# Development and Validation of a Pulmonary Rehabilitation Knowledge Test

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*To facilitate evaluation of the education component of pulmonary rehabilitation programs, the authors developed and validated a knowledge test covering the content areas identified as common to programs nationwide. Procedures were divided into five stages: item construction, item testing, test validation, program evaluation, and cross testing of the final form. Results from 27 programs demonstrated an improvement from pretest and posttest scores ($F(1,57) = 58.44$, $P = 0.000$) and from posttest and the 3-month follow-up ($F(2,57) = 9.99$, $P = 0.003$). The final form of the test has high internal consistency (Cronbach's alpha = 0.86). Development of further educational evaluative instruments specific to pulmonary rehabilitation programs is recommended.*

Education is a vital and accepted component of pulmonary rehabilitation programs.[1-3] Many programs report attempting to measure what the participants have learned, yet lack a valid instrument for doing so. Among nine reported studies, none used an instrument to measure change in knowledge.[1,4-12] A review of the literature revealed no published instrument.

The purpose of this study was the develop and validate a knowledge test suitable for the many and varied pulmonary rehabilitation programs throughout the country. Such an instrument could assist program directors in evaluating the effectiveness of their program's education. Are they giving participants the knowledge necessary to cope with their disease? Are the educational methods conducive to learning and do they aid retention? Additionally, by using a sampling of programs nationwide, the process of development and validation would indicate the content areas commonly included in pulmonary rehabilitation programs.

## METHODOLOGY

**General Procedures.** The plan for the test construction involveed five stages:

*Item Construction Stage.* An outline of the content of the test was developed and sent to a panel of pulmonary rehabilitation experts.§ One hundred fifty-three multiple choice questions were developed, based on the revised outline. The number was reduced to 140 after the questions were reviewed by the panel.

*Item Testing Stage.* The 140 items were divided into three forms and each form administered to separate nationwide samples of pulmonary rehabilitation patients.

*Test Validation Stage.* Items culled from the results of the item testing stage were divided into two 35-question forms and each tested again using separate samples of pulmonary rehabilitation patients. Forty items were selected from this set for the final form.

*Program Evaluation Stage.* A questionnaire was sent to 27 program directors to determine the proportion of time spent on each phase of instruction.

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**TABLE I**
**OUTLINE OF PULMONARY REHABILITATION TOPICS**

| | Percent of Items Developed | Number of Items |
|---|---|---|
| Activities of Daily Living | 11.8 | 18 |
| Anatomy and Physiology of Cardiopulmonary System | 5.9 | 9 |
| COPD Definitions | 5.2 | 9 |
| Diet and Nutrition | 3.3 | 5 |
| Emergency Care/Panic Control | 5.9 | 9 |
| Exercise | 11.8 | 18 |
| Keeping Airways Open | 17.6 | 27 |
| Medications and Treatments | 14.4 | 22 |
| Mental Health | 3.3 | 5 |
| Pathophysiology of Emphysema, Chronic Bronchitis, Asthma, and Bronchiectasis | 3.3 | 5 |
| Recreation | 3.3 | 5 |
| Sleeping | 3.3 | 5 |
| Stress | 5.9 | 9 |
| Support Groups/Organizations | 2.0 | 5 |
| Tests, Examinations and Their Meaning | 3.3 | 5 |
| Total | 100.0 | 153 |

*Cross Testing and Testing of Final Form.* All 70 items from the two 35-item forms were administered to a group of respiratory therapy students. This was done to determine the relationship between the two forms and, also, to evaluate the 40 items selected in the previous stage as a single unit. (It would have been impractical to administer a 70-item test in a pulmonary rehabilitation setting.)

**Item Construction Procedures.** An outline of topics identified as common to pulmonary rehabilitation programs was developed from the literature[1,2] by the pulmonary rehabilitation team at Loma Linda University Medical Center. The outline was then sent to a panel of pulmonary rehabilitation experts who made suggestions for revision. The resulting outline is shown in Table I. Table I also shows the weights we selected for each of these areas to serve as a guide in preparing questions.

