Heart Failure: The Great Masquerader

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Case Presentation

26 year old previously healthy male, exposed to moldy silage

• 1 week later, developed cough productive yellow-brown sputum
  – Subjective fevers, chills, myalgias, chest discomfort, mild SOB
  – PCP: Z-pack, prednisone, albuterol inhaler
  – Fevers resolved, cough improved

• Worsening cough, more SOB (ADL’s)
  – CXR read as “pneumonia”
  – PCP: Amoxicillin, IM steroids
History (continued)

• Orthopnea, recurrent PND, and hemoptysis
  – Poor appetite, post-tussive vomiting
  – Early satiety, 15# weight loss
  – PCP: Levofloxacin, inhaled steroid

• Palpitations, mild leg swelling, generalized weakness, fatigue
  – ED: Hypoxic, tachycardic, NSVT
  – Transfer to UWHC
Physical Exam

Gaunt, ill-appearing, tachypneic

Afebrile, BP 93/59 HR 96 RR 23

Lungs: Scattered bibasilar crackles

CV: Diffuse, inferolaterally displaced PMI. $S_1$ $S_2$ $S_3$ $S_4$
Grade II/VI systolic murmur at apex. JVP 10 cm. (+) HJR

Abdomen: Soft, nontender. Pulsatile liver 1-2 cm below costal margin

Ext: Warm, 1+ ankle and 1+ pedal edema
Imaging

CXR: Increased cardiac silhouette. Patchy areas of airspace disease bilaterally. Indistinct vessels, ? fluid overload

CT Thorax: No bronchiectasis, no air trapping to suggest bronchiolitis obliterans. Multiple areas of abnormal GGO in upper lobes. Lower lobe consolidation c/w cryptogenic organizing pneumonia. Bronchocentric distribution suggestive of inhalation injury. Very enlarged LV.

ECG: Sinus tachycardia, prob LVH, LAE
Clinical Course

- IV diuresis, ACE-I titration, low dose Carvedilol
- Improved CXR, thoracic CT scan
  - No need for bronchoscopy
- Developed nausea, dry heaves, anorexia
  - Transfer to CCU. Swan-Ganz
- No improvement on Echo
  - HeartMate II LVAD
- Heart transplant, LVAD explant
History and Physical Exam

- Foundation of any clinical encounter
- Inexpensive, time-tested
- Particular utility in assessing HF patients
Physicians are Becoming Less Proficient

• Structured teaching in US postgraduate training lacking
  – Auscultation skills among trainees no better than 3rd year students

• Emphasis on physician exam declining
  – JVP documented in 3% of visits to Finnish PCPs in patients with symptomatic HF
  – Dependency on technology
  – Evidence-based medicine revolves around new and developing technologies
  – “too many patients, not enough time”
Symptoms

- Dyspnea (rest, exertional, PND, orthopnea)
- Fatigue
- Cough or wheezing
- Chest pain
- Palpitations
- Anorexia, bloating, early satiety
- Depression
- Insomnia (anxiety, sleep disordered breathing)
- Syncope
- TIA, cognitive impairment
Signs

• Elevated JVP
• S₃ gallop
• Rales
• Dependent edema
• Cool extremities
• Enlarged and displaced point of maximal impulse
• Right ventricular lift
• Hepatomegaly
Vital Sign Abnormalities

- Hypertension > hypotension
- Pulses alternans
- Abnormal valsalva response
- Narrow pulse pressure
- Weight gain or loss
Dyspnea

- Most common symptom in ADHF
  - ~90% in ADHERE, OPTIMIZE-HF
  - 33% to 50% had dyspnea @ rest
  - Older patients more likely to have rest dyspnea, less likely DOE

- Dyspnea @ rest, orthopnea, PND high specificity for HF (>99%)
  - Dyspnea on exertion less specific, sensitive but utility improved if asked about dyspnea on “normal walking” or “after 90 meters at a normal pace”
Chest Pain

- Myocardial ischemia the precipitant of hospitalization in 12% cases (RESOLVD)
- Demand MI
- Increased cardiac filling pressures
- Alternative causes
  - Myocarditis
  - Pulmonary embolism
  - Pulmonary hypertension
Fatigue

• Prevalence surprisingly low in ADHF
  – 31% in ADHERE, 23% in OPTIMIZE-HF
  – May reflect underreporting in face of more alarming symptoms

• Frustrating, disabling complaint
  – Link with depression

• Exacerbated by anemia
Jugular Venous Pressure

- Directly represents right sided filling pressures
- Mirrors left-sided filling pressures in 80% cases
  - (n=1000 transplant referrals)
    - RA > 10 mm Hg, PCWP > 22 mm Hg
    - RA < 10 mm Hg, PCWP < 22 mm Hg
- Positive HJR predicts PCWP > 15 mm Hg
- Exceptions
  - Right sided valve disease (TS, TR, PS, PR)
  - Pericardial disease
  - PHTN
  - Isolated RV disease
Tips to Assist the Clinician in JVP Assessment

