Preoperative Pulmonary Evaluation 2013

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Goals

- Definition and impact of postoperative pulmonary complications (PPCs)
- Patient-related risk factors
- Procedure-related risk factors and the importance of surgical site
- Limited role for spirometry
- Risk reduction strategies
- Review of ACP Guideline
What’s New?

- Impact of pulmonary hypertension
- New systematic reviews of smoking cessation
- Reassessment of incentive spirometry
- Simplified PPC risk index
- Updated reviews on postop analgesia strategies and selective NG tube use
What are we trying to prevent?

- Pneumonia
- Respiratory failure
- Atelectasis
- Bronchospasm
- COPD exacerbation
Why is This a Worthy Field of Study?

- Secondary analysis of data from cohort of patients used to develop revised cardiac risk index
- Prospective study of 3970 patients > 50 years old undergoing elective major noncardiac surgery
- Explicit definitions of complications
- Cardiac complications: 2.5%
- Pulmonary complications: 2.7%

*Am J Med 2003;115:515-520*
NSQIP: Respiratory Failure Confers High Morbidity and Mortality

30 Day Mortality

- MI
- Pneumonia
- ARF
- VTE

- No Resp Failure
- Respiratory Failure

J Am Coll Surg 2007;204:1188
NSQIP: PPCs are the Most Costly Postoperative Complication

Infectious  CV  VTE  Pulmonary

Total Hospital Cost

LOS

J Am Coll Surg 2004;199:531
Patient-Related Risk Factors
Potential Patient-Related Risk Factors

- COPD
- Smoking
- General health status
  - ASA class
  - Functional dependence
- Obesity
- Age
- Respiratory infection
- Asthma
- CHF
- Pulmonary hypertension
Chronic Obstructive Pulmonary Disease is a Risk Factor

- Overall 2 fold increase in risk
- Severity of COPD probably influences risk
- The following physical exam findings predict higher PPC rates:
  - Decreased breath sounds
  - Prolonged expiration
  - Rales
  - Wheezes
  - Rhonchi

Chest 1996;110:744
ASA class
- ASA class > 2
- 3 fold increase in PPC rates

Functional dependence

Self-reported exercise capacity
- May be a predictor

<table>
<thead>
<tr>
<th>ASA class</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A normally healthy patient</td>
</tr>
<tr>
<td>2</td>
<td>A patient with mild systemic disease</td>
</tr>
<tr>
<td>3</td>
<td>A patient with severe systemic disease</td>
</tr>
<tr>
<td>4</td>
<td>A patient with severe systemic disease that is a constant threat to life</td>
</tr>
<tr>
<td>5</td>
<td>A moribund patient who is not expected to survive without the operation</td>
</tr>
</tbody>
</table>
Obesity is Not a Risk Factor

- Studies confounded by difficulty distinguishing obesity from associated comorbid conditions
- Most studies show *no* increase in pulmonary complications, even for morbid obesity and for obesity surgery itself
- ACP guideline: Only 1 of 8 adjusted studies found obesity to be a risk
- Do not consider obesity to be a contraindication to high-risk surgery
Mr. Pickwick

• You see Mr. Pickwick
• 58 year old man
• Planning elective cholecystectomy
• His PMHx includes obesity and type 2 diabetes
• He sleeps in a separate room as snoring keeps his wife awake
• BMI is 40
• The physical examination is otherwise normal
Question #1: Mr. Pickwick

Which of the following is the best strategy for preop evaluation?

1. Proceed to surgery as planned
2. Obtain a home overnight oximetry test
3. Obtain a formal sleep study
4. Provide empiric postop CPAP
5. Give him a private room after surgery
Prospective Study: OSA Increases PPC Rates

172 patients suspected of having OSA before surgery
OSA is Common Among Consecutive Patients Undergoing Bariatric Surgery

<table>
<thead>
<tr>
<th>OSA severity</th>
<th>Apnea Hypopnea Index (AHI)</th>
<th>Prevalence (n=342)</th>
<th>Mean BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>&lt; 5</td>
<td>23%</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>5-15</td>
<td>31%</td>
<td>48.5</td>
</tr>
<tr>
<td>Moderate</td>
<td>16-30</td>
<td>19%</td>
<td>48.7</td>
</tr>
<tr>
<td>Severe</td>
<td>&gt; 30</td>
<td>27%</td>
<td>53.4</td>
</tr>
</tbody>
</table>

