

PULMONARY REHABILITATION

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Objectives

- Understand the benefits of pulmonary rehabilitation for patients with respiratory diseases, and how it can improve overall quality of life.
- Learn about the different components of pulmonary rehabilitation, including exercise training, education and self-management, nutritional counseling, psychological support, and smoking cessation.
- Gain knowledge of the evidence-based guidelines and research that support the use of pulmonary rehabilitation as an essential part of the treatment plan for patients with respiratory diseases.
- Learn about the updates and advancements in pulmonary rehabilitation, including new technologies and interventions that can help to improve patient outcomes.
- Understand the importance of pulmonary rehabilitation in respiratory disease management and increase confidence in referring patients for this type of treatment.

Pulmonary Rehabilitation

- Broad concept revolving mainly around therapeutic intervention
 - Mainly COPD patients
 - Evolving data for ILD (esp. Post COVID era)
 - Bronchiectasis, Asthma, CF, PAH, Pre/Post Lung Transplant
- ATS/ERS defines Pulmonary Rehab as:
 - A comprehensive intervention based on a thorough assessment followed by patient-tailored therapies that include, but are not limited to:
 - Exercise Training
 - Education
 - Behavior Change
 - Designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors.

Pulmonary Rehabilitation

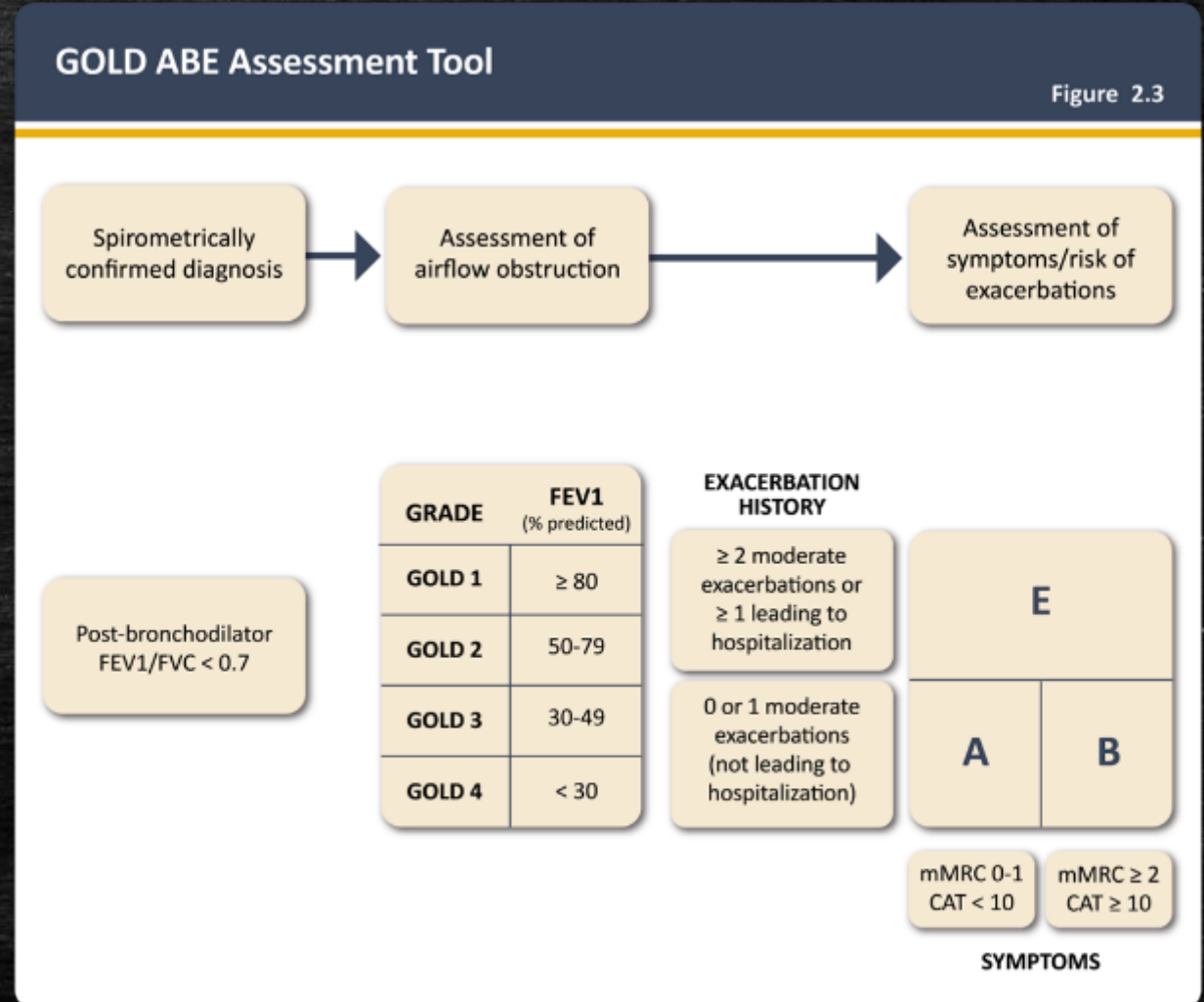
- Despite the lengthy definition
 - Designed around the individual patient's needs
 - Focuses on Treatable Traits
- Revolves around the complex phenotypes of pulmonary symptoms / conditions
 - Pulmonary Pathophysiology
 - Comorbid Conditions
 - Adaptive behaviors (and maladaptive)
 - Available Social Supports
 - And even Cultural Beliefs

Benefits (the beginning)

- Improvements in Patients'
 - Dyspnea
 - Health Status
 - Exercise Tolerance
- These improvements are FAR better seen with Pulmonary Rehab when compared with ANY other therapy for COPD
- Interestingly – results seen despite having NO direct effect on pulmonary function

Who Should We Send to Pulm Rehab?

