93\) \((p = 0.01)\), with better scores revealed for the ETA group compared to the ETLS group. No other significant differences were found. All subsequent repeated measures and test-retest analyses, therefore, controlled for baseline scores and analyzed age as a covariant. While these statistical corrections might not have completely addressed the imbalances in baseline variables, they served to improve the validity of the findings of the study.

The mean number of weeks of the pulmonary rehabilitation program for the participants overall was 9.7 weeks (SD 1.9). The total mean attendance rates for the activity training, lecture series, and exercise training sessions were 94%, 83%, and 98%, respectively.

Table 2—Baseline Variables of Participants With Reevaluation Data

<table>
<thead>
<tr>
<th>Variables</th>
<th>ETLS Group</th>
<th></th>
<th></th>
<th>ETAT Group</th>
<th></th>
<th></th>
<th>ETA Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr†</td>
<td>70.1*</td>
<td>7.3</td>
<td>10</td>
<td>73.5</td>
<td>4.5</td>
<td>11</td>
<td>77.1</td>
<td>4.0</td>
<td>11</td>
</tr>
<tr>
<td>Female/male gender</td>
<td>9/1</td>
<td></td>
<td>10</td>
<td>7/4</td>
<td></td>
<td>11</td>
<td>6/6</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Body mass index</td>
<td>27.7</td>
<td>9.4</td>
<td>10</td>
<td>27</td>
<td>5.7</td>
<td>11</td>
<td>23.3</td>
<td>3.0</td>
<td>11</td>
</tr>
<tr>
<td>Maximum packs smoked, packs/d</td>
<td>1.9</td>
<td>.8</td>
<td>10</td>
<td>1.5</td>
<td>1.5</td>
<td>11</td>
<td>1.1</td>
<td>0.7</td>
<td>11</td>
</tr>
<tr>
<td>Time since diagnosis, yr</td>
<td>4.1</td>
<td>5.9</td>
<td>10</td>
<td>5.6</td>
<td>5.9</td>
<td>9</td>
<td>4.9</td>
<td>5.2</td>
<td>11</td>
</tr>
<tr>
<td>MMSE</td>
<td>29.1</td>
<td></td>
<td>10</td>
<td>28.5</td>
<td>1.4</td>
<td>11</td>
<td>27.9</td>
<td>1.2</td>
<td>11</td>
</tr>
<tr>
<td>CES-D</td>
<td>17.1</td>
<td>9.5</td>
<td>9</td>
<td>18.2</td>
<td>9.5</td>
<td>11</td>
<td>12.6</td>
<td>6.8</td>
<td>11</td>
</tr>
<tr>
<td>6MWT, ft</td>
<td>944</td>
<td>475.63</td>
<td>10</td>
<td>878.64</td>
<td>288.23</td>
<td>11</td>
<td>882.27</td>
<td>287.14</td>
<td>11</td>
</tr>
<tr>
<td>CRQ total†</td>
<td>14.08*</td>
<td>3.03</td>
<td>10</td>
<td>16.61</td>
<td>3.23</td>
<td>11</td>
<td>19.13</td>
<td>3.42</td>
<td>12</td>
</tr>
<tr>
<td>CRQ dyspnea</td>
<td>3.11</td>
<td>1.18</td>
<td>10</td>
<td>3.62</td>
<td>0.98</td>
<td>11</td>
<td>4.22</td>
<td>1.48</td>
<td>12</td>
</tr>
<tr>
<td>CRQ mastery†</td>
<td>3.91*</td>
<td>1.05</td>
<td>10</td>
<td>4.84</td>
<td>1.36</td>
<td>11</td>
<td>5.75</td>
<td>1.15</td>
<td>12</td>
</tr>
<tr>
<td>CRQ fatigue</td>
<td>3.02</td>
<td>1.06</td>
<td>10</td>
<td>3.96</td>
<td>1.31</td>
<td>11</td>
<td>4.04</td>
<td>1.56</td>
<td>12</td>
</tr>
<tr>
<td>CRQ emotional function†</td>
<td>4.07†</td>
<td>0.90</td>
<td>10</td>
<td>4.24</td>
<td>0.88</td>
<td>11</td>
<td>5.18</td>
<td>1.13</td>
<td>12</td>
</tr>
<tr>
<td>PFSDQ-M total</td>
<td>9.30</td>
<td>5.77</td>
<td>10</td>
<td>7.18</td>
<td>6.83</td>
<td>11</td>
<td>5.69</td>
<td>5.53</td>
<td>12</td>
</tr>
<tr>
<td>Activity change</td>
<td>3.05</td>
<td>1.66</td>
<td>10</td>
<td>2.56</td>
<td>2.27</td>
<td>11</td>
<td>2.10</td>
<td>1.91</td>
<td>12</td>
</tr>
<tr>
<td>Dyspnea with activities</td>
<td>3.18</td>
<td>2.09</td>
<td>10</td>
<td>2.51</td>
<td>2.31</td>
<td>11</td>
<td>2.08</td>
<td>2.04</td>
<td>12</td>
</tr>
<tr>
<td>Fatigue with activities</td>
<td>3.07</td>
<td>2.23</td>
<td>10</td>
<td>2.11</td>
<td>2.34</td>
<td>11</td>
<td>1.51</td>
<td>1.72</td>
<td>12</td>
</tr>
<tr>
<td>CSES total</td>
<td></td>
<td></td>
<td>13.63†</td>
<td>1.89</td>
<td>10</td>
<td>16.07</td>
<td>4.69</td>
<td>11</td>
<td>17.86</td>
</tr>
</tbody>
</table>

