COPD and Pulmonary Rehabilitation 2013

Philip T. Diaz, M.D.
Outline

- Definition/Background
- Physiologic rationale: COPD
- Program components
- Outcomes
- Miscellaneous considerations
Definition of Disease

- COPD, a common preventable and treatable disease, is characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patient.

GOLD guidelines 2011 update.
PRIMARY CARE RESPIRATORY JOURNAL
www.thepcrj.org

Thomas 2013
Impact of COPD in U.S.A.

- Fourth leading cause of death
  - 100,000 deaths/year
- Projected to be 3rd leading cause of death by 2020
- Annual cost up to 31.9 billion
  - 50-70% of the cost associated with acute exacerbations
COPD: Assessment and monitoring

- Diagnosis of COPD made based on risk factors and obstruction on spirometry
- Spirometry is the “GOLD” standard for diagnosis
  - FEV1/FVC < 70%
  - More severe stage with decreasing FEV1
- Perform ABG’s if FEV1 < 40% of predicted
- Test for alpha-1 antitrypsin deficiency in patients < 45 or with a strong family history

Global Initiative for Chronic Obstructive Lung Disease, NIH pub. #2701A;
Management of stable COPD

- Smoking cessation
- Vaccination
- Oxygen therapy: $pO2 \leq 55$ (or $\leq 59$, with cor pulmonale, polycythemia)

Global Initiative for Chronic Obstructive Lung Disease, NIH pub. #2701A;
Confirm diagnosis of COPD

- Intermittent symptoms (cough, wheeze, dyspnea)
- Short acting bronchodilator prn
- Limited benefit?
  - Long acting bronchodilator + prn short acting bronchodilator
    - (Salmeterol, formoterol, indacaterol, tiotropium, aclidinium)
    - (albuterol, ipratropium)
    - Limited benefit?
  - Change or combine classes of bronchodilators; consider inhaled steroids; ?PDE4 inhibitors – roflumilast (Daliresp).

Adapted from Celli et al. ATS/ERS 2004
Updated GOLD Guidelines

• December 2011 at www.goldcopd.org
• Assessment of COPD based on:
  – Symptoms
  – Severity of spirometric abnormality
  – Future risk of exacerbations
  – Identification of co-morbidities
Spirometric Assessment

FEV1/FVC less than 0.7

- **GOLD 1** \( \text{FEV1} \geq 80\% \text{ predicted} \)
- **GOLD 2** \( 50\% \leq \text{FEV1} > 80\% \)
- **GOLD 3** \( 30\% \leq \text{FEV1} > 50\% \)
- **GOLD 4** \( \text{FEV1} < 30\% \text{ predicted} \)
PLEASE TICK IN THE BOX THAT APPLIES TO YOU
(ONE BOX ONLY)

mMRC Grade 0. I only get breathless with strenuous exercise.

mMRC Grade 1. I get short of breath when hurrying on the level or walking up a slight hill.

mMRC Grade 2. I walk slower than people of the same age on the level because of breathlessness, or I have to stop for breath when walking on my own pace on the level.

mMRC Grade 3. I stop for breath after walking about 100 meters or after a few minutes on the level.

mMRC Grade 4. I am too breathless to leave the house or I am breathless when dressing or undressing.
New GOLD Classification

GOLD Grade

Airflow Limitation

Symptoms

Exacerbations Per year

1 2 3 4

≥2 1 0

C High Risk, Less Symptoms

D High Risk, More Symptoms

A Low Risk, Less Symptoms

B Low Risk, More Symptoms

mMRC<2

mMRC≥2

Low Risk, Less Symptoms

Low Risk, More Symptoms
## Pharmacologic Treatment

<table>
<thead>
<tr>
<th>Patient</th>
<th>First choice</th>
<th>Second choice</th>
<th>Alternative Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SAMA prn or SABA prn</td>
<td>LAMA or LABA or SABA and SAMA</td>
<td>Theophylline</td>
</tr>
<tr>
<td>B</td>
<td>LAMA or LABA</td>
<td>LAMA and LABA</td>
<td>SABA and/or SAMA Theophylline</td>
</tr>
<tr>
<td>C</td>
<td>ICS + LABA or LAMA</td>
<td>LAMA and LABA</td>
<td>PDE4-inh. SABA and/or SAMA Theophylline</td>
</tr>
<tr>
<td>D</td>
<td>ICS + LABA or LAMA</td>
<td>ICS and LAMA or ICS + LABA and LAMA or LAMA and LABA or LAMA and PDE4-inh.</td>
<td>Carbocysteine SABA and/or SAMA Theophylline</td>
</tr>
</tbody>
</table>

