

Preoperative evaluation of lung cancer

Pusan National University Hospital

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Nodule suspicious for lung cancer

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

Identification of patient factors

- ◇ Age
- ◇ 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

Pretreatment evaluation - diagnosis and staging -

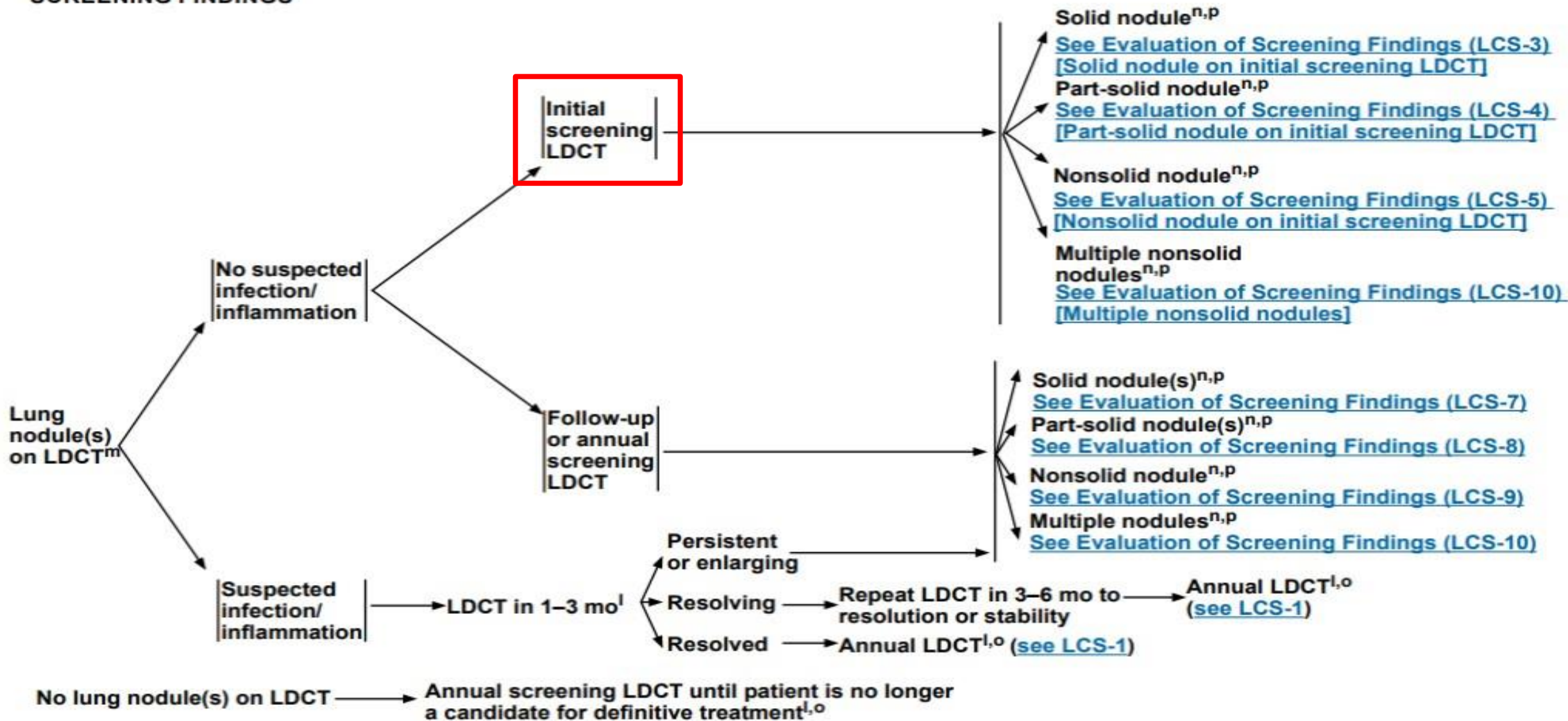
- ◇ Plain chest radiogram
- ◇ *Chest CT*
- ◇ ***PCNA, bronchoscopic biopsy***
- ◇ ***EBUS-TBNA or TBLB, surgical biopsy***
- ◇ *PET CT*, Brain MR, Abdomen CT, Bone scan etc.

Pretreatment evaluation

- diagnosis and staging -

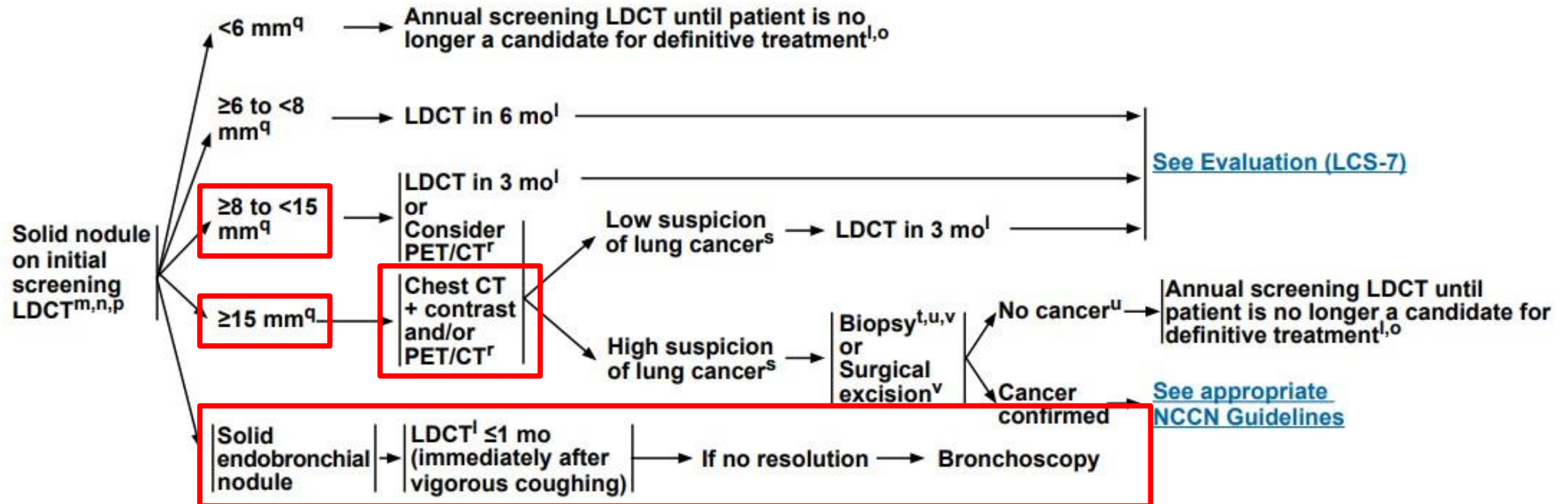
- ◇ *low dose chest CT*
 - ◇ ***Chest CT or PET CT***
 - ◇ ***Bronchoscopy(EBUS), PCNA, bronchoscopic biopsy***
 - ◇ Brain MRI, Abdomen CT, Bone scan etc.
 - ◇ ***Surgical diagnosis /c or /s curable operation***
- 

