

# Chronic Dyspnea

## *Clinical Perspectives*

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## Case

- 58 y.o. male, s/p orthotopic liver transplant in 2004 for Hep C, presents with mild-moderate dyspnea on exertion x 5 years
- Symptoms more noticeable recently, and have occurred:
  - ✓ On ascending > 1 flight of stairs
  - ✓ Walking around Ohio State Fair
  - ✓ Mowing lawn (must stop 3x to catch breath)
- No symptoms at rest or while sleeping

## Objectives

- Review the basic pathophysiologic mechanisms and clinical causes of dyspnea
- Discuss the diagnostic approach to the patient who presents with dyspnea
- Describe treatment modalities for patients who suffer from dyspnea

## Definitions

- What, exactly, are we talking about?
  - ✓ Various definitions used in the lay and medical vernacular
    - “Can’t get my wind”
    - “Shortness of breath”
    - “Difficult, labored, uncomfortable breathing”
    - “Awareness of respiratory distress”
  - ✓ 1999 ATS Consensus Statement
    - Dyspnea is “a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity. The experience derives from interactions among multiple physiological, psychological, social, and environmental factors, and may induce secondary behavioral responses.”

AJRCCM 1999: 159:322

## Epidemiology

- Why is this important?
  - ✓ Prevalence in U.S. of diseases that commonly cause dyspnea
    - COPD: 15-30 million
    - Asthma: 15-20 million
    - Congestive heart failure: 5 million
    - Interstitial lung disease: hundreds of thousands
  - ✓ Dyspnea associated with these diseases has high financial and social cost

## Mechanisms

- Why is my patient short of breath?
  - ✓ 2 general components
    - Sensation
      - Neural input from a peripheral receptor
    - Perception
      - Reaction of the individual to that input
  - Combined, these factors create the *experience* of dyspnea

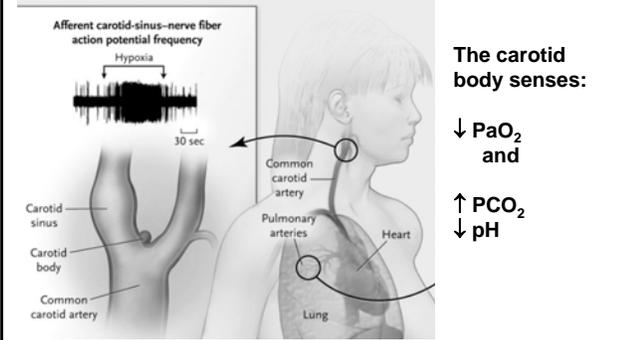
## Mechanisms of Dyspnea

## Sensation

- Numerous types of afferent input in response to breathing
  - ✓ Chemoreceptors
    - Central (medulla)
    - Peripheral (carotid body)
  - ✓ Mechanoreceptors
    - Chest wall
    - Lung parenchyma
    - Airways
    - Peripheral muscles
  - ✓ Pulmonary vagal afferents
  - ✓ Irritant receptors
    - Airways
  - ✓ Direct afferents from central motor output ("Respiratory motor command corollary discharge")

## The Carotid Body

The sensory organ for respiratory responses to hypoxemia



E.K. Weir et al. NEJM 2005

## Perception

- Patient's interpretation of and reaction to neural afferents modified by numerous factors:
  - ✓ Anxiety
  - ✓ Fear
  - ✓ Anger
  - ✓ Depression
  - ✓ Personality
  - ✓ Previous experiences
  - ✓ Interpersonal relationships
- Cause-effect relationships often difficult to sort out

## Sensation

- When afferent impulses from respiratory activity (sensation) does not match outgoing central motor commands, dyspnea occurs
  - ✓ Hypoxemia
  - ✓ Hypercapnea
  - ✓ Hyperinflation
  - ✓ Increased ventilatory demand
  - ✓ Respiratory muscle weakness
  - ✓ Increased ventilatory impedance
    - Airways obstruction
    - Decreased lung compliance
    - Chest wall abnormalities

## Causes of Dyspnea

## Causes

- What disease might my patient have?
  - ✓ Numerically, most patients with chronic dyspnea suffer from these 4 diseases:
    - COPD
    - Asthma
    - Interstitial lung disease
    - Congestive heart failure
  - ✓ The differential, however, includes many others. . .