We, along with the members of the pulmonary rehabilitation team at Loma Linda University (nurse specialist, social worker, physical therapy, occupational therapist, respiratory therapist, dietitian and patient education specialist), served as the item construction panel. This panel was first trained in the construction of test items by Dr. Brian Stecher, a consultant from the Educational Testing Service [ETS]. Then, using the outline as a guide for distribution of items across topics, the panel met over a period of 8 weeks and constructed 153 multiple choice items.

A sample of the multiple choice questions we constructed is as follows:

Which of the following is the best safety rule to follow when taking your medicines? a. Use antacids with all your medicines. b. Swallow all your medicines at one time. c. If one pill works well, two will work better. °d. Take medicines as the doctor prescribes.

These items were reviewed by the panel of pulmonary rehabilitation experts and the ETS consultant, who suggested changes and deletions, which resulted in a total of 140 items. In the review process, some topics areas were eliminated because the expert panel felt they were not germane to all rehabilitation programs. For example, the subcategory of sexual activity replaced the main category of recreation since recommendations regarding other "recreational activities" were not consistent. The resulting categories and the number of items for each category are shown in Table II.

**Item Testing Stage.** The 140 items were divided into three forms labeled form A, form B, and form C, composed of 46, 47, and 47 items, respectively. The three forms were administered to individuals at 30 pulmonary rehabilitation programs, 10 sites for each form. The programs were diverse in geographical location and type of program. Both outpatient and inpatient programs from nine states were included, although one half of the programs were in California. Community hospitals, university teaching hospitals, and Lung Association programs were represented. Additional information about sample size is contained in Table III.

When the tests were returned, they were processed using the TESTAT module of the SYSTAT statistical package (Stenson and Wilkinson, 1986).[13] From the 140 items originally developed, 70 were selected for use in testing two alternate forms. These items were selected on the basis of their item-whole correlations, item difficulty, variability, and with the intention of maintaining, as nearly as possible, the ratio of items that existed in the original content outline.

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TABLE II
DISTRIBUTION OF ITEMS ACROSS CATEGORIES

| | Original | | Form D | | Form E | | Final | |
|---|---|---|---|---|---|---|---|---|
| | N | Percent | N | Percent | N | Percent | N | Percent |
| Activities of Daily Living | 14 | 10.0 | 3 | 8.6 | 4 | 11.4 | 4 | 10.0 |
| Anatomy and Physiology | 12 | 8.6 | 4 | 11.4 | 3 | 8.6 | 3 | 7.5 |
| COPD Definitions | 10 | 7.1 | 2 | 5.7 | 2 | 5.7 | 3 | 7.5 |
| Diet and Nutrition | 6 | 4.3 | 2 | 5.7 | 2 | 5.7 | 2 | 5.0 |
| Emergency Care/Panic Cntrl | 7 | 5.0 | 1 | 2.9 | 2 | 5.7 | 2 | 5.0 |
| Exercise | 9 | 6.4 | 3 | 8.6 | 3 | 8.6 | 3 | 7.5 |
| Keeping Airways Open | 24 | 17.1 | 6 | 17.1 | 6 | 17.1 | 6 | 15.0 |
| Medicines | 16 | 11.4 | 3 | 8.6 | 2 | 5.7 | 4 | 10.0 |
| Mental Health | 7 | 5.0 | 2 | 5.7 | 2 | 5.7 | 2 | 5,0 |
| Pathophysiology | 4 | 2.9 | 1 | 2.9 | 1 | 2.9 | 1 | 2.5 |
| Sex Education | 6 | 4.3 | 2 | 5.7 | 2 | 5.7 | 2 | 5.0 |
| Sleeping | 4 | 2.9 | 1 | 2.9 | 1 | 2.9 | 1 | 2.5 |
| Stress & Relaxation | 16 | 11.4 | 3 | 8.6 | 3 | 8.6 | 5 | 12.5 |
| Support Groups/Organizations | 2 | 1.4 | 1 | 2.9 | 1 | 2.9 | 1 | 2.5 |
| Tests | 3 | 2.1 | 1 | 2.9 | 1 | 2.9 | 1 | 2.5 |
| Total | 140 | 100.0 | 35 | 100.0 | 35 | 100.0 | 40 | 100.0 |

