INITIAL EVALUATION FOR LUNG RESECTION

A TRUE CLINICAL PICTURE

• History
  – Functional Capacity
  – Effort Tolerance
  – Smoking
  – Bronchodilator Therapy

• Physical Findings
CLINICAL INDICATIONS FOR PFTS

- Diagnosis of a disease process
- Monitoring the response to therapy
- Documentation of the course of a disease process
- **Preoperative assessment for lung resection**, cardiac surgery or non-cardiothoracic surgery
- Evaluation of disability
- Evaluating disease prognosis.
PULMONARY FUNCTION TESTS

- Assessment of Ventilation
  - Peak flow
  - Spirometry
    - FVC
    - FEV1
    - FEV1/FVC
- Assessment of Gas exchange
  - Transfer factor
  - Arterial Blood Gas &
  - O2 Saturation
- Exercise testing of Cardiopulmonary reserve
LUNG VOLUMES IN DISEASE

[Diagram showing various lung volumes and their changes in different conditions, including inspiratory capacity (IC), vital capacity (VC), functional residual capacity (FRC), residual volume (RV), etc., across different disease states like young normal, elderly normal, early emphysema, severe emphysema, pulmonary fibrosis, neuromuscular disease, and severe obesity.]
STEPWISE APPROACH TO EVALUATION FOR RESECTION

- **Stage I Assessment (Pre-op lung function)**
  - Spirometry
  - Arterial Blood Gas Analysis
  - DLCO
- **Stage II Assessment (Post-op 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 = reflect lung volume
  - FEV1, FEF25-75% = reflect airflow
  - MVV = Reflects Muscle Strength
- Predicted depend on
  - age,
  - height,
  - gender and race
    - (Debapriya D et al. CHEST 2003;123:2096-2103)
- Spirometry values provides for Risk Stratification in lung resection
- ATS recommendation: significant response is an increase of at least 12% and 0.2 L in either FVC or FEV1
Forced Expiratory Volume in 1 second (FEV) and Forced Vital Capacity (FVC)
IDENTIFYING ABNORMALITIES

Spirometry indicates the presence of an abnormality if any of the following are recorded:
- FEV\textsubscript{1} < 80% predicted normal
- FVC < 80% predicted normal
- FEV\textsubscript{1}/FVC ratio < 0.7

**Obstructive disorder:**
- FEV\textsubscript{1} reduced (<80% predicted normal)
- FVC is usually reduced but to a lesser extent than FEV\textsubscript{1}
- FEV\textsubscript{1}/FVC ratio reduced (<0.7)

**Restrictive disorder:**
- FEV\textsubscript{1} reduced (<80% predicted normal)
- FVC reduced (<80% predicted normal)
- FEV\textsubscript{1}/FVC ratio normal (>0.7)
EXPIRATORY FLOW RATES IN DISEASE

The image depicts a graph showing flow rates in liters per second against volume in liters. The graph includes various conditions:

- **A**: Normal
- **B**: Pulmonary fibrosis
- **C**: Upper airway obstruction
- **D**: Asthma-bronchitis
- **E**: Emphysema

The graph illustrates how different diseases affect expiratory flow rates, with each condition represented by a distinct curve on the graph.
A) FEV1 = 36%; FEV1/VC = 46%; PEF = 48%; TLC = 100% (Obstructive)
B) FEV1 = 57%; FEV1/VC = 73%; PEF = 43%; TLC = 96% (Obstructive)
C) FEV1 = 66%; FEV1/VC = 80%; PEF = 79%; TLC = 62% (Restrictive)
D) FEV1 = 64%; FEV1/VC = 64%; PEF = 82%; TLC = 72% (Mixed)
CENTRAL & UPPER AIRWAY OBSTRUCTION

- A) Fixed obstruction
- B) Variable extra-thoracic obstruction
- C) Variable Intra-thoracic obstruction
STAGE I: FEV1