Independent predictors: age, BMI, male gender, MAP score

Authors recommend screening all patients: NPV only 75%
Age is a Significant Risk Factor

- Is age a risk factor or a marker for comorbidities?
- Previous analyses contradictory
- ACP meta-analysis:
  - Age is an important risk factor even after adjustment
- Differs from cardiac risk assessment

### Adjusted OR for PPC

<table>
<thead>
<tr>
<th>Age</th>
<th>50-59</th>
<th>60-69</th>
<th>70-79</th>
<th>&gt;80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted OR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACP Guideline 2006
Asthma is Not a Risk Factor for Pulmonary Complications

• Mayo Clinic review of 706 surgical patients with asthma
• Incidence of pulmonary complications:
  – Bronchospasm 1.7%
  – Respiratory failure 0.1%
  – Laryngospasm 0.3%
• No deaths, pneumonia, or pneumothorax in entire sample

Anesthesiology 1996;85:460
Pulmonary Hypertension Increases Mortality after Major Orthopedic Surgery

Anesth Analg 2010;111:1110
Higher Rates of Multiple Morbidities if Pulmonary Hypertension

Odds Ratio for Outcome if Pulmonary Hypertension

- THR
- TKR

Mortality
- ARDS
- PE
- DVT
American College of Physicians
Preoperative Pulmonary Evaluation
Guideline

- Smetana GW, Lawrence VA, Cornell JE
- Systematic review of literature dating to 1980 as background paper for ACP guideline
- Separate papers
  - Risk factors and laboratory testing
  - Strategies to reduce PPC rates
  - Guideline

Ann Intern Med 2006;575-608
# ACP Guideline: Patient-Related Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th># Studies</th>
<th>Odds Ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 50-50</td>
<td>2</td>
<td>1.50</td>
<td>(1.31, 1.71)</td>
</tr>
<tr>
<td>Age 60-69</td>
<td>6</td>
<td>2.09</td>
<td>(1.70, 2.58)</td>
</tr>
<tr>
<td>Age 70-70</td>
<td>4</td>
<td>3.04</td>
<td>(2.11, 4.39)</td>
</tr>
<tr>
<td>ASA ≥2</td>
<td>6</td>
<td>4.87</td>
<td>(3.34, 7.10)</td>
</tr>
<tr>
<td>ASA ≥3</td>
<td>11</td>
<td>2.55</td>
<td>(1.73, 3.76)</td>
</tr>
<tr>
<td>Abnormal CXR</td>
<td>2</td>
<td>4.81</td>
<td>(2.43, 9.55)</td>
</tr>
<tr>
<td>CHF</td>
<td>3</td>
<td>2.93</td>
<td>(1.02, 8.03)</td>
</tr>
<tr>
<td>Functional dependence</td>
<td>2</td>
<td>2.51</td>
<td>(1.99, 3.15)</td>
</tr>
<tr>
<td>COPD</td>
<td>8</td>
<td>1.79</td>
<td>(1.44, 2.22)</td>
</tr>
<tr>
<td>Cigarette use</td>
<td>5</td>
<td>1.26</td>
<td>(1.01, 1.56)</td>
</tr>
<tr>
<td>Impaired sensorium</td>
<td>2</td>
<td>1.39</td>
<td>(1.08, 1.79)</td>
</tr>
</tbody>
</table>
Procedure-Related Risk Factors
Potential Procedure-Related Risk Factors

• Surgical site
• Duration of surgery
• Type of anesthetic
• Neuromuscular blockade
• Emergency surgery
Surgical Site is the Key to Risk Assessment

