Case Presentation

Alireza Sadeghi MD
Lutheran Medical Center
University Hospital of Brooklyn
Downstate Medical Center
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Case Presentation

- xx years old Caucasian Male
- History of Stage III Colon Cancer in xxxx year
  - S/P Resection and Chemotherapy
- Presented to Thoracic Service at LMC for elective VATS & Pulmonary Resection for a 3.1 cm lesion in the Right Lower Lobe on ___ date.
- Denied SOB, Weight Loss, Cough, Hemoptysis
- No other complaints
Case Presentation

• Past Medical History:
  – DM, BPH, HTN

• Past Surgical History:
  – Colon Cancer (date): S/P resection and chemotherapy
  – Pulmonary Metastasectomy (date) for metastatic colon CA: Left upper lobectomy
  – Bladder Cancer (date): TURBT

• Allergies:
  – PCN

• Medications:
  – Proscar
  – Glipizide
  – Cozaar
  – Multivitamins

• Social History:
  – ☹ 51 Pk yr Tobacco
  – ☹ EtOH
Case Presentation

• Vital Signs
  – Temp: 98.1 F
  – BP: 108/61
  – HR: 70
  – RR: 18
  – O₂ Sat: 100 % RA

• Physical Exam
  – No cervical adenopathy
  – No head/neck/arm edema
  – Chest:
    • CTA B/L
    • RRR, S₁ & S₂, no murmurs
  – Abd: S/ND/NT/+BS
  – Exterm: 2+ distal pulses
  – Neuro: Intact
Case Presentation

• Preoperative Labs:
  – WBC: 7.5
  – Hgb/HCT: 15.3/46.3
  – Plts: 170
  – Chem: 144/5.0/108/28/21/1.1/115
  – INR: 0.9
  – CEA level:
    • 2.1-2.5 ng/ml since initial surgery in (date)
  – ABG: 7.45/37/85/25.6/+1.8/99%
Case Presentation

- Cardiac Catheterization:
  - LV Function: Normal
  - EF 55%
  - Non obstructive CAD
  - Minimal MR
Case Presentation

• Pulmonary Function Tests:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Predicted</th>
<th>Actual</th>
<th>% Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>FVC</td>
<td>4.87 L</td>
<td>3.63 L</td>
<td>75</td>
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<tr>
<td>FEV1</td>
<td>3.86 L</td>
<td>2.78 L</td>
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<tr>
<td>FEV1/FVC</td>
<td>78 %</td>
<td>77%</td>
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<td>FEF 25-75%</td>
<td>3.79 L/sec</td>
<td>1.81 L/sec</td>
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<tr>
<td>MVV</td>
<td>142 L/min</td>
<td>98 L/min</td>
<td>69</td>
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<tr>
<td>TLC</td>
<td>7.27 L</td>
<td>6.22 L</td>
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</tr>
<tr>
<td>DLCO (ml/min/mmHg)</td>
<td>24.6</td>
<td>16.2</td>
<td>66</td>
</tr>
</tbody>
</table>
Case Presentation

- **Imaging:**
  - Surveillance CT Scan (date)
    - Lobulated mass in the RLL; posteriomedial location
    - 3.1 x 2.5 x 2.8 cm
    - No Axillary LN involvement
    - Previous Surveillance CT Scans did not reveal any lesions
      - 10/28/2004
      - 05/12/2004
      - 12/03/2003
  - PET Scan (date)
    - Single Hyper metabolic focus in the Right Lower Lobe
Case Presentation

• Operative Course:
  – Bronchoscopy: No intraluminal lesions
  – Double lumen ET intubation
  – SCD Boots
  – Patient positioned in R Thoracotomy position
  – Right VATS performed
    • Patient tolerates LLL ventilation: O\textsubscript{2} Sat 97-99%
    • Unable to safely remove the lesion due to its location
    • Procedure abandoned
    • Right Muscle Sparing Thoracotomy performed
Case Presentation

• Operative Course:
  – Exploratory Right Thoracotomy:
    • Lesion not amenable to wedge resection due to central location
    • Decision made to perform a complete right lower lobectomy
    • EBL: 900 cc
    • 2 chest tubes inserted and the chest was closed.
    • Patient tolerated procedure well.
Case Presentation