LAMA = long acting muscarinic antagonist; LABA = long acting beta-2 agonist
Note: monotherapy with ICS not recommended
EW
- 56 y.o. AA female; 50 pack years
- Long standing dyspnea - quit bowling
- On salmeterol bid; prn albuterol
- FEV1 – 0.44 liters, 22% of predicted
- pO2 61 mmHg, pCO2 52 mmHg
- RV 199% pred

Which of the following intervention is likely to provide the greatest improvement in her shortness of breath?
1. Inhaled Atrovent added to her regimen.
2. Roflumilast (Daliresp) added to her regimen.
3. Discontinuation of salmeterol and replacement with tiotoprium (Spiriva).
4. Replacement of serevent with Advair.
5. Pulmonary rehabilitation.
Pulmonary Rehabilitation

“An evidence-based multidisciplinary and comprehensive intervention for patients with chronic respiratory diseases who are symptomatic and often have decreased daily life activities. Integrated into the individualized treatment of the patient, pulmonary rehabilitation is designed to reduce symptoms, optimize functional status, increase participation, and reduce health care costs through stabilizing or reversing systemic manifestations of the disease.

American Thoracic Society/European Respiratory Society, 2006
Pulmonary rehabilitation – historical perspective

- Originally described 1960’s by Barach
- Advanced by Petty in 1970’s
- Remained controversial as a treatment until mid-1990’s
REVIEW

Rehabilitation for Patients With Chronic Obstructive Pulmonary Disease

Meta-analysis of Randomized Controlled Trials

Ghassan F. Salman, MD, MPH, Michael C. Mosier, PhD, Brent W. Beasley, MD, David R. Calkins, MD, MPP
FIGURE 3. Shortness of breath measured by effect size of each trial. * P values for test of heterogeneity.
FIGURE 2. Walking distance measured by effect size of each trial. * P values for test of heterogeneity.
Outline

• Definition/Background
• Physiologic rationale: COPD
• Program components
• Outcomes
• Miscellaneous considerations
• Rehab in non-COPD settings
Which of the following pulmonary physiologic parameters is consistently improved following pulmonary rehabilitation?

A. FEV1
B. FVC
C. PO2
D. Oxygen saturation during exercise
E. None of the above
COPD as a “systemic disease”

Chronic obstructive pulmonary disease • 5: Systemic effects of COPD

E F M Wouters

The role of body cell mass wasting, muscle wasting, and changes in muscle metabolism in the pathogenesis of chronic obstructive pulmonary disease is reviewed.

Thorax 2002;57:1067-1070

higher levels of lipid peroxidation products. The presence of systemic oxidative stress was further supported by Noguera et al who reported the upregulation of some neutrophil adhesion molecules such as CD11/CD18 in circulating neu-
Systemic inflammation in COPD

- Chronic inflammation occurs in COPD lungs
- “Spillover” of inflammatory molecules into systemic circulation
- Systemic inflammation responsible for COPD related co-morbidities

Sinden and Stockley, Thorax 2010
The Mitochondrion
Mitochondrial oxidative enzymes

Capillary density

Earlier onset anaerobic metabolism

Lactic acid

pCO₂

DYSPNEA

Deconditioning

Malnutrition

Hypoxemia/hypercarbia

Systemic inflammation

Earlier onset anaerobic metabolism

↓ Mitochondrial oxidative enzymes

↓ Capillary density

↓ % Type I “oxidative” fibers

Skeletal muscle dysfunction and COPD
Citrate synthase – key enzyme in Kreb’s cycle and metabolism of oxygen

The Mitochondrion

Product of Kreb’s cycle

<table>
<thead>
<tr>
<th>Cycle</th>
<th>One Cycle</th>
<th>Two Cycles</th>
<th>Energy</th>
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</thead>
<tbody>
<tr>
<td>NADH</td>
<td>4</td>
<td>6</td>
<td>24 ATP</td>
</tr>
<tr>
<td>FADH₂</td>
<td>1</td>
<td>2</td>
<td>4 ATP</td>
</tr>
<tr>
<td>H₂O</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>GTP</td>
<td>1</td>
<td>2</td>
<td>2 ATP</td>
</tr>
</tbody>
</table>

