

Imaging and Staging of Lung Cancer



What the Chest Physician Want to Know

Thida Win



Lung Cancer Introduction, Statistics, Survival, Causes, Investigations, Diagnosis

Lung Cancer Staging, T, N, M, TNM

What we want to know

Example of Reports

Summary

Lung Cancer Introduction

Lung Cancer is the most common cause of cancer-related death in men and second most common in women [1]

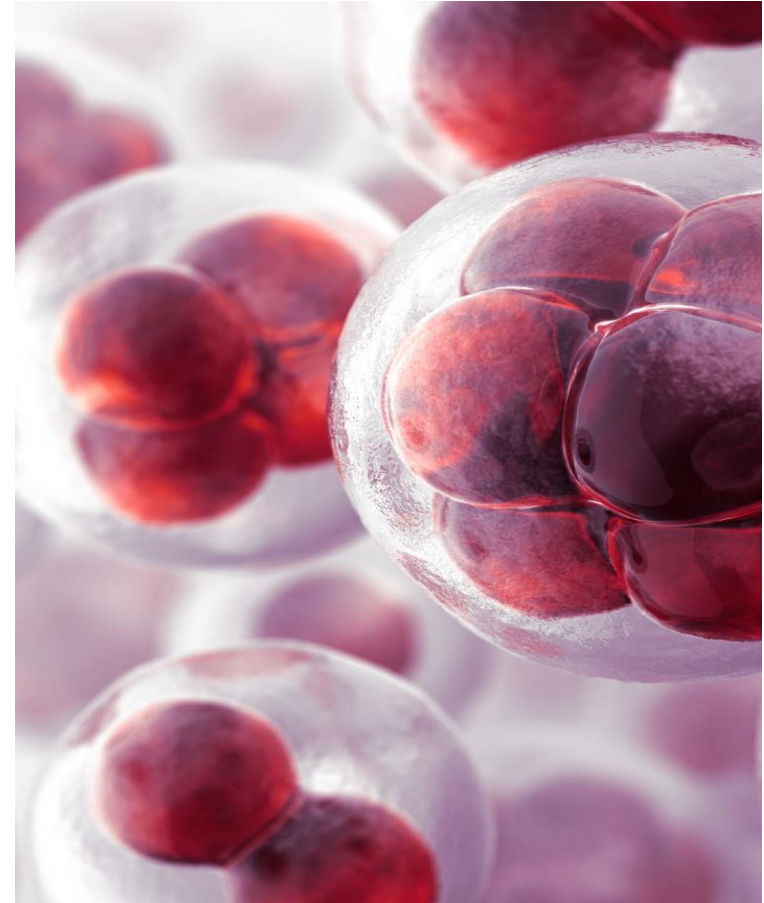
Worldwide in 2012, lung cancer occurred in 1.8 million people and resulted in 1.6 million deaths [2]

Representing 19.4% of all deaths from cancer. [1]

The highest rates are in North America, Europe, and East Asia, with over a third of new cases in China that year.

World Cancer Report 2014. World Health Organization. 2014. pp. Chapter 1.1. ISBN 978-92-832-0429-9.

World Cancer Report 2014. World Health Organization. 2014. pp. Chapter 5.1. ISBN 978-92-832-0429-9.



Lung Cancer statistics 2019

<https://lungevity.org/for-supporters-advocates/lung-cancer-statistics>



**ANYONE CAN
GET LUNG
CANCER**



10% to 15% of new lung cancer cases are among never-smokers. [1,2,3,4,5](#)



One in 16 people in the US will be diagnosed with lung cancer in their lifetime. [1](#)



More than 228,000 people in the US will be diagnosed with lung cancer this year, with a new diagnosis every 2.3 minutes. [1](#)



60% to 65% of all new lung cancer diagnoses are among people who have never smoked or are former smokers. [1,2,3,4,5](#)

1. Howlader N, Noone AM, Krapcho M, Miller D, Bresi A, Yu M, Ruhl J, Tatalovich Z, Mariotto A, Lewis DR, Chen HS, Feuer EJ, Cronin KA (eds). SEER Cancer Statistics Review, 1975-2016, National Cancer Institute. Bethesda, MD, http://seer.cancer.gov/csr/1975_2016, based on November 2018 SEER data submission, posted to the SEER website, April 2019.
2. Burns, DM. Primary prevention, smoking, and smoking cessation: Implications for future trends in lung cancer prevention. *Cancer*, 2000; 89:2506-2509.
3. Thun, MJ, et al. Lung Cancer Occurrence in Never-Smokers: An Analysis of 13 Cohorts and 22 Cancer Registry Studies. *PLOS Medicine*, 2008; 5(9):e185. doi: 10.1371/journal.pmed.0050185.
4. Satcher D, Thompson TG, Kaplan, JP. Women and Smoking: A Report of the Surgeon General. *Nicotine Tob Res*, 2002; 4(1): 7-20.
5. Park ER, et al. A snapshot of smokers after lung and colorectal cancer diagnosis. *Cancer*, 2012; 12:3153-3164. doi: 1002/cncr.26545; <http://onlinelibrary.wiley.com/doi/10.1002/cncr.26545/abstract>.

<https://lungevity.org/for-supporters-advocates/lung-cancer-statistics>



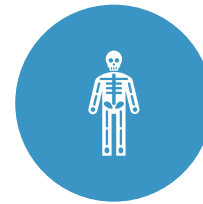
WE NEED TO GET BETTER AT FINDING AND TREATING LUNG CANCER



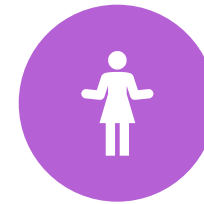
LUNG CANCER ACCOUNTS FOR 13% OF ALL NEW CANCER DIAGNOSES BUT 24% OF ALL CANCER DEATHS.¹



LUNG CANCER IS THE LEADING CAUSE OF CANCER DEATH, REGARDLESS OF GENDER OR ETHNICITY, TAKING ABOUT 156,000 AMERICAN LIVES EACH YEAR.¹



MORE LIVES ARE LOST TO LUNG CANCER THAN TO COLORECTAL, BREAST, AND PROSTATE CANCERS COMBINED.¹



LUNG CANCER HAS BEEN THE LEADING CANCER KILLER OF WOMEN SINCE 1987, KILLING ALMOST 1.5 TIMES AS MANY WOMEN AS BREAST CANCER.⁶

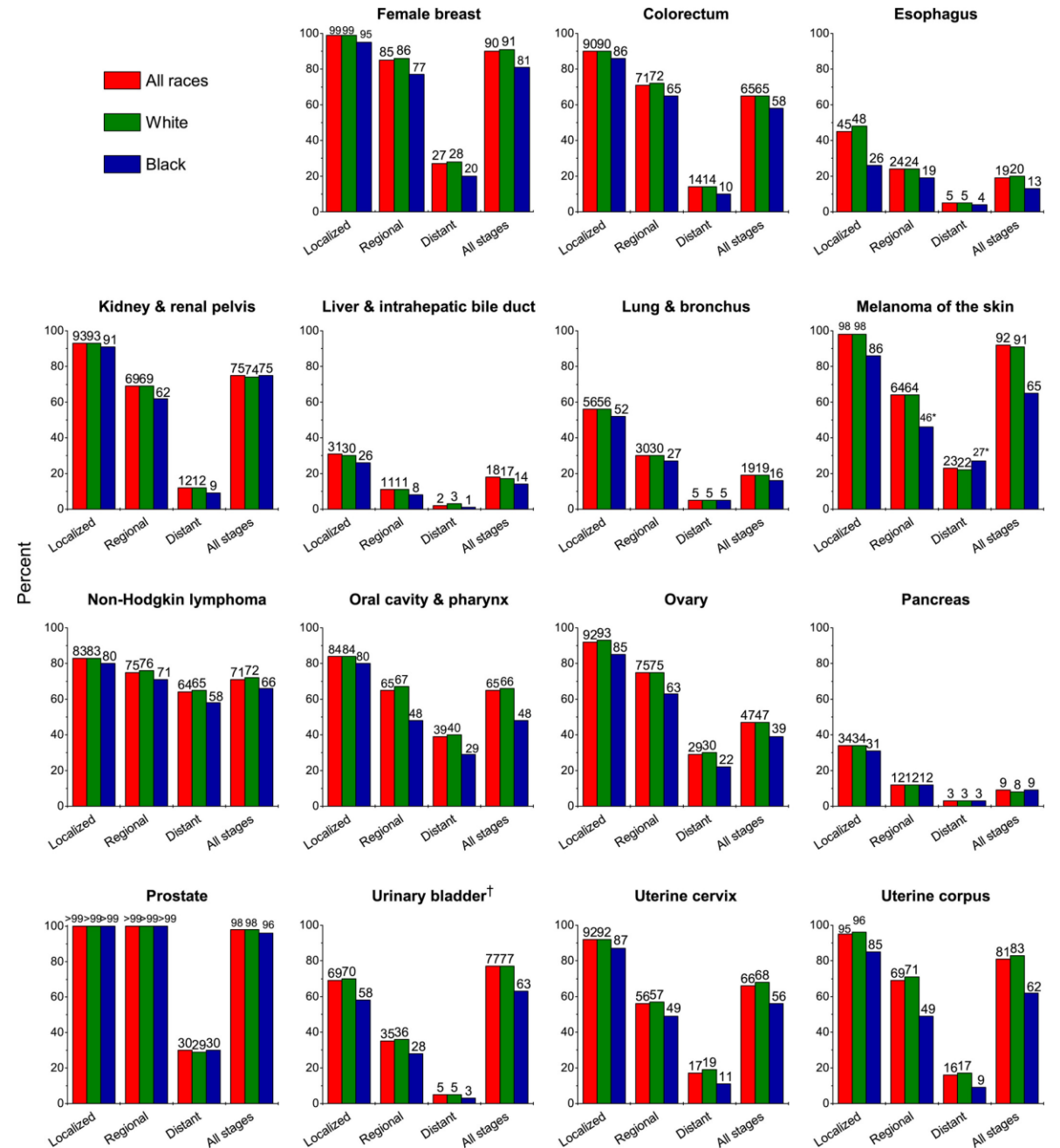


ONLY 19% OF ALL PEOPLE DIAGNOSED WITH LUNG CANCER WILL SURVIVE 5 YEARS OR MORE, BUT IF IT'S CAUGHT BEFORE IT SPREADS, THE CHANCE FOR 5-YEAR SURVIVAL IMPROVES DRAMATICALLY

