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68 y.o. Female with Severe Shortness of Breath

P=130 RR=32 BP=220/120 P.Oxm=86% ➔ 90%

Differential Diagnosis

- PE
- CHF/Pulmonary edema
- Pneumonia
- COPD
- Pneumothorax
- Pericardial effusion
68 y.o. Female with Severe Shortness of Breath

• History
  – Onset (gradual or sudden)
  – Cough, fever, unilateral leg swelling
  – Orthopnea, PND, DOE, Swelling
  – PMH: CAD, CHF, PE/DVT, ESRD
  – Same it past?
68 y.o. Female with Severe Shortness of Breath

• Physical Exam
  – VS: (T/RR/HR/BP/Pulse Oxm)
  – Neck: JVD
  – Chest: ↓ BS, rales, wheezing, rhonchi
  – Heart: Afib, bradycardia, distant HS, S3
  – Extremities: edema, unilateral swelling, cord, tenderness
68 y.o. Female with Severe Shortness of Breath

- HPI: 3-4 days, cough, ↑↑↑worse this am
- PMH: COPD, CHF, CAD, & HTN
- PE: Obese, severe resp. distress

- Chest: ↓ BS, ?rales, ?wheezing
- Cardiac: RRR no Murmur
- Extremities: 2+ bilateral edema
Goal

• Review pathophysiology
• Evaluate diagnostic findings
  – H&P, CXR, BNP, U/S
• Evaluate medical management
  – Oxygen delivery, nitroglycerin, lasix, morphine
Acute Congestive Heart Failure (CHF)

• Definition
Diagnosis

- History & Physical Exam
- Chest X-ray
- Laboratory tests
- Ultrasound
## Diagnosing CHF

<table>
<thead>
<tr>
<th>Increased Likelihood</th>
<th>Decreased Likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hx CHF LR=5.8</td>
<td>No hx CHF LR=.45</td>
</tr>
<tr>
<td>PND LR=2.6</td>
<td>No DOE LR=.48</td>
</tr>
<tr>
<td>S3 LR=11</td>
<td>No rales LR=.51</td>
</tr>
<tr>
<td>+ CXR LR=12</td>
<td>-Cardiomegaly LR=.51</td>
</tr>
<tr>
<td>Afib LR=3.8</td>
<td>EKG WNL LR=.64</td>
</tr>
</tbody>
</table>

Wang et al. JAMA 2005
Myocardial stretch/stress

NT-pro-BNP

Pro-BNP

A. Mukkamala

Wapcaplet, Wikimedia Commons

BotanyBRA, Wikimedia Commons
## BNP and NT pro-BNP

<table>
<thead>
<tr>
<th>AGE</th>
<th>BNP</th>
<th>NT pro-BNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>&lt;50</td>
<td>50-70</td>
</tr>
<tr>
<td>Rule out</td>
<td>&lt;100</td>
<td>&lt;300</td>
</tr>
<tr>
<td>Sens/Spec</td>
<td>90%/74%</td>
<td>99%/85%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rule in</th>
<th>BNP</th>
<th>NT pro-BNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;400</td>
<td>&gt;450</td>
<td>&gt;900</td>
</tr>
<tr>
<td>Sens/Spec</td>
<td>81%/90%</td>
<td>93%/95%</td>
</tr>
</tbody>
</table>

**References:**
- Korenstein BM Emerg Med 2007
- Jannuzi et al Am J Card 2005
- Berdague et al., Am Heart J
# Impact of High & Low BNP on Pre-Test Probabilities

<table>
<thead>
<tr>
<th>Pre-test Probability</th>
<th>Post-test Probability for BNP&lt;105 pg/ml</th>
<th>Post-test Probability for BNP &gt;300 pg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>2%</td>
<td>46%</td>
</tr>
<tr>
<td>30%</td>
<td>5%</td>
<td>77%</td>
</tr>
<tr>
<td>50%</td>
<td>12%</td>
<td>88%</td>
</tr>
<tr>
<td>70%</td>
<td>25%</td>
<td>95%</td>
</tr>
<tr>
<td>90%</td>
<td>56%</td>
<td>99%</td>
</tr>
</tbody>
</table>

Reference: Korenstein Et. al., BM Emerg Med 2007
Causes of Elevated BNP

- Acute CHF
- Renal Failure
- Sepsis
- Pulmonary Embolism
BNP Decreases LOS & Cost

ED LOS

- BNP: P=0.031
- No BNP: $6,129

Hospital Costs

- BNP: P=0.023
- No BNP: $5,180

References:
- Mueller et al., NEJM
- Moe et al., Circ 2007
Summary of BNP

• Combining clinical judgment & BNP may improve accuracy of diagnosis

• Most helpful when diagnosis unclear (e.g. COPD)

• Can be elevated in ARF, sepsis or PE
Diagnosing CHF by Ultrasound

• Extravascular lung fluid
  – Look for “comet tails”

