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The Clinical Year in Review: Exercise and Rehabilitation

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This is the first year that "Exercise and Rehabilitation" has been given recognition as a topic worthy of a separate Year in Review presentation. This seems especially appropriate. Pulmonary rehabilitation is being increasingly recognized as the standard of care for patients with debilitating pulmonary disease. The GOLD Guidelines, among others, recommend rehabilitation *early* in the disease course. This can be seen as an attempt to restore patients to full activity as productive members of society (e.g., so they may return to employment), rather than the current situation where the main focus is restoring the ability of those with severe disease to leave the home and engage in activities that improve quality of life.

At the same time, exercise programs are increasingly seen as the focal point of pulmonary rehabilitation. A number of laboratories around the world are intent on defining the mechanisms by which rehabilitative exercise benefits patients, designing optimal exercise training programs and discovering adjunctive therapies that will enhance the benefit of these programs. A major effort is underway to address skeletal muscle dysfunction as an integral component of COPD and to seize on this largely reversible component as a therapeutic focus.

The coming year should be an interesting one for those of us interested in rehabilitative sciences. A new ATS/ERS Statement on pulmonary rehabilitation is being prepared. A State of the Art Review on pulmonary rehabilitation is likely to be published in the American Journal of Respiratory and Critical Care Medicine. And the Pulmonary Rehabilitation Section continues its quest for Assembly status within the American Thoracic Society (a status already achieved in the European Respiratory Society).

I have chosen four papers for inclusion out of roughly 250 papers retrieved in a Pub Med search of "pulmonary rehabilitation" for 2004 and early 2005. The first paper, by Mador, et al., attempts to reinforce the scientific basis of adding a strength training component to the traditional endurance training exercise program. What benefits can be expected (and cannot be expected) from strength training are clearly defined. In the second paper, Plankeel et al. retrospectively mine a large data base from the Duke University exercise laboratory. They ask whether the primary mechanism of exercise limitation can be used to predict those who will benefit most (in terms of increased exercise tolerance) from pulmonary rehabilitation. The third paper presents the long-awaited (by me, at least) results of the California Pulmonary Rehabilitation Collaborative Group's study of pulmonary rehabilitation outcomes. What makes this study rather unique is that most participating centers are not university-based research centers. This study gives us a better idea of what can be expected from typical community-based rehabilitation programs. Finally, the study by Man et al. explores a new model for pulmonary rehabilitation. Can a rehabilitation program delivered shortly after an exacerbation requiring hospitalization affect the short-term prospects for recovery of functionality and lessen the likelihood of rehospitalization? Modesty forbade inclusion of a fifth paper, one from my laboratory, that tests the possibility that short-term testosterone supplementation might improve muscle mass and strength in men with COPD. For those interested in this subject, the reference is: Casaburi, et al., Effects of testosterone and resistance training in men with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2004 Oct 15;170(8):870-8.

Endurance and strength training in patients with COPD.

Mador MJ, Bozkanat E, Aggarwal A, Shaffer M, Kufel TJ.

Chest. 2004; 125(6):2036-45.

Division of Pulmonary, Critical Care and Sleep Medicine, State University of New York at Buffalo, Buffalo, NY, USA.

The purpose of this study was to compare the effects of endurance training only to endurance plus strength (combined) training in a randomized trial of patients with COPD. Twenty-four patients completed the study: 11 patients in the combined training group (FEV_1 45±5% predicted), and 13 patients in the endurance training group (FEV_1 40±4% predicted) [mean +/- SE]. Muscle strength, quality of life, exercise performance, and quadriceps fatigability were measured before and after rehabilitation.

Combined training led to significant improvements in quadriceps (23.6%), hamstring (26.7), pectoralis major (17.5%), and latissimus dorsi (20%) muscle strength. However, endurance training alone did not produce significant improvements in muscle strength. Six-minute walk distance, endurance exercise time, and quality of life (as measured by the Chronic Respiratory Questionnaire) significantly increased in both groups after rehabilitation with no significant differences in the extent of improvement between groups. The extent of improvement in quadriceps fatigability after training (assessed by quadriceps twitch force before and after exercise) was not significantly different between groups.