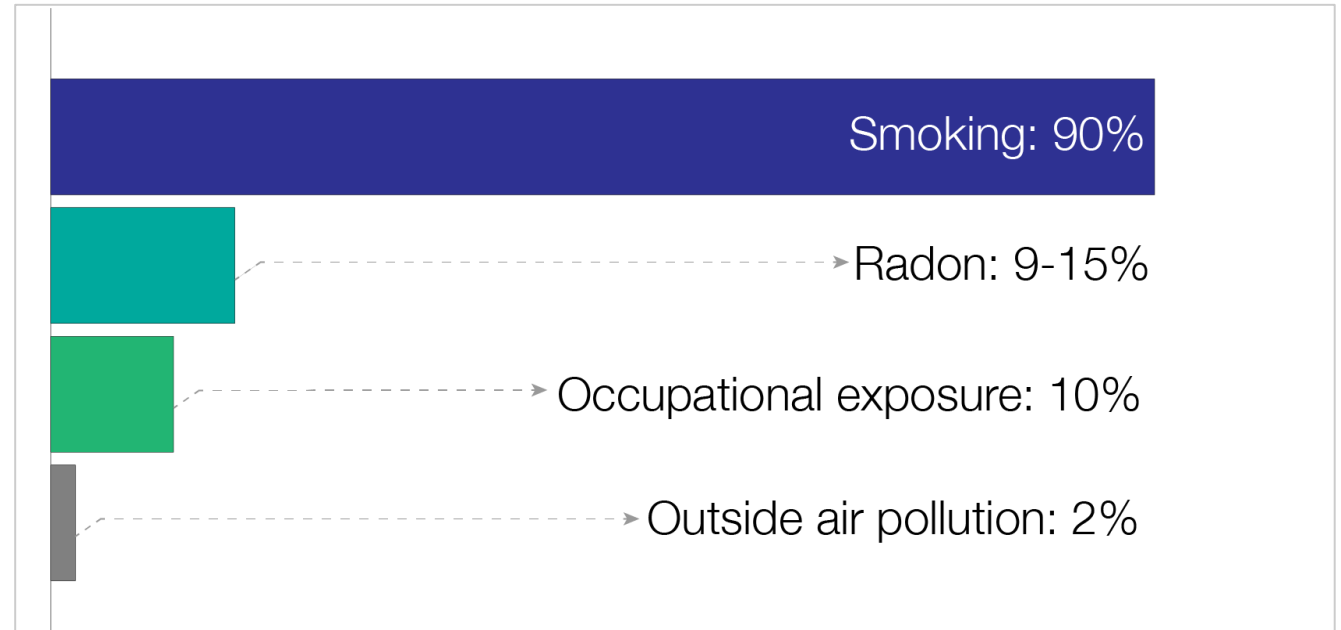
<https://onlinelibrary.wiley.com/>

Five-Year Relative Survival Rates for Selected Cancers by Race and Stage at Diagnosis, United States, 2008 to 2014.

■ All races
■ White
■ Black



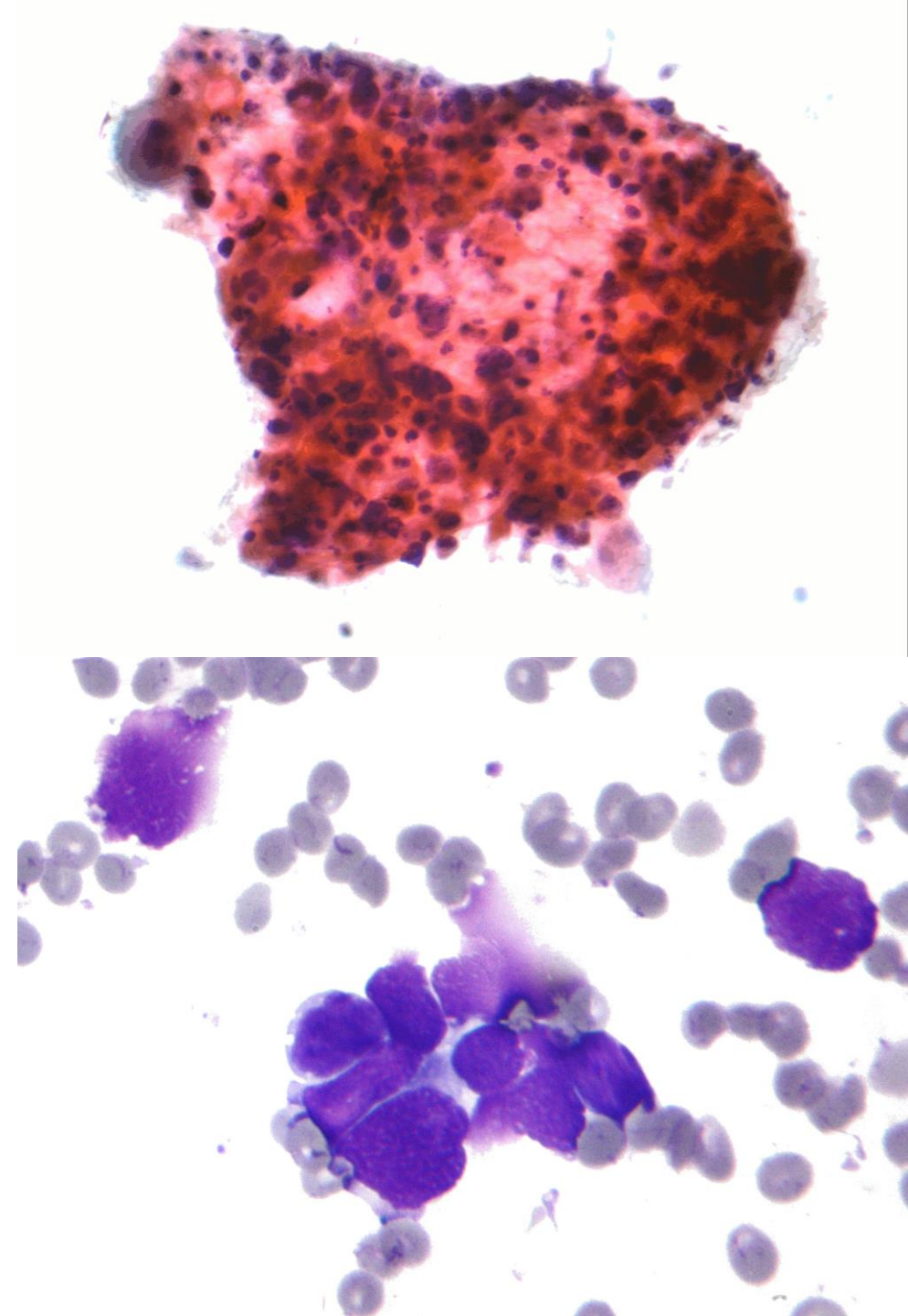
Estimated proportions of lung cancer causes*



- **New global cancer data suggests that the global cancer burden has risen to 18.1 million cases and 9.6 million cancer deaths**

Lung Cancer

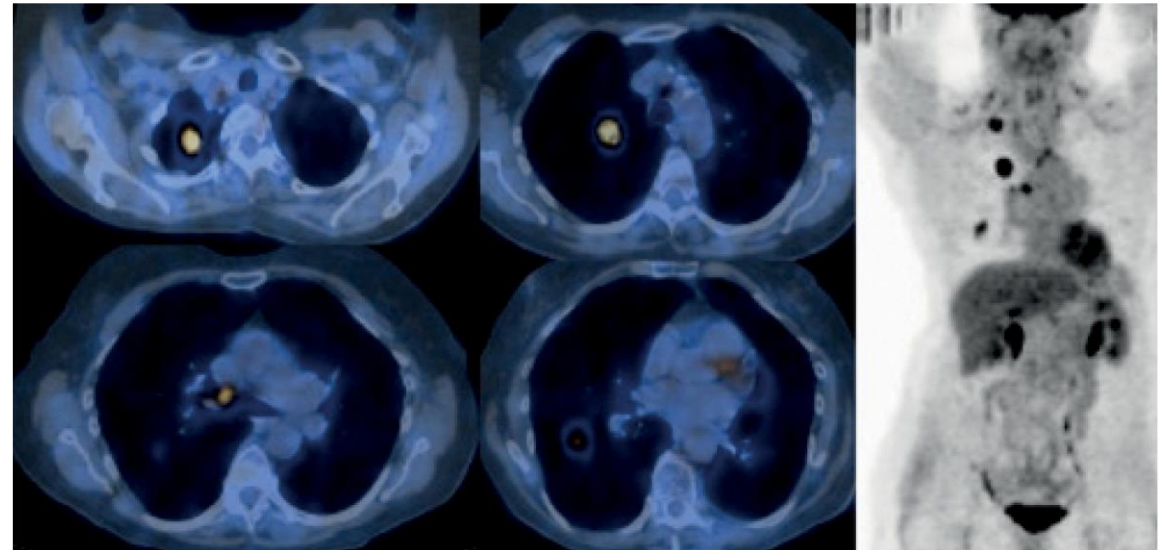
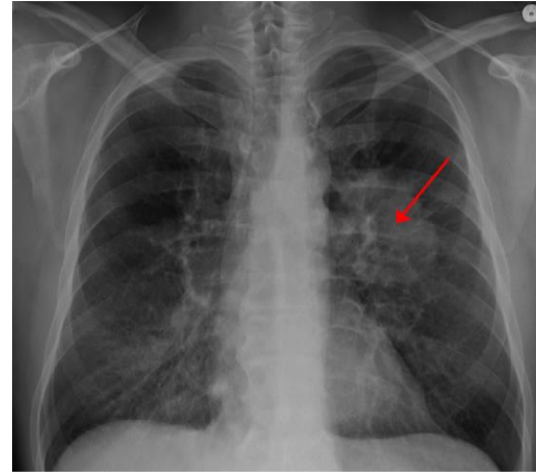
- There are 2 main Histological Classification
 - NSCLC (87%)
 - Squamous
 - Adeno
 - Large Cell
 - SCLC (13%)
 - Others



