Pulmonary Diseases and Exercise Testing

- Types of Pulmonary Diseases
- Effect on Exercise Response
- Role of Exercise in Treatments

Mallory and Norton, 26,800 ft, Mt. Everest

Pulmonary Diseases

- Obstructive
- Restrictive
- Pulmonary Vascular Diseases
- Hypo-ventilation Syndromes

Obstructive Pulmonary Diseases

- Due to a narrowing of airways
- Can restrict airflow in and out of the lungs
- COPD
  - worsening expiratory obstruction
  - Dyspnea on exertion
  - Reversible airway hyper-reactivity
- Common in cigarette smokers

Cardiovascular Consequences of COPD

- Lungs are under-ventilated and over-perfused
- Arterial hypoxemia
  - Stimulant for vasoconstriction
- Pulmonary hypertension
  - Right heart hypertrophy/failure
- Secondary polycythemia
- Increased myocardial work/CAD common

COPD

- Figure: Schematic of the effects of COPD on the lung and cardiovascular systems.

Two Main Types of COPD

- Chronic bronchitis
  - Disease of airways
  - Chronic cough, excessive sputum
  - Blue Bloaters: cyanosis, reduced ventilatory drive, low minute ventilation/inactive
- Emphysema
  - Disease of lung parenchyma
  - Enlarged air spaces and loss of airway elasticity
  - Pink puffers: thin from malnutrition and increased cost of breathing. Barrel-chested from air trapping. High ventilation to overcome increased dead space.
Role of Elastic Recoil in Airway Caliber

Common Causes of Emphysema

- Cigarette smoking
  - Upsets protease/anti-protease balance in the airways
  - Smoking increases protease activity (from inflammatory cells?)
- Genetic disease
  - Deficiency of alpha-1 anti-trypsin (anti-protease)

Management for Patients with COPD

- Identify/eliminate sources of inflammation
  - Cigarette smoke, inhaled irritants
- Dilate airways
  - Bronchodilators, corticosteroids
  - Prevent respiratory infections
    - Vaccinations, anti-biotics
    - Rehabilitation programs
      - individualized

Asthma

- Asthma = Greek “to pant”
- A type of obstructive lung disease
- Inflammation of the lungs which causes airways to narrow
  - constriction of smooth muscles of airways
  - swelling of mucosal cells
  - secretion of mucous

Occurrence

- 5000 people/year die from asthma attacks
- Affects ~5% of Americans (15 million)
  - twice as common in Blacks than Whites
  - more common in urban areas
- 49% increase since the 1980s
  - tightly sealed housing
  - pollution
  - greater awareness
  - changes in diet

Types of Asthma

- Childhood asthma (7% children)
  - affects twice as many boys as girls
  - some outgrow
  - others experience asthma-free teens and early 20s, then returns as an adult
- Adult on-set asthma (5% adults)
  - appears as an adult
  - no gender differences
  - gets worse with age (75% of deaths in elderly)
Asthma “triggers”
- Exercise: 80% of children and 60% of adults
- Dust mites
- Allergens in animal fur and cockroaches
- Tobacco smoke
- Mold, fungal spores, pollens
- Smoke from wood-burning stoves
- Colds and respiratory infections

Exercise-Induced Asthma
- Mechanism?
  - Primarily due to broncho-constriction
  - Mucosal airway cells dried and cooled
  - Increased osmolality of mucus
  - Chemicals released by airway cells that cause constriction
  - Pollutants and pollen increase risk

EIA: clinical definition
- When FEV₁ falls by more than 15% following 6-8 minutes of exercise

EIA: timecourse
- Early Phase
  - Wheezing, coughing, chest tightness appears within several minutes after exercise
- Spontaneous Recovery
  - Symptoms gradually diminish (usually 45-60 min)
- Refractory Period
  - Symptoms markedly less is exercise again within 30-90 min.

Exercise Training and Asthma
- As asthmatic becomes physically fit, EIA attacks are less frequent
- Several famous athletes have asthma
  - Jackie Joyner-Kersee, Jim Ryun, Tom Dolan, Nancy Hogshead
- Need to establish a medication/treatment plan

Cystic Fibrosis
- Another type of Obstructive Lung Disease
- Genetic disorder, affects mucus secretions
  - Lungs, digestive, reproductive
  - Sodium and chloride loss is increased
- Most life-shortening genetic disease in Caucasians
- 1/3000 live births
- Median survival age is 31 yrs
Restrictive Lung Diseases