\*\(p < 0.01\), mean difference is significant for the ETLS and ETA groups.

\†\(p < 0.01\) between the three treatment groups.

\‡\(p < 0.05\) between the three treatment groups.

\§\(p < 0.05\), mean difference significant between ETLS and ETA groups.

\∥\(p = 0.05\).

Pulmonary Functional Status (PFSDQ-M)

Significant three-way interactions were found between the variables treatment group, age, and time for total functional status and PFSDQ-M subscales \((p \leq 0.05);\) Table 3). The continuous variable age was divided into three covariate levels (68 years, 75 years, and 80 years) to analyze the three-way interaction effects. Covariate levels of age were used instead of age groups because there were not enough data for multiple age groups and the groups were not balanced with respect to age.

Functional status outcomes were significantly better at 12 weeks (discharge) for comparatively older participants in the ETAT group compared to the ETA group. The ETAT group had significantly less dyspnea with activities \((p \leq 0.003)\), fatigue with activities \((p \leq 0.003)\), and change in activity involvement from premorbid levels \((p \leq 0.02)\), and significantly better total functional status compared to the ETA group at 12 weeks for older participants \((p \leq 0.01)\).

At 6 weeks and 12 weeks, dyspnea and fatigue with activities were significantly less in the ETAT group compared to the ETLS group for older participants \((p \leq 0.04)\). Also, for older participants at 12 weeks, change in activity involvement from premorbid levels was significantly less (adjusted \(p \leq 0.0004\)) and total functional status was significantly better (adjusted \(p \leq 0.02\)) in the ETAT group compared to the ETLS group.
At 6 weeks, however, dyspnea and fatigue with activities were significantly less for participants in the ETA group compared to those in the ETLS group for the covariate value 80 years ($p \leq 0.03$). At 12 weeks, greater activity involvement ($p \leq 0.03$) for comparatively older participants and greater total