SCREENING FINDINGS



EVALUATION OF SCREENING FINDINGS

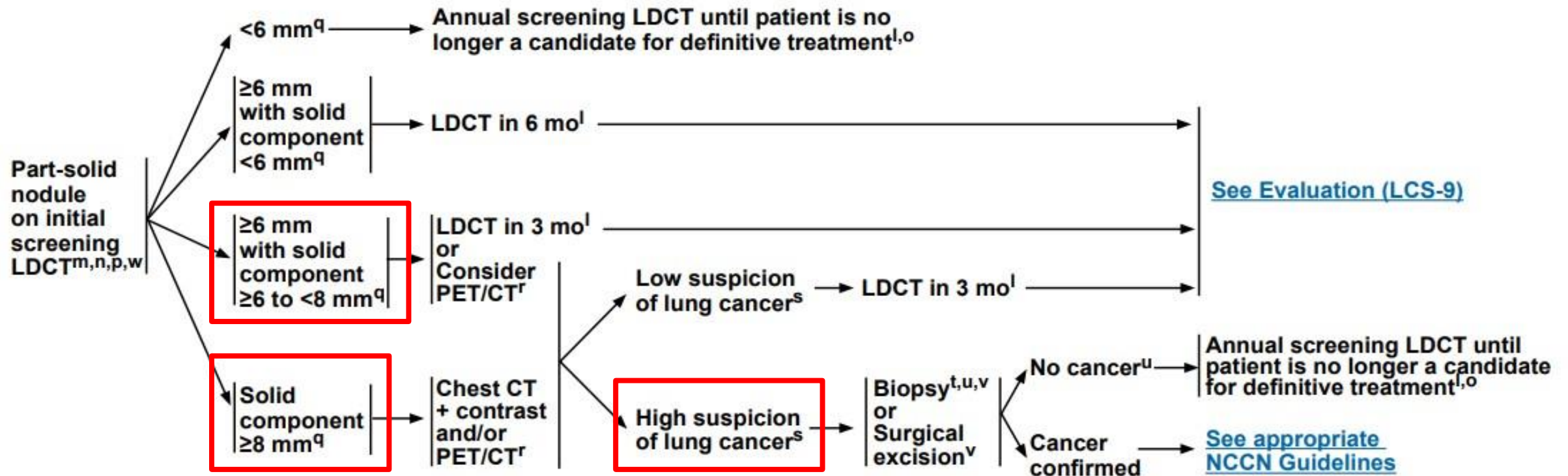
FOLLOW-UP OF SCREENING FINDINGS





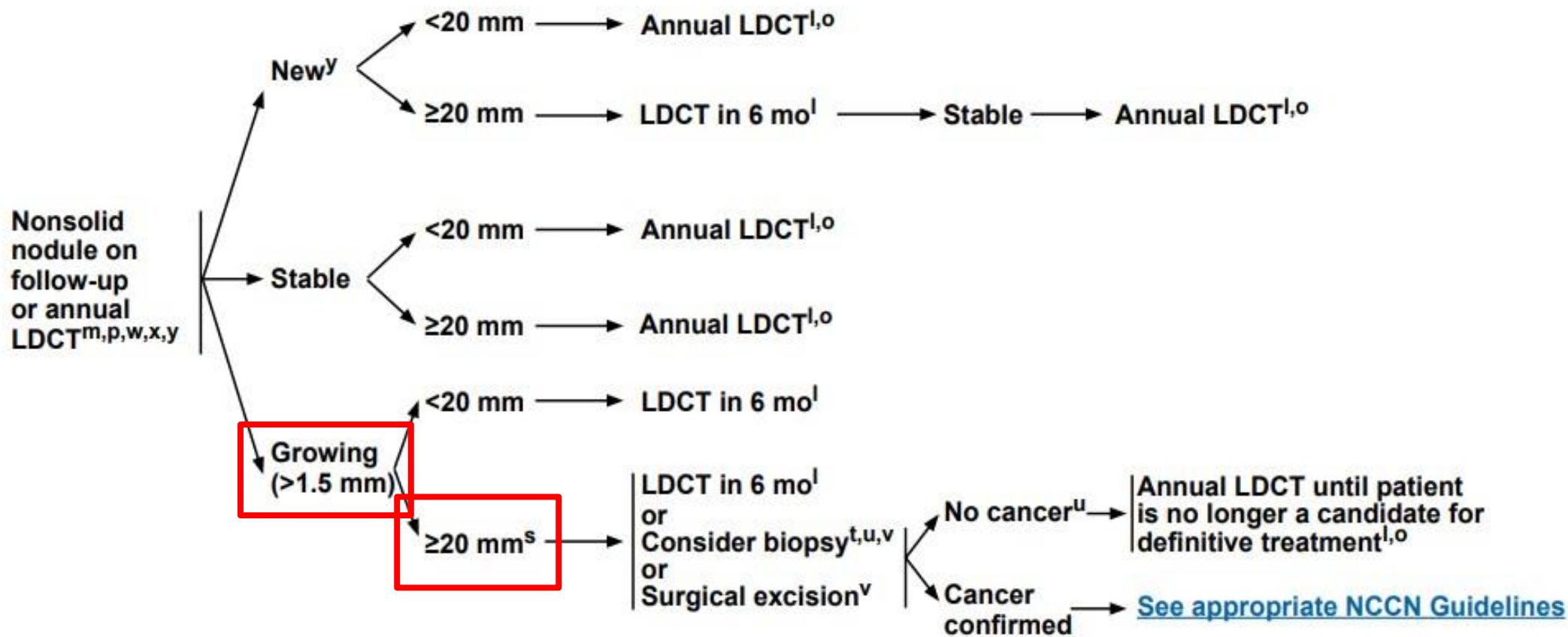
EVALUATION OF SCREENING FINDINGS

FOLLOW-UP OF SCREENING FINDINGS



EVALUATION OF SCREENING FINDINGS

FOLLOW-UP OF SCREENING FINDINGS



Multidisciplinary approach

- 1. Thoracic radiology**
- 2. Pulmonary medicine**
- 3. Thoracic surgeon**

Solitary Pulm

< Back

Calculator: Solitary pulmonary nodule malignancy risk in adults (Brock University cancer prediction equation)

- 1. Age?
- 2. Smoker (current or previous)?
- 3. Extra-thoracic disease (more than 5 years)?
- 4. Diameter?
- 5. Upper Lobe?
- 6. Spiculated?
- 7. PET?

7/7 completed

$$\text{Logodds} = (0.0287 * (\text{Age} - 62)) + \text{Sex} + \text{FamilyHistoryLungCa} + \text{Emphysema} - (5.3854 * ((\text{NoduleSize}/10)^{-0.5} - 1.58113883)) + \text{NoduleType} + \text{NoduleUpperLung} - (0.0824 * (\text{NoduleCount} - 4)) + \text{Spiculation} - 6.7892$$

$$\text{CancerProbability} = 100 * (e^{\text{Logodds}} / (1 + e^{\text{Logodds}}))$$

Input:

Age years

Sex Female (0.6011)
 Male (0)

Family history of lung cancer (0.2961)

Emphysema (0.2953)

Nodule size mm

Nodule type Nonsolid or ground-glass (-0.1276)
 Partially solid (0.377)
 Solid (0)

Nodule in upper lung (0.6581)

Nodule count #

Spiculation (0.7729)

Results:

Log odds

Cancer probability %

Decimal precision

Reset form

Notes

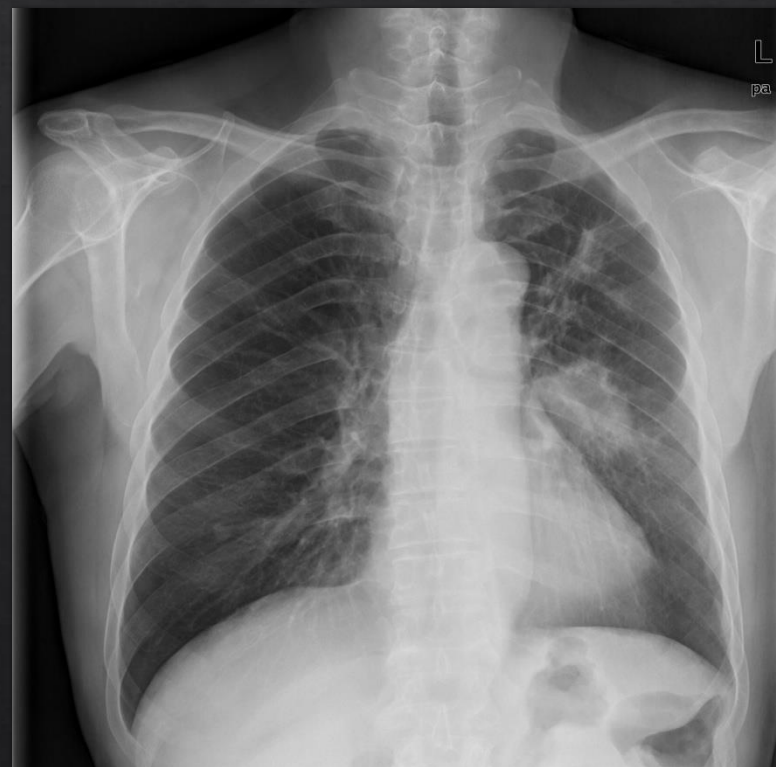
- This calculator estimates the probability that a lung nodule described above will be diagnosed as cancer within a two- to four-year follow-up period.

Equation parameters, such as **Sex**, have two or more discrete values that may be used in the calculation. The numbers in the parentheses, eg, (0.6011), represent the values that will be used.

References

1. McWilliams A, Tammemagi MC, Mayo JR, et al. Probability of cancer in pulmonary nodules detected on first screening CT. N Engl J Med. 2013 Sep 5;369(10):910.

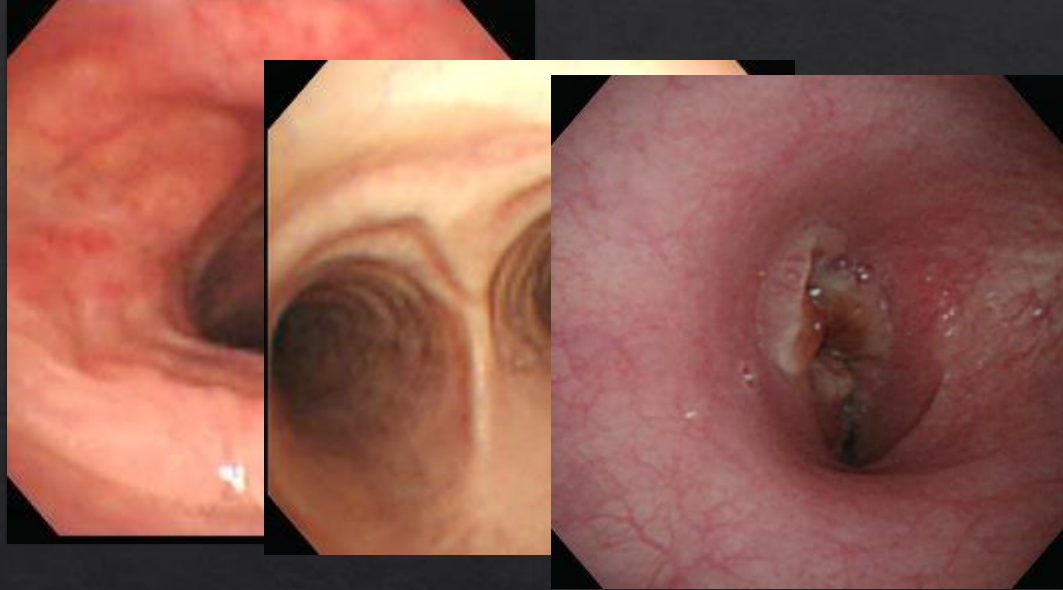
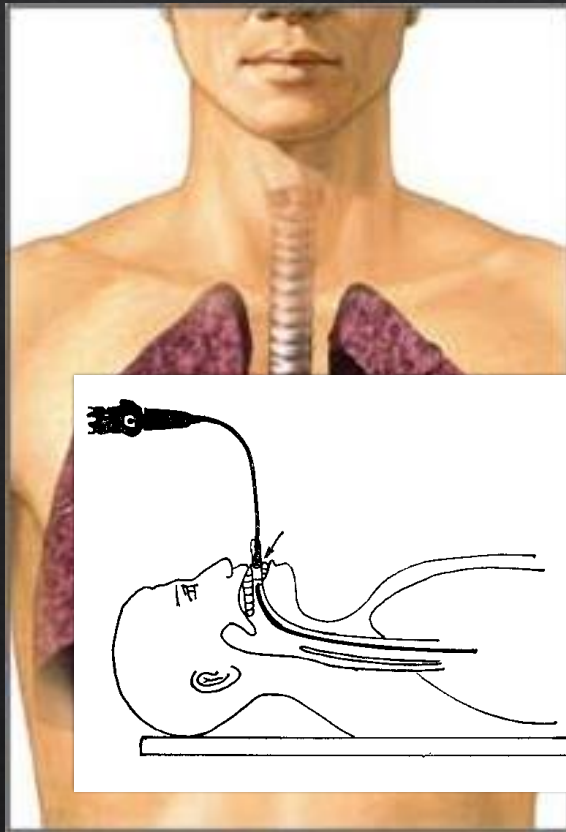
Plain chest radiogram



