Preoperative assessment for lung resection

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"The ideal assessment of operative risk would identify every patient who could *safely tolerate surgery*. This ideal is probably unattainable……"

Mittman, 1961

Whose responsibility?

- The anaesthetist is the perioperative physician, and co-ordinator
- Preoperative assessment is

  “an interdisciplinary approach to the specific problems of a severely compromised or co-morbid patient”

Zollinger, 2001

Why do the assessment?
Morbidity and Mortality

- Respiratory - 15-20%
  - Atelectasis
  - Pneumonia
  - Respiratory failure
- Cardiac - 10-15%
  - Ischaemia
  - Arrhythmia
- *What is an acceptable operative mortality when the alternative is death?*

Clinical scenarios

- Inflammatory lung disease (PTB)
- Malignant disease (Ca Bronchus)
- Emphysema (Lung Volume Reduction)

PTB

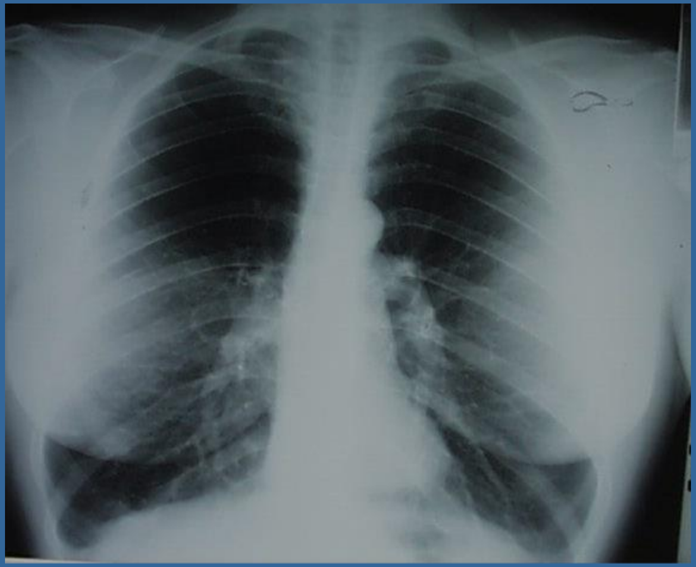
- Nutritional status
- Airway distortion-DLT
- Secretions
- Haemoptysis
- Difficult surgery
- Haemorrhage
- Bronchospasm

Malignancy

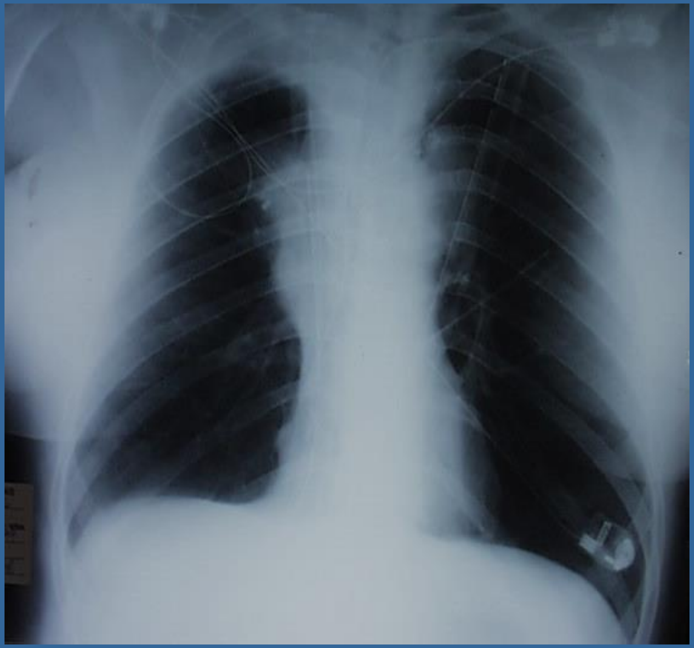
- Associated medical conditions
  - -IHD, HT, Arrhythmia
- Hypoxaemia-shunt
- 4 M's

Lung volume reduction surgery

("Permissive hypercapnia versus pulmonary tamponade")



Pre-op CXR



Post-op CXR

Approach to preoperative assessment

- History
- Examination
- Operability
  - bronchoscopy, mediastinoscopy, CT/MRI
- Cardiac assessment
- Can the patient tolerate the surgical procedure?
  - Respiratory mechanics
  - Lung parenchymal function
  - Cardiopulmonary reserve

History and Examination

(1) General: Age, obesity, medication, smoking, COPD, ASA 3, renal impairment

(2) Respiratory assessment:

Bronchopulmonary symptoms

- Cough
- Sputum
- Haemoptysis
- Dyspnoea
- Wheeze
- Chest pain

History and Examination

(3) Cardiac assessment:

- Chest pain
- Clinical Cardiac evaluation:
  - NB RV function and PHT
- ECG and Radiological features
  - Pulmonary hypertension