- Criteria remains vague
 - That's a good thing
- GOLD recommends referral for COPD patients in group B and E
- Patients with any respiratory disease
 - Remain symptomatic despite optimized medical therapy
 - Experience disability despite optimized medical therapy



Reasons for Referral

- Severe dyspnea / fatigue
- Decreased exercise tolerance, or ability
- Low physical activity levels
- Difficulty performing ADLs
- Impaired Health Status
- Decreased occupational performance or ability
- Frequent/increased medical resource utilization
- Difficulty managing their respiratory disease
- Recovery from exacerbation (COPD, IPF etc)
- Preparation for or recovery from lung transplantation
- Nutritional depletion

Who Should NOT be Referred?

- Absolute Contraindications:
 - Unstable Angina or Arrhythmia
 - Unstable bone fracture
 - Communicable infectious disease (ie TB, COVID, etc...)
 - Unstable psychiatric condition posing harm to self or others

- Relative Contraindications
 - Severe Cognitive Impairment
 - Lack of Motivation
 - Severe Progressive Neurologic Disease
 - Severe Anemia
 - Severe Debilitating Fatigue

- Some patients with cardiovascular comorbidities may be better suited to Cardiac Rehab first

Dispelling the Myth

- “My Patient is Too Far Gone to Benefit from Pulmonary Rehab”
- While frailty is a predictor of noncompletion of Pulm Rehab
 - These patients can still achieve significant benefits
- 816 patients with stable COPD
 - 26 percent (212) met criteria for frailty
 - Those who completed:
 - Reduced Dyspnea
 - Improved Exercise Performance
 - Improved Physical Activity Level
 - **61% no longer met criteria for frailty!!!**

- Fatigue (“Have you felt fatigued? Most or all of the time over the past month?”) Yes = 1, No = 0
- Resistance (“Do you have difficulty climbing a flight of stairs?”) Yes = 1, No = 0
- Ambulation (“Do you have difficulty walking one block?”) Yes = 1, No = 0
- Illnesses (“Do you have any of these illnesses: hypertension, diabetes, cancer (other than a minor skin cancer), chronic lung disease, heart attack, congestive heart failure, angina, asthma, arthritis, stroke, and kidney disease?”) Five or greater = 1, fewer than 5 = 0
- Loss of weight (“Have you lost more than 5 percent of your weight in the past year?”) Yes = 1, No = 0

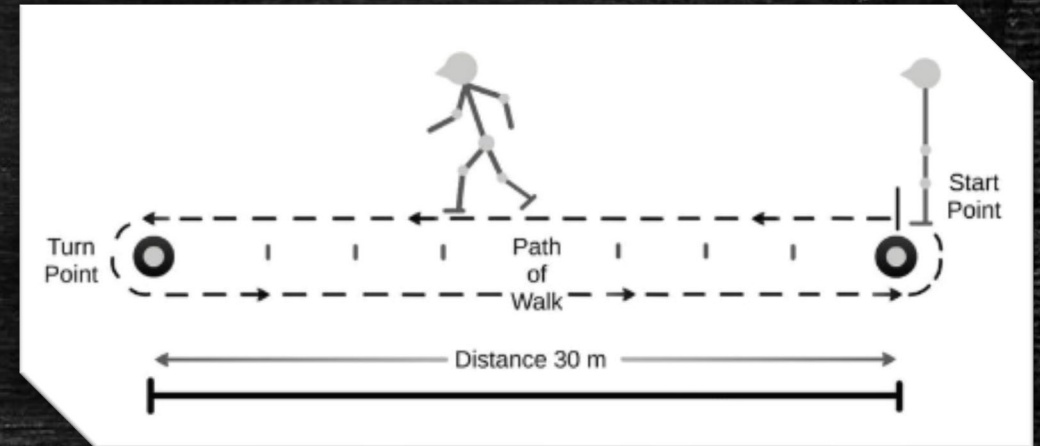
Frail scale scores range from 0 to 5 (0 = best, 5 = worst) and represent frail (3 to 5), pre-frail (1 to 2), and robust (0) health status.

Preparing Your Patient – Know Before You Go

- None of the following are REQUIRED but help to have completed
 - May actually be completed by the PR program or Pulmonary
 - Pre-program eval can be compared to post-program outcomes
- Pulmonary Function Testing
- Spirometry
 - FEV₁ pre and post bronchodilator
 - DLCO
- Exercise Capacity Testing
 - Six Minute Walk Test
 - Shuttle Walk Test
 - Cardio-Pulmonary Exercise Test [CPET]
 - Most comprehensive test and NOT typically performed before or after PR
 - Reserved for undifferentiated dyspnea

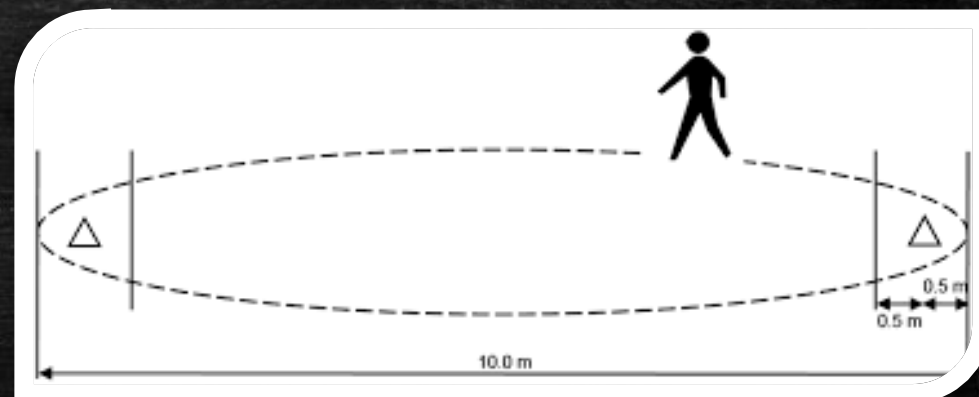
Six Minute Walk Test

- Patient walks as far as possible in 6 minutes time
 - Total distance, O₂ saturation, Heart Rate are all monitored
- 4 combined trials looking at 6MWT pre and post PR
 - Mean improvement in 6MWT distance was **107 Meters**
 - **35 meters increased is considered a significant improvement**