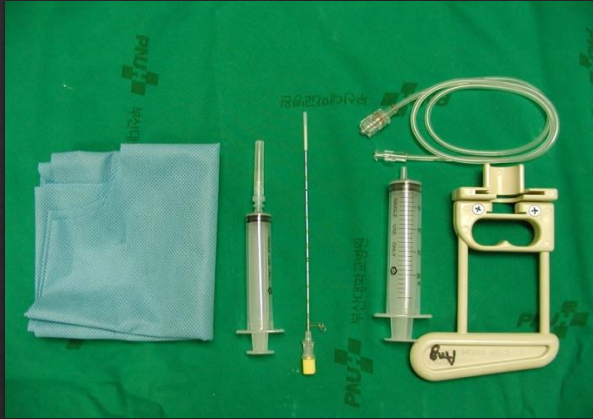
Chest CT



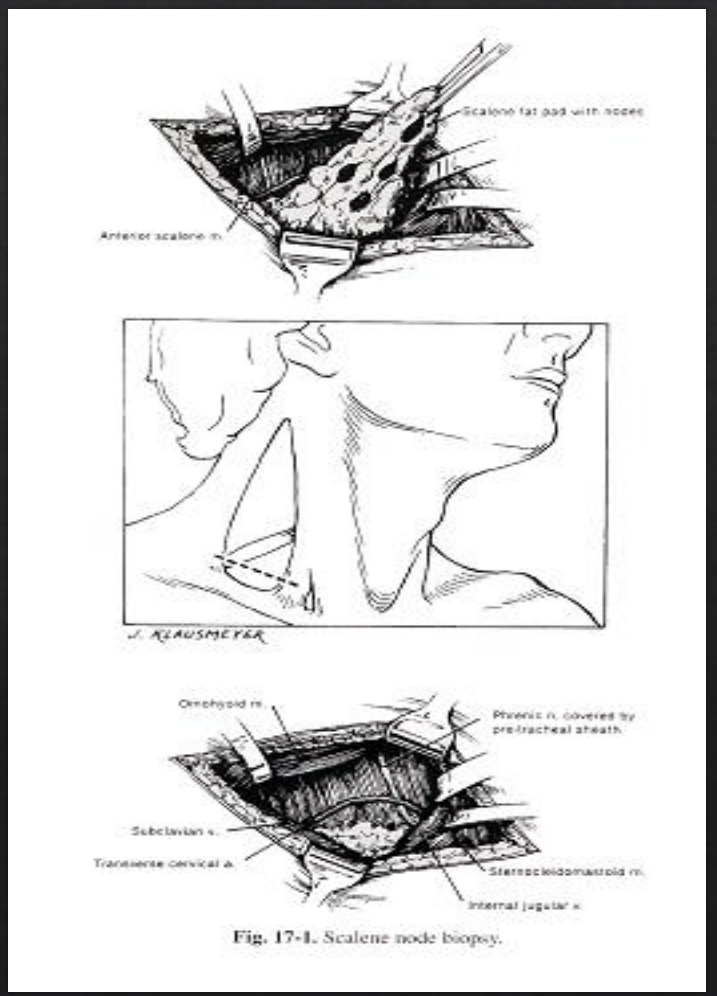
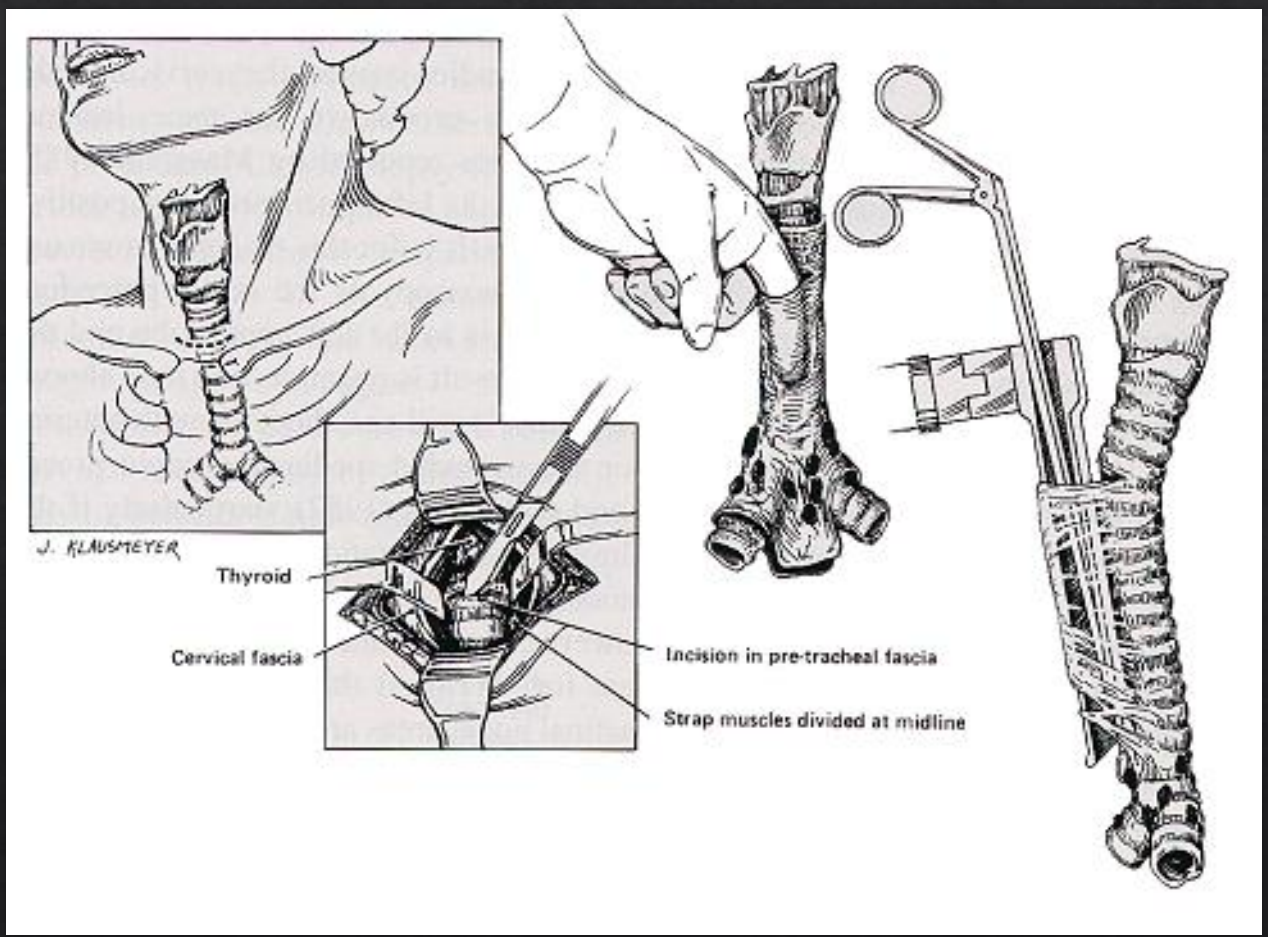
Bronchoscopy



PCNA



Surgical biopsy



Surgical biopsy

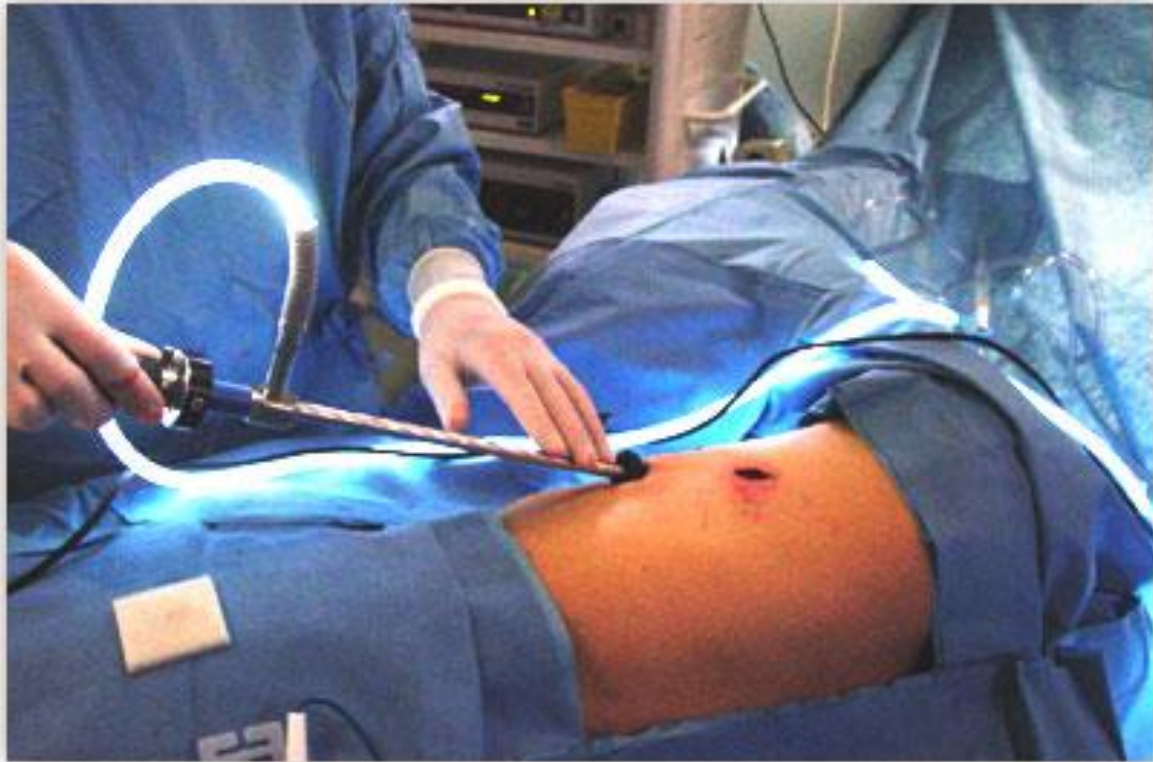
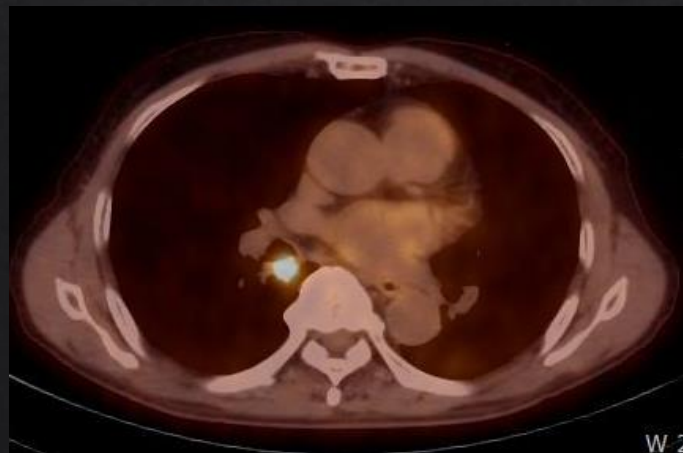
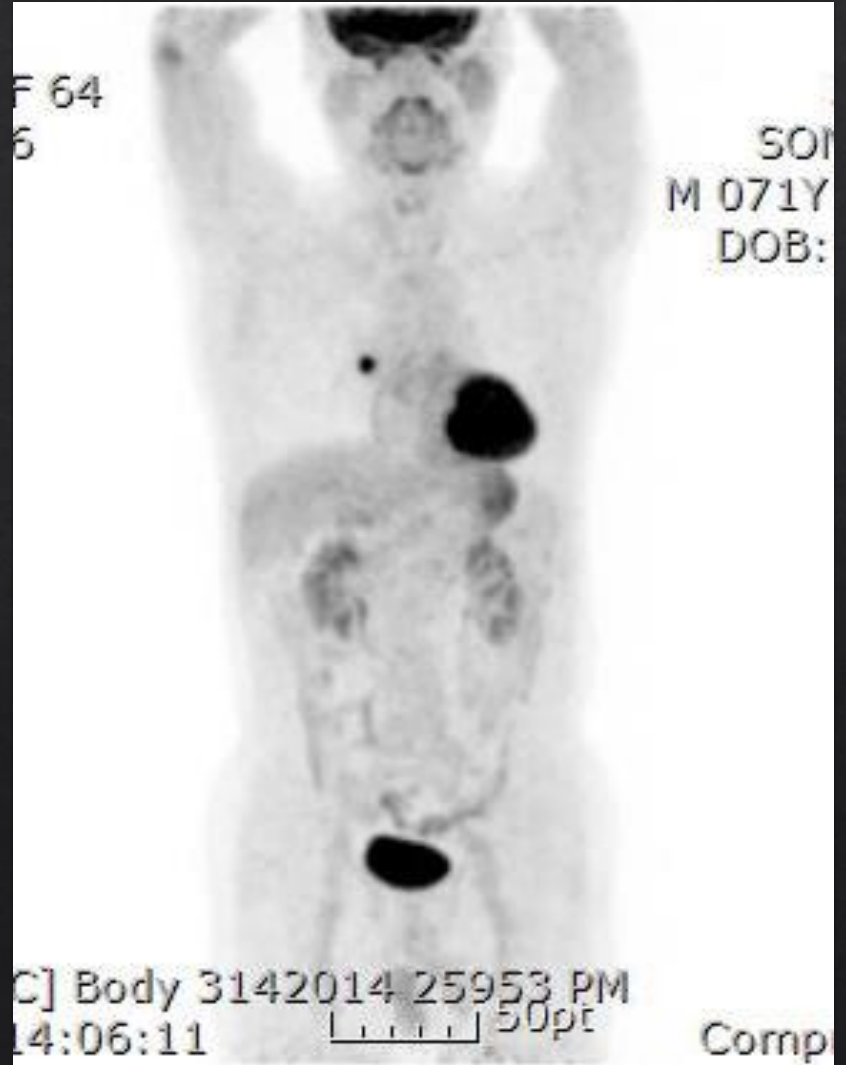


Fig. 18-3. Four incisions for improved access and visualization.