• Begin with patient upright @ 90 degrees
  – Lower the patient gradually until pulsation seen

• Examine both sides of the neck
  – Anatomic variations

• If external jugular vein visible, confirm respirophasic changes before using it to estimate RA pressure

• Confirm venous not arterial
  – Biphasic waveform
  – Compressible?
  – Pulsatile?
Cardiac Auscultation

• Rhythm

• Prominent murmurs
  – Valve disease complicating or causing HF

• $S_3$ gallop
  – Independent prognostic significance
  – Stethoscope bell over PMI, patient left lateral decubitus position
Pulmonary Auscultation

- Rales present in 2/3 of ADHF patients  
  (ADHERE, OPTIMIZE-HF)

- Cough (69% of ADHF patients)

- Wheezing (~ 1/3 of elderly ED patients with HF)
  - Decreased airway diameter resulting from mucosal edema and intraluminal fluid
  - Reflex bronchoconstriction

- Clear lung fields common in chronic HF
  - Hypertrophied lymphatics
  - Sclerotic capillary basement membranes
Peripheral Edema

If the JVP is not elevated, the edema is not due to HF.

- Venous insufficiency
- DVT
- Obesity
- Nephrotic syndrome
- Cirrhosis
- Calcium antagonists

In addition to LE edema, be sure to look for fluid in the gut.
Abnormalities of Rhythm, HR, Pulse Variability

• Atrial fibrillation
  – 20-30% of patients with ADHF (ADHERE, OPTIMIZE-HF)
  – Trigger for decompensation (22% in RESOLVD)

• Tachycardiac
  – May portend decompensation

• Pulsus alternans (alternating strong and weak pulse)
  – Indicative of larger LV volumes, lower EF
  – Altered calcium handling

• Impaired perfusion
  – Decreased capillary refill, pedal pulses
  – Cyanosis
  – Cool extremities
  – Narrowed pulse pressure
Influence of Valsalva on BP in HF
How Well Do We Do In Assessing Volume And Perfusion?

ESCAPE Trial Substudy

- **JVP**
  - Clinician-estimated RA pressure <8 mmHg correlated with measure RA pressure 8 mmHg in 82% of patients
  - Clinician-estimated RA pressure >12 mm Hg correlated with measured RA pressure >12 mm Hg in 70% of patients

- **PCWP ≥ 30 mm Hg**
  - Estimated RA pressure ≥ 12 mm Hg and orthopnea ≥ 2 pillows

- **Low cardiac index**
  - Only overall profile of inadequate perfusion (a “cold” profile) had clinical utility
Effect of Persistent Congestion on Mortality

![Graph showing survival rates over months after re-assessment, with categories: No Congestion (80), 3-5 Congestion (26), 1-2 Congestion (40). The graph indicates a statistically significant difference with p < 0.0001.](image)

Relationship of JVP and $S_3$ on Survival

BNP: Source and Biologic Effects

- Volume ↑
- Pressure ↑
- CNP
- ANP
- BNP =
  - Suppression of renin-angiotensin and endothelin
  - Decreased peripheral vascular resistance (decreased blood pressure)
  - Increased natriuresis

- LV Systolic Dysfunction
- LV Diastolic Dysfunction
- Valvular Dysfunction
- RV Dysfunction

Eur J Heart Fail 10:824-839, 2008
BNP: Discriminator of Dyspnea in the ED

NEJM 347:161-167, 2002

![Box plot showing B-Type Natriuretic Peptide levels for different groups.]

- **No Congestive Heart Failure** (N=770)
- **Dyspnea Due to Noncardiac Causes** in Patients with a History of Left Ventricular Dysfunction (N=72)
- **Dyspnea Due to Congestive Heart Failure** (N=744)
Area under the receiver-operating-characteristic curve, 0.91 (95% confidence interval, 0.90–0.93)

<table>
<thead>
<tr>
<th>BNP pg/ml</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive Predictive Value</th>
<th>Negative Predictive Value</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>97 (96–98)</td>
<td>62 (59–66)</td>
<td>71 (68–74)</td>
<td>96 (94–97)</td>
<td>79</td>
</tr>
<tr>
<td>80</td>
<td>93 (91–95)</td>
<td>74 (70–77)</td>
<td>77 (75–80)</td>
<td>92 (89–94)</td>
<td>83</td>
</tr>
<tr>
<td>100</td>
<td>90 (88–92)</td>
<td>76 (73–79)</td>
<td>79 (76–81)</td>
<td>89 (87–91)</td>
<td>83</td>
</tr>
<tr>
<td>125</td>
<td>87 (85–90)</td>
<td>79 (76–82)</td>
<td>80 (78–83)</td>
<td>87 (84–89)</td>
<td>83</td>
</tr>
<tr>
<td>150</td>
<td>85 (82–88)</td>
<td>83 (80–85)</td>
<td>83 (80–85)</td>
<td>85 (83–88)</td>
<td>84</td>
</tr>
</tbody>
</table>