TABLE III
SAMPLE SIZES FOR FORMS AND TEST SITES

| | Item Testing | | | Item Validation | |
|---|---|---|---|---|---|
| Form label | A | B | C | D | E |
| Number of items in form | 46 | 47 | 47 | 35 | 35 |
| Number of test sites sent forms | 14 | 14 | 14 | 13 | 14 |
| Number of test sites returning forms | | | | | |
| Pretest | 10 | 11 | 9 | 10 | 10 |
| Posttest | 11 | 10 | 9 | 9 | 10 |
| 3-month follow-up | — | — | — | 8 | 5 |
| Total number individuals tested | | | | | |
| Pretest | 64 | 42 | 56 | 100 | 83 |
| Posttest | 74 | 40 | 51 | 88 | 78 |
| 3-month follow-up | — | — | — | 50 | 30 |

**Test Validation Stage.** These two forms, labeled D and E, were sent to 30 test sites. Table 3 provides additional information on sample size. When the forms were returned, they were once again subjected to item analysis and 40 items were selected on the basis of good item characteristics, distribution of content, and importance of content. These 40 items made up the final form.

**Cross-Testing of Final Forms.** The two 35-item alternate forms were administered to a group of 24 respiratory therapy students. This provided an opportunity to assess the reliability of the alternate form. It also allowed us to obtain an estimate of the reliability of the 40-item set that had been selected in the previous step.

## RESULTS

**Test Validation Stage.** The 70 items were divided into two forms (labeled forms D and E) made up of 35 items each. This length was decided on the basis of the impracticality of administering a longer test to patients in a pulmonary rehabilitation setting. The distribution and sample sizes for the testing of these forms are found in Table 3. In each participating program, a pretest, an immediate posttest, and a 3-month follow-up were administered. Table IV provides means, standard deviations, coefficient alphas, and other test information for each form.

TABLE IV
CHARACTERISTICS OF FORMS D AND E AND ESTIMATES OF FINAL FORM MEANS

| | Pretest | Posttest | Follow-up |
|---|---|---|---|
| Sample Size | | | |
| Form D | 100 | 88 | 50 |
| Form E | 83 | 78 | 30 |
| Mean (Percentage of total possible correct) | | | |
| Form D | 22.01 (62.9%) | 26.56 (75.9%) | 28.18 (80.5%) |
| Form E | 21.95 (62.7%) | 26.65 (76.1%) | 28.40 (81.1%) |
| Final 40* (est.) | 24.76 (61.9%) | 30.82 (77.0%) | 32.77 (81.9%) |
| Standard Deviation | | | |
| Form D | 6.66 | 4.65 | 3.77 |
| Form E | 6.12 | 4.65 | 4.51 |
| Standard Error | | | |
| Form D | 0.67 | 0.50 | 0.54 |
| Form E | 0.68 | 0.53 | 0.84 |
| Maximum | | | |
| Form D | 34 | 34 | 35 |
| Form E | 32 | 35 | 35 |
| Minimum | | | |
| Form D | 5 | 9 | 16 |
| Form E | 6 | 14 | 15 |
| Coefficient Alpha | | | |
| Form D | 0.86 | 0.77 | 0.70 |
| Form E | 0.83 | 0.76 | 0.79 |

*See text section entitled "Construction of the Final Form."