Total 30 ATP for Kreb

Glycolysis

0 ATP 6 are from NADH

C₆H₁₂O₆ + 6O₂ + 6H₂O ⇌ 6CO₂ + 12H₂O
• Citrate synthase is significantly decreased in the muscle of COPD patients. *Maltais et al 2000; Thorax*
Correlation of citrate synthase activity and functional status in COPD

Maltais et. al. Thorax 2000

- Least functional patients have lowest citrate synthase activities
Improvement in citrate synthase with rehab  (Maltais et al)

<table>
<thead>
<tr>
<th>Citrate Synthase</th>
<th>Pre-rehab</th>
<th>Post-rehab</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22.3 +/- 3.5</td>
<td>25.8 +/- 3.8</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>
Reductions in exercise lactic acidosis and ventilation as a result of exercise training in patients with obstructive lung disease.


Decreased lactate production for a given level of exercise following exercise training
Outline

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- Rehab in non-COPD settings
Lower extremity endurance training
Exercise Prescription

• Treadmill (Walking)
  – Start
    • Speed corresponding to 50-85% of VO2 max on initial CPET
    • Or 80% of the speed walked on the initial six-minute walk
    • 10 or more minutes (intervals are appropriate)
  – Once patient is able to walk continuously for 20 minutes, the speed is increased by 10%
  – Once patient is able to walk 2.0 mph, then an incline is added

• **Bicycle ergometry**
  - **Start**
    - Based on 50-85% of VO2 max
    - Or 25% of maximum achieved on cardiopulmonary exercise test
    - 10 or more minutes
    - Move to 60% of max within two weeks
  - Once patient is able to do 15 minutes then the resistance is increased in 5-10 Watt increments
Exercise Intensity

• High vs. Low Intensity
• Improved “training” vs. improved long term compliance
High intensity exercise

• Intensity of 60-75% of maximal oxygen uptake for 20-30 minutes at least 2-3 times per week virtually assures increased endurance
Skeletal Muscle Adaptations to Interval Training in Patients With Advanced COPD

Ioannis Vogiatzis, Gerasimos Terzis, Serafeim Nanas, Grigoris Stratakos, Davina C. M. Simoes, Olga Georgiadou, Spyros Zakythinos and Charis Roussos

_Chest_ 2005; 128; 3838-3845
DOI: 10.1378/chest.128.6.3838
Very high intensity interval training vs. moderate-high intensity constant load training

• 19 patients with advanced COPD
• Randomized to:
  – Constant load exercise (CLE)
    • 60-80% of peak workload on bicycle ergometer for 30 minutes
  – Interval exercise (IE)
    • 30 seconds at 100-140% of peak workload on bicycle ergometer
    • 30 seconds of rest
    • 45 minutes total
  – 10 week program with follow-up muscle biopsies
Improved oxidative enzyme content with both types of exercise

Interval very high intensity exercise

Constant load moderate-high intensity exercise
Improved capillary density with both types of exercise
Less dyspnea and leg discomfort with very high intensity interval training.
Benefits of pulmonary rehabilitation in patients with COPD with normal exercise capacity

Chou-Chin Lan¹,², Wen-Hua Chu³, Mei-Chen Yang¹,², Chih-Hsin Lee¹,², Yao-Kuang Wu¹,²*, and Chin-Pyang Wu⁴*

RESPIRATORY CARE Paper in Press. Published on January 01, 2013 as DOI: 10.4187/respcare.02051
Table 2. Effects of PR on pulmonary function test, respiratory muscle strength, and health-related quality of life