Operability - Malignancy

- Mass effects
- Metabolic abnormalities
- Metastases
- Medications

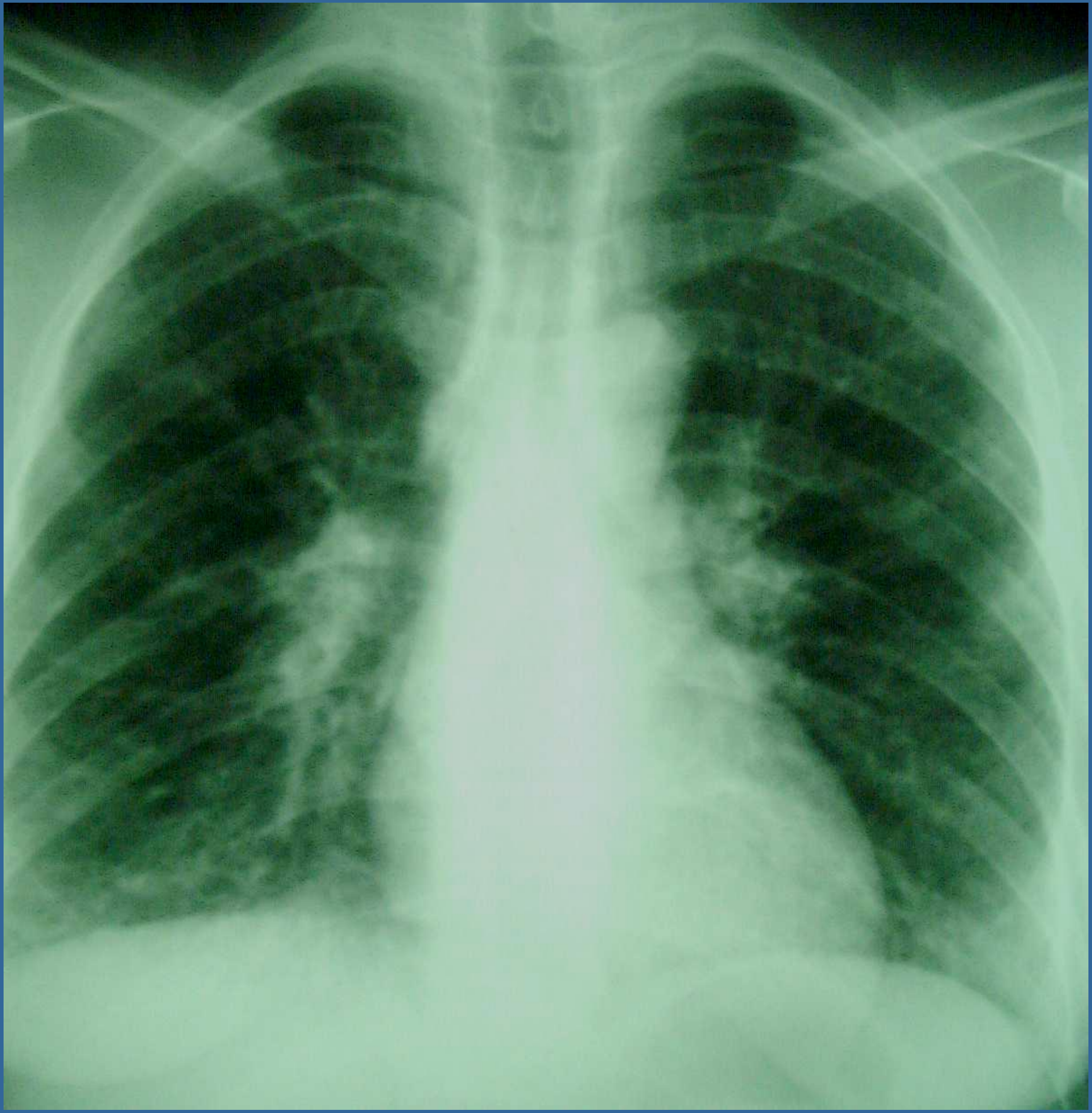
Slinger, 2001

Mass effects

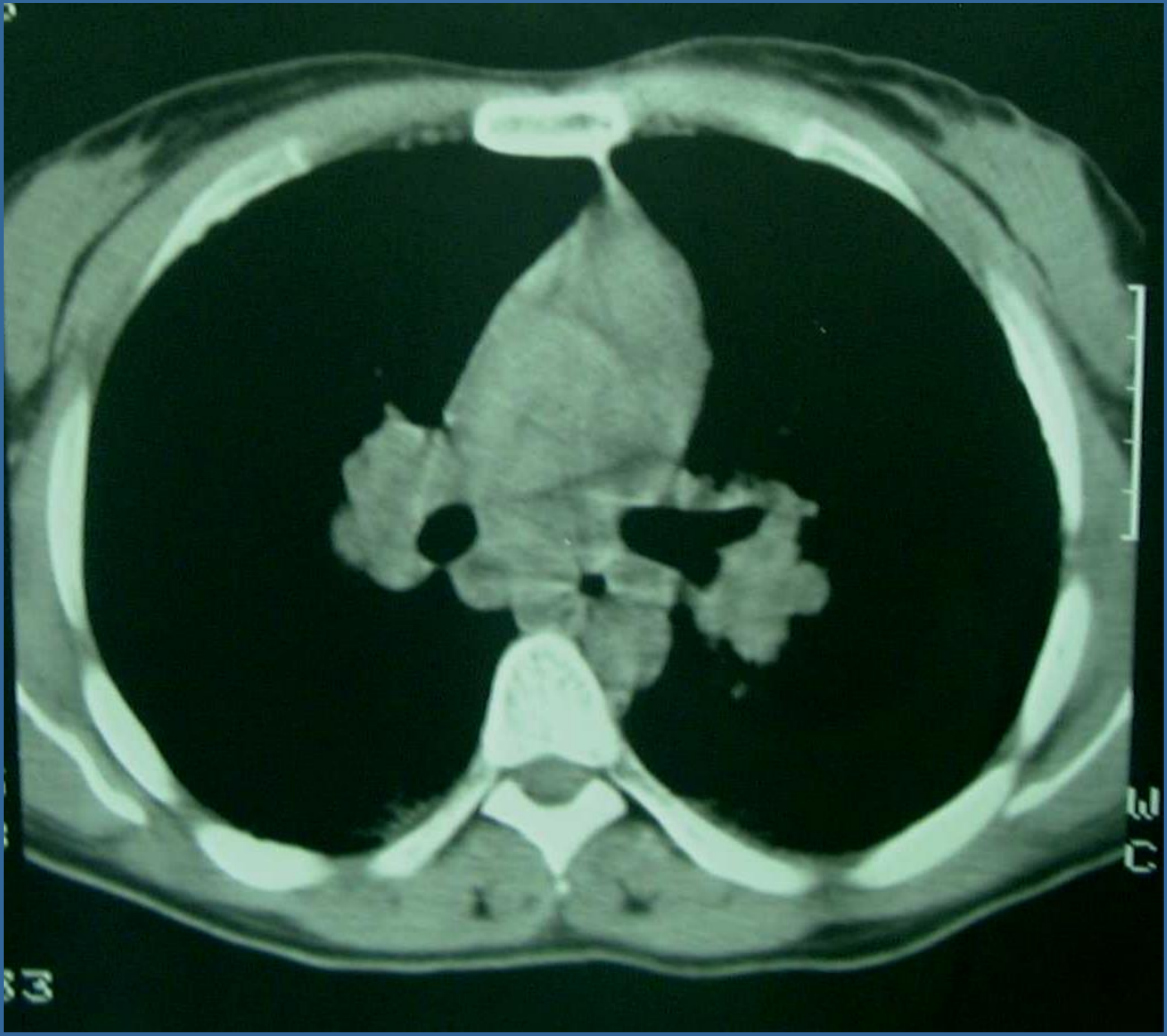
The Value of the CT Scan

- Malignancy
- Pulmonary tuberculosis

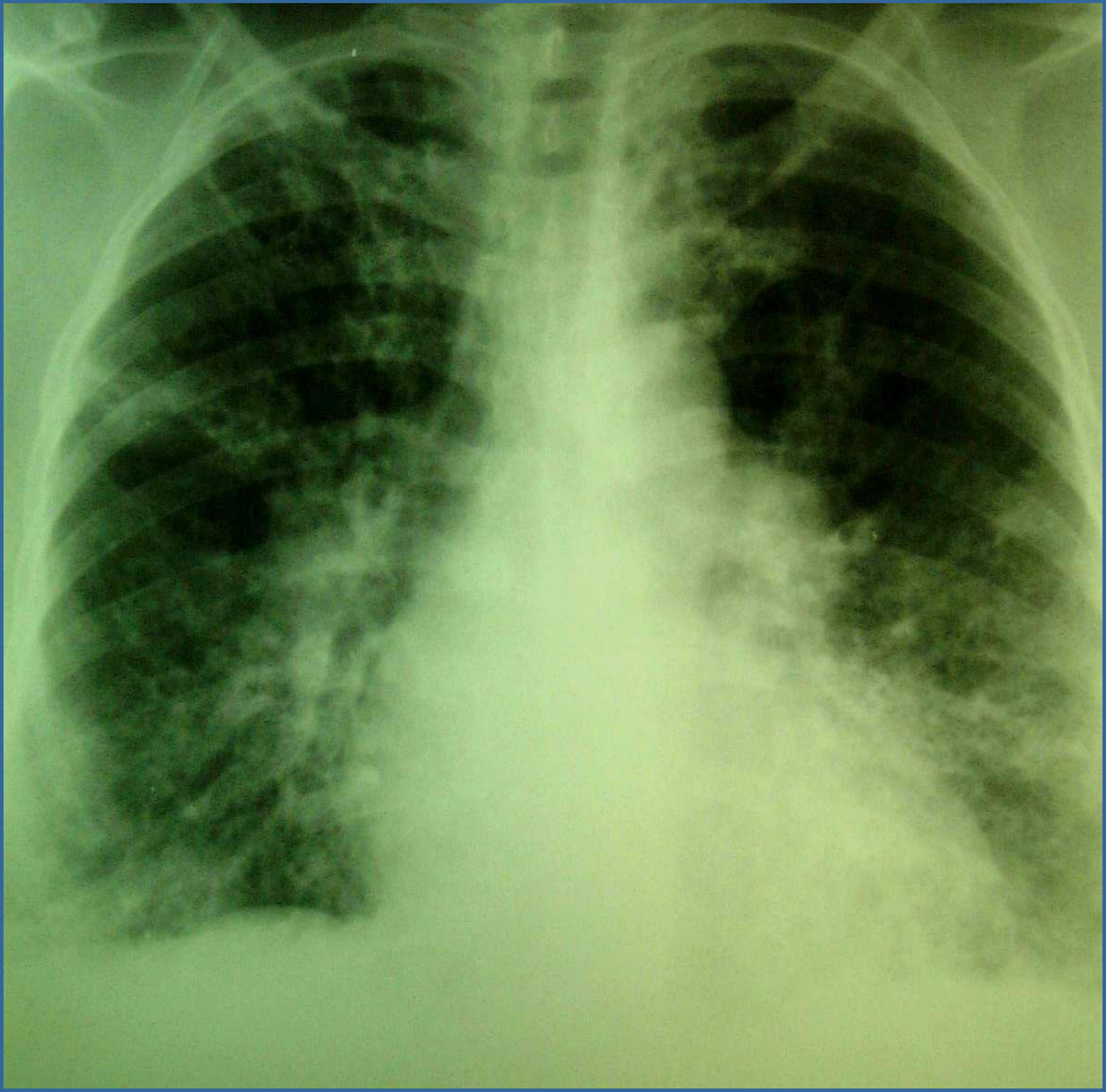
Malignancy - Hilar Nodes



