Conflicts of Interest Disclosure

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I have no financial relationships with a commercial entity producing healthcare-related products and/or services.
A 62 year old man comes to your office complaining about increasing difficulty breathing. He has trouble going up stairs and walking more than two blocks without stopping. He has a diagnosis of COPD, is treated with bronchodilators, and no cardiac history.

PE: mildly obese, using accessory muscles, low diaphragm, hyperresonant chest, reduced breath sounds, I/E=1/3

Question

• Based on the information provided, the most likely cause of this patient’s dyspnea is:
  – Hypoxemia
  – Obstructive lung disease
  – Cardiovascular deconditioning
  – Hyperinflation
  – All of the above
  – It doesn’t matter; we won’t be able to do anything about it.

Why should you care?

• Approximately 50% of patients admitted to the hospital have shortness of breath.
• Level of dyspnea in COPD more closely correlated with 5-year survival than FEV1 (Chest 121:1434, 2002).
• Suffocation is torture.

Goals

At the end of this session, you should be able to…

• Describe the physiological principles underlying dyspnea.
• Relate the quality of sensations used by patients to describe their SOB to physiological mechanisms producing dyspnea.
• Describe the interplay between behavior and physiological factors in dyspnea
• Delineate the role of pulmonary rehabilitation in treating dyspnea in patients with chronic lung diseases.

Dyspnea as a Complex Symptom

“…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 physiological and behavioral responses.”

Am J Respir Crit Care Med 159:321, 1999
CASE

64 year old man with hx of COPD and lung cancer resected 6 months ago. Inoperable
– Complaining of shortness of breath with activities
– Describes dyspnea as “huffing and puffing.”

Case - cont.

• PE: mildly obese, NAD sitting in chair. RR 16, HR 104 after getting on exam table.
  – Chest hyperinflated, diminished breath sounds throughout, expiratory prolongation.
  – Heart: diminished heart sounds; no gallop.
  – Extremities: no peripheral edema, 1+ clubbing.

Case - cont.

• Lab:
  – Hct 35
  – O2 saturation at rest: 93%
  – Spirometry: FEV1=60% pred, FVC 85% pred (unchanged from one year ago).
  – CXR: Mild hyperinflation. No infiltrates or effusions. Heart borderline enlarged.

Case - cont.

• What is the cause of his dyspnea?
• What do you do now?
  – Diagnostic tests?
  – Therapy?

Dyspnea Questionnaire

<table>
<thead>
<tr>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>My breath does not go in all the way</td>
</tr>
<tr>
<td>My breathing requires effort</td>
</tr>
<tr>
<td>I feel I am smothering</td>
</tr>
<tr>
<td>I feel a hunger for more air</td>
</tr>
<tr>
<td>My breathing is heavy</td>
</tr>
<tr>
<td>I cannot take a deep breath</td>
</tr>
<tr>
<td>I feel out of breath</td>
</tr>
<tr>
<td>My chest feels tight</td>
</tr>
<tr>
<td>My breathing requires more work</td>
</tr>
<tr>
<td>I feel I am smothering</td>
</tr>
<tr>
<td>I feel that my breath stops</td>
</tr>
<tr>
<td>I feel I am gasping for breath</td>
</tr>
<tr>
<td>My chest is constricted</td>
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<tr>
<td>I feel that my breathing is rapid</td>
</tr>
<tr>
<td>My breathing is shallow</td>
</tr>
<tr>
<td>I feel that I am breathing more</td>
</tr>
<tr>
<td>I cannot get a deep breath</td>
</tr>
<tr>
<td>My breath does not go out all the way</td>
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</table>

Dyspnea Sensations in Patients
Data Summarized from Eight Studies

Clusters of Phrases Associated with Different Disease States

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Dyspnea</th>
<th>Effort</th>
<th>Shortness</th>
<th>Rest</th>
<th>Collapse</th>
<th>Sputum</th>
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<tbody>
<tr>
<td>Deep</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Stop</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Overlap</td>
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<td>X</td>
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<td>None</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td></td>
</tr>
<tr>
<td>Exhalation</td>
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<td>X</td>
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<tr>
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<tr>
<td>Heavy</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
<tr>
<td>Effort</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Shortness</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
</tbody>
</table>
Three Features of the Response

- Multiplicity
  - Each stimulus associated with more than one sensation
- Uniqueness
  - Each stimulus has its own grouping of sensations
- Sharing
  - Sensations may characterize more than one stimulus

Language of Dyspnea Insights into Physiology

- Hypothesis: different qualities of respiratory discomfort are consequence of different physiological derangements
- Implications:
  - Most diseases causing dyspnea are characterized by more than one physiological derangement
  - Language may help us determine cause of functional limitation
  - Target therapy

Physiology of Dyspnea

- Complex interaction of:
  - Receptors: flow, stretch, irritant, chemoreceptors
  - The “drive to breathe”
  - Muscular “effort”
  - Expectations for a given neural drive and actual performance of the respiratory system

INCREASED NEURAL OUTPUT

- Voluntary vs. automatic control
- Chemoreceptors
  - Hypoxia a relatively weak dyspneogenic stimulus
  - Acute hypercapnia much stronger stimulus; probably mediated by pH
- Pulmonary and chest wall receptors as well as behavioral factors also have role
- Amount of ventilation alone is not the major determinant of dyspnea

MECHANOReCEPTORS

- Respond to changes in pressure, volume, and flow.
- Located in upper airways, lungs, chest wall.
- Source of primary information (lungs).
- Help monitor response of the respiratory system to a given neural output, i.e., a given “drive to breathe”.

