The Importance of Pulmonary Rehabilitation

November 21, 2017

Presenter: George Pyrgos, MD
The importance of Pulmonary Rehabilitation

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Disclosures

- PI for Pearl Therapeutics, COPD clinical trial
- PI for AstraZeneca, COPD clinical trial
- PI for Sanofi-Aventis, investigational asthma clinical trial
- Have previously conducted clinical trials for Boehringer Ingelheim, Teva Pharmaceuticals
- None of these conflict with today’s topic
Outline

- Exercise Physiology Concepts
- Concepts of Dyspnea in Obstructive Lung Disease
- Pulmonary Rehabilitation
- Criteria for referral
- Type of patient who benefit
- Benefits of Pulmonary Rehabilitation
- Conclusions
Burden of Chronic Lung Diseases

• COPD
• Asthma
• Interstitial Lung Disease
• Pulmonary Hypertension
• Affects millions of Americans
• Common symptoms
  – Cough
  – Dyspnea
  – Limited exercise capacity
What determines our Exercise Capacity?

• Ability to generate energy for work

• **Measure of Aerobic Capacity**
  • **VO\textsubscript{2} max** is the measurement of the maximum amount of oxygen that an individual can utilize during intense, or maximal exercise. (ml O\textsubscript{2}/min/Kg)

• **Ventilatory Anaerobic Threshold:**
  • Measure of exercise capacity (usually beyond 50-60% VO\textsubscript{2} max) when lactate begins to accumulate
Endurance Exercise Performance: Physiology of Champions

Performance Velocity or Power

Performance VO₂ (aerobic) + Performance O₂ deficit (anaerobic) x Gross Mechanical Efficiency

Lactate Threshold VO₂

Total Buffering Capacity

Maximal Oxygen Consumption

Muscle Capillary Density
Stroke Volume
Max Heart Rate
Hemoglobin Content
Aerobic Enzyme Activity
Distribution of Power Output
% Slow Twitch (Type I)
Muscle Fibers
Anthropometry and Elasticity

The Journal of Physiology
Volume 586, Issue 1, pages 35-44, 2 JAN 2008 DOI: 10.1113/jphysiol.2007.143834
Relationship of Age and VO₂ and People

- Cyclist Oskar Svendsen VO₂ max = 97.5 ml/kg/min O₂
- Cyclist Armstrong’s VO₂ max = 85 ml/kg/min O₂
- Marathon runner Joan Benoit VO₂ max = 78.6 ml/kg/min O₂
- Average “couch potato” 45 ml/kg/min O₂
SCUBA Diving: Limited Supply of Air

If you swim at a rate of 100 feet/min

VO₂ max = 40 ml/Kg/min

Only 65% VO₂ max

VO₂ max = 25 ml/Kg/min, mild COPD

100% VO₂ max
Dyspnea in COPD

- Peripheral muscle dysfunction
- Dynamic Hyperinflation
- Increased Respiratory Load
- Defective gas exchange
- Physical deconditioning
  - (early Anaerobic threshold/ \( \text{VO}_2 \text{max} \) is low)
- Age related decline
- Other comorbid conditions
Lung Hyperinflation

- Patient with moderate obstruction
- Voluntarily initiates rapid respirations
- Does not have time to fully expire
- Temporary increase in FRC
- Increase in expiratory flow rate
Increased Work of Breathing: Work = P x V

Knowledge and Compassion Focused on You

Pharmacologic Therapies

- Inhaled Corticosteroids (ICS)
- Short Acting Bronchodilators (SABA, SAMA)
- Long Acting Bronchodilators (LABA, LAMA)
- Combination (ICS, LAMA/LABA, ICS/LABA, ICS/LABA/LAMA)
- Phosphodiesterase Inhibitors (Theophylline, Roflumilast)
- Mucolytics (N-Acetylcysteine, Carbocysteine (not in US))
- Antibiotics, steroids, and other disease specific drugs
Pathophysiology in Chronic Lung Disease

- Inflammation
- Cachexia
- Malnutrition
- Corticosteroids

- Atrophy of Muscles
- Decreased Glycogen Stores

- Decreased Capillarization
- Decreased oxidative metabolic capacity (VO$_2$ max)
- Altered Metabolism at rest

- Anxiety
- Depression

- Decreased Exercise Tolerance

- Respiratory Muscle Weakness
- Ventilatory Limitation
- Skeletal Muscle Dysfunction
- Gas Exchange Limitation

Thorax 1993;48:936-946
What is the treatment for inactivity?

Exercise
History of Pulmonary Rehabilitation

- Charles Denison 1895
- Recovering from Pulmonary Tb
- “Exercise as compared with other preventive and remedial treatments for Phthisis”
- 1970s Becomes acceptable treatment for Lung Disease

Denison, Charles, 1845-1909, Denver, Colo. : Chain & Hardy, 1893
Full Digital Copy: Library of Congress
Pulmonary Rehabilitation

Pulmonary rehabilitation is a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence of health-enhancing behaviors.”

Interdisciplinary Team (Physician, Physiotherapists, Respiratory Therapists, Nurses, Psychologists, nutritionists, social work etc.)

Individualized to patient unique needs

A spectrum of support for COPD

Goals of Pulmonary Rehabilitation

- Increase exercise tolerance and reduced dyspnea
- Increased muscle strength and endurance
- Improve health related quality of life
- Increase independence in daily functioning
- Increase knowledge of lung condition and promote self management
- Promote long-term commitment exercise
Who should be referred?