NEJM 347:161-167, 2002
# BNP in the Diagnosis of Heart Failure

<table>
<thead>
<tr>
<th>Predictor</th>
<th>P Value</th>
<th>Odds Ratio (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.04</td>
<td>1.02 (1.00-1.03)</td>
</tr>
<tr>
<td>History of congestive heart failure</td>
<td>&lt;0.001</td>
<td>11.08 (6.55-18.77)</td>
</tr>
<tr>
<td>History of myocardial infarction</td>
<td>&lt;0.001</td>
<td>2.72 (1.63-4.54)</td>
</tr>
<tr>
<td>Rales</td>
<td>&lt;0.001</td>
<td>2.24 (1.41-3.58)</td>
</tr>
<tr>
<td>Cephalization of vessels</td>
<td>&lt;0.001</td>
<td>10.69 (5.32-21.47)</td>
</tr>
<tr>
<td>Edema</td>
<td>&lt;0.001</td>
<td>2.88 (1.81-4.57)</td>
</tr>
<tr>
<td>Jugular venous distention</td>
<td>0.04</td>
<td>1.87 (1.04-3.36)</td>
</tr>
<tr>
<td>B-type natriuretic peptide ( \geq 100 \text{ pg/ml} )</td>
<td>&lt;0.001</td>
<td>29.60 (17.75-49.37)</td>
</tr>
</tbody>
</table>

*The odds ratio reflects the odds for patients with the characteristic in question, as compared with those without the characteristic. The odds ratio for age represents the exponent for each year of age in the logistic equation. CI denotes confidence interval.*
For Heart Failure Diagnosis

Patients presenting with Dyspnea
History & Physical Exam,
Chest x-ray,
ECG, BNP Level

- BNP <100 pg/mL
  HF very improbable (2%)

- BNP 100-400 pg/mL
  Clinical suspicion of HF
  Or Past History of HF
  HF probable (75%)

- BNP >400 pg/mL
  HF very probable (95%)

Eur J Heart Fail 10:824-839, 2008
BNP: Relationship with NYHA Class

New York Heart Association Class

B-Type Natriuretic Peptide (pg/ml)

I (N=18)  II (N=152)  III (N=351)  IV (N=276)

NEJM 347:161-167, 2002
## Optimal NT-proBNP Cut-points

### “Rule in”

<table>
<thead>
<tr>
<th>Age strata</th>
<th>Optimal cut-point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>All &lt;50 years (n=183)</td>
<td>450 pg/ml</td>
<td>97%</td>
<td>93%</td>
<td>76%</td>
<td>99%</td>
<td>95%</td>
</tr>
<tr>
<td>All 50-75 years (n=554)</td>
<td>900 pg/ml</td>
<td>90%</td>
<td>82%</td>
<td>82%</td>
<td>88%</td>
<td>85%</td>
</tr>
<tr>
<td>All &gt;75 years (n=519)</td>
<td>1800 pg/ml</td>
<td>85%</td>
<td>73%</td>
<td>92%</td>
<td>55%</td>
<td>83%</td>
</tr>
</tbody>
</table>

Overall average              |                   | 92%         | 84%         | 88%  | 66%  | 93%      |

### “Rule out”

<table>
<thead>
<tr>
<th></th>
<th>Optimal cut-point</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule out</td>
<td>300 pg/mL</td>
<td>99%</td>
<td>62%</td>
<td>55%</td>
<td>99%</td>
<td>83%</td>
</tr>
</tbody>
</table>

Eur J Heart Fail 10:824-839, 2008
BNP as a Diagnostic Tool

Low levels “rule out” HF

Exceptions

- **Obesity**
  - Increased concentration of NP receptor-C clearance receptors on adipocytes
  - Double the NP value of an obese patient (35 kg/m²) as a correction factor
  - “rule-out” values of NT-pro BNP remain robust, irrespective of BMI

- **Mitral stenosis**

- **Pericardial disease**

- **Flash pulmonary edema**
  - Very small quantities of BNP stored in secretory granules
  - Requirement for de novo synthesis and secretion of peptide
Non-Heart Failure Causes for Elevated BNP

- Acute pulmonary embolism
  - Associated with worse outcome (~30% patients)
- Acute coronary syndrome
- Pulmonary HTN
- COPD
- Pneumonia
- Renal failure
  - Impaired clearance
Other Potential Uses for BNP Determination

- BNP @ admission predicts death, re-hospitalization
- BNP @ discharge risk stratifies the HF patient
- BNP guided therapy may improve morbidity and/or mortality in chronic HF
  - Not consistently validated in clinical trials
- May be helpful as a screen for asymptomatic LV dysfunction in high risk patients
Echocardiography

- LV size, function
  - Influences treatment approach

- Valvular disease

- Pulmonary artery pressure

- Estimate of left atrial pressure

- Evaluation of CVP
Caveats

- History and physical exam form the cornerstone of HF diagnosis, assessment
- CXR, ECG, BNP help confirm or refute diagnostic impressions
- Echocardiography
  - Clarifies pathophysiology
  - Measures cardiac filling pressures, PA pressure
  - Helps determine treatment approach