SENSE OF EFFORT

- Present when there is a “mechanical load” on the system.
  - Airway obstruction
  - Elastic load: e.g., fibrosis, hyperinflation
- Reflects neural signal sent from motor to sensory cortex (corollary discharge) at same time that message sent to ventilatory muscles.
NEURO-MECHANICAL DISSOCIATION
(Efferent-reafferent dissociation)

- Efferent messages leave CNS to ventilatory muscles.
- In presence of mechanical pump problems, the system responds poorly (volume, flow).
- Discomfort intensity appears to relate to discordance of expectation and result.

Sensations

- Increased drive - “air hunger”
- Mechanical load - “effort or work of breathing”
- Bronchoconstriction - “chest tightness”
- Cardiovascular deconditioning - “huffing and puffing”

Dyspnea of Bronchoconstriction

BACK TO THE CASE

- Patient complained of “huffing and puffing” - cardiovascular deconditioning; enter into pulmonary rehabilitation.
- Two months later, improved exercise tolerance and reduced dyspnea.

Cycle of Deconditioning

Exercise
**Cycle of Hypersensitization**

- Disease
- Dyspnea
- Reduced Activity
- Anxiety with activity and change in ventilation
- Forgetfulness of "normal" hyperpnea

**Pulmonary Rehabilitation**

- Importance of deconditioning as a limiting factor in many patients with COPD
- Mechanism of effect probably varies with patient:
  - reconditioning;
  - more efficient use of breathing muscles;
  - strengthening of breathing muscles;
  - desensitization to dyspnea

**Pulmonary Rehab**

- Ries et al., Ann Int Med 1995
  - Increased treadmill endurance
  - Decreased dyspnea
  - Decreased muscle fatigue
  - Effects lasted for 12 months of follow-up

**BACK TO THE CASE**

- Six months later the patient is brought to the emergency department.
  - He has been anxious today about a friend who is dying from lung cancer, and is complaining of increased shortness of breath.
  - He denies any cough, fever, or sputum. No chest pain. No peripheral edema.

**Respiratory Rate and Hyperinflation**

- COPD: up to 34% of patients meet criteria for anxiety disorder, 24% for panic disorder
- Asthma: 6-30% meet criteria for panic disorder.
  Anxiety associated with increased respiratory rate and ventilation.

**Pulmonary Disease and Emotional Disorders**

- COPD: up to 34% of patients meet criteria for anxiety disorder, 24% for panic disorder
- Asthma: 6-30% meet criteria for panic disorder.
  Anxiety associated with increased respiratory rate and ventilation.
### Respiratory Pattern and Work of Breathing

- Rapid, shallow breathing
- Increased VD/VT
- Increased VE for any given level of CO2 production
- $\Delta P = \text{flow} \times \text{resistance}$
- If high resistance, $\uparrow$RR leads to high $\Delta P$
- “Increased work/effort to breathe.”

### Respiratory Rate and Hyperinflation

![Graph showing volume and pressure over time.](image)

### Back to the Case

- Three years later, the lung cancer has recurred. Despite several rounds of chemotherapy, there are multiple pleural metastases, and probable lymphangitic spread of tumor.
- Exam: severe restriction of tidal volume
- O2 saturation 75-80% with walking despite supplemental oxygen; PFTs-TLC 45% pred.
- Dyspnea is severe with activity and becoming a problem at rest.

### Patient’s Physiology

- Increased drive to breathe - hypoxemia and stimulation of pulmonary receptors AIR HUNGER
- Efferent-reafferent dissociation - restricted tidal volume leads to increased intensity of air hunger
- Affective component - he is very scared.

### What Can We Offer?

- Increase supplemental oxygen - transtracheal catheter
  - Trial on treadmill with 100% oxygen by mask
- Stimulate pulmonary or chest wall receptors to increase “match” of neural output and respiratory system response?
- Alter affective component?

### Dyspnea Evaluation

**The Essentials**

- History - What does it feel like? What is causing you to stop?
- Physical Exam (including walking O2 sat)
- Radiology: CXR (CT or CTA if concern about ILD or chronic PE)
- PFT’s
- Echo (systolic & diastolic function, valves)
- Lab: hct, ?BNP
**DYSPNEA - SUMMARY**

- “Dyspnea” is comprised of multiple, qualitatively distinct sensations.
- The qualities of respiratory discomfort provide clues to the physiological mechanisms producing the symptom.
- A better understanding of the physiology of dyspnea may allow us to target therapies after treatment for the underlying disease is optimized.
- Cardiovascular deconditioning is a common complication of chronic pulmonary disease and can be improved with an exercise program.

**REFERENCES**

- A recent overview of the pathophysiology of dyspnea.
- A study showing the use of early pulmonary rehabilitation in the evaluation of patients with chronic obstructive pulmonary disease.
- A study demonstrating the use of pulmonary rehabilitation in patients with chronic obstructive pulmonary disease.