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Surgical Diseases of the Lung

- Lung Cancer
- Empyema
- Pneumothorax

- Lung surgery is surgery done to repair or remove lung tissue. There are many common lung surgeries, including:
- Biopsy of an unknown growth
- Lobectomy, to remove one or more lobes of a lung
- Pneumonectomy, to remove a lung
- Lung transplant
- Surgery to prevent the buildup or return of fluid to the chest (pleurodesis)
- Surgery to remove an infection in the chest cavity (empyema)
- Surgery to remove blood in the chest cavity, particularly after trauma
- Surgery to remove small balloon-like tissues (blebs) that cause lung collapse (pneumothorax)
- Wedge resection, to remove part of a lobe in a lung

Risks of this surgery include

- Failure of the lung to expand
- Injury to the lungs or blood vessels
- Need for a chest tube after surgery
- Pain
- Prolonged air leak
- Repeated fluid buildup in the chest cavity
- Bleeding
- Infection
- Heart rhythm disturbances
- Damage to the diaphragm, esophagus, or trachea
- Death

Lung Cancer

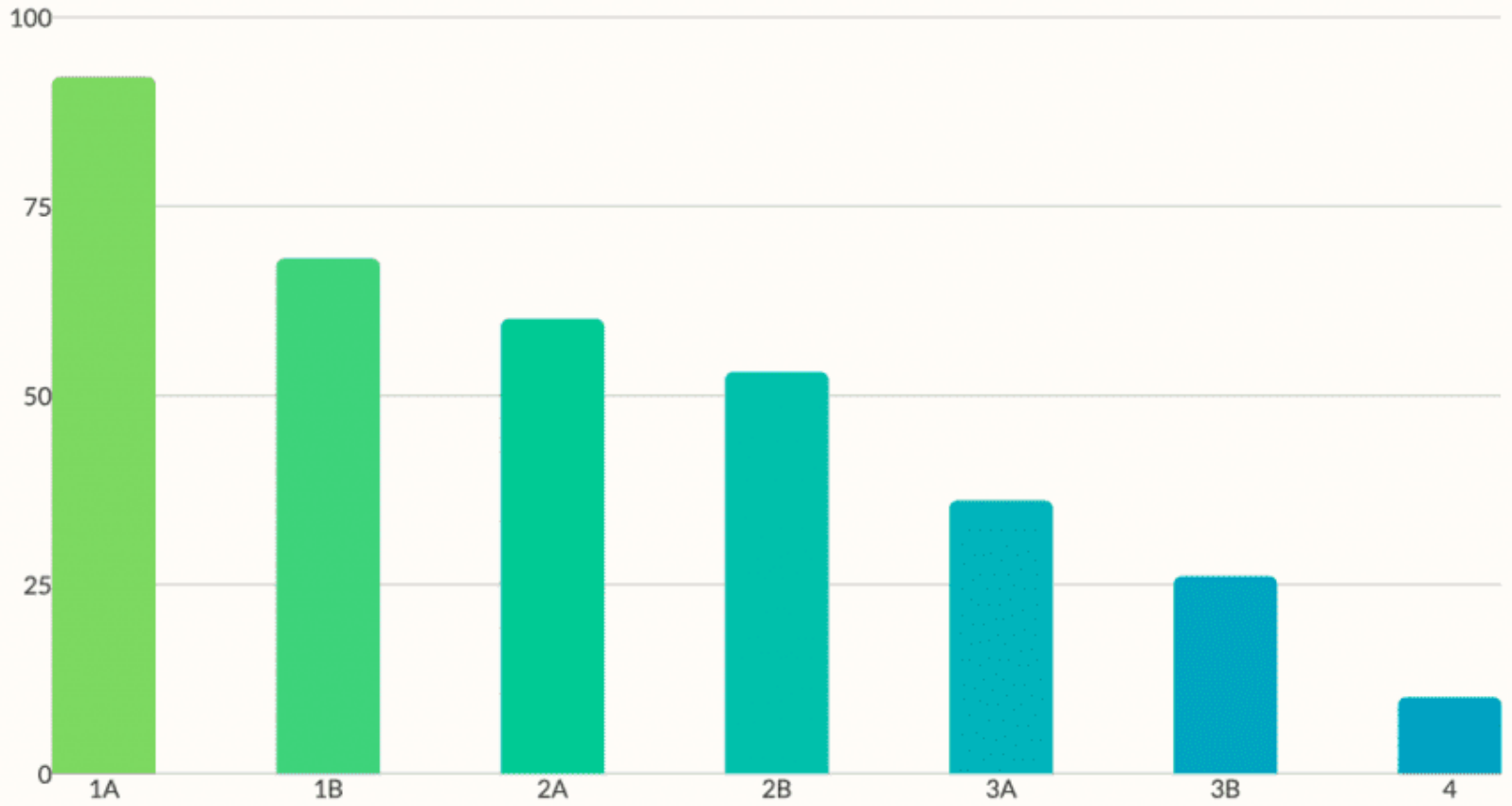
Lung cancer is the leading cause of cancer-related death in Europe and in the United States