Interestingly enough, not only did the test scores increase from the pretest to the posttest by approximately four and one half points, but there appeared to be an increase in test scores from the posttest to the 3-month follow-up. Such an increase could be an artifact of the reduced sample size in the follow-up. (Those individuals with lower knowledge on the pretest and posttest might be less likely to return for the follow-up either because of less motivation or greater mortality, or both.) To correct for this possibility a repeated measures ANOVA was computed using only data from individuals who completed tests at all three testing points. The MGLH module of SYSTAT[14] was used. The multivariate approach to repeated measures was used because of its less restrictive assumptions. There were no significant differences in scores between forms D and E ($F(1,57) = 0.07$, $P = 0.792$). The pattern of change in test scores over time was not different between forms D and E (Time by form interaction: Pillai trace = 0.02, $F(2,56) = 0.53$, $P = 0.591$). This would suggest that the forms are likely to be equivalent. There was a change in the test scores across time that approached significance. (Pillai trace = 0.61, $F(2,56) = 43.98$, $P = 0.000$). The means, averaged across forms, were 20.27 for the pretest, 26.54 for the immediate posttest, and 28.25 for the pretest, 26.54 for the immediate posttest, and 28.25 for the 3-month follow-up. When difference contrasts were computed, the difference between the pretest and posttest was found to be significant (univariate $F(1,57) = 58.44$, $P = <0.005$). The difference between the posttest and the 3-month follow-up was also significant (univariate $F(2,57) = 9.99$, $P = 0.003$). The multivariate test for these two contrasts, was also significant (Pillai trace = 0.611, $F(4,112) = 43.98$, $P = <0.0005$).

Table IV also shows coefficient alpha for each form of the test at each point in time. It would appear that the internal consistency of the test is less after pulmonary rehabilitation participants have been through training than before training. This is no doubt because of the decrease in the range of individual test scores that is inevitable after effective training. After all, if the programs managed to train everyone to the point that all 35 items were answered correctly after the test by all individuals, then coefficient alpha could not be computed.

Table V provides information concerning the correlation of the tests across time. The correlations are generally in the 0.4 and 0.5 range. However, generally the test-retest correlations involving the 3-month follow-up are lower. In fact, when looking at the two

TABLE V
CORRELATIONS BETWEEN TESTING TIMES

| | Pretest vs Posttest | Posttest vs Follow-up | Pretest vs Follow-up |
|---|---|---|---|
| Form D | | | |
| Correlation | 0.5 | 0.35 | 0.71 |
| Probability* | 0.00000 | 0.16917 | 0.00003 |
| Sample Size | 85 | 44 | 34 |
| Form E | | | |
| Correlation | 0.51 | 0.46 | 0.25 |
| Probability* | 0.00002 | 0.18218 | 1.00000 |
| Sample Size | 76 | 25 | 25 |
| Forms D and E Combined | | | |
| Correlation | 0.52 | 0.38 | 0.47 |
| Probability* | 0.00000 | 0.01287 | 0.00159 |
| Sample Size | 161 | 69 | 59 |

*These are Bonferroni adjusted probabilities, which take into account the total number of significance tests.[14] For standard significance levels divide the above probabilities by nine.

forms separately, in three of four cases they are insignificant. This may be in part due to the relatively small sample size on which these correlations are based and the relatively stringent Bonferroni significance criterion adopted. When the two forms are examined as a single test (thus increasing the sample size), all test-retest correlations are statistically significant, though not terribly large.

**Construction of the Final Form.** Item analysis statistics were calculated for each of the 70 questions in the two 35-question alternate forms (forms D and E). Items were then sorted into their content categories (*e.g.*, exercise, keeping the airways open, and so on). Next we determined how many items would be needed within each category to approximately maintain the balance of content areas that had existed in the earlier forms. Then, within each content category, items were ranked for importance to pulmonary rehabilitation programs. This ranking was done by the two authors familiar with pulmonary rehabilitation programs (Hopp and Hills). Finally, 40 items were selected on the basis of three criteria: 1) importance, 2) balance of content area, and 3) statistical quality. There were 22 items selected from form D and 18 from form E.

