PREOPERATIVE EVALUATION OF LUNG CANCER

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이종근

PURPOSE

- **Assess "operability"**
  – cardiopulmonary fitness & perioperative risk.
- **"resectability"**
  – tumor stage, anatomical feasibility.
- **Optimize comorbidities**
  – cardiac, pulmonary, nutritional, metabolic
- **Guide treatment strategy**
  – surgery alone vs induction therapy vs nonsurgical options
- **Provide prognosis**
  – for patient counseling & team decision-making

NODULE SUSPICIOUS FOR LUNG CANCER

- ***Identification of patient factors***
- ***Identification of radiologic factors***
- Multidisciplinary evaluation
- Smoking cessation counseling

IDENTIFICATION OF PATIENT FACTORS

- Age, Performance status
- Smoking history
- Previous cancer history
- Family history
- Occupational exposures
- Other lung disease (COPD, IPF)
- Expose to infectious disease (tuberculosis, fungus, HIV, etc)

IDENTIFICATION OF RADIOLOGIC FACTORS

- Size, shape, and density of the pulmonary nodule
- Associated parenchymal abnormality

  (eg, scarring or suspicion of inflammatory changes)
- PET finding
- TNM staging

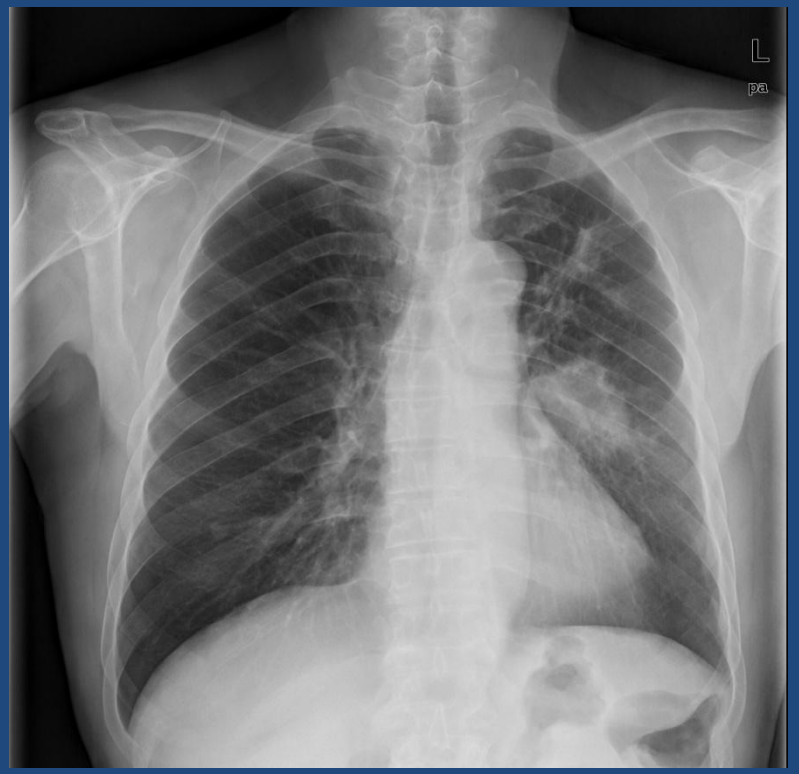
PRETREATMENT EVALUATION
- DIAGNOSIS AND STAGING -

- Plain chest radiogram
- ***Chest CT***
- ***PCNA, bronchoscopic biopsy***
- ***EBUS-TBNA or TBLB, surgical biopsy***
- ***PET CT,*** Brain MR, Abdomen CT, Bone scan etc.

PRETREATMENT EVALUATION
- DIAGNOSIS AND STAGING -

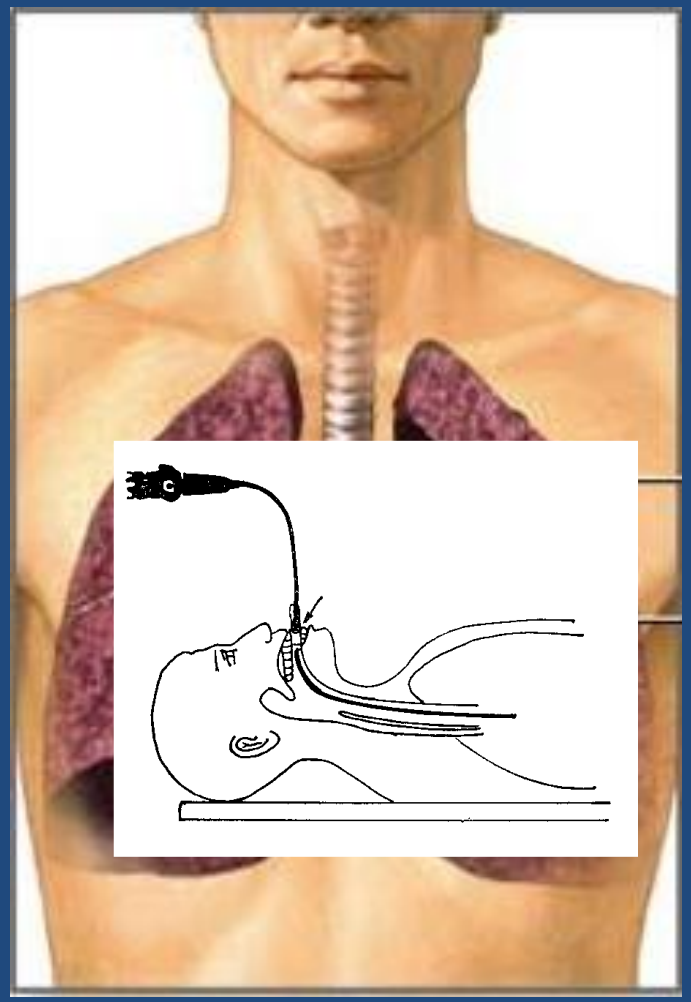
- *low dose chest CT*
- ***Chest CT or PET CT***
- ***Bronchoscopy(EBUS), PCNA, bronchoscopic biopsy***
- Brain MR, Abdomen CT, Bone scan etc.
- ***Surgical diagnosis /c or /s curable operation***