- Single most important PPC risk factor
- Risk increases as incision is closer to the diaphragm
  - Upper abdominal 20%
  - Lower abdominal 8%
  - Thoracic 20-40%
  - Aortic 25%
  - Esophageal 35%
- Prolonged surgery also a risk
  - OR 2.1 for surgery > 3 hours
- Pancuronium increases risk
### ACP Guideline: Procedure-Related Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th># Studies</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Surgical site</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Aortic</td>
<td>2</td>
<td>6.9</td>
<td>(2.74, 17.36)</td>
</tr>
<tr>
<td>• Thoracic</td>
<td>3</td>
<td>4.24</td>
<td>(2.89, 6.23)</td>
</tr>
<tr>
<td>• Any abdominal</td>
<td>6</td>
<td>3.01</td>
<td>(2.43, 3.72)</td>
</tr>
<tr>
<td>• Upper abdominal</td>
<td>4</td>
<td>2.91</td>
<td>(2.35, 3.60)</td>
</tr>
<tr>
<td>• Neurosurgery</td>
<td>2</td>
<td>2.53</td>
<td>(1.84, 3.47)</td>
</tr>
<tr>
<td>• Head and neck</td>
<td>2</td>
<td>2.21</td>
<td>(1.82, 2.68)</td>
</tr>
<tr>
<td>• Vascular</td>
<td>2</td>
<td>2.1</td>
<td>(0.81, 5.42)</td>
</tr>
<tr>
<td><strong>Emergency surgery</strong></td>
<td>6</td>
<td>2.21</td>
<td>(1.57, 3.11)</td>
</tr>
<tr>
<td><strong>Prolonged surgery</strong></td>
<td>4</td>
<td>2.14</td>
<td>(1.33, 3.46)</td>
</tr>
<tr>
<td><strong>General anesthesia</strong></td>
<td>6</td>
<td>1.83</td>
<td>(1.35, 2.46)</td>
</tr>
<tr>
<td>Transfusion &gt; 4 units</td>
<td>2</td>
<td>1.47</td>
<td>(1.26, 1.71)</td>
</tr>
<tr>
<td>Score</td>
<td>Definition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Good evidence supports factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Fair evidence supports factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Fair evidence against factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Good evidence against factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Insufficient evidence: Evidence is lacking, poor quality, or conflicting.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# ACP Position Statement: Summary of Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Grade</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced age</td>
<td>A</td>
<td>Aortic aneurysm repair</td>
</tr>
<tr>
<td>ASA class ≥ 2</td>
<td>A</td>
<td>Thoracic surgery</td>
</tr>
<tr>
<td>Functionally dependent</td>
<td>A</td>
<td>Abdominal surgery</td>
</tr>
<tr>
<td>COPD</td>
<td>A</td>
<td>Upper abdominal surgery</td>
</tr>
<tr>
<td>CHF</td>
<td>A</td>
<td>Neurosurgery</td>
</tr>
<tr>
<td>Impaired sensorium</td>
<td>B</td>
<td>Emergency surgery</td>
</tr>
<tr>
<td>Abnormal chest exam</td>
<td>B</td>
<td>General anesthesia</td>
</tr>
<tr>
<td>Cigarette use</td>
<td>B</td>
<td>Head and neck surgery</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>B</td>
<td>Vascular surgery</td>
</tr>
<tr>
<td>Weight loss</td>
<td>B</td>
<td>Prolonged surgery</td>
</tr>
<tr>
<td>Obesity</td>
<td>C</td>
<td>Perioperative transfusion</td>
</tr>
<tr>
<td>Asthma</td>
<td>D</td>
<td>Hip surgery</td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td>I</td>
<td>GU/GYN surgery</td>
</tr>
<tr>
<td>Poor exercise capacity</td>
<td>I</td>
<td>Esophageal surgery</td>
</tr>
</tbody>
</table>
Preoperative Testing
Role of Preoperative Pulmonary Function Testing

- **Consensus:**
  - Indicated for all patients prior to lung resection
- **Controversial:**
  - Role prior to abdominal, non-resective thoracic, and other high-risk surgeries
- **Questions:**
  - Do PFTs predict risk more accurately than clinical evaluation alone?
  - Are there prohibitive values for spirometry below which surgery should be denied?
ACP Guideline: Spirometry

- 14 eligible studies of spirometry
- 3 of 4 multivariable studies found FEV1 to predict PPC rates
- Few studies compared FEV1 to history and physical examination or adjusted for this in MV analysis
- ACP strength of recommendation: I
  - Insufficient or conflicting evidence
- Guideline:
  - Do not use routinely
Recommendations: Limited Role for Preoperative PFTs

