

LUNG NODULES IN 30 MINUTES

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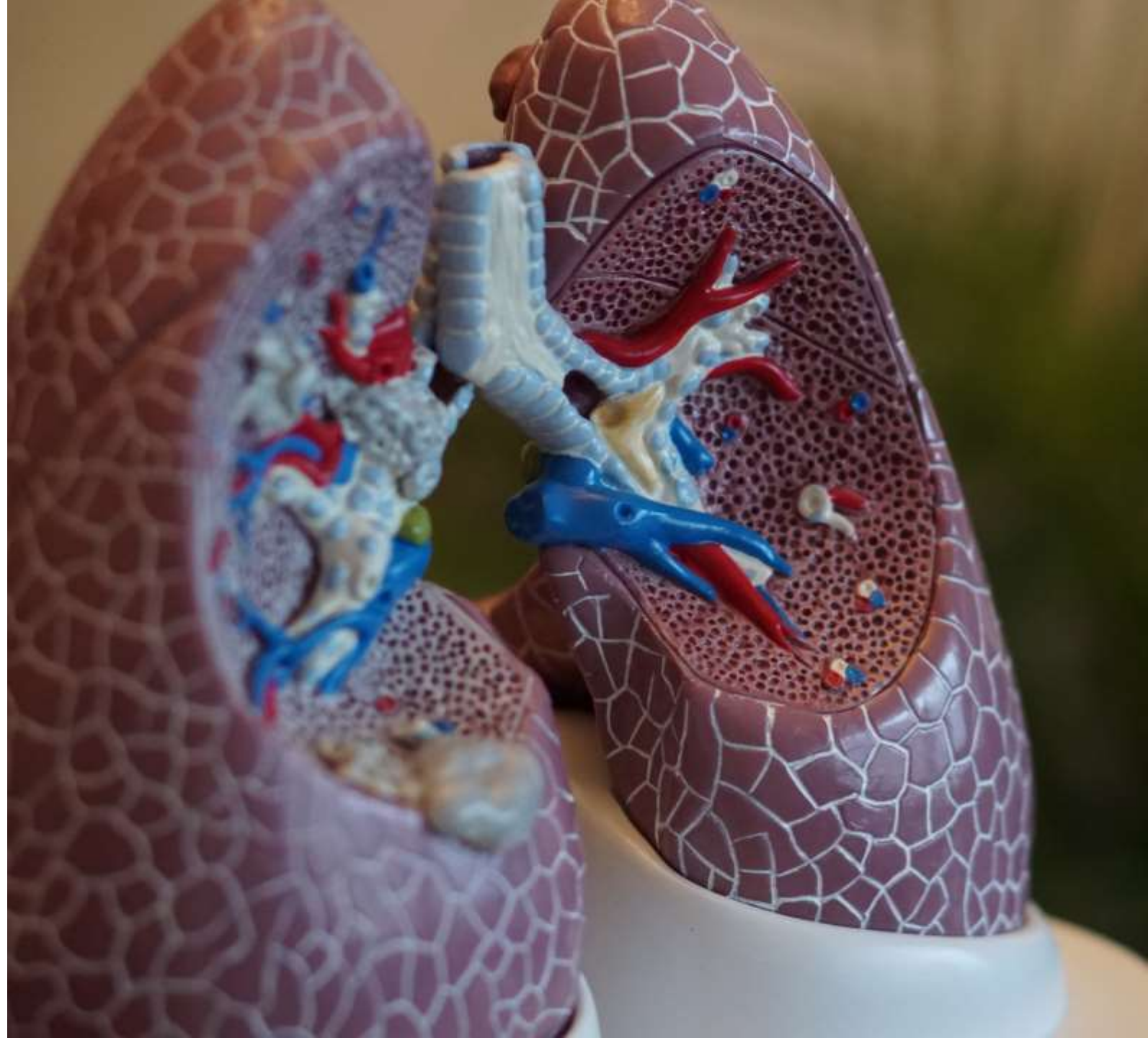
ACKNOWLEDGMENT



TRADITIONAL OWNERS OF THIS LAND

DISCLOSURES

I do not have any financial
or other disclosures



PDF of his talk and a one page summary is available for download at www.lokeshyagnik.com/education

INTERVENTIONAL
Pulmonology Clinic

IMPORTANT INFORMATION CLICK HERE: COVID19/ CLINIC CLOSURES

HOME ABOUT PATIENTS **REFERRERS** CONTACT

EDUCATION

Dear Colleagues,

I shall be updating this page regularly with useful information pertaining to respiratory medicine and Interventional pulmonology (IP). IP is a rapidly evolving speciality that has a role in every aspect of respiratory medicine in a diagnostic and therapeutic role.

I shall post links to download CME talks I have done for GPs

If you would like to know more about any of our services and would like me to visit your practice for a lunch time CME meeting then please contact me via the email above.

GP CME - Downloads

Talk 1: Lung nodule evaluation update	- Full Talk	- One page summary	- Quiz
Talk 2: COPD	- Full Talk	- One page summary	
Talk 3: Incidental lung nodule	- Full Talk		





QUIZ TIME

Visit [Slido.com](https://www.slido.com)

- Poll code # AIMALY



QUIZ QUESTION 1

How many types of lung nodules are there?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5

QUIZ QUESTION 2

You request a CT Chest for a 55yo M, recent exsmoker. It shows a 18mm solid nodule in the right upper lobe. Radiologist recommends consider a PET scan or repeat scan in 3 months time. FDG PET scan shows the nodule is mildly/not FDG avid. What do you do?

- A. Not PET avid, not cancer, ignore
- B. Refer to cardiothoracic surgeon for a right upper lobectomy
- C. Arrange CT guided biopsy via your local radiologist
- D. Arrange a Spirometry
- E. Refer to respiratory physician

QUIZ QUESTION 3

50 year old Asian lady never smoker lady with no family history of lung cancer has a check CT overseas. CT chest shows a 18mm RUL pure ground glass nodule. Which of the following statements are not correct?

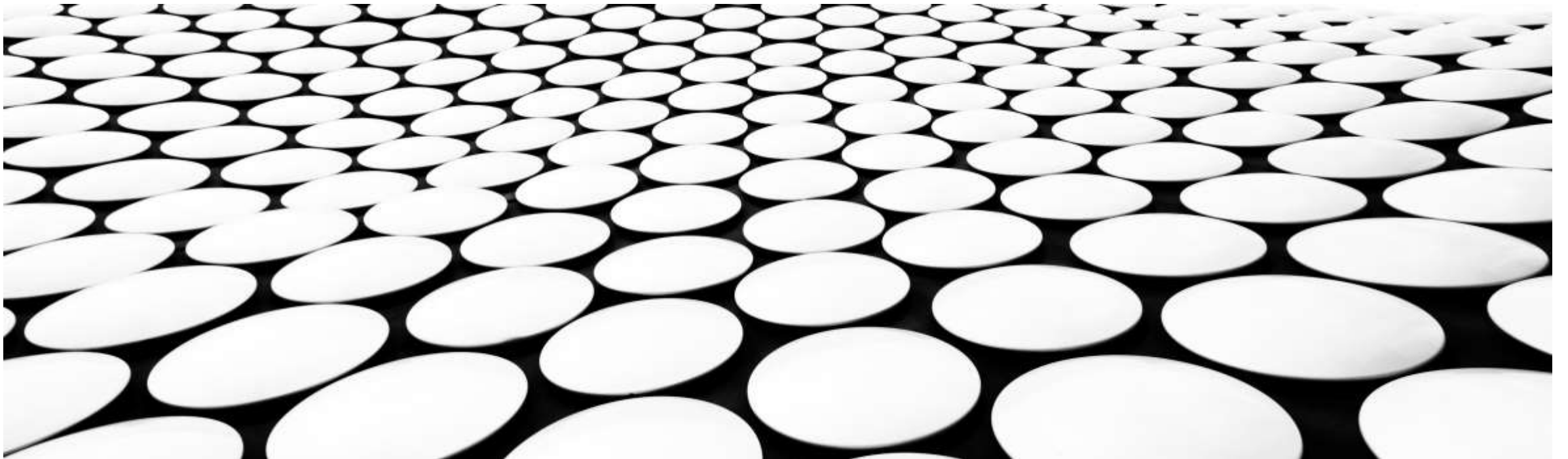
- A. FDG PET scan will determine if this nodule is benign
- B. She has risk factors for developing lung cancer
- C. The nodule is high risk for being lung cancer
- D. Repeat CT at 3 months is indicated
- E. Review of any previous imaging is indicated