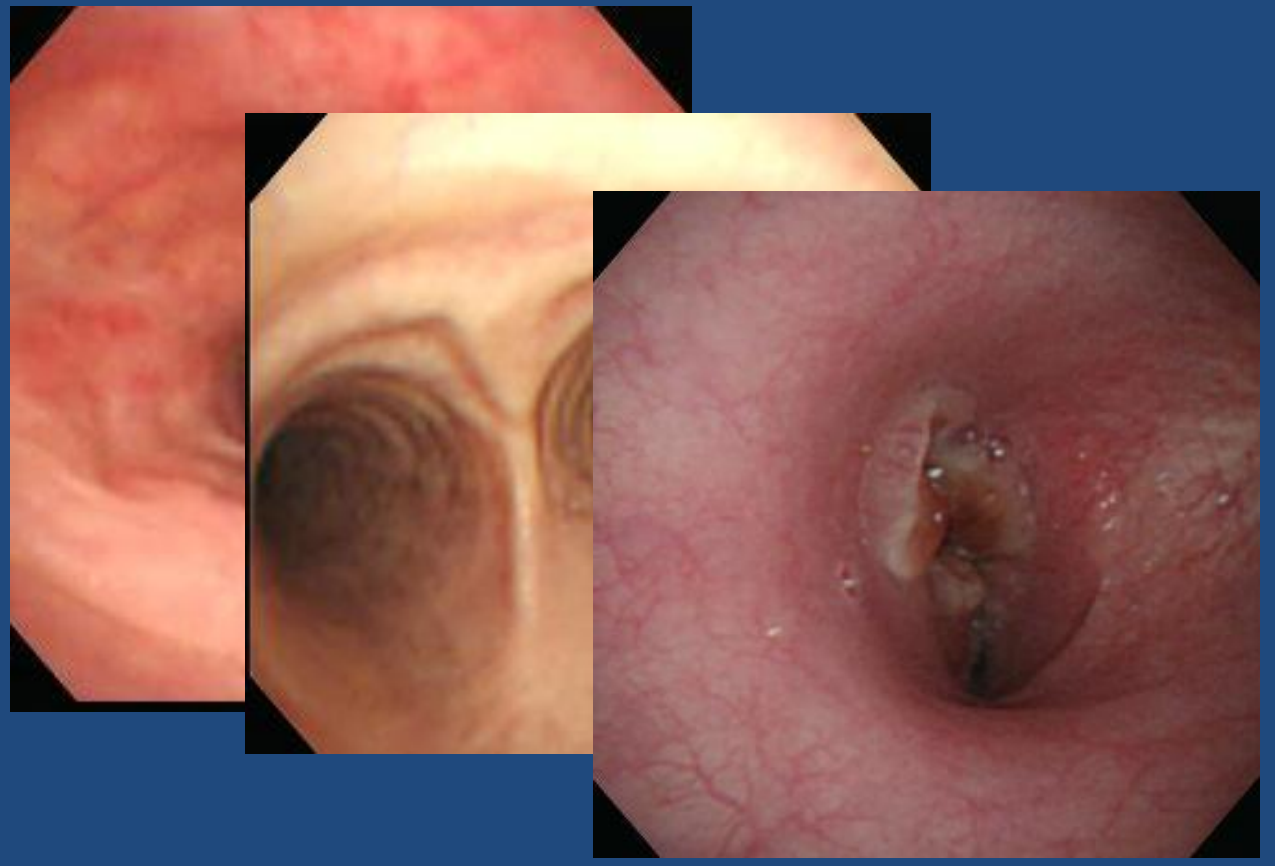
PLAIN CHEST RADIOGRAM



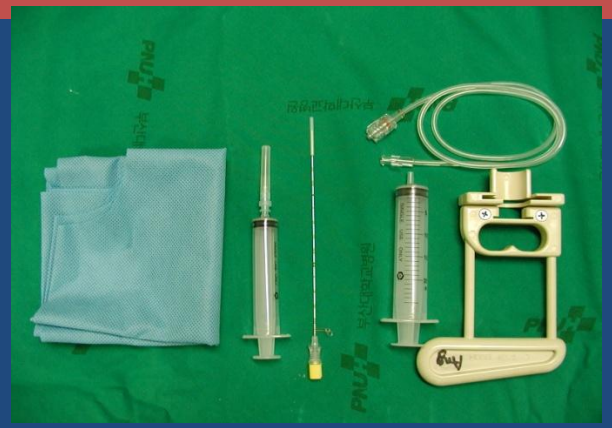
CHEST CT

BRONCHOSCOPY





PCNA



SURGICAL BIOPSY

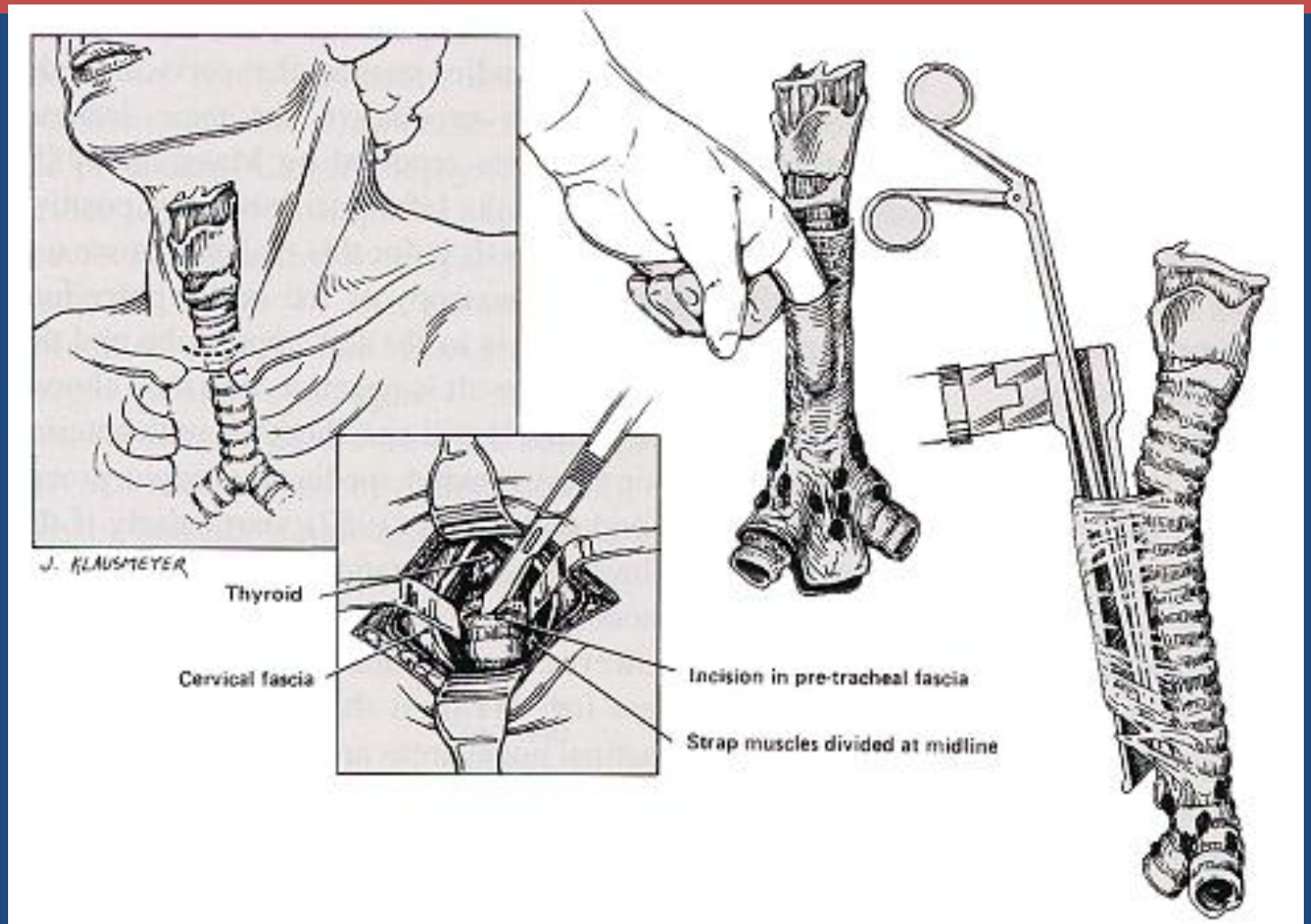


Fig. 17-1. Scalene node biopsy.

SURGICAL BIOPSY

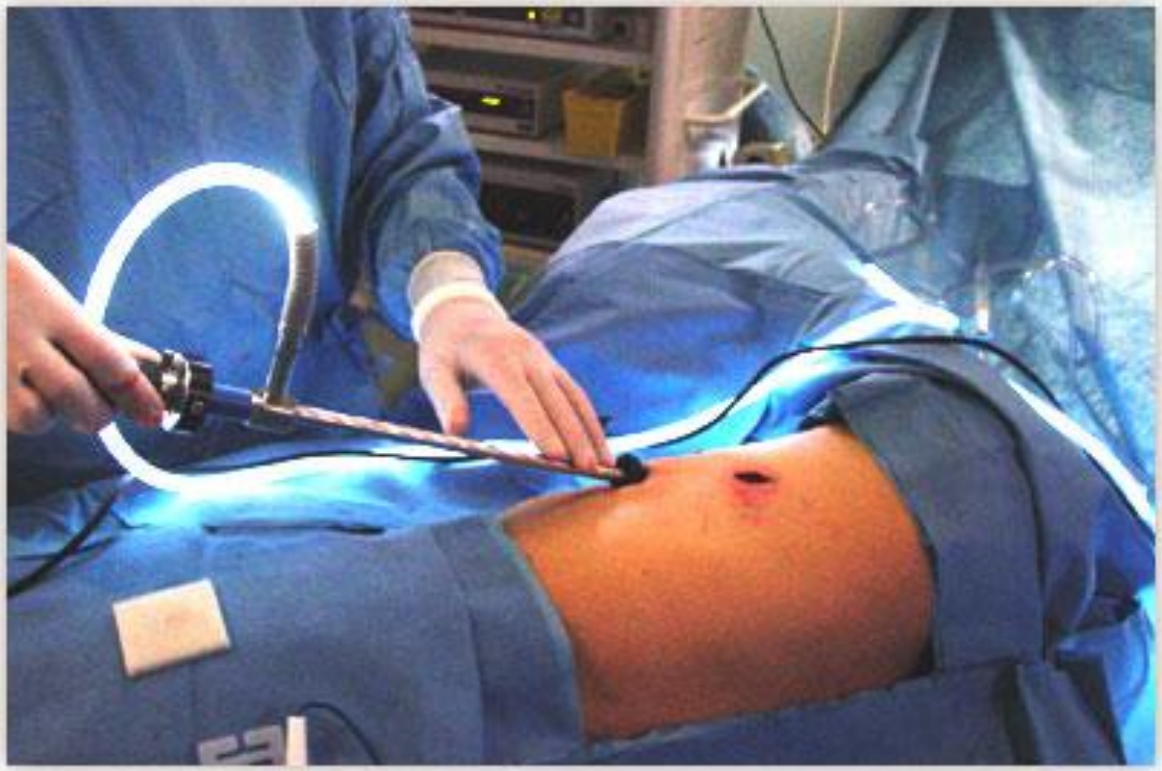
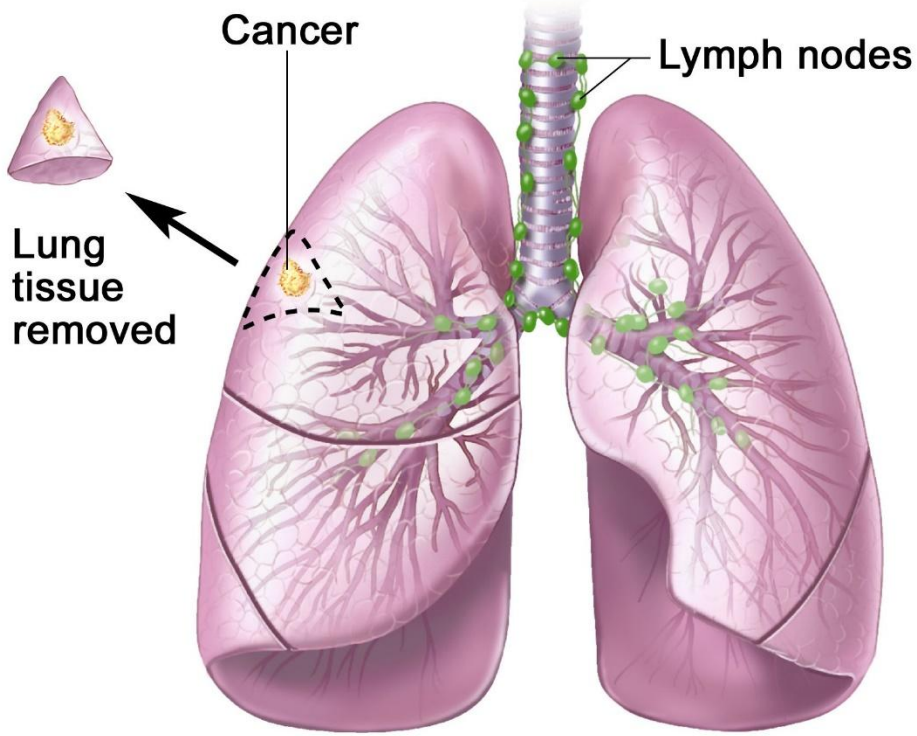
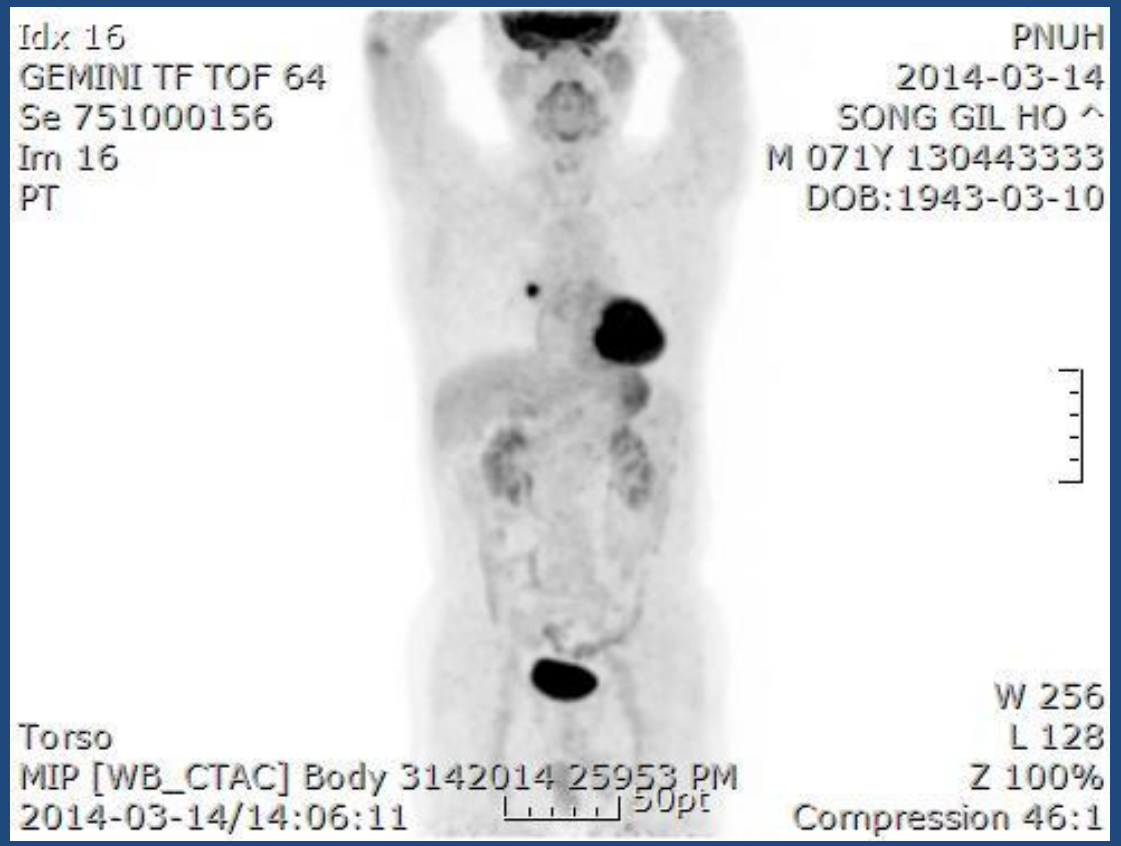


Fig. 18-3. Four incisions for improved access and visualization.