Because use of the final form requires some knowledge of how a typical pulmonary rehabilitation patient does on the test, we calculated estimates of the pretest, and follow-up means in the following way. From the data for the 35-item form D, we selected only the answers that pulmonary rehabilitation patients had given to the 22 form D questions we were including in the final form. We then calculated a mean correct on these 22 items. We calculated a similar mean correct for the 18 final form items taken from form E. Finally, we added the resulting form D and form E means to obtain estimates of the means for the final form. Only one assumption is required to make these estimated means valid. Namely, that there is no systematic difference between those pulmonary rehabilitation patients who responded to form D and those who responded to form E. This seems a reasonable assumption since programs were assigned at random to the two different forms and since the ANOVA, reported earlier, showed that there was no overall difference in mean correct responses between patients receiving forms D and E. The resulting mean correct for the pretest, posttest, and follow-up are, respectively, 24.8, 30.8, and 32.8 out of 40 possible. Percentages correct were 61.9%, 77.0%, and 81.9%.

**Program Evaluation Phase.** Twenty-seven programs directors were sent forms requesting information about the number of hours they spent teaching each of the topics included in the pulmonary rehabilitation knowledge test. These forms were returned by 24 of the program directors. Table VI shows statistics on the number of hours that they reported they spent on each of the program topics tested. As can be seen, the number of hours spent on each topic varies widely.

One might expect that there would be some relationship between the total hours involved in a program and the average test scores of individuals in that program. Interestingly, this was not true. In fact, the correlation between the number of hours reported spent in training and the average score immediately after the training was only 0.07 ($N = 14$, $P = 0.821$), whereas the correlation of hours of training with the 3-month follow-up test score was actually negative ($r = -0.47$). This correlation, however, was nonsignificant ($N = 12$, $P = 0.127$). Either the small sample size available for this comparison made it impossible to detect the positive correlations that were there or program factors other than hours of training are the crucial variables in determining learning.

Three of the 24 program directors indicated that they had made marked changes in their educational programs as a result of participation in the validation study. One third of the programs changed directors during the 2½ years of the study; in some instances, this resulted in sharp loss of time since new directors were not oriented to the validation study until we wrote to question why tests were not being returned.

**Relationship Between Forms D and E.** To help de-

TABLE VI
HOURS TAUGHT ON VARIOUS TOPICS IN COPD PROGRAMS (N = 24)

| | Mean | Median | Minimum | Maximum | Standard Deviation | Percentage of Total |
|---|---|---|---|---|---|---|
| Activities of Daily Living | 2.79 | 2.00 | 1.00 | 10.00 | 2.32 | 9.39% |
| Anatomy and Physiology | 1.24 | 1.00 | 0.50 | 3.00 | 0.66 | 4.45% |
| COPD Definitions | 1.17 | 0.75 | 0.00 | 7.25 | 1.64 | 3.85% |
| Diet and Nutrition | 1.47 | 1.25 | 0.00 | 3.00 | 0.79 | 4.73% |
| Emergency/Panic Control | 1.27 | 1.00 | 0.00 | 3.00 | 0.97 | 3.91% |
| Exercise | 9.75 | 10.00 | 1.00 | 20.00 | 6.29 | 30.22% |
| Keeping Airways Open | 1.33 | 1.25 | 0.00 | 3.00 | 0.71 | 4.77% |
| Medicines | 1.78 | 2.00 | 0.00 | 4.00 | 0.88 | 5.63% |
| Mental Health | 2.02 | 1.25 | 0.00 | 10.00 | 2.45 | 5.41% |
| Pathophysiology | 1.09 | 1.00 | 0.25 | 3.00 | 0.66 | 3.94% |
| Sex Education | 0.64 | 0.50 | 0.00 | 3.00 | 0.69 | 2.18% |
| Sleeping | 0.43 | 0.00 | 0.00 | 3.00 | 0.75 | 1.39% |
| Stress and Relaxation | 2.81 | 2.63 | 0.50 | 6.00 | 1.51 | 8.86% |
| Tests | 1.37 | 1.50 | 0.00 | 3.00 | 0.92 | 4.46% |
| Other* | 1.93 | 0.75 | 0.00 | 8.50 | 2.52 | 6.80% |
| Total Hours training | 33.86 | 31.00 | 7.25 | 85.00 | 17.58 | 100.00% |

*Travel and smoking cessation were the only topics mentioned under this heading that could not fit into the other listed categories.

termine the characteristics of the two forms when used together, the two 35-item forms were administered together to 24 respiratory therapy students. The internal consistency (coefficient alpha) for the two tests taken together was 0.89. When the two forms were separated, form D had a coefficient alpha of 0.81 and form E had a coefficient alpha of 0.83.