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age × Time × Group</th>
<th>Time, wk</th>
<th>Three Levels of Age, yr</th>
<th>Post hoc Effect Slices: Time × Group × Age</th>
<th>Post hoc Pairwise Comparisons</th>
<th>Differences of Least Squares Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyspnea with activities subscale</td>
<td>F(6,31) = 4.72, p = 0.002</td>
<td>6</td>
<td>75</td>
<td>F(2,26) = 3.95, $p = 0.032$</td>
<td>ETAT vs ETLS, $t(26) = -2.81$, $p = 0.009$</td>
<td>$t(26) = -2.30$, $p = 0.030$; ETLS vs ETA, $t(26) = 2.39$, $p = 0.025$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>80</td>
<td>F(2,26) = 3.43, $p = 0.048$</td>
<td>ETAT vs ETLS, $t(27) = -3.59$, adjusted $p = 0.04$; ETAT vs ETA, $t(28) = -2.81$, $p = 0.009$</td>
<td>$t(28) = -3.91$, adjusted $p = 0.02$; ETAT vs ETA, $t(29) = -3.21$, $p = 0.003$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>75</td>
<td>F(2,27) = 7.29, $p = 0.003$</td>
<td>ETAT vs ETLS, $t(28) = -3.19$, adjusted $p = 0.002$; ETAT vs ETA, $t(29) = -3.20$, $p = 0.003$</td>
<td>$t(28) = 3.59$, adjusted $p = 0.04$; ETAT vs ETA, $t(29) = 3.21$, $p = 0.003$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>80</td>
<td>F(2,27) = 7.93, $p = 0.002$</td>
<td>ETAT vs ETLS, $t(28) = -3.19$, adjusted $p = 0.002$; ETAT vs ETA, $t(29) = -3.20$, $p = 0.003$</td>
<td>$t(28) = 3.59$, adjusted $p = 0.04$; ETAT vs ETA, $t(29) = 3.21$, $p = 0.003$</td>
</tr>
<tr>
<td>Fatigue with activities subscale</td>
<td>F(6,32) = 2.38, p = 0.051</td>
<td>6</td>
<td>75</td>
<td>F(2,42) = 3.72, $p = 0.033$</td>
<td>ETAT vs ETLS, $t(40) = -2.73$, $p = 0.01$</td>
<td>$t(40) = -2.70$, $p = 0.01$; ETLS vs ETA, $t(41) = 2.76$, $p = 0.009$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>80</td>
<td>F(2,40) = 4.68, $p = 0.015$</td>
<td>ETAT vs ETLS, $t(39) = -3.45$, $p = 0.001$; ETAT vs ETA, $t(48) = -3.12$, $p = 0.003$</td>
<td>$t(39) = -3.19$, adjusted $p = 0.02$; ETAT vs ETA, $t(41) = -3.21$, $p = 0.003$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>75</td>
<td>F(2,47) = 7.48, $p = 0.002$</td>
<td>ETAT vs ETLS, $t(46) = -3.45$, $p = 0.001$; ETAT vs ETA, $t(48) = -3.12$, $p = 0.003$</td>
<td>$t(46) = -3.19$, adjusted $p = 0.02$; ETAT vs ETA, $t(48) = -3.21$, $p = 0.003$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>80</td>
<td>F(2,45) = 8.57, $p = 0.001$</td>
<td>ETAT vs ETLS, $t(46) = -4.02$, adjusted $p = 0.01$; ETAT vs ETA, $t(46) = -3.42$, $p = 0.001$</td>
<td>$t(46) = -3.19$, adjusted $p = 0.02$; ETAT vs ETA, $t(48) = -3.21$, $p = 0.003$</td>
</tr>
<tr>
<td>Change in activity involvement subscale</td>
<td>F(6,57) = 3.37, p = 0.007</td>
<td>12</td>
<td>75</td>
<td>F(2,49) = 12.37, $p &lt; 0.0001$</td>
<td>ETAT vs ETLS, $t(47) = -4.97$, adjusted $p = 0.0004$; ETAT vs ETA, $t(53) = -2.39$, $p = 0.021$; ETLS vs ETA, $t(47) = 2.66$, $p = 0.011$</td>
<td>$t(47) = -4.02$, adjusted $p = 0.01$; ETAT vs ETA, $t(46) = -3.42$, $p = 0.001$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>80</td>
<td>F(2,46) = 14.82, $p &lt; 0.0001$</td>
<td>ETAT vs ETLS, $t(48) = -5.42$, adjusted $p = &lt; 0.0001$; ETAT vs ETA, $t(50) = -3.21$, $p = 0.002$; ETLS vs ETA, $t(43) = 3.64$, adjusted $p = 0.03$</td>
<td>$t(48) = -3.21$, adjusted $p = 0.02$; ETAT vs ETA, $t(49) = -3.20$, $p = 0.003$</td>
</tr>
<tr>
<td>Total functional status</td>
<td>F(6,32) = 5.87, p = 0.0003</td>
<td>12</td>
<td>75</td>
<td>F(2,27) = 8.43, $p = 0.001$</td>
<td>ETAT vs ETLS, $t(27) = -4.00$, adjusted $p = 0.02$; ETAT vs ETA, $t(28) = -2.60$, $p = 0.01$</td>
<td>$t(27) = -4.11$, adjusted $p = 0.01$; ETAT vs ETA, $t(29) = -3.20$, $p = 0.003$; ETLS vs ETA, $t(25) = 2.30$, $p = 0.03$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12</td>
<td>80</td>
<td>F(2,27) = 9.76, $p = 0.0006$</td>
<td>ETAT vs ETLS, $t(28) = -4.41$, adjusted $p = 0.01$; ETAT vs ETA, $t(29) = -3.20$, $p = 0.003$; ETLS vs ETA, $t(25) = 2.30$, $p = 0.03$</td>
<td>$t(28) = -3.20$, adjusted $p = 0.02$; ETAT vs ETA, $t(29) = -3.20$, $p = 0.003$</td>
</tr>
</tbody>
</table>