## Approach to Dyspnea

## Causes

- Pulmonary
  - ✓ Pleural disease
  - ✓ Pulmonary vascular disease
    - Pulmonary hypertension
    - Thromboembolic disease
  - ✓ Neuromuscular disease
  - ✓ Chest wall abnormalities
  - ✓ Malignancy
  - ✓ Large airways obstruction
  - ✓ Bronchiectasis
- Cardiac
  - ✓ Coronary artery disease
  - ✓ Valvular disease
  - ✓ Congenital defects
  - ✓ Arrhythmias
  - ✓ Pericardial disease
- Others
  - ✓ Peripheral vascular disease
  - ✓ Deconditioning
  - ✓ Obesity
  - ✓ Vocal cord diseases
  - ✓ Gastrointestinal diseases
  - ✓ Endocrine/metabolic diseases
  - ✓ Anemia
  - ✓ Psychogenic

## Approach

- How should I evaluate my dyspneic patient?
  - ✓ Careful history (as always)
    - Quality of dyspnea can be helpful
      - Chest tightness may = bronchospasm
      - Increased breathing effort often implies abnormal mechanical load (e.g., COPD, interstitial lung disease, neuromuscular disease)
      - Sensation of suffocation or air hunger often seen in CHF
      - Rapid, shallow breathing common in ILD
      - “Heavy” breathing often seen in deconditioning

## Approach

- History
  - ✓ Circumstances of dyspnea
    - Orthopnea often implies CHF, diaphragmatic weakness, or GERD
    - Dyspnea on bending forward often suggestive of diaphragmatic limitation (e.g., diaphragmatic paralysis, obesity)
    - Worsening with activity common to most organic causes of dyspnea
    - *Presence of dyspnea at rest that improves with exercise strongly suggestive of psychogenic cause*

## Approach

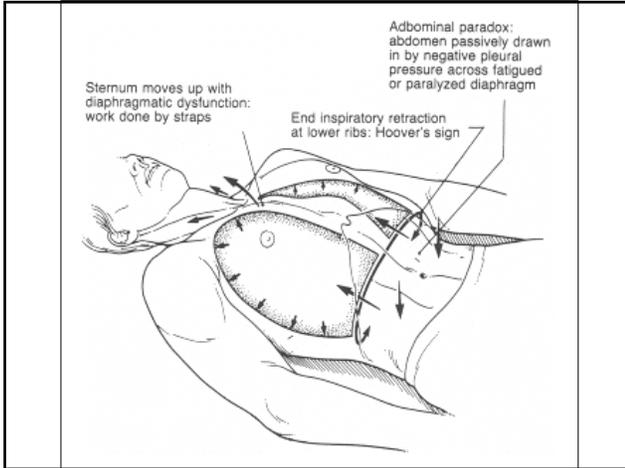
- History
  - ✓ Other
    - Other medical conditions
      - Risk factors for coronary disease (e.g., HTN, diabetes)
      - Allergies/atopic disease often seen with asthma
    - Medication history
    - Tobacco history
      - Significant COPD unlikely in the absence of smoking Hx
    - Recreational drugs
      - Patients often very reticent with this information
    - Occupational/recreational history
      - Environmental lung diseases, chronic infections

## Approach

- History
  - ✓ Associated symptoms also helpful
    - Wheezing, chest tightness suggests bronchospasm
    - Dry cough prominent in ILD
    - LE swelling suggestive of cardiovascular disease
    - Neck tightness, voice change can imply vocal cord disease
    - Chest pain common in cardiovascular disease and pleural disease
    - Recent weight loss or constitutional symptoms can suggest malignancy

## Approach

- Exam
  - ✓ HEENT, cardiovascular, lung, and peripheral vascular exam particularly important
    - Stridor = upper airway obstruction (tumor, tracheostenosis, vocal cord disease)
    - Dry/velcro rales often imply ILD
    - “Wet” rales suggestive of CHF
    - Breathing pattern can be useful
      - Accessory muscle use implies increased workload
      - Rapid, shallow breathing often = ILD
      - “Abdominal” breathing and rib retraction often = chest wall or neuromuscular disease



## Case

- **Medications:** cyclosporine, amlodipine, TMP/SMX, pegylated interferon, ribavirin, simvastatin, aspirin, and a multivitamin
- **Social Hx:** never smoker, no alcohol or recreational drugs, former supervisor/office manager in metal industry, but no direct fume/dust exposure, no unusual hobbies; no regular exercise since transplant 5 years prior

## Case

- Pt characterized dyspnea as “heavy” breathing with exertion
- No changes in dyspnea with position, eating
- No symptoms at rest, no nocturnal awakenings
- No associated wheezing, chest tightness/pain, cough, fevers, weight loss, GERD symptoms, or swelling
- **PMH:** liver transplant 2004, Hep C, childhood measles, longstanding heart murmur (benign per previous Cardiologist eval)