The correlation between the two forms was not as high as we would have liked ($r = 0.65$). The split-half correlation of the odd and even items out of the 70 was $r = 0.86$.

**Characteristics of the 40-Item Final Form.** We were also able to test some characteristics of the final 40-item form because these 40 items were a part of the 70-item form administered to the 24 respiratory therapy students. Coefficient alpha was 0.86 for the 40-item set. Mean score for the 24 students was 32.2 out of 40 possible (80.5%) with a standard deviation of 5.9. Maximum and minimum scores were 40 and 16. As a percentage of possible correct, this was comparable to the mean scores obtained by the pulmonary rehabilitation patients at the 3-month follow-up (80.5% and 81.1%).

## DISCUSSION AND RECOMMENDATIONS

Following the statistical analysis for forms A, B, and C, the percentage of questions per topic on forms D and E and on the final form were comparable with the percentages on the original test. Discrepancies between these percentages and those shown for the proposed examination (Table I) were primarily in the areas of "Keeping Airways Open" and "Exercise." These differences can be related to the overlapping of topics in these two content areas. We found it difficult to separate questions regarding breathing training from some aspects of exercise. This could also explain why exercise seems so heavily emphasized in reports of amount of time spent on a topic (Table VI). Some of what we called "Keeping Airways Open" may be categorized by program directors as "Exercise."

We started the study with 42 programs participating. The directors of each of these programs, contacted by telephone and given a description of the participation required, had agreed, after discussion with their respective medical directors, that they could perform what was required. However, we received data from only 30 of the 42 programs in Phase One. Response decreased to 27 programs in Phase Two. Upon contact by telephone, some program directors said that they had insufficient patient numbers, or that their programs were changing. Change of directors appeared to affect participation, with new directors reporting that they received no instruction regarding the study. One third of the 27 participating programs, however, experienced change of directors and were still able to continue in the study. This high turnover rate in program directors is somewhat distressing because it raises questions about the

continuity of the training received by chronic obstructive pulmonary disease (COPD) patients.

Table IV shows that over one half of the participants at 3-month follow-up. Program directors reported that often this was due to the state of the participants' health. Since COPD is a progressive disease, this progression or exacerbation of the disease could have prevented the completion of the 3-month follow-up. This loss of participants could have also been caused by a lack of compliance, death of a participant, or loss of contact.

The increased means between each of the test administration times provides evidence of information retention over time. The decrease in variability seen in the standard deviation can be ascribed to the learning and practice process.

Coefficient alpha data show that there is good indication of consistency in the pretest and the final form (>0.8). Coefficient alpha decreased in the posttest and follow-up. However, one would expect it to decrease (Table IV) with training given in pulmonary rehabilitation programs. If training is successful, there will be less variability among individuals in a trained group and, hence, it will be more difficult to distinguish among them. It is encouraging that coefficient alpha for the final form was as high as it was in testing a trained group (0.86). The data do show that the test distinguishes between people with high knowledge levels and people with low knowledge levels.

The program directors' descriptions of their programs (Table VI) indicate there is a wide variability between the minimum and maximum number of hours used for teaching/training. With both the mean and the median in the 30 to 35 hour range, the question arises: Why do some program directors spend up to three times that many hours? Program length and its relation to effectiveness should be examined in future research.

Benefits of knowledge testing in a pulmonary rehabilitation program include immediate feedback and correction of misperceptions. If a participant provides a wrong answer at posttest, the topic can be discussed and the correct answer reinforced. In programs where participants are taught by several team members, some content areas may fall between the cracks. This would be demonstrated by knowledge deficits on the part of the participants. Such deficits could be remedied before the program's end.