PET-CT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GEMINI TF TOF 64
Se 751000156
Im 16
PT
PNUH
2014-03-14
SONG GIL HO ^
M 071Y 130443333
DOB:1943-03-10
W 256
L 128
Z 100%
Compression 46:1
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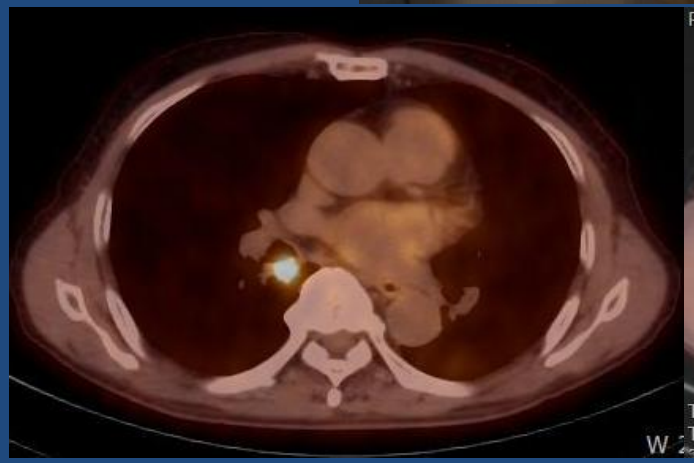
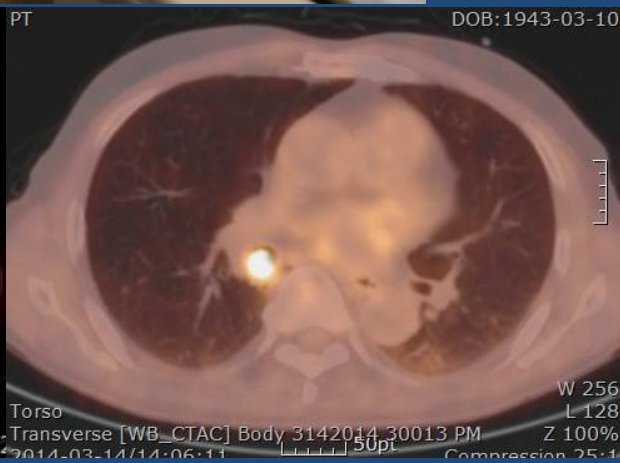
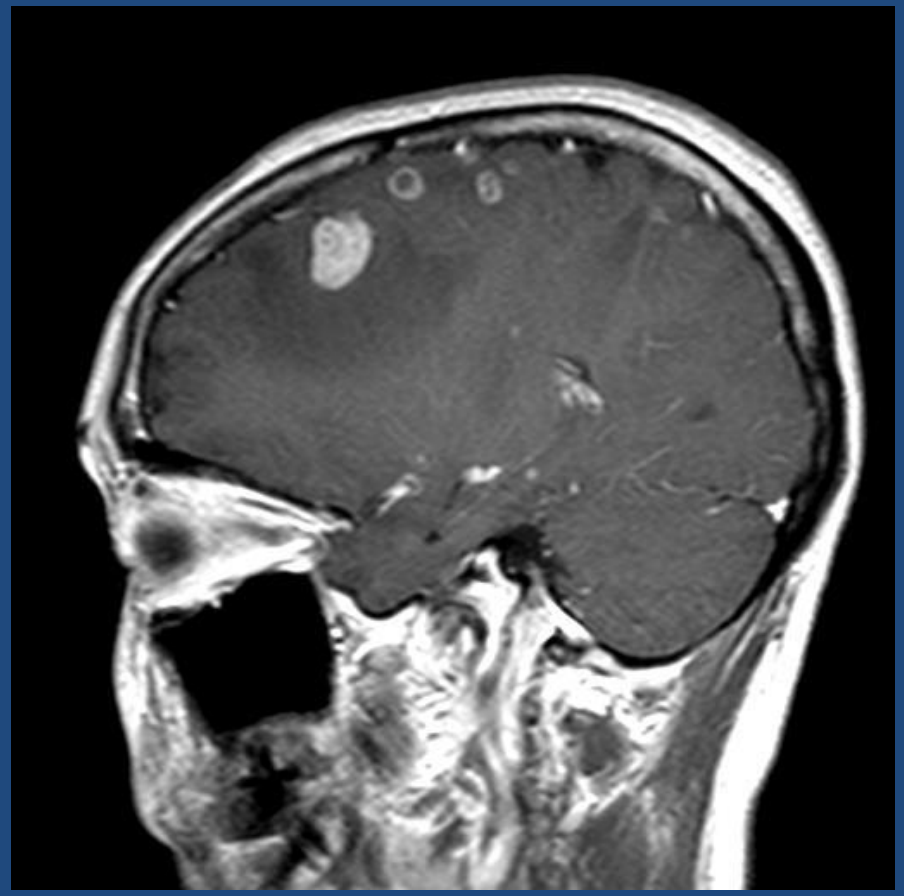
MIP [WB_CTAC] Body 3142014 25953 PM
2014-03-14/14:06:11
50pt


PHILIPS




PT
DOB:1943-03-10
W 256
L 128
Z 100%
Torso
Transverse [WB_CTAC] Body 3142014 30013 PM
50pt

BRAIN MR AND ABDOMINAL CT FOR DISTANT METASTASIS



NCCN Guidelines Version 7.2025
Non-Small Cell Lung Cancer

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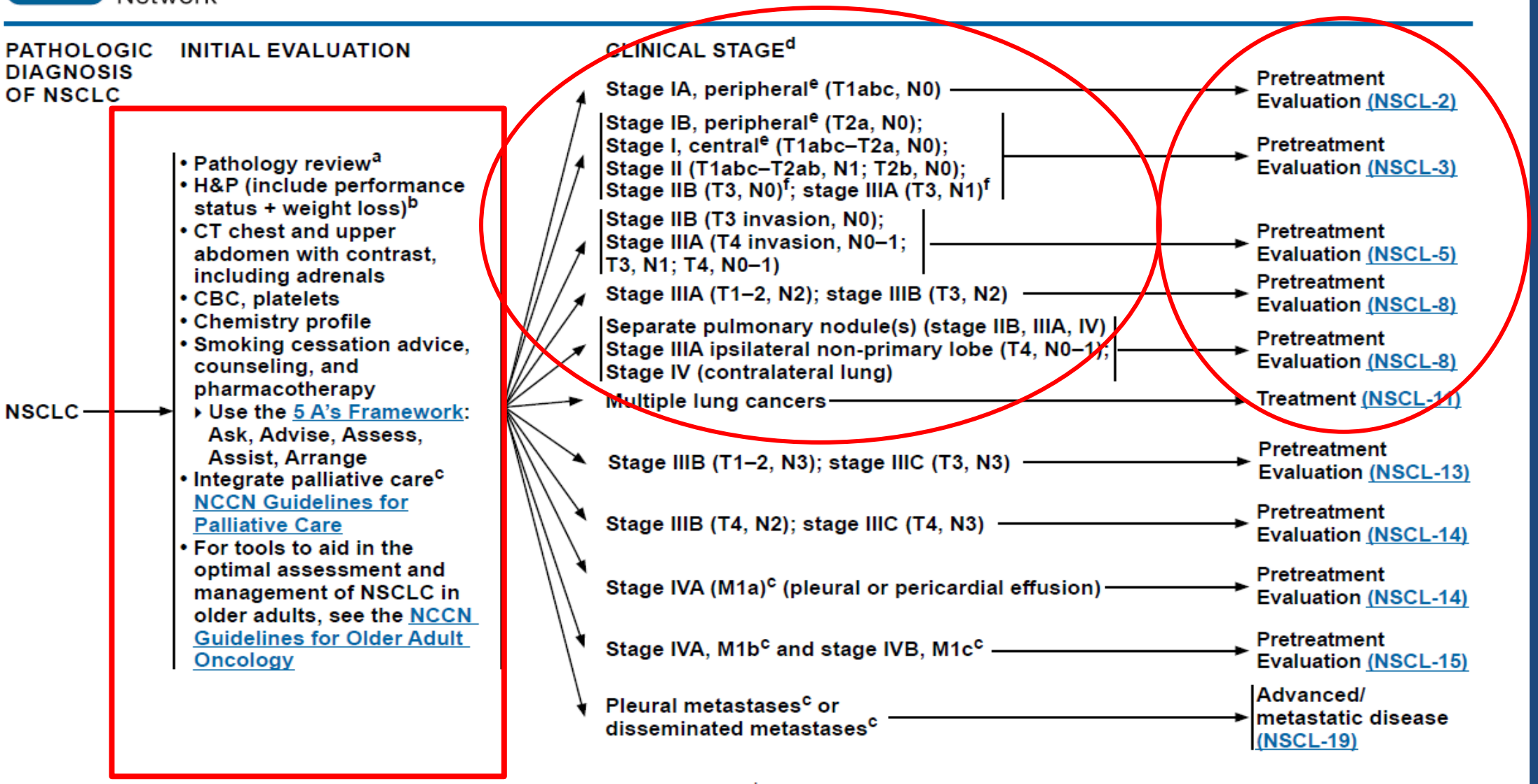

[a] Principles of Pathologic Review (NSCL-A).
[b] Enhanced frailty or geriatric assessments may predict complications better following treatment modalities, particularly surgery. A preferred frailty assessment system has not been established.
[c] Temel JS, et al. N Engl J Med 2010;363:733-742.
[d] For patients where more than one treatment modality (surgery, radiation therapy [RT], or systemic therapy) is usually considered, a multidisciplinary evaluation should be performed.
[e] Based on the CT of the chest: Peripheral = outer third of lung; Central = inner two thirds of lung.
[f] T3, N0 related to size or satellite nodules.

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Non-Small Cell Lung Cancer

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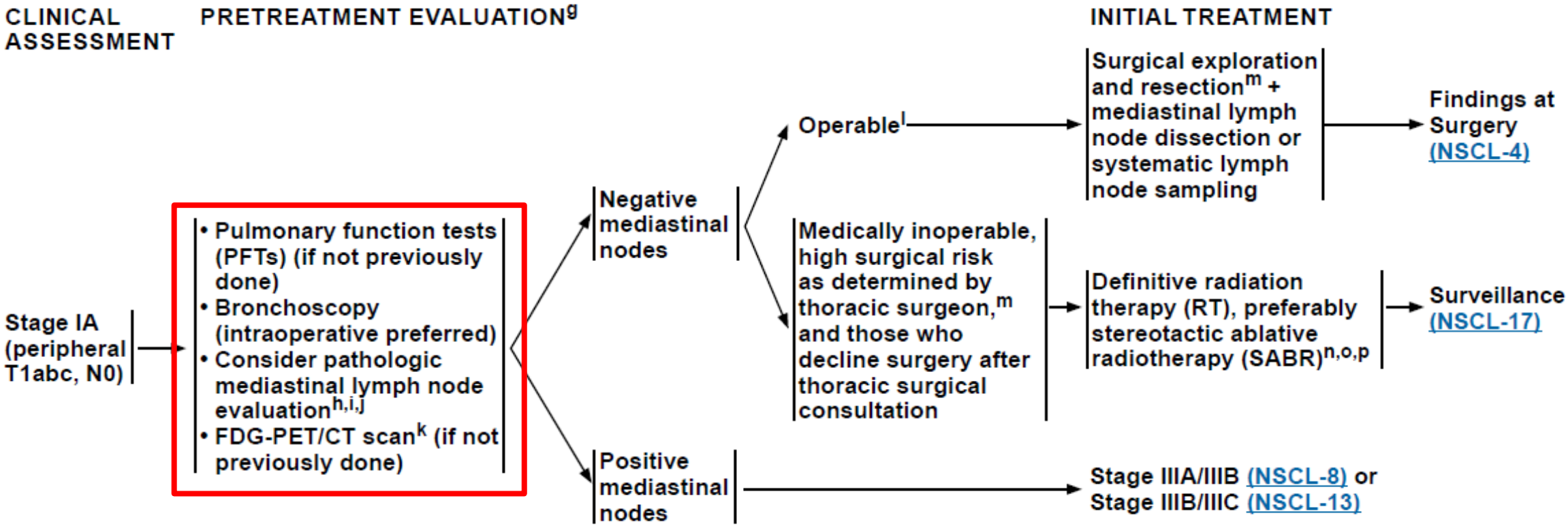