QUIZ QUESTION 4

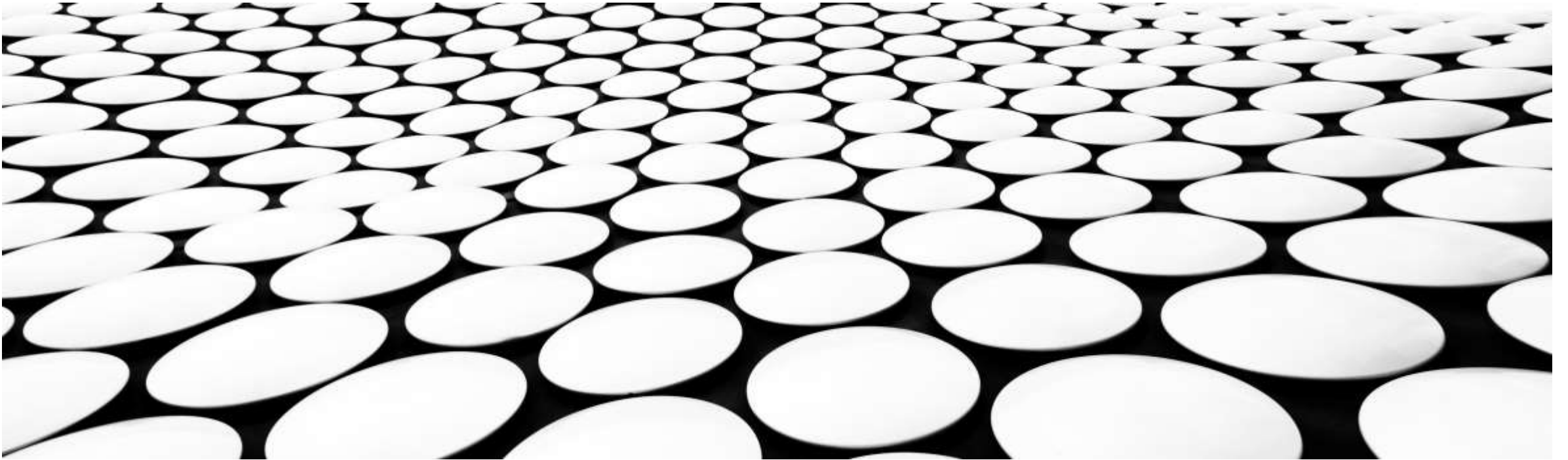
65 year old lady has a CTCA for atypical chest pain. A 6mm solid nodule is seen in right lower lobe. Radiologist states nodule is indeterminate and recommends a repeat scan in 6 months. What is your immediate next step?

- A. Arrange a CTCA in 6 months
- B. Arrange a CT chest in 6 months
- C. Arrange a CT chest now
- D. Refer to respiratory physician
- E. Refer to a cardiothoracic surgeon
- F. Too small to be cancer, ignore

LUNG NODULES IN 30 MINUTES



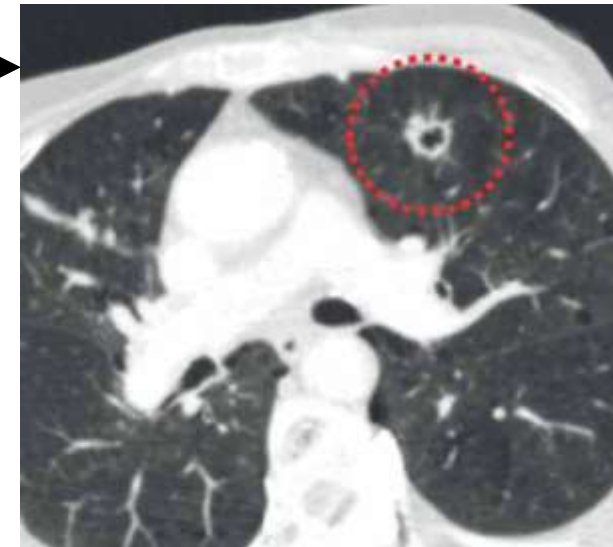
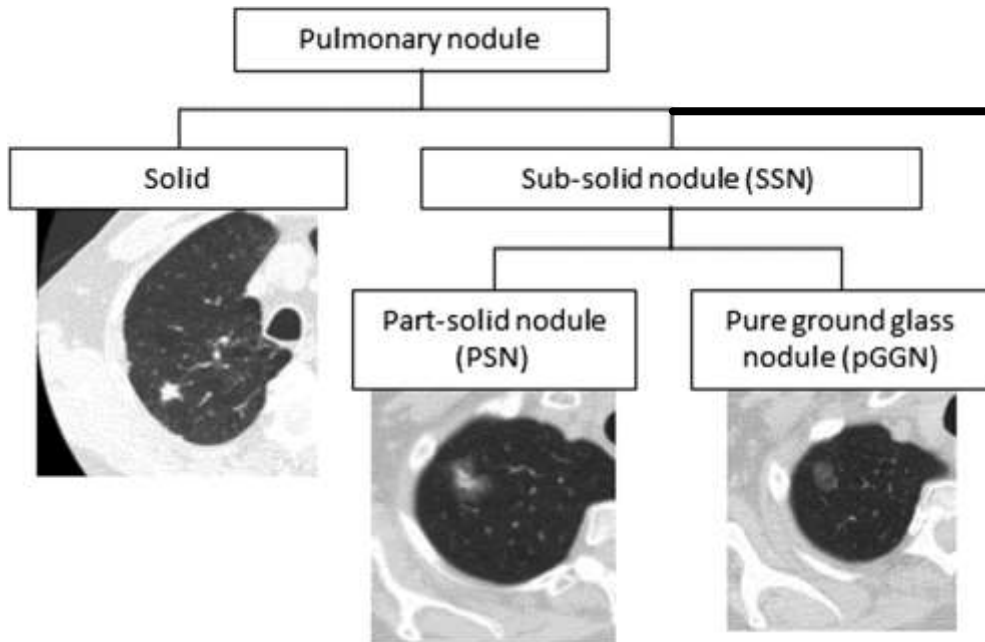
**HISTORICALLY
LUNG NODULES IN 30 SECONDS → CUT IT OUT!**



TYPES OF LUNG NODULES

- Well defined pulmonary parenchymal opacity < 3cm in size

Consolidation/other terminologies have specific radiological definitions



- Type 1 exophytic solid nodule
- Type 2 endophytic solid nodule
- Type 3 asymmetrical or circumferential wall thickening
- Type 4 multilocular cystic lesion

Perifissural nodules are benign representing intrapulmonary lymph nodes*

Lung cancer associated with cystic air spaces (LC-CAS)

Guidelines for Management of Incidental Pulmonary Nodules Detected on CT
Images: From the Fleischner Society 2017 MacMahon et al Radiology: Volume 284:
Number 1–July 2017