*Statistically significant differences only shown; adjusted $p$ = adjusted $p$ value with Tukey-Kramer correction.
functional status (p = 0.03 for 80-years covariate level) were found in the ETA group compared to the ETLS group. No other significant differences were found between the treatment groups. At the 18-week and 24-week follow-ups, treatment groups did not differ significantly.

**Health-Related Quality of Life (CRQ)**

Total quality-of-life scores were significantly higher for the ETAT group compared to the ETLS group, t(15) = 2.79 (adjusted p = 0.03) [Table 4]. No significant interaction effects of time with group assignment were found for CRQ scores (p ≥ 0.27). Mean emotional function scores of the ETAT and ETA groups were also significantly better than those of the ETLS group (p = 0.02 and p = 0.03, respectively). No main treatment group effects were found for dyspnea (p = 0.09), fatigue (p = 0.22), or mastery (p = 0.37). Age was found to be a significant covariate for CRQ total quality of life (p = 0.048) and mastery (p = 0.007) only.

**Exercise Tolerance and Self-Efficacy**

No significant differences were found between the treatment groups for self-efficacy (p = 0.53) and walk distance (p = 0.77). The estimated means for exercise tolerance at discharge for the ETAT, ETA, and ETLS groups were 1,148.37 feet (SE 82.76), 1,083.96 feet (SE 83.64), and 1,026.50 feet (SE 84.88), respectively. A significant overall combined treatment effect, however, was found for all participants with respect to exercise tolerance, F(3,23) = 16.44 (p < 0.0001). Walking distance increased by 179.84 feet at discharge (n = 27) as compared to baseline. The estimated marginal mean walking distance at baseline was 905.56 feet, and at discharge the estimated marginal mean walking distance was 1,085.40 feet (SE 43.73).

**DISCUSSION**

**Functional Status**

Age was found to have a linear effect and to predict ETAT treatment effectiveness for functional status. Participants of older age in the ETAT group experienced the greatest improvements in functional status as compared to the other two groups at 12 weeks. The ETAT treatment appeared to have no greater effect on functional status for participants of comparatively young age.

The finding that age predicts functional status treatment effectiveness is consistent with the theoretical information of Neugarten,25 who separated the older adult population into two groups, the “young-old” (55 to 75 years) and the “old-old” (≥ 76 years old), postulating that chronological age groups approximate different abilities and situations of individuals. It is reasonable, therefore, to expect that individuals will respond differently to physical performance demands and have different learning needs based on their age.

The application of andragogy principles to breathing retraining may have enhanced the effectiveness of activity training. This adjunct afforded patients with increased learning opportunities and learning techniques to aid their memory and learning of dyspnea management strategies. Examples of such methods included the use of analogies to aid memory, training in context, practice of personally relevant activities, immediate and task-related feedback, repetition of new information presented in a variety