- Do not use PFTs to deny surgery
- Obtain for all patients before lung resection
- Do not routinely obtain PFTs before high risk non-cardiothoracic surgery
- Consider if exercise intolerance or dyspnea is unexplained after clinical evaluation
- Suggest in a patient with COPD or asthma if not clear that patient is at best baseline
- $\text{PCO}_2 > 45$ not an absolute contraindication to surgery
Serum Albumin and BUN Predict PPC Risk

• National VA Surgery Quality Improvement Study
• Risk of respiratory failure among 180,000 veterans undergoing noncardiac surgery
• Laboratory data that were independent risk predictors in multivariate analysis:
  – Albumin < 3.0 g/dl
  – BUN > 30 mg/dl
• Low albumin one of most predictive factors in ACP guideline

Do the Results of Preoperative CXR Modify PPC Risk?
Preoperative Chest X-Rays

- Value as baseline unproven
- Changes preoperative management in 3% of patients
- OR for abnormal CXR 4.8 (limited data)
- Consider for patients > 50 years old with risk factors undergoing high risk surgery

ACP Guideline
Strategies to Reduce Postoperative Pulmonary Complication Rates
Preoperative Strategies: Optimize COPD or Asthma

- Ipratropium or tiotropium for all symptomatic patients with COPD
- Inhaled β-agonists added as needed for symptoms
- Liberal use of steroids to achieve best baseline
- Optimize airflow obstruction to a goal peak flow 80% of personal best
- Antibiotics only if change in character of sputum suggests infection
Mr. Salem

- 74 year old man with COPD who you see 2 weeks before a planned hemicolecotomy for colon cancer
- He smokes 2 ppd and has for 30 years
- Should you advise him to quit smoking?
- If he is successful, will this reduce his risk of postoperative pulmonary complications?
Question #3: What is the Optimal Duration of Cigarette Cessation before Major Surgery?

1. 0-2 weeks
2. 2-8 weeks
3. > 8 weeks
4. It doesn’t matter: any duration is OK
RCT’s of Smoking Cessation: Still Inadequate Power for PPCs

<table>
<thead>
<tr>
<th>Trial</th>
<th># patients</th>
<th>Rx</th>
<th>#PPC Intervention</th>
<th>#PPC Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moller et al</td>
<td>120</td>
<td>6-8 wks</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>• THR / TKR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lindstrom et al</td>
<td>117</td>
<td>4 wks</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>• THR / TKR / Lap Chole / Hernia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Meta Analysis of Impact of Smoking Cessation

- Systematic review
- Both RCTs and observational studies
- Primary outcome: all postop complications
- Secondary outcomes: wound, PPC, mortality, LOS
- Searched 10 databases from inception
- Assessed methodologic rigor and risk of bias
- 6 RCTs and 15 observational studies

Am J Med 2011;124:144
Smoking Cessation Marginally Reduced PPCs: No Difference between Early and Late Quitters

- 7 Eligible observational studies of PPCs
- Past vs. current smokers: RR 0.81 (CI 0.70-0.93)
- Early vs. late quitters: 0.88 (CI 0.28-2.71)
- Impact on total complications
  - RCTs: each additional week provides more risk reduction
  - Observational: RR 0.80 favoring long term (> 4 weeks) vs short term
**Intensive Preoperative Inspiratory Muscle Training**

- RCT
- 279 patients
- CABG surgery
- All high risk for PPCs by usual risk factor assessment
- Assigned to IMT or usual care

**Inspiratory muscle training (IMT)**
- Incentive spirometry
- Active breathing techniques
- Forced expiration techniques
- 20 minutes per day for at least two weeks before surgery

*JAMA 2006;296:1851-1857*
Preoperative Inspiratory Muscle Training Reduces PPC Rates after CABG

OR 0.52

OR 0.40

JAMA 2006;296:1851-1857
Intraoperative Strategies

• Epidural or spinal anesthesia if possible in high-risk patients
• Regional nerve block even lower risk
• Avoid pancuronium in high risk patients
• Select shorter duration procedures (less than 3 hours) in high risk patients
• Laparoscopic procedures when possible
• Consider less ambitious procedure in high-risk patients
Postoperative Lung Expansion Maneuvers Reduce PPC Rates