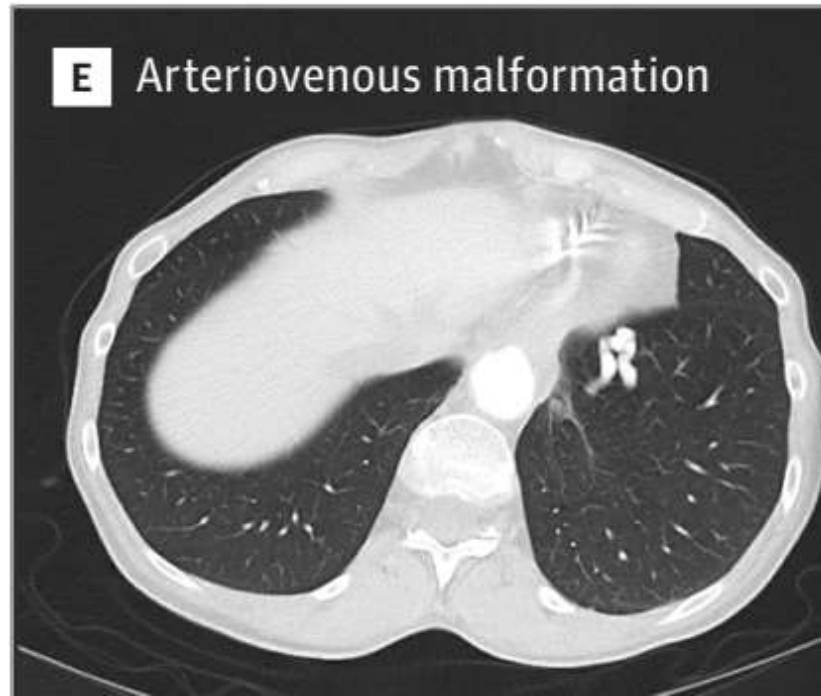
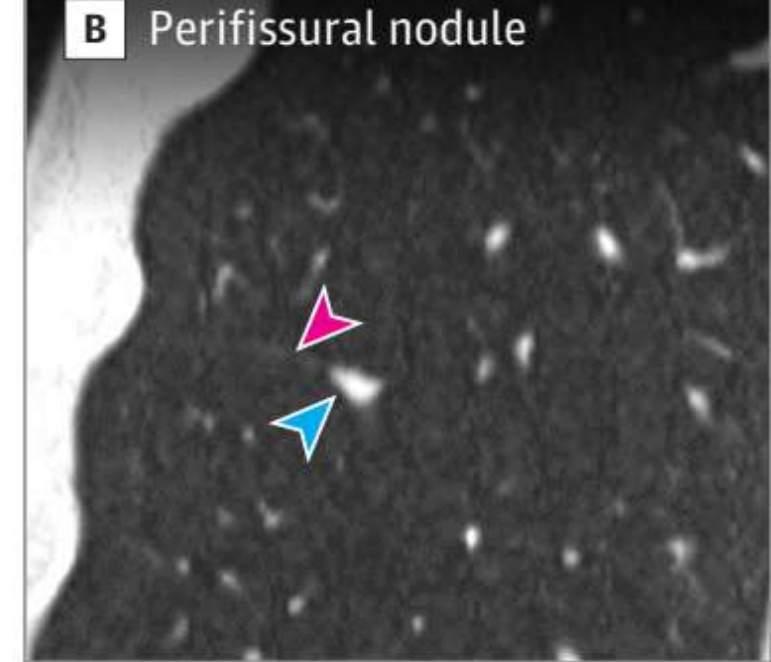
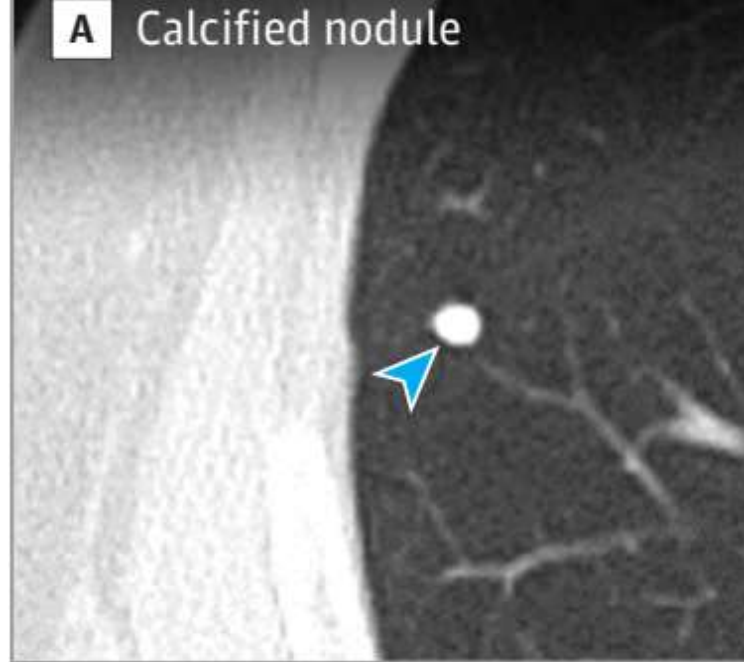
Snoeckx et al J Thorac Dis 2019;11(3):987-1004
Mets et al Eur Respir Rev 2018; 27: 180079



WHY LUNG NODULES?

1. LUNG NODULES ARE COMMON

- USA: 1.6 million people/year
- ~ 30% of all CT chest
- Not all nodules are lung cancer
- 95% of detected lung nodules are benign

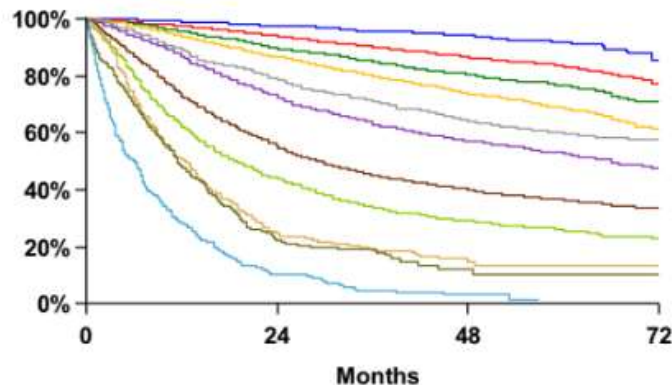




Incidental findings can kill you!

2. LUNG NODULES: AN OPPORTUNITY TO CURE LUNG CANCER

- Lung cancer is a rare disease, until tobacco smoke
- >1.6m deaths annually death worldwide
- **Majority have advanced stage disease at clinical presentation**
- Lung cancer as pulmonary nodule is early stage



Proposed	Events / N	MST	24 Month	60 Month
IA1	68 / 781	NR	97%	92%
IA2	505 / 3105	NR	94%	83%
IA3	546 / 2417	NR	90%	77%
IB	560 / 1928	NR	87%	68%
IIA	215 / 585	NR	79%	60%
IIB	605 / 1453	66.0	72%	53%
IIIA	2052 / 3200	29.3	55%	36%
IIIB	1551 / 2140	19.0	44%	26%
IIIC	831 / 986	12.6	24%	13%
IVA	336 / 484	11.5	23%	10%
IVB	328 / 398	6.0	10%	0%



3. NATIONAL LUNG CANCER SCREENING PROGRAM

Lung cancer screening trials
PLCO (CXR)
NLST (LDCT vs CXR)
NELSON (LDCT)
DANTE (LDCT)
DEPISCAN (LDCT vs CXR)
DLCST (LDCT vs CXR)
ITALUNG (LDCT)
MILD (LDCT)
LUSI (LDCT)
UKLS (LDCT)
ILST*

The National Lung Cancer Screening Program will maximise prevention and early detection of lung cancer.

On 2 May 2023, the Minister for Health and Aged Care, the Hon Mark Butler MP, [announced Government investment of \\$263.8 million from 2023-24 to implement a National Lung Cancer Screening Program](#), for commencement by July 2025.

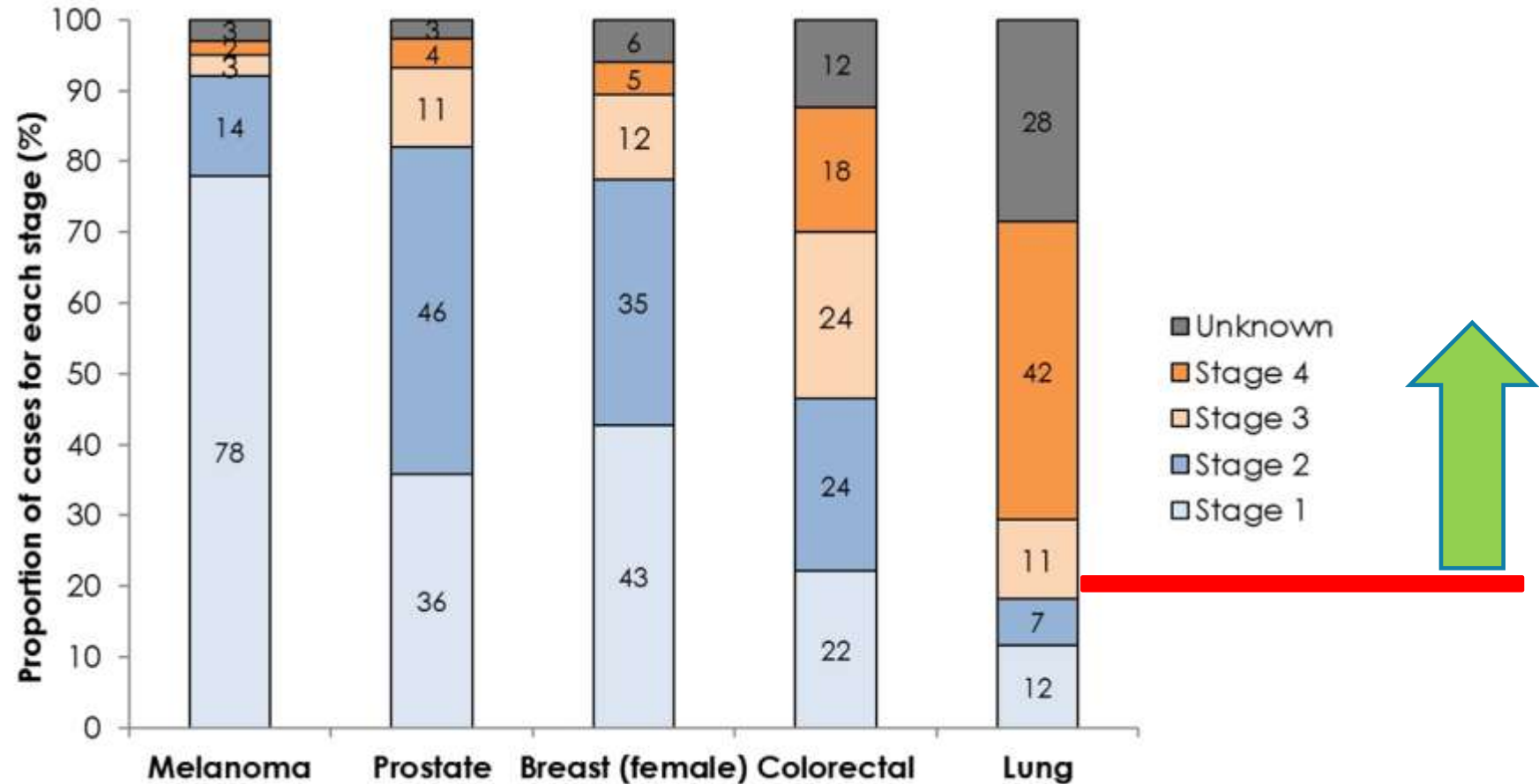
The announcement is a culmination of the [feasibility assessment conducted by Cancer Australia](#) and the positive recommendation from the [Medical Services Advisory Committee supporting the introduction of the program](#).