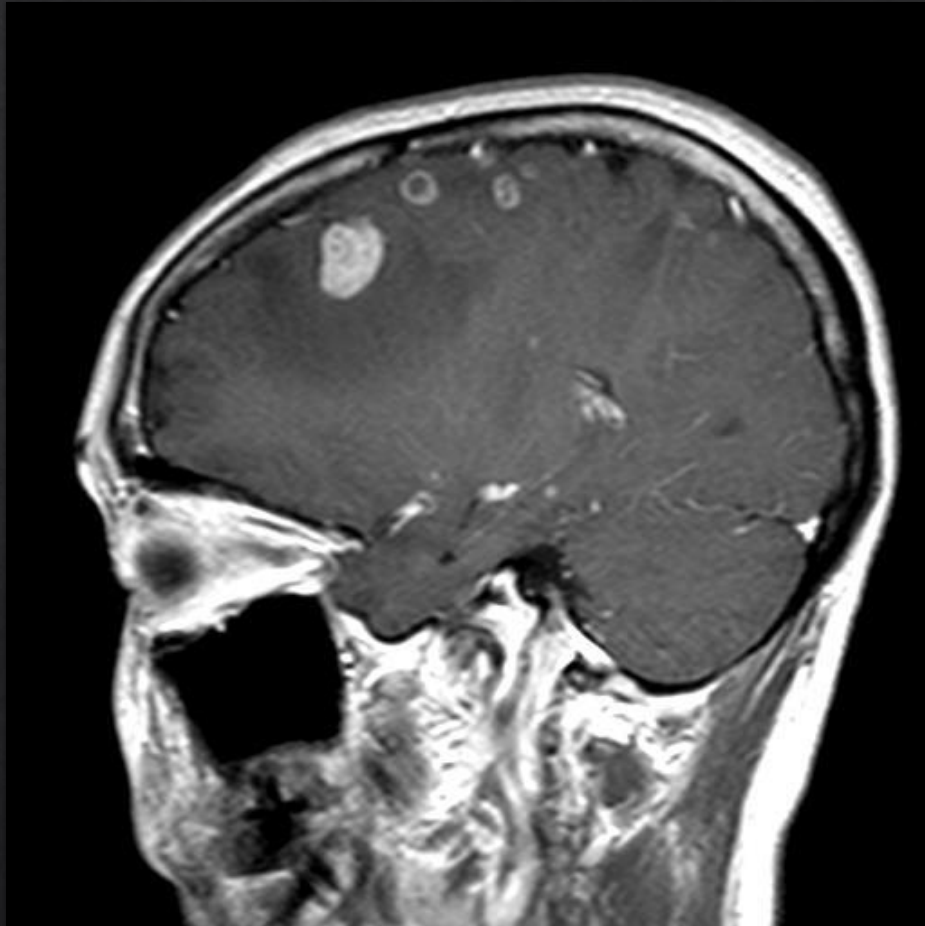


췌기절제술

PET-CT



Brain MR and abdominal CT for distant metastasis





PATHOLOGIC DIAGNOSIS OF NSCLC

INITIAL EVALUATION

CLINICAL STAGE

NSCLC

- Pathology review^a
- H&P (include performance status + weight loss)^b
- CT chest and upper abdomen with contrast, including adrenals
- CBC, platelets
- Chemistry profile
- Smoking cessation advice, counseling, and pharmacotherapy
- ▶ Use the 5 A's Framework: Ask, Advise, Assess, Assist, Arrange
<http://www.ahrq.gov/clinic/tobacco/5steps.htm>
- Integrate palliative care^c (See [NCCN Guidelines for Palliative Care](#))
- For tools to aid in the optimal assessment and management of older adults, see the [NCCN Guidelines for Older Adult Oncology](#)

Stage IA, peripheral^d (T1abc, N0)

Stage IB, peripheral^d (T2a, N0);
Stage I, central^d (T1abc–T2a, N0);
Stage II (T1abc–T2ab, N1; T2b, N0);
Stage IIB (T3, N0)^e; Stage IIIA (T3, N1)

Stage IIB^f (T3 invasion, N0);
Stage IIIA^f (T4 extension, N0–1; T3, N1; T4, N0–1)

Stage IIIA^f (T1–2, N2); Stage IIIB (T3, N2)

Separate pulmonary nodule(s) (Stage IIB, IIIA, IV)

Multiple lung cancers

Stage IIIB^f (T1–2, N3); Stage IIIC (T3, N3)

Stage IIIB^f (T4, N2); Stage IIIC (T4, N3)

Stage IVA (M1a)^c (pleural or pericardial effusion)

Stage IVA (M1b)^c

Stage IVB (M1c)^c disseminated metastases

[See Pretreatment Evaluation \(NSCL-2\)](#)

[See Pretreatment Evaluation \(NSCL-3\)](#)

[See Pretreatment Evaluation \(NSCL-5\)](#)

[See Pretreatment Evaluation \(NSCL-8\)](#)

[See Pretreatment Evaluation \(NSCL-8\)](#)

[See Treatment \(NSCL-10\)](#)

[See Pretreatment Evaluation \(NSCL-12\)](#)

[See Pretreatment Evaluation \(NSCL-13\)](#)

[See Pretreatment Evaluation \(NSCL-13\)](#)

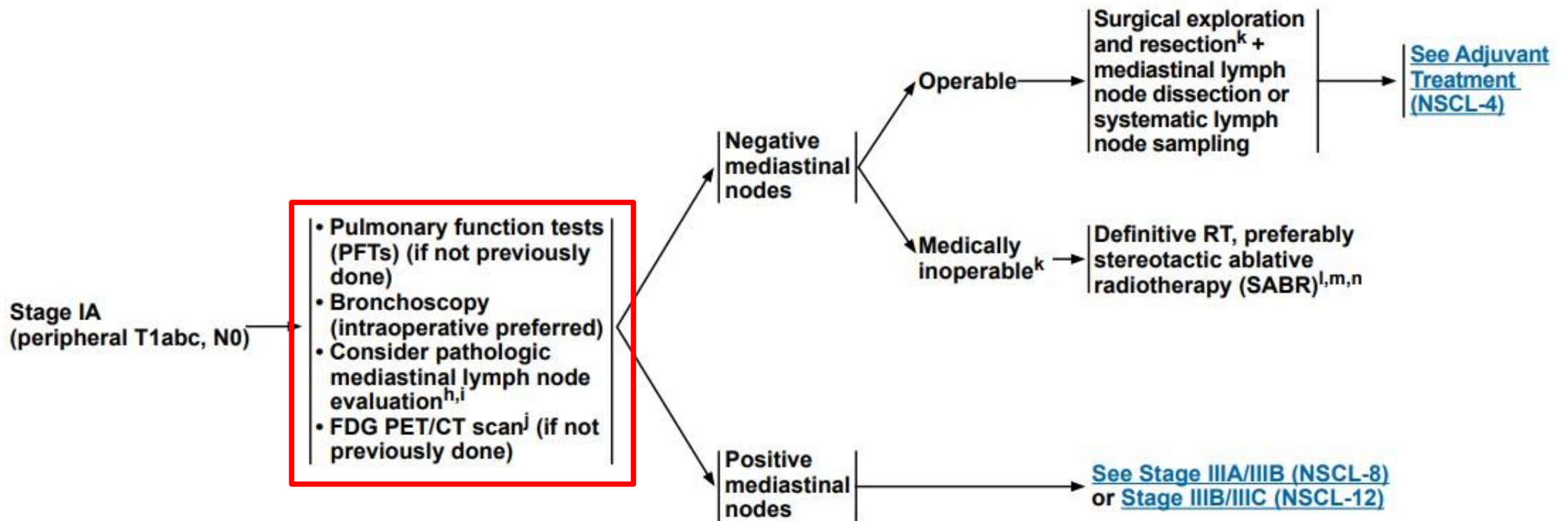
[See Pretreatment Evaluation \(NSCL-14\)](#)

[See Systemic Therapy \(NSCL-18\)](#)



CLINICAL ASSESSMENT PRETREATMENT EVALUATION^g

INITIAL TREATMENT





CLINICAL ASSESSMENT PRETREATMENT EVALUATION^g INITIAL TREATMENT

Stage IB (peripheral T2a, N0)
Stage I (central T1abc–T2a, N0)
Stage II (T1abc–2ab, N1; T2b, N0)
Stage IIB (T3, N0)^e
Stage IIIA (T3, N1)

- PFTs (if not previously done)
- Bronchoscopy
- Pathologic mediastinal lymph node evaluation^h
- FDG PET/CT scan^j (if not previously done)
- Brain MRI with contrast^o (Stage II, IIIA) (Stage IB [optional])

Negative mediastinal nodes

Operable

Surgical exploration and resection^{k,p,q} + mediastinal lymph node dissection or systematic lymph node sampling

[See Adjuvant Treatment \(NSCL-4\)](#)

Medically inoperable^k

N0 → Definitive RT, preferably SABR^{l,n}

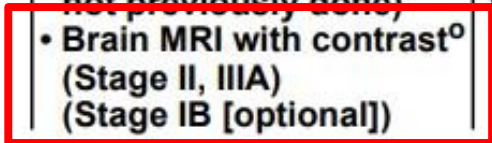
Consider adjuvant chemotherapy^r for high-risk stages IB–IIB^s

N1 → Definitive chemoradiation^{l,t}

Durvalumab^{t,u} (category 1 stage III; category 2A stage II)

Positive mediastinal nodes

[See Stage IIIA/IIIB \(NSCL-8\)](#) or [Stage IIIB/IIIC \(NSCL-12\)](#)