Shuttle Walk Test

- Patient walks back and forth between two cones
- Cones placed 10M apart
- Walk is either performed
 - At 85% of a previous maximal speed consistently
 - Increased with a timed tone which gradually shortens and ends the test when the cone is not reached
- Post PR -the mean improvement in shuttle walk test was 81 meters
 - Data taken from an analysis of 2 trials



The Nuts and Bolts

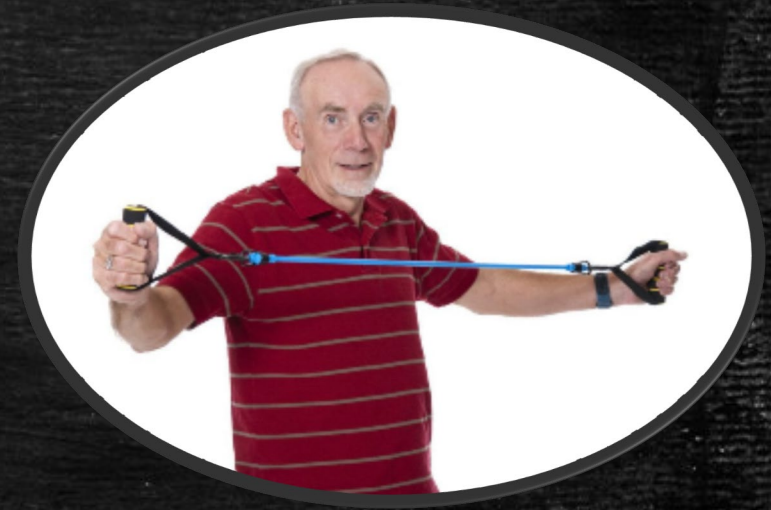


- Pulmonary Rehabilitation is NOT just exercise
- Multiple aspects that comprise the entire PR experience
 - Exercise Training
 - Promotion of Healthy Behaviors
 - Smoking Cessation
 - Nutritional Support
 - Proper Medication Usage / Inhaler Instruction
 - Disease Self-Management
 - Psychological Support
 - Coping Strategies
 - Improve Self Efficacy

Exercise Training

- Respiratory disease + Comorbidities limit functional abilities
 - Usually associated ventilatory limitation
 - Gas transfer limitations
 - Pulmonary vascular abnormalities
 - PH/PAH
 - Muscle dysfunction of the limbs (long standing under-utilization + comorbidities)
 - Many patients with PAD / Arthritis
- Many patients (and even providers) believe there is “recoverability” of the lungs with PR
- The overall goal of PR is to improve cardiorespiratory and skeletal muscle function, thereby reducing dyspnea and improving quality of life.

- What is the OPTIMAL type of exercise training?
 - We really aren't sure
 - Tends to vary from patient to patient
- What we DO know, is that programs that utilize one or a combination of the following show benefits:
 - Endurance Training
 - Interval Training
 - Resistance Training / Strength Training



Endurance Training (ie Conditioning)

- Most common form of exercise in PR programs
 - Upper Extremity Training
 - Lower Extremity Training (more data on this)
 - Stationary Bike, Treadmill, free walking, etc...
- Very Important that the workload EXCEEDS that of normal loads the patient experiences on a day-to-day basis



- Ergometer (leg or arm)
 - Continuous 20-30 min at 60% of the patient's maximal work rate
 - Ie: Max work rate is 100W – 20-30 min should be targeted at 60W
 - Intensity usually correlates with a BORG dyspnea of 4-6

0	Nothing at all
0.5	Very, very slight (just noticeable)
1	Very slight
2	Slight (light)
3	Moderate
4	Somewhat severe
5	Severe (heavy)
6	
7	Very severe
8	
9	
10	Very, very severe (maximal)

Endurance Training

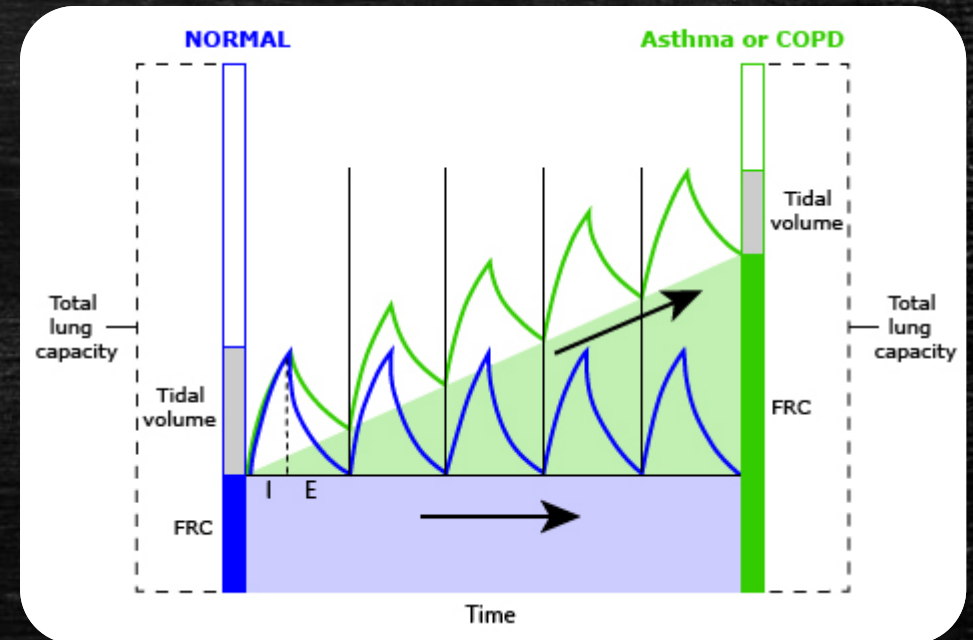
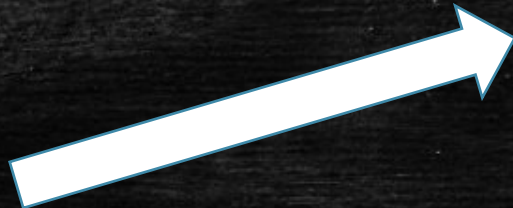
- All patients benefit to some degree with intense exercise regimens
 - Patients with FEV₁ ranging between 0.38L – 3.24L
 - Most severe FEV₁ had the best proportional improvement in 12 minute walk distance
- Because we know PFTs and muscle mechanics don't actually change
 - Long believed that the benefit of PR was the DESENSITIZATION to dyspnea
 - Studies now show actual biological benefits

Zu Wallack RL, Patel K, Reardon JZ, et al. Predictors of improvement in the 12-minute walking distance following a six-week outpatient pulmonary rehabilitation program. *Chest* 1991; 99:805.