Co-designed with the First Nations health sector, the program will maximise prevention and early detection of lung cancer and achieve equity in cancer outcomes for vulnerable groups.

The program is expected to prevent over 500 lung cancer deaths per year.

Further information about implementation will be provided over coming months.

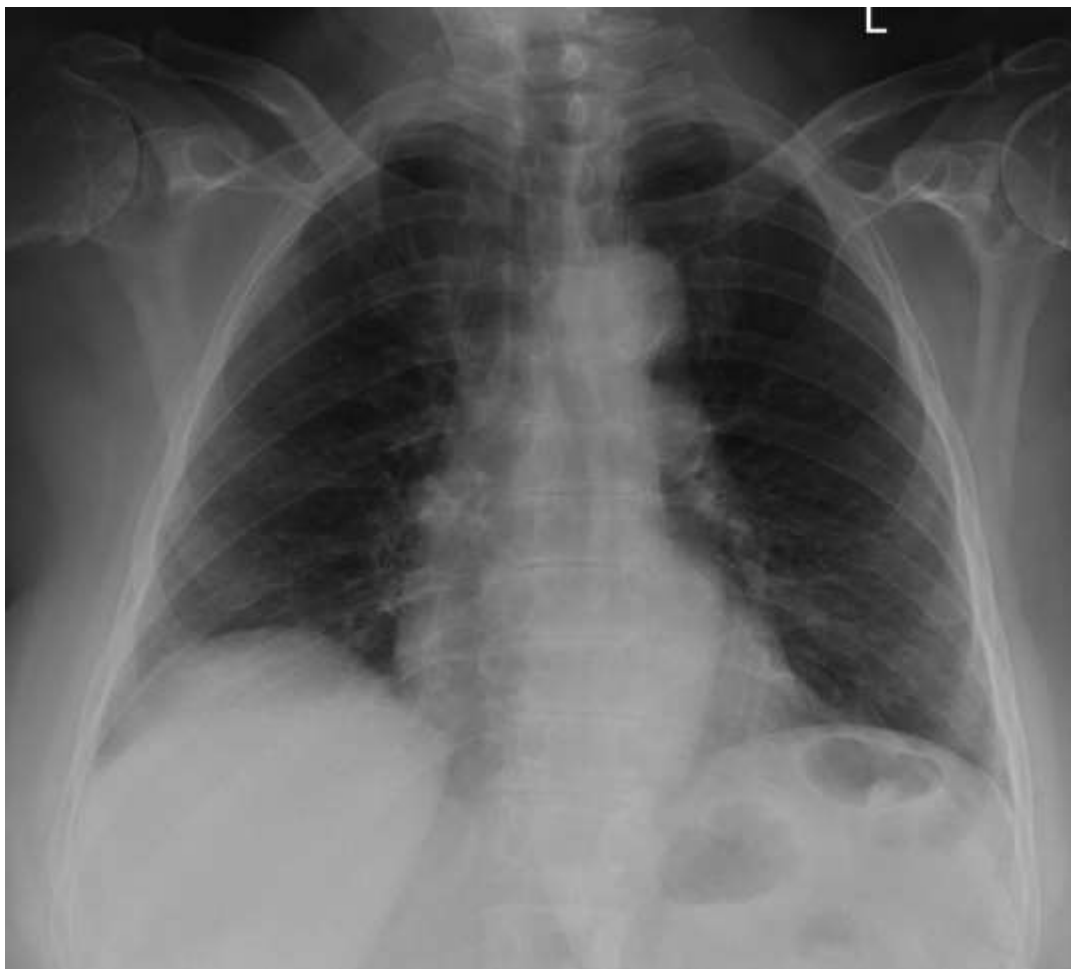
IMPACT OF SCREENING – STAGE SHIFT, MORE NODULES



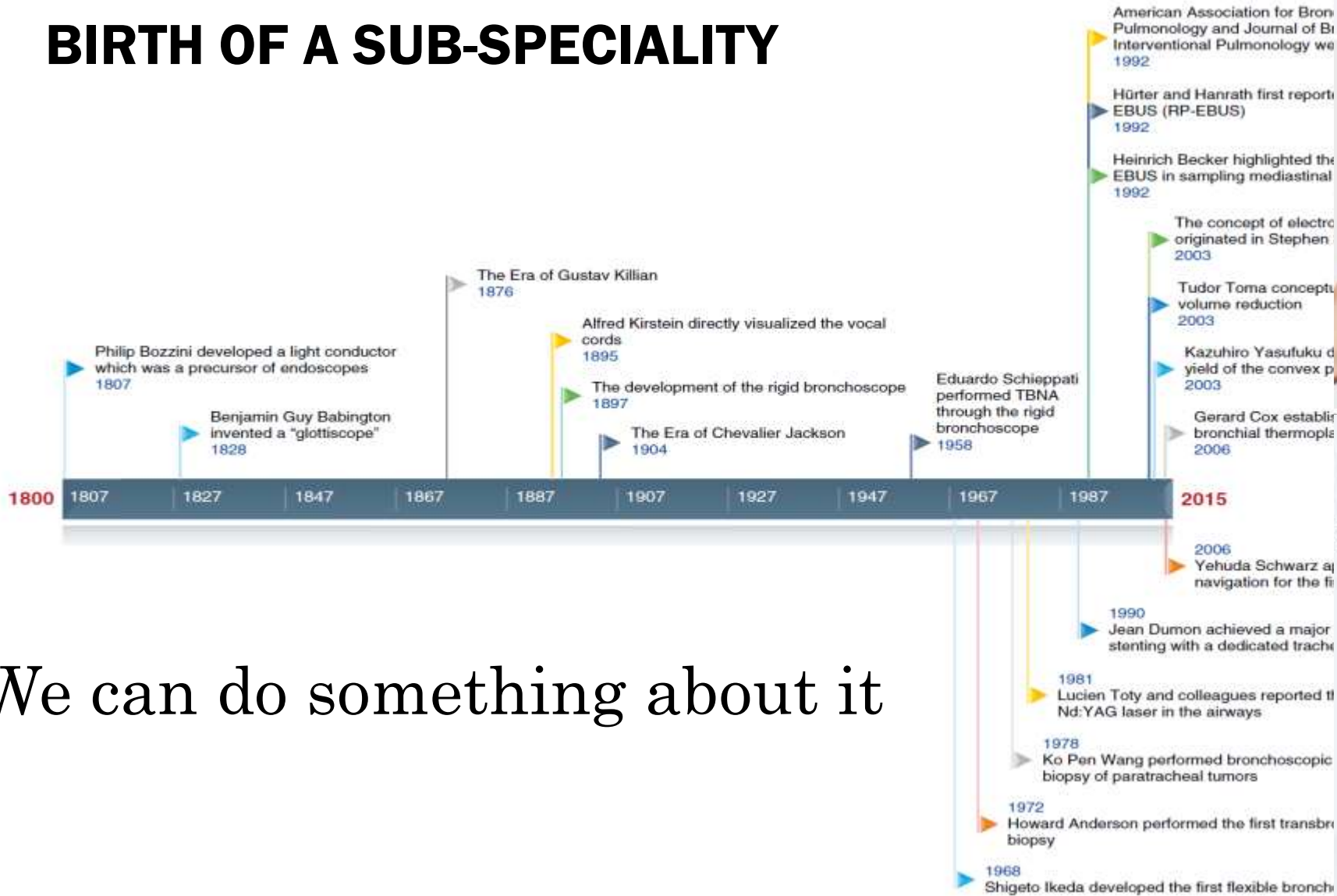
NLST trial LDCT arm - Stage I/II = 57.1%

Cancer Australia
NEJM 2011;365:395-409.