CLINICAL ASSESSMENT

PRETREATMENT EVALUATION

CLINICAL EVALUATION

Stage IIB (T3 invasion, N0)
Stage IIIA (T4 extension,
N0-1; T3, N1; T4, N0-1)

- PFTs (if not previously done)
- Bronchoscopy
- Pathologic mediastinal lymph node evaluation^h
- Brain MRI with contrast^o
- MRI with contrast of spine + thoracic inlet for superior sulcus lesions abutting the spine or subclavian vessels
- FDG PET/CT scan^l (if not previously done)

Superior sulcus tumor → [See Treatment \(NSCL-6\)](#)

Chest wall → [See Treatment \(NSCL-7\)](#)

Proximal airway or mediastinum → [See Treatment \(NSCL-7\)](#)

Stage IIIA (T4, N0-1) → [See Treatment \(NSCL-7\)](#)

Unresectable disease → [See Treatment \(NSCL-7\)](#)

Positive mediastinal nodes → [See Stage IIIA/IIIB \(NSCL-8\)](#)

Metastatic disease → [See Treatment for Metastasis limited sites \(NSCL-14\) or distant disease \(NSCL-17\)](#)



CLINICAL ASSESSMENT

PRETREATMENT EVALUATION

MEDIASTINAL BIOPSY FINDINGS AND RESECTABILITY

Stage IIIA (T1–2, N2)
Stage IIIB (T3, N2)

- PFTs (if not previously done)
- Bronchoscopy
- Pathologic mediastinal lymph node evaluation^h
- FDG PET/CT scan^j (if not previously done)
- Brain MRI with contrast^o

N2, N3 nodes negative

[See Treatment T1–3, N0–1 \(NSCL-9\)](#)

N2 nodes positive, M0

[See Treatment \(NSCL-9\)](#)

N3 nodes positive, M0

[See Stage IIIB \(NSCL-12\)](#)

Metastatic disease

[See Treatment for Metastasis limited sites \(NSCL-14\) or distant disease \(NSCL-17\)](#)

Separate pulmonary nodule(s)
(Stage IIB, IIIA, IV)

- PFTs (if not previously done)
- Bronchoscopy
- Pathologic mediastinal lymph node evaluation^h
- Brain MRI with contrast^o
- FDG PET/CT scan^j (if not previously done)

Separate pulmonary nodule(s), same lobe (T3, N0–1) or ipsilateral non-primary lobe (T4, N0–1)

[See Treatment \(NSCL-10\)](#)

Stage IVA (N0, M1a):
Contralateral lung (solitary nodule)

[See Treatment \(NSCL-10\)](#)

Extrathoracic metastatic disease

[See Treatment for Metastasis limited sites \(NSCL-14\) or distant disease \(NSCL-17\)](#)

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*

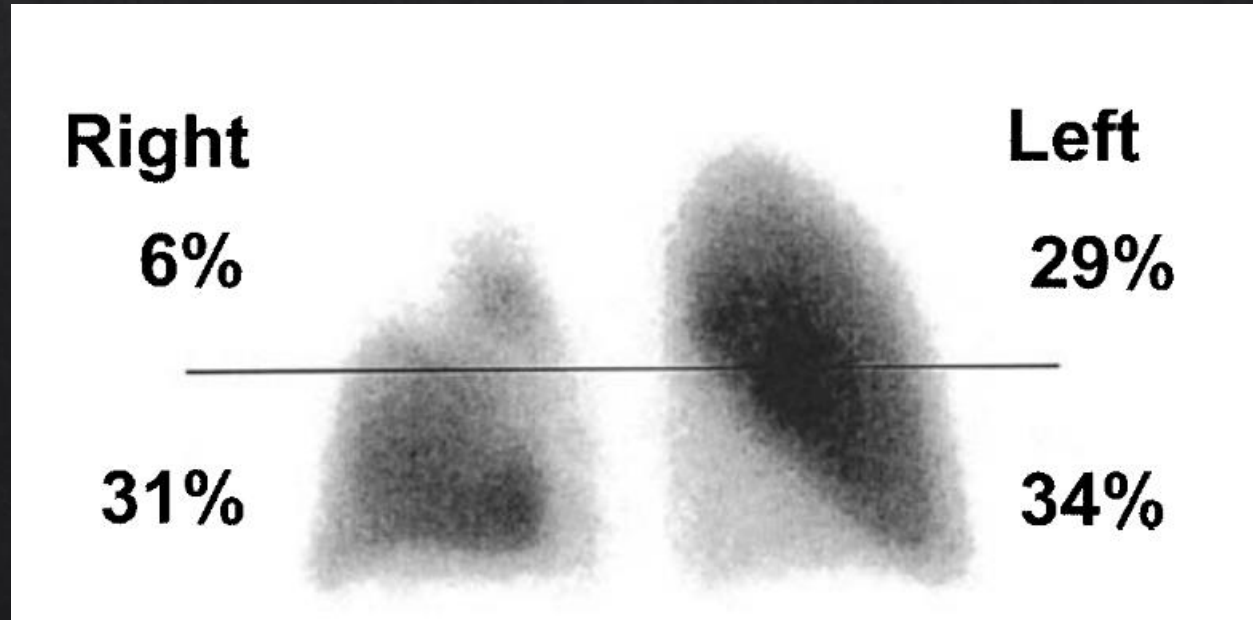
- ◇ Myocardial perfusion, Treadmil test, CAG
- ◇ Echocardiography

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



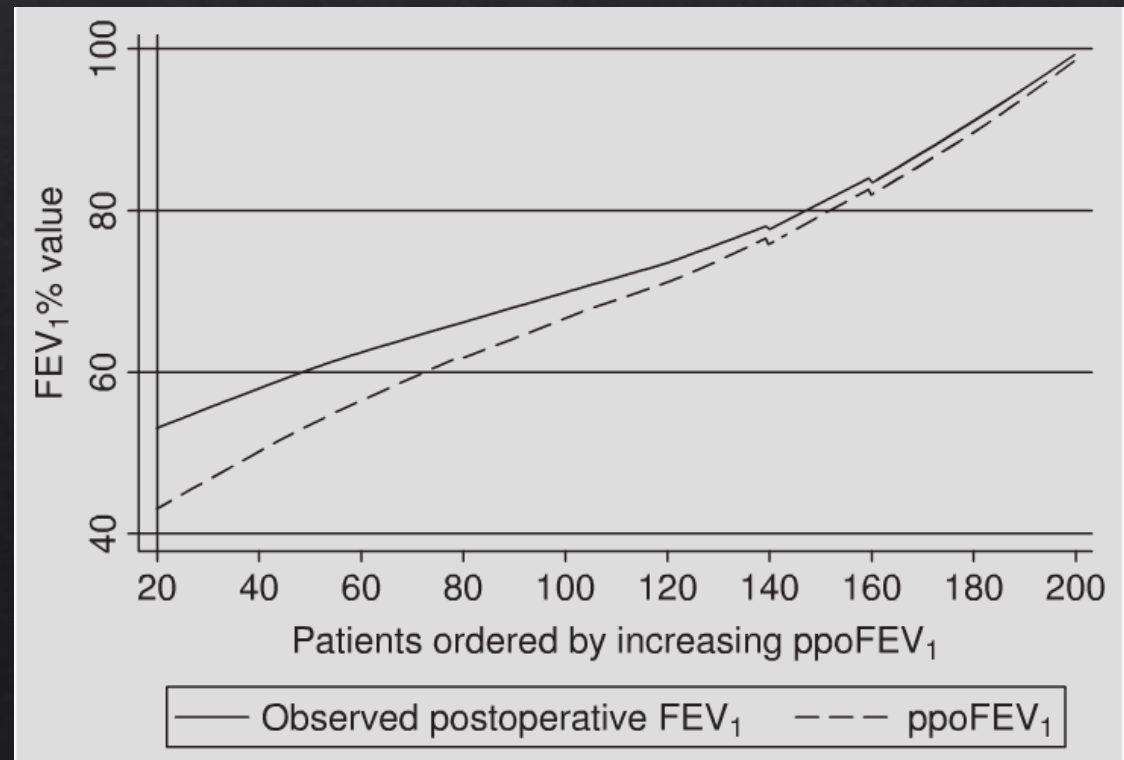
Predictive postoperative FEV1

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.