Lung Cancer Investigations

■ Radiological

- CXR
- CT
- PET



Lung Cancer Diagnosis

Tissue diagnosis is paramount

Bronchoscopy

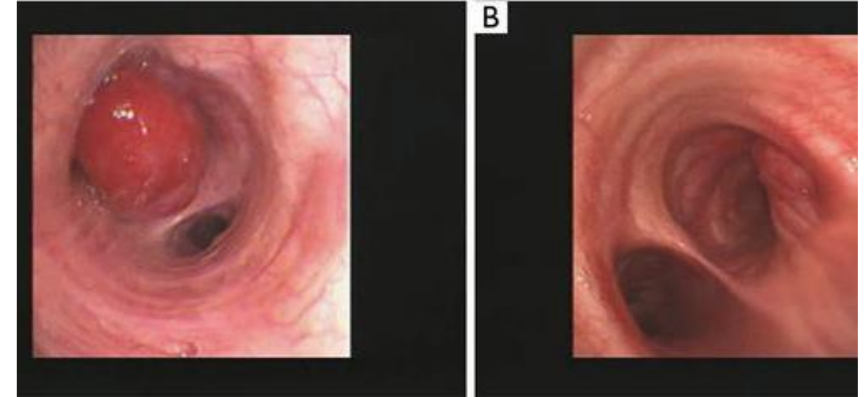
Endobronchial ultrasound

CT guided biopsy

USG guided biopsy

Thoracoscopy

Liquid biopsy



- The evaluation of non-small-cell lung carcinoma (NSCLC) staging uses the **TNM classification** (tumour, node, metastasis). This is based on the size of the primary tumour, lymph node involvement, and distant metastasis.

8th Edition Lung Cancer Stage classification Report from the American Joint Committee on Cancer (AJCC) and The International Association for the Study of Lung Cancer (IASLC)

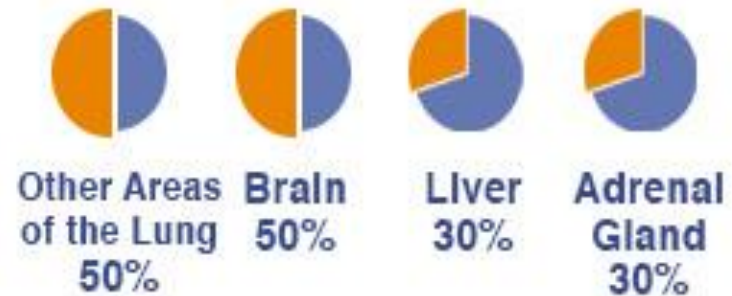
T: Primary Tumour

T: Primary tumour		
TX	Any of:	<p>Primary tumour cannot be assessed</p> <p>Tumour cells present in sputum or bronchial washing, but tumor not seen with imaging or bronchoscopy</p>
T0		No evidence of primary tumor
Tis		Carcinoma in situ
T1		Tumour size less than or equal to 3 cm across, surrounded by lung or visceral pleura, without invasion proximal to the lobar bronchus
	T1mi	Minimally invasive adenocarcinoma
	T1a	Tumour size less than or equal to 1 cm across
	T1b	Tumour size more than 1 cm but less than or equal to 2 cm across
	T1c	Tumour size more than 2 cm but less than or equal to 3 cm across
T2	Any of:	<p>Tumour size more than 3 cm but less than or equal to 5 cm across</p> <p>Involvement of the main bronchus but not the carina</p> <p>Invasion of visceral pleura</p> <p>Atelectasis/obstructive pneumonitis extending to the hilum</p>
	T2a	Tumour size more than 3 cm but less than or equal to 4 cm across
	T2b	Tumour size more than 4 cm but less than or equal to 5 cm across
T3	Any of:	<p>Tumour size more than 5 cm but less than or equal to 7 cm across</p> <p>Invasion into the chest wall, phrenic nerve, or parietal pericardium</p> <p>Separate tumor nodule in the same lobe</p>
T4	Any of:	<p>Tumour size more than 7 cm</p> <p>Invasion of the diaphragm, mediastinum, heart, great vessels, trachea, carina, recurrent laryngeal nerve, esophagus, or vertebral body</p> <p>Separate tumour nodule in a different lobe of the same lung</p>

N: Lymph nodes

NX	Regional lymph nodes cannot be assessed
N0	No regional lymph node metastasis
N1	Metastasis to ipsilateral peribronchial and/or hilar lymph nodes
N1a	Metastasis to a single N1 nodal station
N1b	Metastasis to two or more N1 nodal stations
N2	Metastasis to ipsilateral mediastinal and/or subcarinal lymph nodes
N2a1	Metastasis to one N2 nodal station with no involvement of N1 nodes
N2a2	Metastasis to one N2 nodal station and at least one N1 nodal station
N2b	Metastasis to two or more N2 nodal stations
N3	Any of: Metastasis to scalene or supraclavicular lymph nodes Metastasis to contralateral hilar or mediastinal lymph nodes

Organs involved most often in metastatic lung cancer



M: Metastasis	
MX	Distant metastasis cannot be assessed
M0	No distant metastasis
M1a	Separate tumor nodule in the other lung
	Tumour with pleural or pericardial nodules
	Malignant <u>pleural</u> or <u>pericardial effusion</u>
M1b	A single metastasis outside the chest
M1c	Two or more metastases outside the chest

Using the TNM descriptors, a group is assigned, ranging from occult cancer, through stages 0, IA (one-A), IB, IIA, IIB, IIIA, IIIB, and IV (four). This stage group assists with the choice of treatment and estimation of prognosis

Stage group according to TNM classification in lung cancer

TNM	Stage group
T1a–T1b N0 M0	IA
T2a N0 M0	IB
T1a–T2a N1 M0	IIA
T2b N0 M0	
T2b N1 M0	IIB
T3 N0 M0	
T1a–T3 N2 M0	IIIA
T3 N1 M0	
T4 N0–N1 M0	
N3 M0	IIIB
T4 N2 M0	
M1	IV

T / M	Subcategory	N0	N1	N2	N3
T1	T1a	IA1	IIB	IIIA	IIIB
	T1b	IA2	IIB	IIIA	IIIB
	T1c	IA3	IIB	IIIA	IIIB
T2	T2a	IB	IIB	IIIA	IIIB
	T2b	IIA	IIB	IIIA	IIIB
T3	T3	IIB	IIIA	IIIB	IIIC
T4	T4	IIIA	IIIA	IIIB	IIIC
M1	M1a	IVA	IVA	IVA	IVA

T1

Tumour size ≤ 3 cm

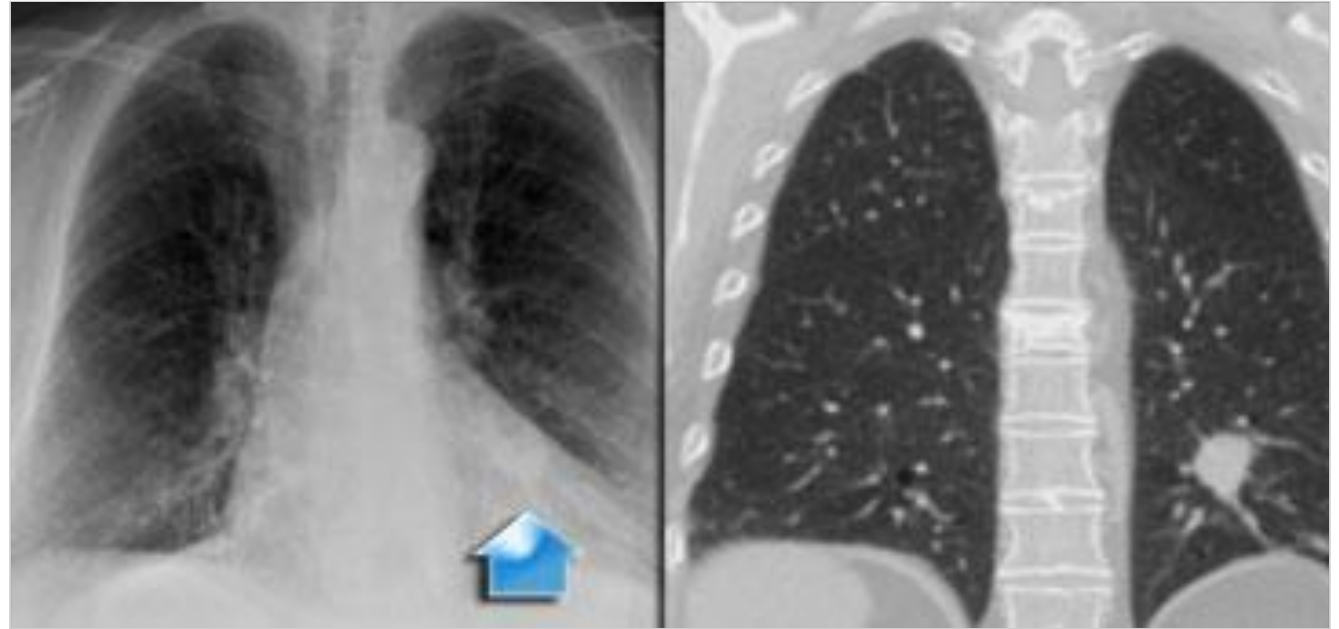
Tumour ≤ 1 cm \Rightarrow T1a

Tumour > 1 cm but ≤ 2 cm \Rightarrow T1b

Tumour > 2 cm but ≤ 3 cm \Rightarrow T1c

T1a(mi) is pathology proven 'minimally invasive',
irrespective of size.