<table>
<thead>
<tr>
<th></th>
<th>Pre-PR</th>
<th>Post-PR</th>
<th>Mean Difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1/FVC (%)</td>
<td>59.4 ± 14.1</td>
<td>61.5 ± 15.0</td>
<td>2.1</td>
<td>0.336</td>
</tr>
<tr>
<td>FEV1 (L)</td>
<td>1.29 ± 0.47</td>
<td>1.33 ± 0.46</td>
<td>0.04</td>
<td>0.464</td>
</tr>
<tr>
<td>FEV1 (% predicted)</td>
<td>64.8 ± 23.0</td>
<td>66.7 ± 22.3</td>
<td>2.0</td>
<td>0.423</td>
</tr>
<tr>
<td>FVC (L)</td>
<td>2.24 ± 0.79</td>
<td>2.21 ± 0.66</td>
<td>-0.03</td>
<td>0.745</td>
</tr>
<tr>
<td>FVC (% predicted)</td>
<td>88.3 ± 34.5</td>
<td>87.7 ± 32.0</td>
<td>-0.6</td>
<td>0.865</td>
</tr>
<tr>
<td>PImax (cmH2O)</td>
<td>68.1 ± 25.7</td>
<td>75.9 ± 24.0</td>
<td>7.8</td>
<td>0.021*</td>
</tr>
<tr>
<td>PImax (%)</td>
<td>73.6 ± 25.6</td>
<td>82.5 ± 22.2</td>
<td>8.9</td>
<td>0.019*</td>
</tr>
<tr>
<td>PEmax (cmH2O)</td>
<td>109.4 ± 30.5</td>
<td>121.4 ± 37.3</td>
<td>12.0</td>
<td>0.026*</td>
</tr>
<tr>
<td>PEmax (%)</td>
<td>65.2 ± 20.7</td>
<td>71.5 ± 20.4</td>
<td>6.3</td>
<td>0.036*</td>
</tr>
<tr>
<td>SGRQ-total</td>
<td>39.8 ± 16.3</td>
<td>28.6 ± 16.0</td>
<td>-12.4</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>SGRQ-symptom</td>
<td>47.8 ± 23.9</td>
<td>35.5 ± 25.9</td>
<td>-7.8</td>
<td>0.027*</td>
</tr>
<tr>
<td>SGRQ-activity</td>
<td>50.6 ± 18.7</td>
<td>42.8 ± 18.2</td>
<td>-12.5</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>SGRQ-impact</td>
<td>31.2 ± 20.1</td>
<td>18.7 ± 15.3</td>
<td>-11.1</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

P values = comparison between pre-PR and post-PR
* = significantly different between pre-PR and post-PR
Table 3. Effect of PR on exercise capacity, cardiorespiratory function and dyspnea

<table>
<thead>
<tr>
<th></th>
<th>Pre- PR</th>
<th>Post- PR</th>
<th>Mean Difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work rate (watt)</td>
<td>82.1 ± 30.4</td>
<td>90.3 ± 32.7</td>
<td>8.2</td>
<td>0.001*</td>
</tr>
<tr>
<td>Work rate (% pred)</td>
<td>97.8 ± 15.9</td>
<td>108.6 ± 18.8</td>
<td>10.8</td>
<td>0.003*</td>
</tr>
<tr>
<td>VO₂ (ml/min)</td>
<td>1232.6 ± 327.9</td>
<td>1334.0 ± 359.3</td>
<td>101.3</td>
<td>0.001*</td>
</tr>
<tr>
<td>VO₂ (% pred)</td>
<td>91.6 ± 8.2</td>
<td>100.0 ± 12.6</td>
<td>7.9</td>
<td>0.001*</td>
</tr>
<tr>
<td>VE (L/min)</td>
<td>40.2 ± 13.2</td>
<td>39.3 ± 12.4</td>
<td>-0.9</td>
<td>0.518</td>
</tr>
<tr>
<td>VT (ml)</td>
<td>1152.8 ± 394.6</td>
<td>1153.4 ± 406.7</td>
<td>0.6</td>
<td>0.989</td>
</tr>
<tr>
<td>VE/VCO₂</td>
<td>33.6 ± 7.5</td>
<td>32.3 ± 7.8</td>
<td>-1.4</td>
<td>0.160</td>
</tr>
<tr>
<td>HR (beats/min)</td>
<td>134.5 ± 14.9</td>
<td>137.4 ± 19.9</td>
<td>3.0</td>
<td>0.357</td>
</tr>
<tr>
<td>MBP (mmHg)</td>
<td>109.6 ± 15.7</td>
<td>110.3 ± 15.1</td>
<td>0.7</td>
<td>0.718</td>
</tr>
<tr>
<td>O₂P (mL•beat⁻¹)</td>
<td>9.2 ± 2.5</td>
<td>9.8 ± 2.7</td>
<td>0.6</td>
<td>0.022*</td>
</tr>
<tr>
<td>SpO₂ (%)</td>
<td>93.9 ± 3.1</td>
<td>94.0 ± 2.9</td>
<td>0.1</td>
<td>0.791</td>
</tr>
<tr>
<td>PETCO₂ (mmHg)</td>
<td>39.8 ± 8.3</td>
<td>41.2 ± 6.8</td>
<td>1.4</td>
<td>0.276</td>
</tr>
<tr>
<td>Exertional dyspnea</td>
<td>5.7 ± 1.3</td>
<td>4.8 ± 2.0</td>
<td>-0.9</td>
<td>0.012*</td>
</tr>
</tbody>
</table>