• Pre-op. FEV1 <60% of predicted, Strongest predictor of post-op. complications

• ACCP & BTS Guidelines:
  – FEV1 > 2 L tolerate pneumonectomy
  – FEV1 > 1.5 L tolerate lobectomy


• Post-op pulmonary complication in patients with
  – FEV1<2L was 40% VS 19% for those with
  – FEV1 >2L

  (Stephan MK et al. Chest 2000;118:1263-1270)
STAGE I: FEV1

- BTS Guidelines compiled on data from >2000 patients in 3 large series (1970s)
  - Mortality Rate < 5%
  - FEV1 > 1.5 L for Lobectomy
  - FEV1 > 2 L or > 80% predicted for Pneumonectomy

» (BecklesMA et al., CHEST 2003; 123:105S-114S)
STAGE I: DLCO

- Alveolar Volume
- Alveolar-capillary membrane integrity
- Pulmonary capillary blood flow
  - Most important predictor of mortality
  - Sole predictor of post-op pulmonary complications (Fergusen et al)
  - Equally significant as FEV1 (DebapriyaD et al., CHEST 2003;123:2096-2103)
STAGE I: DLCO

- ACCP guideline for DLCO
  - FEV1>80% but:
    - Undue dyspnoea
    - Interstitial lung disease
- Routine measurement of DLCO for lung resection, irrespective of FEV1 value, improves surgical risk stratification (Brunelli A et al., EurJ Cardiothoracic Surg2006;29;567-70)
- Predicted DLCO < 60% associated with "mortality"
- DLCO < 80% 2-3 fold increased complications (Ferguson et al)
- DLCO & FEV1 are complementary physiologic tests (BecklesMA et al., CHEST 2003; 123:105S-114S)
ARTERIAL BLOOD GAS ANALYSIS

- Little evidence as predictor of post-op complication
- PCO2 >45 mm Hg (6.0kPa)
  - Traditional relative contraindication to lung resection
  - But recent studies: PCO2 > 45 mm Hg (6kPa) did well post-op
  - Not predictive of postoperative complications (DebapriyaD et al. CHEST 2003;123:2096-2103)

- Hypoxemia (SaO2 < 90%) associated with "risk of postoperative complications" (Kearney DJ et al., Chest 1994;105:753-759)
<table>
<thead>
<tr>
<th>RECOMMENDATIONS</th>
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<tbody>
<tr>
<td>• Spirometry recommended pre-resection</td>
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<tr>
<td>• Pneumonectomy</td>
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<tr>
<td>• FEV1 &gt;2 L or 80% predicted</td>
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<tr>
<td>• Lobectomy</td>
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<tr>
<td>• FEV1 &gt;1.5 L,</td>
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<tr>
<td>• Segmentectomy or Wedge Resection</td>
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<tr>
<td>• FEV1 &gt;0.6 L,</td>
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<td>(Gene L 2007 Chest)</td>
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RISK OF MORBIDITY AND MORTALITY

• Pneumonectomy:
  • FEV1 <2L or 80% of predicted,
  • MVV < 55% of predicted
  • DLCO <50% of predicted,
  • FEF25-75% < 1.6L/s.

• Lobectomy:
  • FEV1 <1.5 L,
  • MVV <40% of predicted
  • FEF25-75% <0.6 L/s,
  • DLCO <50% of predicted.

• Wedge resection/Segmentectomy:
  • FEV1 <0.6 L,
  • DLCO <50% of predicted.