T1a(ss) is a superficial spreading tumor in the
central airways, irrespective of location.



- Stage 1A1 (T1aN0M0)
- Stage 1A2 (T1bN0M0)
- Stage 1A3 (T1cN0M0)

T2

- Tumour size $>3\text{cm}$ to $\leq 5\text{cm}$ or
- Tumour of any size that
 - invades the visceral pleura
 - involves main bronchus, but not the carina
 - shows an atelectasis or obstructive pneumonitis that extends to the hilum

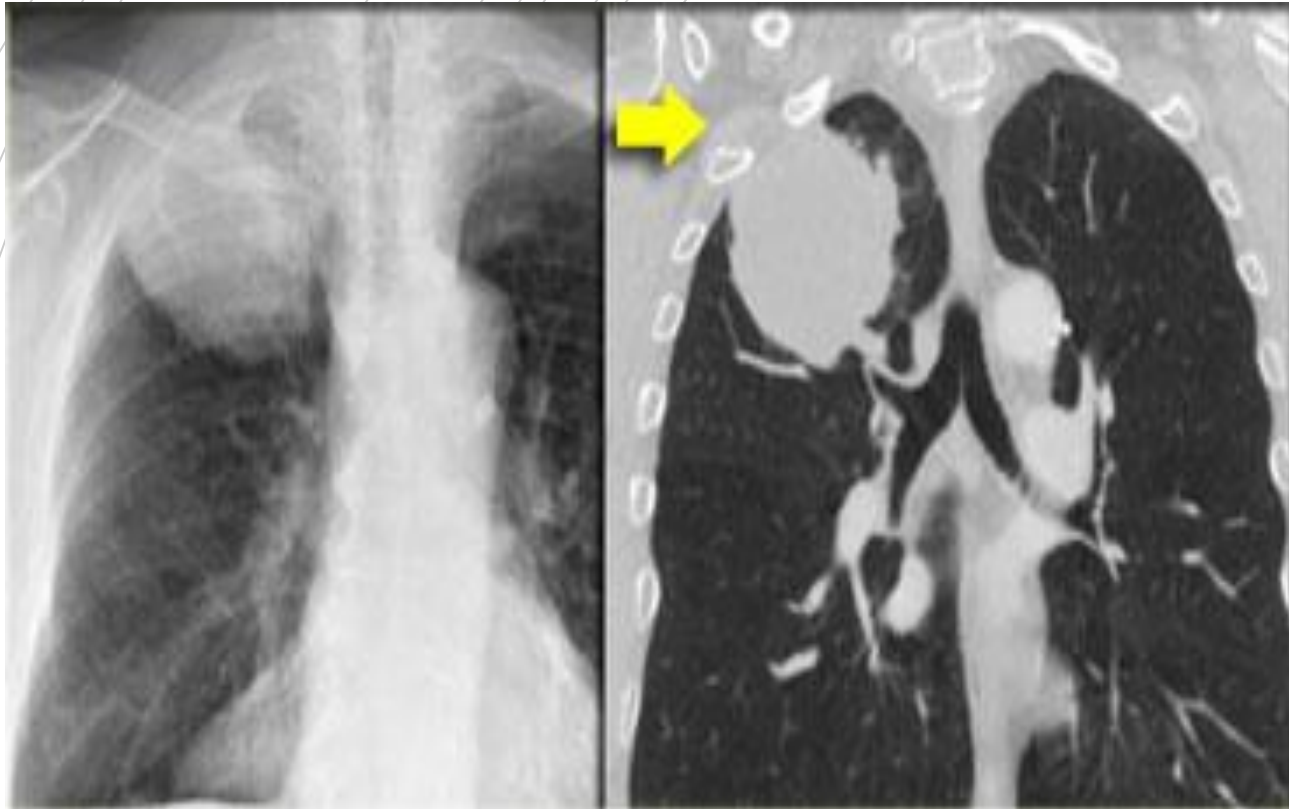
T2a= >3 to 4cm

T2b= >4 to 5cm

T2a N0 M0	IB
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T1a–T2a N1 M0	IIA
T2b N0 M0	





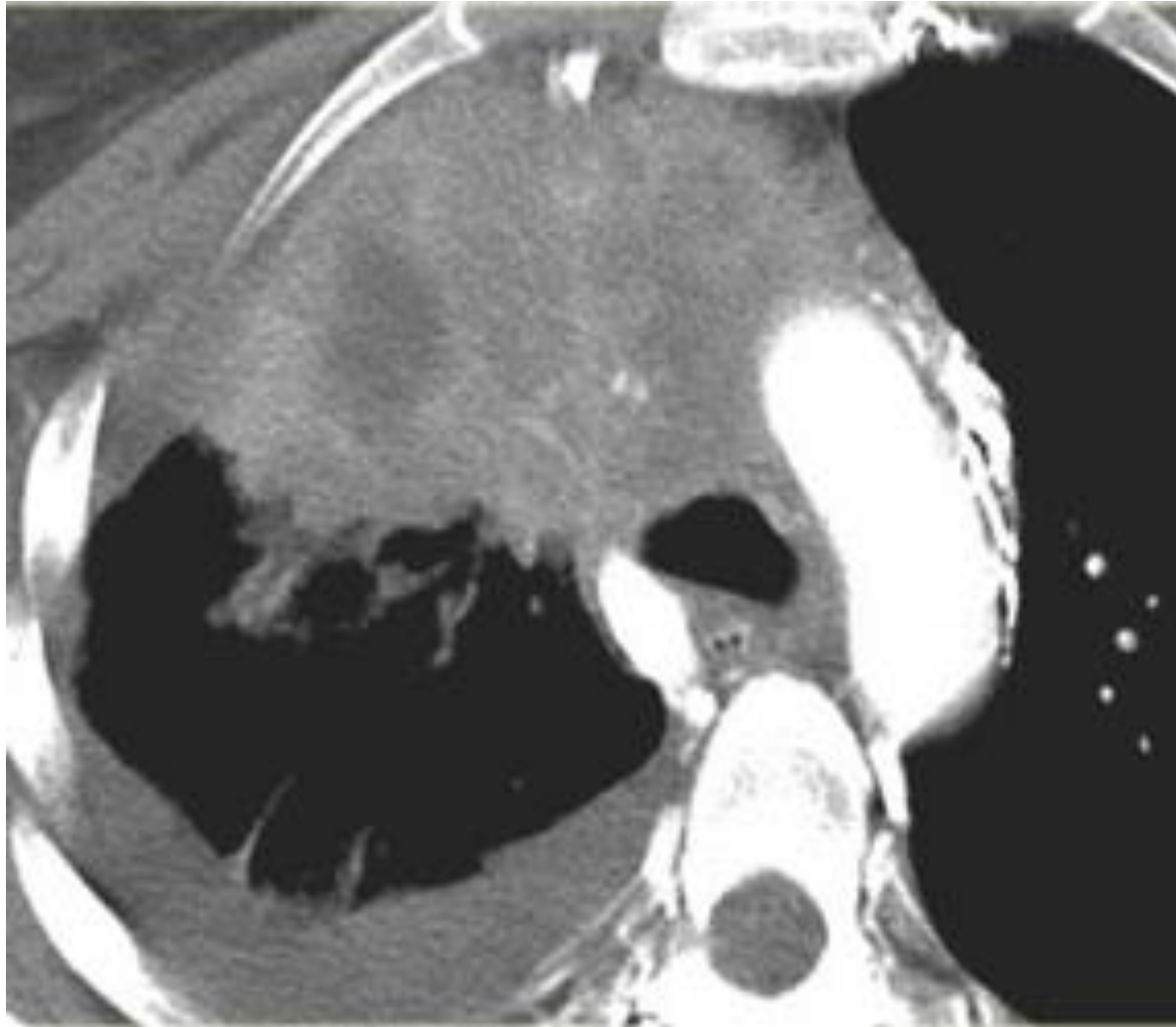
T2b N1 M0

IIB

T3 N0 M0

T3

- Tumour size >5cm to 7cm or
- Pancoast that involves thoracic nerve roots T1 and T2 only.
- Tumour of any size that
 - invades the chest wall
 - invades the pericardium
 - invades the phrenic nerve
 - shows one or more satellite nodules in the same lung lobe



IIIA

T4N0M0, T4N1M0, T3N1M0, T1-2N2M0

IIIB

T3-4N2M0, T1-2N3M0

- **T4**
- Tumour size >7cm or
- Pancoast tumour that involves C8 or higher nerve roots, brachial plexus, subclavian vessels or spine
- Tumour of any size that
 - invades mediastinal fat or mediastinal structures
 - invades the diaphragm
 - involves the carina
 - shows one or more satellite nodules in another lobe on the ipsilateral side

Regional Lymph Node Classification System

Supraclavicular nodes

1. Low cervical, supraclavicular and sternal notch nodes

Superior mediastinal nodes

2. *Upper Paratracheal*: above the aortic arch, but below the clavicles.

