

# DYSPNEA: THE CRITICAL EVALUATION

Patrick C. Cullinan, DO  
Surgical Intensivist and Emergency Physician  
Washington Hospital Center  
Washington, DC

# OBJECTIVES

- Define dyspnea
- Review the physiology of dyspnea
- Evaluation of the adult with dyspnea
  - History
  - Physical exam
  - Differential
  - Labs and diagnostics
- Special considerations

# CASE STUDY

- 56 yo female c/o 1 wk hx of worsening dyspnea
- PMHx: DM, HTN, hypercholesterolemia, obesity, seropositive RA (10 yrs)
- Meds: methotrexate 10 mg PO weekly, folic acid 1 mg daily, enbrel (etanercept) 50 mg SQ weekly and ibuprofen 800 mg daily PRN only.
- FHx: mother with type 2 diabetes, younger brother with asthma.
- SHx: Tobacco use 1/2 ppd x 40 years. No recent travel

# DYSPNEA

- Consensus statement of the American Thoracic Society

“Dyspnea is a term used to characterize a **subjective** experience of **breathing discomfort** that is comprised of qualitatively distinct sensations that vary in intensity. The experience derives from the interactions among multiple **physiological, psychological, social, and environmental factors**, and may induce secondary physiological and behavioral responses”

# PATHOPHYSIOLOGY

- Respiratory System
  - “Respiratory Controller”  
(Air Hunger)
    - Rate and depth via efferent pathways to respiratory muscles
  - “Ventilatory Pump”  
(Work of Breathing)
    - Ventilatory muscles
    - Chest wall skeletal system
    - Pleura
  - “Gas Exchanger”  
(Stimulate Control Center)
    - Alveoli
    - Pulmonary capillaries
- Cardiovascular System
  - Transport oxygen to tissue
  - Transport carbon dioxide from tissue
    - CHF
    - Anemia

# PATHOPHYSIOLOGY

- Adequate oxygenation
- Maintenance of acid-base status
  - Chemoreceptors
    - Sensory cortex – Most sensitive to  $PCO_2$
    - Medullary – pH and  $PCO_2$
    - Carotid bodies –  $O_2$ ,  $PCO_2$ , pH
    - Aortic arch -  $O_2$ ,  $PCO_2$ , pH

# PATHOPHYSIOLOGY

- Maintenance of acid-base status
  - Facial receptors – trigeminal nerve
  - Mechanoreceptors – pressure/flow/volume
    - Airways
    - Lungs
    - Chest wall
  - Ergoreceptors – peripheral muscles sensitive to localized metabolic acidosis
  - Limbic system and brainstem

# HISTORY AND PHYSICAL

- “Language” the pt uses to describe dyspnea
- PMHx and Meds
- Tobacco use and occupational history
- Disease focused physical exam

# WHAT WORDS MEAN

- Acute hypercapnia/restricted thoracic motion
  - “air hunger”
- Acute bronchoconstriction/neuromuscular dz/reduced chest wall/pulm compliance
  - “chest tightness”
  - Increased “effort to breathe”
  - Severe condition leads to “air hunger”
- COPD
  - Increased “effort to breathe”
  - “can not get a deep breath”
- CHF
  - “air hunger”
  - “suffocation”
- Deconditioning
  - “heavy breathing”

# ACUTE DYSPNEA

- Acute myocardial ischemia
- Heart failure
- Cardiac tamponade
- Bronchospasm/COPD/asthma
- Pulmonary embolus
- Pneumothorax
- Pneumonia
- Anaphylaxis

# DIFFERENTIAL

- HEENT
- Chest wall
- Pulmonary
- Cardiac
- Neurologic
- Toxic/Metabolic
- Miscellaneous

## Differential diagnosis of acute dyspnea

<b>HEENT</b>	<b>Neurological</b>
Angiodema	Stroke
Anaphylaxis	Neuromuscular disease
Pharyngeal infections	<b>Toxic/metabolic</b>
Deep neck infections	Organophosphate poisoning
Foreign body	Salicylate poisoning
Neck trauma	CO poisoning
<b>Chest wall</b>	Toxic ingestion
Rib fractures	Diabetic ketoacidosis
Flail chest	Sepsis
<b>Pulmonary</b>	Anemia
COPD exacerbation	Acute chest syndrome
Asthma exacerbation	<b>Miscellaneous</b>
Pulmonary embolism	Hyperventilation
Pneumothorax	Anxiety
Pulmonary infection	Pneumomediastinum
ARDS	Lung tumor
Pulmonary contusion or other lung injury	Pleural effusion
Hemorrhage	Intra-abdominal process
<b>Cardiac</b>	Ascites
ACS	Pregnancy
ADHF	Massive obesity
Flash pulmonary edema	
High output failure	
Cardiomyopathy	
Arrhythmia	
Valvular dysfunction	
Cardiac tamponade	