- Reduced lung volume
- Thorax diseases
  - Diseases of rib cage or spine
  - Diseases of the respiratory muscles and nerves
  - Morbid obesity
- Lung parenchyma diseases
  - Interstitial or alveolar disease (>200 kinds)
  - Infection, pulmonary edema, interstitial lung disease
- Occupational exposures
  - Black lung disease, asbestos, solvents

Pulmonary Vascular Disease

- Thrombo-embolism = most common
- Conditions that predispose:
  - Bed rest
  - Post-operative
  - Chronic cardiac disease
  - Injury to lower extremity
  - Clotting disorders

Pulmonary Rehabilitation

- Exercise training is a key component in pulmonary rehab:
  - increases functional capacity
  - decreases severity of dyspnea
  - improves quality of life
- Specific breathing exercises
  - Respiratory muscle training
  - Upper body resistive training

Hypoventilation Syndromes

- CNS disorders (stroke, tumor, encephalitis)
- Sleep apnea
  - Upper airway muscles lose tone
  - Hypertrophied tonsils
  - Anatomical abnormalities of jaw
- Diseases of the respiratory control system
- Obesity hypoventilation syndrome
  (Pickwickian Syndrome)

Pickwickian Syndrome

- Cause?? Link with obesity is incompletely understood
  - Mechanical effects of obesity
  - Depressed responsiveness to hypoxia and hypercapnia
  - Lose of tone of pharyngeal muscles

Exercise Prescription

- Standard Principles apply:
  - Mode:
    - walking, cycling, rowing: indoors
  - Frequency:
    - minimum 3-5 d/wk
  - Intensity: 2 major approaches
    - 50% VO2pk
    - maximal limit tolerated by symptoms, GXT
  - Duration:
    - intermittent exercise may be necessary to get 20-30 min.
Pursed-lip Breathing

- breathe in through nose, breathe out slowly (twice as long as inhale) blow out firmly through mouth with lips tightly closed except at very center
  - good for patients with obstructive disease
  - decreases frequency of respiration
  - increases tidal volume
  - reduces breathing distress

Supplemental Oxygen

- Oximetry recommended during GXT and initial training sessions
  - if PaO2 < 55 mmHg or SaO2 < 88% use supplemental oxygen
  - adjust flow rate to maintain SaO2 > 90% throughout exercise

Alternate Exercise Modes

- Continuous positive airway pressure (CPAP)
- Upper body resistance training
- Ventilatory Muscle Training (VMT)

CPAP

- Lung diseases
  - Hyper- or under-inflation
  - Ventilation/perfusion mismatching
  - Increased work of breathing
- CPAP
  - Start 2-3 cm water & work up to 5-10 cm water
  - Reduces work of breathing and dyspnea
  - Increases ventilation to collapsed regions of the lungs
  - Increases exercise duration

Upper Body Resistance Exercise

- Arm and shoulder exercises
- high vol, low intensity (1-2 kg)
- slow expiration linked with lift

Ventilatory Muscle Training

- Strength training
  - inspiratory resistance at near maximal effort
- Endurance training
  - low to moderate inspiratory resistances for 15-30 minutes
Indications for VMT

- Symptomatic and limited patients
- Decreased respiratory muscle strength
  - inspiratory and expiratory mouth pressures
- Absence of severe hyperinflation on chest radiograph

Guidelines for VMT

- Frequency:
  - minimum 4-5 times/wk
- Intensity
  - 30% Pimax measured at FRC
- Duration
  - two 15 min or one 30 min session

Exercise Monitoring

- Pulse oximetry, SaO₂ > 90%
- SaO₂/HR
- dyspnea rating (5 out of 10) “severe”

Precautions for Exercise Testing in Pulmonary Patients

- medications taken before exercise test?
- inhaler and broncho-dilating drugs handy
- Oxygen, mouthpiece for gas analyses or mask?
- CPAP
- Cardiovascular effects of meds?

Precautions cont.

- consider the patient’s triggers (indoor)
  - design prescription with regard to the patient’s symptoms (ventilation level, intermittent)
- Other training?

Case Study, Ehrman et al. pg 356

- See handout
- Medical history
  - 69 yr old male with shortness of breathe
  - Quit smoking 3 yrs ago
  - Stage 2 obstructive lung disease, obesity, HTN, sedentary
- Exercise test results
  - 2 min, 1.5 mph, 1% grade
  - 83% HRmax predicted, bp 194/100,dyspnea, Po2 85%
- Exercise prescription
  - Exercise to dyspnea
  - 30-min interval training
  - Upper body resistive exercise, flexibility