Evaluation of shortness of breath: how to avoid pitfalls and make a timely diagnosis

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December 31, 2016
**Dyspnea:** *dys* (bad) + *pnoe* (breathing)

*Dyspnea:* a *subjective* experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity (ATS)

Perhaps the most common manifestation of lung disease

Distinct sensations include effort/work, chest tightness, air hunger and an unpleasant urge to breathe

Dyspnea can be a *normal sensation in heavy exertion or at extreme elevation*
Receptors

Central
nucleus tractus solitarius in the medulla, >thalamus >insular cortex and limbic systems

Peripheral
chest wall mechanoreceptors: muscle spindles and tendon organs –sense muscle tension and contraction > ant. horn cells >somatosensory cortex

Chemoreceptors
hypercapnia or **severe** hypoxia

Lung receptors
myelinated and unmyelinated (C) fibers via vagus nerve
Lung-heart axis

**Lungs** (upper and conductive airways, parenchyma, diaphragm)

**Heart** (systolic, diastolic dysfunction, valvulopathies, intracardiac shunts)

**Pulmonary vasculature** (pulmonary HTN, PE, shunts)

- \( \text{CaO2} = 1.36 \times \text{Hb} \times \text{SaO2} / 100 + 0.0031 \times \text{PaO2} \)
- \( \text{SaO2} = \frac{C(\text{HbO2})}{C(\text{HbO2}) + C(\text{Hb})} \times 100 \)
- \( \text{DO2} = \text{CO} \times (1.39 \times \text{Hb} \times \text{SaO2} + (0.003 \times \text{PaO2})) \)
- \( \text{PaCO2} = \frac{\text{VCO2} \times 0.863}{\text{VA}} \)
Evaluation: the tools

- History and physical
- Pulse oximetry (at rest and with exercise)
- Imaging (CXR, CT chest)
- Pulmonary function testing (spirometry, complete PFTs, CPET)
- Cardiac evaluation (echo, right/?left heart cath)
- Serologies
- Tissue biopsy
H & P

• Smoking/occupational/environmental history
• Family history
• Medication use history
• Examination: lung sounds, expiratory time, persistent rales/crackles always indicate pathology
• Upper airway wheezing >not too concerned
• Clubbing
Pulse oximetry

- Low Hb > easier to saturate, elevated Hb > the opposite
- Methemoglobinemia and carboxyhemoglobinemia can cause falsely elevated SpO2
- Cool extremities can increase Hb’s affinity to O2 and underestimate tissue hypoxia
- Tremor can affect the pulse oximetry reading > use the earlobes
- Allow time to equilibrate
- Check at rest and with exercise
- 95-100% - probably normal
- <= 94% probably impaired
- Dropping O2 sats with exercise suggests supply < demand = abnormal
Imaging

Start with a CXR – may be more sensitive than a CT scan for detecting increased markings.

CT chest w/o contrast usually adequate for evaluating parenchymal lung disease. Pattern recognition: IPF or not?

The radiologist may under-read CXRs and CTs in subtle lung disease: “no acute cardiopulmonary findings”; possibility of inter-observer bias.

CTA/VQ scan for evaluation for PE.

VQ: low/intermediate/high probability
Spirometry/PFTs

- Look at the flow-volume loop
- “normal range” 80-100% predicted
  >normal is 95-100% predicted
- Spirometry and lung volumes need to be supportive of each other
- “significant” post-bronchodilator response is 12%/200cc increase in FEV1 or FVC per ATS
- Obstruction and restriction in the same person can result in changes in the opposite direction, may lead to pseudo-normalization
- DLCO, DLCOcor, DLCO/VA >I look at the DLCO(DLCOcor)
- MIP, MEP – effort dependent, fraught with measurement errors
Cardiac evaluation

- **BNP** > released from the ventricles, causes vasodilation and natriuresis

- **Echocardiography** > equivalent of a coin-flip when it comes to RVSP, unless there are right chamber abnormalities associated with elevated estimated pressures