3A. *Pre-vascular*: nodes not adjacent to the trachea like the nodes in station 2, but anterior to the vessels.

3P. *Pre-vertebral*: nodes not adjacent to the trachea, but behind the esophagus, which is prevertebral (3P).

Inferior Mediastinal nodes

4. *Lower Paratracheal* (including *Azygos Nodes*): below upper margin of aortic arch down to level of main bronchus.

Aortic nodes

5. *Subaortic* (A-P window): nodes lateral to ligamentum arteriosum. These nodes are not located between the aorta and the pulmonary trunk, but lateral to these vessels.

6. *Para-aortic* (ascending aorta or phrenic): nodes lying anterior and lateral to the ascending aorta and the aortic arch.

Subcarinal nodes

7. *Subcarinal*.

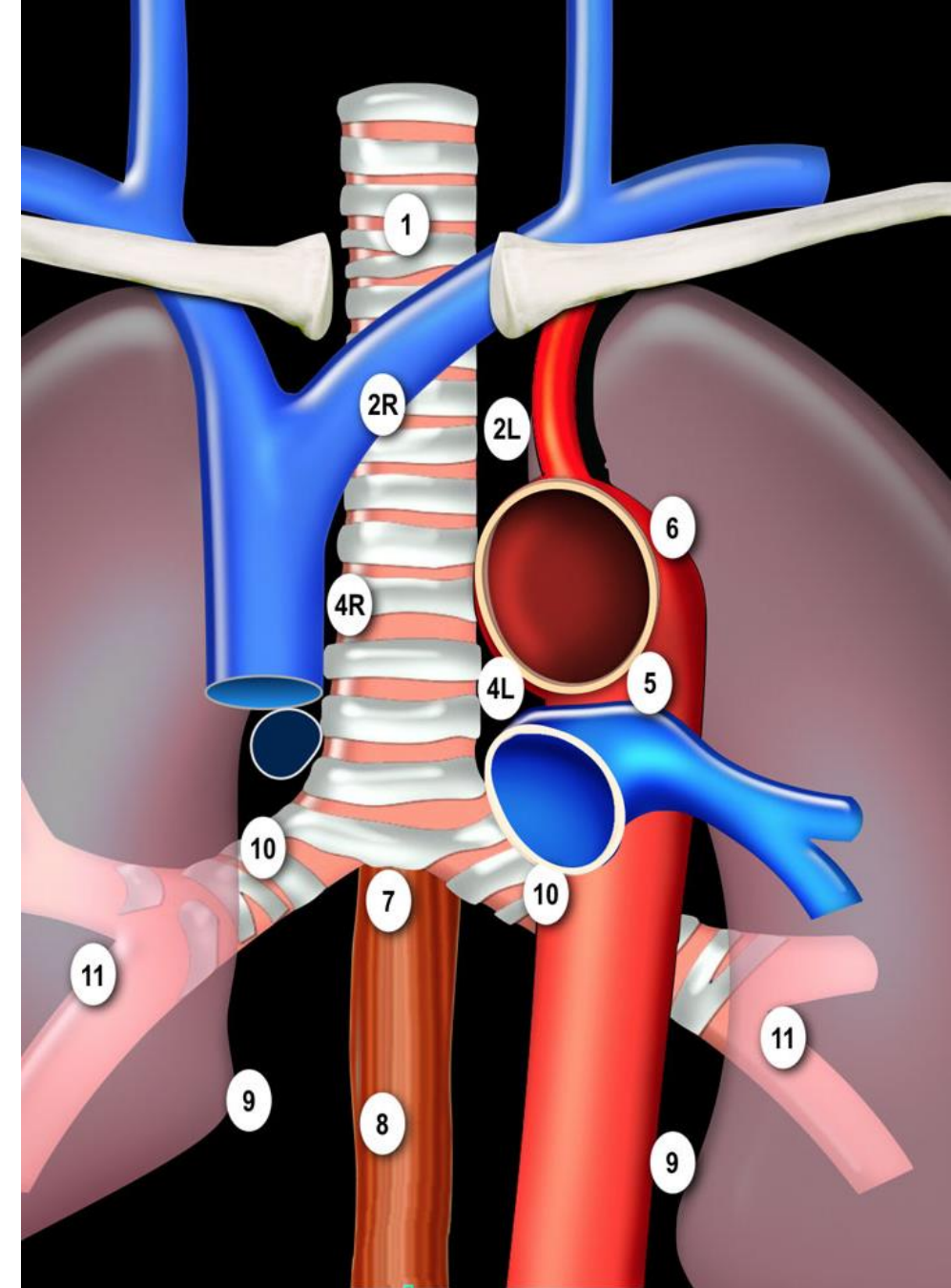
Inferior Mediastinal nodes

8. *Paraesophageal* (below carina).

9. *Pulmonary Ligament*: nodes lying within the pulmonary ligaments.

Pulmonary nodes

10-14. *N1-nodes*: these are located outside of the mediastinum.