4. IMPROVED TECHNOLOGY

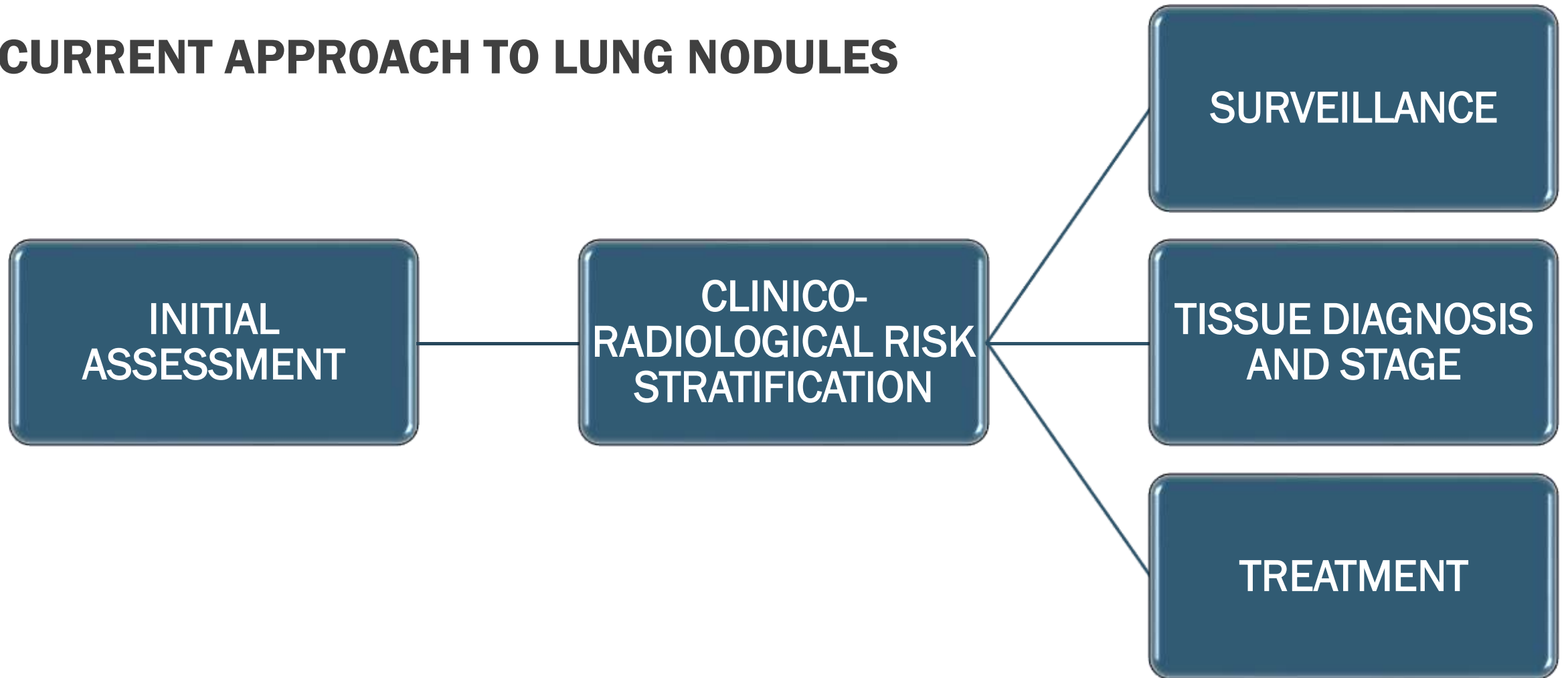


BIRTH OF A SUB-SPECIALITY



We can do something about it

CURRENT APPROACH TO LUNG NODULES





LUNG NODULE EVALUATION INITIAL STEPS

- What is the value of the scan? Partial CT vs CT chest vs type of CT chest
- What is the reliability of the report?
- Is there any old imaging?
- Are there any High risk features?

LUNG NODULE EVALUATION INITIAL STEPS

- Partial CT – Cardiac CT, head and neck CT, Aortic CT, Abdominal CT
 - May miss key findings which aid diagnosis and management planning
 - Inaccurate for nodule size measurement
 - Recommendation: Confirm findings with a CT chest (contrast) <NOT HRCT>
- Reliability of the report – Dependent on clinical information provided ?
- Previous imaging
 - Dedicated CT chest or Partial CT chest acceptable
 - Looking for an estimate of when the nodule started and has it evolved.
- High risk features
 - Lung masses (>3cm), Thoracic lymphadenopathy, indication of malignancy elsewhere, metastatic disease

NODULE MALIGNANCY RISK ASSESSMENT

- **Radiological characteristics:** Type, size, spiculation, architectural distortion
- **Clinical characteristics:** Smoking history, radiation exposure, family and past history
- **CT indication characteristics:** Incidental vs Symptomatic vs Screen detected

RADIOLOGIST RECOMMENDATION ARE BASED ON RADIOLOGICAL FEATURES

- Size
- Spiculation
- Persistence
- Enlargement
- Architectural distortion
- Calcification pattern



- A. Benign nodule
- B. Surveillance
- C. Biopsy
- D. Referral

CLINICAL RISK CALCULATORS

RISK PREDICTION MODEL	MAYO CLINIC MODEL	HERDER MODEL	VA MODEL	BROCK UNIVERSITY MODEL	CLEVELAND CLINIC MODEL
YEAR	1997s	2005	2007	2013	2019
TOTAL PATIENTS	629	106	375	1871	301
NODULE DETECTION	Incidental on CXR	Incidental on CXR + PET	Incidental on CXR + CT +/- PET	LDCT as part of screening	Incidental nodule referred to biopsy/ resection
MALIGNANT NODULES IN DEVELOPMENT COHORT	23%	57%	54%	5.5%	66.5%
VARIABLES	Age, Smoking, Hx extrathoracic malignancy, nodule size, spiculation, UL	Mayo clinic model + FDG PET	Age, smoking, time since quitting smoking, nodule size	Age, gender, nodule size, type, location, count, emphysema, family history,	Age, smoking, UL, solid and irregular/ spiculated edges, Emphysema, PET, Hx non lung ca
AOC	0.83	0.88	0.79	0.94	0.75-0.82



CT INDICATION CHARACTERISTICS

- Incidental nodule
- Screen detected nodule (50-70 yrs, smoker/exsmoker, FH cancer)
- Clinical case

Category	Low dose computed tomography finding	Action plan
CAT1	Normal finding, benign calcification, perifissural nodule, hamartoma, nodule risk index <1.5%	Consider biennial screening
CAT2	Low risk of malignancy: Nodule risk index 1.5% to <6%	Schedule annual repeat screening
CAT3	Moderate risk of malignancy: Nodule risk index 6% to <30%	Rescreen in 3 months: <ul style="list-style-type: none"> • If no growth, annual screening • If interval growth, refer for definitive diagnosis • May consider definitive diagnosis for nodule risk index between 10% and <30% after discussion between the clinician and patient
CAT4	High risk of malignancy: Nodule risk index \geq 30%	Refer for definitive diagnosis
CAT5	Suspicious for lung cancer: Mass lesion with a non-infectious cause; mediastinal or hilar lymphadenopathy irrespective of nodule size	Refer for definitive diagnosis

***ILST TRIAL**

Preoperative Staging of Lung Cancer
with Combined PET-CT
New England Journal of Medicine 2009;361:32-9

PET SCAN

- FDG PET scan is useful for detection of extrathoracic metastasis and prevent unnecessary surgery
- PET/CT is associated with clinically **relevant false positive** lymph nodes
 - DDx Granulomatous disease (TB, Histoplasmosis, Sarcoidosis), Anthrasilicosis
- Not very useful in
 - Determination of nodule is benign or malignant
 - Small nodules < 8mm
 - Ground glass nodules
 - Thoracic lymph node metastasis

Darling et al J Thorac Oncol. 2011;6: 1367-1372

ESTABLISHING A TISSUE DIAGNOSIS: PERIPHERAL LUNG NODULE

Cardiothoracic
Surgery



ENDOBRONCHIAL ULTRASOUND (EBUS)

Linear/Convex Probe EBUS

- Flexible bronchoscope with a convex ultrasound probe on the tip in addition of traditional white light camera