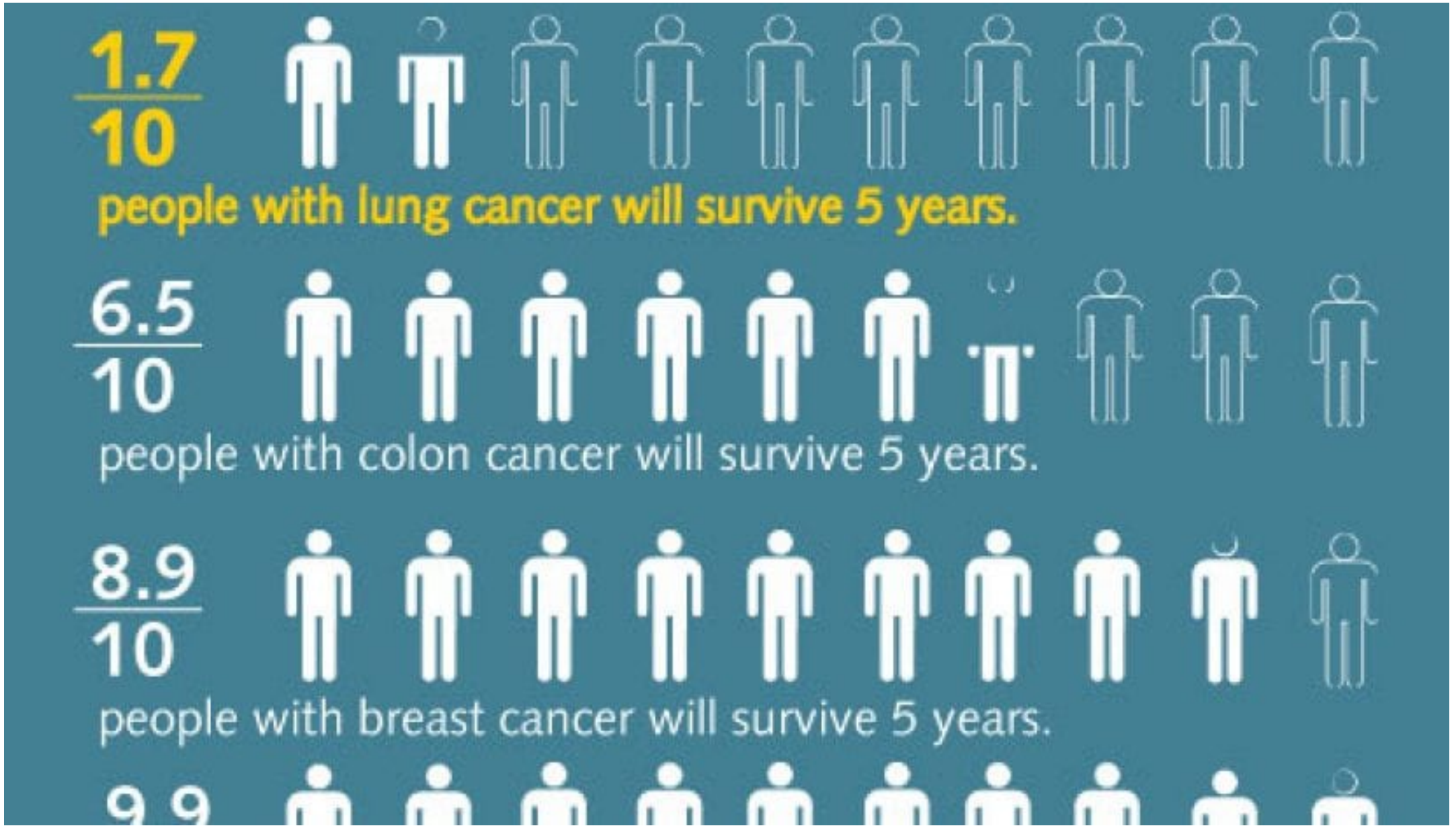
Overall 5-year survival rates: 14%-15%

60-70% of patients present with advanced disease (stages IIIB or IV) at diagnosis that is considered to be incurable

