Shortness of Breath

Differential Causes

Physical Exam

Imaging Tests

Laboratory Tests

Cardiac Differential Causes
Shortness of Breath: Dyspnea

Complex interaction involving:

**Mechanical Receptors**: airway, chest wall, lungs, and heart

**Chemo Receptors**: carotid sinus and medulla of the brain
Differential Causes of Dyspnea

**CARDIAC**
- Rhythm
- Pericardium
- Coronary Arteries
- Muscle
- Valves

**NON-CARDIAC**
- Upper Airway
- Chest Wall
- Lungs
- Neuromuscular
- Systemic (high cardiac output states)
- Toxins/ Medications
  - “Flash” pulmonary edema (RAS)
UPPER AIRWAY

Foreign body

Infection

Edema (angio or anaphylaxis)

Mass lesion

Stridor:
  Inspiratory: above chords
  Expiratory: below chords

CHEST WALL

Trauma:
  Rib fracture
  Flail Chest

Structural:
  Pectus
  Scoliosis/Kyphosis
  Ankylosing Spondylitis
<table>
<thead>
<tr>
<th>LUNGS</th>
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</thead>
<tbody>
<tr>
<td>COPD</td>
<td>Interstitial lung disease</td>
</tr>
<tr>
<td>Asthma</td>
<td>Pulmonary mass lesion</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Pulmonary embolus</td>
</tr>
<tr>
<td>ARDS</td>
<td>Wells’ Criteria</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>PERC (pulmonary embolus rule out criteria)</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td></td>
</tr>
<tr>
<td>Pulmonary hypertension</td>
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</table>
## WELLS’ CRITERIA

<table>
<thead>
<tr>
<th>Condition</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leg swelling or discomfort</td>
<td>3.0</td>
</tr>
<tr>
<td>Other diagnosis less likely</td>
<td>3.0</td>
</tr>
<tr>
<td>Heart rate &gt; 100</td>
<td>1.5</td>
</tr>
<tr>
<td>Surgery w/1 4 weeks</td>
<td>1.5</td>
</tr>
<tr>
<td>Immobilization &gt; 2 days</td>
<td>1.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior DVT or pulmonary embolus</td>
<td>1.5</td>
</tr>
<tr>
<td>Hemoptysis</td>
<td>1.0</td>
</tr>
<tr>
<td>Malignancy</td>
<td>1.0</td>
</tr>
</tbody>
</table>

High risk: > 6

Low risk: < 2
PERC is for low risk patient only

Age < 50

Heart rate < 100

O2 sat ≥ 95% or greater

No unilateral leg swelling

No surgery w/ l 4 weeks

No history of DVT or embolus

No hemoptysis

No birth control medication

If Wells’ score is < 2, and Perc score 0: no pulmonary embolus
NEUROMUSCULAR DYSPNEA

Guillain-barre  
Myasthenia Gravis  
Amyotrophic lateral sclerosis  
Genetic neuromuscular diseases  
Autoimmune demyelinating  
T cell mediated antibody toward postsynaptic neuromuscular junction (acetylcholine receptors)  
Motor neuron degeneration
SYSTEMIC Related Dyspnea

High cardiac output states

Anemia, thyroid, sepsis

Diabetic ketoacidosis

Toxins: multiple agents

Carbon monoxide

Organophosphates

Botulism

Medications: over 100 reported

Ticagrelor: decreased adenosine clearance

ACE inhibitor: angioedema

Beta blockers

Amiodarone

Hydralazine
History and Physical Exam

**BP**

- Pulse: low volume, bounding (AR)
- Paradox: tamponade, asthma, COPD

**O2 saturation**

**Lungs:** clear and equal
- Rales: wet vs dry
- Absent: pneumothorax vs pneumonia

**Edema:** chronic elevation RA pressure

**JVD:** elevated RA pressures

**Cardiac**

- S3: volume overload
- S4: pressure overload
- S2: loud (PHT) or persistently split (ASD)
- S1: loud (MS)
- Friction rubs: pericarditis vs abscess

**Murmur**
Aortic Valve Cardiac Murmur for Dyspnea

Aortic stenosis

Rough sounding systolic

Mid-to-late peaking

Loss of A2

HCM

Systolic aortic outflow

Supine vs Standing

Louder after standing with HCM

Aortic Regurgitation

Diastolic

Often-times not loud

? Rub: suggests possible abscess
Mitral Valve Area

Mitral Stenosis

- Diastolic-hard to hear
- Best heard left lateral position
- Opening snap:
  - Depends on mobility of the valve
  - Short A2-OS: severe MS

Mitral Regurgitation

- Non-harsh systolic apical
- Usually holosystolic
- Listen for a diastolic flow rumble
- Correlates with large volume of flow through the valve (severe)
Exam Findings can focus on particular differentials

Dyspnea with clear lungs, no edema, tachycardia and + JVD (elevated right atrial pressures)

