The Components of a Respiratory Rehabilitation Program*

A Systematic Overview

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Objective: To determine the contribution of the various components of a rehabilitation program to the improvement of exercise capacity and health-related quality of life (HRQL) in patients with COPD.

Data sources: MEDLINE (1966 to April 1996) was searched. Abstracts presented at international conferences were also hand searched for additional relevant trials. Bibliographies of the retrieved articles were reviewed. Experts in rehabilitation were consulted to uncover unpublished trials.

Study selection: Randomized controlled trials (RCTs) of exercise training, breathing exercises, education, and psychosocial support in patients with COPD were primarily included if (1) the treatment effect of a specific component of a rehabilitation program could be isolated, and (2) exercise capacity, HRQL, compliance with medical therapy, and/or knowledge about the disease were measured.

Data synthesis: A best-evidence synthesis was conducted. 22 RCTs contributed to the analysis. We found the following: (1) the patients exposed to interventions that included exercise training improved their functional exercise capacity and HRQL; (2) exercise training was muscle specific; (3) the evidence to support inspiratory muscle training and other breathing exercises as an adjunct to exercise training in COPD remains equivocal; (4) the contribution of education has not been well addressed; and (5) psychosocial support reduced dyspnea acutely and, when used as an adjunct to rehabilitation, promoted compliance with an exercise regimen and improved HRQL.

Conclusion: Respiratory rehabilitation is likely to improve functional exercise capacity and HRQL if it includes exercise training and psychosocial support. Further research is required to better define the types and intensity of exercise as well as the influence of respiratory muscle training and patient education.

Key words: chronic obstructive lung diseases; education; exercise therapy; rehabilitation; social support

Abbreviations: HRQL=health-related quality of life; IMT=inspiratory muscle training; SCL-90=Symptom Checklist; SIP=Sickness Impact Profile

Respiratory rehabilitation for patients with COPD is gaining wider acceptance,1,2 as reports of its effectiveness begin to address the physiologic basis of exercise training3 and randomized controlled trials include rigorous measures of health-related quality of life (HRQL)4,5 and exercise capacity.

We recently undertook a meta-analysis of respiratory rehabilitation in patients with COPD in which we included randomized controlled trials comparing rehabilitation with usual community care.6 We defined a rehabilitation program as any inpatient, outpatient, or home-based program of at least 4 weeks' duration that primarily included systemic exercise therapy, with or without education and/or psychosocial support. We identified 16 clinical trials that satisfied the inclusion criteria, 14 of which finally contributed to our analysis. We observed that rehabilitation improved exercise capacity and HRQL to an extent that most often approached or exceeded the minimal clinically important difference.7-9 Although the small number of trials and the limitations of between-study comparisons reduced the power of the subgroup analyses, simple rehabilitation programs consisting of exercise training alone were as
effective in improving exercise capacity and HRQL as the most comprehensive ones.

Given that exercise training is the cornerstone of any rehabilitation program, there is considerable uncertainty regarding the contribution of other program components. Therefore, we undertook to identify randomized controlled trials that provided further definition of the exercise component of respiratory rehabilitation in COPD (intensity, upper vs lower limb, inspiratory muscle training [IMT], breathing exercises) as well as to determine whether education and psychosocial support were effective on their own or as adjuncts to exercise training in improving exercise capacity, HRQL, compliance, or knowledge about the disease. Such information is important to physicians and allied health professionals who prescribe rehabilitation and to those who allocate resources to promote more widespread availability of this modality for patients with COPD.

**Materials and Methods**

In conducting the systematic overview, we used the approach of "best-evidence synthesis" proposed by Slavin. This approach considers that the best evidence comes from studies that have a high internal and external validity and that use well-specified and defined a priori inclusion criteria. Furthermore, it refers to the magnitude of the treatment effect as an adjunct to a full discussion of the literature at hand.

**Literature Search**

The following search strategies were used to uncover relevant publications from the English-language medical literature. First, MEDLINE (1966 to April 1996) was searched for original articles using the following strategy: [lung diseases, obstructive] and (1) [exercise therapy or rehabilitation]; or (2) [patient education or health education]; or (3) [psychotherapy or counseling or social support]. All the terms were explored. The results of this search were then combined with [research design or longitudinal studies or evaluation study or randomized controlled trial]. Reference lists of relevant articles were reviewed, and potential additional citations were retrieved. Abstracts presented at international meetings (American Thoracic Society, 1980 to 1995, and European Respiratory Society, 1987 to 1994) were also hand searched. The reference list of the latest official statement of the American Thoracic Society about the standards for the diagnosis and care of patients with COPD [11] was examined. Finally, experts in the field of respiratory rehabilitation were consulted to uncover unpublished material.

**Inclusion Criteria**

The following criteria were used in selecting studies for inclusion in the overview.

**Target Population:** The population under study consisted of patients with a clinical diagnosis of COPD. No attempt was made to distinguish chronic bronchitis from emphysema.

**Respiratory Rehabilitation:** Any intervention consisting of systemic exercise therapy, education, and/or psychological support delivered to patients with limitations attributable to COPD was considered. We included only trials in which (1) the treatment effect of a specific component of a rehabilitation program could be isolated (such as physical therapy alone vs physical therapy plus education, or exercise training alone vs exercise training plus inspiratory muscle training), or (2) an innovative treatment modality was compared with a standard treatment approach (such as high- vs low-intensity training, or comprehensive rehabilitation vs education alone).