• Elevated Rt heart filling pressures
  – Examine IVC within 2 cm of Rt atrium
Ultrasound B-lines (Lung Rockets) in CHF

• Pros:
  – Easy windows
  – 80-90% sensitivity & specificity

• Cons:
  – Takes 2-5 minutes
  – Limited data from ED
Lung Ultrasound for B-Lines (Lung Rockets)

- Use a 3-5 MHz Probe
- Position 1: anterior chest view
- Position 2: lateral chest views

Drickey, Wikimedia Commons
Measuring IVC by Ultrasound in AHF

• Pros:
  – Rapid
  – 69% PPV & 91% NPV
  – Accuracy 83% for ↑ Atrial Pressures

• Cons:
  – Correlation ↑ Atrial Pressures to AHF
  – Technically challenging

Management of Acute CHF

• Oxygen
• Diuretics
• Nitroglycerin
• Morphine
CPAP/BiPAP Decreases Mortality & Intubation

45% ↓ mortality*  

<table>
<thead>
<tr>
<th></th>
<th>NIPVV</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0.11</td>
<td>0.2</td>
</tr>
<tr>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25%</td>
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</table>

42% ↓ Intubation*  

<table>
<thead>
<tr>
<th></th>
<th>NIPVV</th>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>0%</td>
<td>0.18</td>
<td>0.31</td>
</tr>
<tr>
<td>5%</td>
<td></td>
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<tr>
<td>10%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001  
Reference: Masip et al. JAMA 2005  
Reference: Masip et al. JAMA 2006
CPAP & BiPAP Equivalent

CPAP = Bipap

- Mortality
- Intubation rates
- AMI

<table>
<thead>
<tr>
<th></th>
<th>CPAP</th>
<th>BiPAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>6%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Reference: Masip et al. JAMA 2005
ED Study of NIPPV vs. Standard Medical Care (SMC)

- 1069 ED
- Randomized for 2 hrs of treatment
  - CPAP
  - BiPAP
  - Oxygen by NC or FM

Gray et al. NEJM 2008
No Difference NIPPV vs. SMC

• No Difference
  – Mortality
  – Intubation rates

• NIPPV better
  – ▼ Respiratory distress
  – ▼ Metabolic disturbances

Reference: Gray et al. NEJM 2008
Why Discrepancy Between Studies?

<table>
<thead>
<tr>
<th>Study</th>
<th>Mortality</th>
<th>Intubation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gray et al. <em>NEJM</em></td>
<td>16.5%???</td>
<td>2.8%</td>
</tr>
<tr>
<td>Masip et al <em>JAMA</em></td>
<td>20%</td>
<td>31%</td>
</tr>
<tr>
<td>Cochrane</td>
<td>20%</td>
<td>30%</td>
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</tbody>
</table>
## Reason for Discrepancy

<table>
<thead>
<tr>
<th>Change in Treatment</th>
<th>Standard Oxygen (N=367)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intubation</td>
<td>3</td>
</tr>
<tr>
<td>CPAP</td>
<td>43</td>
</tr>
<tr>
<td>NIPPV</td>
<td>13</td>
</tr>
<tr>
<td>Standard treatment</td>
<td>---</td>
</tr>
<tr>
<td>Type treatment not noted</td>
<td>6</td>
</tr>
</tbody>
</table>

65/367 (18%) Patients Crossed Over in Standard Treatment Group
Summary of NIPPV

• Most likely:
  – Decreases mortality
  – Decreases intubation rate
  – Decreases respiratory distress

• Use in Patients with:
  – Significant respiratory distress
  – $O_2$ Saturation <90%
68 y.o. Female in Severe CHF. Home Meds 80 mg Lasix

• How much IV Lasix should you give her?
  – None
  – 40 mg
  – 80 mg
  – 160 mg
Decreased Effectiveness of Loop Diuretics in CHF

• Delayed onset of action
  – 15-30 minutes normal patients
  – 45-120 minutes in CHF

• Drug resistance in chronic users
Cardiac Effects of Lasix

- Venous dilatation
  - Healthy subjects
  - Maximized @ 20 mg

- Arterial constriction
  - CHF patients
  - Predominates early

<table>
<thead>
<tr>
<th>Physiological Effect</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVR</td>
<td>↑</td>
</tr>
<tr>
<td>SVR</td>
<td>↑</td>
</tr>
<tr>
<td>MAP</td>
<td>↑</td>
</tr>
<tr>
<td>HR</td>
<td>↑</td>
</tr>
<tr>
<td>RtAFP</td>
<td>↑</td>
</tr>
<tr>
<td>SV??</td>
<td>↓</td>
</tr>
<tr>
<td>Catecholamines</td>
<td>↑</td>
</tr>
</tbody>
</table>
Worsening Creatinine and Acute Congestive Heart Failure

- Occurs in 72% of patients with CHF
- Increased mortality
- ↑ LOS
Increased Mortality Associated with Worsening Creatinine

Relative Risk of Death

Creatinine Elevation