Median survival is approx. 4-5 months

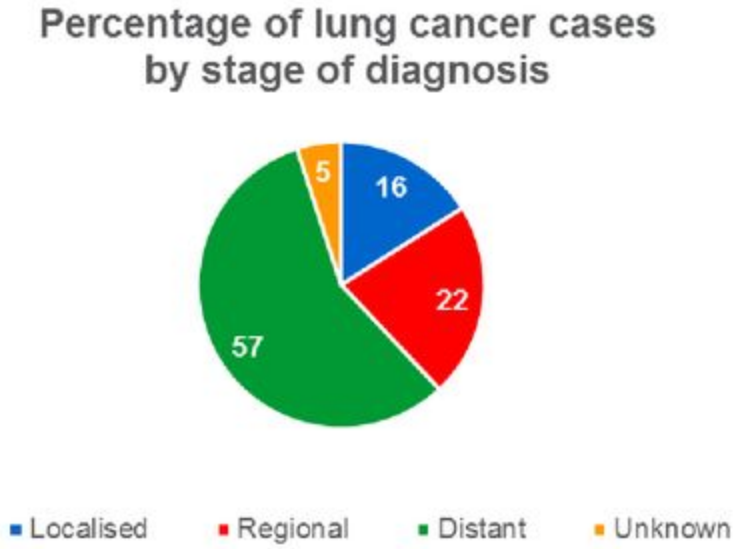
LUNG CANCER SURVIVAL RATES



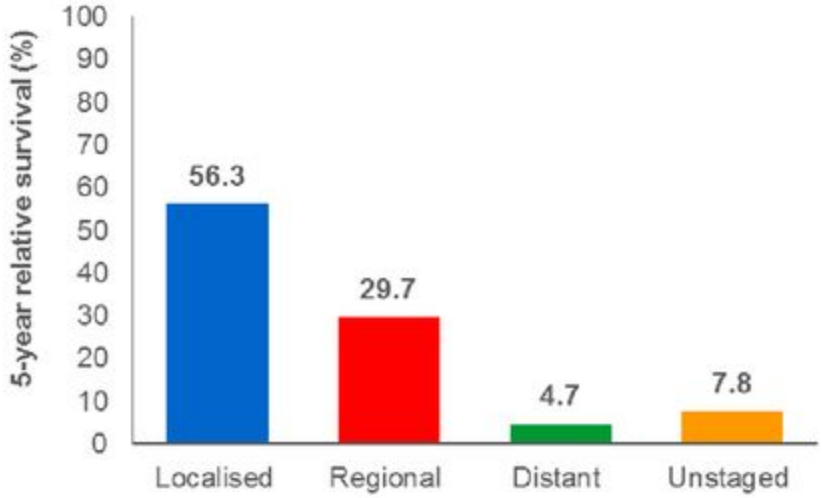

1.7
10
people with lung cancer will survive 5 years.
6.5
10
people with colon cancer will survive 5 years.
8.9
10
people with breast cancer will survive 5 years.

Stage of diagnosis affects 5-year survival rate

Almost 60% of patients with lung cancer have late-stage disease at diagnosis



The 5-year survival rate is low in patients with late-stage disease



1. National Cancer Institute Surveillance, Epidemiology, and End Results (SEER). https://seer.cancer.gov/statfacts/html/lungb.html (Accessed: 07 December 2018).

- Lung cancer remains the leading cause of cancer death worldwide and is responsible for over 1.6 million deaths per year

Global Burden of Disease Cancer Collaboration , Fitzmaurice C, Allen C, et al.. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: A systematic analysis for the Global Burden of Disease Study. *JAMA Oncol* 2016;3:524–48.