**Outcomes:** Exercise capacity and HRQL were considered as relevant primary outcomes. Secondary outcomes related to education and psychosocial support included compliance with medical therapy and knowledge about the disease.

**Methodologic Criteria:** Randomized controlled trials were primarily considered. If no such trials were available, we accepted nonrandomized concurrent cohort studies as the next strongest level of evidence.

The above criteria were applied liberally and separately by two independent reviewers (Y.L. and B.S.G.) to the MEDLINE search printout in deciding which articles to retrieve. Any article for which either the title or the abstract suggested any possibility that it might be relevant was retrieved. Abstracts related to rehabilitation in COPD that were retrieved from hand searching were also photocopied. The first authors of the abstracts were contacted. Whether the paper had been published, a copy of the text was requested and included in the study list if relevant. The agreement between coders regarding the review of the MEDLINE search was measured using quadratic-weighted kappa statistics. A minimum a priori criterion for the agreement to be considered as substantial was set at kappa \(\geq 0.65\). A log of reasons for rejection of citations identified from the searches was kept.

**Outcomes**

**Exercise Capacity:** A number of protocols have been advocated for exercise testing. Conceptually, these protocols can be divided into two broad categories: (1) maximal exercise capacity tests (incremental cycle ergometry or treadmill tests) where exercise capacity is expressed in terms of workload, energy, or oxygen consumption, and (2) functional exercise capacity tests (as exemplified by the timed-walk tests). The results of maximal and functional exercise capacity have been compared in at least five studies, and most often, the investigators have found only a moderate correlation, suggesting that they represented different constructs.

**Health-Related Quality of Life:** We searched for evidence of validity and responsiveness of the measures of health-status used in each trial.

**Compliance and Knowledge About the Disease:** No single measure of compliance and knowledge is currently available. Therefore, the measurement strategies used by the investigators were examined in an attempt to ascertain their measurement properties.

**Assessment of Methodologic Quality**

Validity of the trials was independently assessed by two reviewers (Y.L. and B.S.G.) to examine the relationship between methodologic quality and treatment effect. We used the only existing validity assessment scale that has been formally validated. This instrument was specifically developed to assess the quality of the report of trials. It contains three items assessing (1) whether the study was truly randomized, (2) whether the trial was described as double blinded, and (3) whether a detailed follow-up of the patients was provided. However, as this scale yields high scores for double-blinded trials and only a few trials were described as such, we also focused on two additional study...
characteristics that have proved to be major determinants in the magnitude of the effect size in clinical trials. First, bias associated with poor allocation concealment can lead to an overestimation of the treatment effect by up to 40%. Second, unblinded study personnel measuring outcomes may, by providing differential encouragement, influence the results (up to 30.5 m in a 6-min walk test). Percentage agreement between the reviewers was calculated for each item. Disagreement between reviewers was resolved by consensus.

Data Extraction and Synthesis

Two reviewers (Y.L. and R.S.G.) abstracted information from the original articles selected for inclusion in the best-evidence synthesis. The abstracted information included the following: (1) the baseline characteristics of the participants in the study; (2) the number and distribution of patients who dropped out or withdrew from the study; (3) a full description of the respiratory rehabilitation program (setting, components, and duration); (4) the exercise capacity outcome measures and the corresponding results; and (5) the HRQOL measures and the associated results. The reviewers discussed the content of each study included in the best-evidence synthesis to ascertain that their interpretation of the article was the same. Disagreement was also resolved by consensus.

All the studies included in the best-evidence synthesis were listed and described in tables specifying the design of the studies and the major variables. In each trial and for each outcome, whenever possible, a “gain score” was calculated. The gain score refers to the magnitude of the treatment effect and was defined, in order to take into account preexperiment group differences, as the difference between the preintervention and postintervention differences in the treatment and control groups. In the tables of study characteristics and gain scores, results from the studies for which the gain score could not be computed were represented as “+” (statistically significant difference between groups favoring the treatment group), “0” (no significant difference), and “−” (statistically significant difference favoring the control group). Unless otherwise specified in the primary studies included in the overview, statistical significance was set at the 0.05 level.

RESULTS

Literature Search

Two hundred eighty-eight publications were retrieved from the computerized search; 12 met the inclusion criteria of the best-evidence synthesis. The level of agreement between the reviewers was excellent (Kappa=0.84 [95% confidence interval, 0.72 to 0.96]). Fifty-four abstracts were also identified, none of which contributed to the review. The reasons for excluding 276 studies were as follows: wrong population (mostly asthmatics [n=167]); intervention not meeting the definition of rehabilitation (n=43); control group receiving conventional community care only (n=5); trials not randomized (n=29); and miscellaneous reasons (n=32). Contacts with experts in the field of respiratory rehabilitation and the review of the reference lists of the relevant articles led to the recovery of 14 additional studies, for a total of 26 articles included in the best-evidence synthesis. The results of three trials were also reported in more than one publication. The articles reporting on the same trials were considered together. Therefore, 22 separate trials were finally considered in the best-evidence synthesis. These articles are summarized in Tables 1 to 5.

Validity Assessment

The level of agreement (percentage agreement) between the two reviewers regarding each of the five validity criteria was good, ranging from 73 to 100% (median, 95%). Although all the trials were described as randomized and controlled, the randomization process was described in only three reports. In one instance in which two reports related to different aspects of the same trial, different randomization processes were described. Randomization could clearly be identified as concealed in only one trial. Only two trials were described as double blinded. The description of the dropouts and withdrawals was appropriate in 14 trials (64%). Finally, only four trials specified that those responsible for the outcome measures remained blinded as to the group allocation of the patients. The results of the validity assessment are also presented in Tables 1 to 5. In summary, even though all the selected trials were described as controlled and randomized, the information reported in the methods section of the articles did not allow a clear categorization into high- and low-quality trials.