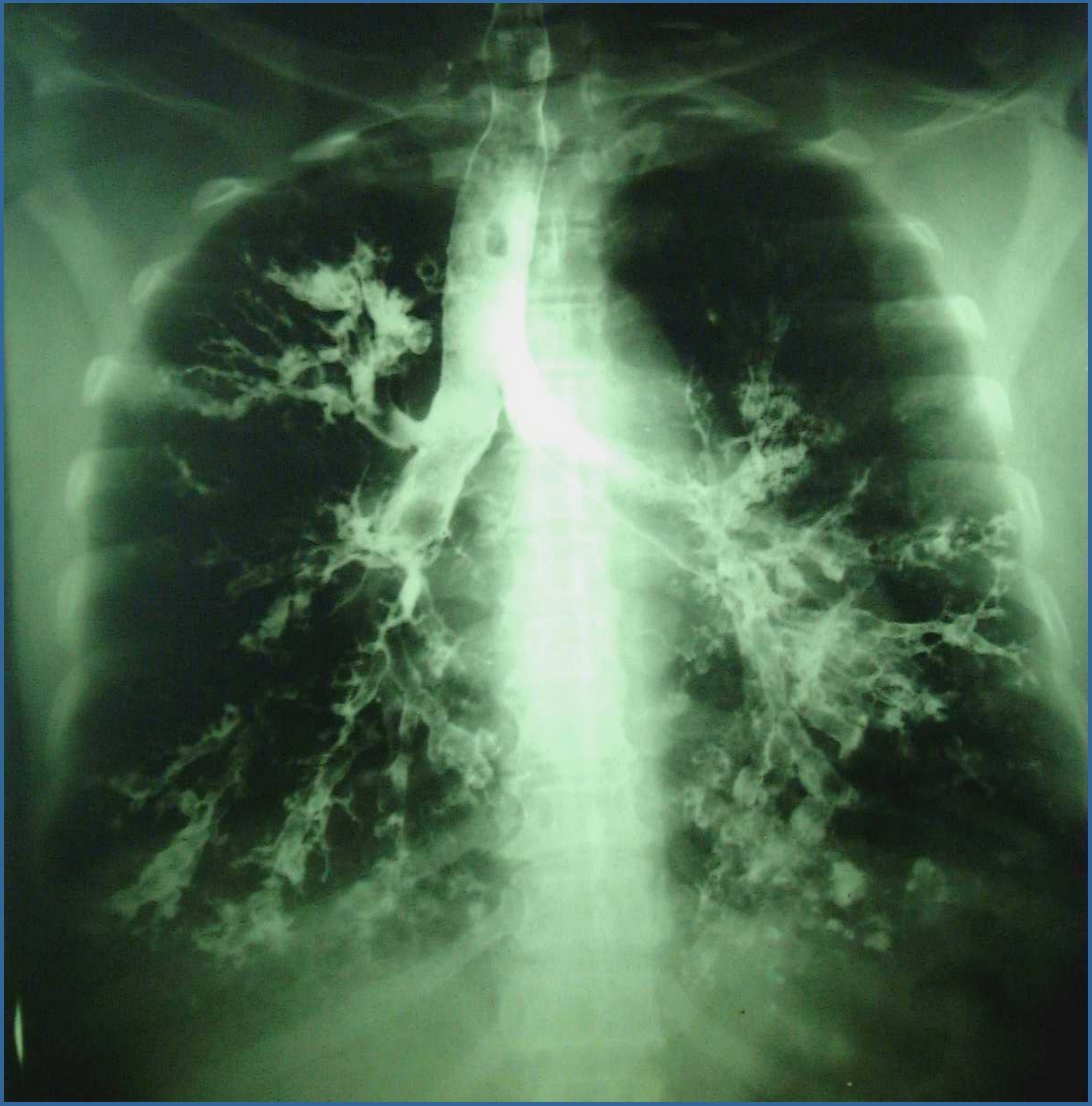
Malignancy - Hilar Nodes



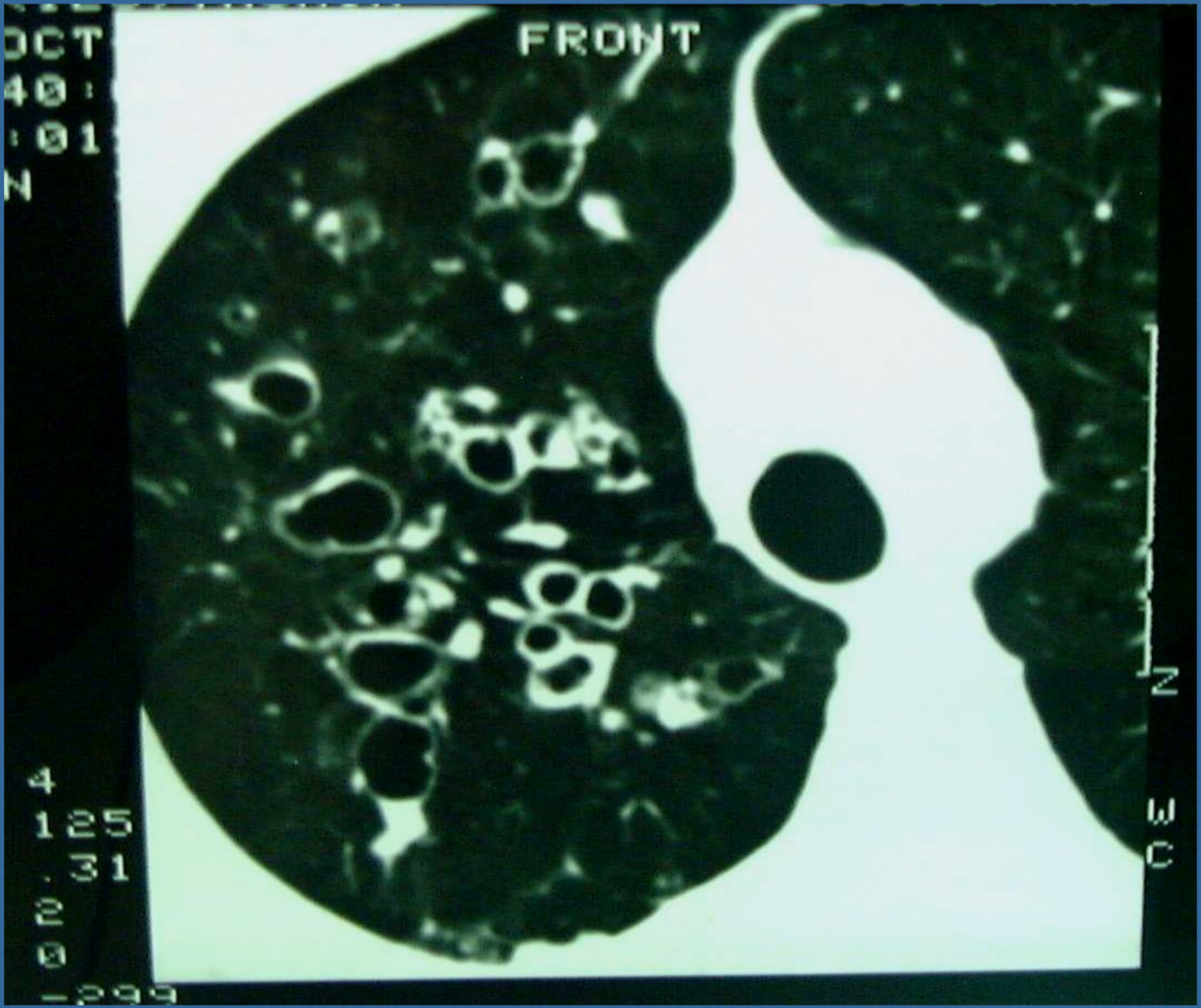
Bronchiectasis



Bronchogram - bronchiectasis



Bronchiectasis



Approach to preoperative assessment

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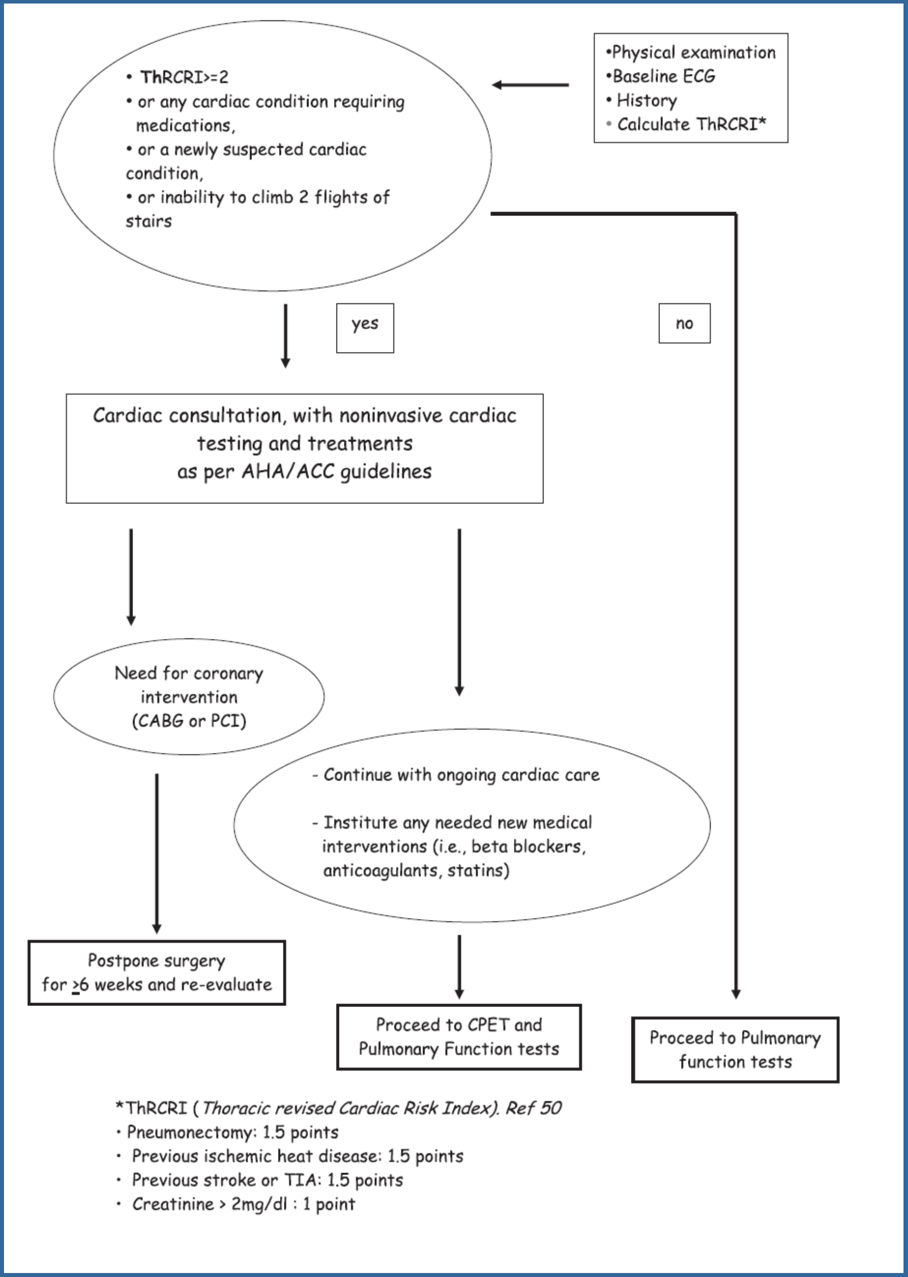
Cardiac assessment