ACS: Acute coronary syndrome; ADHF: Acute decompensated heart failure; ARDS: Acute respiratory distress syndrome; CO: Carbon monoxide; COPD: Chronic obstructive pulmonary disease

# DIFFERENTIAL

- 3.5%-10% emergency room visits for dyspnea or related complaints
  - Over 1 million visits
  - Comprised of
    - Heart failure
    - Pneumonia
    - COPD
    - PE
    - Asthma

# RED FLAGS

- Decreased mental status
- Labored respiratory effort
- Cyanosis
- Speaks in fragmented sentences
- Diaphoresis

# DIAGNOSTICS

- Pulse oximetry
- Vital signs
- Disease specific exam
  - Stridor/wheeze
  - Crackles – dry vs wet
  - Lack of breath sounds
  - Paradoxical or nonsymmetrical chest excursion
  - JVD
  - Lower extremity edema – bilateral vs unilateral
  - Cardiac murmurs/gallop/rubs
    - Cardiac heave (retrosternal lift)
  - Pulses paradoxus

# DIAGNOSTICS

- PCXR
- ECG
- Cardiac enzymes
- ABG
- CBC

# DIAGNOSTICS

- BNP
- D-dimer
- Peak flow
- Negative inspiratory force/forced vital capacity
- Pulmonary function testing
- Chest CT/VQ scan/HRCT
- Echocardiography

# SPECIAL CONSIDERATIONS

- Christopher Study
  - Prospective cohort study – 3306
  - Sudden onset of dyspnea/worsened dyspnea/pleuritic chest pain
  - Modified Wells criteria
    - $\leq 4$  vs  $>4$
  - Low probability – D-dimer negative
  - High probability or low probability with D-dimer positive – CT - PA

# SPECIAL CONSIDERATIONS

- 3 month followup
  - 1028 Low probability with negative D-dimer
    - DVT 0.1%
    - Nonfatal PE 0.4%
  - 1436 CT-PA negative
    - DVT 0.6%
    - Nonfatal PE 0.2%
    - Fatal PE (1.6%
  - 674 CT-PA positive
    - DVT 0.9%
    - Nonfatal PE 0.4%
    - Fatal PE 1.6%

# SPECIAL CONSIDERATIONS

- PERC-based study
  - Multicenter, prospective cohort study - 8138
    - Chest pain or dyspnea
    - Evaluated with 8 clinical criteria
      - Age < 50
      - HR < 100
      - Saturation > 95%
      - No hemoptysis
      - No estrogen
      - No DVT/PE hx
      - No unilateral leg swelling
      - No surgery/trauma with hospitalization in past 4 wks
    - AND
      - Wells criteria = low probability

# SPECIAL CONSIDERATIONS

- 45 day follow-up
  - 1666 fulfilled PERC criteria + low probability
    - DVT/PE < 1%

## Wells criteria and modified Wells criteria: clinical assessment for pulmonary embolism

Clinical symptoms of DVT (leg swelling, pain with palpation)	3.0
Other diagnosis less likely than pulmonary embolism	3.0
Heart rate >100	1.5
Immobilization ( $\geq 3$ days) or surgery in the previous four weeks	1.5
Previous DVT/PE	1.5
Hemoptysis	1.0
Malignancy	1.0
<b>Probability</b>	<b>Score</b>
<b>Traditional clinical probability assessment (Wells criteria)</b>	
High	>6.0
Moderate	2.0 to 6.0
Low	<2.0
<b>Simplified clinical probability assessment (Modified Wells criteria)*</b>	
PE likely	>4.0
PE unlikely	$\leq 4.0$

Data from van Belle, A, et al. JAMA 2006; 295:172.

### Pretest probability of deep vein thrombosis (Wells score)

Clinical feature	Score
Active cancer (treatment ongoing or within the previous 6 months or palliative)	1
Paralysis, paresis, or recent plaster immobilization of the lower extremities	1
Recently bedridden for more than 3 days or major surgery, within 4 weeks	1
Localized tenderness along the distribution of the deep venous system	1
Entire leg swollen	1
Calf swelling by more than 3 cm when compared to the asymptomatic leg (measured below tibial tuberosity)	1
Pitting edema (greater in the symptomatic leg)	1
Collateral superficial veins (nonvaricose)	1
Alternative diagnosis as likely or more likely than that of deep venous thrombosis	-2
Score	
High probability	3 or greater
Moderate probability	1 or 2
Low probability	0 or less
<b>Modification:</b>	
This clinical model has been modified to take one other clinical feature into account: a previously documented deep vein thrombosis (DVT) is given the score of 1. Using this modified scoring system, DVT is either likely or unlikely, as follows:	
DVT likely	2 or greater
DVT unlikely	1 or less

Adapted from Wells, PS, Anderson, DR, Bormanis, J, et al. *Lancet* 1997; 350:1795 and Wells, PS, Anderson, DR, Rodger, M, et al. *N Engl J Med* 2003; 349:1227.