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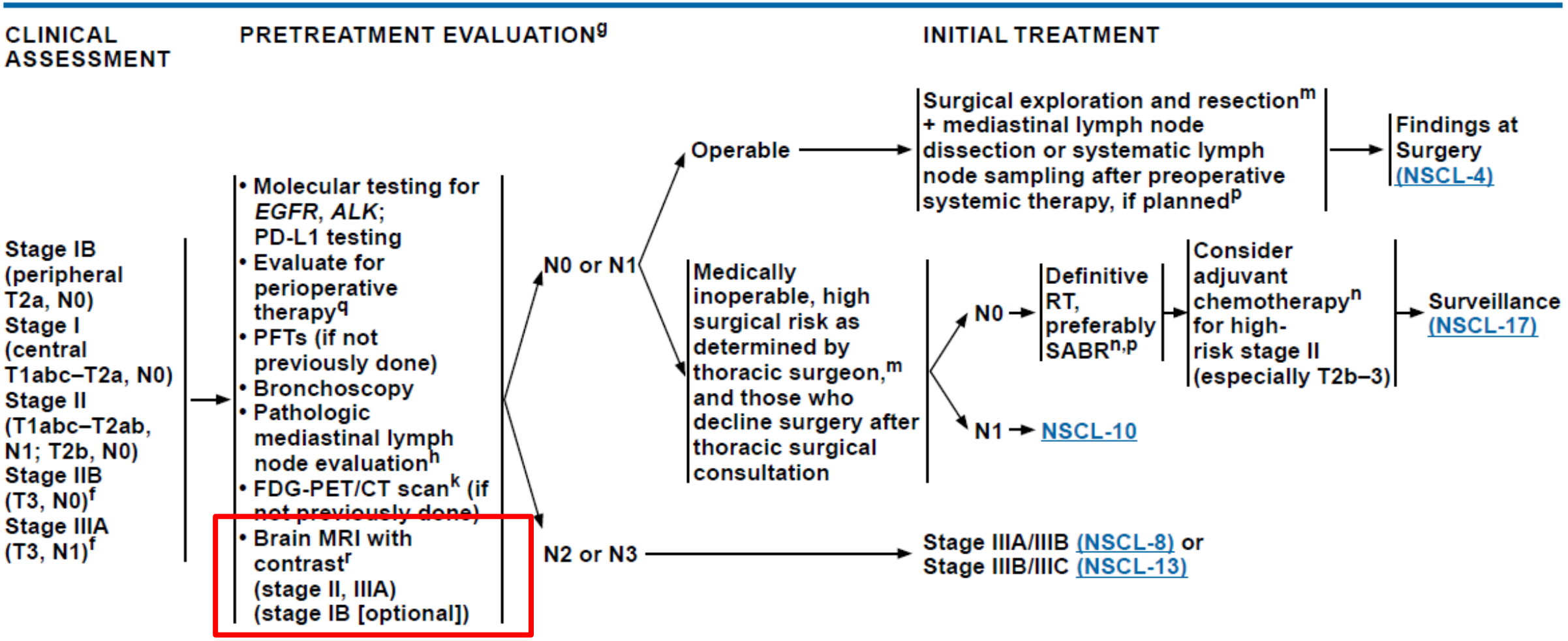
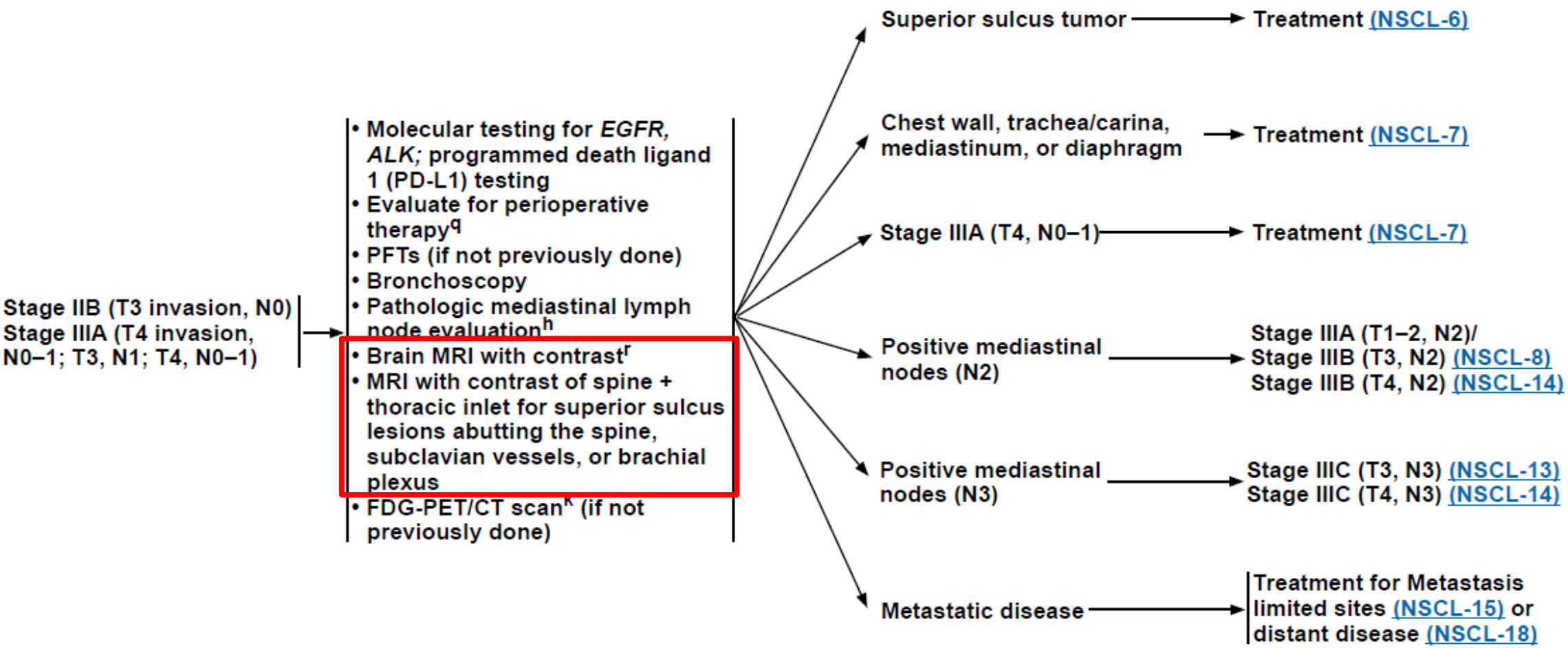
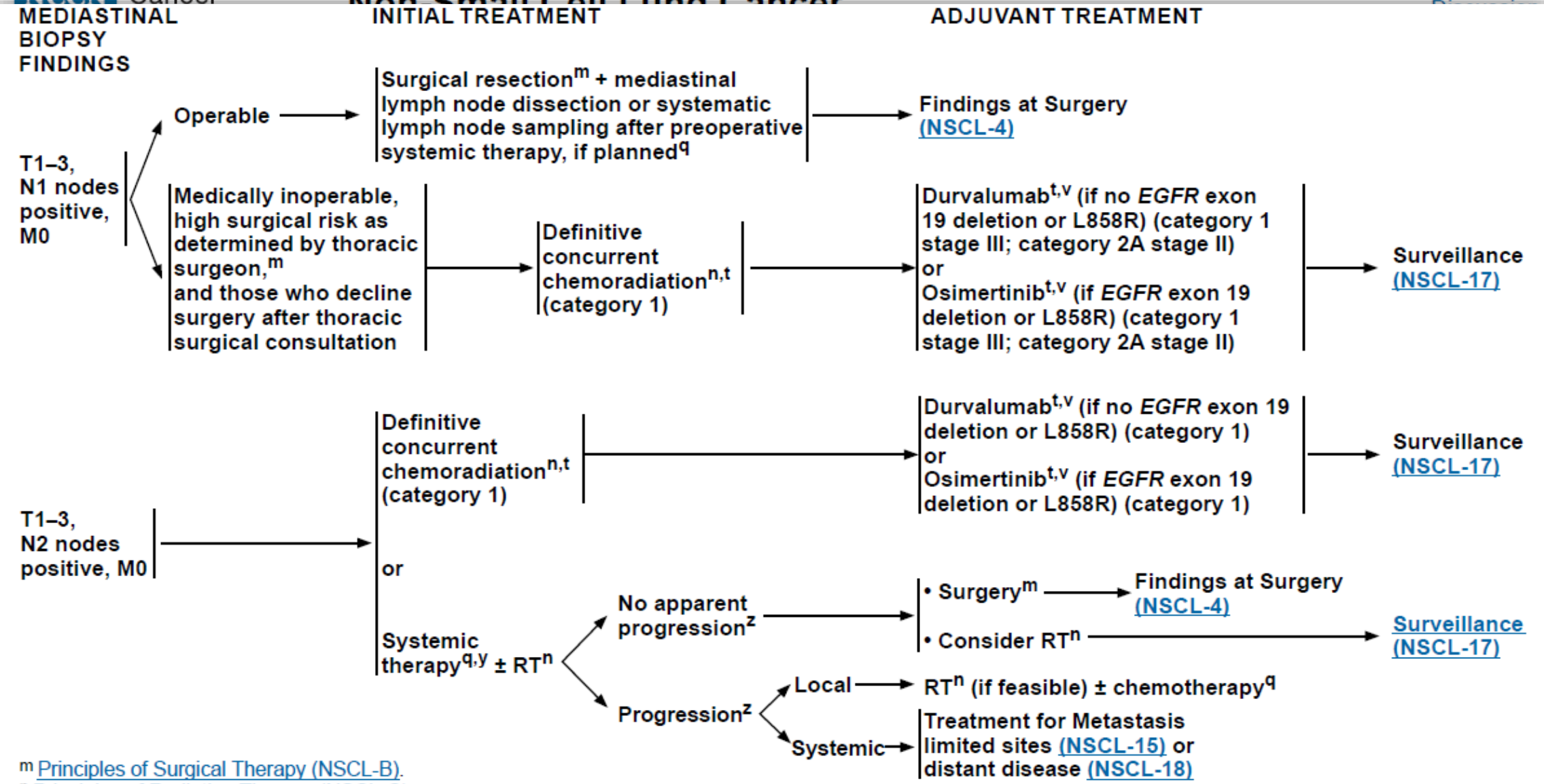



CLINICAL ASSESSMENT
PRETREATMENT EVALUATION
CLINICAL EVALUATION
Stage IIB (T3 invasion, N0)
Stage IIIA (T4 invasion, N0–1; T3, N1; T4, N0–1)
• Molecular testing for EGFR, ALK; programmed death ligand 1 (PD-L1) testing
• Evaluate for perioperative therapy[q]
• PFTs (if not previously done)
• Bronchoscopy
• Pathologic mediastinal lymph node evaluation[h]
• Brain MRI with contrast[r]
• MRI with contrast of spine + thoracic inlet for superior sulcus lesions abutting the spine, subclavian vessels, or brachial plexus
• FDG-PET/CT scan[k] (if not previously done)
Superior sulcus tumor → Treatment (NSCL-6)
Chest wall, trachea/carina, mediastinum, or diaphragm → Treatment (NSCL-7)
Stage IIIA (T4, N0–1) → Treatment (NSCL-7)
Positive mediastinal nodes (N2) → Stage IIIA (T1–2, N2)/ Stage IIIB (T3, N2) (NSCL-8) Stage IIIB (T4, N2) (NSCL-14)
Positive mediastinal nodes (N3) → Stage IIIC (T3, N3) (NSCL-13) Stage IIIC (T4, N3) (NSCL-14)
Metastatic disease → Treatment for Metastasis limited sites (NSCL-15) or distant disease (NSCL-18)



[m] Principles of Surgical Therapy (NSCL-B).