• Pathology Report:

  – Right Lower Lobe
    • Metastatic Moderately Differentiated Adenocarcinoma
    • 3.1 cm x 2.9 cm x 2.8 cm
    • Solitary Lesion
    • Histologically compatible with Colonic Origin
Case Presentation

• Postoperative Course:
  – POD #1: SICU
    • Supportive Management:
      – 2U PRBC & Pressor Support
      – HCT 28 → 33
    • Extubated successfully
    • SCD boots
    • No evidence postoperative MI
    • Chest Tubes: 1200 cc/24 hr
    • Post Extubation ABG on 3 L NC:
      – 7.42/34.9/153/22/-1.9/99%
Case Presentation

• Postoperative Course:
  – POD #2: SICU
    • Supportive Care/SCD Boots & HSC
      – Chest tubes: 300 cc/24 hrs
      – Apical CT removed
    • Diet Advanced
  – POD #3: Floor
    • OOB/Incentive Spirometry/SCD Boots & HSC
      – Chest tube: 130 cc/24 hrs
      – CXR: mild atelectasis
Case Presentation

• Postoperative Course:
  – POD #4: Floor
    • Acute SOB with desaturation to 90%
    • Afebrile/VSS/No evidence of MI
    • ABG: 7.46/36/225/25/+1.9/100% on NRB mask
    • A-a Gradient: 371
    • CTA Chest:
      – Large hypo dense filling defect within R Middle Lobe PA
      – B/L Pneumonitis
    • Lower Extremity Duplex: No evidence of DVT
    • Heparin Anticoagulation Started/Broad Spectrum Abx
    • Transferred to ICU
Case Presentation

• Postoperative Course:
  – POD #5: ICU
    • Brief initial improvement
    • IV Anticoagulation therapeutic/Warfarin started
    • Respiratory Distress continues
    • Medical Oncology team assumes care of patient
    • Oxygen Saturation 90-93% on NRB Mask
    • Patient maintained on BIPAP ventilation
    • INR therapeutic 2.9
    • Transferred to MICU
Case Presentation

- **Postoperative Course:**
  - **POD #5: MICU**
    - Continued Respiratory Failure
    - Patient deteriorates
    - BIPAP
    - ABG: 7.45/41/63/28/+3.3/93%
  - **POD #6: MICU**
    - Fulminant Respiratory Failure
    - BIPAP
    - ABG: 7.47/38/28
    - Cardiac Arrest/Unsuccessful ACLS → Pt Expired.
Preoperative Evaluation for Lung Resection Surgery

Alireza Sadeghi MD
University Hospital of Brooklyn
Downstate Medical Center
March 10th 2006
Spirometry

• Recording of the volume of air inhaled & exhaled, plotted against time, during a series of Ventilatory maneuvers.

• Results depict a Normal vs. Abnormal pattern of Ventilatory reserve
  – Obstructive
  – Restrictive
  – Mixed Disorders

## Terminology

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;</td>
<td>Forced expiratory volume in 1 second; volume of air forcibly expired from a maximum inspiratory effort in the first second (L)</td>
</tr>
<tr>
<td>FEV&lt;sub&gt;1&lt;/sub&gt;/FVC ratio</td>
<td>Ratio of FEV&lt;sub&gt;1&lt;/sub&gt; to FVC</td>
</tr>
<tr>
<td>FRC</td>
<td>Functional residual capacity; the volume of air in the lungs following a tidal volume exhalation = ERV + RV (L)</td>
</tr>
<tr>
<td>FVC</td>
<td>Forced vital capacity; the total volume that can be forcibly expired from a maximum inspiratory effort (L)</td>
</tr>
<tr>
<td>DLCO</td>
<td>Diffusing capacity of the lung; the capacity of the lungs to transfer carbon monoxide (mL/min/mm Hg)</td>
</tr>
<tr>
<td>RV</td>
<td>Residual volume; the volume of air that remains in the lungs after maximal exhalation (L)</td>
</tr>
<tr>
<td>TLC</td>
<td>Total lung capacity; the total volume of air in the lungs at full inhalation; the sum of all volume compartments (IC + FRC or IRV + V&lt;sub&gt;T&lt;/sub&gt; + ERV + RV) (L)</td>
</tr>
<tr>
<td>TV or VT</td>
<td>Tidal volume; the volume of air that is inhaled or exhaled with each breath when a person is breathing at rest (L)</td>
</tr>
<tr>
<td>VC</td>
<td>Vital capacity; the maximum volume of air that can be exhaled starting from maximum inspiration, TLC (L) can be measured either as slow vital capacity (SVC) or forced vital capacity (FVC)</td>
</tr>
</tbody>
</table>