- **Right heart catheterization** > measure the pulmonary artery pressures and the PCWP

- **Left heart catheterization** - in select cases
Polysomnography

- OSA may contribute to pulmonary hypertension
Serologies

• Autoimmune and inflammatory,
• Infectious serologies
Lung biopsy/sampling

• Tissue biopsies
  – Bronchoscopic (tissue and cultures, cell count with diff)
  – Trasthoracic needle
  – Open lung (VATS, thoracotomy)
Lead time bias

• ???
Pre-test probability
Effects of ageing on the lungs

• ???
Lung disorders seen in my practice

Treatable/curable
- COPD, asthma*
- Sarcoidosis
- Hypersensitivity pneumonitis*
- Bronchiectasis*
- Eosinophilic bronchitis

Not a great prognosis
- Bronchiolitis obliterans
- NSIP*
- IPF
- LAM
- Sjogren’s
- Cryptogenic organizing pneumonia*
- Wegener’s granulomatosis
- Other vasculitides
- MAC
- Pulmonary hypertension*
- Recurrent laryngeal nerve paralysis
- Malignancy*
- Yet unspecified lung disease
Treatment strategies

• Will treatment make patients feel better or live longer?
• Appropriate immunizations
• Exercise program, nutrition
• Trial of meds for a period of time – if not effective (or not essential for longevity) may be OK to stop
Patient examples.

Impression: Essentially normal spirometry and lung volumes but borderline DLCO which corrected to normal after adjusting for alveolar volumes. I suspect, clinically, that he has either hypersensitivity pneumonitis or sarcoidosis, the latter being less likely. DLCO could and will be used to follow treatment efficacy.

Impression: Spirometry is within normal limits but FEV1/FVC ratio is increased. Flow volume loop does not suggest restriction. DLCO was mildly reduced and did not fully correct after adjusting for alveolar volumes. Compared with his December test, his DLCO is lower.
Flow-volume loops were adequate for interpretation. There was no evidence of upper airway obstruction.

Spirometry showed an FVC of 86% and an FEV1 of 67% predicted. There was no post-bronchodilator response.

MVV was 115% predicted.

Lung volumes showed a TLC of 86% and an RV of 72% predicted.

DLCO was 113%, DLCO/VA was 114% predicted.

NIP was -174 cm H2O, MEP was 137 cm H2O.

Patient examples...

Flow volume loops were adequate for interpretation. There is no evidence of upper airway obstruction.

Spirometry shows an FVC of 91% and an FEV1 of 99% predicted. FEF 25-75% was 134% predicted.

MVV was 81% predicted.

Lung volumes showed a TLC of 103% and RV of 100% predicted.

DLCO was normal at 98% predicted.

Maximal inspiratory pressure was -55 cmH2O, maximal expiratory pressure was 55 cmH2O.

Impression: PFTs are within normal limits. MVV slightly reduced compared with FEV1 and maximal inspiratory and expiratory pressures were low normal. This raises a concern for some neuromuscular condition.
Patient examples....

Flow-volume loops were adequate for interpretation. There was no evidence of upper airway obstruction.

Spirometry showed an FVC of 75% and an FEV1 of 80% predicted. FEF 25-75% was 94% predicted. FEF max was 91% predicted.

MVV was 53% predicted.

DLCO was 85%, DLCO/VA was 120% predicted.

MIP was 62 cmH2O, MEP was 148 cmH2O.

Impression: PFTs are suggestive of a restrictive process. DLCO was low normal but overcorrected after adjusting for alveolar volumes. Possible decreased diaphragm strength.

When compared to her 2015 PFTs, there is a downward trend.

Mild interstitial prominence in the mid to lower lungs is again seen but is comparable. Heart size and cardiomeediastinal silhouette are unchanged. No visible pleural effusions.