PRETREATMENT EVALUATION – PATIENT CONDITION-

- **Preoperative routine lab**
  - CBC, ESR, LRFT, electrolyte, ABO type
  - HBV, HCV, HIV, VDRL
  - Tumor marker (CEA, CA19-9, cyfra21-1, NSE, SCC etc)
- ***Pulmonary Function Test, Lung perfusion scan***
- ***Cardiac evaluation***
  - Myocardial perfusion, Treadmill test, CAG
  - Echocardiography

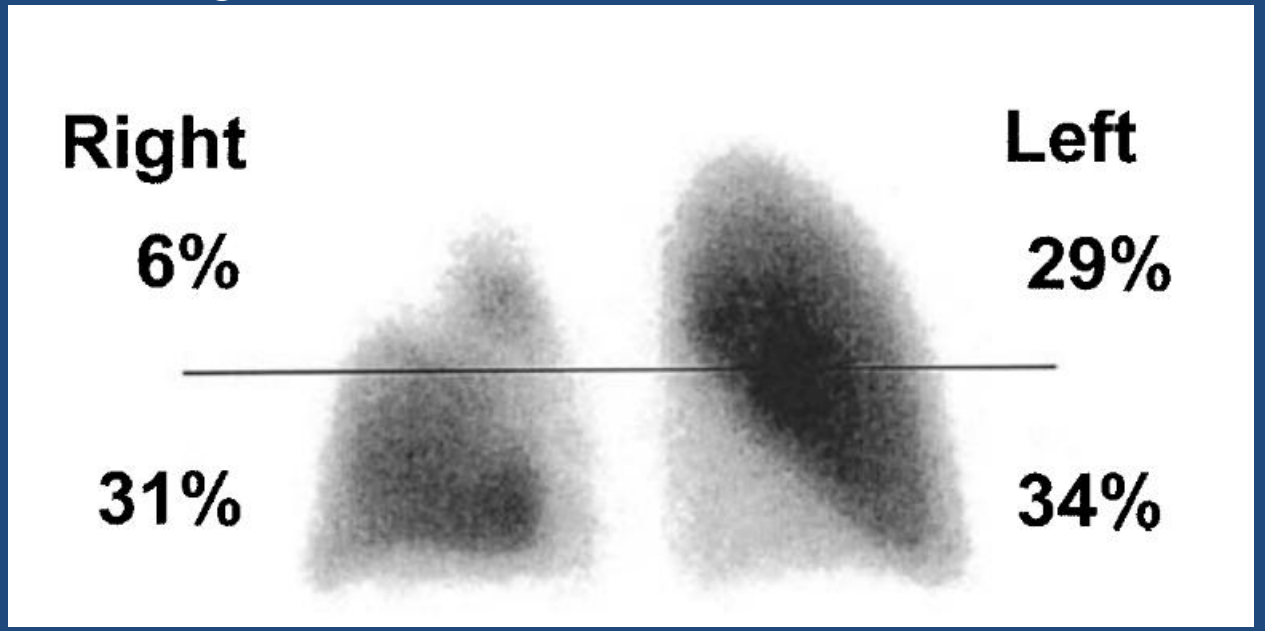
PREDICTIVE POSTOPERATIVE FEV1

1. **Lung perfusion scintigraphy**

The percentage of function attributed to the lung not being resected was multiplied by the preoperative measured value of lung function to achieve a predicted postoperative value for lung function

Example)

RUL lung cancer



PREDICTIVE POSTOPERATIVE FEV1

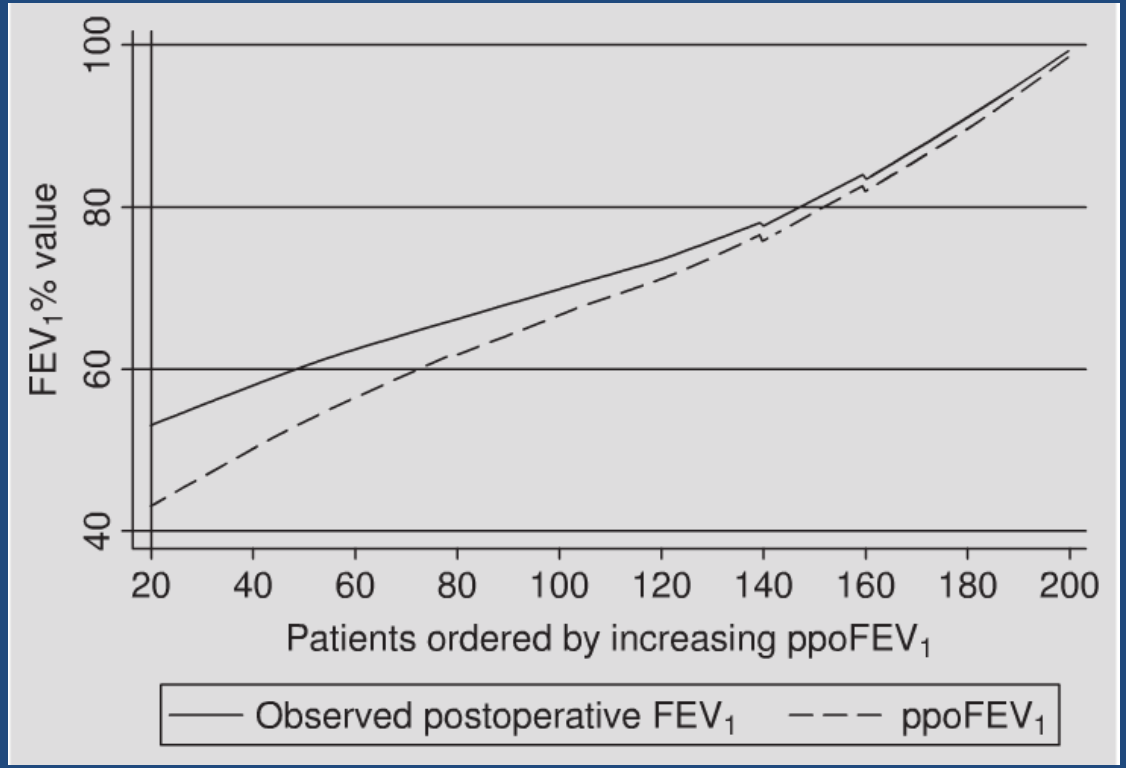
2. The calculation of postoperative lung function using simple equations rather than physiologic tests was originally introduced in 1975: an equal value was assigned to each of the **19 lung segments** in order to determine the amount of functioning lung remaining after resection.

3. More recent techniques for calculating predicted postoperative spirometric values use the number of **functioning segments** as the denominator and the number of functioning segments

$$\text{Postoperative function} = \text{Preoperative function} \times \frac{\text{Functioning segments remaining following resection}}{\text{Functioning segments present prior to resection}}$$

PREDICTIVE POSTOPERATIVE FEV1

4. The use of **quantitative computed tomography (CT)** in estimating relative lung function as a means for calculating predicted postoperative function has been shown to be similar to **lung perfusion scintigraphy** and segmental percentage loss in the accuracy of predicting postoperative function.



- Anatomical (Segment Counting) method
- ppo FEV_1 = pre-op FEV_1 × (1 – resected segments/19)

- Perfusion method
- ppo FEV_1 = pre-op FEV_1 × (1 – Σ perfusion of resected lobes)

- ppo FEV_1 < 30% predicted → 고위험군
- 30–60% predicted → 중등도 위험 (CPET 추가 필요)

CARDIOPULMONARY EXERCISE TESTING (CPET)

- **Purpose**
- **PFT alone** is insufficient to predict postoperative complication risk
- **CPET** evaluates the integrated response of **cardiovascular, respiratory, and metabolic systems**
- Provides a **powerful predictor** of postoperative respiratory failure, complications, and mortality

CPET

Incremental exercise (on a treadmill or cycle ergometer)
while measuring **gas exchange, ECG, blood pressure, and oxygen saturation**
•Using a **metabolic cart**, real-time analysis of **oxygen consumption (VO_2), carbon dioxide output (VCO_2), and ventilation (VE)** is performed

CPET

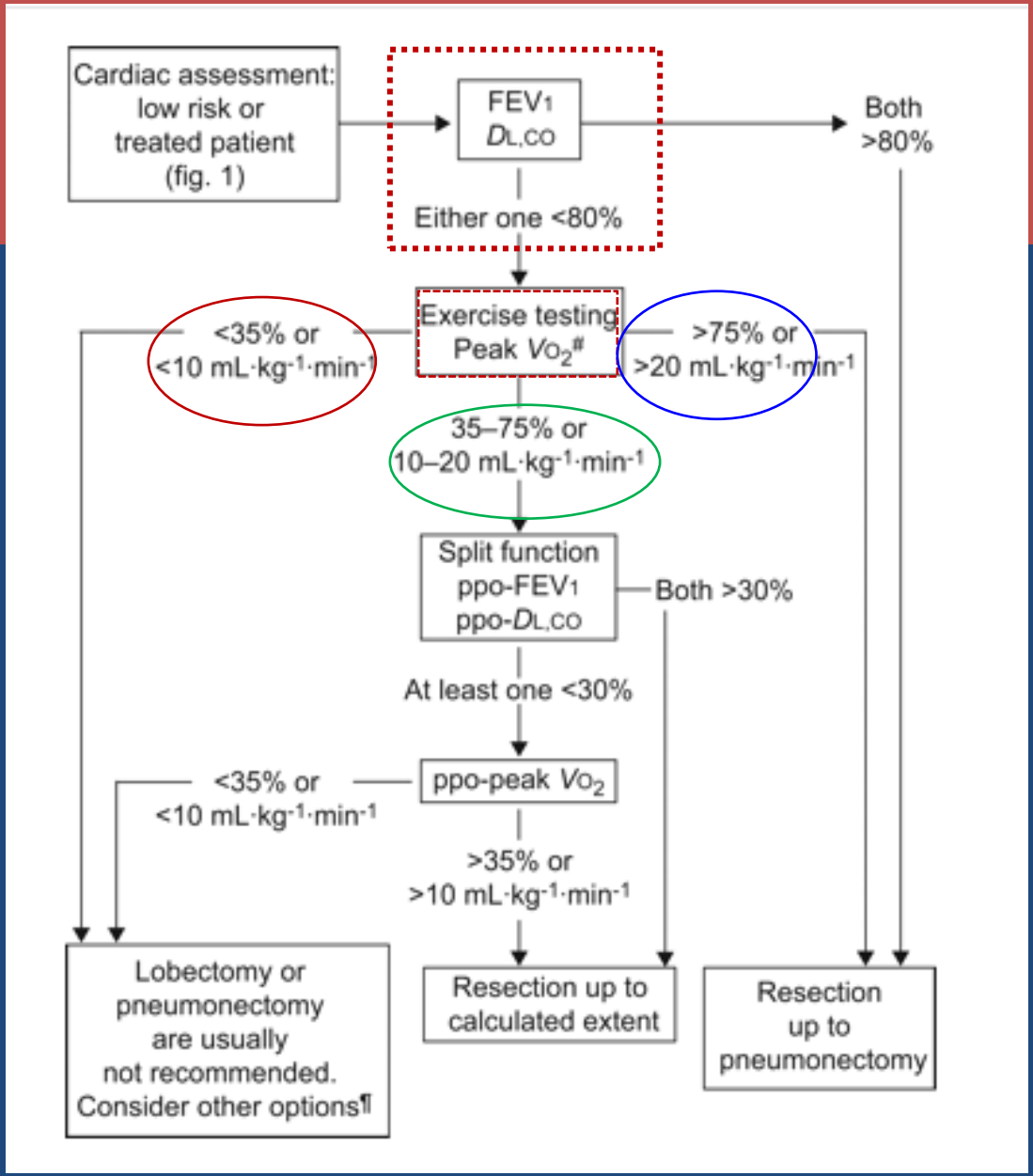
Peak VO_2 (maximal oxygen uptake)

Anaerobic Threshold (AT)

AT < 11 mL/kg/min → Increased surgical risk

VE/VCO_2 slope (ventilatory efficiency)

O_2 pulse (VO_2/HR)



- "ERS/ESTS CLINICAL GUIDELINES ON FITNESS FOR RADICAL THERAPY IN LUNG CANCER PATIENTS

  (SURGERY AND CHEMO-RADIOTHERAPY)"
- *EUR RESPIR J* 2009; 34: 17–41.