<table>
<thead>
<tr>
<th>Previous Systematic Reviews</th>
<th>Year</th>
<th># studies</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas and McIntosh</td>
<td>1994</td>
<td>2</td>
<td>IS Compared to no Rx: OR 0.44 (CI 0.18-0.99)</td>
</tr>
<tr>
<td>Overend et al</td>
<td>2001</td>
<td>3</td>
<td>IS Compared to no Rx: 1/3 studies effective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>IS Compared to other Chest PT: 3/5 studies comparable, 2/5 studies found inferior</td>
</tr>
<tr>
<td>Lawrence et al ACP Guideline</td>
<td>2006</td>
<td>Above plus 5 studies</td>
<td>Any lung expansion better than no Rx (Grade A) No difference between strategies</td>
</tr>
</tbody>
</table>

Cochrane concludes: IS ineffective

More appropriate conclusion: IS probably effective but no more effective than chest PT
# Systematic Reviews: Postop Epidural Analgesia Reduces PPCs

<table>
<thead>
<tr>
<th>Surgery</th>
<th>Study Type</th>
<th>All PPCs OR</th>
<th>Pneumonia OR</th>
<th>Respiratory Failure OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA*</td>
<td>Meta Analysis</td>
<td></td>
<td>0.64</td>
<td>0.63</td>
</tr>
<tr>
<td>CABG*</td>
<td>Meta analysis</td>
<td>0.41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AAA*</td>
<td>RCT</td>
<td></td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>Abdominal*</td>
<td>RCT</td>
<td></td>
<td></td>
<td>0.77</td>
</tr>
<tr>
<td>Abdominal &amp; Thoracic**</td>
<td>Meta Analysis</td>
<td></td>
<td>0.54</td>
<td>0.61</td>
</tr>
</tbody>
</table>

*Anesth Analg 2007;104:689 , **Arch Surg 2009;143:990
Systematic Review: Selective NG Tube Use Reduces PPC Rates

• Routine use of NG decompression after abdominal surgery may increase risk of aspiration and PPCs
• Selective = based on symptoms or abdominal distension
• Meta-analysis of 24 RCTs of selective vs. routine NG use
• Abdominal surgery
• OR 1.45 [CI 1.08-1.93] for PPCs with routine NG use

Cochrane Database of Systematic Reviews 2007, Issue 3.
### ACP Position Statement: Risk Reduction Strategies

<table>
<thead>
<tr>
<th>Postoperative lung expansion modalities</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selective postop nasogastric tube use</td>
<td>B</td>
</tr>
<tr>
<td>Short-acting neuromuscular blockade</td>
<td>B</td>
</tr>
<tr>
<td>Laparoscopic (versus open) operation</td>
<td>C</td>
</tr>
<tr>
<td>Intraoperative neuraxial blockade</td>
<td>I</td>
</tr>
<tr>
<td>Postoperative epidural analgesia</td>
<td>I</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>I</td>
</tr>
<tr>
<td>TPN or total enteral nutrition</td>
<td>D</td>
</tr>
<tr>
<td>Right heart catheterization</td>
<td>D</td>
</tr>
</tbody>
</table>
## Summary: Risk Factors

<table>
<thead>
<tr>
<th>Patient-related</th>
<th>Procedure-related</th>
</tr>
</thead>
<tbody>
<tr>
<td>• COPD</td>
<td>• Upper abdominal, thoracic, aortic, head and neck, or esophageal surgery</td>
</tr>
<tr>
<td>• Advanced age</td>
<td>• Surgery lasting &gt; 3 hours</td>
</tr>
<tr>
<td>• Smoking</td>
<td>• Pancuronium</td>
</tr>
<tr>
<td>• ASA class &gt; 2</td>
<td>• General anesthesia</td>
</tr>
<tr>
<td>• Pulmonary hypertension</td>
<td>• Emergency surgery</td>
</tr>
<tr>
<td>• Functionally dependent</td>
<td>• Routine postop NG tube placement</td>
</tr>
<tr>
<td>• Albumin &lt; 3.6</td>
<td></td>
</tr>
<tr>
<td>• CHF</td>
<td></td>
</tr>
<tr>
<td>• OSA</td>
<td></td>
</tr>
</tbody>
</table>
Summary: Risk Reduction Strategies

• Cigarette cessation
• Optimize COPD
• Avoid pancuronium
• Preop inspiratory muscle training
• Deep breathing or incentive spirometry
• Postop CPAP
• Postoperative epidural analgesia
• Selective NG decompression