Brunelli, 2013

1 Coronary stenting can be performed before lung resection, but not been shown to influence cardiac risk

2 Coronary artery bypass surgery before lung surgery, as suggested previously, might delay curative resection, which is problematic because of the time constraints in the management of lung cancer

3 Combining lung cancer surgery and conventional bypass surgery increases the risk of morbidity and mortality

4 Minimally invasive (off-pump) direct coronary artery bypass surgery simultaneous with lung resection has comparable complications with lung resection alone

Approach to preoperative assessment

- History
- Examination
- Operability
  - bronchoscopy, mediastinoscopy, CT/MRI
- Cardiac assessment
- *Can the patient tolerate the surgical procedure?*
  - *Respiratory mechanics*
  - *Lung parenchymal function*
  - *Cardiopulmonary reserve*

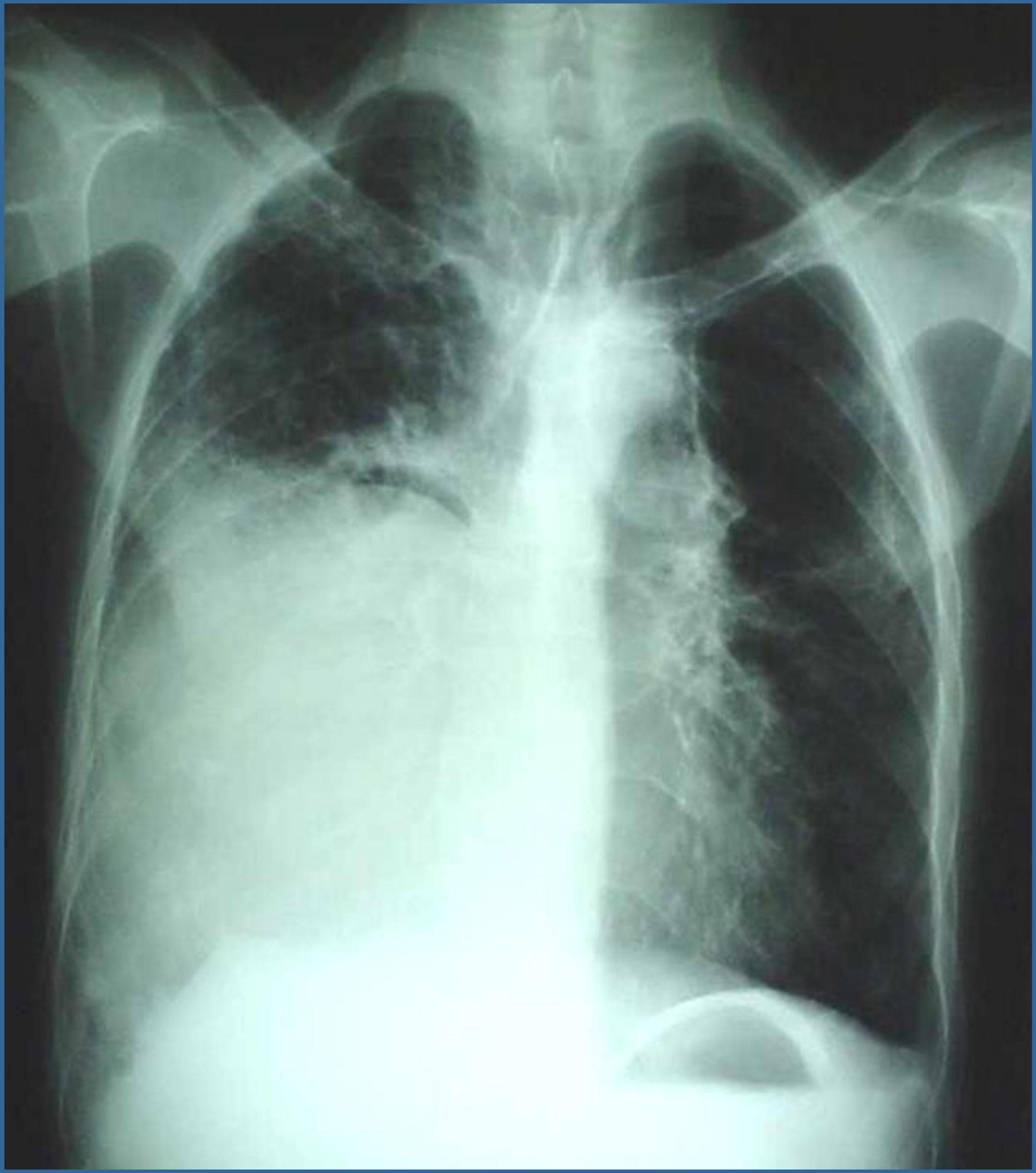
Respiratory mechanics

- Identify the high risk patient on spirometry
- Starting FEV1> 2 L: pneumonectomy
- Starting FEV1< 1.5 L: >25% complications
- Predicted postoperative FEV1<800 mL (30%N): Increased m+M
- RV/TLC, >50%: Increased m+M
- Maximal voluntary ventilation<50%

Lung parenchymal function

- PaO_2 < 8 kPa
- $PaCO_2$ > 6 kPa
- Predicted postoperative DLCO < 40% correlates with an inadequate total functioning surface area of the alveolar-capillary interface