There are also drawbacks to knowledge testing. Some people take tests well or memorize information easily, but are unable to put their knowledge to use. Other participants resist taking knowledge tests because they are sensitive to their inability to read well. Some programs include several kinds of written tests; additional tests may be too tiring for some persons.

This knowledge test is limited by the number of test items included. Our experience indicates that pulmonary rehabilitation program participants balk at a test that takes more than 30 minutes to complete. Program directors reported that the 35-item test version used in Phase Two took 20 to 25 minutes to complete. Hence, we felt that 40 questions was the maximum number that could be placed on the final version of the knowledge test.

Because of the variability of programs throughout the country, this test may not meet the needs of all programs. However, program directors who want to use the test may select those categories of questions that fit their programs. This would limit comparison between programs for research purposes, but would still provide an evaluative tool for individual programs.

We recognize that knowledge change may not be translated into behavior change, but knowledge can be the basis upon which behavior change is built. Thus, we see an instrument to measure knowledge as only one of the tools for evaluating pulmonary rehabilitation programs. A second, more important tool, would measured behavior change. Our future research will pursue that goal.

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Copies of the test, copyrighted by Loma Linda University, may be secured from the Department of Respiratory Therapy, School of Allied Health Professions, Loma Linda University, Loma Linda, CA 92350. (714) 824-4932.

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## REFERENCES


1. MacDonnel RJ: Suggestions for establishment of pulmonary rehabilitation programs. *Respiratory Care* 1981;26:966-977.
2. Davido J: Pulmonary rehabilitation. *Nursing Clinics of North America* 1981;16:275-283.
3. American Thoracic Society: Pulmonary rehabilitation: Official statement adopted by ATS Executive Committee March 1981. *Respiratory Disease* 1981;124:663-666.
4. Perry JA: Effectiveness of teaching in the rehabilitation of patients with chronic bronchitis and emphysema. *Nursing Research* 1981;30;219-222.
5. Wright RW, Larsen DF, Monie RG, Aldred RA: Benefits of a community hospital pulmonary rehabilitation program. *Respiratory Care* 1983;28: 1474-1479.
6. Miracle VA: Pulmonary exercise program: A model for pulmonary rehabilitation. *J Cardiopulmonary Rehabil* 1986;6:368-371.
7. Petty TL, Nett LM, Finigan MM, Brink GA, Corsello PR: A comprehensive care program for chronic airway obstruction. *Ann Intern Med* 1969;6:1109-1120.
8. Casciari RJ, Fairshter RD, Morrison JT, Wilson AF: Effects of breathing retraining in patients with chronic obstructive pulmonary disease. *Chest* 1981;79:393-398.
9. Bebout DE, Hodgkin JE, Zorn EG, Yee AR, Sammer EA: Clinical and

physiological outcomes of a university-hospital pulmonary rehabilitation program. *Respiratory Care* 1983;28:1468–1473.
**10.** Fishman DB, Petty TL: Physical, symptomatic and psychological improvement in patients receiving comprehensive care for chronic airway obstruction. *J Chron Dis* 1971;24:775–785.
**11.** Lertzman MM, Cherniack RM: Rehabilitation of patients with chronic obstructive pulmonary disease. *Am Rev Respir Dis* 1976;114:1145–1165.
**12.** Moser K, Bokinsky G, Savage R, Archibald C, Hansen P: Results of a comprehensive rehabilitation program. *Arch Intern Med* 1980;140:1596–1601.
**13.** Stenson H, Wilkinson L; *TESTAT: A Supplementary Module for SYSTAT.* Evanston, IL: SYSTAT, Inc, 1986.
**14.** Wilkinson L; *SYSTAT: The System for Statistics (version 4.0).* Evanston, IL: SYSTAT, Inc., 1988;490–491.

## Erratum

In the April 20, 1989 issue for the article by Keyser, et al. (J Cardiopulmonary Rehabil 1989;9:145–154), the following correction should be noted: in Table VI, Peak SV and SV at Peak Work Rate, under the column heading 30 rpm Arm-Cranking Speed, Peak SV(ml) should read 128 (±40).