Assessment of suitability for lung resection

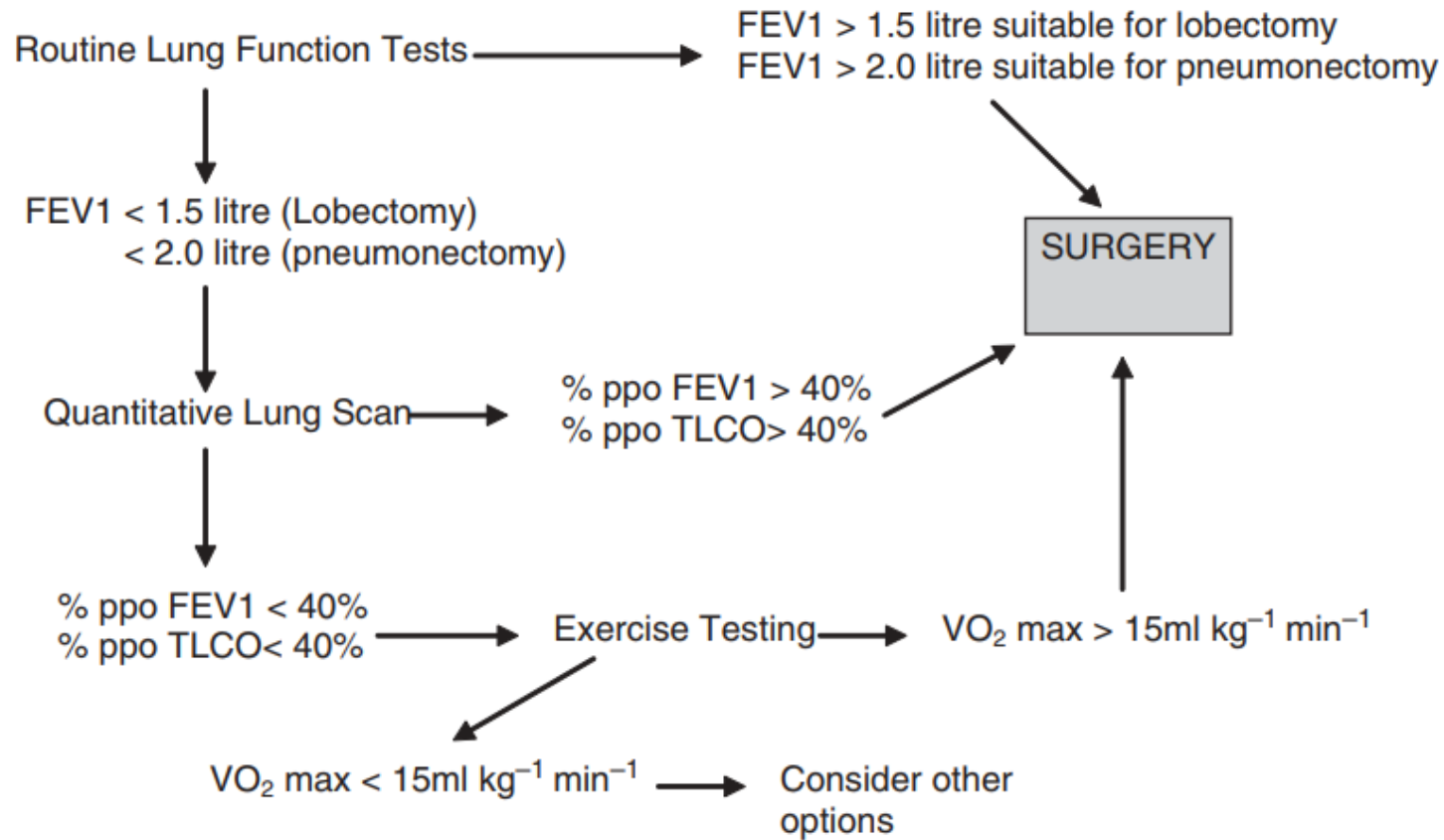
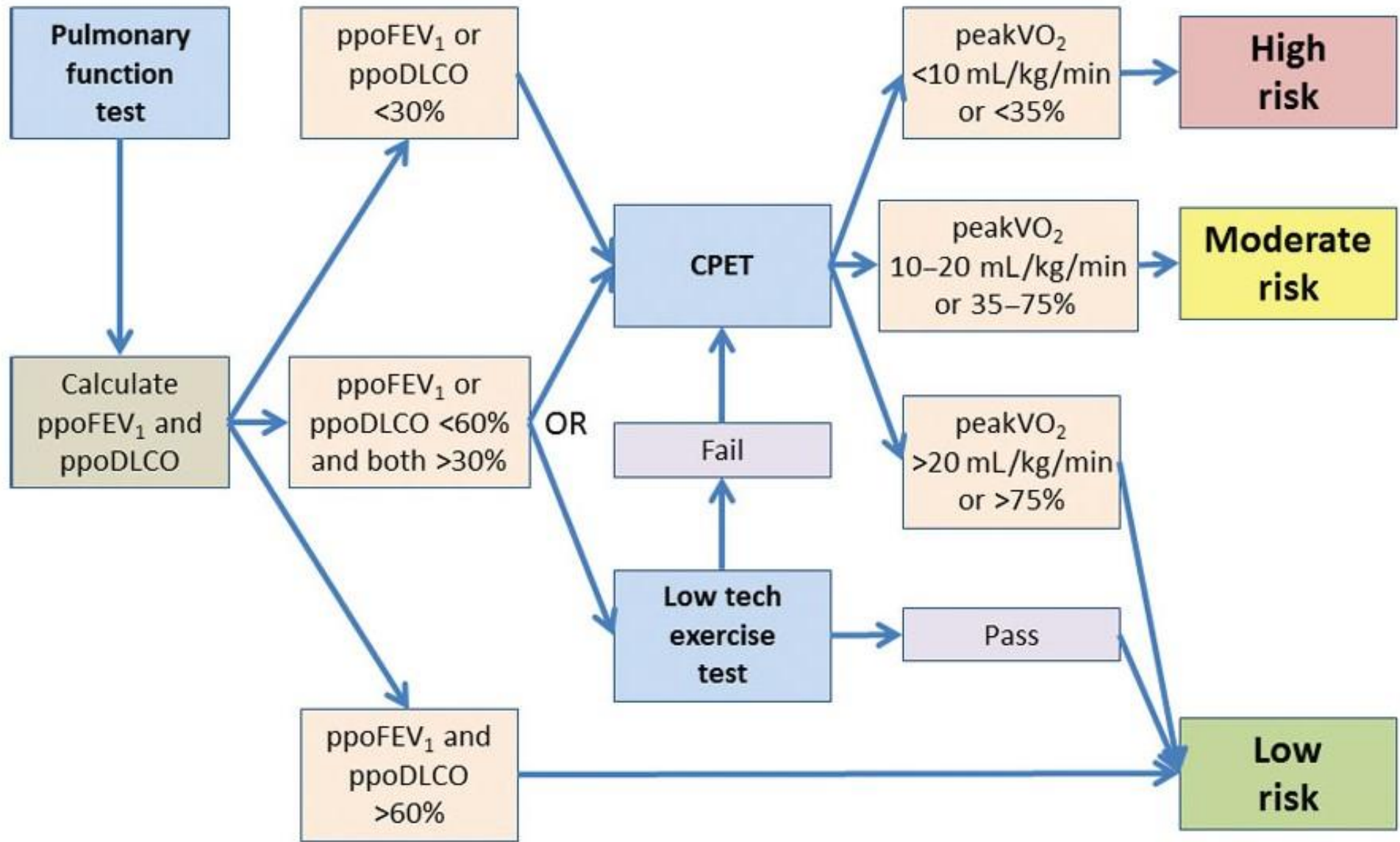
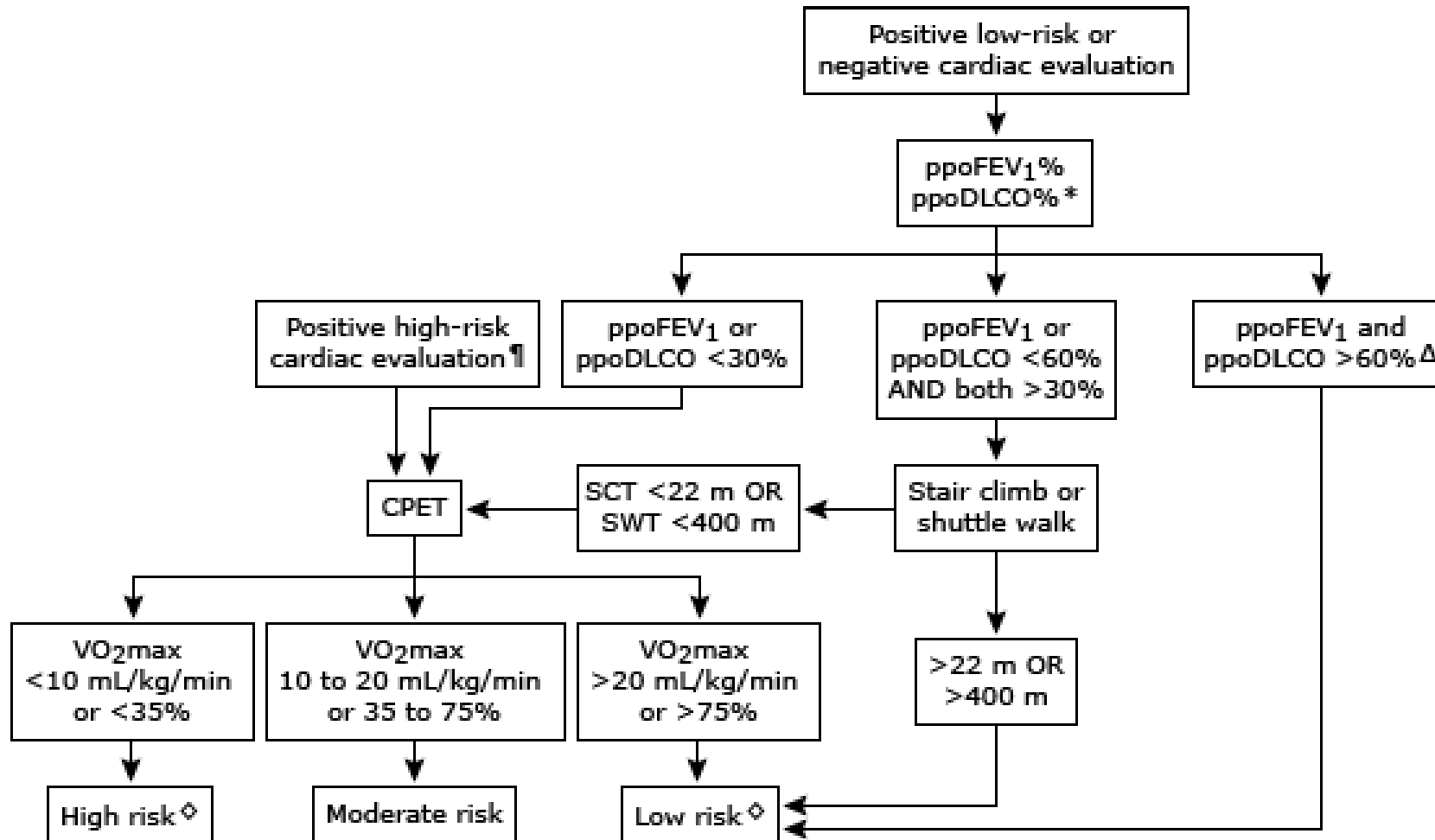


Fig. 3 Preoperative evaluation before lung resection.



Algorithm for pulmonary preoperative assessment of patients requiring lung resection



Physiologic evaluation resection algorithm.

Actual risks affected by parameters defined here and:

Up to date 2021

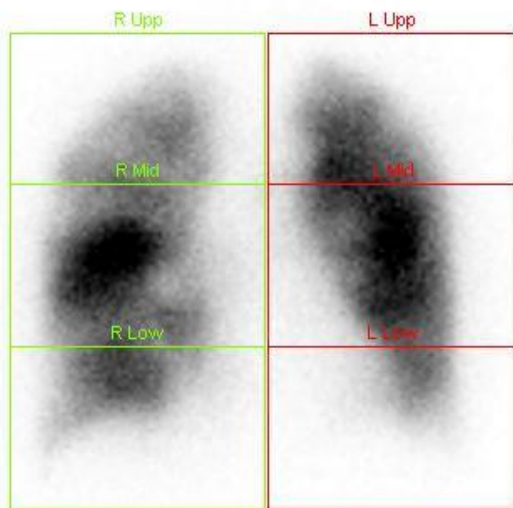
Risk group

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.**

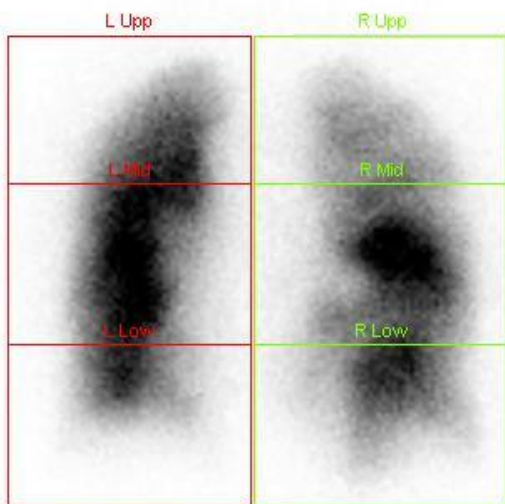
Case 1

- ◇ Compromised lung function
- ◇ Lung cancer (squamous cell carcinoma, T1c)
- ◇ Chronic obstructive pulmonary disease with
- ◇ PFT
 - ◇ FEV1 1.50L (51%), DLCO 65%
- ◇ **Lung perfusion scan**