Pericardial Tamponade

Tension pneumothorax

Pulmonary embolus

RV infarction

CHF and dyspnea

May not have rales

May not have edema

Will have JVD due to RA pressure
Tests for Evaluation of Dyspnea

Pulmonary Function

Spirometry

Plethysmography

Dlco

6 minute walk

Negative Inspiratory Force
Imaging Tests for Dyspnea

ECG: rhythm, LVH, ischemia, infarct

Chest X-Ray

CT chest (coronary calcium)

CTA: use Well’s and d-dimer

Echo: pericardium, muscle and valves

Transthoracic

TEE: for aortic and mitral valves details

MRI heart:

- structural evaluation
- muscle analysis

Pyrophosphate scan heart

TTR amyloid
Stress Test for Risk Stratification of Ischemia

Normal ECG: exercise ECG stress

Abnormal ECG: image stress exercise

Pharmacological image stress test
  Used in patients who cannot walk
  Dobutamine Echo: no radiation
  Nuclear Perfusion for LBBB
## Laboratory Testing for Dyspnea

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBC</td>
<td>D-dimer (use Wells’ and PERC to guide)</td>
</tr>
<tr>
<td>CMP</td>
<td>Troponin</td>
</tr>
<tr>
<td>H-CRP</td>
<td>BNP</td>
</tr>
<tr>
<td>Procalcitonin</td>
<td></td>
</tr>
<tr>
<td>TSH</td>
<td></td>
</tr>
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</table>
High Sensitivity Troponin (hscTn)

10-100x more sensitive in detecting troponin

Single test drawn > 6 hours after onset of symptoms

Undetectable: no MI

Low probability: < 10ng/L (female)

< 15 ng/L (male)

Rule In: > 50 ng/L

Serial tests at arrival and 2 hours

Rule-out: < 10 ng/L (female)

< 15 ng/L (male)

and

Absence of change > 4 ng/L

Rule-in: > 50 ng/L
BNP: Essential Role in Normal Pressure-Volume Homeostasis

- Anti-hypertrophic / anti-fibrotic
- Natriuresis
- Diuresis
- Vasodilation
- Inhibition of RAAS
- Sympathetic nervous system
- Positive lusitropism (cardiac relaxation)

Entresto: Sacubitril/Valsartan

- Valsartan: angiotensin receptor blocker
- Sacubitril: inhibits neprilysin
- Neprilysin: enhanced enzymatic breakdown of BNP and ANP

Obesity: common to have normal levels of BNP with CHF in 20-40% of cases
Cardiac Causes for Dyspnea: Elevated LVED

- Rhythm Abnormal
- Pericardium Abnormal
- Perfusion inadequate
- Muscle dysfunction
- Valve dysfunction

Common Theme: Increased diastolic pressure

Pressure / Volume Overload

Rx: Reduce pressure

Reduce volume
Rhythm Abnormal

Too Fast: SVT, Atrial fibrillation

- pressure in pulmonary bed due to volume overload
- possible myocardial ischemia

Too Slow: 3 degree AV block

- Atrial contraction against closed MV
- increased pressure in pulmonary bed
Pericardium Abnormal

Tamponade and Constriction

In both the diastolic pressures in all 4 chambers are elevated

Normal: RA and RV : 5mmHg
LA and LV : 10mmHg

Tamponade/Constriction

RA and RV: 20mmHg
LA and RV: 20mmHg

Tamponade: acute - no edema and positive JVD

Constriction: chronic –positive edema and positive JVD
Coronary Perfusion Inadequate (ischemia)

1. Hypotension: ↓ in proximal pressure
   - Especially relevant in LVH, Aortic Stenosis and HCM

2. Coronary Artery Pathology: ↓ distal pressure
   - Pd/Pa < .80
   - Atherosclerosis
   - SCAD (dissection)
   - Spasm (Prinzmetal)

3. Microvascular disease: Primary determinant for resistance
   - Diabetes
**Muscle Dysfunction**

**HFrEF**: <40%

**HFpEF**: > 50%

**HCM**

**Restrictive cardiomyopathy**

Common themes in all of these:

- ↑ in LV diastolic pressure
- Left atrium enlargement
- Elevated PCWP in the lungs
- >20-25 mmHg forces fluid through the alveolar capillaries
- Pulmonary edema
Potential Causes HFrEF and HFpEF

Ischemia most common

Idiopathic

Hypertension

ETOH

Cocaine/Methamphetamine

Sarcoid

Obesity

High Output

anemia

thyroid

tachycardia mediated

thiamine deficiency (Beri-beri)

Non-compaction
Treatment for HFrEF

Revascularization for Ischemia

ACE-I or ARB: titrate to BP or tolerance

Beta blocker
  Carvedilol
  Metoprolol Succinate
  Bisoprolol

Aldosterone Inhibitor: neuro-hormonal- renal

Loop diuretic

Valsartan/Sacubitril (Entresto)

SGL-2 inhibitor: sodium glucose co-transporter 2

Dash diet

Daily exercise

Cardiac Rehabilitation

Ideal body weight
Treatment for HFpEF

Diuretic for symptoms

Guideline directed BP

Ideal body weight

Daily exercise

DASH diet

Guideline directed statin therapy

SGL-2 inhibitor

Obesity related bariatric surgery

Sleep apnea treatment
Hypertrophic Cardiomyopathy (HCM)