The authors conclude that strength training can lead to significant improvement in muscle strength in elderly patients with COPD. However, this improvement in muscle strength does not translate into additional improvement in quality of life, exercise performance or quadriceps fatigability compared to that achieved by endurance exercise alone.

Comment: A key finding of this paper is that the addition of strength training to endurance training does not improve measures of quality of life. This supports other studies where isolated strength training was studied. Why does the patient perceive strength training as “unimportant” while perceiving endurance training as a strong contributor to enhanced quality of life? Presumably, this relates to the predominance of endurance activities in activities of daily living. Nonetheless, improved strength may have benefits not captured in quality of life assessments. Fro example, it has been postulated that muscle weakness predisposes to falls (and broken bones).

Exercise outcomes after pulmonary rehabilitation depend on the initial mechanism of exercise limitation among non-oxygen-dependent COPD patients.

Plankeel JF, McMullen B, MacIntyre NR.

Chest. 2005; 127(1):110-6.

Department of Pulmonary and Critical Care Medicine, Duke University Medical Center, Durham, NC, USA.

Pulmonary rehabilitation that includes exercise training can improve exercise tolerance and quality of life for patients with COPD. However, the degree of benefit from pulmonary rehabilitation is variable. It was hypothesized that the exercise response to pulmonary rehabilitation varies depending on the initial factors that limit exercise. The change in exercise capacity after pulmonary rehabilitation was retrospectively analyzed in 290 nonhypoxemic patients with COPD. Patients were classified into the following subgroups based on the primary limitation seen on initial exercise testing (based on ventilatory reserve and heart rate reserve): (1) ventilatory-limited (VL); (2) cardiovascular-limited (CVL); (3) mixed ventilatory/cardiovascular-limited (VLCVL); and (4) non-cardiopulmonary-limited (NL). Outcomes were compared among subgroups.

In the entire study population, pulmonary rehabilitation led to increased timed walk distance (by 30%; $p < 0.0001$) and maximal oxygen consumption (VO_2max) (by 85 mL/min; $p < 0.0001$). Stepwise multiple regression selected age, ventilatory reserve at peak exercise, and exercise arterial oxygen pressure as individual predictors of improvement in VO_2max. VO_2max increased in the VL subgroup (30 mL/min; $p = 0.008$), the CVL subgroup (109 mL/min; $p < 0.0001$), the mixed VLCVL subgroup (61 mL/min; $p < 0.0001$), and NL subgroups (111 L/min; $p < 0.0001$). The improvement in VO_2max was greater in the CVL subgroup than in the VL subgroup ($p < 0.0001$). Timed walk distance improved to a similar degree in all subgroups (26 to 36%).

Patients with nonventilatory exercise limitations experience the greatest increase in VO_2max after pulmonary rehabilitation. However, even patients with severe ventilatory limitation can improve exercise tolerance with pulmonary rehabilitation.

Comment: Although significant differences in improvement in peak oxygen uptake existed among subgroups of COPD patients, considerable overlap among groups was present. We have yet to discern a set of characteristics that will usefully predict that a given patient will fail to benefit from a program of pulmonary rehabilitation. It remains an appropriate position that all COPD patients debilitated by their disease deserve to be enrolled in pulmonary rehabilitation.

The dissociation between the improvement in a timed walking test and in peak oxygen uptake is striking. One possible explanation is that these two tests exploit substantially different determinants of exercise tolerance. Another is that one or both of these measures is not a reliable measure of exercise tolerance and/or that

the correlation between the two is corrupted by random variation in the measurement.

Effects of pulmonary rehabilitation on dyspnea, quality of life, and healthcare costs in California.

California Pulmonary Rehabilitation Collaborative Group.
J Cardiopulm Rehabil. 2004; 24(1):52-62

This study evaluated pulmonary rehabilitation as practiced in the general California medical community to determine its effectiveness in improving dyspnea and health-related quality of life and reducing the use of healthcare resources. For this study, 10 established pulmonary rehabilitation programs agreed to collect common clinical health outcome data on consecutive patients over a two year period. Three self-administered questionnaires were obtained before and after rehabilitation, then at 3-, 6-, 12-, and 18-month follow-up assessments: Medical Outcomes Survey Short Form (SF-36), University of California, San Diego Shortness of Breath Questionnaire (SOBQ), and Health Care Utilization in the preceding 3 months. Information also was collected on patient demographics, diagnostic categories, use of supplemental oxygen, and available spirometry and 6-minute walk tests.