Slinger, 2009



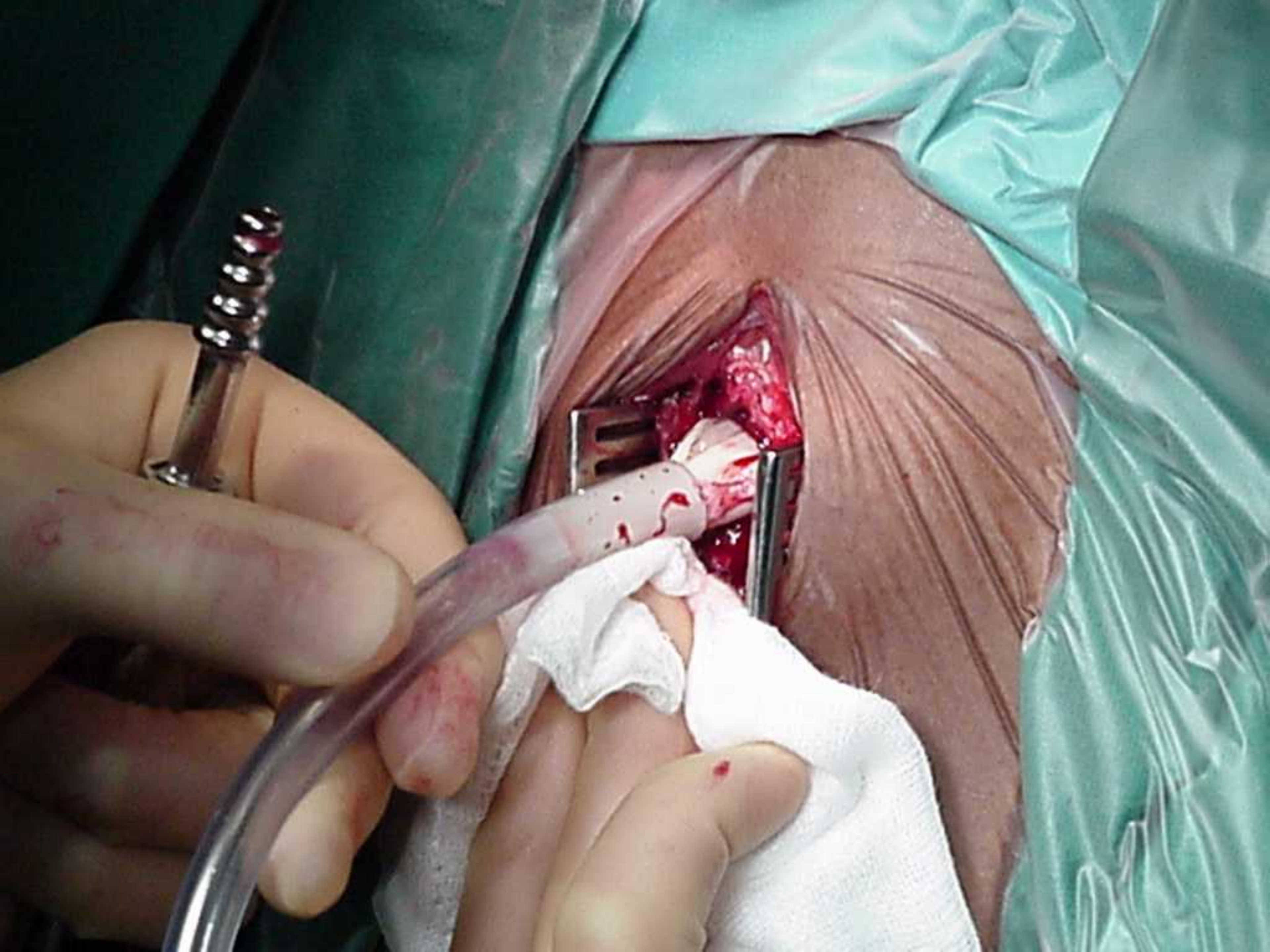
FEV_1 800 mL

pH 7.28

PaO_2 8.6 kPa

$PaCO_2$ 7 kPa

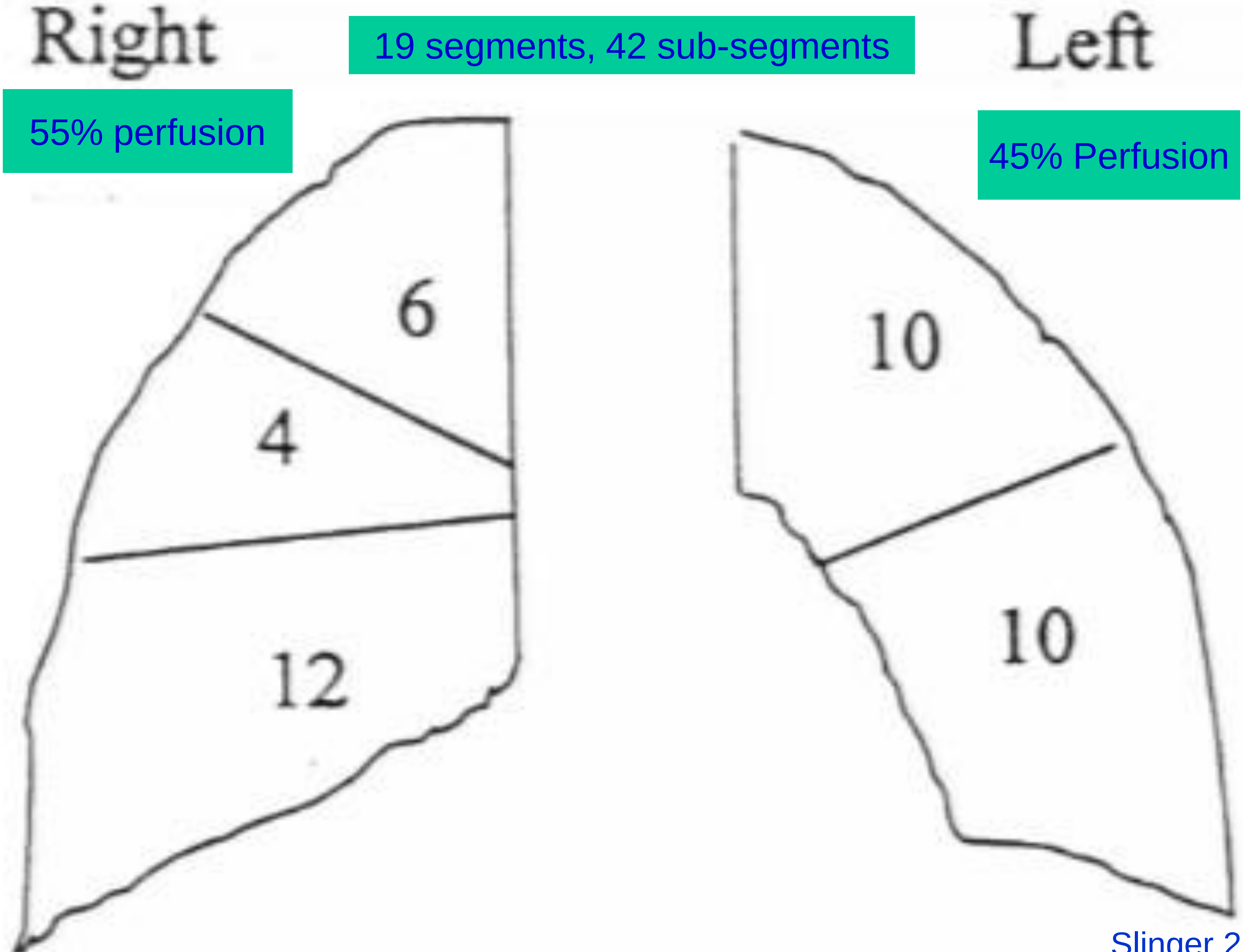
BE 0 mmol/L



Predicted postoperative FEV1 (ppoFEV1)

- Number of unobstructed segments to be resected
- Radionuclide perfusion scan
- Quantitative CT scanning
- Contrast enhanced perfusion MRI

19 segments, 42 sub-segments



55% perfusion

45% Perfusion

Slinger 2001

The role of the radionuclide scan

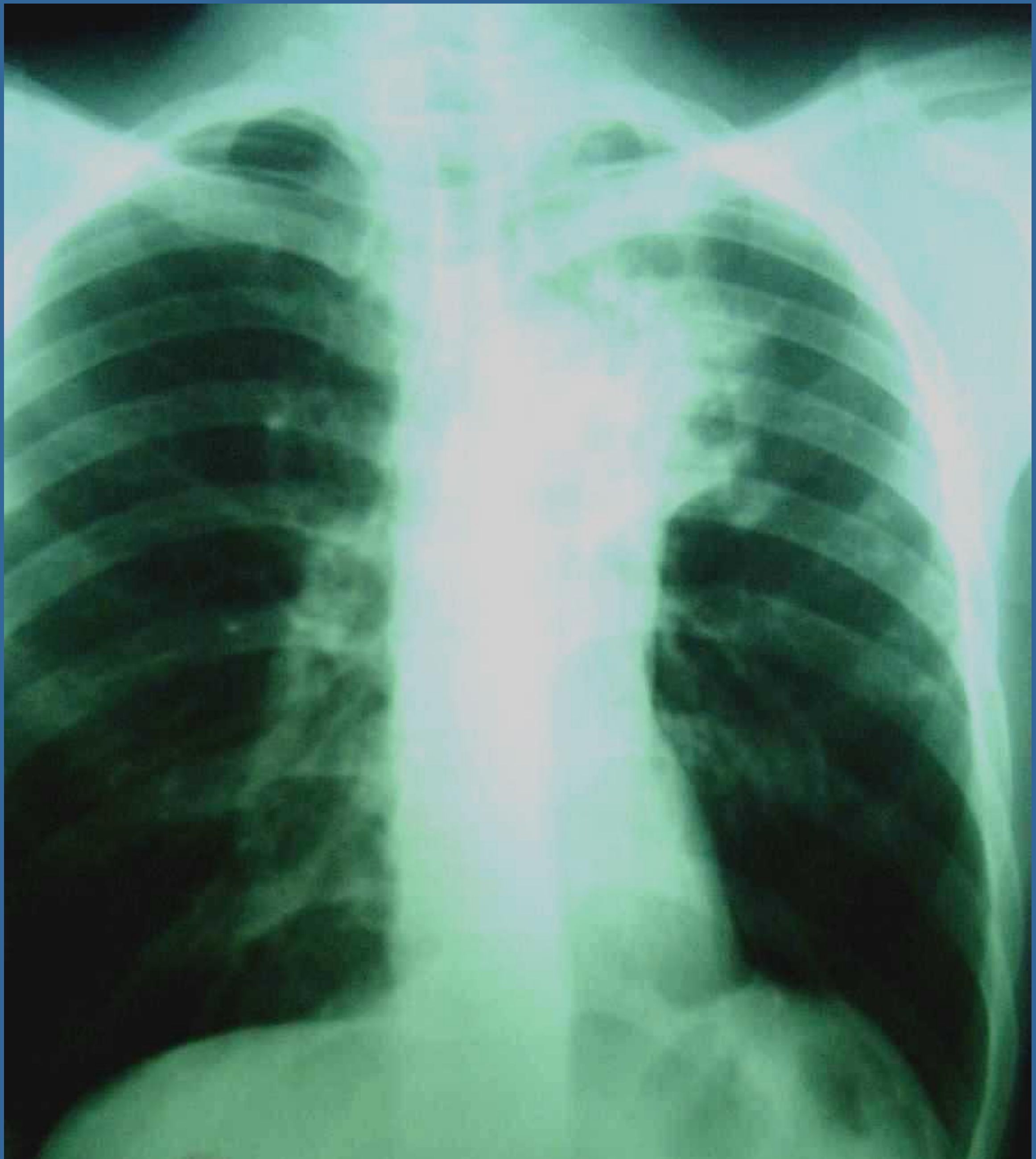
- Measurement of the ventilation and perfusion of each individual lung (as a fraction of the total), by radioisotopic scanning, using ^{133}Xe and ^{99}Tc: *evaluates lungs separately*