Belman MJ, Kendregan BA. Exercise training fails to increase skeletal muscle enzymes in patients with chronic obstructive pulmonary disease. *Am Rev Respir Dis* 1981; 123:256.

Maltais F, LeBlanc P, Simard C, et al. Skeletal muscle adaptation to endurance training in patients with chronic obstructive pulmonary disease. *Am J Respir Crit Care Med* 1996; 154:442.

- Biological and Physiological Benefits:
 - Skeletal muscle adaptation
 - Increased concentration of skeletal muscle oxidative enzymes
 - Reductions in exercise-induced lactic acidosis and ventilation
- Improvements from baseline were proportional to the intensity of the treatment
 - 12% lower rise in Lactic Acid in patients trained at **LOW WORK** rate
 - 32% lower rise in Lactic Acid in patients trained at **HIGH WORK** rate
- Lower Heart Rate Response
- Faster Kinetics of Oxygen Consumption
 - And CO₂ production
- Earlier achievement of Steady State
- Respiratory Mechanics
 - Lower Respiratory Rate
 - Lower Ventilatory Requirements
 - Less Dynamic Lung Hyperinflation



What About My Patient Who Can't Walk

- Upper Extremity Exercises
- Yes... the majority of data comes from Lower Extremity Training
- Many ADLs involve the upper extremities
 - Also don't forget about postural muscles
- Arm only training HAS been linked to improvement overall
 - Mainly task-specific improvements
 - Mixed results from studies commenting on respiratory status
 - Some show possible effect on respiratory muscle improvement and others found no change in ventilatory muscle performance
 - Unsupported arm training vs arm cranking showed decreased O₂ uptake
 - Meta-analysis of UE exercises did confirm decreased dyspnea and arm fatigue during ADLs
 - No difference in BORG dyspnea scale rating

Interval Training

- What if the patient cannot reach their target workload with endurance training?
 - Dyspnea
 - Low O₂ saturations
- Interval training is an option
 - Interval training has proven to provide similar benefits to endurance training
- Could Interval Training have additional benefits?
 - Interval Training compared to Endurance:
 - 98 patients with severe COPD – had similar improvements at 3 weeks
 - QOL score and 6MWD (additional study showed similar BODE improvement)
 - Adherence to the Interval Program higher than Endurance (48% vs 24%)
- The problem? – We don't know what that actual Interval should be
 - Consensus is that at least for 1 minute of intense work to see any decreased dyspnea

Resistance Training

- Resistance training seems to have additive benefits to endurance training
- Resistance training leads to:
 - Lower oxygen consumption
 - Lower minute ventilation
 - Less dyspnea
 - Can help with endurance training (cyclical benefit)
- The optimal weight has not been established
 - However even light weights can make a difference (ie walking with light weight)

Additional Interventions / Therapies



- In addition to Exercises, Pulmonary Rehabilitation can offer:
 - Breathing Retraining
 - Utilizing Yoga and breathing exercises
 - Leads to less rapid breathing and less dynamic hyperinflation
 - Data conflicting, but has led to improved 6MWD but
 - No improvement in dyspnea or QOL scores
 - Ventilatory Muscle Training
 - Due to the hyperinflation and flattening of the diaphragm, ventilatory muscles suffer increased impairment
 - Mixed data in regard to improvements
 - Some meta-analyses showed improvement in QOL and exercise capacity, others did not

Education

- **Smoking Cessation**
 - SMOKING is an independent risk predictor of lack of successful completion of pulmonary rehabilitation
 - Smoking cessation should be the CENTER of any pulmonary rehab program due to it's immense impact on disease progression and survival
 - Can offer education, support, nicotine replacement, etc
- **Oxygen Therapy Education**
 - Don't smoke and use oxygen
 - Understanding of oxygen delivery devices (tanks, concentrators)
 - Teaching how to utilize different devices
- **Nutritional Support**
 - Weight loss where important
 - Weight MAINTAINENCE in Emphysema patients (BMI linked to mortality)
- **Inhaler Technique and Proper Utilization of Medications**