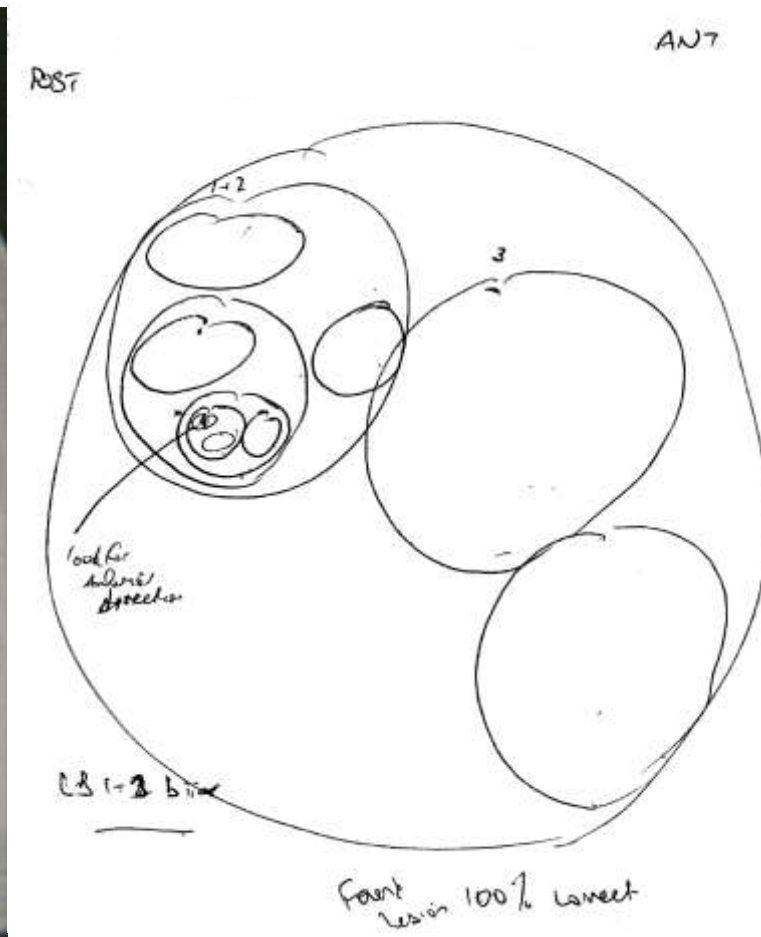


Radial EBUS

- Thin (1.7mm) wire with 360° spinning ultrasound at distal tip



PERIPHERAL NODULE MAPPED



SAFETY: RADIAL EBUS

- Meta-analysis, studies from 2002-2016: 57 studies, 7872 lesions

	Radial EBUS
Diagnostic yield	70%
Safety:	
Pneumothorax	2.8% (All complications)
ICC	0.2%

Radial endobronchial ultrasound for the diagnosis of peripheral pulmonary lesions: A systematic review and metaanalysis Ali et al *Respirology* (2017)

CASE EXAMPLE 1

62 yo F, never smoker, Asian, fit with shoulder /neck pain

CT neck – 21mm RUL nodule

Confirmed on CT Chest

No infective symptoms

Persistent on short term follow up CT.

Review of previous imaging: CTA 8mm incidental nodule in 2013!

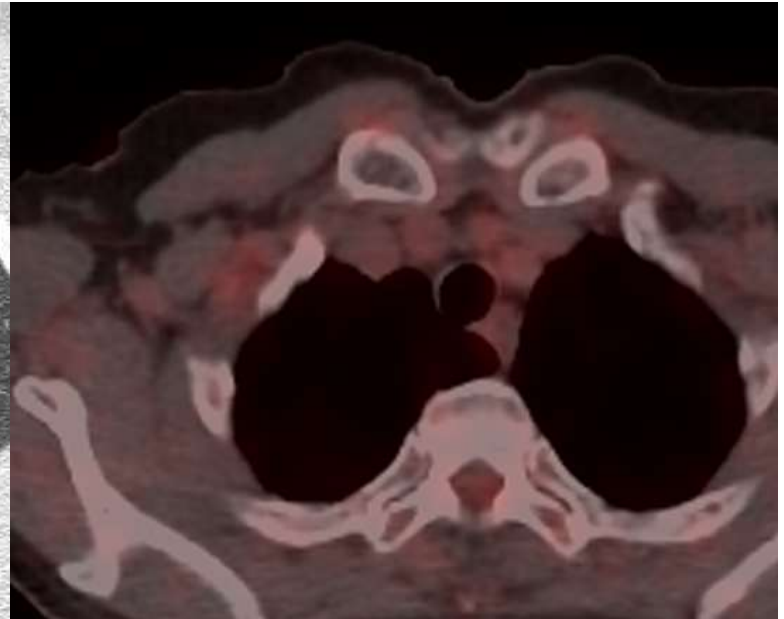
2013



2021



FDG PET



Enlarging pure ground glass nodule

Invisible on FDG PET scan

CASE EXAMPLE 1

CTFNA – Atypical adenomatous hyperplasia (NOT CANCER, pre-invasive lesion)

MDT recommendation:

- Path: Non Malignant
- Radiology: No invasive (solid) component
- Consider surveillance. Surgical option if patient keen

Progress: VATS Wedge → Frozen section – Malignant

Proceeded to lobectomy

Pathology: Malignant adenocarcinoma

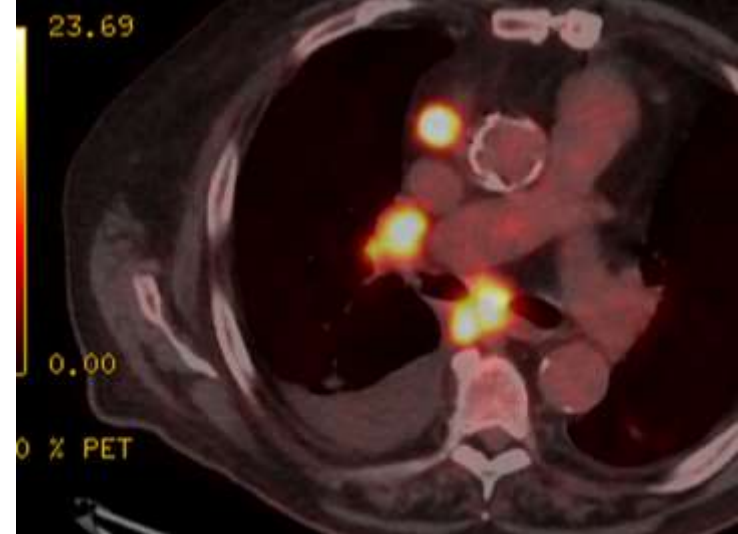
CASE EXAMPLE 2

- 85yo M with severe Aortic stenosis, elective admission had a CT TAVI
- Middle lobe nodule and large thoracic lymphadenopathy
- **Radiologist comment: Intrathoracic malignant lymphadenopathy likely possible middle lobe primary. Pleural effusion potentially neoplastic.** Probable degree of interstitial oedema but the right lower lobe is more severe than left potentially suggesting lymphangitis. Calcified pleural thickening left side? Post sternotomy/surgical.
- Pleural aspirate – transudative, non-malignant
- Referred for urgent EBUS bronchoscopy



CASE EXAMPLE 2

- Initial assessment:
 - Patient in acute heart failure (Clinical context)
 - High risk features
 - No lymphadenopathy or nodule in previous CT chest (2018)
 - Initial scan is a Partial CT
- Recommendation: Dedicated CT chest followed by FDG PET
 - CT chest – shows RML nodule is smaller (1.9→1.3cm), presence of supraclavicular LN
 - FDG PET – RML nodule low grade FDG activity, extensive FDG avid thoracic and supraclavicular adenopathy
- Plan – Supraclavicular lymph node ultrasound guided biopsy
- Diagnosis: Diffuse large B Cell lymphoma