- Perfusion scan alone is usually performed

Indications

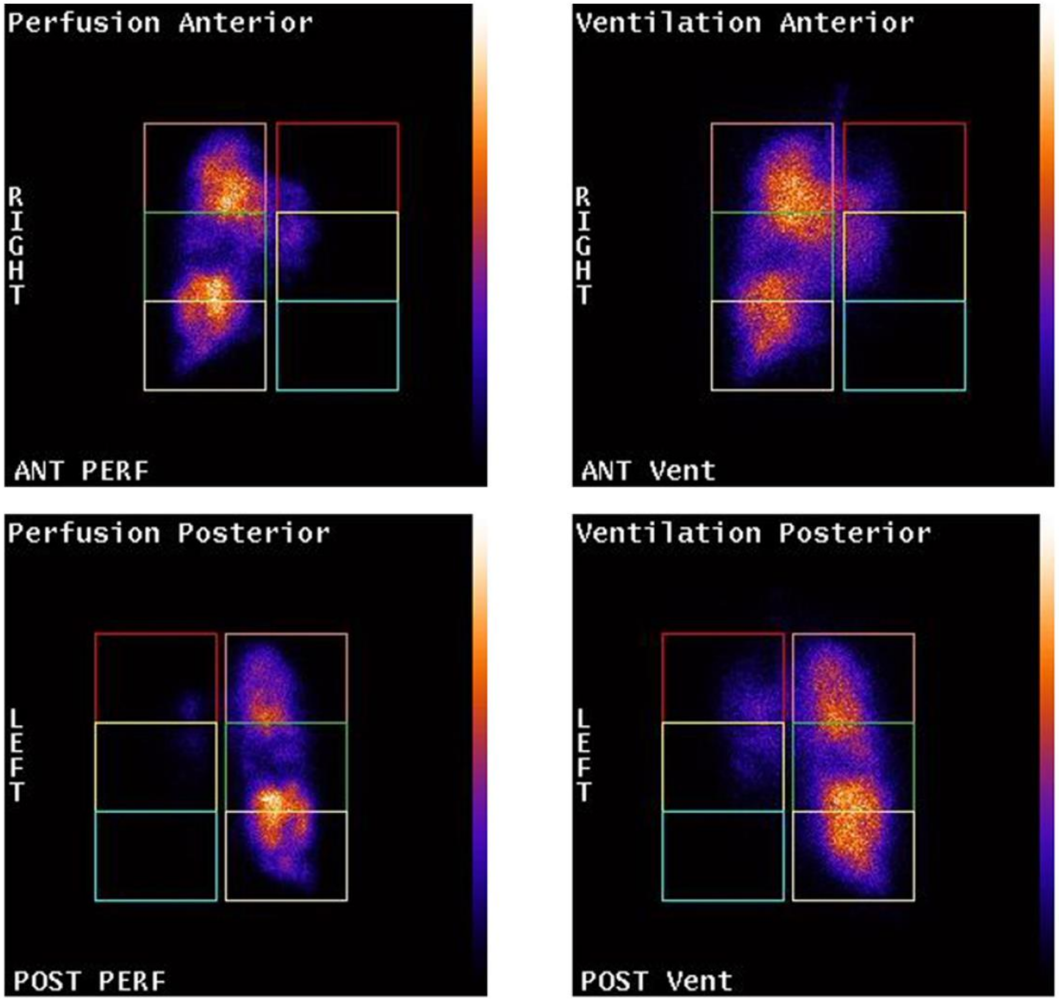
- Borderline predicted postoperative lung function
- Uncertain of perfusion in area to be resected (e.g. PTB)
- ? Perfusion in area to be resected if pulmonary hypertension present

The Value of the Perfusion Scan in PTB

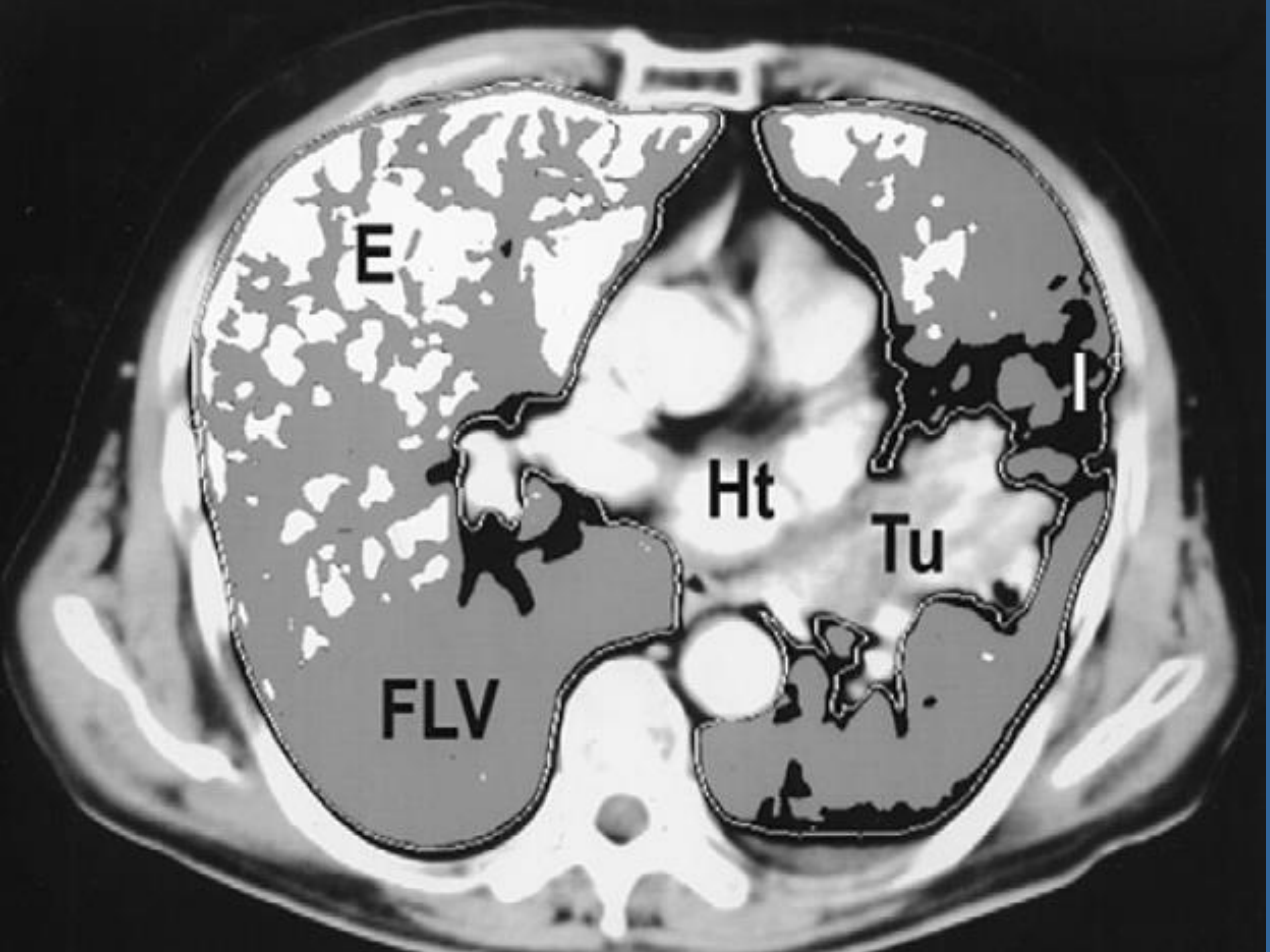


FEV_1=1L

FEV_1=2L



	Perfusion% Geometric Mean		Ventilation% Geometric Mean	
	Right	Left	Right	Left
Upper	28.0	4.5	24.6	8.8
Middle	33.5	7.1	31.0	10.0
Lower	25.6	1.4	23.6	2.0
Total	**87.0**	**13.0**	**79.2**	**20.8**