(Stephan F et al., Chest 2000; 118:1263-1270)
CONCLUSION

• Patients should undergo evaluation for surgical resectability
• Patients with FEV1 and DLco>80% of predicted can be referred for surgery without undergoing other tests
• Patients with pre-op.FEV1 and DLco<80% of predicted need further evaluation
• Quantitative V/Q lung scan is done estimate PPO FEV1 and DLco
Assessment Cardio-Pulmonary Exercise Testing

• Indicated when PPO FEV1 < 35 to 40% and DLCO < 40% of predicted
• Stresses the entire cardiopulmonary & oxygen delivery system
• Provides a good estimate of cardiopulmonary reserve
• Pulmonary/cardiac function & peripheral oxygen utilization
• Measurement of exhaled gases
  – Oxygen uptake (Vo2)
  – Maximal Vo2 (Vo2max)
• Formula for estimating Vo2
• Predicted Vo2=5.8xwt.in kg+151+10.1
  (W of workload)
• VO2max With increasing muscular work VO2 rises to a point where there is a plateau of the VO2 work rate slope.
• VO2 max is a measure of aerobic capacity of the peripheral tissue (Oxygen Consumption) (MazzonePJ et al., Am J Med 2005; 118:578-583)
EXERCISE TESTING

• 3 major types of tests
  – Fixed exercise challenge (Sustained level of work)
  – Incremental exercise challenge (Work rate is sequentially increased to a desired end point)
  – Submaximal vs. Maximal oxygen consumption (VO2 Max)
    • (DebapriyaD et al., CHEST 2003;123:2096-2103)
Fixed Challenge Exercise Testing

• Fixed Challenge Exercise Testing
  – Climbing a certain number of stairs
  – Walking a fixed distance

• Patients who able to climb up to three floor (i.e. 75 steps) had low number of postoperative complications
  – (Olsen GN et al., Chest 1991; 99:587–590)

• Prospective study of 16 patients 6-min walk distance > 1000 feet & Stair climb of > 44 steps, Successful surgical outcome
  – (Holden DA et al., Chest 1992; 102:1774–1779)
Fixed Challenge Exercise Testing

• Prospectively evaluated of 83 patients, complications occurred
  – Who unable to climb one floor-89%
  – Who unable to climb two floor-80%
  – Inability to climb 5 floor-32%
  – Who could climb 7 floor-No complications
    • (GirishM et al. Chest 2001;120:1147-1151)
Incremental Exercise Testing

• Measurement VO2 max in patients for lung resection
  – VO2 Max > 1 L/min - No mortality
  – VO2 Max < 1 L/min - 100% mortality
    • (Eugene Jet al., SurgForum 1982; 33:260–262)
  – 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
      – (Smith TP et al., Am Rev RespirDis1984; 129:730–734)
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
CONCLUSION

• If the PPO FEV1 and DLco are 40% of predicted, surgical risk is acceptable.
• Patients with PPO FEV1 and DLco < 40% should undergo exercise testing to evaluate pulmonary reserve and to assess the adequacy of oxygen transport.
• Cycle ergometry with incremental workloads, which can measure VO2, VO2max.
CONCLUSION

• Patients with Vo2max <10 ml/kg/min. should not undergo lung resection surgery
• Patients with PPO FEV1/ DLco < 40% of predicted, but Vo2max > 15 mL/kg/min, can undergo surgical resection, including pneumonectomy
ABNORMAL FLOW-VOLUME CURVE

Identifying abnormalities with flow-volume curves

Obstructive disorder:
In this example of a patient with obstructive airways disease, the peak expiratory flow (PEF) is reduced and the decline in airflow to complete exhalation follows a distinctive dipping (or concave) curve.

Severe obstructive disorder:
In a severe airflow obstruction, particularly with emphysema, the characteristic 'steeple pattern' is seen in the expiratory flow trace.

Restrictive disorder:
The pattern observed in the expiratory trace of a patient with restrictive defect is normal in shape but there is an absolute reduction in volume.
FLOW VOLUME LOOPS IN DISEASE

A. Normal
B. Emphysema
C. Unilateral main-stem bronchial obstruction
D. Fixed UAO
E. Variable extrathoracic UAO
F. Variable intrathoracic UAO
G. Restrictive parenchymal lung disease
H. Neuromuscular weakness