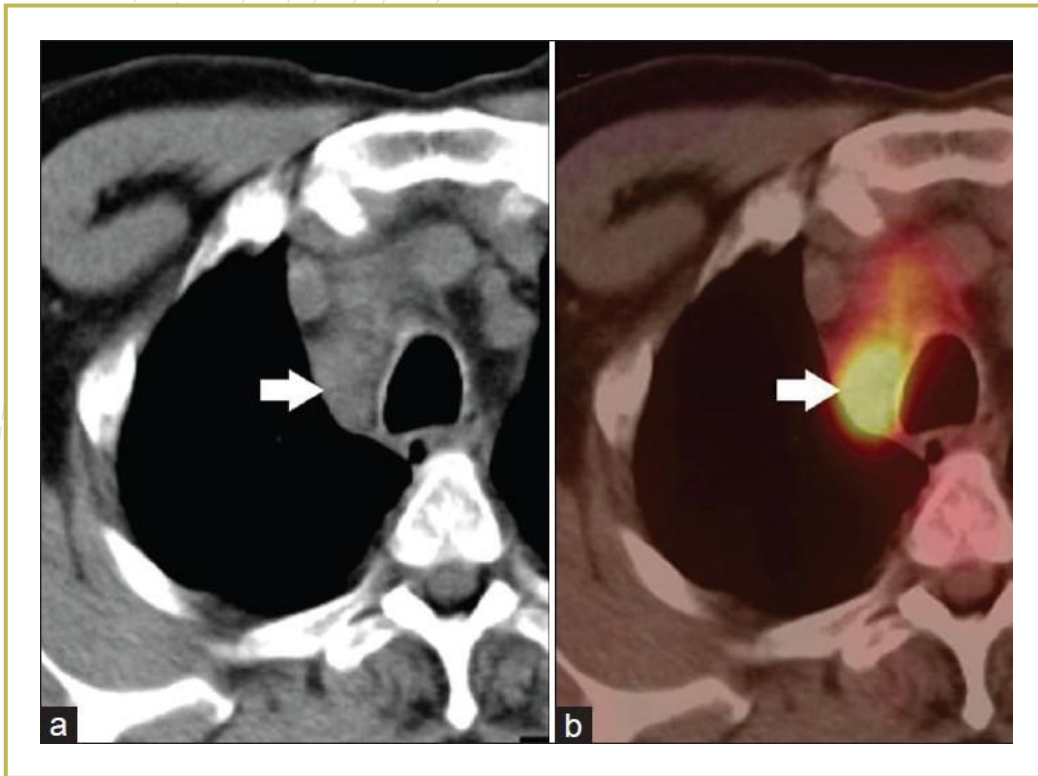


N1 - Nodes

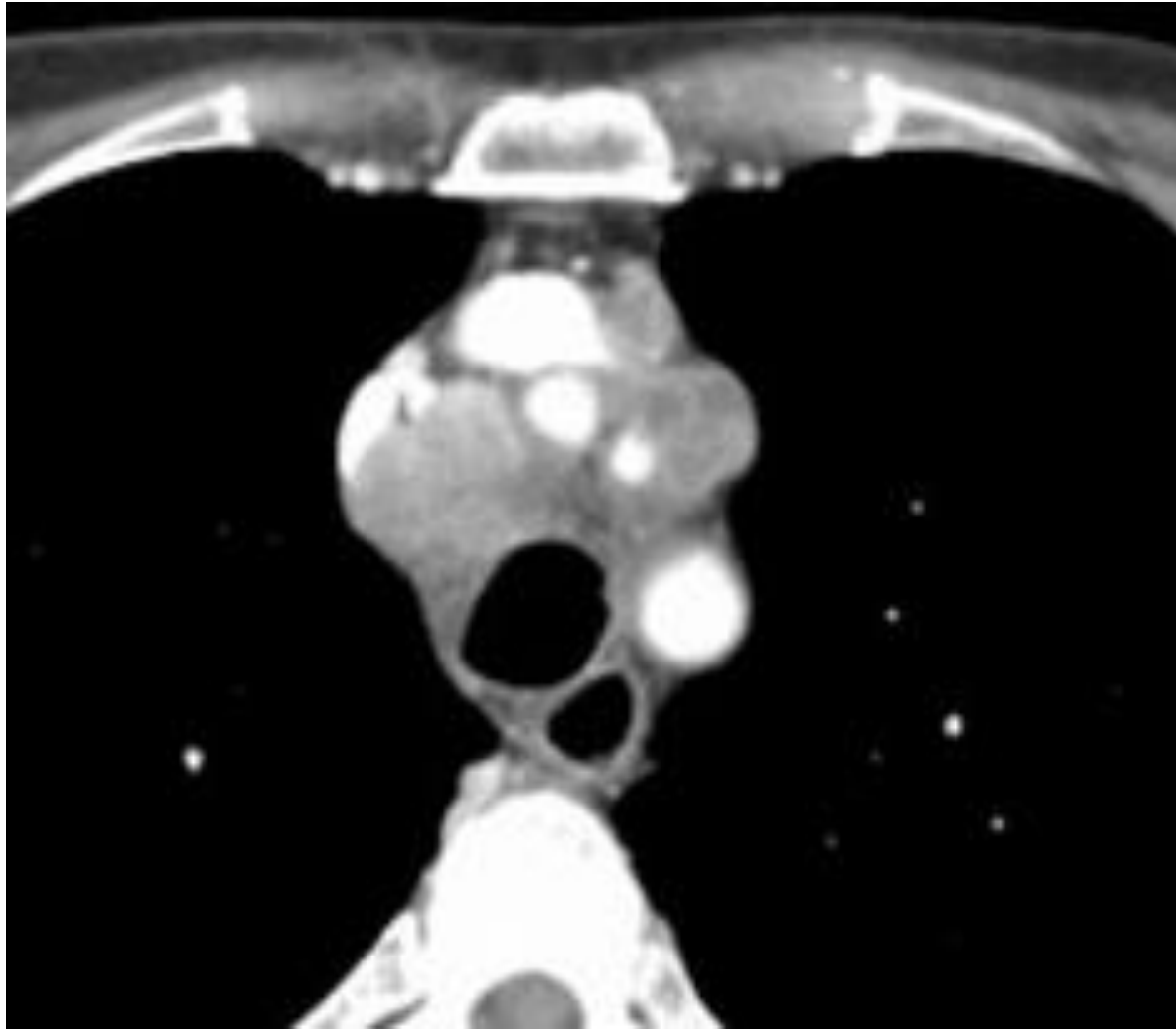


- N1-nodes are ipsilateral nodes within the lung up to hilar nodes.
N1 alters the prognosis but not the management.

N2 - Nodes



- N2-nodes represent ipsilateral mediastinal or subcarinal lymphadenopathy.



N3 - Nodes

- N3-nodes represent contralateral mediastinal or contralateral hilar lymphadenopathy or any scalene or supraclavicular nodes.

For a tumor in the right lung the N-stages are:

N1

Ipsilateral peribronchial and/or hilar lymph nodes

10R-14R

N2

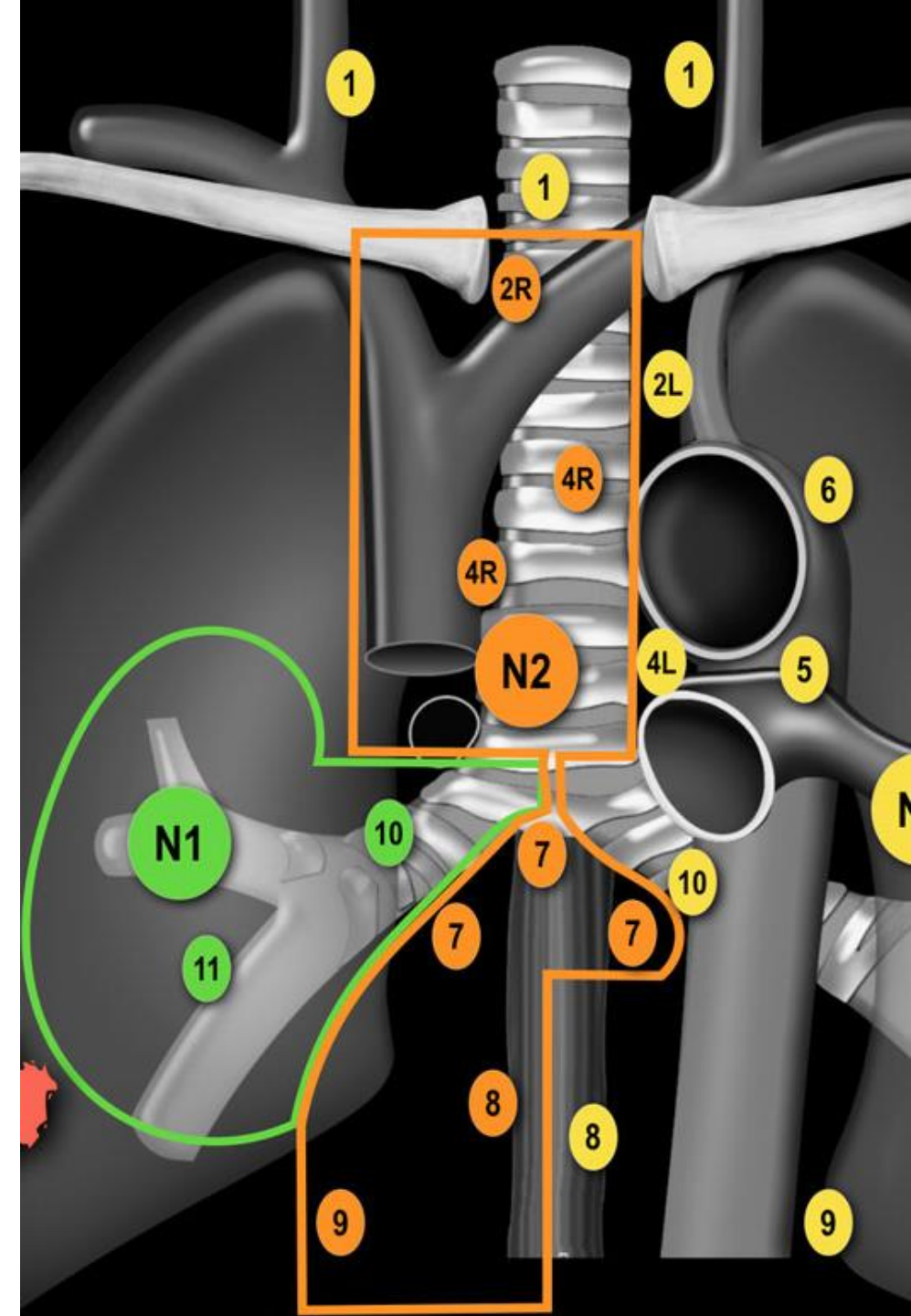
Ipsilateral mediastinal and/or subcarinal lymph nodes

2R, 3aR, 3p, 4R, 7, 8R, 9R

N3

Contralateral mediastinal and/or hilar, as well as any supraclavicular lymph nodes

1, 2L, 3aL, 4L, 5, 6, 8L, 9L, 10L-14L

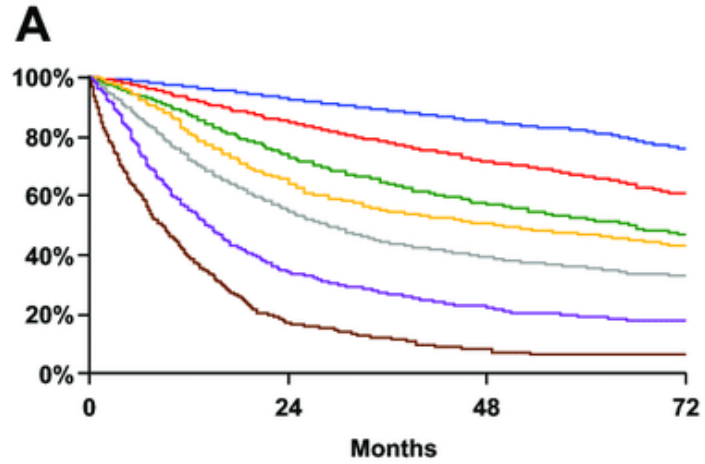


A large red graphic consisting of a horizontal bar at the top and a larger rectangular area below it. The letter 'M' is centered in white within the lower rectangle. The graphic is set against a background of curved, concentric lines in shades of gray.

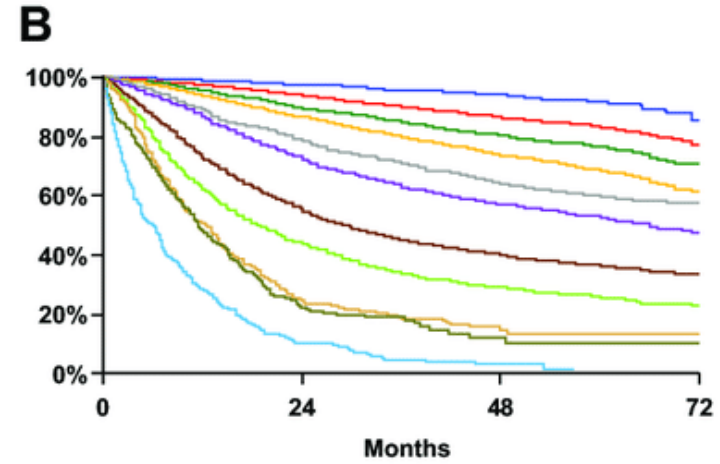
M

- **Almost every organ may be involved in metastatic disease.**
- **Common are adrenal, nodal, brain, bone and liver involvement.**
- **M-staging in the current edition is based on the presence of metastases, their location and multiplicity.**
- **A distinction is made between regional metastatic disease (M1a) and solitary (M1b) or multiple (M1c) distant metastatic disease.**

<https://radiologyassistant.nl/chest/lung-cancer-tnm-8th-edition>



7 th Ed.	Events / N	MST	24 Month	60 Month
IA	1119 / 6303	NR	93%	82%
IB	768 / 2492	NR	85%	66%
IIA	424 / 1008	66.0	74%	52%
IIB	382 / 824	49.0	64%	47%
IIIA	2139 / 3344	29.0	55%	36%
IIIB	2101 / 2624	14.1	34%	19%
IV	664 / 882	8.8	17%	6%