**Table 4—Results for Repeated-Measures Analyses Using the CRQ: Effect of Treatment Group on Health-Related Quality of Life (Controlling for Time)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>ETLS</th>
<th>ETAT</th>
<th>ETA</th>
<th>Mixed Linear Models: Treatment Group</th>
<th>Mean Difference, ETAT vs ETLS</th>
<th>Mean Difference, ETAT vs ETA</th>
<th>Mean Difference, ETLS vs ETA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adjusted</td>
<td>Adjusted</td>
<td>Adjusted</td>
<td>Mean</td>
<td>Difference</td>
<td>Mean</td>
<td>Difference</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>3.94</td>
<td>0.34</td>
<td>4.91</td>
<td>0.30</td>
<td>4.22</td>
<td>0.32</td>
<td>F(2.29) = 2.63, p = 0.099</td>
</tr>
<tr>
<td>Fatigue</td>
<td>3.95</td>
<td>0.28</td>
<td>4.47</td>
<td>0.27</td>
<td>3.84</td>
<td>0.27</td>
<td>F(2.19) = 1.62, p = 0.22</td>
</tr>
<tr>
<td>Emotional function</td>
<td>4.20</td>
<td>0.23</td>
<td>4.91</td>
<td>0.20</td>
<td>5.02</td>
<td>0.22</td>
<td>F(2.29) = 3.55, p = 0.04</td>
</tr>
<tr>
<td>Mastery</td>
<td>4.77</td>
<td>0.32</td>
<td>5.17</td>
<td>0.28</td>
<td>5.45</td>
<td>0.30</td>
<td>F(2.29) = 1.03, p = 0.37</td>
</tr>
<tr>
<td>CRQ Total</td>
<td>16.43</td>
<td>0.99</td>
<td>19.99</td>
<td>0.82</td>
<td>18.31</td>
<td>0.54</td>
<td>F(2.18) = 3.96, p = 0.04</td>
</tr>
</tbody>
</table>

*Unadjusted, p < 0.05.
†Adjusted, p < 0.05 (with Tukey-Kramer correction).
of ways, and trying out new behaviors in a safe therapeutic environment.26

The emphasis on controlled breathing practice in activity training appears to have helped further reduce the constraining influence of dyspnea with daily activities.27 It is possible that the paced breathing and coordinated breathing elements of activity training promoted more efficiency with performing daily activities. The ETAT treatment combination may have had the greatest effect on functional status by decreasing dyspnea directly and also indirectly by decreasing anxiety.24 There is disagreement in the literature regarding the effectiveness of controlled breathing, including pursed-lip breathing and diaphragmatic breathing with compensatory postures, in reducing dyspnea;1 the findings of this study suggest that the effectiveness of breathing retraining is enhanced when combined with supervised activity training for older patients.

A strength of the activity training was that sessions were mostly limited to one or two patients, which afforded individualized training and feedback. In contrast, in the study by Sassi-Dambron et al,28 groups of between four and eight patients practiced techniques at activity stations. This group size may have been too large to offer patients sufficient, individualized feedback and practice opportunity, contributing to their findings that a combination of breathing training, activity training, and education did not improve functional status and health-related quality of life. The addition of a domiciliary environment for the activity-training component may have also promoted better integration of controlled breathing into daily living.29,30

The minimally important difference score of the PFSDQ-M has not yet been established; however, we estimated it to be 1 U or 10% (on its 11-point scale) based on our clinical experience. Difference in scores between the ETAT group and other groups for PFSDQ-M subscales were between 1 U and 3 U for older adults, which appeared to be clinically meaningful. For example, dyspnea with activities at 12 weeks and 80-year level was 1.37 (lower range of mild) for the ETAT group, 3.83 (the lower range of moderate) for the ETLS group, and 2.57 (upper range of mild) for the ETA group.

The greater improvements in functional status for the ETAT group were not adequately robust to be maintained in the long term. A decreased rehabilitation effect over time for functional status is supported by other research findings.29,31–34 Research is needed to investigate ways to maintain rehabilitation gains long-term such as with the provision of follow-up services.

The results may further suggest that the PFSDQ-M is a more sensitive scale compared to the CRQ in detecting dyspnea and fatigue score differences between groups. The PFSDQ-M has a higher number of response choices and greater number of items per subscale, which may contribute to greater sensitivity. The sensitivity of these two scales has not been specifically compared in the literature.

The addition of a lecture series was ineffective in improving functional status compared to exercise training alone and appeared to result in significantly less short-term improvement in functional status for the oldest participants. The lectures may have been too limited in depth and scope to benefit patients.5 It is important to note that the additional attention from health-care professionals in the ETLS group did not improve quality of life and functional status compared to ETA. This finding serves to enhance the validity of the findings regarding the relative effectiveness of the ETAT treatment.