Exercise Regimen

Intensity of the Training: An important article addressing the physiologic basis for exercise training in patients with COPD was published by Casaburi and collaborators (Table 1). The authors evaluated 19 patients with moderate COPD (mean FEV1, 56% predicted) who were randomized to either high-intensity (11 patients) or low-intensity (eight patients) exercise training. Following an incremental cycle exercise test, high-intensity work was defined as work at 60% of the difference between the anaerobic threshold and the maximal exercise capacity. Low-intensity work was defined as work at 90% of the anaerobic threshold. Patients exercised 5 days a week for 8 weeks. The low-intensity training group exercised for longer than the high-intensity group in order to allow the total work to be similar between the groups. The response to training was assessed by repeating the incremental cycle ergometer test and by measuring steady-state exercise at high and low work rates. Although the total work was the same, patients who trained at high work rates experienced...
Table 1—Exercise Regimen: Summary of the Characteristics of the Randomized Trials Included in the Systematic Overview

<table>
<thead>
<tr>
<th>First Author, yr</th>
<th>Setting</th>
<th>Comparison Groups*</th>
<th>Duration, wk</th>
<th>Exercise Capacity1</th>
<th>Health Status1</th>
<th>Magnitude of the Treatment Effect1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casaburi,3 1991</td>
<td>Inpatient</td>
<td>High-intensity LLE (n=11) vs low-intensity LLE (n=8)</td>
<td>8</td>
<td>ICET; SSCET (at high- and low-intensity work)</td>
<td>Not measured</td>
<td>At identical levels of heavy exercise: Lactates -1.7 mEq/L (-); Minute ventilation: -6.3 L/min (-)</td>
</tr>
<tr>
<td>Vallet,37 1986</td>
<td>Inpatient</td>
<td>Individualized training at the anaerobic threshold (n=12) vs training at 50% maximal heart rate (n=12)</td>
<td>4</td>
<td>ICET</td>
<td>Not measured</td>
<td>At identical levels of heavy exercise: Heart rate: (-); O2 pulse: (+)</td>
</tr>
<tr>
<td>Lake,39 1990</td>
<td>Outpatient</td>
<td>ULE+LLE (n=7) vs ULE (n=6) vs LLE (n=6) vs control (no exercise) (n=7)</td>
<td>8</td>
<td>IAET; ICET; 6-min walk</td>
<td>Modified self-efficacy scale of Bandura</td>
<td>ULE+LLE vs LLE alone: IAET: +6.2 kilopound-meters/min (+); ICET: -50 kilopound-meters/min (0); 6-min walk test: -13.3 m (0)</td>
</tr>
<tr>
<td>Martinez,42 1993</td>
<td>Outpatient</td>
<td>Rehabilitation (LLE+IMT)+(1) supported arm exercise (n=17) vs (2) unsupported arm exercise (n=18)</td>
<td>10</td>
<td>12-min walk; ICET; IAET; dowel test</td>
<td>Not measured</td>
<td>Unsupported vs supported: dowel test: (+); ICET, IAET, 12-min walk test: (0)</td>
</tr>
<tr>
<td>Ries,43 1988</td>
<td>Outpatient</td>
<td>LLE, BE, education, psychological support+(1) ULE (gravity resistance) (n=8) vs (2) ULE (proprioceptive neuromuscular facilitation) (n=9) vs (3) control (n=11)</td>
<td>6</td>
<td>ICET; SSTT; IAET (isotonic and isokinetic); arm lift</td>
<td>Not measured</td>
<td>Gravity resistance vs control: Arm lift: +9 lifts (+); Isokinetic IAET (endurance time): +1,045 s (+)</td>
</tr>
</tbody>
</table>

*LLE=lower-limb exercise; ULE=upper-limb exercise; BE=breathing exercises.
1ICET=incremental cycle ergometer test; SSCET=steady-state cycle ergometer test; SSTT=steady-state treadmill test; IAET=incremental arm ergometer test.
2Numeric data not available in all studies; plus sign=statistically significant, positive; zero=no significant difference; minus sign=statistically significant, negative.

less lactate and a lower minute ventilation compared with patients who trained at low work rates.

Vallet et al37 also examined the effect of individualizing training intensity by heart rate in 28 patients with moderate COPD. Patients participating in a 4-week comprehensive rehabilitation program (5 days a week for 45 min) were randomized to receive exercise training at the heart rate corresponding to their anaerobic threshold or exercise training at an intensity set at 50% of the maximal heart rate reserve (standard training). Twenty-four patients completed the study. Patients in the standard training group exercised above or below the anaerobic threshold. An increase in the maximal oxygen consumption and a decrease in lactate level was observed in the individualized group but not in the standard training group.

The results of these two studies conducted in patients with mild or moderate COPD suggest such patients can achieve physiologic training that may be maximized by establishing an individual training intensity either at or above the anaerobic threshold. Whether this physiologic training influences functional exercise capacity, daily activities, or health-related quality of life has not been explored. Whether a high-intensity training regimen is feasible in patients with severe COPD remains unknown.