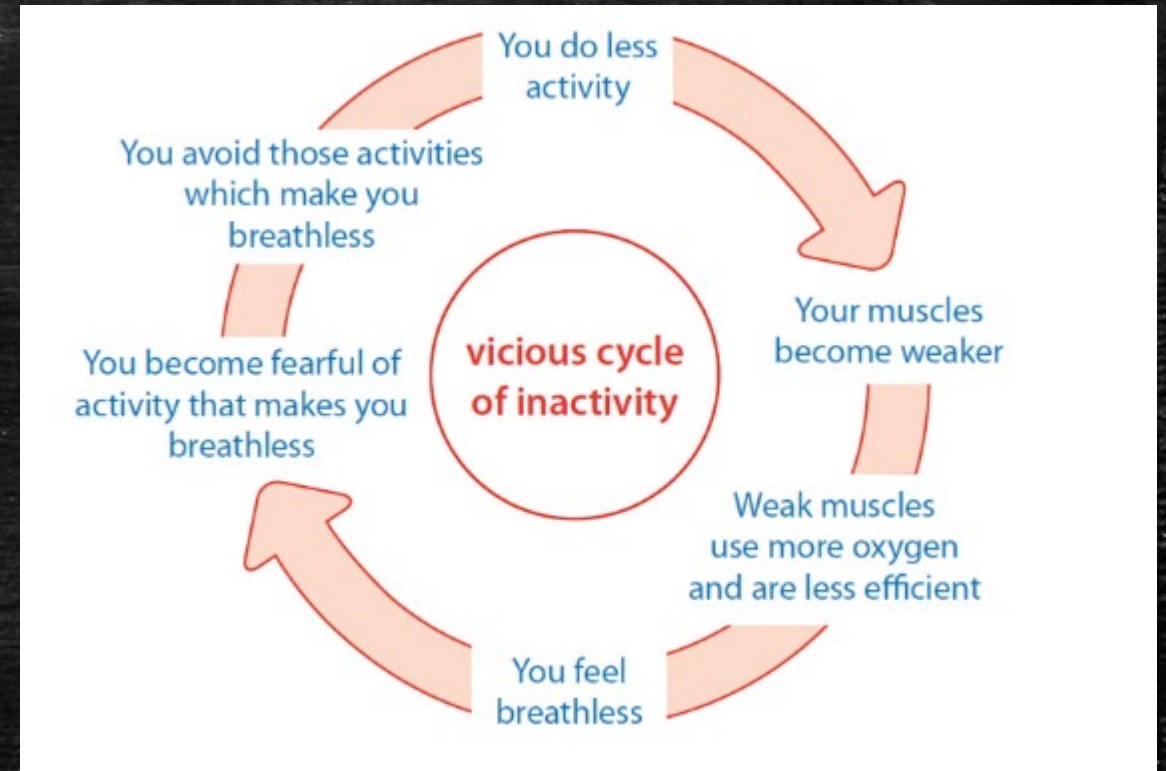
Psychological Support

- Significant association with COPD (and other respiratory diseases) with anxiety and depression
 - Breathlessness leads to anxiety
 - Limited ADLs, QOL etc contributed to Depression
- In as little as 15-20 SESSIONS of PR, patients have shown improvement in reducing anxiety
 - Combination of education, exercise, breathing, and relaxation techniques
 - **IMPROVED anxiety symptoms when compared to the same number of psychotherapy sessions**
 - Also conferred improvement in a large magnitude of depression symptoms
- Dignity
 - Loss of dignity can be very high in the severely symptomatic patient
 - PR has been shown to improve this or completely resolve this feeling of dignity loss

The Benefits

What We Have Established

- COPD patients (and other chronic respiratory failure patients) suffer from progressive dyspnea
 - Progressive dyspnea leads to inactivity
 - Inactivity leads to deconditioning
 - Deconditioning leads to dyspnea
- Pulmonary Rehab looks to **BREAK THE CYCLE**

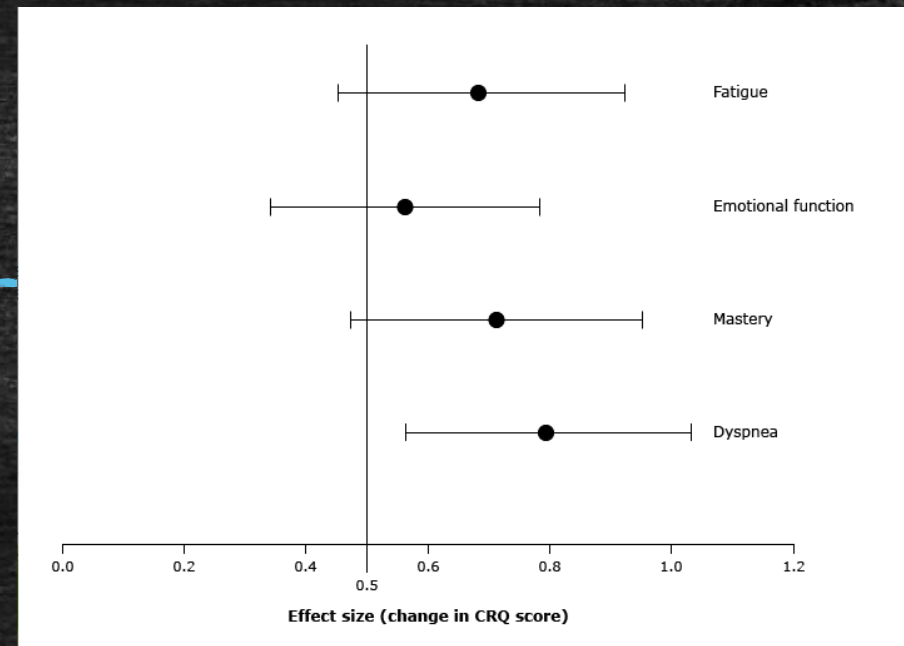


Quality of Life

- Quality of Life studies encompass:
 - Patient Symptoms
 - Activities
 - Social Interactions
 - Psychological State
- PR was shown to be more effective than standard community-based care when looking at scores on the Chronic Respiratory Questionnaire
 - Dyspnea
 - Fatigue
 - Emotional Function
- Statistical differences also noted on the St. Georges Respiratory Questionnaire