*P values = comparison between pre-PR and post-PR

* = significantly different between pre-PR and post-PR
Upper Extremity Training
Exercise Prescription

• Specificity of training
  – “…benefits are largely specific to the muscles and tasks involved in training”

• Applied to pulmonary population:
  – If the purpose of pulmonary rehab is to maximize physical potential or limit burden of disease
  – Then must train in ways to mimic activities of daily living

Upper extremity training in COPD

- Upper extremity tasks divert shoulder girdle muscles that patient uses to assist in breathing
- Upper extremity exercises
  - Unsupported weight lifting
  - Therabands
  - Arm ergometry
12 patients with moderate-severe COPD
6 weeks of arm training program
Evaluation of arm exercise capacity, dynamic hyperinflation and dyspnea before and after training
Dynamic hyperinflation in COPD

- Increasing FRC with increasing ventilation
- This results in decreased IC
- COPD lungs are working in a “less compliant range”
Arm exercise and inspiratory capacity in patients with COPD: effect of arm training

- Better preservation of inspiratory capacity during arm exercise after training

**Inspiratory capacity**

Gigliotti, Chest 2005

- Arm training program
  - Decreases work effort
  - Decreases level of dyspnea
  - Decreases dynamic hyperinflation
Effects of unsupported arm training on arm exercise-related perception in COPD patients

I. Romagnoli, G. Scano, B. Binazzi, C. Coli, G. Innocenti Bruni, L. Stendardi, F. Gigliotti
Time course of changes in VE, Ir, and sensory perceptions before and after UAET. Closed symbols: before UAET; open symbols: after UAET; VE ventilation, Ir respiratory rate. Arrows indicate isotime; *p < 0.05, **p < 0.001; ***p < 0.0005.
Upper extremity exercise prescription

• Upper Body Ergometer
  – Start - 4 minutes at 120 rpm
  – Increase
    • Resistance
    • Time – aiming for 15 minutes of continuous training
Upper extremity exercise prescription

• Resistance Training
  – Start
    • Proper technique is important
      – Arms: 1-2 lb dumbbells
  – Increase
    • Repetitions
    • Sets
    • Weight
Arm Elevation and Coordinated Breathing Strategies in Patients with Chronic Obstructive Pulmonary Disease

Running head: Arm Elevation and Coordinated Breathing in COPD

Thomas E. Dolmage, Tania Janaudis-Ferreira, Kylie Hill, Shirley Price, Dina Brooks, and Roger S. Goldstein
Inspiratory muscle training in COPD

- Rationale – Inspiratory muscle dysfunction
  - Geometric changes in the thorax and diaphragm
  - Systemic factors
  - Possible structural changes in the respiratory muscles

- Data
  - Conflicting
  - Intervention controversial
POWERbreathe

'Dumb-bells for your diaphragm'

Better Breathing

It's unlikely you'll be able to make your lungs larger, but there are ways to make the muscles that control your breathing function more effectively.
The Effects of 1 Year of Specific Inspiratory Muscle Training (IMT) in Patients With COPD*


- 42 consecutive COPD patients (FEV1 < 50% of predicted)
- Randomized to IMT vs sham
- IMT (*POWERbreathe*)
  - Threshold loading device – two 15 minute training sessions BID for 12 months
  - Begin at 15% PImax, increase by 5-10% each session until 60% of PImax by end of first month
  - Training then continued at 60% PImax
- Sham
  - Device used without any significant load
Results: Improved functional status with IMT

Results: Improved dyspnea with IMT
Decrease hospitalizations with inspiratory muscle training

![Graph showing decreased hospitalizations](image)

**Figure 5.** Hospital admissions, days spent in the hospital, and the use of primary-care consultations during the training period in the study group and in the control group.
Inspiratory muscle training protocol

- Used in patients with PI_{max} < 50\% of predicted
- Threshold loading device
- Gradual increase in resistance
Breathing retraining

- Pursed lip breathing
- Diaphragmatic breathing
Education topics

- Orientation
- Anatomy and physiology of lungs
- Benefits of exercise
- Respiratory muscles
- Oxygen and oxygen therapy
- Infection control
- Medication management
- Energy conservation
- Diet/Nutrition
- Maintenance
Psychosocial/Behavioral Component