**Upper-Limb Training:** The observation that upper-extremity exercise was associated with dyssynchronous breathing and disproportionate dyspnea38 has provoked interest in upper-limb training for patients with COPD. However, only one small randomized controlled trial has compared the results of upper-limb training with lower-limb training and a combination of both.39 Twenty-eight patients (mean FEV1, 32% of predicted value) participating in an 8-week comprehensive rehabilitation program were randomized to receive the following: (1) upper-limb exercise; (2) lower-limb exercise; (3) combined exercise; and (4) no exercise (control). Training was for 40 to 50 min three times a week. Leg exercises consisted of walking. Arm exercises included arm ergometry and a variety of simple exercises during which the arms were held above the horizontal.
Outcome measures included a maximal cycle ergometer test, a maximal and submaximal arm ergometer test, a 6-min walk test, and a modified self-efficacy scale of uncertain validity. Self-efficacy refers to the personal conviction people have regarding whether they feel that they can successfully execute particular behaviors in order to produce certain outcomes. Twenty-six patients completed the study. Although the magnitude of the treatment effect attributable to arm training was small and of unknown clinical significance, the results indicated that training was muscle specific (Table 1).

Upper-Limb Exercise Modalities: Martinez and collaborators compared the effect of supported and unsupported arm exercises in patients with severe COPD. Forty patients were enrolled in a 10-week, comprehensive, outpatient rehabilitation program. All patients were offered lower-extremity training (cycle ergometer or treadmill) and inspiratory muscle training. The patients were randomized to either supported arm training (arm ergometry) or unsupported arm training (various exercises performed using a dowel). Patients trained three times a week for about 45 min. Thirty-five patients completed the study. Both groups experienced similar and significant increases in their 12-min walked distance, maximal cycle ergometry, and arm ergometry. Those who received unsupported arm exercise had a greater improvement in dowel endurance.

Ries and coworkers evaluated two simple upper-extremity exercise programs. Fifty-five patients with severe COPD who participated in an 8-week comprehensive pulmonary rehabilitation program (including lower limb exercise, breathing exercise, education, and psychosocial support) were randomized to receive (1) no upper-extremity training, (2) gravity-resistance upper-extremity training (low-resistance exercises), and (3) a proprioceptive neuromuscular facilitation program (exercise of functionally related muscles). Twenty-eight patients completed the program. Patients who underwent upper limb training improved their tests of arm function, whereas control patients did not.

Overall, upper-extremity training improved arm-specific measures of exercise capacity. The measurement properties of the instruments used to evaluate the effect of upper-limb training, however, were not well characterized. Furthermore, the correlation between these measures and HRQL has not been described. Whether arm training improved HRQL more than leg training alone remains untested. Since many activities of daily living (and most household activities) involve the upper extremities, the contribution of upper-extremity exercise training to improvements in HRQL should be examined further.

Inspiratory Muscle Training as an Adjunct to Exercise Training

In a meta-analysis published in 1992, Smith and collaborators found little evidence of clinically important benefits of IMT beyond an improvement in results of respiratory muscle endurance tests (Table 2). Although randomized controlled trials that evaluated the effect of respiratory muscle training were considered, no distinction was made between trials of IMT vs conventional care and trials in which IMT was added to exercise therapy. Conceivably, the effect of IMT might differ depending on the study design. This hypothesis was not tested in their meta-analysis.

We identified a total of seven studies in which IMT was added to systemic exercise therapy in the study group, with the control group receiving only exercise therapy. The results are summarized in Table 2. Three trials reported that maximal or functional exercise capacity improved with the addition of IMT to the rehabilitation programs. HRQL was measured in two trials. In the trial of Berman et al, an early version of the Chronic Respiratory Disease questionnaire did not identify any change associated with the addition of IMT. In the trial of Dekhuijzen et al, the Symptom Checklist (SCL-90) did not identify any changes attributable to IMT in its nine domains.

In summary, the evidence that IMT confers any additional benefit over exercise alone is equivocal. Notwithstanding the previous meta-analysis by Smith et al, further studies evaluating IMT as an adjunct to exercise therapy would be of interest.

Other Types of Breathing Exercises

Breathing exercises such as pursed-lip breathing and diaphragmatic breathing conventionally are associated with respiratory rehabilitation. An early trial by Lustig et al suggested that breathing exercises alone may modify patients’ anxiety and attitude toward work. In 1978, Tandon conducted a randomized controlled trial of yoga vs chest physiotherapy in 24 male patients with severe COPD. The exact maneuvers were not described by the author, but the positions were selected to facilitate full utilization of the abdominal and thoracic muscles. Both groups trained one to three times a week for 9 months. Twenty-two patients (11 in each group) completed the program. Those trained in yoga increased their maximal exercise capacity by more than 60 kilopound-meter per minute (approximately 10 W), whereas in those who received chest physiotherapy it decreased by 14 kilopound-meter per minute. During interviews, patients trained with yoga also...
Table 2—IMT Added to Exercise Therapy for Patients With COPD: Summary of the Characteristics of the Randomized Trials Included in the Systematic Overview