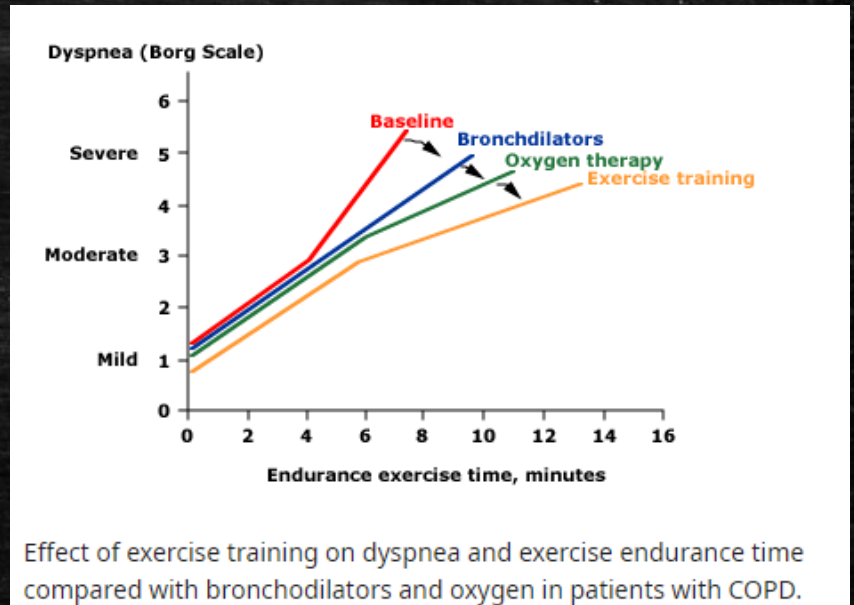


All noted to be improved on CRQ



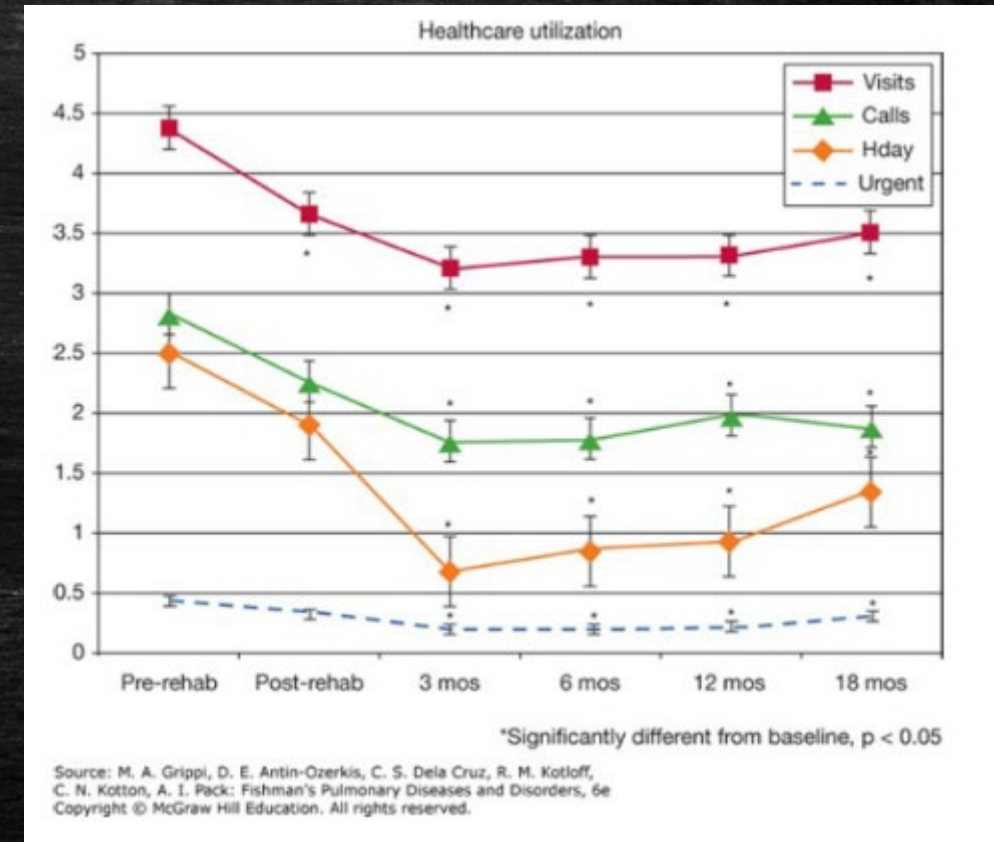
Lung Function and Exercise Capacity

- We have established Pulm Rehab can help with exercise capacity and with the mitigation hyperdynamic lung function
- But how does Lung Function and Exercise Capacity do vs Standard Community Care?
 - PR yields better functional exercise capacity
 - Improved 6MWD
 - Improved Maximal Workload
 - Improved BMI
 - Overall better health status (ie frailty etc...)