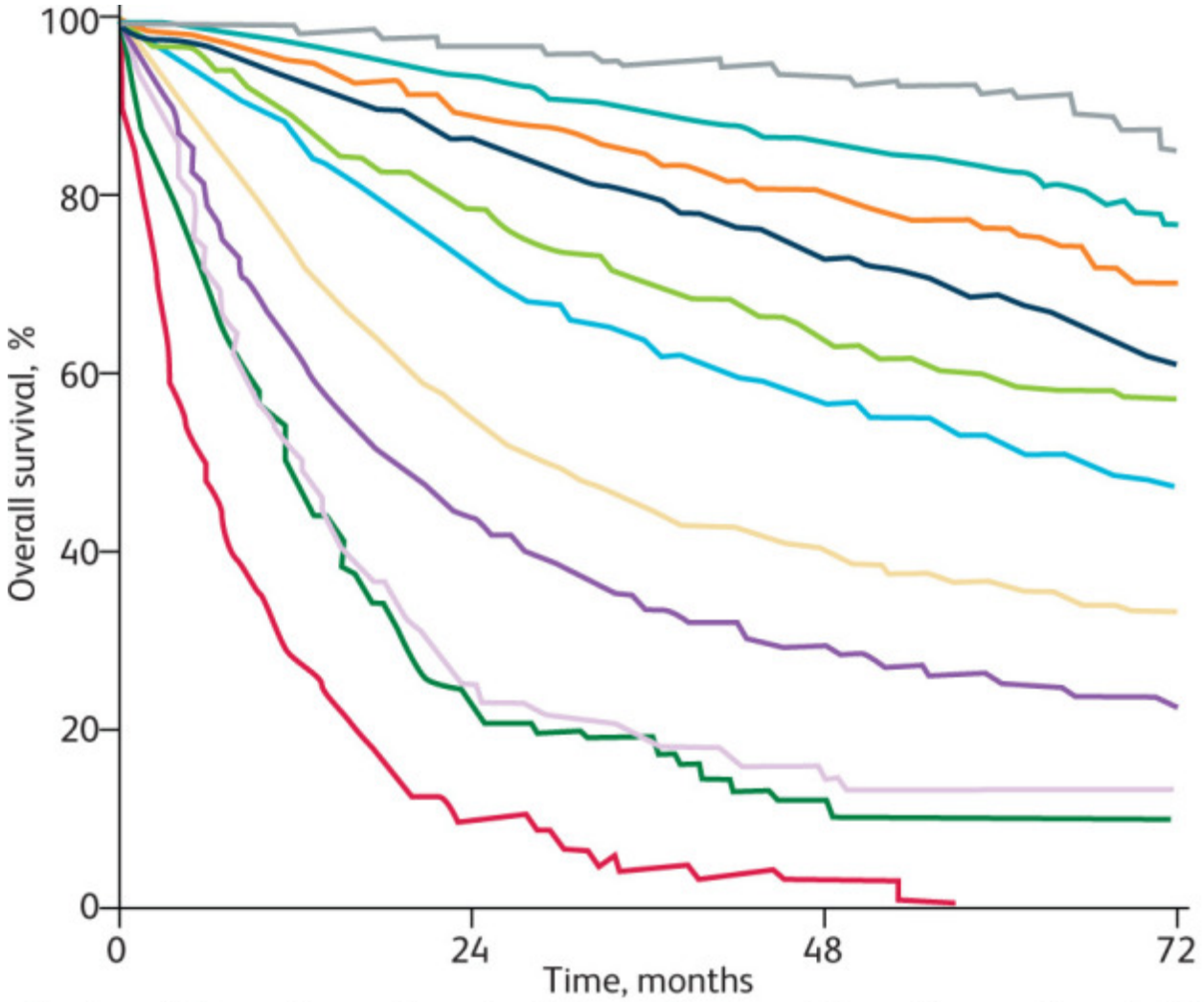
- This accounts for approximately 20% of all cancer deaths, and is more than the combined total for breast, colon and prostate cancer

Ferlay J, Soerjomataram I, Dikshit R, et al.. Cancer incidence and mortality worldwide: sources, methods and major patterns in GLOBOCAN 2012. *Int J Cancer* 2015;136:E359–86

- Early-stage disease remains asymptomatic and, therefore, approximately 70% of cases are diagnosed at an advanced stage when cure is no longer possible.
- In the UK, over a third of lung cancers are diagnosed as an emergency presentation, of which, almost 30% will die within months

O'Dowd EL, McKeever TM, Baldwin DR, et al.. What characteristics of primary care and patients are associated with early death in patients with lung cancer in the UK? *Thorax* 2015;70:161–8

- This is a major contributing factor to current poor survival outcomes, with a 5-year survival rate of just over 15%



Staging	60-month overall survival, %
IA1	92
IA2	83
IA3	77
IB	68
IIA	60
IIB	53

Staging	60-month overall survival, %
IIIA	36
IIIB	26
IIIC	13
IVA	10
IVB	0

Lung Cancer:
Are You at Risk?