Quality of Life

The activity training adjunct led to significantly higher quality of life than the lecture series adjunct. The benefit of activity-based occupational therapy in promoting health-related quality of life is consistent with other research findings.35 Active participation in meaningful activities is associated with satisfaction of one’s needs, improvement in relationships, and increased enjoyment of life.27,36–38

Emotional function was significantly higher in the ETAT and ETA groups as compared to the ETLS group. This result seems to suggest that the lecture series adjunct negatively affected emotional function. This result, while surprising, is consistent with the study by Scherer et al,39 who found an increase in psychological distress after education. Given the high levels of anxiety characteristic of adults with COPD, lecture content individualized to the preferences and needs of a set group of patients with COPD may promote better outcomes.

Exercise Tolerance

The increased walking ability (of 179.8 feet) gained by the participants overall was more than the minimum clinically important difference of 164 feet for indoor mobility.40 Exercise tolerance increased despite the participants attending exercise training only twice a week. This finding was consistent with other studies40 that have found less intensive pulmonary treatments can yield good outcomes. It was, however, inconsistent with the study results of Ringbaek et al,41 who found that exercise training provided twice a week was not enough to improve exercise tolerance for patients with COPD.
Limitations of the Study

Participants were predominately white and highly educated, and living in an urban environment. Therefore, the findings of this study cannot be generalized to other cultural groups or educational backgrounds. A potential source of bias was that the data collector (the first author) was not blinded to group assignment. Funding constraints precluded the additional control of a neutral, blind researcher.

Most likely because of the small sample size of the study, the randomization method did not ensure that the treatment groups were equal at baseline. Statistical baseline differences were found between the ETA and ETLS groups. However, these differences were controlled for statistically in later analyses.

The power was low for several statistical tests related to the small sample size. For example, the power to find an overall significant treatment effect for the CRQ dyspnea subscale was 0.48. A minimum sample size of 65 participants would have been required to increase the power to an acceptable level of 0.77.

As part of the attrition procedure, participants remained in the study despite colds or respiratory infections developing provided they did not receive additional therapy. The development of respiratory infections, however, added a confounding variable.

The research design of this study allowed two experimental groups to receive more attention and time than the ETA comparison group. This was justified based on the aim of replicating the standard of care. Nonetheless, treatment time may be a confounding variable.

Also, postrehabilitation maintenance programs were not standardized. The intensity, attendance, and compliance with a home exercise program could not be standardized. It cannot therefore be concluded whether improvements maintained after discharge were due to the pulmonary program of the study.

Conclusion

A strength of this study was the inclusion of two experimental treatment groups that allowed for comparison of treatment combination effects, including teaching methods and content, and increased control of the placebo effect of attention. An important focus was on the effect of dyspnea management strategies directed toward daily activity performance in contrast to most other pulmonary outcome studies that have primarily investigated the effect of dyspnea management on exercise performance.

It was found that age predicted treatment effectiveness for functional status. The doing of supervised physical activity and practice of controlled breathing in activity training were found to be more effective in increasing both functional status and quality of life compared to didactic instruction on topics other than controlled breathing. The best candidates for the activity training adjunct were motivated patients of comparatively older age with dyspnea and or dyspnea-related anxiety during daily activities. Follow-up study is recommended to further evaluate interaction effects between treatment group and age for different outcomes.

The ETAT treatment combination resulted in additional benefits compared to ETA. Much evidence exists in the literature to support that exercise training improves exercise tolerance for adults with COPD, establishing exercise training as standard care. However, when activity training is combined with exercise training, older participants with COPD appear to gain greater functional status at the end of treatment. The additional benefits gained from the activity training adjunct may result from improved learning and application of dyspnea management strategies and more diversified opportunities for desensitization to dyspnea.

The sample size of this study was small. Further outcome research, with larger sample sizes, of the effectiveness of activity training as an adjunct therapy to standard exercise training and the effects of different training methods for older adults with COPD is needed. The benefit of postdischarge programs in maintaining rehabilitation gains also warrants further study.

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