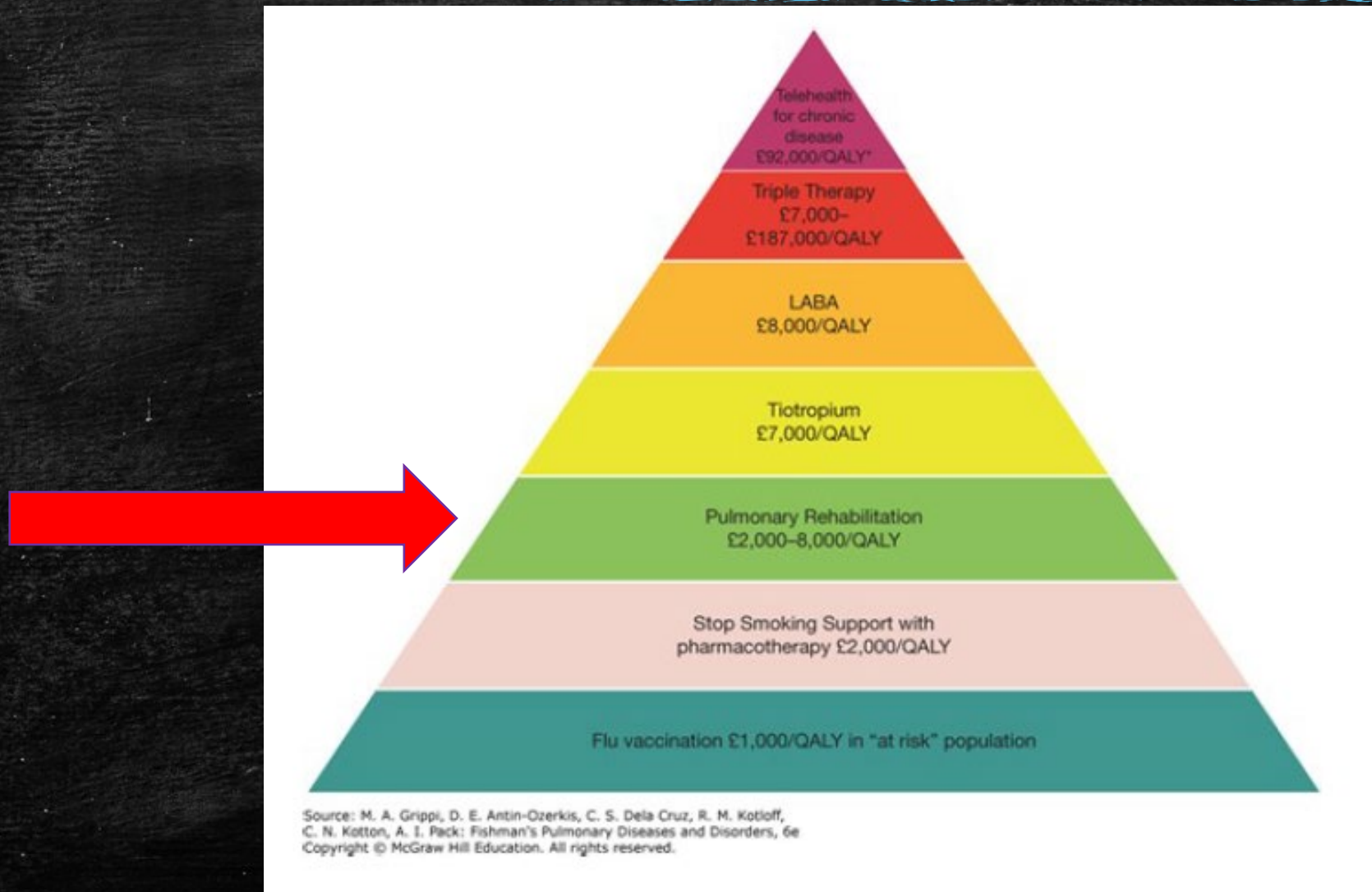


Health Care Utilization

- With the initiation of PR in COPD patients
 - Decreases hospital days an average of 23 days per year per patient
 - Additional study of 64 patients over 4 years, 44 still alive at the end of the study
 - Total cumulative 529 days (12 per year) 1 year prior to PR
 - Decreased to average of 145,270,278, and 207 days (avg 5 days per patient per year)
- Follow up studies don't always share such dramatic benefits
 - Some average a decrease in only 2.4 days of hospitalization
 - Others show less hospitalizations BUT the PR patients discharge sooner
- Patients in PR had less ER visits
- Estimated in 2020 that COPD costs are about \$49 billion annually
 - Lots of improvement for less Health Care Dollars to be spent on COPD



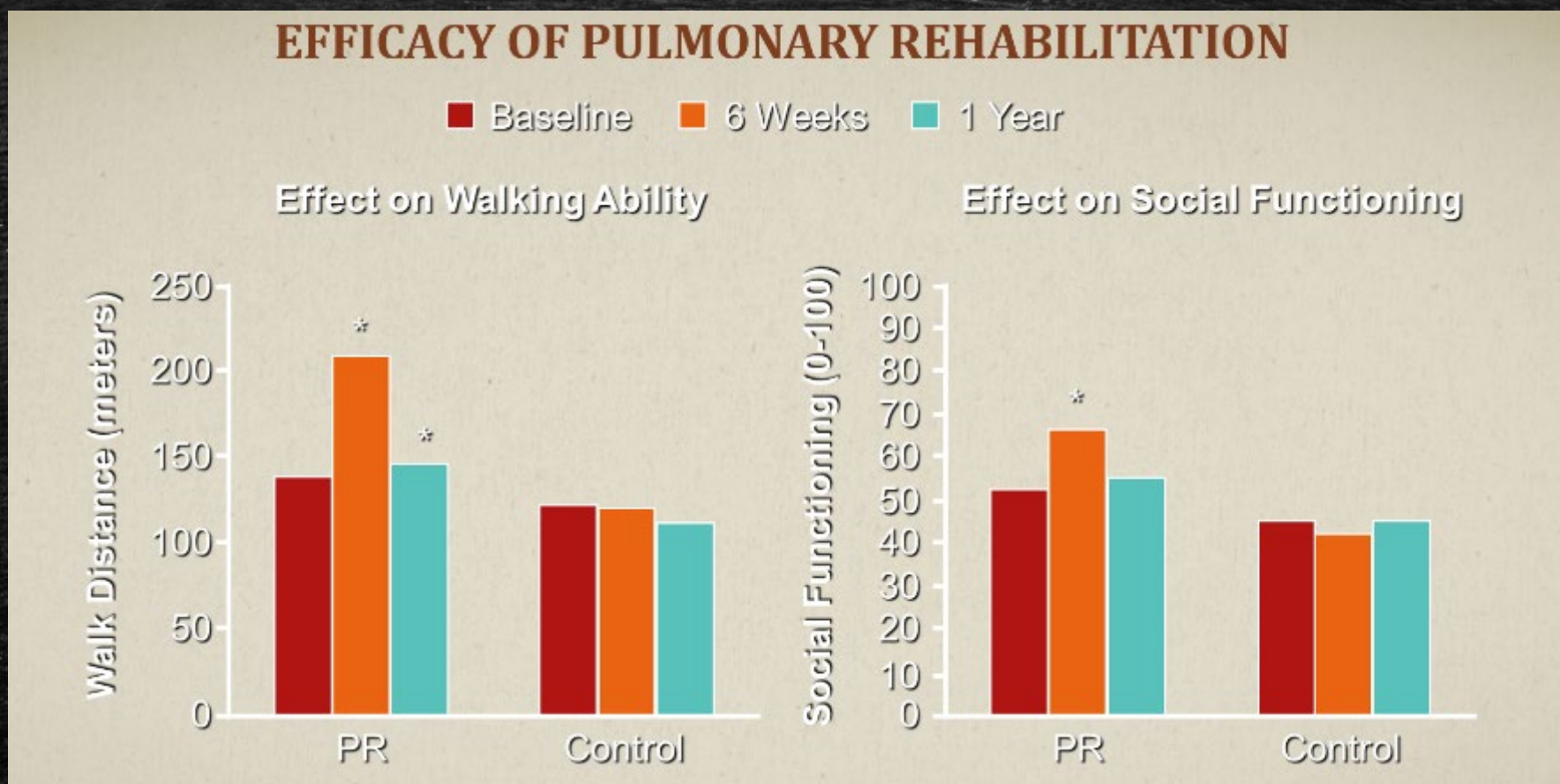
Cost-Effectiveness per quality -adjusted life year



MORTALITY

- Unfortunately the data isn't REALLY clear... can be contradictory
- BUT...
 - COPD patients admitted to PR within 90 days of discharge
 - Decrease in all-cause mortality at one year (-6.7% absolute risk difference)
 - Not a randomized trial so.... ☹️
 - Another post COPD exacerbation referral suggests up to a 42% reduction in mortality when compared to usual care
- Equivalent outcomes in exercise capacity but no change in mortality when comparing PR start at 2 weeks post discharge or 2 months later
 - Go ahead and refer as early as 2 weeks
- INCREASED Mortality if inpatient Pulmonary Rehab was started within 48 hours of an ICU admission
 - More studies needed
- Hopefully the underutilization in the setting of chronic stable disease is decreased and data can be analyzed for additional mortality benefits

How Long Do These Benefits Last?