Terminology

• Forced vital capacity (FVC):
  – Total volume of air that can be exhaled forcefully from TLC
  – The majority of FVC can be exhaled in <3 seconds under normal circumstances
  – Measured in liters (L)
Terminology

- Forced expiratory volume in 1 second: (FEV\textsubscript{1})
  - Volume of air forcefully expired from full inflation (TLC) in the first second
  - Measured in liters (L)
  - Normally more than 75-80% of FVC is exhaled in the first second
Terminology

- **Forced expiratory flow 25-75% (FEF<sub>25-75</sub>)**
  - Mean forced expiratory flow during middle half of FVC
  - Measured in L/sec
  - May reflect effort independent expiration and the status of the small airways
  - Highly variable
FVC

• Interpretation of % predicted:
  – 80-120% Normal
  – 70-79% Mild reduction
  – 50%-69% Moderate reduction
  – <50% Severe reduction

FEV$_1$

• Interpretation of % predicted:
  – >75% Normal
  – 60%-75% Mild obstruction
  – 50-59% Moderate obstruction
  – <49% Severe obstruction
• Interpretation of % predicted:
  – >60% Normal
  – 40-60% Mild obstruction
  – 20-40% Moderate obstruction
  – <10% Severe obstruction
Introduction

• Statistics from Center for Disease Control & Prevention
  – About 30,000 lung resections are performed annually in the United States

• Commonly performed surgeries for lung cancer include
  – Pneumonectomy
  – Lobectomy
  – Wedge Resection
  – Segmentectomy

Introduction

• Indications for Pulmonary Resection:
  – Neoplastic Disease
    • Primary
    • Metastatic
  – Bullous Lung Disease: LVRS
  – Diagnosis & Management of inflammatory conditions
    • Granulomas
    • Pulmonary infiltrates
    • Resection of segments destroyed by bronchiectasis

Introduction

• Recent Studies: Mortality Rates
  – Pneumonectomy: 6.8% $^1$ & 5.7% $^2$
  – Bilobectomy: 4.4 % $^2$
  – Lobectomy: 3.9% $^1$
  – Lesser Resection: 1.4% $^2$

• Risk of morbidity & mortality
  – mandatory to assess as accurately as possible which patients with anatomically resectable disease are suitable candidates for resectional surgery

Purpose

• The Purpose of Preoperative Physiologic Assessment:
  – Using the least invasive test possible
    • Identify the High Risk Patient
      – Complications
      – Long term Disability
    • Adequately Counsel the patient on treatment options and risks to make an informed decision
    • Identify possible steps to reduce risks of peri-operative complications & long-term pulmonary disability

Complications

• Postoperative Cardiopulmonary Complications
  – Acute Hypercapnia
  – Mechanical Ventilation > 48hrs
  – Arrhythmias
  – Pneumonia
  – Pulmonary Emboli
  – Myocardial Infarction
  – Lobar Atelectasis requiring Bronchoscopy
Preoperative Evaluation

• Who should be evaluated?
  – The general answer
    • *All patients* undergoing lung resection surgery, irrespective of age or extent of the lesion.

• History
  – Smoking & COPD
    • Preoperative Medical Optimization

Pulmonary-Specific Evaluation

• The aims of pulmonary-specific evaluation
  – Assessment of the patient’s physiologic pulmonary function
  – Determining the patient candidacy for surgery and the extent of resection that can be tolerated.

• There is no single measure that is a “gold standard” in accurately predicting complications.

• However, certain criteria, when applied have been shown to be predictive of outcome.