ANT



POST



ANT



POST



LAO



RPO



RAO



LPO



RT LAT

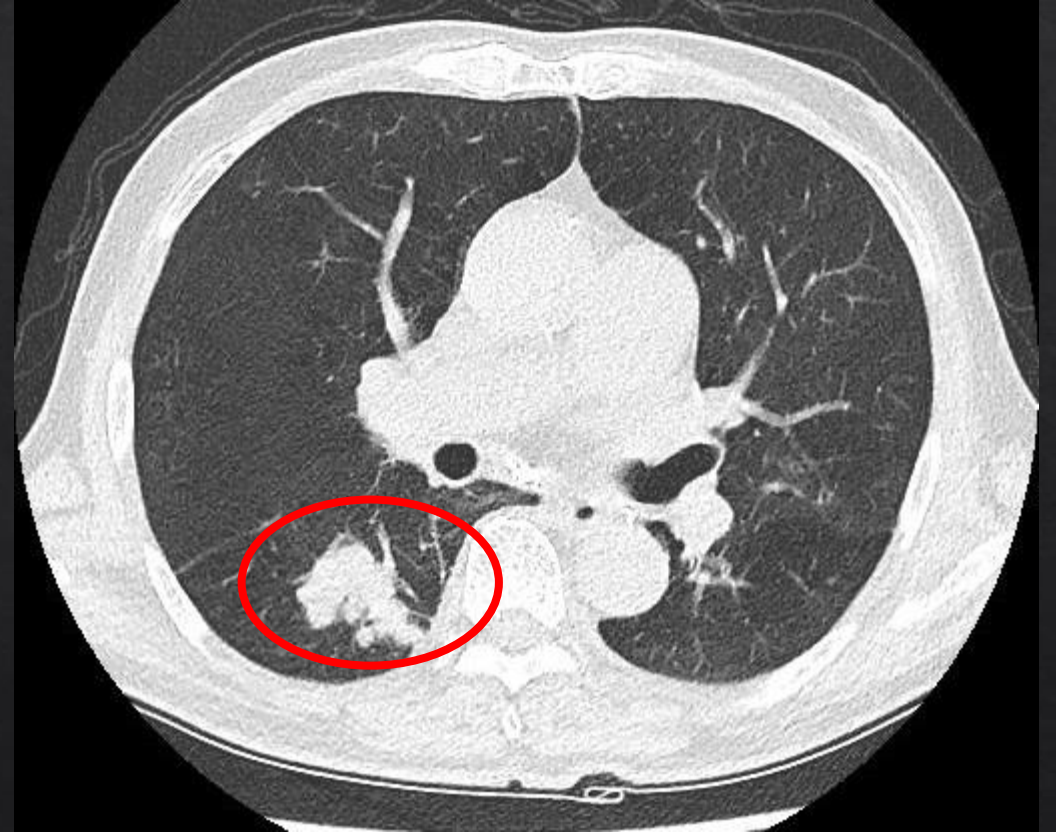


LT LAT

- ◇ **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 MLDN**
- ◇ Uneventful discharge at POD#5

Case 2

- ◇ Compromised lung function
- ◇ M/76
- ◇ RLL cancer
 - tumor size 4.0cm
 - Sup segment
- cT2aN0M0



◇ TMT - positive for MI, METS 10.5

➤ Cardiology consult: moderate risk

◇ PFT

➤ FEV1 1.44L (62%)

➤ DLCO 90%

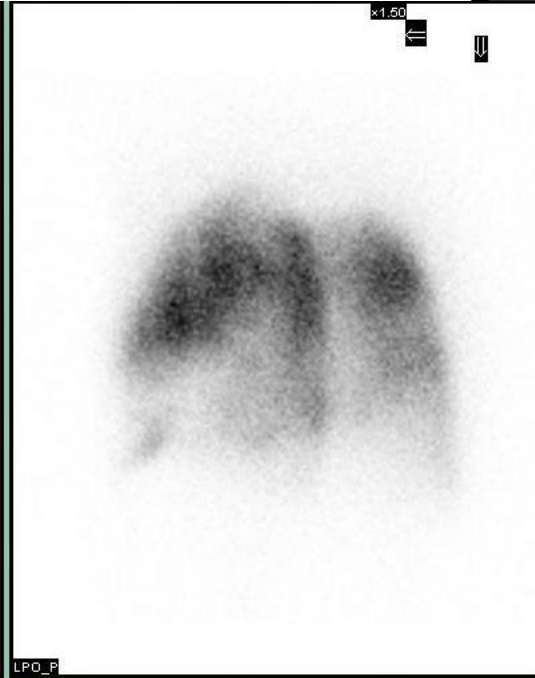
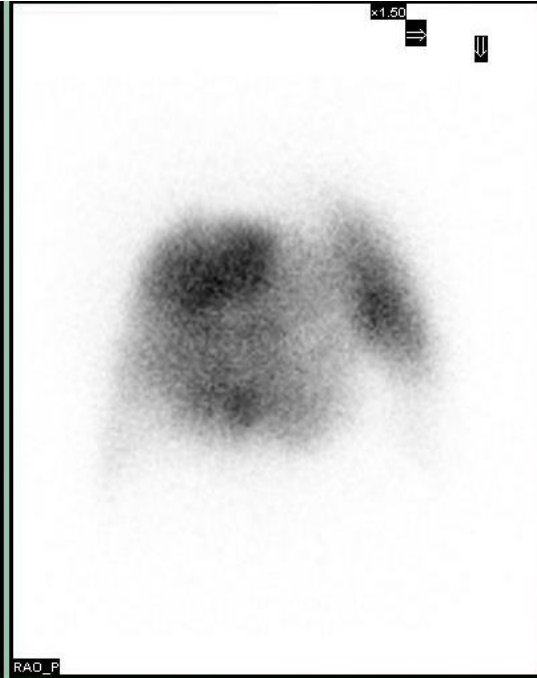
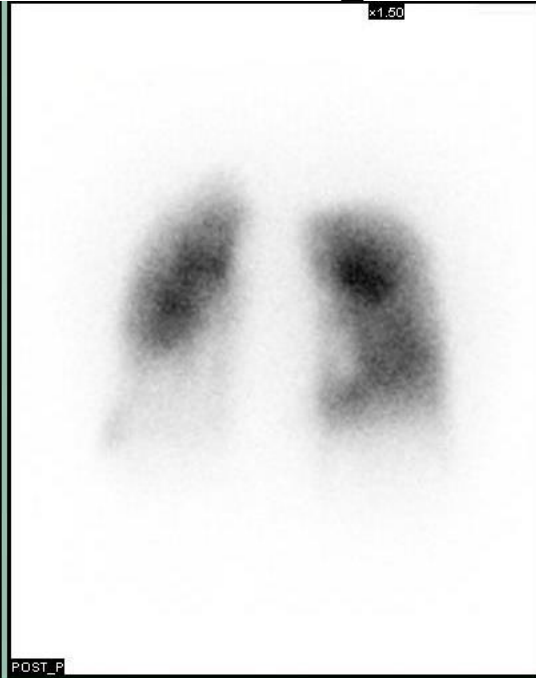
◇ **Lung perfusion scan**

KWON NAM YONG
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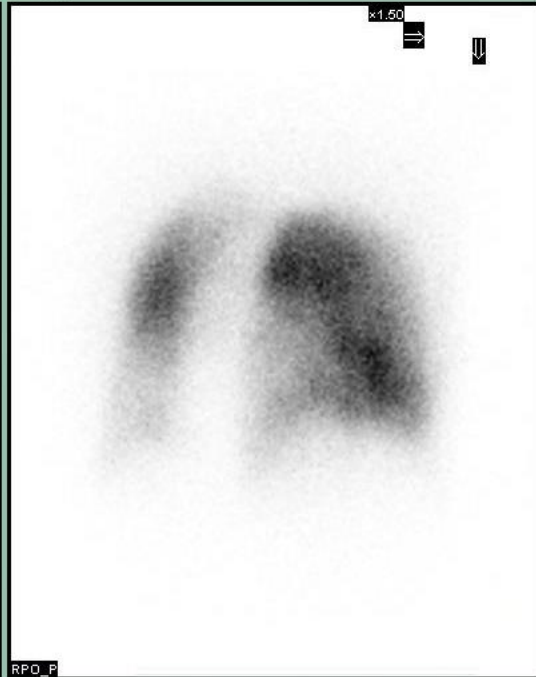
x1.25

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x1.25



4/3/2018
Lung Perfusion
ANT POST PERF
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Upper Zone: 1%

Middle Zone: 2%

Lower Zone: 5%

Total Lung: 4%

- ◇ Predicted postoperative FEV1 after RLL
- ◇ CEPT
 - VO2 max 16.2 mL/kg/min (45%), VE
- ◇ 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 fa

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%
<ul style="list-style-type: none">▪ Breast▪ Dental▪ Endocrine▪ Eye▪ Gynaecology▪ Reconstructive▪ Orthopaedic—minor (knee surgery)▪ Urologic—minor	<ul style="list-style-type: none">▪ 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	<ul style="list-style-type: none">▪ Aortic and major vascular surgery▪ Peripheral vascular surgery