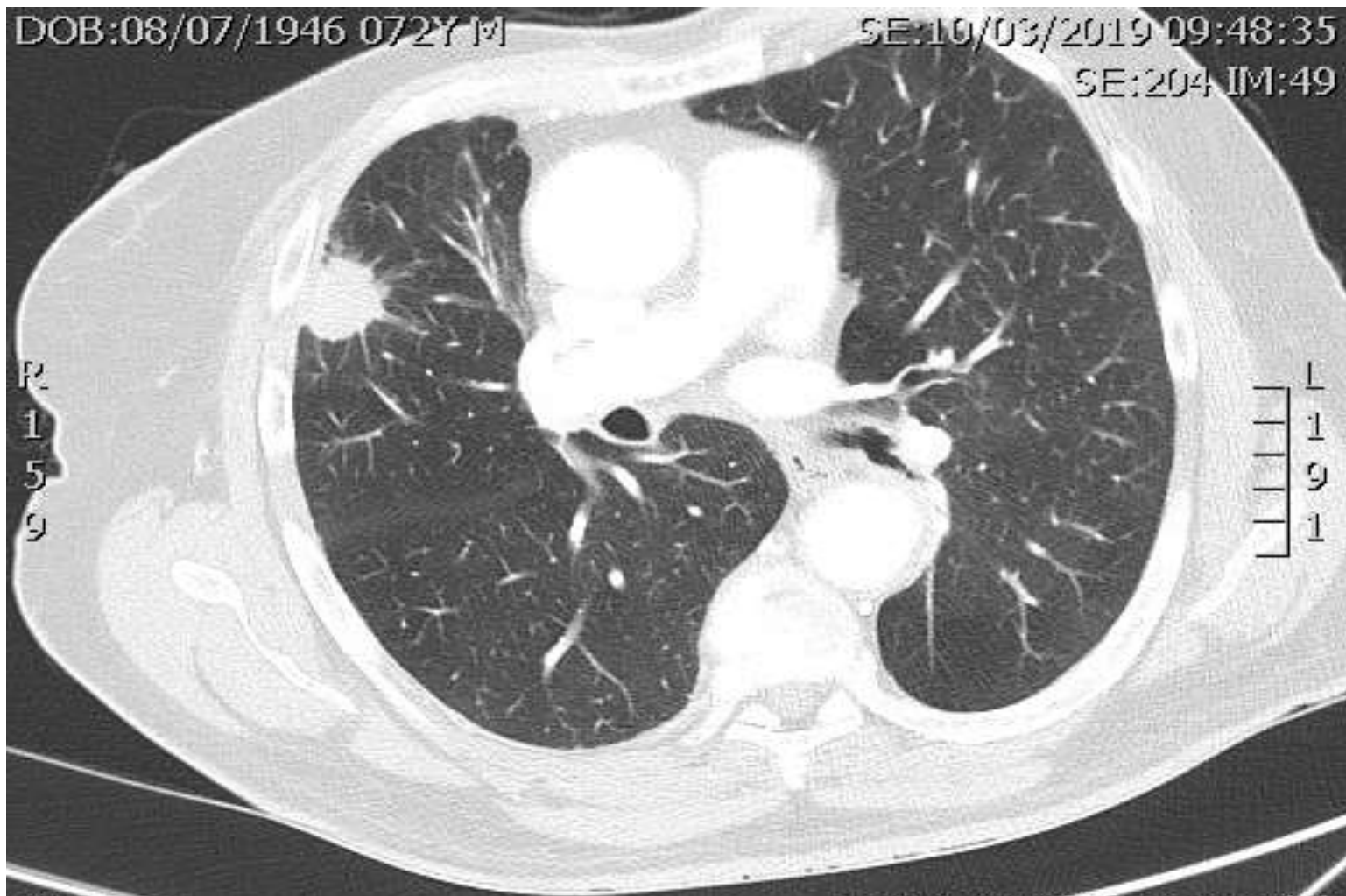
CASE EXAMPLE 3

73YO M, ECOG 0, EX-SMOKER,
LUNG FUNCTION- MILD OBSTRUCTION, NORMAL GAS TRANSFER

DOB:08/07/1946 072Y M

SE:10/03/2019 09:48:35

SE:204 IM:49



GRH

LUNG AX 3MM, iDose (3)



**CASE: 73YO M, ECOG 0, EX-SMOKER,
LUNG FUNCTION- MILD OBSTRUCTION, NORMAL GAS
TRANSFER**

Initial assessment: No old scans. Asymptomatic at the time of CT chest

Clinico-radiological nodule risk - High

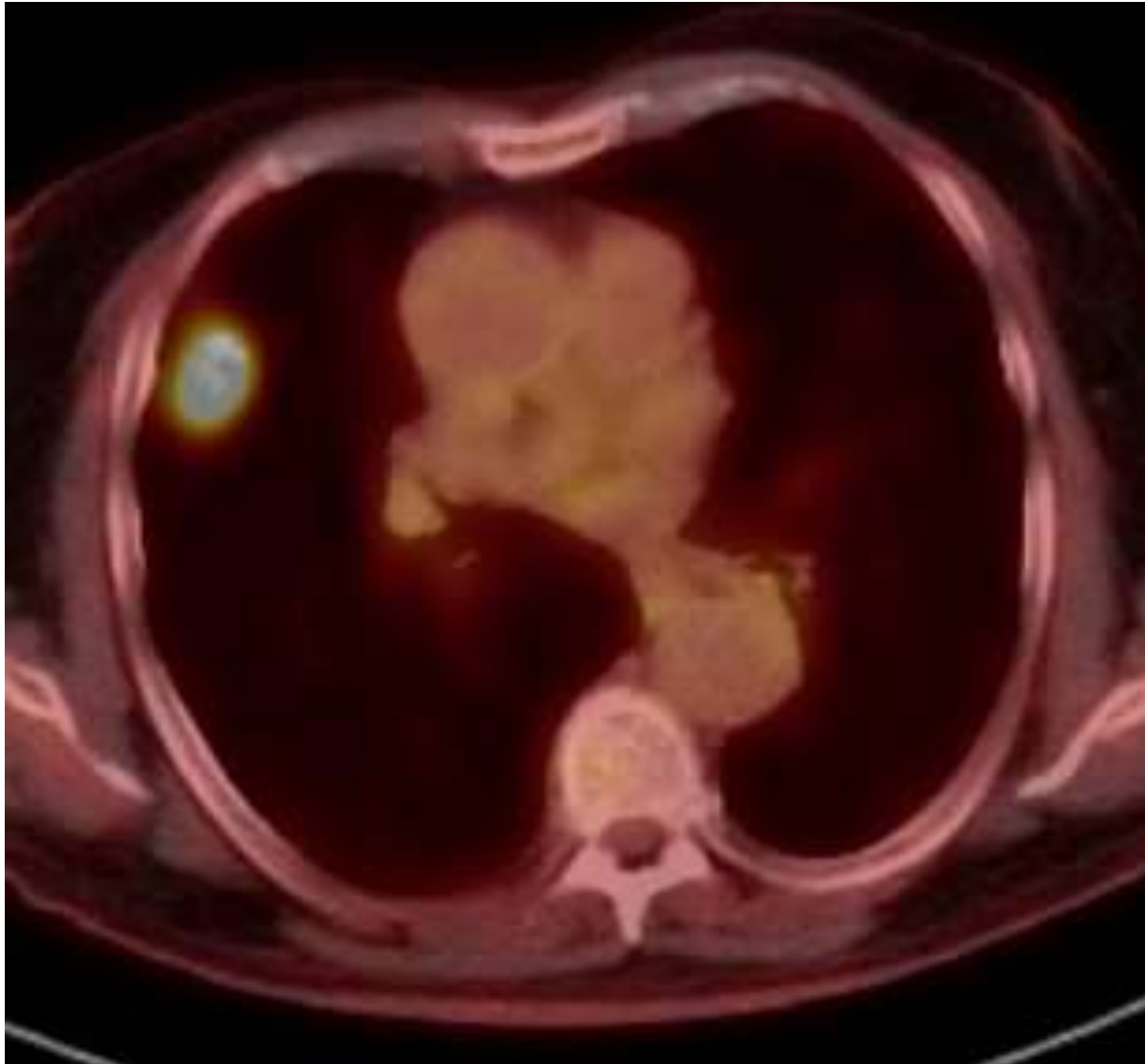
Biopsy Options: Radial EBUS or CT guided EBUS

Bronchoscopy

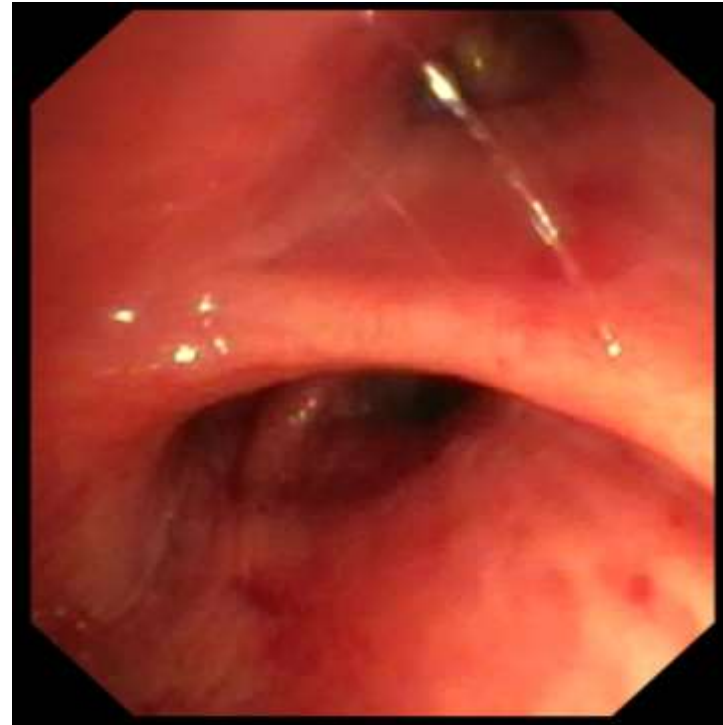
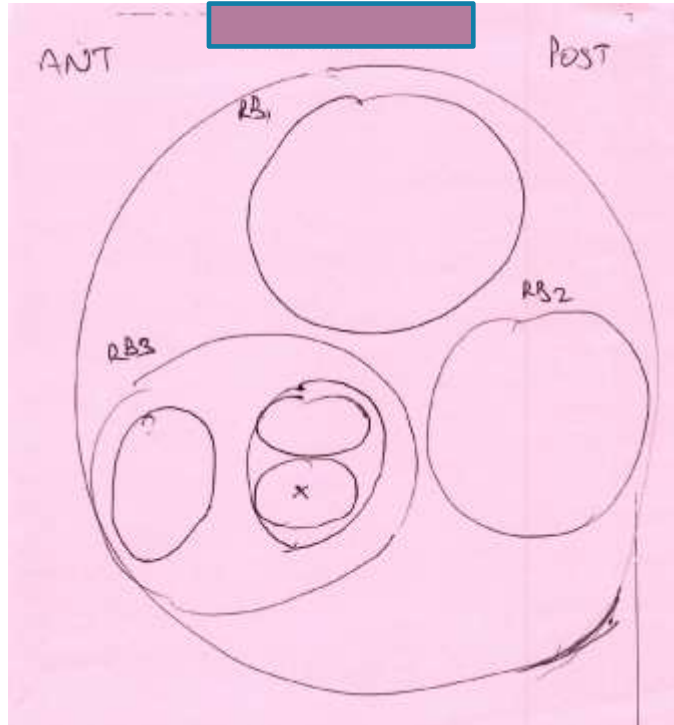
Decision: PET and proceed