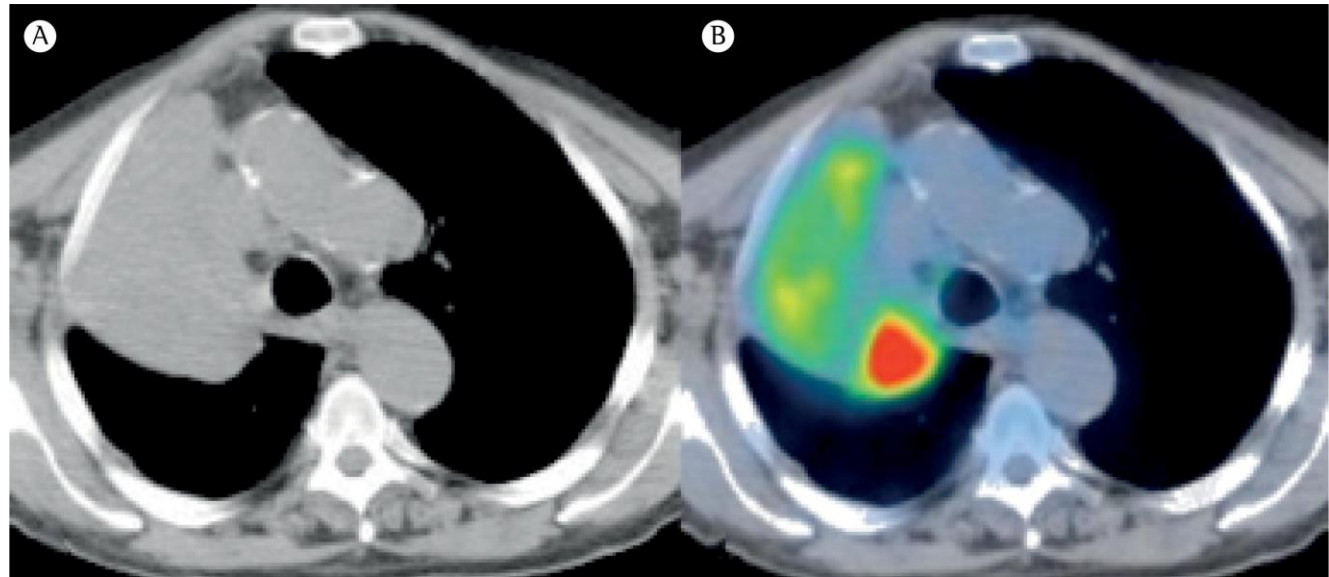


Proposed	Events / N	MST	24 Month	60 Month
IA1	68 / 781	NR	97%	92%
IA2	505 / 3105	NR	94%	83%
IA3	546 / 2417	NR	90%	77%
IB	560 / 1928	NR	87%	68%
IIA	215 / 585	NR	79%	60%
IIB	605 / 1453	66.0	72%	53%
IIIA	2052 / 3200	29.3	55%	36%
IIIB	1551 / 2140	19.0	44%	26%
IIIC	831 / 986	12.6	24%	13%
IVA	336 / 484	11.5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

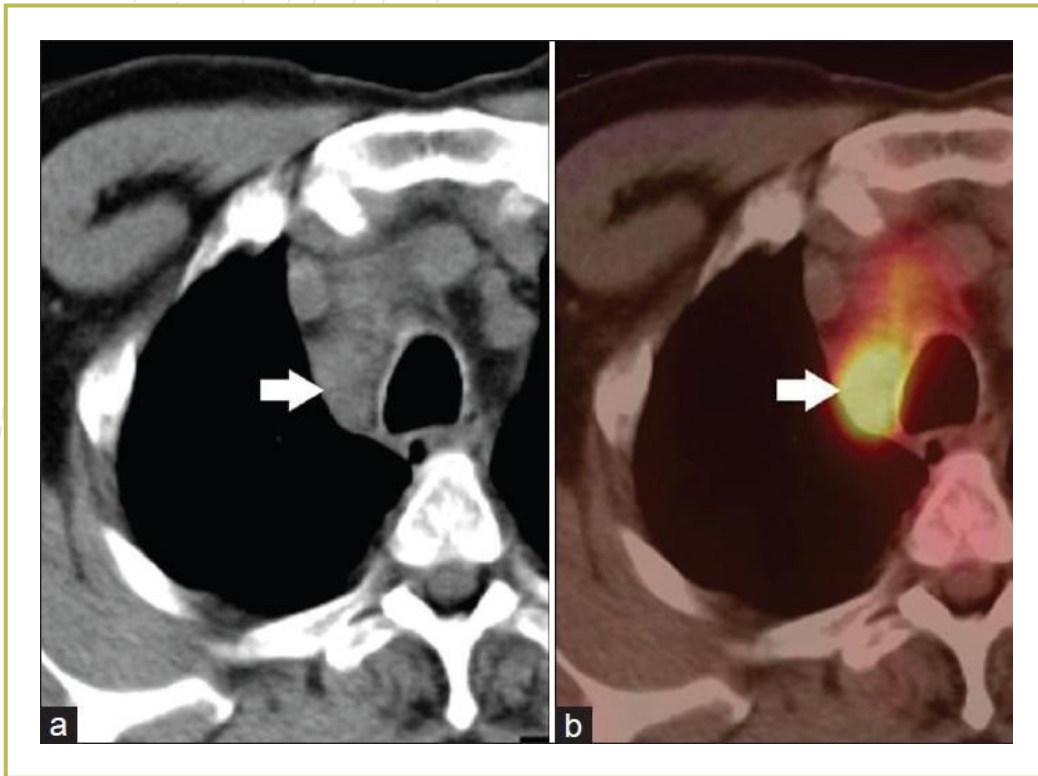
What we want to know

Tumour

- **Accurate T status and location**
 - Every cm difference have prognosis indication
 - Where; i.e nearer to main structure, chest wall, carina
 - Which lobe; guide for surgery/ radiotherapy
 - Guide methods of biopsy
- **SUV value**
 - Guide where to biopsy
 - Prognosis indicator
 - Disease progression
 - Response to treatment



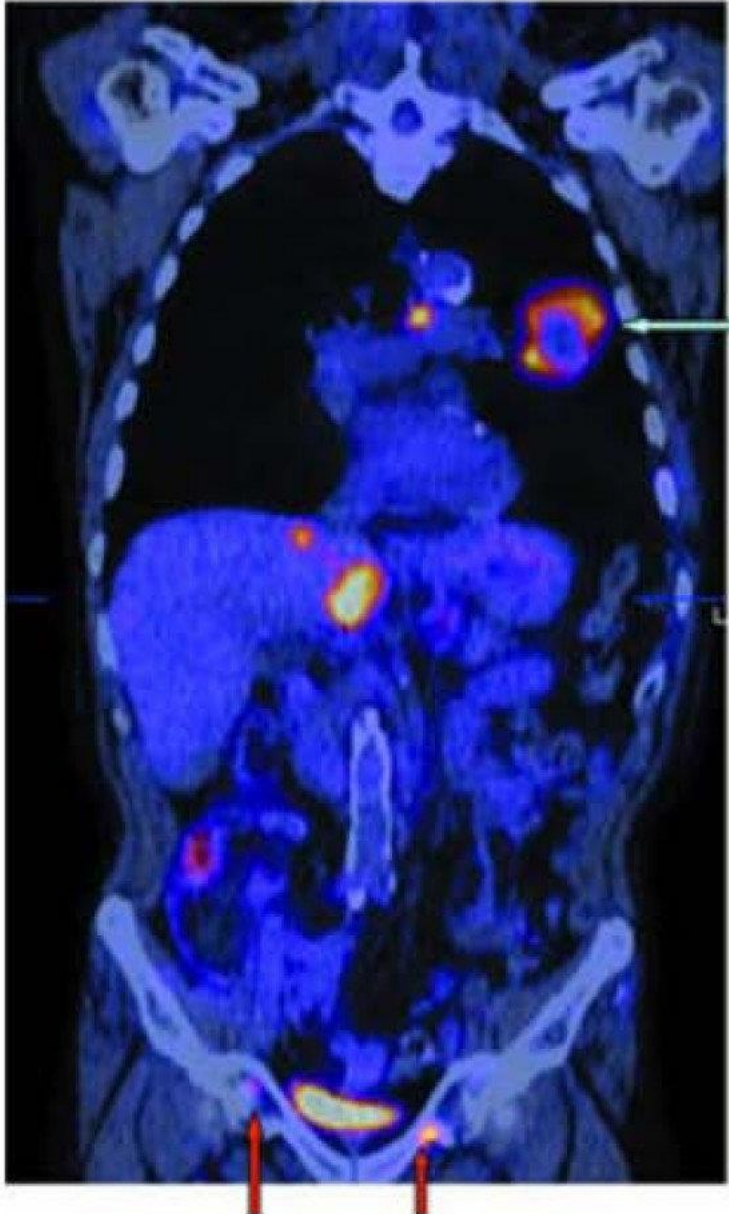
What we want to know



Nodal status

- Which nodes are involved
- How many nodes
- How high SUV is
- Which one is accessible

M status



- Where
- How accurate
- How we confirm
- Benign/Metastasis/second primary?
- Physiological uptake?
- Mis-registration?