<table>
<thead>
<tr>
<th>First Author, yr</th>
<th>Setting</th>
<th>Program Description*</th>
<th>Duration</th>
<th>Exercise Capacity</th>
<th>Health Status</th>
<th>Magnitude of the Treatment Effect†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen, 1985</td>
<td>Outpatient</td>
<td>Moderate cycling × 20 min 3 times a week (n=6) vs exercise+IMT: uncontrolled resistance (17-62% PImax) 15 min bid (n=7)</td>
<td>4 wk</td>
<td>ICET and SSCET</td>
<td>Not measured</td>
<td>ICET: (0); SSCET: (0)</td>
</tr>
<tr>
<td>Berman, 1986</td>
<td>Outpatient</td>
<td>Cycling: 4-min periods repeated 6 times, 3 days a week (n=5) vs exercise+IMT: controlled resistance (n=4)</td>
<td>9 wk</td>
<td>6-min walk; ITT</td>
<td>Early version of the Chronic Respiratory Disease questionnaire</td>
<td>6-min walk: (0); ITT: (0); Chronic Respiratory Disease questionnaire</td>
</tr>
<tr>
<td>Goldstein, 1989</td>
<td>Inpatient</td>
<td>Treadmill walking+upper extremity training: education, breathing retraining, psychosocial support (n=5) vs exercise+IMT: controlled resistance×20 min (n=6)</td>
<td>4 wk</td>
<td>6-min walk; SSTT</td>
<td>Not measured</td>
<td>6-min walk: −4 m (0); SSTT: −1.07 min (0)</td>
</tr>
<tr>
<td>Dekhuijzen, 1991</td>
<td>Outpatient</td>
<td>Cycling: walking; back, shoulder, abdominal muscles training; education, breathing retraining, psychosocial support, 5 days a week (n=20) vs exercise+IMT: controlled resistance (70% PImax)×15 min bid (n=20)</td>
<td>10 wk</td>
<td>12-min walk; ICET</td>
<td>Activities in Daily Life list; SCL-90</td>
<td>12-min walk: (0); ICET: (0); Activities in Daily Life list; SCL-90: (0)</td>
</tr>
<tr>
<td>Weiner, 1992</td>
<td>Outpatient</td>
<td>Cycling; rowing; abdominal muscles strengthening×45 min 3 times a week (n=12) vs exercise+IMT: resistance controlled (80% PImax)×15 min (n=12)</td>
<td>6 mo</td>
<td>12-min walk; SSCET</td>
<td>Not measured</td>
<td>12-min walk: +143 m (+); SSCET: +5.1 min (+)</td>
</tr>
<tr>
<td>Wanke, 1994</td>
<td>Supervised (in?)</td>
<td>Cycling×20 min, 4 days a week (n=21) vs exercise+IMT: controlled resistance (80% PImax) 7 days a week (n=21)</td>
<td>8 wk</td>
<td>ICET</td>
<td>Not measured</td>
<td>ICET: +8.8 W (+)</td>
</tr>
<tr>
<td>Berry, 1996</td>
<td>Supervised (in?)</td>
<td>Walking×20 min, upper extremity weight training, 3 days a week (n=9) vs exercise+IMT: controlled resistance (80% PImax) 7 days a week (n=8)</td>
<td>12 wk</td>
<td>12-min walk; ITT</td>
<td>Not measured</td>
<td>12-min walk: (0); ITT: (0)</td>
</tr>
</tbody>
</table>

*PImax=maximal inspiratory pressure.
†See Table 1 footnote for explanation of symbols and abbreviations. ITT=incremental treadmill test.

identified improvement in dyspnea, recovery after exertion, and overall exercise tolerance.

Weaker evidence (level 3 evidence13) also exists as to whether breathing exercises improved exercise capacity or HRQOL when added to exercise training. A nonrandomized concurrent cohort study50 suggested that the addition of pursed-lip breathing, expiratory abdominal augmentation, relaxation of the accessory respiratory muscles, education, and psychological support during the last 3 weeks of a 9-week respiratory rehabilitation program marginally improved oxygen consumption as measured on a maximal treadmill test. Therefore, patients with COPD may gain from specific breathing exercises such as are learned in yoga or Tai Chi. In the absence of more detailed clinical trials, it is not possible to assess the value of these exercises.

**Education**

Toshima et al28 reported on a trial of comprehensive rehabilitation vs education in patients with COPD (Table 4). This article was followed by two additional articles about the same trial,29,30 the most recent reporting the results of long-term follow-up.
Table 3—Breathing Exercises: Summary of the Characteristics of the Trials Included in the Systematic Overview

<table>
<thead>
<tr>
<th>First Author, yr</th>
<th>Rehabilitation Program</th>
<th>Outcome Measures</th>
<th>Magnitude of the Treatment Effect*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lustig, 1972</td>
<td>Outpatient Breathing exercises (n=15) vs psychotherapy (n=15) vs control (n=15)</td>
<td>15-20 sessions (follow-up at 6-7 wk)</td>
<td>Not measured</td>
</tr>
<tr>
<td>Tandon, 1978</td>
<td>Outpatient Yoga (breathing exercises+yogic postures) (n=11) vs conventional chest physiotherapy (n=11)</td>
<td>9 mo (1-3 sessions/wk)</td>
<td>Incremental cycle ergometer</td>
</tr>
</tbody>
</table>

*See Table 1 footnote for explanation of symbols and abbreviations. kpm/min=kilopound-meters per minute.

One hundred nineteen patients were randomized to either an 8-week comprehensive rehabilitation program or to a four-session didactic education program. Improvements in exercise capacity, self-efficacy for walking, and shortness of breath scores were noted in the group receiving comprehensive rehabilitation. These were not associated with changes in quality of life or depression. Of note, the group assigned to receive education alone did not change in exercise capacity or symptom scores.