Nine centers enrolled 647 patients that met prespecified inclusion criteria. Of these, 521 completed the rehabilitation program and both the pre- and the postprogram assessment. At least two of the four follow-up assessments were completed by 415 patients in eight centers. The mean age of the patients was 68 years, and 42% were men. Overall, the FEV_1 was 44% of the predicted value. There were few significant differences between the centers. The baseline outcome measures demonstrated marked symptoms, as evidenced by the mean SOBQ score (56.8) and the mean impaired quality of life results (SF-36 physical component score, 31.2; SF-36 mental component score, 47.5). These measures also showed high utilization of healthcare services over the preceding 3 months in terms of mean hospital stay (2.4 days), urgent care visits (0.4), physician visits (4.4), and telephone calls (2.7). After rehabilitation, there were significant improvements in symptoms and quality of life in all the centers, as evidence by mean changes of -6.8 for the SOBQ, 7.5 for the physical component score, and 3.9 for the mental component score. Over 18 months, benefits gradually declined, but levels remained above baseline values. There also were significant reductions in all measures of healthcare utilization.

Pulmonary rehabilitation was effective in improving symptoms and quality of life and reducing the utilization of healthcare resources over 18 months. The results were consistent across participating centers despite variations in practice settings, patient referral patterns, and program structure.

Comment: This study documents, in a large patient cohort, that community based pulmonary rehabilitation programs improve measures of quality of life. It also suggests a substantial reduction in healthcare utilization. However, in an uncontrolled study, these conclusions may not be on firm ground. Patients tend to be referred for rehabilitation when they have experienced a recent downturn in their health status (e.g., a disease exacerbation). Therefore, the selected baseline (the few months preceding the rehabilitation program) may be unrepresentative.

Community pulmonary rehabilitation after hospitalisation for acute exacerbations of chronic obstructive pulmonary disease: randomised controlled study.

Man WD, Polkey MI, Donaldson N, Gray BJ, Moxham J.
BMJ. 2004;329(7476):1209.
Respiratory Muscle Laboratory, Guy's, King's, and St Thomas' School of Medicine, King's College Hospital, London SE5 9PJ.

This study's objective was to evaluate the effects of an early community based pulmonary rehabilitation program after hospitalization for an acute exacerbation of COPD. This was a single center, randomized controlled trial in an inner city, secondary and tertiary care hospital in London. Participants were 42 patients admitted with an acute exacerbation of COPD. Participants were randomized to an eight week, outpatient pulmonary rehabilitation program, started within 10 days of hospital discharge, or to usual care. Principal outcome measures were incremental shuttle walk distance, disease specific health status (St George's respiratory questionnaire, SGRQ; chronic respiratory questionnaire, CRQ) and generic health status (medical outcomes short form 36 questionnaire, SF-36) at three months after hospital discharge.

Early pulmonary rehabilitation, compared with usual care, led to significant improvements in median incremental shuttle walk distance (60 meters, $P = 0.0002$), mean SGRQ total score (-12.7, $P = 0.002$), all four domains of the CRQ (dyspnoea 5.5, $P = 0.003$; fatigue 5.3, $P = 0.004$; emotion 8.7, $P = 0.008$; and mastery 7.5, $P < 0.001$) and the mental component score of the SF-36 (20.1, $P = 0.02$). Improvements in the physical component score of the SF-36 did not reach significance (10.6, $P = 0.057$).

Early pulmonary rehabilitation after admission to hospital for acute exacerbations of COPD is safe and leads to statistically and clinically significant improvements in exercise capacity and health status at three months.

Comments: At least as important as the ability to restore these patients' exercise capacity and quality of life is the ability of early rehabilitation to prevent further exacerbations. In the three months after discharge from hospitalization, the group participating in early rehabilitation experienced 39% fewer hospital readmissions, 30% fewer hospital days and 70% fewer emergency room visits. Perhaps because of the small sample size, the first two of these three decreases did not achieve

statistical significance. If the findings of this study are confirmed in a larger, longer term study, impetus will be given for widespread adoption of this strategy for treating patients experiencing serious exacerbations.