The Algorithm

Routine PFTS → FEV1 > 60%, DLCO > 60%

FEV1 < 60%, DLCO < 60%

Quantitative Lung Scan → PPO-FEV1 > 40%
PPO-DLCO > 40%

PPO-FEV1 < 40% / PPO-DLCO < 40%

EXERCISE TESTING → VO2max > 15ml/kg/min

VO2max < 15ml/kg/min → Other Options prior to attempting Surgery

Figure 1. A schematic representation of a stepwise approach to preoperative evaluation prior to lung resection surgery.

Risk Factors for Postoperative Cardiopulmonary Complications

- Non Pulmonary Factors
  - Site of Surgery
  - Duration of Surgery
  - Laparoscopic approach
  - Nutrition
  - Age
  - Obesity

- Pulmonary Factors
  - COPD
  - Smoking
  - Obesity
  - Productive Cough
  - Wheezing
  - FEV$_1$/FVC ratio
  - PaCO$_2$
  - ASA Classification

Pulmonary-Specific Evaluation

• Pulmonary Functions Tests
  – Used to evaluate risk for postoperative complications since 1950s
  – 1955 first published case of preoperative PFTs
    • Patients undergoing lung resection for pulmonary TB
    • MVV <50% & FVC <70%
      – 40% Mortality following Thoracotomy

Pulmonary-Specific Evaluation

• Pulmonary Function Tests Include:
  – Spirometry
  – Lung Volumes
  – Diffusion Capacity
  – Oximetry
  – Arterial Blood Gas Analysis
  – Radionuclide Lung Scanning
  – Cardiopulmonary Exercise Testing

Stages of Pulmonary-Specific Evaluation

• **Stage I Assessment (Preop lung function)**
  – Spirometry
  – Arterial Blood Gas Analysis
  – DLCO

• **Stage II Assessment (Postop lung function)**
  – Quantitative Ventilation-Perfusion Scan
  – Quantitative CT Scan

• **Stage III Assessment**
  – Exercise Testing: Oxygen Uptake (VO₂ Max)

• Spirometry:
  – Simple, inexpensive, standardized & readily available
    • FVC → volume
    • FEV1 → airflow
      – Factor regarded as being the best for predicting complications of lung resection in the initial assessment
    • FEF₂₅₋₇₅% → airflow
    • Maximal voluntary ventilation (MVV) → Muscle Strength
      – Maximal inhalation & exhalation over 12 sec: Air Flow & MS
      – Dependent on patient effort
  – Predicted values of pulmonary function depend on age, height, gender and race

Stage I

• **Forced Expiratory Volume One Second: FEV$_1$**
  
  – Correlates well with the degree of respiratory impairment in patients with COPD
  
  – Indirect measure of pulmonary reserve
  
  – In studies evaluating preoperative spirometric values a reduced FEV$_1$ (<60% of predicted)
    • Strongest predictor of postoperative complications
  
  – ACCP & BTS Guidelines:
    
    • FEV$_1 > 2$ L tolerate pneumonectomy
    • FEV$_1 > 1$-1.5 L tolerate lobectomy

Stage I

• Retrospective Studies in 1970s
  – British Thoracic Society (BTS) Guidelines compiled on data from >2000 patients in 3 large series
  – FEV₁ studied at the main factor
  – Mortality Rate < 5%
    • FEV₁ > 1.5 L for Lobectomy
    • FEV₁ > 2 L or FEV₁ > 80% predicted for Pneumonectomy

Stage I

- **Diffusing capacity of the lung for carbon monoxide (DLCO)**
  
  - Reflects alveolar membrane integrity & pulmonary capillary blood flow in the patient’s lungs.
  
  - In the past (Ferguson et al) 237 patients
    
    • Was the most important predictor of mortality & was the sole predictor of postoperative pulmonary complications.
  