Few trials have directly evaluated the influence of education alone or as an adjunct to exercise training in patients with COPD. Most often, education groups served as controls in trials of more comprehensive rehabilitation programs. We identified only one that was randomized and controlled. 51 Sixty-four patients with COPD received either written educational material or participated in “Breathing Workshops,” six 2-h sessions that addressed medications, complication of the disease, nutrition, breathing retraining, and relaxation. Forty-eight patients (25 treatment and 23 control) were accounted for in the final analysis. An investigator developed a questionnaire that focused on ten specific domains, including attitudes regarding the disease, knowledge about COPD, and performance of self-help activities. Construct validity of their questionnaire was tested against objective measures such as hospital stay and physician contacts. At follow-up (4 months after the intervention), significant differences were identified in the domains of social disability and knowledge of COPD. The authors acknowledged that there was a

Table 4—Education for Patients With COPD: Summary of the Characteristics of the Randomized Trials Included in the Systematic Overview

<table>
<thead>
<tr>
<th>First Author, yr</th>
<th>Rehabilitation Program</th>
<th>Outcome Measures</th>
<th>Magnitude of the Treatment Effect*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toshima, 1990</td>
<td>Outpatient Rehabilitation: systemic exercise+breathing exercises+education (n=57) vs education alone (n=62)</td>
<td>8 wk (12 sessions)</td>
<td>Incremental treadmill exercise test</td>
</tr>
<tr>
<td>Ashikaga, 1990</td>
<td>Outpatient Education: six 2-h didactic educational sessions (n=25) vs written material only (n=23)</td>
<td>Follow-up at 4 mo (not measured)</td>
<td>Questionnaire developed for the purpose of the study</td>
</tr>
</tbody>
</table>

*See Table 1 footnote for explanation of symbols.
need to validate their results against more objective measures of behavior. Because the validity of their instrument was questionable, the true significance of the results is unknown.

In the absence of valid randomized controlled trials of education, we included a nonrandomized concurrent cohort study55 (level 3 evidence15). In this study by Howland and collaborators,52 patients with COPD in two northern US communities (Brattleboro, Vt, and Laconia, NH) were contacted. Those from Brattleboro were encouraged to participate in a health education program (six 2-h sessions). A variety of scales and questionnaires were used to evaluate the effect of the program. Health perception was measured by the Health Locus of Control; respiratory symptoms were assessed by the American Thoracic Society questionnaire; the Zung scales were used as indicators of mental health status (anxiety and depression); and the Sickness Impact Profile was used to measure physical and social function. Although the validity and reliability of these instruments had been demonstrated previously, their responsiveness is less certain. In Brattleboro, 213 patients completed the workshops. Of 405 patients with COPD identified in Laconia, 325 were reassessed after 1 year. With the exception of the Health Locus of Control, the health education program was not associated with results of any health status measure.

In summary, the influence of education alone or as an adjunct to exercise training in patients with COPD remains inadequately evaluated. No satisfactory randomized controlled trial has addressed this area. The results of a nonrandomized concurrent cohort study were difficult to interpret because of the health-status measure instruments employed and the limitations of the study design.

Psychosocial Support

Psychological Intervention Alone: The short-term effects of progressive relaxation on dyspnea and anxiety in patients with COPD have been studied in two trials53,54 (Table 5). Both trials were similar, with the exception of the timing of the measured outcomes. Patients with COPD were randomly assigned to receive progressive muscle relaxation or a nonintervention control group. Progressive muscle relaxation consisted of four weekly 45-min sessions during which the patients were trained to relax in a quiet environment. Each session was followed by daily home practice using taped instructions. In both trials, dyspnea was measured before and after each session with a visual analog scale. Anxiety was measured with the Spielberger’s State Anxiety Inventory. Renfro53 assessed dyspnea and anxiety at the end of each session, whereas Gift and collaborators54 did so only after the fourth session. In both trials, the patients in the treatment group reported significantly less dyspnea and less anxiety than those in the control group. Both trials have two important limitations. First, the clinical significance of the observed changes in anxiety scores is unknown. Second, these improvements were measured acutely, and whether they were sustained was not assessed.

An important clinical trial was directed at whether strategies for dyspnea management alone might influence functional exercise, HRQL, or dyspnea itself.55 Sassi-Dambron and colleagues55 randomized 89 patients to either a 6-week program of dyspnea management or to lectures on general health education. The dyspnea management strategies included the following: education, relaxation, breathing techniques, pacing, energy conservation, self-talk, panic control, and stress management. Outcomes measured at baseline, 6 weeks, and 6 months included the Baseline and Transition Dyspnea Indices, the American Thoracic Society dyspnea scale, the Oxygen Cost Diagram, a dyspnea scale developed at the University of California, San Diego, and a visual analog dyspnea scale. Other measures of psychosocial function included the Quality of Well-Being Scale, the Spielberger’s State-Trait Anxiety Inventory, and the Center for Epidemiologic Studies’ Depression Scale. Functional exercise capacity was assessed with a 6-min walk test. There were no significant differences between the study and control groups in any measures. The investigators concluded that a program of dyspnea management without structured exercise training was not sufficient to produce significant improvements in dyspnea, exercise tolerance, health-related quality of well-being, anxiety, or depression.