Assessment of suitability for lung resection

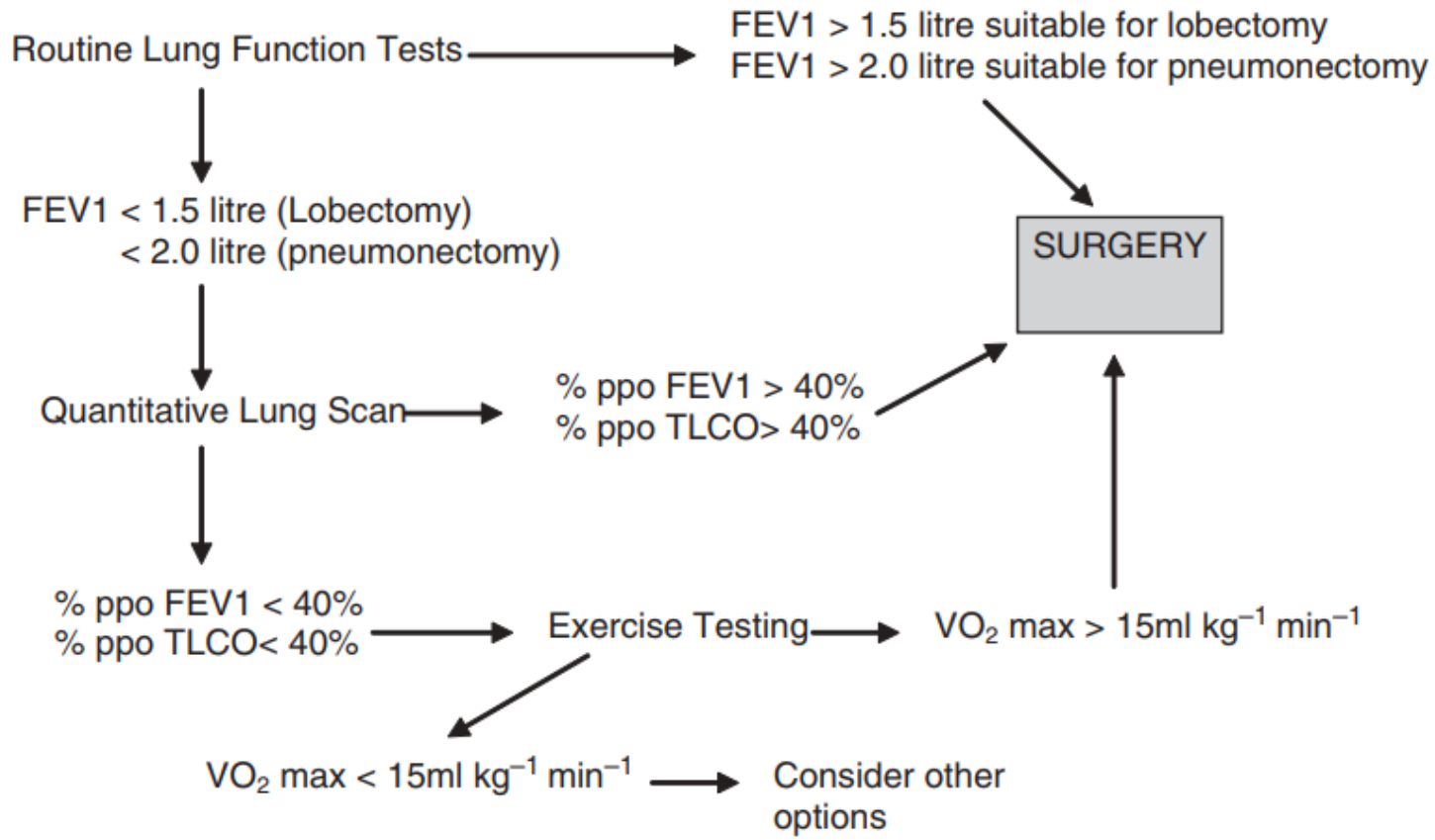
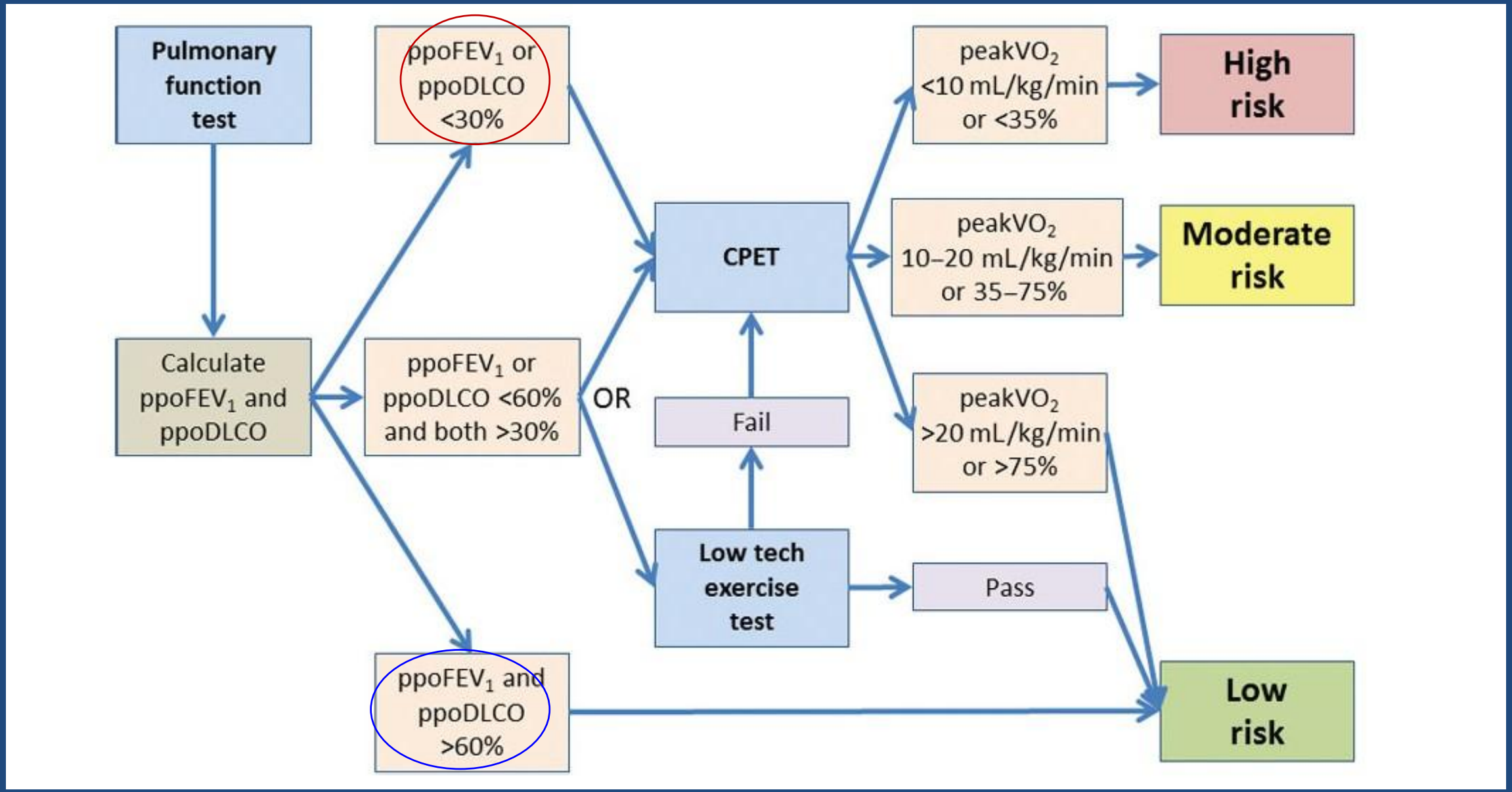


Fig. 3 Preoperative evaluation before lung resection.



Shields' General Thoracic Surgery, 8th edition, section VI chapter 24
Pulmonary physiologic assessment of operative risk

RISK GROUP

1. **Low risk** : The expected risk of **mortality is below 1%.** Major anatomic resections can be safely performed in this group

2. **Moderate risk**: Morbidity and mortality rates may vary according to the values of split lung functions, exercise tolerance and extent of resection. **Risks and benefits of the operation should be thoroughly discussed with the patient.**

3. **High risk: The risk of mortality** after standard major anatomic resections may **be higher than 10%.** Considerable risk of severe cardiopulmonary morbidity and residual functional loss is expected. Patients should be counseled about **alternative surgical (minor resections or minimally invasive surgery) or nonsurgical options.**

CPET

- VO_2 max
- ≥ 20 ml/kg/min: 수술 가능
- 10–20: 중간위험, 수술 범위 고려
- < 10: 수술 금기 또는 대체 치료

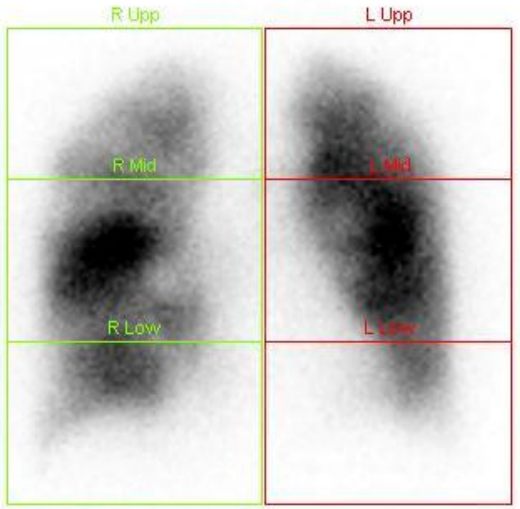
지표	저위험	중간위험	고위험
Peak VO_2	>20	10–20	<10
AT	>11	8–11	<8
VE/VCO_2 slope	<30	30–34	>34

CASE 1

- Compromised lung function
- Lung cancer (squamous cell carcinoma, T1cN0M0, stage IA3), RML
- Chronic obstructive pulmonary disease with pulmonary emphysema
- PFT
  - FEV1 **1.50L (51%),** DLCO 65%

- **Lung perfusion scan**

Patient Name:
Institution Name:
Patient ID: 180092611
Study Name: Lung Perfusion Scan
Study Date: 3/8/2018