# SPECIAL CONSIDERATIONS

- Quarterly Journal of Medicine – Oxford journal
  - Differential diagnosis of acute dyspnea: the value of B natriuretic peptides in the emergency department
    - Review
    - MEDLINE studies January 1990 – January 2008
      - Diagnosis
      - Acute dyspnea
      - Acute respiratory failure
      - Heart failure
      - Pulmonary edema
    - Human studies only
    - Sn/Sp/ROC

# SPECIAL CONSIDERATIONS

- BNP
  - Independent predictor of high left ventricular end diastolic pressure
  - Correlates with NYHA classification
  - Inverse relationship with EF
  - $< 100$  – 98% negative predictive value
  - $> 500$  – 87% CHF

# SPECIAL CONSIDERATIONS

- Proposed algorithm for acute dyspnea evaluation
  - Medical hx/physical exam/CXR/ABG/EKG
    - Unknown dx vs obvious dx
    - Evaluate BNP
      - $<100$  – suspect pulmonary as cause – CT chest with contrast
      - $>500$  – CHF very likely – begin treatment
      - 100-500 – consider echocardiogram +/- CT chest with contrast

# PEARLS

- Baseline activity level before the illness serves as a useful point of comparison for the current functional level
- Physical exam has greater negative predictive value than positive predictive value
- Dyspnea is the dominant presenting symptom in > 50% of pts with ACS and NO chest pain
- Clinically unrecognized MI's are detected by routine ECG's in the elderly 21%-68%

# PITFALLS

- Failure to recognize red flags and secure the airway prior to respiratory failure
- Failure to recognize abnormal vital signs
- Failure to expand your differential diagnosis
- Failure to recognize that tachypnea is not always due to pulmonary disease

# REFERENCES

1. Dyspnea. Mechanisms, assessment, and management: a consensus statement. American Thoracic Society. Am J Respir Crit Care Med 1999; 159:321
2. Pratter, MR, Curley, FJ, Dubois, J, Irwibn, RS. Cause and evaluation of chronic dyspnea in a pulmonary disease clinic. Arch Intern Med 1989;149:2277.
3. Simon, PM, et al. Distinguishable sensations of breathlessness induced in normal volunteers. Am Rev Respir Dis 1989; 140:1021.
4. Banzett, RB, Lansing, RW, Reid, MB, et al. "Air hunger" arising from increased PCO<sub>2</sub> in mechanically ventilated quadriplegics. Respir Physiol 1989;76:53.
5. Banzett, RB, Lansing, RW, Brown, R, et al. "Air hunger" arising from increased PCO<sub>2</sub> persists after complete neuromuscular block in humans. Respir Physiol 1990;81:1.
6. Simon, PM, et al. Am Rev Respir Dis 1990;142:1009.

# REFERENCES

7. Elliott, MW, Adams, L, Cockcroft, A, et al. The language of breathlessness: Use of verbal descriptors. *Am Rev Respir Dis* 1991;144:826.
8. Mahler, DA, Harver, A, Lentine, T, et al. Descriptors of breathlessness in cardiorespiratory diseases. *Am J Respir Crit Care Med* 1996; 154:1357.
9. O'Donnell, DE, Bertley, JC, Chau, LK, Webb, KA. Qualitative aspects of exertional breathlessness in chronic airflow limitation: Pathophysiologic mechanisms. *Am J Respir Crit Care Med* 1997; 155:109.
10. Moy, ML, Lantin, ML, Harver, A, Schwartzstein, RM. Language of dyspnea in assessment of patients with acute asthma treated with nebulized albuterol. *Am J Respir Crit Care Med* 1998;158:749.
11. Clark, AL, Piepoli, M, Coats, AJ. Skeletal muscle and the control of ventilation on exercise: Evidence of metabolic receptors. *Eur J Clin Invest* 1995;25:299.
12. Clark, A, Volterrani, M, Swan, JW, et al. Leg blood flow, metabolism and exercise and exercise capacity in chronic stable heart failure. *Int J Cardiol* 1996;55:127.

# REFERENCES

13. Banzett, RB, Lansing, RW. Respiratory sensations arising from pulmonary and chemoreceptor afferents. In: Adams, L, Guz, A (Eds), Respiratory Sensation, Marcel Dekker Inc, New York, 1996, pp. 155-180.
14. Clark, AL, Piepoli, M, Coats, AJ. Skeletal muscle and the control of ventilation on exercise: Evidence of metabolic receptors. Eur J Clin Invest 1995;25:299.
15. Ray, P, Birolleau, S, Lefort, Y, et al. Acute respiratory failure in the elderly: etiology, emergency diagnosis and prognosis. Crit Care 2006; 10:R82
16. Ray, P, Delerme, S, Jourdain, P, Chenevier-Gobeaux, C., Differential diagnosis of acute dyspnea: the value of B natriuretic peptides in the emergency department. Q J Med 2008;101: 831-843
17. Torres, M, Moayedi, S, Evaluation of the Acutely Dyspneic Elderly Patient, Clin Geriatr Med 2007; 23: 307-325