  - In recent studies
    
    • Equally significant predictor of postoperative complications as FEV$_1$


Stage I

- Factors That Enhance CO Diffusion:
  - Increase in Lung Capillary Blood Volume
  - Recruitment & distention of Pulmonary Capillaries
  - Supine Position

- Factors That Decrease CO Diffusion:
  - Age
  - Standing Position
  - Decrease in Lung Capillary Blood Volume
  - Alveolar disease
  - Loss of Lung Disease

Stage I

- DLCO as a useful marker of operative risk
  - Ferguson et al in 237 patients
    - Relation between preoperative DLCO and M&M
  - Preoperative DLCO as percentage predicted had higher correlation with postoperative mortality than FEV$_1$
    - DLCO < 60% predicted associated with ↑ mortality.
  - DLCO & FEV$_1$ should be viewed as complementary physiologic tests

Stage I

• Arterial Blood Gas Analysis (ABG)
  – Not extensively studied as predictor of postoperative complication (PCO$_2$ > 50 mmHg & PO$_2$ < 60 mmHg)
  – Hypercapnia (PCO$_2$ > 50 mm Hg) in arterial blood has been a traditional contraindication to lung resection as it indicates chronic respiratory failure.
  – In recent studies
    • Patients with a PCO$_2$ of 45 mm Hg did well postoperatively
    • Was not predictive of postoperative complications

Stage I

• Arterial Blood Gas Analysis (ABG)
  – Evidence:
    • No difference in postoperative complications
    • Preoperative PCO$_2$ < 45 mmHg vs. PCO$_2$ > 45 mmHg
      – 17% vs. 13%
    • Hypercapnia is now NOT a contraindication to surgery
      – Low PPO FEV$_1$
      – Poor exercise tolerance
    • Hypoxemia (SaO$_2$ < 90%) was associated with ↑ risk of postoperative complications
Original Studies

• Study complications in 500 patients undergoing lung resection and correlated them with preoperative spirometric indexes & type of surgery performed.
  – Recommendation for Pneumonectomy
    • MVV $\rightarrow$ 55%; FEV$_1$ $\rightarrow$ 2 L; FEF$_{25-75\%}$ $\rightarrow$ 1.6 L/min.
  – Recommendation for Lobectomy
    • MVV $\rightarrow$ 40%; FEV$_1$ $\rightarrow$ 1 L; FEF$_{25-75\%}$ $\rightarrow$ 0.6 L/s.
  – Recommendation for Segmentectomy or Wedge Resection
    • MVV $\rightarrow$ 40%; FEV$_1$ $\rightarrow$ 0.6 L; FEF$_{25-75\%}$ $\rightarrow$ 0.6 L/s

Recent Studies

• **Summary:**
  - following criteria are predictive of increased postoperative complications and mortality:
    - **Pneumonectomy:**
      - FEV$_1$ $\rightarrow$ <2L or 60% of predicted & MVV $\rightarrow$ 55% of predicted
      - DLCO $\rightarrow$ <50% of predicted & FEF$_{25-75\%}$ $\rightarrow$ 1.6L/s.
    - **Lobectomy:**
      - FEV$_1$ $\rightarrow$ <1 L & MVV $\rightarrow$ <40% of predicted
      - FEF$_{25-75\%}$ $\rightarrow$ 0.6 L/s, DLCO $\rightarrow$ <50% of predicted.
    - **Wedge resection/Segmentectomy:**
      - FEV$_1$ $\rightarrow$ <0.6 L & DLCO $\rightarrow$ <50% of predicted.

Stage II

• Quantitative Ventilation-Perfusion Scan:
  – Measures predicted Postoperative lung function
  – Quantitative measurement of the contribution of each lung to pulmonary ventilation & perfusion
  – Readily available with negligible risk to the patient
  – Highly accurate in the prediction of postoperative pulmonary function following resection

• Spirometry & Lung Scan

Stage II

- Inhaled $^{133}$Xe or IV $^{99}$Tc-Labeled Macroaggregates of Albumin
  - % of radioactivity contributed by each lung correlates with the contribution of the function of that lung
  - Normally: 19 Segments (10 R & 9 L)
    - Right Lung (3/2/5): 55 % & Left Lung (3/2/4): 45%
  - Calculation:
    - \[ \text{postoperative FEV}_1 = \text{preoperative FEV}_1 \times \% \]
      of radioactivity contributed by nonoperated lung
  - Predicted Postoperative FEV$_1$ of the remaining lung

Stage II

• Using $^{133}$Xe Inhalation:
  – Predicted Postoperative (PPO) FEV$_1$ of $< 1$ L is indicative of physiologic inoperability.