ANT

ANT

POST

LAO

RPO

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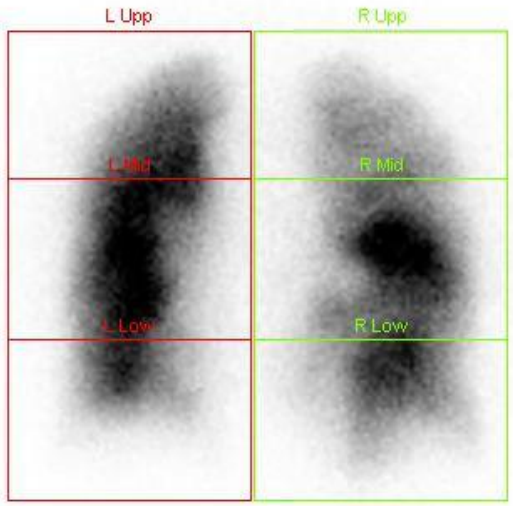


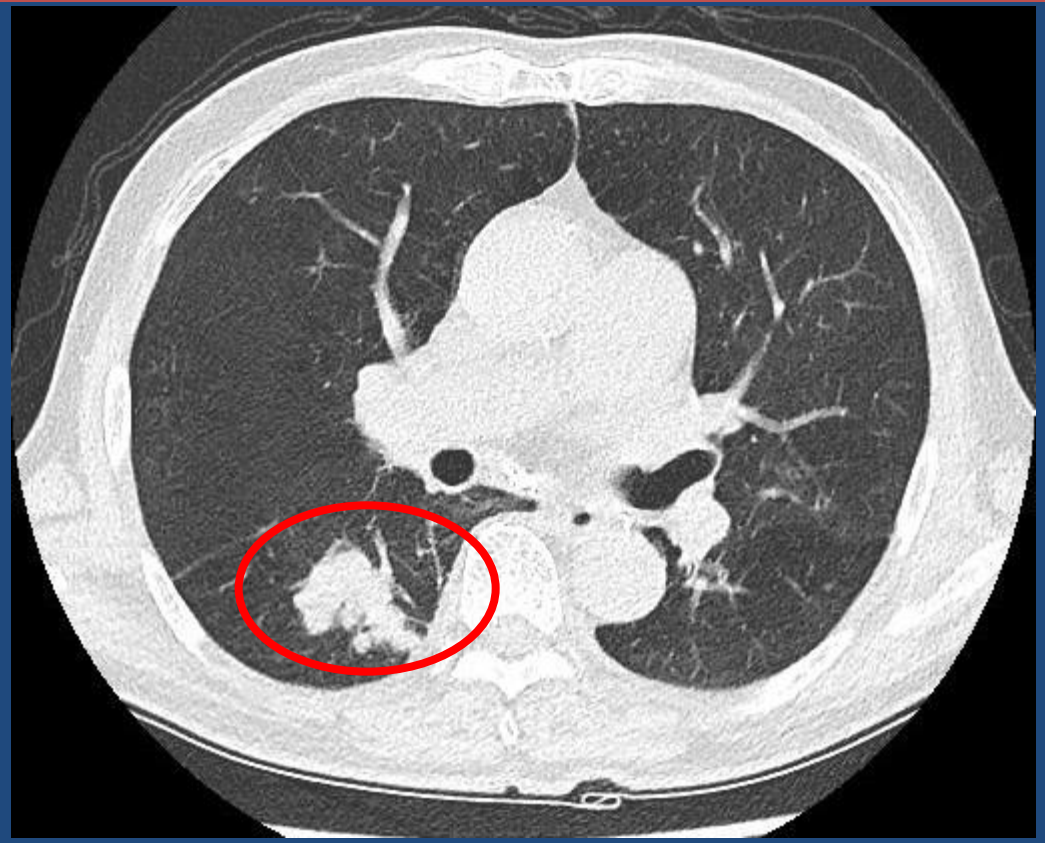
POST

All Images

- **Predicted FEV1** after RMLobectomy : **43%**
- Stair test: 계단 3층 정도는 안 쉬고 올라갈 수 있다
- EchoCG - Normal LV systolic function
- **CPET - VO2 max 25.4 mL/kg/min (79%), METs 6.0**
- Intraop ABGA under one lung ventilation : **PCO2 40mmHg**
- **RMLobectomy with MLND**
- Uneventful dischage at POD#5

CASE 2

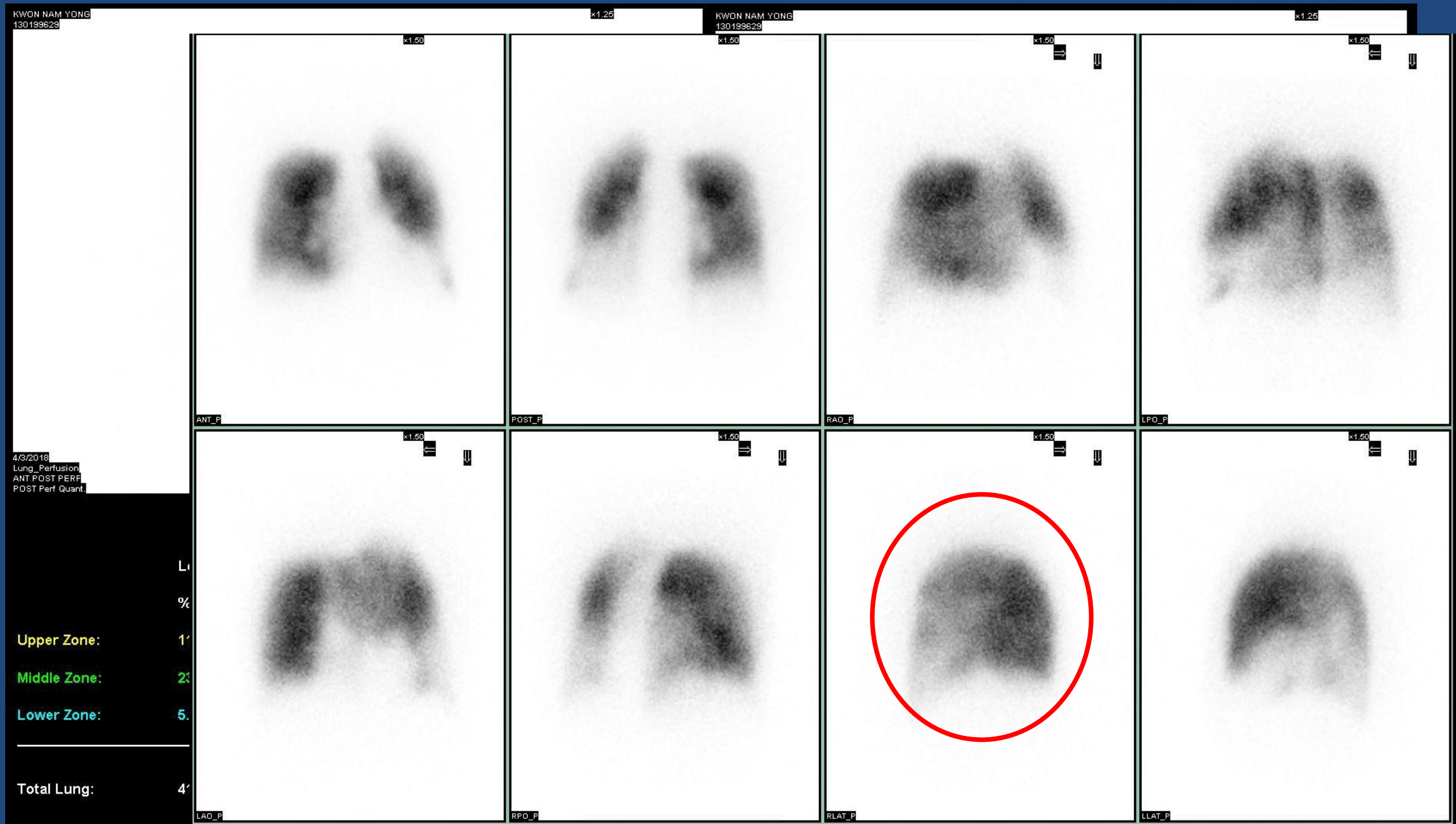
- Compromised lung function
- M/76
- RLL cancer
  - ➢tumor size 4.0cm
  - ➢Sup segment
- ➢cT2aNoMo



- TMT - positive for MI, METS 10.5
  - Cardiology consult: moderate risk

- PFT
  - FEV1 1.44L (62%)
  - DLCO 90%

- **Lung perfusion scan**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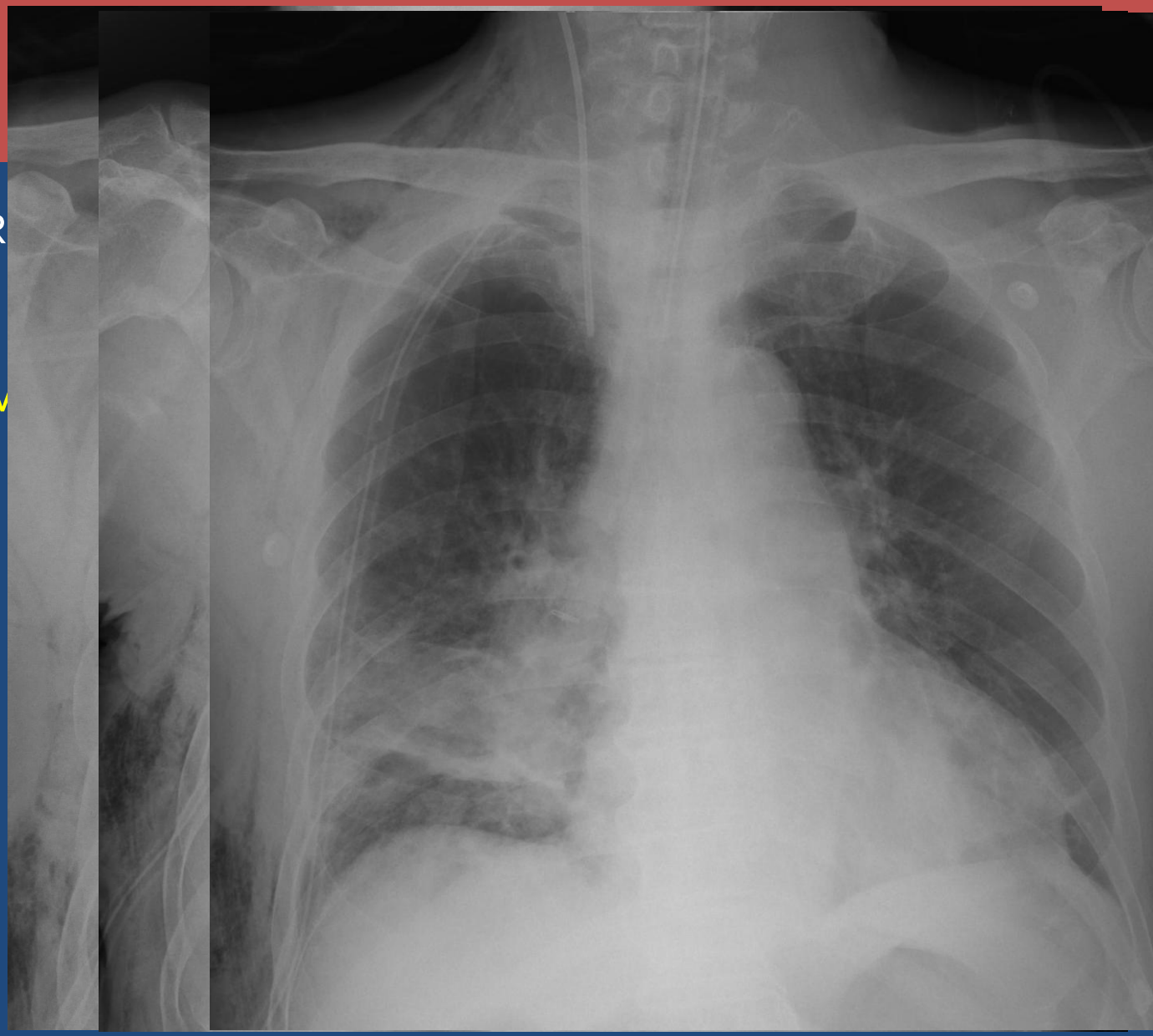
×1.50
RAO_P
×1.50
LPO_P
4/3/2018
Lung_Perfusion
ANT POST PERF
POST Perf Quant.
L
%
Upper Zone:
1
Middle Zone:
2
Lower Zone:
5.
Total Lung:
4
×1.50
LAO_P
×1.50
RPO_P
×1.50
RLAT_P
×1.50
LLAT_P