• Prevalence of anxiety and depression very high in chronic lung disease

• Group sessions
  – Introduction/Stress
  – Physical symptoms
  – Cognitive issues
  – Emotional issues
  – Coping
COPD vicious cycle

COPD → Hyperinflation/air-flow obstruction → Increased load and decreased efficiency of respiratory muscles

Increased lactate production during exercise → Systemic inflammation

Systemic inflammation → Anxiety/Depression

Anxiety/Depression → Dyspnea on exertion

Dyspnea on exertion → Decreased oxidative capacity of skeletal muscle enzymes → Deconditioning
COPD → Hyperinflation/air-flow obstruction → Increased load and decreased efficiency of respiratory muscles

* Respiratory muscle training/
  Upper extremity training

Increased lactate production during exercise → Dyspnea on exertion → Deconditioning

* Psychosocial counseling/education

Anxiety/Depression

* Lower extremity “aerobic” training

Increased oxidative capacity of skeletal muscle enzymes

Intervention with pulmonary rehab

* Breathing retraining
Outline

- Definition/Background
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- Indications
Effects of Pulmonary Rehab

*Griffiths et al, Lancet 355:362; 2000*

- At one year, significant and sustainable improvements in:
  - Exercise tolerance
  - Respiratory symptoms
  - Depression
  - Quality of life
Effects of Pulmonary Rehab at 1 year

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<th></th>
<th>Control</th>
<th>Rehab</th>
<th>P value</th>
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<tbody>
<tr>
<td>Deaths (n)</td>
<td>12</td>
<td>6</td>
<td>NS</td>
</tr>
<tr>
<td>Hospitalized (n)</td>
<td>41</td>
<td>40</td>
<td>NS</td>
</tr>
<tr>
<td>Admissions/pt</td>
<td>2.2</td>
<td>1.7</td>
<td>.048</td>
</tr>
<tr>
<td>Hospital days</td>
<td>21.0</td>
<td>10.4</td>
<td>.022</td>
</tr>
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Griffiths et al; Lancet 2000;355:362-368
## Cost effectiveness of various medical interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Cost/QALY</th>
</tr>
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<tbody>
<tr>
<td>Pulmonary rehabilitation</td>
<td>&lt; 0</td>
</tr>
<tr>
<td>Hip replacement</td>
<td>$1979</td>
</tr>
<tr>
<td>CABG</td>
<td>$3490</td>
</tr>
<tr>
<td>Intensive insulin (DM II)</td>
<td>$21,710</td>
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<tr>
<td>Beta-blocker for HTN</td>
<td>$44,750</td>
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<tr>
<td>Interferon for MS</td>
<td>$124,415</td>
</tr>
</tbody>
</table>
Optimizing the 6-Min Walk Test as a Measure of Exercise Capacity in COPD

Divay Chandra, MD; Robert A. Wise, MD, FCCP; Hrishikesh S. Kulkarni, MD; Roberto P. Benzo, MD, FCCP; Gerard Criner, MD, FCCP; Barry Make, MD, FCCP; William A. Slivka, RPFT; Andrew L. Ries, MD, MPH, FCCP; John J. Reilly, MD, FCCP; Fernando J. Martinez, MD, FCCP; and Frank C. Sciurba, MD, FCCP; on behalf of the NETT Research Group
Barriers to Pulmonary Rehab:
Retrospective study of 711 COPD patients referred to rehab.
Hayton, Respir Med 2013; Selzler, COPD 2012

- Poor Attendance
  - Oxygen use
  - Living alone

- Poor Adherence
  - Current smoking (especially younger)
  - Poor shuttle test walking distance
  - Hospitalizations
  - Poor perceived health status
Pulmonary rehabilitation and lung transplant

- Even after bilateral lung function and restoration of normal lung function, exercise capacity remains significantly abnormal.
- Rehab addresses skeletal muscle dysfunction and maximizes functional capacity.
Pulmonary rehab and lung cancer resection

- Even marginal candidates (very low FEV1) may be candidates for at least wedge resection
- Recent data suggests perioperative rehab significantly improves outcomes
- “Rehab express”
Pulmonary rehabilitation and LVRS

- Rehab established as an integral component of LVRS with the NETT
- Maximal medical therapy necessary to see if surgery is warranted
- Pre-operative and post-operative conditioning critical for the procedure
E.W.
October
2008

- FEV1 = 0.38 liters (21% of pred.)
- pO2 55; pCO2 52
- Metachronous lung cancer
- Extensive pulmonary rehab
- Bilateral LVRS with cancer resection