• Symptomatic individuals with FEV$_1$ <50% predicted
• Exercise limited individuals with FEV$_1$ >50%
• Dyspnea/ fatigue and chronic respiratory symptoms
• Decreased functional capacity, difficulty with ADLs
• Increased use of medical resources
• Gas exchange abnormalities including hypoxemia
Not just for COPD

- Interstitial lung disease
- Bronchiectasis
- Cystic fibrosis
- Asthma
- Pulmonary Hypertension
- Lung cancer
- Lung volume reduction surgery
- Lung transplantation (pre and post)

Barriers to enrollment

- 8-50% patients offered therapy enroll
- Disruption to patient’s established routine
- Travel transportation, program location
- Inconvenient timing
- Lack of perceived benefit from program
- Influence of healthcare provider

Respirology 2009;14:230–238
Components of Pulmonary Rehabilitation

- Exercise training
- Education
- Nutritional therapy
- Psychosocial in behavioral intervention
  - Smoking Cessation Adherence, Psychological Support
- Outcome assessment
  - CPET, 6MWD
- Promotion of long-term exercise adherence
Exercise Training
Components of Exercise

- **Endurance Training:**
  Cycling or walking is most common three to five times/week high level intensity (>60% max) 20-60 minutes

- **Interval training**
  intersperse high intensity activity with periods of rest/lower exercise activity
  May allow for more exercise overall due to lower dyspnea

*Cochrane Database Syst Rev 2006;4:CD003793.*  
*Am J Respir Crit Care Med 1997;155:555–561*
Strength Training

- Promotes healthy aging
- Benefit COPD patients with reduced muscle mass and strength
- Decreases fall risk
- Optimum level not known but American College of Sports Medicine
  
  1 to 3 sets of repetitions 2 to 3 days/week (60% of maximum load with one rep)

- Demands less oxygen than endurance training (e.g. during exacerbation, low VO$_2$max)

Supervised Walking

- Nordic Study comparing supervised walking to control
- 60 patients with moderate to severe COPD randomized to Nordic Walking or control
- 1 hr of walking at 75% max Heart Rate 3x/week vs. no intervention [Pred Max HR: 208- (0.7x Age)]
- 3 months of outdoor training:
  - Improved time walking/standing (14.9±1.9 min/day), walking intensity and 6 min walk distance (increased by 78 ± 28m, p<0.01)

*Respir Res* 2010;11:112.
Walking may be preferable to cycling

- In study bicycle vs. walking- RCT
- 8 week duration of training- 36 recruits
- 3x/week training with walking or cycling
- Training intensities were based on baseline function
- Walking group had increased endurance shuttle walk time vs. cycling group (279 seconds, 95%CI)

- Specific Exercise improves specific muscle groups
- Individualization for training program

Outcomes in Severe Disease

- Improved exercise tolerance and dyspnea
- The Maugeri Study compared COPD with COPD and chronic respiratory failure (N=1047, n=347)
- Improvement in all parameters in CRF (p=0.001)
- Mean changes FEV$_1$ (112ml), PaO$_2$ 3mmHg, PaCO$_2$ =3.3.mmHg
- 6MWT 48m , MRF28 total score 11.5 units (QOL respiratory questionnaire)
- Similar changes in all patients even without chronic respiratory failure

Mild COPD

- 46 patients with Stable GOLD Class II, III and IV
- 10 week 3x/week high intensity exercise program
- Quadriceps muscle biopsy
- Improved exercise tolerance, quality of life
- Remodeling of skeletal muscle in all groups
- Issue? (who’s going to pay for it)

After COPD Exacerbation

- Resistive training likely to be better tolerated
- Reduces healthcare use, readmissions and mortality
- 2011 Cochrane Review of 11 RCTs
- 42% reduction in hospital readmission over 25 weeks (OR, 0.22; 95% CI, 0.08 to 0.58)
- 16% decrease in mortality (OR, 0.28; 95% CI, 0.10 to 0.84).
- Clinically safe and effective

Symptoms of Anxiety and Depression

- 40% of patients with COPD have symptoms of depression / anxiety
- Even higher incidence in patients on oxygen
- Cochrane review of 3 RCTs (n=269)
  - Reduction in short term anxiety and depression
- Idea of psychotherapists has been explored – further research is needed

Technology-assisted exercise training.

- Limited data
- Cellphone remotely monitored endurance program with music with tempo
- Adherence monitored using GPS
- Improvement in walking distance
- Short form quality of life questionnaire
- Fewer exacerbations

No change in lung function but it will....

- Improve skeletal muscle function
- Improve oxidative capacity and efficiency of skeletal muscles
- Increase motivation for exercise beyond program
- Reduce mood disturbances
- Improve overall cardiovascular function
Conclusions

• Improves symptoms and quality of life of patients
• Primary candidate patients with moderate to severe COPD or other chronic lung disease
• Resistance and Endurance training both benefit.
• Program customized to individual needs
• Walking is a great exercise for patients. Even at home
  – 1 hr of walking at 75% max Heart Rate 3x/week
• Consider employing technology to encourage patient activity/adherence
Thank you for your attention.
November is COPD Awareness Month!
November is Lung Cancer Awareness Month!
Thank you pulmonary rehabilitation team!