Blake and collaborators56 also examined the long-term effects of psychosocial intervention in adults with COPD. Patients were randomized to receive one to three 60- to 90-min individual sessions with a specially trained nurse. The care plan developed by the nurse and the patient included a combination of relaxation exercises, meditation, guided imagery that focused on breathing, social and recreational activities, and interactive behavior. Ninety-four patients were randomized to either the intervention group or a control group. The Sickness Impact Profile (SIP), the Social Readjustment Rating Scale (a self-esteem scale), and a questionnaire assessing social support were applied. Follow-up measures were obtained at 6 months for 80 patients and at 12 months for 68 of them. At the 6-month and the 12-month follow-up, there were no significant differences between the experimental and control groups in life change, self-esteem, and social support. At 12 months, a
Table 5—Psychological Support for Patients With COPD: Summary of the Characteristics of the Randomized Trials Included in the Systematic Overview

<table>
<thead>
<tr>
<th>First Author, yr</th>
<th>Setting</th>
<th>Comparison Groups</th>
<th>Duration</th>
<th>Outcome Measures</th>
<th>Magnitude of the Treatment Effect*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Psychological intervention alone</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lustig,31 1972</td>
<td>Outpatient</td>
<td>Breathing exercises (n=15) vs psychotherapy (n=15) vs control group (n=15)</td>
<td>15-20 sessions (follow-up at 6-7 wk)</td>
<td>Not measured</td>
<td>Minnesota Multiphasic Personality Inventory; Lustig medical orientation scale; Livingstone work attitude scale</td>
</tr>
<tr>
<td>Gift,34 1992</td>
<td>Outpatient + home based</td>
<td>Progressive muscle relaxation (n=13) vs control group (n=13)</td>
<td>Four 45-min weekly sessions+daily home practice</td>
<td>Not measured</td>
<td>Visual analog scale (0-100 mm); Spielberger’s Anxiety Inventory; Visual analog scale: −21 millimeters (−); Spielberger’s Anxiety Inventory: (+)</td>
</tr>
<tr>
<td>Renfroe,53 1988</td>
<td>Outpatient + home based</td>
<td>Progressive muscle relaxation (n=12) vs control group (n=8)</td>
<td>Four 45-min weekly sessions+daily home practice</td>
<td>Not measured</td>
<td>Visual analog scale (0-200 mm); Spielberger’s Anxiety Inventory; Visual analog scale: −13 millimeters (−); Spielberger’s Anxiety Inventory: (+)</td>
</tr>
<tr>
<td>Sassi-Dambron,55 1995</td>
<td>Outpatient</td>
<td>Dyspnea management strategies: (1) education about COPD; (2) relaxation; (3) breathing techniques; (4) pacing and energy saving; (5) self-talk and panic control; (6) stress management (n=46) vs general health didactic educational lectures (n=43)</td>
<td>Six wk (weekly session)</td>
<td>6-min walk test</td>
<td>Baseline and Transition Dyspnea Indexes; American Thoracic Society Dyspnea scale; UCSD Shortness of Breath questionnaire; visual analog scale; quality of well-being; Center for Epidemiologic Studies Depression Scale; Spielberger’s Anxiety Inventory; 6-min walk test: +10.5 meters (0); Health status measures: overall: (0)</td>
</tr>
<tr>
<td>Blake,56 1990</td>
<td>Home based</td>
<td>Psychosocial intervention: one to three 60-90-min session(s) focusing on relaxation, meditation, imagery, increased social and recreational activities (n=45) vs conventional care (n=49)</td>
<td>Follow-up at 6 and 12 mo</td>
<td>Not measured</td>
<td>SIP; Social Readjustment Rating Scale; Rosenberg’s Self-Esteem Scale; social support index; SIP (at 12 mo follow-up): −3.0 (−) all the other measures: (0)</td>
</tr>
<tr>
<td><strong>Psychological intervention during exercise training</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gormley,57 1993</td>
<td>Outpatient</td>
<td>Treadmill walking program: coaching (supervision and encouragement) (n=24) vs monitoring only (n=28)</td>
<td>4 wk (12 24-min sessions)</td>
<td>Treadmill performance (15-point scale)</td>
<td>Adapted self-efficacy scale</td>
</tr>
<tr>
<td><strong>Psychological intervention added to exercise training</strong></td>
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<tr>
<td>Atkins,31 1984</td>
<td>Home based</td>
<td>Exercise training ×3 months) + either of: (1) behavior modification (n=15); (2) cognitive modification (n=16); (3) behavior and cognitive modification (n=13); (4) attention (n=15); (5) control (n=15)</td>
<td>Five 1-h sessions</td>
<td>Minutes walked per week (log); incremental treadmill test</td>
<td>Quality of well-being; adapted Bandura’s self-efficacy scale</td>
</tr>
</tbody>
</table>

*See Table 1 footnote for explanation of symbols.

Slight improvement in the SIP was observed in the treatment group. The authors questioned the clinical interpretation of this finding.

**Psychological Intervention as an Adjunct to Exercise Training:** Gormley et al37 randomized 52 patients who were participating in a 4-week treadmill walking program to either a coached or a control group. In the coached group, a nurse helped the patients to set realistic objectives and provided encouragement during the training sessions. Although the patients in the control group were also monitored during exercise training, they received no additional attention. Self-efficacy was measured using an adapted questionnaire for which neither
validity nor responsiveness had been established beforehand. At the end of the program, there was no significant group difference in self-efficacy. The authors commented that the presence of a nurse during exercise sessions was insufficient to increase self-efficacy.

