

## 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

## COPD

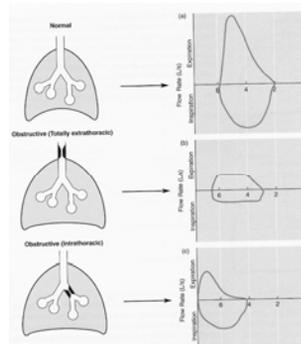


Figure 37.2. Maximal flow-volume curves in normal subject, extrathoracic airway obstruction, intrathoracic airway obstruction, and restrictive lung disease.

## 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

## 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

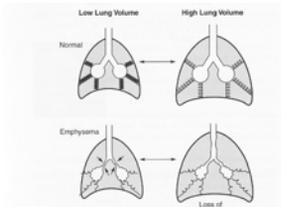


Figure 37.1. Small airways are tethered open by radial traction of lung tissue. Airway caliber depends on recoil of the lung, which is greater at a high lung volume; hence, airway caliber is also greater at a high lung volume. In diseases in which elastic recoil is lost, small airways are prone to dynamic collapse when pressure outside the airway becomes more positive, as during forced expiration.

## 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”

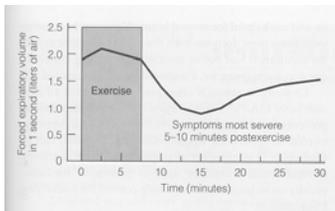
- Exercise: 80% of children and 60% adults
- Dust mites
- Allergens in animal fur and cockroaches
- tobacco smoke
- mold, fungal spores, pollens
- smoke from wood-burning stoves
- colds and respiratory infections

## Exercise-Induced Asthma

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

## EIA: clinical definition

- When FEV<sub>1</sub> 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 if 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-Kersey, 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

## 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

## 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

## Exercise Prescription

- Standard Principles apply: 
  - Mode:
    - walking, cycling, rowing: indoors
  - Frequency:
    - minimum 3-5 d/wk
  - Intensity: 2 major approaches
    - 50% VO<sub>2</sub>pk
    - 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  $\text{PaO}_2 < 55$  mmHg or  $\text{SaO}_2 < 88\%$  use supplemental oxygen
  - adjust flow rate to maintain  $\text{SaO}_2 > 90\%$  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,  $\text{SaO}_2 > 90\%$
- $\text{SaO}_2/\text{HR}$
- 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,  $\text{Po}_2$  85%
- Exercise prescription
  - Exercise to dyspnea
  - 30-min interval training
  - Upper body resistive exercise, flexibility



Khumba Icefall, Everest Approach