• Using $^{99}$Tc Macroaggregate of Albumin Perfusion:
  – Predicted Postoperative (PPO) FEV$_1$ of $< 0.8$ L is indicative of surgical inoperability.

Stage II

• Predictors of Morbidity & Mortality after lung resection
  – Evidence:
    • PPO FEV$_1$ < 40% of predicted → 50% ↑ Mortality
    • PPO FEV$_1$ > 40% of predicted → 50% ↓ Mortality
    • PPO DLCO < 40% of predicted → ↑ Mortality
      – Best predictor of postoperative respiratory failure
  • Recommendation:
    – If PPO FEV$_1$ & DLCO > 40% (or PPO FEV$_1$ > 1 L) may undergo lung resection including pneumonectomy.
    – Otherwise → Exercise Testing

Stage II

- Other Tests:
  - Bronchospirometry, Lateral position testing & Total Unilateral pulmonary artery occlusion
  - Invasive tests & Require specialized equipment with a high level of technical expertise
  - These test are no longer performed in the preoperative evaluation of patients awaiting lung resection

Stage III

- **Cardio-Pulmonary Exercise Testing (CPET)**
  - Stresses the entire cardiopulmonary & oxygen delivery system
    - Provides a good estimate of cardiopulmonary reserve
    - Pulmonary/cardiac function & peripheral oxygen utilization
    - Used before the advent of PFTs & sophisticated exercise testing
  - Two major types of tests
    - Fixed exercise challenge
      - Sustained level of work (i.e. walking a fixed distance or a flight of stairs)
    - Incremental exercise challenge
      - Work rate is sequentially increased to a desired end point
    - Submaximal vs. Maximal oxygen consumption
      - \( \text{VO}_2 \text{ Max} \)

Stage III

• Maximal Oxygen Consumption:
  – With increasing muscular work $\text{VO}_2$ rises to a point where there is a plateau of the $\text{VO}_2$ work rate slope.

• $\text{VO}_2$ max is a measure of aerobic capacity of the peripheral tissue
  – i.e. Oxygen Consumption

Stage III

• Fixed Challenge Exercise Testing
  – Van Nostrand 1968
    • Test of endurance in the preoperative evaluation
    • 50% postoperative mortality rate in patients who failed to climb one flight of stairs with minimal dyspnea
    • 11% postoperative mortality rate in patients who successfully climbed two flight of stairs with minimal dyspnea

Stage III

• Fixed Challenge Exercise Testing
  – Olsen et al 1991
    • Patients who were able to climb 3 flights of stairs (i.e. 75 steps) had ↓ number of postoperative complications
  – Holden et al 1992
    • Prospective study of 16 patients
      – 6-min walk distance > 1000 feet & Stair climb of > 44 steps
        » Successful surgical outcome
  – Girsch et al 2001
    • 89% complication rate in patients unable to walk up one flight of stairs.

Holden DA, Rice TW, Stelmach K. Exercise testing, 6-minute walk and stair climbing in the evaluation of patients at high risk for pulmonary resection. Chest 1992; 102:1774–1779
Stage III

• Incremental Exercise Testing
  – Exercise to maximal exertion
    • Measurement VO₂ max in patients for lung resection
    • VO₂ Max > 1 L/min → No mortality
    • VO₂ Max < 1 L/min → 100% mortality
  – Incidence of Postoperative complications
    • VO₂ Max < 15 mL/kg/min → 100% complication rate
    • VO₂ Max 15-20 mL/kg/min → 66% complication rate
    • VO₂ Max > 20 mL/kg/min → 10% complication rate


Changes in Lung Volume

Decline in Lung Function Varies with the extent of resection

- **Pneumonectomy:**
  - $FEV_1$ reduced by 34 - 36%
  - FVC reduced by 36 - 40%
  - $VO_2$ max reduced by 20 - 28%

- **Lobectomy:**
  - $FEV_1$ reduced by 9 - 17%
  - FVC reduced by 7 - 11%
  - $VO_2$ max reduced by 0 - 13%