Population incidence 1/500

Multiple gene abnormalities identified

Multiple forms

- Asymmetric Septal Hypertrophy
- Symmetric Septal Hypertrophy
- Diffuse LV Hypertrophy
- Apical Hypertrophy

Primary dysfunction with HCM

- Diastolic dysfunction (abnormal relaxation)
- LVEDP
- Mitral regurgitation in ASH

95% of patients with HCM do ok

5% : sudden death or symptoms requiring surgery or transplant
Treatment for HCM

High risk for sudden death

- ICD

No high level competitive sport

Symptomatic with LV/Ao gradient

- Beta blocker
- Diltiazem or Verapamil
- Disopyramide

Surgery for persistent symptoms and gradient

- Myectomy
- Septal Ablation

Cautious use of diuretics, ACE-inhibitors and amlodipine
Restrictive Cardiomyopathy

Infiltrative disorders that cause severe diastolic dysfunction, as well as systolic problems end stage

Amyloidosis

AL: bone marrow

Rx: stem cell transplant

Systemic infiltration: poor prognosis

TTR (transthyretin) – liver

Wild type- senile amyloid

Familial genetic type

Wild type (senile)

15-20% histologic + over age 70

Projected to become the most common form of cardiac amyloid as population grows

New drug therapy available
Dyspnea Caused by Heart Valve Dysfunction

Majority of cases involve left side valves

AS/AR

MS/MR

Occasionally right sides valves

PS-almost always congenital, carcinoid

PR- endocarditis, repaired TET, prior valvuloplasty or prior ROSS procedure

TR- severe

endocarditis, pacemaker lead, pulmonary hypertension, carcinoid
Valve Stenosis

Valve Stenosis; AS and MS

Chronic progression over years

Aortic Stenosis: LV/Ao gradient with \( \uparrow \) LVEDP

Degenerative:

Up to age 60: < 1% population

60”s: 1.5%

70’s: 4%

80’s: 10% (amyloid)

Echo criteria for severe AS

Mean gradient > 40mmHg

Velocity > 4m/sec (pressure= 4 V2)

Area < 1 cm-sq ( normal 3-4 )

Symptomatic severe AS: poor prognosis 1 year

Treatment : SAVR vs TAVR
Mitral Stenosis

Etiology: Rheumatic Fever

Rule of 10

Severe: LA/LV gradient: 10 mm Hg

MVA < 1.6 cm² (nl 4-6)

Heart rate dependent: P=4V

Tachycardia will ↑ gradient

Rx: slow the heart rate

Indications for surgery:

Dyspnea

Elevated pulmonary pressures

Surgery options

Balloon Valvuloplasty

Valve Replacement

Wilken’s Score
Valve Regurgitation: Chronic vs Acute

Chronic: Volume overload leads to dilated LV with combined systolic and diastolic dysfunction

Chronic AR

Define etiology: aorta or valve

Well tolerated for years

No effective medical treatment

Operate: symptoms of dyspnea or

EF < 50%

ESD > 50 mm

LV can recover if not too dilated
Chronic Mitral Regurgitation

Define etiology: valve vs dilated LV

May tolerate for years

If primary valve problem, do not wait for symptoms if the ventricle is not normal. LV does not recover

Operate: symptoms or

EF< 60%

ESD > 40mm

Repair if possible

Mitraclip: high risk surgery or

Secondary to dilated LV and symptomatic
Acute Valve Regurgitation

Acute AR and MR: pressure overload due to sudden increase in volume

Pressure in a fluid-filled space dependent on the volume of fluid and size of space

Acute AR

Sudden increase in LV diastolic pressure due to volume overload of the LV

Aortic diastolic pressure / LVEDP

LVEDP can go from 10mmHg to 50mmHg acutely

Define etiology: aorta vs valve

Operate
Acute Mitral Regurgitation

Sudden ↑ in pulmonary pressures as well as LVEDP due to volume overload LA & pulmonary bed as well as LV

PCWP 30-40 > pulmonary edema

Define etiology: valve, chords, papillary muscle

Operate

3 typical clinical scenarios:

1. Complications of inferior-posterior MI
   Papillary muscle dysfunction or rupture

2. Endocarditis
   Leaflet tear or perforation
   Torn chordae
   Papillary muscle abscess

3. Healthy individual exercising: torn chordae
Physical Exam in Acute AR or MR

Murmur: can be soft or absent

AR: duration of the murmur depends on the diastolic pressure in the LV

Higher LVEDP=shorter duration gradient for flow

MR: large volume may not make a lot of noise if the valve orifice is large
Cardiac Causes for Dyspnea

Rhythm
Pericardium
Coronary Artery
Muscle
Valve

Common theme:

Diastolic pressure in the LV and/or pulmonary bed

Pressure/Volume overload

Rx: Pressure
Volume