Why PET scan important

T: Can Localize Tumour (From surrounding Pneumonitis, Collapsed Lung)

N: Much better than CT scan in sensitivity/ Specificity

M: Can detect whole body (Exception of Brain)

PET is now essential for accurate staging of Lung Cancer

Now is indicated for pulmonary nodules, Radical treatment

Some evidence of PET in radiotherapy planning, treatment response

General Report



Please mentioned indication



Please compare other imaging



Please mentioned other important findings



Please answer the question in conclusion



Please conclude important positive and negative findings



If cancer is likely diagnosis, please mentioned PET staging

What is good report looks like to clinician

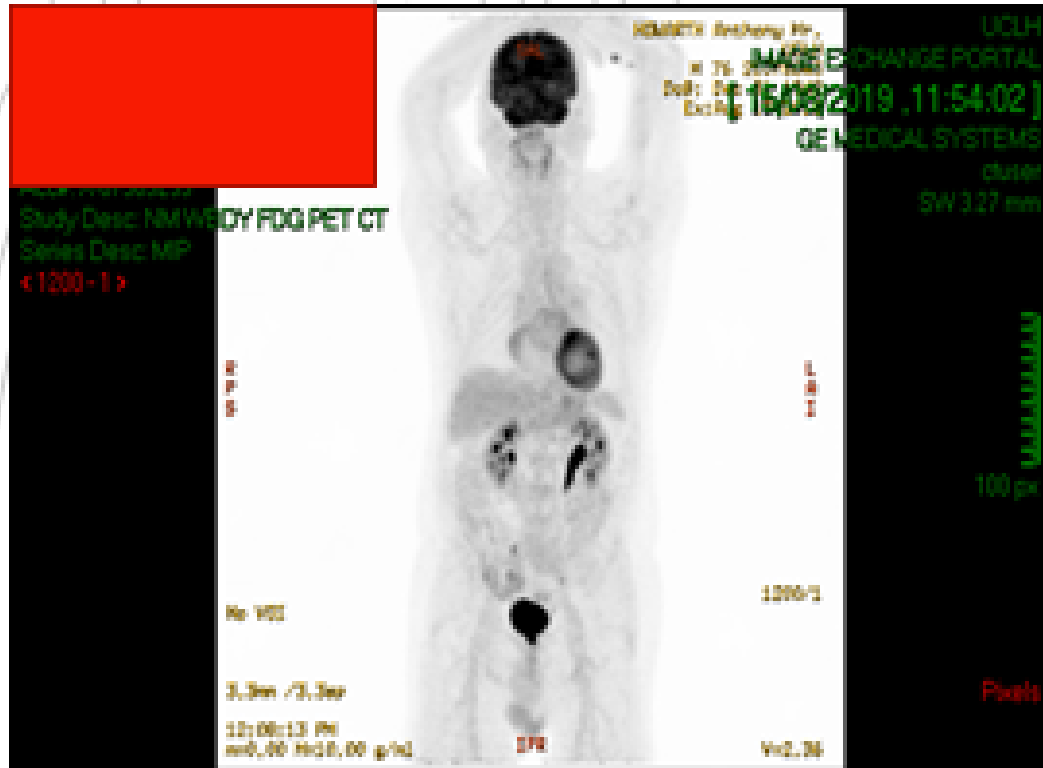
- Clinical indication:
 - 1 cm right base lung nodule.
- Comparison:
 - None available at the time of reporting.
- Findings:
 - 18 F FDG PET/CT with low-dose CT for attenuation correction and image fusion.
 - Head and neck:
 - There is no abnormal intracranial uptake. There is no tracer avid or enlarged cervical lymphadenopathy. There is low-grade bilateral subcentimetre cervical lymphadenopathy which is reactive.
 - Chest:
 - There is subcentimetre mediastinal lymphadenopathy with low-grade uptake which appears reactive. There is a calcified right paratracheal lymph node. There is no tracer avid or enlarged mediastinal lymphadenopathy. There is coronary artery calcification and stenting.
 - There is a subcentimetre area of nodularity in the right base are affected by breathing artefact, which is non-avid (separate image sent to PACS) as well as, further areas of linear atelectasis and high-density change in the right lower lobe (separate image sent to PACS). There is non-avid small volume apical scarring. There are several 1-2 mm areas of non-avid subpleural nodularity in the right upper lobe associated with some subtle reticular change. There is subtle non avid subpleural reticular change in the left upper lobe and tiny granulomata in the left upper lobe and lingula. No other suspicious pulmonary nodularity. No pleural or pericardial effusion. No pulmonary artery enlargement.
 - Abdomen and pelvis:
 - There is no focal liver, gallbladder, pancreas, spleen, adrenal or renal lesion. The left adrenal is nodular and low-attenuation in keeping with benign adenomatous change. No hydronephrosis. There is no tracer avid or enlarged abdominal or pelvic lymphadenopathy. There is low-grade tracer uptake of benign looking inguinal lymph nodes. There is sigmoid diverticular change with no increased uptake. There is no focal suspicious bowel uptake. There is calcification in the prostate gland. There is calcification of the infrarenal abdominal aorta and of the proximal common iliac arteries.

■ **Bones and soft tissues:**

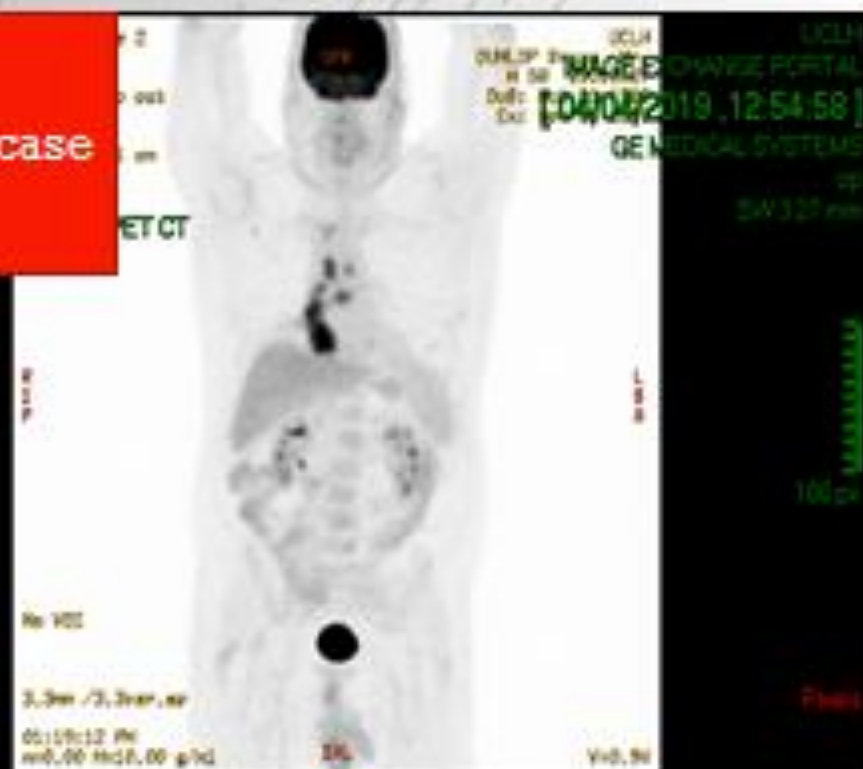
There is no tracer avid focal bone, lytic or sclerotic lesion. There is mild degenerative bilateral acromioclavicular joint uptake. There is mild uptake at the degenerative pubic symphysis. There is mild non-avid loss of vertebral body height in the thoraco and lumbar spine worst affected at L5 where there is 25% loss of vertebral body height which is likely degenerative or related to low bone density.

Conclusion:

- 1) Non-avid area of soft tissue nodularity in the right lower lobe which is affected by breathing artefact. Please compare with the local imaging (separate images sent to PACS) to assess whether this is the nodule described in the clinical details. Further areas of subtle subpleural reticular change and granulomata but no evidence of FDG avid soft tissue nodule or morphologically suspicious pulmonary lesion/abnormality.
- 2) No other FDG avid or assessable disease.
- 3) Mild non avid thoraco and lumbar vertebral body height loss as described (either degenerative or related to bone density).



Second case



- Clinical indication: Right hilar mass.? Operable
- Findings: Whole-body FDG PET with low dose CT scan for attenuation correction and image fusion.
- Head and neck:
 - No focal suspicious FDG activity. FDG avid 8 mm right supraclavicular fossa node (SUV max 2.1), suspicious for nodal metastasis.
- Chest:
 - There is a FDG spiculated mass centred in the right hilar (measuring ~ 7.5 x 4 cm, SUV max 12). The mass is encasing the right main bronchus and inseparable from the right main pulmonary artery. The mass is extending inferiorly to the right lower lobe and it is in direct contact with the posterior parietal pleura.
 - There is however no clear invasion noted into the adjacent rib or vertebral body.
 - No other FDG avid pulmonary masses or nodules identified.
 - There are multiple enlarged FDG avid bilateral mediastinal nodes. For example:
 - -Right paratracheal lymph node, measuring 2.6 cm (SUV max 7.9);
 - -Left paratracheal lymph node, measuring 2.2 cm (SUV max 5.2);
 - -Subcarinal, SUV max 7.5;
 - -Left lower para-aortic, measuring 1.3 cm (SUV max 3.3).
 - Non-FDG avid axillary lymphadenopathy.
 - No FDG avid pleural effusion.

Another report continue

- **Abdomen and pelvis:**
- The medial arm of the left adrenal gland is slightly enlarged with low-grade FDG activity (SUV max 2.3 cf. liver SUVmax 4.6).
- No FDG focality in the liver, spleen, right adrenal or pancreas.
- No FDG avid abdominal or pelvic lymphadenopathy.
- No focal FDG activity in the bowel or the pelvis.
-
- **Skeleton:**
- FDG avid mild lucent lesions in the mid sternum, the coracoid process and possibly at the medial aspect of the right scapula (SUVmax 3.6).
-
- **Conclusion:**
- 1. FDG avid (~7.5 cm) right hilar lung mass, suspicious for malignancy.
- 2. Bilateral mediastinal and right supraclavicular nodal disease.
- 3. Suspicious bony deposits in the sternum and right scapula.
- 4. The lowgrade activity in nodular left adrenal is likely to be explained by adenoma rather than metastatic disease.

In case of histologically proven lung malignancy, the suggested TNM stage would be T4 N3 M1c

Summary

- We discussed
 - Lung cancer overview
 - Lung Cancer Staging
 - Why PET Scan is important
 - What we need from you

Any
Question?

Thank You

ID 56331118