Lung Volume Reduction Surgery

• Selected patients with severe emphysema
  – Surgery may lead to improvement in lung function

• Lung Nodules:
  – In individuals who do not meet standard criteria

<table>
<thead>
<tr>
<th>Author</th>
<th>Patients</th>
<th>Cancer</th>
<th>Preop FEV1 (% predicted)</th>
<th>Postop FEV1 (% predicted)</th>
<th>Mortality (%)</th>
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<td>Edwards⁸</td>
<td>14</td>
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<td>DeRose⁴⁵</td>
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<td>DeMeester⁴⁶</td>
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<td>26.2</td>
<td>38.5</td>
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<td>McKenna⁴⁸</td>
<td>51</td>
<td>11</td>
<td>21.7</td>
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</tbody>
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Summary

• Reasons for Resection of Lung Cancer
  – Poor prognosis without resection
  – Low Operative Mortality Rate
    • Improve Surgical Technique
    • Improved Anesthesia & Postoperative Care
  – Modest decline in lung function

<table>
<thead>
<tr>
<th>Author</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boushy7</td>
<td>40% with FEV1 &lt; 2.0L and age &gt; 60 did poorly</td>
</tr>
<tr>
<td>Brunelli23</td>
<td>70% with ppoFEV1 &lt; 35% predicted had complications</td>
</tr>
<tr>
<td>Putnam24</td>
<td>Decreased mortality with ppoFEV1 &gt; 34% predicted</td>
</tr>
<tr>
<td>Wahi25</td>
<td>Decreased mortality with ppoFEV1 &gt; 58% of preoperative value</td>
</tr>
<tr>
<td>Markos26</td>
<td>No deaths with ppoFEV1 &gt; 40% predicted, 50% mortality rate in those &lt; 40%</td>
</tr>
</tbody>
</table>

Summary

- **Guidelines for Preoperative Evaluation:**


Guidelines

- Individuals with lung cancer should be assessed by a multidisciplinary team to determine their suitability for lung resection.
- Individuals with lung cancer should not be denied surgery on the basis of age alone.
- Individuals with an FEV1 > 2 L or > 80% predicted normal are suitable for pneumonectomy without further evaluation unless there is evidence of interstitial lung disease or undue dyspnea on exertion. In that case, the DLCO should be measured.
- Individuals with an FEV1 > 1.5 L are suitable for lobectomy without further evaluation unless there is evidence of interstitial lung disease or undue dyspnea on exertion. In that case, the DLCO should be measured.
- If an individual is not clearly operable after initial testing (FEV1 or DLCO < 80% predicted normal), predicted postoperative lung function should be estimated.


Guidelines

- If the ppoFEV1 < 30% predicted normal or the product of the ppoFEV1 and ppoDLCO < 1650, there is a very high risk of perioperative death and cardiopulmonary complications. Other options should be considered.
- If ppoFEV1 or ppoDLCO < 40% predicted normal, exercise testing should be considered.
- Individuals who walk < 25 shuttles (250 m) on 2 shuttle walks, climb < 1 flight of stairs, or desaturate > 4% during testing are at high risk of perioperative death and cardiopulmonary complications. Other options should be considered.
- Individuals with a VO₂ max of < 10 mL/kg/min regardless of other values, or < 15 ml/kg/min with both ppoFEV1 and ppoDLCO < 40% predicted, are at high risk for perioperative death and cardiopulmonary complications. Other options should be considered.
- Individuals with very poor lung function may be considered for combined lung volume reduction surgery and lung cancer resection if the emphysema is heterogeneous and involves primarily the lobe to be resected.

The Algorithm

Routine PFTS → FEV1 > 60%, DLCO > 60%

FEV1 < 60%, DLCO < 60%

Quantitative Lung Scan → PPO-FEV1 > 40%
PPO-DLCO > 40%

PPO-FEV1 < 40% / PPO-DLCO < 40%

EXERCISE TESTING → VO2max > 15ml/kg/min

VO2max < 15ml/kg/min → Other Options prior to attempting Surgery

Figure 1. A schematic representation of a stepwise approach to preoperative evaluation prior to lung resection surgery.