E
I
Ht
Tu
FLV

ppoFEV1

Predicted Postoperative $FEV_1\%$

$= \text{Preoperative } FEV_1\% \times (1 – \% \text{ functional tissue removed} / 100)$

Aim for > 40%

Calculation of ppoFEV1

- Subtract % perfusion or ventilation of area to be resected from FEV_1 measured spirometrically
- Resecting volume = $\dfrac{\text{activity in area to be resected}}{\text{activity in total lung fields}}$

Calculation

- $ppoFEV_1$ = Preoperative FEV_1 × (1- resecting volume), or × % perfusion of the contralateral side

- If perfusion of lung to be removed is 40% of total, and preoperative FEV_1 = 1.4 L:

  $ppoFEV_1$ is 1.4 × (1-0.4) =1.4 × 0.6 = 0.84 L

- ppoDLCO and $ppoVO_{2max}$ may also be calculated

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  - *Cardiopulmonary reserve*

Low technology exercise testing

- 6 minute walk: self-paced exercise test
  - > 2000 feet = VO_{2max} of 15 mL/kg/min
- Shuttle walk test:
  - Incremental timed exercise test
  - 25 shuttles (250 metres) correlates with VO_{2max} of 15 mL/kg/min

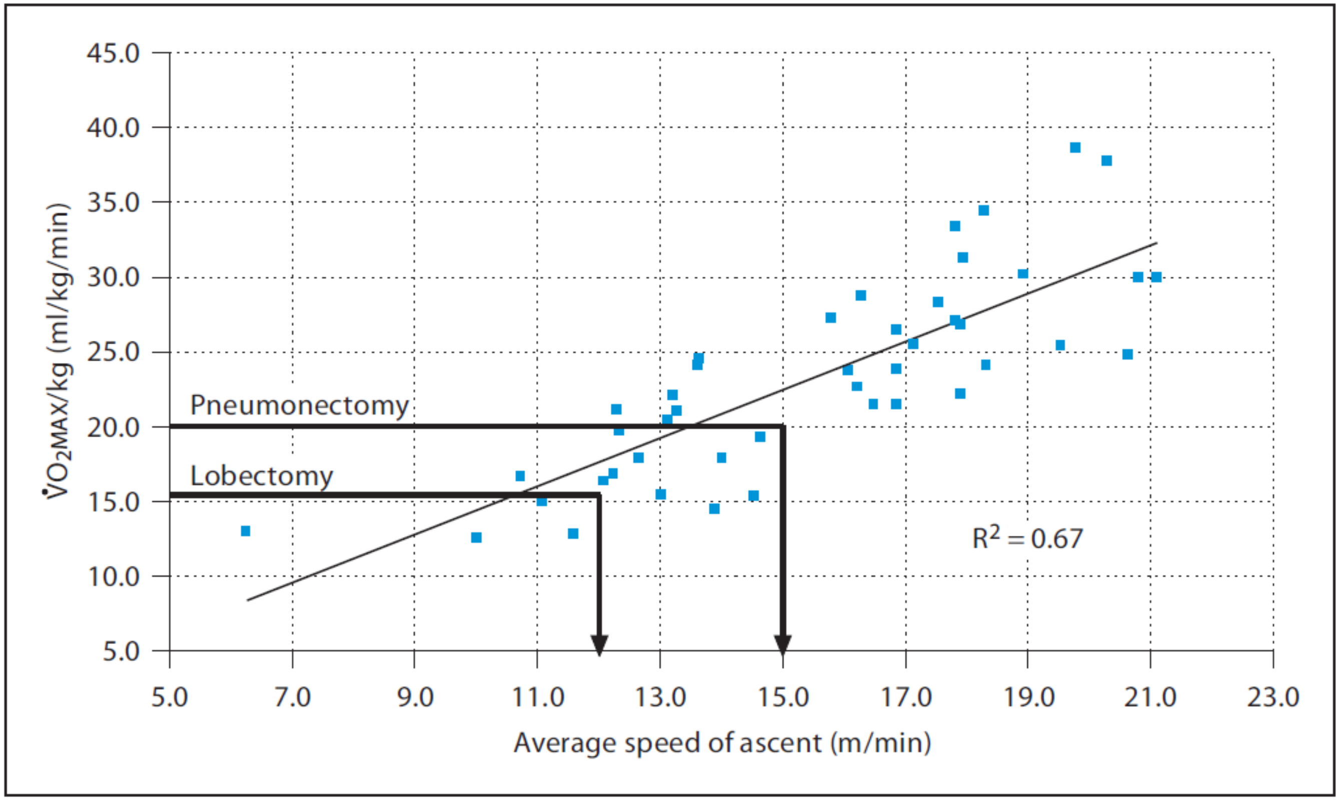
Singh, 1992; Benzo, 2009

Low technology exercise testing

- Stair climbing:
  - <1 flight of stairs: VO_{2max} of <10 mL/kg/min
  - 3 flights of stairs: FEV1 > 1.7 L
  - 5 flights of stairs: FEV1 > 2 L: VO_{2max} of 20 mL/kg/min
  - Patients climbing <12 metres (3 flights) had 13 - and 2-fold greater morbidity and mortality than 22 metres
  - Rate of ascent may be as important as height

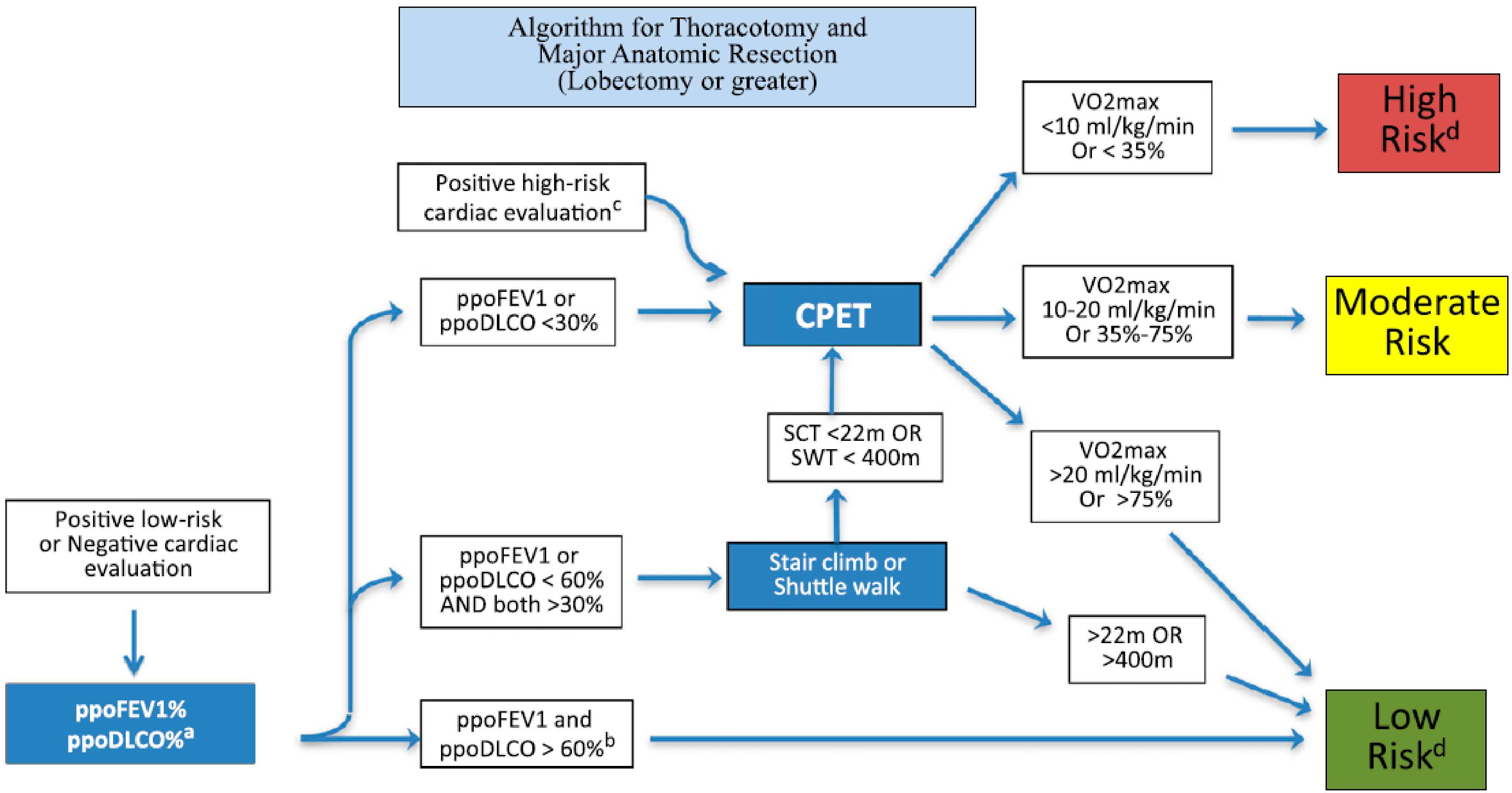
Koegelenberg, 2008; Brunelli, 2009

Rate of ascent



High technology exercise testing

- VO_{2max} > 20 mL/kg/minute (>75% predicted) required for pneumonectomy
- VO_{2max} < 10 mL/kg/minute (<40% predicted) places patient at high risk
- Exercise desaturation >4% may represent high risk



3.9.2. In patients with lung cancer being considered for surgery and a $\dot{V}O_2max < 10 mL/kg/min$ or < 35% predicted it is recommended that they are counseled about minimally invasive surgery, sublobar resections or nonoperative treatment options for their lung cancer (Grade 1C).