- Predicted postoperative FEV1 after R
- CPET
  - VO2 max 16.2 mL/kg/min (45%), V
- One lung ventilation
  - Intraop ABGA PCO2 > 60mmhg

- **Sup segmentectomy with MLND**



CARDIAC EVALUATION

Physiologic reasons for especially high risk of cardiac complications

1. Significant atelectasis, decreased lung compliance, and decreased diffusing capacity after thoracic surgery may lead to hypoxia, hypercarbia, or increased work of breathing, which all decrease **myocardial oxygen** supply and increase myocardial oxygen demand. This **mismatch** may precipitate ischemia, which in turn can lead to arrhythmias, congestive heart failure, or even MI.

2. Postoperative patients develop a **hypercoagulable** state that may exacerbate fixed coronary stenoses, contribute to new coronary plaque rupture, or place strain on the heart through the development of pulmonary emboli.

3. After major lung resections, the decrease in the pulmonary vascular bed results in **increased preload**, which can worsen congestive heart failure.

- Which patients warrant *non invasive cardiac stress testing* (tread mill test, stress echocardiography, or a nuclear stress test)?

- Which patients should proceed directly to *coronary angiography*?

- Who should have *no testing* at all?

Clinical Predictors of Increased Perioperative Cardiovascular Risk (Myocardial Infarction, Heart Failure, Death)

Major

Unstable coronary synd

Acute or recent MI

clinical symptom

Unstable or severe

Decompensated heart f

Significant arrhythmias

High-grade atriove

Symptomatic ventri

underlying heart

Supraventricular ar

Severe valvular disease

Intermediate

Mild angina pectoris (Canadian class I or II)

Previous MI by history or pathologic Q waves

Compensated or prior heart failure

Diabetes mellitus (particularly insulin-dependent)

Renal insufficiency

Minor

Advanced age

Abnormal ECG (left ventricular hypertrophy, left bundle-branch block, ST-T abnormalities)

Rhythm other than sinus (e.g., atrial fibrillation)

Low functional capacity (e.g., inability to climb one flight of stairs with a bag of groceries)

History of stroke

Uncontrolled systemic hypertension

Table 4 Surgical risk[a] estimate (modified from Boersma *et al.*[6])

Low-risk <1%	Intermediate-risk 1–5%	High-risk >5%
▪ Breast ▪ Dental ▪ Endocrine ▪ Eye ▪ Gynaecology ▪ Reconstructive ▪ Orthopaedic—minor (knee surgery) ▪ Urologic—minor	▪ Abdominal ▪ Carotid ▪ Peripheral arterial angioplasty ▪ Endovascular aneurysm repair ▪ Head and neck surgery ▪ Neurological/ orthopaedic—major (hip and spine surgery) ▪ Pulmonary renal/ liver transplant ▪ Urologic—major	▪ Aortic and major vascular surgery ▪ Peripheral vascular surgery

[a]Risk of MI and cardiac death within 30 days after surgery.

Table 13 Clinical risk factors

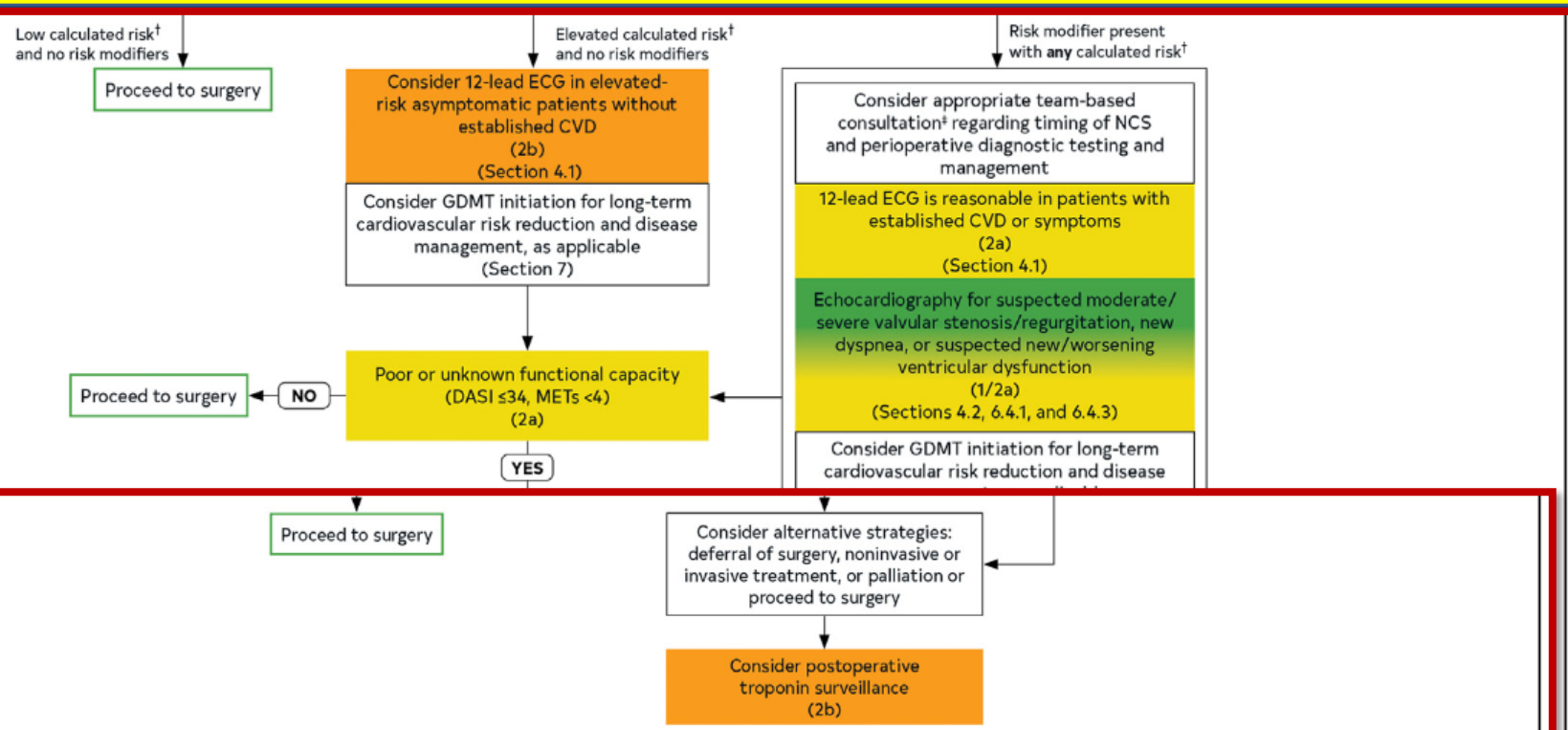
Angina pectoris
Prior MI[a]
Heart failure
Stroke/transient ischaemic attack
Renal dysfunction (serum creatinine >170 μmol/L or 2 mg/dL or a creatinine clearance of <60 mL/min)
Diabetes mellitus requiring insulin therapy

Physical activity	MET

Functional activities (■는 심폐 기능 강화 활동이며 이보다 낮은 강도의 활동은 안전하게 시행 가능합니다.)

METs	활동	METs	활동
☐ 2.0	시속 1.5km로 걷기	☐ 6.0	시속 7.3km의 조깅, 복식 테니스(많이 뛰는) 시속 16km의 자전거
☐ 2.5	계단 내려가기, 개 산책시키기	☐ 6.5	하이킹
☐ 2.8	시속 4km 걷기, 골프, 볼링, 낚시	☐ 7.0	조정, 격렬한 춤동작
☐ 3.5	시속 5km 걷기	☐ 8.0	시속 8km의 조깅, 시속 20km의 자전거
☐ 4.0	계단오르기, 보통 속도의 춤, 수중에어로빅 탁구, 시속 15km의 자전거	☐ 10.0	시속 9.6km의 조깅, 시속 24km의 자전거 단식 테니스, 스쿼시, 라켓볼
☐ 4.5	느린 수영, 골프, 배드민턴(레저)	☐ 13.5	시속 11.2km의 조깅
☐ 5.0	시속 6.4km로 걷기, 빠른 춤동작, 복식 테니스 성생활	☐ 14.0	스피닝

Summary of pre-operative cardiac risk evaluation and perioperative management



*Cardiovascular risk factors: hypertension, smoking, high cholesterol, diabetes, women age >65 y, men age >55 y, obesity, family history of premature CAD. †Determining elevated calculated risk depends on the calculator used. Traditionally, RCRI >1 or a calculated risk of MACE with any perioperative risk calculator >1% is used as a threshold to identify patients at elevated risk. §Abnormal biomarker thresholds: troponin >99th percentile URL for the assay; BNP >92 ng/L, NT-proBNP ≥300 ng/L. ‡Conditions that pose additional risk for MACE. ||Noninvasive stress testing or CCTA suggestive of LM or multivessel CAD. Colors correspond to Class of Recommendation in Table 3. BNP indicates B-type natriuretic peptide; CABG, coronary artery bypass grafting; CAD, coronary artery disease; CCTA, coronary computed tomography angiography; CIED, cardiovascular implantable electronic device; CVD, cardiovascular disease; DASI, Duke Activity Status Index; ECG, electrocardiogram; GDMT, guideline-directed management and therapy; ICD, implantable cardioverter-defibrillator; LM, left main; MACE, major adverse cardiovascular event; METs, metabolic equivalents; NCS, noncardiac surgery; NT-proBNP, N-terminal pro b-type natriuretic peptide; RCRI, Revised Cardiac Risk Index; and URL, upper reference limit.

CASE 3

- Compromised cardiac function - ICMP
- M / 75
- PCI (+) - 2012
- RUL cancer, large cell carcinoma, cT1cNoMo
- FEV1 2.25L (84%) DLCO 80%

- **EchoCG**

  LV: LVE

  RWMA(+)

  Moderate to severe LV systolic dysfunction **(EF 33%)**

  LV diastolic dysfunction (Impaired relaxation and normal filling pressure)

- **TMT** negative for MI, **METS 7.0**

- Cardiology consult
  - Not active cardiac condition and emergency surgery
  - Good functional capacity (METS 7.0)

  ➢**Intermediate perioperative risk**

- RULobectomy with MLND
- No cardiac event
- TIA (+) -> delayed discharge

PREOPERATIVE EVALUATION IS IMPORTANT FOR DECISION MAKING OF OPERABILITY AND SUITABLE RESECTION EXTENT

경청해 주셔서 감사합니다!