- Despite intensive therapies, good follow up, and better life choices taught to our patients, benefits of PR continue to wane over time
 - This doesn't mean patients have to go back to their baseline
 - Quite the opposite
 - Patients do seem to have a plateau of benefits at some point
 - What is that timeline?
 - We really don't know...

- Patient have been followed for 7 years which consisted of 5 full PR programs
 - Every successive program did have improvements in:
 - Exercise Capacity
 - Health Status
 - Dyspnea
 - BODE Index
 - But the degree of improvement decreased with each successive program

- **HOWEVER** – Health Status did NOT worsen over 7 years despite a continued decrease in their FEV₁

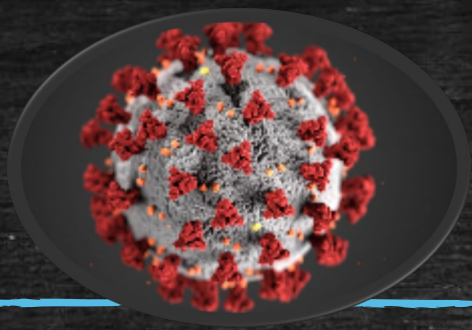
What about OTHER Respiratory Diseases?

- Most of our Data comes from the VAST number of COPD patients
- ILD
 - Benefits seen in exercise tolerance, dyspnea, and QOL
 - Applies the same educational benefits (breathing techniques, meds, O₂)
- Bronchiectasis
 - Improvements with inspiratory muscle strength, shuttle walk distance, exercise capacity
 - Educational benefits as well (specifically airway clearance techniques)
- Asthma
 - Improvements in asthma symptoms, anxiety, depression and QOL
 - Centered around exercise training and it's effects
 - Education about pre-exercise bronchodilator usage

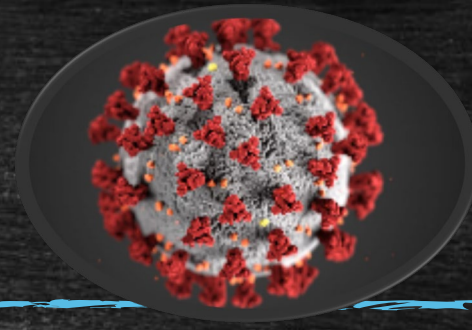
- Pulmonary Arterial Hypertension
 - Improvements in exercise capacity and 6MWD
 - More concern for syncope and sudden death during exertional exercises
 - Less intensive workloads are targeted
 - Aims to help with muscular deconditioning which is well documented in the PAH community

- Lung Cancer
 - Typically associated with Obstructive Lung Diseases
 - Lung Cancer patients suffer from significant deconditioning
 - Improved walk distance, dyspnea, fatigue, and pear exercise capacity

- Lung Transplant
 - IMPERATIVE role in conditioning patients FOR transplant and Post-Transplant recovery
 - Increased exercise tolerance has been limed to improved surgical outcomes



COVID



- “Long Covid”
 - Dyspnea, headaches, fatigue, muscle weakness, depression
- Data is still being analyzed
 - 140 patients after acute hospitalization
 - Significant improvement in Short Physical Performance Battery and Barthel Index
 - Significantly more patients able to stand, rise from a chair, and walk when they could not prior to therapy
 - Chinese Study – older COVID survivors – 6 week Respiratory Rehab
 - Significant improvements in Lung Function and 6MWD compared to control group
 - Less anxiety but no difference in depression

Why Aren't Patients Being Referred?

- Referral rates are between 3-16%
 - (another study sited only 5%)
- Less than 3% receive PR after a COPD exacerbation hospitalization!
 - Data most closely related to mortality benefit within 90 days
- While data is lacking - very likely referral rates LOWER in patients with other respiratory diseases other than COPD
- WHY?
 - Lack of education (patients, physicians)
 - Lack of Exposure in daily practice
 - Did not get experience with PR in their training
 - Patient fear of exercise

Poor Access

- An additional problem contributing to the low referral rate
 - Lack of PR programs / facilities in rural areas
 - Lower socioeconomic status
 - No rides
 - Can't get time off work
 - No resources
 - United States
 - Other Countries

Lack of Funding

- Poor Reimbursement Rates
 - Leads to less number of programs
 - No new programs opening
 - Insufficient resources
 - Equipment
 - Specialized Staff
 - Sustainability

What Can We DO?

- Telehealth
 - COVID was terrible but brought telehealth services into light
- 8 weeks of telehealth PR (166 patients) compared to traditional outpatient pulmonary rehab
 - Home PR found to be noninferior with 6MWD
- Multiple options for home / remote based
 - Web Based Programs
 - Videoconferencing
 - Mobile/Traditional phone systems
- All combined with the delivery of simple home based exercise equipment
- Of Note:
 - Home based programs seem to have a better overall adherence
 - Psychosocial benefits are minimized with the utilization of home based programs

In Summary

- Pulmonary Rehabilitation should be considered for any respiratory patient with symptoms
 - While data is best for COPD – don't forget about ILD, PAH, Bronchiectasis, Lung Transplant (pre-and-post-transplant), and Long Covid
- Even if your patient is frail, they CAN still have significant benefit
- Early referral is better – especially after COPD Exacerbation Hospitalization
- Education is key
 - Education of medical professionals to refer
 - Education of patient to PR **AND** the education at their PR program
- Look into remote programs if an in-person program isn't available
- Patients get out of PR what they put into it... and it needs to continue to have sustainable benefits

Thank You