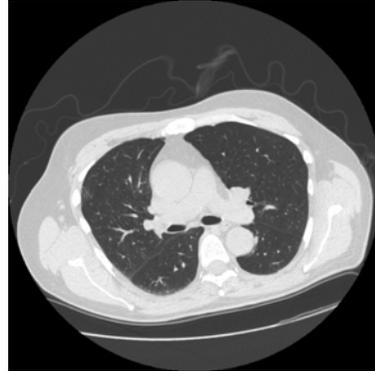
## Case

- **Vitals:** BP 124/86, HR 108, RR 12, afebrile, SpO2 98 % on room air
- **Soft musical 2/6 systolic murmur over precordium, loudest over mitral area; healed chevron incision over upper abdomen; exam otherwise entirely normal**

## Labs

- Hemoglobin/hematocrit in most/all patients to evaluate for anemia
- Others (metabolic profile, LFT's, endocrine testing) as history and exam dictation
- Our patient: Hgb = 14.1

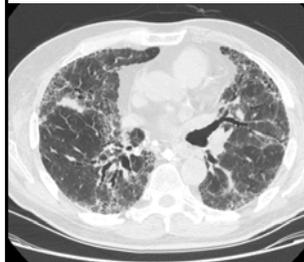
## Case



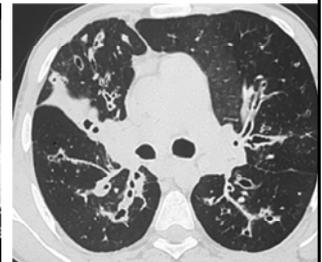
## Assessment

- Chest imaging
  - ✓ Chest X-ray
    - Reasonable screening tool for gross cardiopulmonary abnormalities
  - ✓ CT chest
    - More sensitive for subtle parenchymal lung disease, which may be missed on plain x-ray
      - Particularly important if a diagnosis of interstitial lung disease is being entertained, and should include high-resolution cuts
      - Can be done with PE contrast protocol if thromboembolic disease suspected

## High Resolution Chest CT



Interstitial Lung Disease



Bronchiectasis

## Assessment

- Pulmonary function testing
  - ✓ Spirometry
    - Measure of expiratory airflow
    - Particularly useful if obstructive lung diseases are suspected (e.g., asthma, COPD)
    - Can be done before/after bronchodilator to see if obstruction is reversible (e.g., asthma)
    - Can be done in primary care office
    - Can (and usually should) be done in conjunction with a flow-volume loop, which gives a visual rendition of expiratory *and* inspiratory flow
    - Can be done in concert with inhalational or simulated exercise challenges (for asthma diagnosis)

## Flow-volume loop in paradoxical vocal cord motion disorder

Flow volume loops

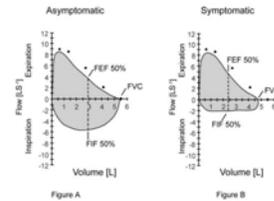


Figure A - Normal inspiratory and expiratory loops  
 Figure B - Truncated expiratory loop suggestive of variable extra thoracic large airway obstruction and normal inspiratory loop. This is pathognomonic of paradoxical vocal cord motion.  
 FVC - Forced vital capacity  
 FEV 50% - Forced expiratory flow 50%



## Assessment

- Lung volumes
  - ✓ Measurement of capacity of lungs at various moments during the respiratory cycle
    - Usually abnormally increased in COPD, sometimes in asthma
    - Usually abnormally decreased in interstitial lung disease
    - Must be done in pulmonary function lab

## Assessment

- Diffusing capacity
  - ✓ Measure of efficiency of gas exchange in lungs
    - Decreased in COPD, pulmonary vascular disease, anemia, and others
    - Must be done in pulmonary function lab

## Assessment

- Maximum inspiratory/expiratory pressure measurement
  - ✓ Indicators of diaphragmatic and accessory muscle strength, respectively
- 6-minute walk test
  - ✓ Ambulation with continuous pulse oximeter for six minutes
    - Both distance and SpO<sub>2</sub> recorded
    - Measure of both exercise tolerance and oxygenation during exercise

## Full-body plethysmography



## Case

- Spirometry, lung volumes, diffusing capacity: all normal

## Assessment

- Cardiac testing
  - ✓ EKG
    - Reasonable screen for conduction system disease, previous infarction/ischemic disease, arrhythmias, chamber hypertrophy
  - ✓ Holter/event monitoring
    - Good screen for arrhythmia as cause of episodic dyspnea
  - ✓ Echocardiogram
    - Can evaluate directly for LV and valvular dysfunction, as well as indirectly for pulmonary vascular disease (e.g., pulmonary hypertension) via RV and tricuspid valve function
  - ✓ Stress testing/cardiac catheterization
    - Functional and anatomic tests for coronary artery disease; can also directly assess for pulmonary hypertension