Atkins and collaborators\(^3\) evaluated the influence of behavioral modification added to exercise training. Seventy-six patients with COPD participated in an unsupervised home walking program. They were randomized to one of five groups. Three groups received an experimental intervention designed to enhance compliance with their exercise prescription. In the behavior modification group (n=15), the patients were asked to self-administer reinforcers contingent on daily walking. In the cognitive modification group (n=16), the patients were trained to become aware of their own negative thoughts, feelings, and behaviors, and to replace them with more positive cognition. The cognitive-behavior modification group (n=16) received a combination of both strategies. Each of the three experimental groups met for seven sessions over a 3-month period. Five of the seven 1-h sessions (sessions 2 through 6) occurred in the patient’s home. An attention-control group (n=15) and a no-treatment control group (n=13) received only the walking prescription. At 3-month follow-up, the three experimental groups differed from the two control groups in the time that they spent walking and in their exercise tolerance. They also differed in their Quality of Well-Being scores and in a measure of walking self-efficacy. Patients in the cognitive-behavior modification group improved more than those in the other groups.

In summary, little is known about the nature and the efficacy of psychosocial support either alone or as an adjunct to exercise training. Although relaxation may relieve dyspnea and anxiety short term, whether these effects can be maintained is unclear. Cognitive and behavior modification techniques as an adjunct are effective in improving exercise tolerance and HRQL.

**DISCUSSION**

Although respiratory rehabilitation has been shown to be beneficial in improving HRQL and exercise capacity,\(^6\) the contribution of the components of rehabilitation programs has been less well defined. Clearly, a better understanding of the components will have important implications for resource allocation as respiratory rehabilitation becomes more widespread.

The varied outcome measures used within a particular intervention did not allow us to estimate satisfactorily the real treatment effect of most interventions. In fact, the choice of outcome measures has been a major limitation of most of the randomized controlled trials included in the best-evidence synthesis. In evaluating health-care interventions, the most important properties of the measuring instruments are their validity, responsiveness, and interpretability.\(^5\) Validity refers to whether the instrument is measuring what it claims to measure; responsiveness whether an evaluative instrument will detect real change, even when it is small; and interpretability whether a particular change in score represents a small, moderate, or large clinical change.\(^5\) Unfortunately, in many trials, the validity of the instruments selected to measure HRQL had not been clearly ascertained beforehand. Furthermore, generic rather than specific instruments were frequently used. The former were more likely to have missed small but clinically important treatment effects. Finally, when significant changes over time were detected, the magnitude of the changes in scores was often difficult to interpret. Since the management of patients with COPD is largely symptomatic,\(^1\) it is the view of the authors that HRQL should become the primary outcome measure when assessing the influence of rehabilitation. Future investigations should rely on valid health status measures that are able to detect change over time in evaluating rehabilitative interventions.

The few studies on education highlight an area for further clinical evaluation. The effectiveness of education for patients with non-COPD chronic conditions was reviewed by Mazzuca.\(^6\) Thirty studies, including 24 randomized controlled trials, were included in the meta-analysis. Both didactic and behavioral approaches were included. The change in compliance attributed to education (30 studies) was 0.67 SD units; for therapeutic response, the mean change (27 studies) was 0.49 SD units, and for long-term health outcome (five studies), it was 0.20 SD units. Behavioral approaches to education appeared to be more effective than didactic approaches. Notwithstanding many limitations of this analysis (poorly described clinical outcomes, results not expressed as natural units, very limited subgroup analysis), this meta-analysis suggested that education may improve compliance and clinical outcomes in patients with chronic conditions. Although it is a current belief that education in COPD has no measurable effect in either exercise capacity or HRQL, one must recognize that this statement is not supported by any strong evidence.

Exercise training should be a mandatory component of any rehabilitation program that seeks to

Downloaded From: http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21746/ on 04/16/2017
improve functional exercise capacity and HRQL. Support for this notion comes from a number of randomized controlled trials in which simple rehabilitation programs consisting of exercise training alone were as effective in improving exercise capacity and HRQL as the most comprehensive ones. It is further supported by the findings of this review that dyspnea management strategies alone failed to influence dyspnea, exercise capacity, or HRQL, and that education alone was less effective than comprehensive rehabilitation.\textsuperscript{28-30} Although individualized and high-intensity training optimized the physiologic outcomes, whether these changes are associated with further improvements in functional exercise capacity or HRQL is unknown. Exercise training is muscle specific. Therefore, the addition of upper-extremity training to an exercise program is necessary if the program goals include improving the ability to perform upper-limb activities. To our knowledge, the contribution of arm training in improving health status has not been evaluated yet. The evidence to support inspiratory muscle training as an adjunct to exercise training in COPD remains equivocal. The contribution of education to the care of patients with COPD has not been well addressed and requires further evaluation. Too few studies were available for the authors to gain a clear idea as to its contribution. Psychosocial support will reduce dyspnea for a short time. As an adjunct to rehabilitation, such support may promote patients' compliance with an exercise regimen.

In this best-evidence synthesis, we have not addressed the important issue of the setting (supervised or unsupervised) of the rehabilitation program. In a previous review of randomized controlled trials comparing rehabilitation with conventional community care, we conducted a subgroup analysis of the settings and did not identify any significant difference between the subgroups. In a recent randomized controlled trial, Strijbos and colleagues\textsuperscript{41} compared 12 weeks of outpatient rehabilitation with 12 weeks of home-based rehabilitation. A control group received no rehabilitation at all. Following rehabilitation, both treatment groups improved equally in both maximal and functional exercise capacities. The improvement, however, was better maintained at 18 months in the group that had received home-based rehabilitation. Unfortunately, no valid measures of HRQL were used.

Respiratory rehabilitation is important for patients with COPD. More widespread application should be accompanied by trials that allow further evaluation of the contribution of exercise and psychosocial support as well as the degree of supervision and maintenance necessary to ensure optimum results. Such studies should be accompanied by valid, responsive, and interpretable outcome measures specific to HRQL in patients with COPD.

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