FDG PET INTENSELY AVID NODULE AND UPTAKE IN HILAR LN



CASE OUTCOME



- Mapping – RB3aii
- Combined EBUS: Rt hilar LN biopsy - anthrasilicosis, RUL brush - NSCLCa
- Lung Cancer MDT: Stage 1A3 → RUL lobectomy



SUMMARY

- Incidental lung nodules are a common and an opportunity to cure lung cancer
- Nodule malignancy risk depends on multiple clinico-radiological factors
- FDG PET scans have a place in planning a biopsy strategy than determining malignant/benign status

PRACTICAL TIP

- If initial CT is non lung then confirm lung nodule with CT chest
- If high clinical suspicion for infection then antibiotics and short term interval scan (4-8 weeks) is a reasonable first step before referral

THANK YOU

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I N T E R V E N T I O N A L

Pulmonology Clinic

FLEISCHNER SOCIETY GUIDELINES FOR INCIDENTAL PULMONARY NODULES

- >35 years, no active cancer, not immunocompromised. Not for screening population

Fleischner Society 2017 Guidelines for Management of Incidentally Detected Pulmonary Nodules in Adults

A: Solid Nodules*

Nodule Type	Size			Comments
	<6 mm (<100 mm ³)	6–8 mm (100–250 mm ³)	>8 mm (>250 mm ³)	
Single				
Low risk†	No routine follow-up	CT at 6–12 months, then consider CT at 18–24 months	Consider CT at 3 months, PET/CT, or tissue sampling	Nodules <6 mm do not require routine follow-up in low-risk patients (recommendation 1A).
High risk†	Optional CT at 12 months	CT at 6–12 months, then CT at 18–24 months	Consider CT at 3 months, PET/CT, or tissue sampling	Certain patients at high risk with suspicious nodule morphology, upper lobe location, or both may warrant 12-month follow-up (recommendation 1A).
Multiple				
Low risk†	No routine follow-up	CT at 3–6 months, then consider CT at 18–24 months	CT at 3–6 months, then consider CT at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).
High risk†	Optional CT at 12 months	CT at 3–6 months, then at 18–24 months	CT at 3–6 months, then at 18–24 months	Use most suspicious nodule as guide to management. Follow-up intervals may vary according to size and risk (recommendation 2A).

B: Subsolid Nodules*

Nodule Type	Size		Comments
	<6 mm (<100 mm ³)	≥6 mm (>100 mm ³)	
Single			
Ground glass	No routine follow-up	CT at 6–12 months to confirm persistence, then CT every 2 years until 5 years	In certain suspicious nodules < 6 mm, consider follow-up at 2 and 4 years. If solid component(s) or growth develops, consider resection. (Recommendations 3A and 4A).
Part solid	No routine follow-up	CT at 3–6 months to confirm persistence. If unchanged and solid component remains <6 mm, annual CT should be performed for 5 years.	In practice, part-solid nodules cannot be defined as such until ≥6 mm, and nodules <6 mm do not usually require follow-up. Persistent part-solid nodules with solid components ≥6 mm should be considered highly suspicious (recommendations 4A–4C)
Multiple	CT at 3–6 months. If stable, consider CT at 2 and 4 years.	CT at 3–6 months. Subsequent management based on the most suspicious nodule(s).	Multiple <6 mm pure ground-glass nodules are usually benign, but consider follow-up in selected patients at high risk at 2 and 4 years (recommendation 5A).

Note.—These recommendations do not apply to lung cancer screening, patients with immunosuppression, or patients with known primary cancer.

* Dimensions are average of long and short axes, rounded to the nearest millimeter.

† Consider all relevant risk factors (see Risk Factors).

LUNG- RADS (LU

- Classification proposed to aid with findings in LDCT screening exams for lung cancer
- Standardize follow-up and management decisions

Category (Malignancy risk)		Follow up
0 (Incomplete)	Prior study not seen	comparison with prior studies before assignment of Lung-RADS
1 (<1%)	No nodules, benign characteristics	Continue annual screen
2 (<1%)	solid nodule(s) <6 mm at baseline, new nodule <4 mm <10 mm perifissural nodules with benign appearance subsolid nodule(s) <6 mm on baseline screening ground glass nodule(s) <30 mm, ≥30 mm and unchanged or slowly growing category 3 or 4 nodules that are unchanged for ≥3 months	Continue annual screening with LDCT
3 (1-2%)	solid nodule(s) ≥6 mm to <8 mm at baseline, new nodule 4 mm to <6 mm subsolid nodule(s) ≥6 mm total diameter with solid component <6 mm new <6 mm total diameter, ground glass nodule(s) ≥30 mm on baseline CT or new	6-month follow-up with LDCT
4A (5-15%)	solid nodule(s) ≥8 mm to <15 mm at baseline, growing nodule(s) <8 mm, new nodule 6 mm to <8 mm, subsolid nodule(s) ≥6 mm total diameter with solid component ≥6 mm to <8 mm new or growing <4 mm solid component endobronchial nodule	3-month follow-up with LDCT PET-CT may be used if there is a ≥8 mm solid component
4B (>15%)	solid nodule(s) ≥ 15 mm at baseline new or growing, and ≥8 mm subsolid nodule(s) solid component ≥8 mm, new or growing ≥4 mm solid component For new large nodules that develop on an annual repeat screening CT, a 1 month LDCT may be recommended	Category 4B and 4X: chest CT +/- Contrast PET-CT and/or tissue sampling For new large nodules that develop on an annual repeat screening CT, a 1 month LDCT
4X (>15%)	category 3 or 4 nodules with malignancy features spiculation, ground glass nodule(s) that double in size in 1 year, enlarged regional lymph nodes.	

UPDATE FOR RADIOLOGIST

- 4x Major Surgical Clinical trials (JCOG 0804, 0802, 1211, CALBG) recently published
 - Roll out of screening program
- Need for consistent image acquisition and accurate meaningful reporting of lung nodules
1. Type: solid, part solid, subsolid
 2. Size (size of solid component)
 3. Consolidation to tumour ratio
 4. Location
 5. Central/Peripheral

Example

- 7mm RUL solid, spiculated peripheral nodule CTR 1 subpleural at level of carina (slice 47)

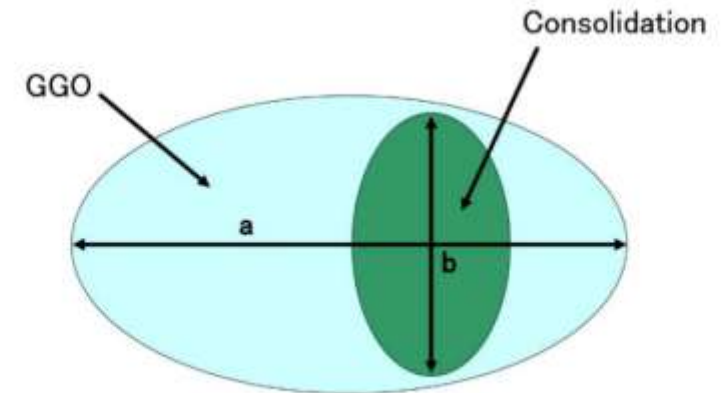


Figure 3.5.2.a Methods for measuring maximum tumor and consolidation diameter.

KEY POINT: SMOKING CESSATION REMAINS A KEY INTERVENTION



- [Why Quit](#)
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