## Assessment

- Cardiopulmonary exercise testing (CPET)

- ✓ Bicycle ergometer with measurement of cardiac rhythm, HR, blood pressure, pulse oximetry inspired/expired O<sub>2</sub> and CO<sub>2</sub>, speed, time, resistance, and (sometimes) arterial blood gases



## Case

- Surface echocardiogram (done prior to Pulmonary referral): non-significant aortic stenosis (AoV area 1.9), otherwise normal
- Cardiac catheterization (also prior to Pulmonary referral): normal

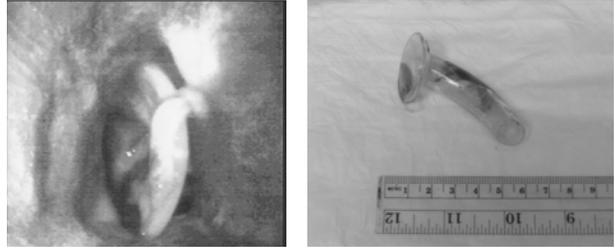
## Assessment

- Cardiopulmonary exercise testing
  - ✓ Final test output includes a number of parameters, including:
    - Minute ventilation
    - VO<sub>2</sub> max (oxygen uptake)
    - Power output (work)
    - Anaerobic threshold
  - ✓ These parameters tend to occur in patterns specific to various diseases (e.g., cardiac vs. pulmonary, ILD vs. COPD)
  - ✓ Can be very useful in patients with dyspnea of unclear cause

## Case

- Underwent cardiopulmonary exercise testing
  - ✓ Evidence of moderate exercise impairment (low VO<sub>2</sub> max and power output)
  - ✓ No evidence of cardiac or pulmonary cause of impairment (adequate pulmonary and adequate, though borderline, cardiac reserve at maximal exercise)
  - ✓ No oxygen desaturation with exercise
  - ✓ Overall, findings most consistent with deconditioning

## Bronchoscopy



## Assessment

- Other testing
  - ✓ Bronchoscopy
    - Evaluation for airway lesions (e.g., malignancy, tracheostenosis)
    - Bronchoalveolar lavage and biopsy to obtain tissue diagnosis of parenchymal lung disease
  - ✓ Nasopharyngoscopy/Video laryngostroboscopy
    - Evaluation for anatomic and functional vocal cord disorders

## Treatment of Dyspnea

# Treatment

- How can I make my patient better?
  - ✓ *Primary treatment of dyspnea is treatment of the underlying cause*
  - ✓ Other treatments aimed at:
    - Reducing metabolic load
    - Altering respiratory afferent information
    - Reducing ventilatory impedance
    - Improving respiratory muscle function
    - Altering central perception of afferent impulses

# Treatment

- Altering afferent information
  - ✓ Applied external vibration
  - ✓ Inhaled airway anesthetics/opiates
  - ✓ Appropriate ventilator settings
  - ✓ Fans



# Treatment

- Reduction of metabolic load
  - ✓ Exercise training
  - ✓ Supplemental O<sub>2</sub> during exercise when indicated



# Treatment

- Reducing ventilatory impedance
  - ✓ Bronchodilators
  - ✓ CPAP
  - ✓ Lung volume reduction surgery



## Treatment

- Improving respiratory muscle function
  - ✓ Adequate nutrition
  - ✓ Inspiratory muscle training
  - ✓ Partial ventilatory support
  - ✓ Minimizing steroid use



## Case

- Patient given diagnosis of chronic deconditioning
- Further discussions revealed significant fear on patient's part of making himself ill again if he exercised vigorously post-transplant
- Reassurance given
- Enrolled in formal exercise program through local YMCA
- After 3 months, symptoms much improved

## Treatment

- Altering perception
  - ✓ Education
  - ✓ Relaxation therapy
  - ✓ Desensitization
  - ✓ Pharmacologic therapy
    - Opiates
    - Anxiolytics
    - Antidepressants



## Pearls

- Dyspnea is a product of multiple sensory inputs from respiratory activity and the patient's perception of those inputs
- COPD, asthma, interstitial lung disease, and congestive heart failure are the most common causes of chronic dyspnea
- A careful history and physical, coupled with targeted objective testing, is necessary when evaluating dyspnea
- The primary treatment of dyspnea is treatment of the underlying cause