^aRisk 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

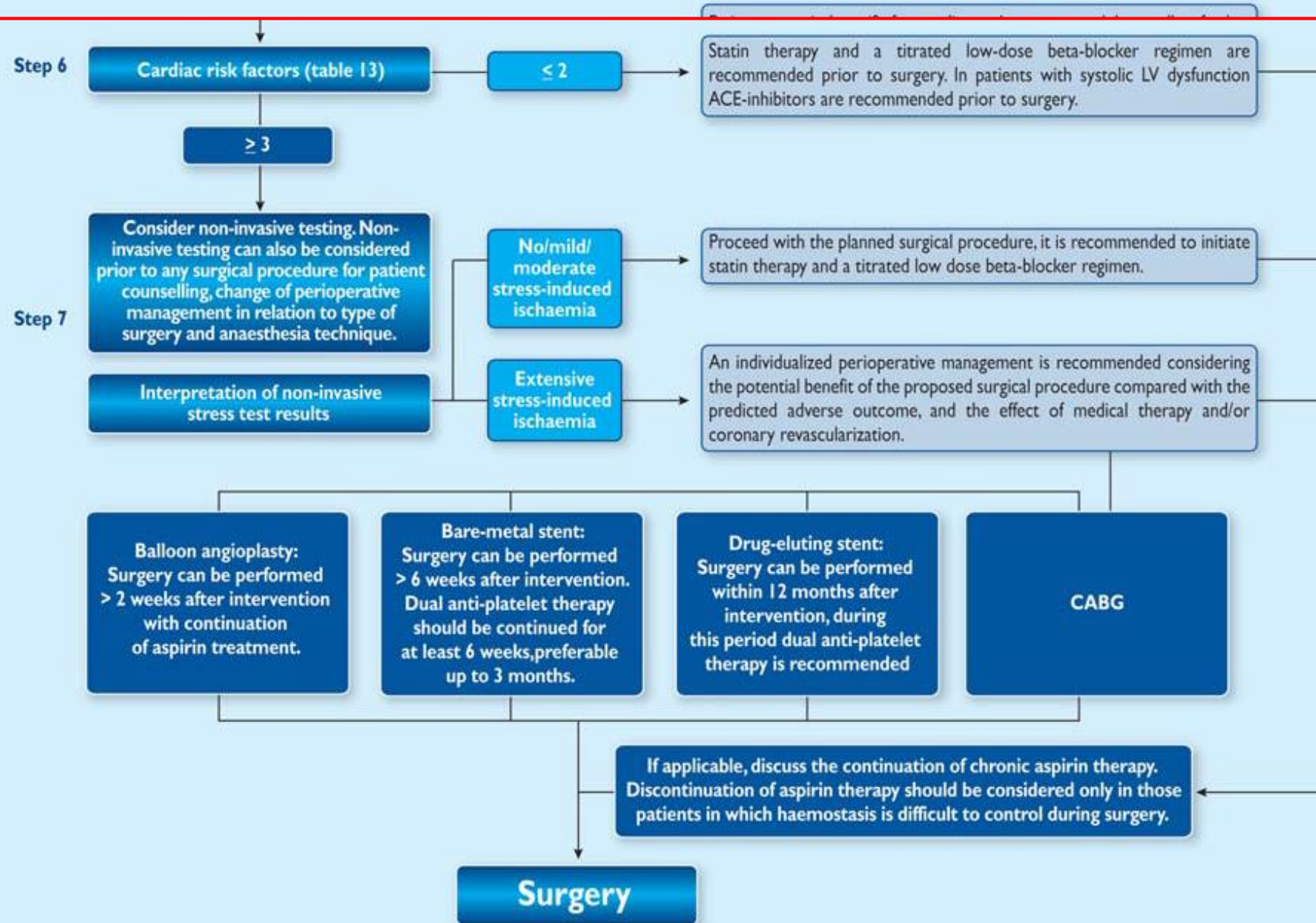
Renal dysfunction (serum creatinine >170 $\mu\text{mol/L}$ or 2 mg/dL or a creatinine clearance of <60 mL/min)

Diabetes mellitus requiring insulin therapy

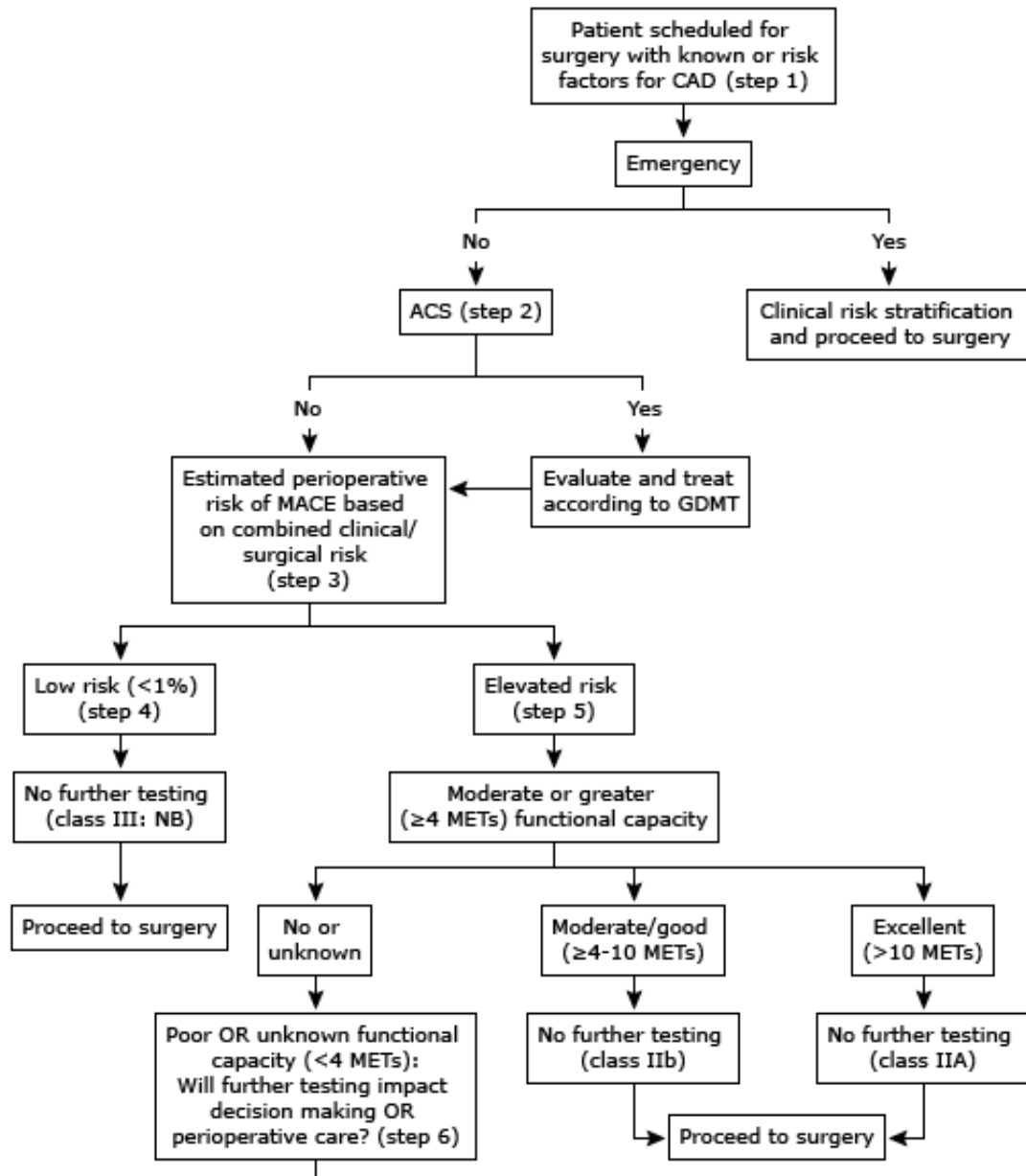
Functional activities (■는 심폐 기능 강화 활동이며 이보다 낮은 강도의 활동은 안전하게 시행 가능합니다.)

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

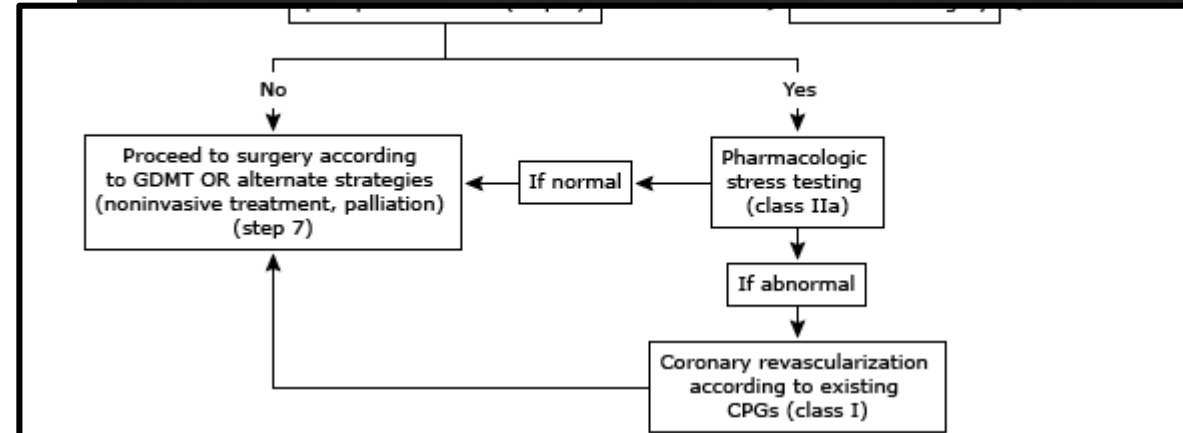
Summary of pre-operative cardiac risk evaluation and perioperative management



Stepwise approach to perioperative cardiac assessment for CAD



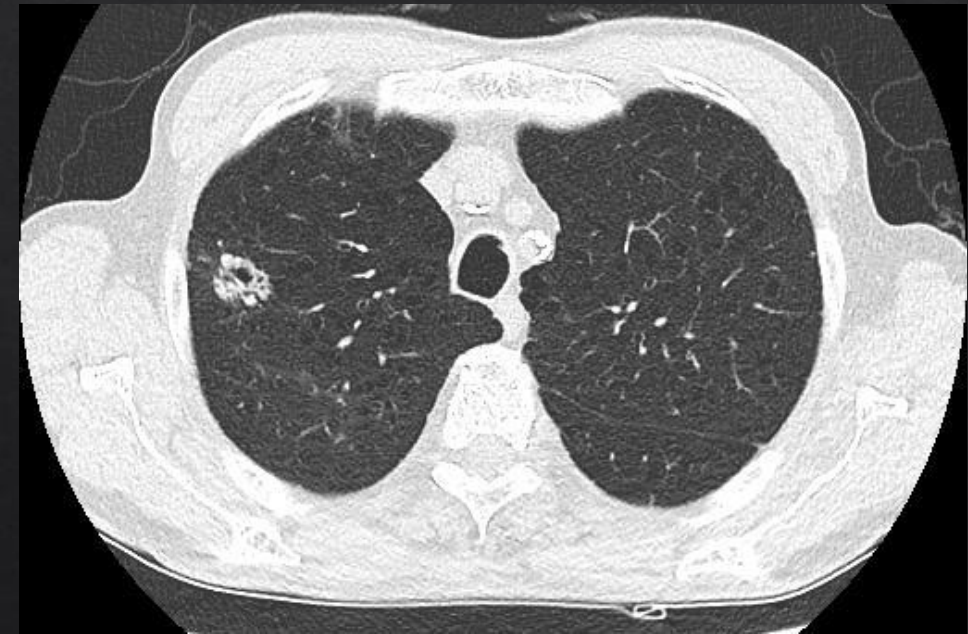
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ACS: acute coronary syndrome; CABG: coronary artery bypass graft surgery; CAD: coronary artery disease; CPG: clinical practice guideline; DASI: Duke Activity Status Index; GDMT: guideline-directed therapy; HF: heart failure; MACE: major adverse cardiac event; MET: metabolic equivalent; NB: no benefit; NSQIP: National Surgical Quality Improvement Program; PCI: percutaneous coronary intervention; RCRI: Revised Cardiac Risk Index; STEMI: ST elevation myocardial infarction; UA/NSTEMI: unstable angina/non-ST elevation myocardial infarction; VHD: valvular heart disease.

Case 3

- ◆ Compromised cardiac function - **ICMP**
- ◆ M / 75
- ◆ PCI (+) - 2012
- ◆ RUL cancer, large cell carcinoma, cT1cN0M0
- ◆ 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 MLDN**
- **No cardiac event**
- **TIA (+) -> delayed discharge**

Preoperative evaluation is important for
Decision making of
operability and suitable resection extent

경청해 주셔서 감사합니다!