Actual Risks affected by parameters defined here and:
- Patient Factors: Comorbidities, age
- Structural Aspects: center (volume, specialization)
- Process factors: Management of complications
- Surgical access: Thoracotomy vs. minimally invasive

Pulmonary hypertension

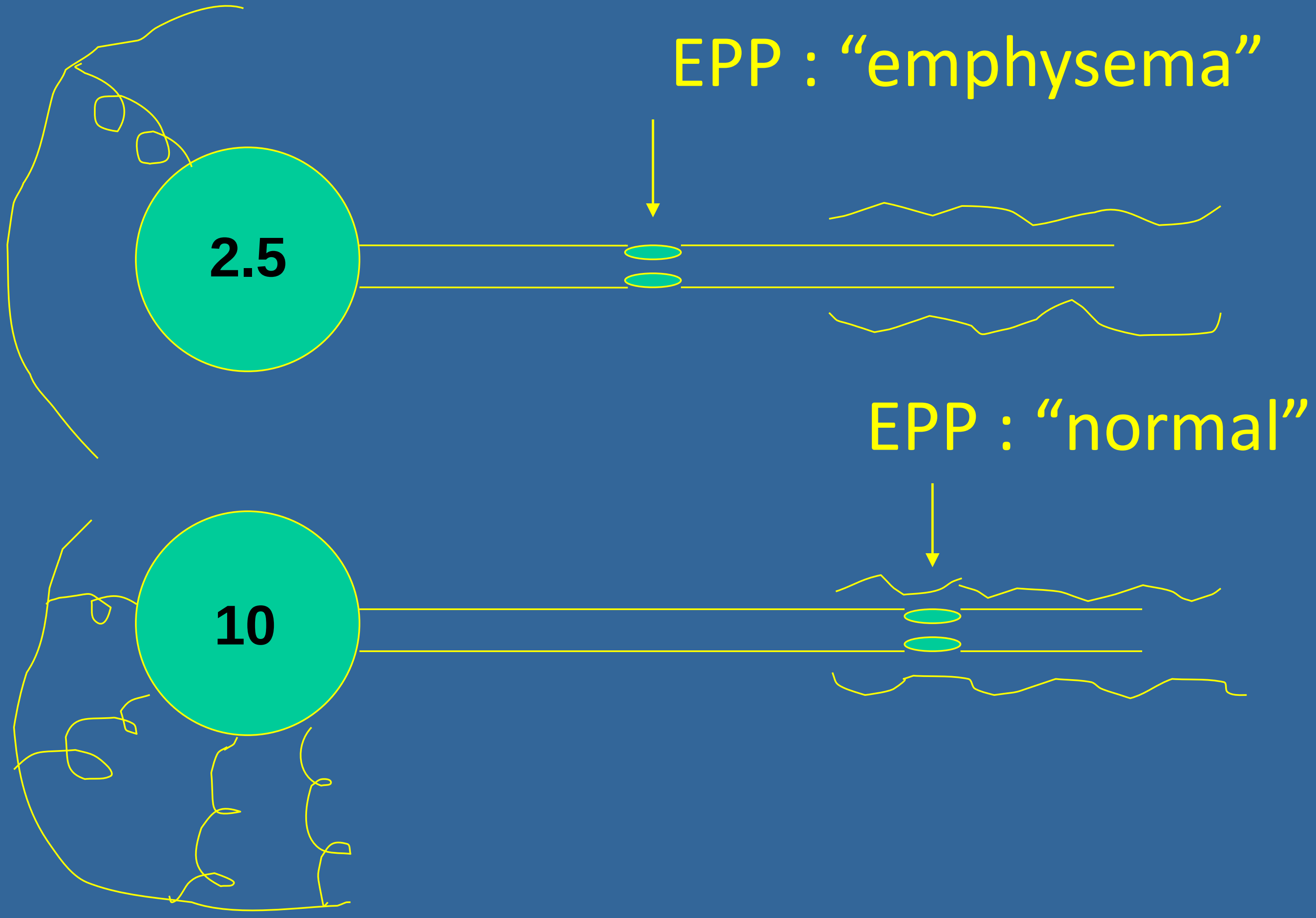
- Pulmonary artery catheterisation and assessment of pulmonary artery pressure and response to exercise
- Pulmonary vascular resistance > 190 $dyne.sec.cm^{-5}$
- Balloon occlusion of PA tests distensibility of remaining pulmonary vascular bed
  - Increase in mean pulmonary artery pressure to > 40 mmHg
  - Or PaO_2 decreases to < 6 kPa
- NB Echocardiography for RV dysfunction

“Expect the worst and hope for the best”

- Any lobectomy may become a pneumonectomy
- Dependent lung may become impaired
- Functional impairment of remaining lung on operative side for 2 weeks
- Compensatory hyperinflation may produce V/Q mismatch
- Early improvement after relief of compression

Lung volume reduction surgery

Pulmonary pathophysiology



Pulmonary pathophysiology

- Loss of elastic recoil
- Diaphragm at mechanical disadvantage
- V/Q mismatch
- Consequences
  - Increased ventilatory requirement, work of breathing
  - Hypoxaemia complicates V/Q mismatch
  - Hypercapnia tolerated
  - Pulmonary hypertension, cor pulmonale

Inclusion criteria for LVRS

- FEV1 20-40% predicted
- TLC > 100%, RV > 150% predicted
- $PaCO_2$ < 60 mmHg
- 6 minute walk > 140 m
- No coronary artery disease
- No previous thoracotomy
- Commitment to pre and postoperative pulmonary rehabilitation

Outcomes

- 1218 patients randomised
- Mortality similar in 2 groups at 29 months
- But ✝ 5.2% vs 1.5% for LVRS vs medical Rx in first 3 months
- 15% vs 3% had a > 10 Watt increase in exercise capacity at 2 years
- Predictors of benefit of LVRS:
  - Inhomogeneous emphysema, low preoperative exercise capacity
    - Risk ratio 0.47, p = 0.005
  - Homogeneous emphysema, high preoperative exercise capacity
    - Risk ratio 2.06, p = 0.02

N Engl J Med 2003

Conclusions

- No single test of respiratory function has adequate validity as a preoperative assessment tool
- Outcome is not based entirely on preoperative lung function
- Cannot extrapolate from one indication for surgery to another

Conclusions

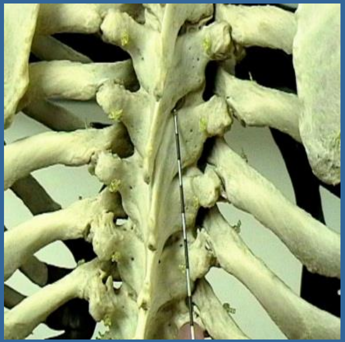
- Influences on outcome are multifactorial:
  - Motivation
  - Lung and cardiac function
  - Secretions
  - Surgery
  - Anaesthesia and postoperative pain relief

Summary

- History and examination
- ECG, CXR, +/- CT/MRI
- FEV_1/FVC
- ABG
- Further lung function: DLCO +/- V/**<u>Q</u>**
- Exercise testing - bedside
- Exercise testing - laboratory
- Further cardiac function: PAC

Treat

- Reversible airways obstruction
- Chest infection
- Atelectasis
- Pulmonary oedema
- Plan for thoracic epidural analgesia
- DLT / risk of hypoxaemia



CHEST

Supplement

DIAGNOSIS AND MANAGEMENT OF LUNG CANCER, 3RD ED: ACCP GUIDELINES

Physiologic Evaluation of the Patient With Lung Cancer Being Considered for Resectional Surgery

Diagnosis and Management of Lung Cancer, 3rd ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines

Alessandro Brunelli, MD, FCCP; Anthony W. Kim, MD, FCCP; Kenneth I. Berger, MD, FCCP; and Doreen J. Addrizzo-Harris, MD, FCCP

CHEST 2013; 143(5)(Suppl):e166S–e190S

Functional Evaluation before Lung Resection

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KEYWORDS

• Lung resection • Operability • Preoperative evaluation
• Regional lung function • Cardiopulmonary exercise test

Clin Chest Med 32 (2011) 773–782

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