LCFA
Lung Cancer Foundation of America

Smoking	Second-Hand Smoke	Radon Gas Exposure
Asbestos Exposure	Other Carcinogens	Air Pollution
Arsenic in Drinking Water	Previous Lung Radiation	Personal or Family History

Learn more about lung cancer symptoms, types, and research at
www.LCFAmerica.org

Predisposing factors of bronchogenic carcinoma

1- Tobacco smoking:

- Some **85%** of lung cancers occur in cigarette smokers.
- **Most types** are linked to cigarette smoking, but the **strongest** association is with **squamous cell carcinoma small cell carcinoma.**
- The **nonsmoker** who develops cancer of the lung usually has an adenocarcinoma.
- Is **directly proportional** to the **number of cigarettes smoked daily** and the **number of years of smoking.**
- Cessation "انقطاع تام" of cigarette smoking for at least 15 years **brings** the **risk down**.
- Passive smoking "inhaling of smoke from other people's cigarettes" **increases** the risk to approximately twice than non-smokers.
- Cigarette smokers show various histologic changes, including **squamous metaplasia of the respiratory epithelium** which may progress to **dysplasia**, **carcinoma in situ** and **ultimately invasive carcinoma.**

2- Radiation:

All types of radiation may be **carcinogenic** and increase the risk of **developing lung cancer**. **Tradium and uranium workers are at risk**

3- Asbestos:

- **increased incidence of cancer** with asbestos exposure, especially in combination with cigarette smoking.

4- Industrial exposure:

- to **nickel and chromates, coal, mustard gas, arsenic, iron** etc.

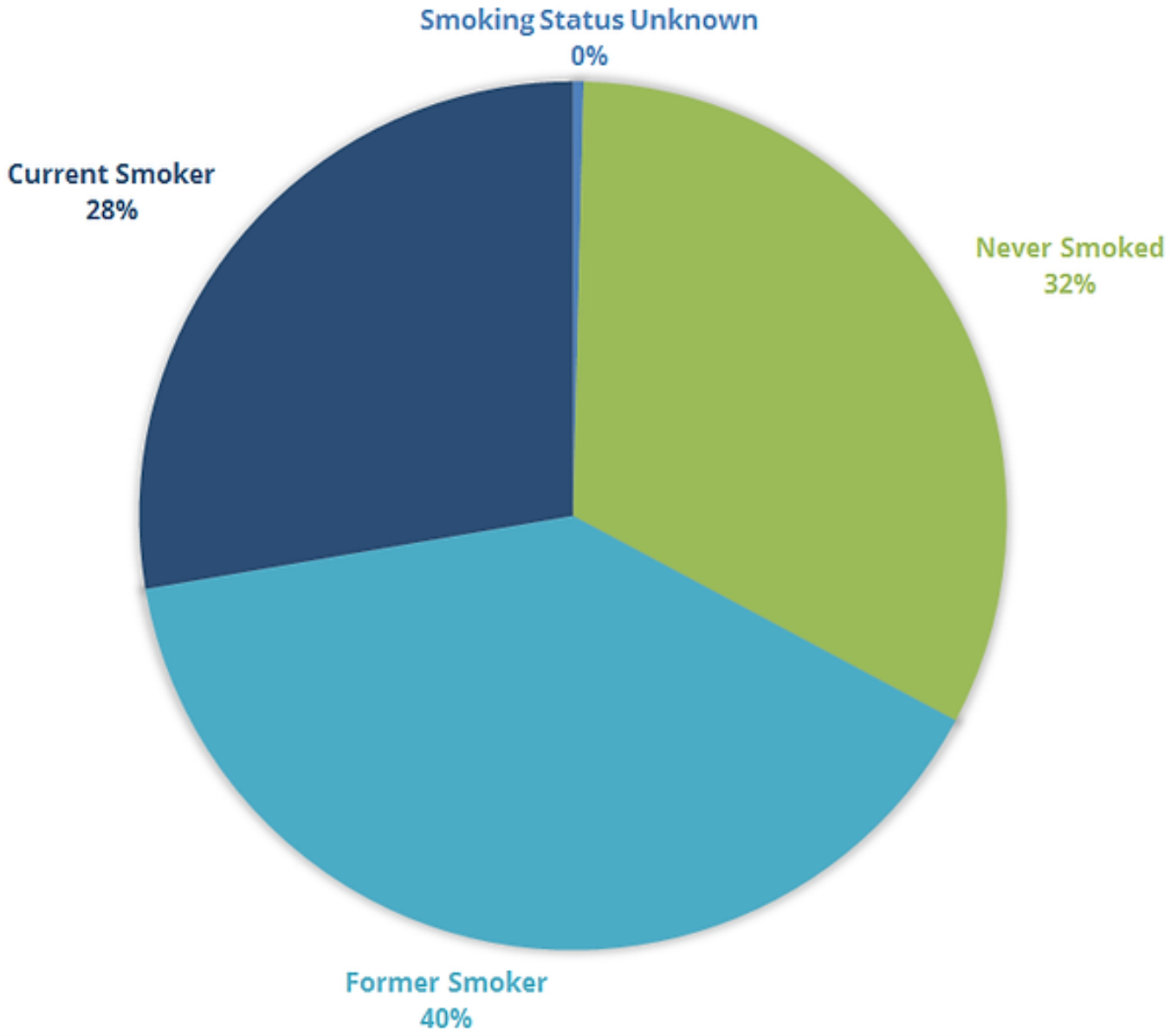
5- Air pollution:

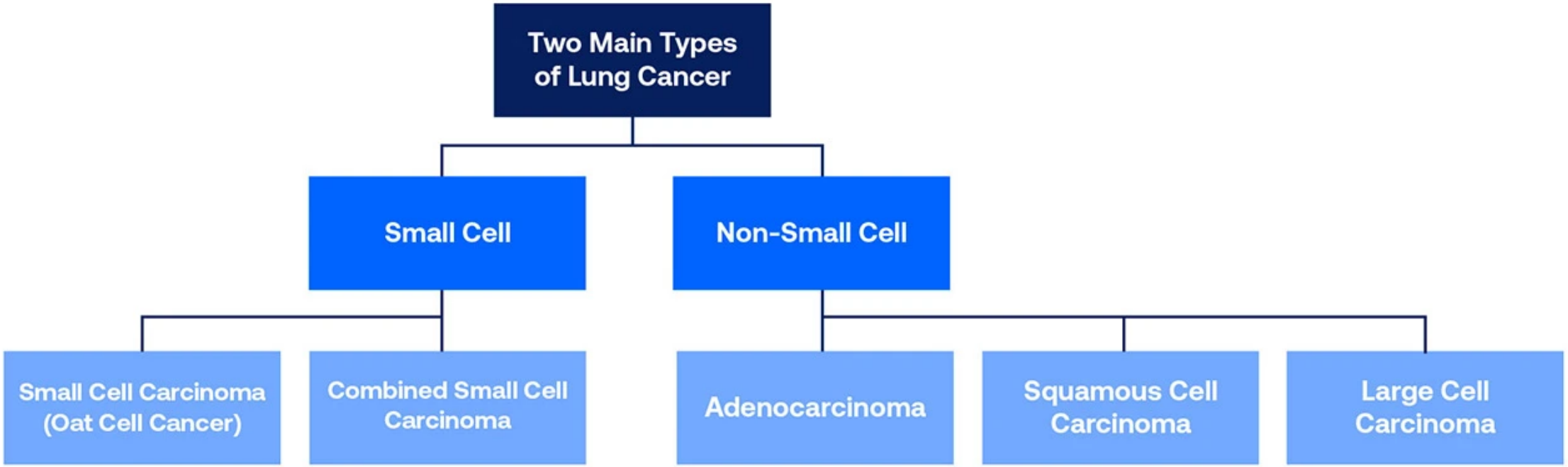
- May play some role in **increased incidence**.
- Indoor air pollution especially by radon "chemical element (noble gas series)"

6- Scarring:

- sometimes **old infarcts**, **wounds**, **scar**, **granulomatous infections** are associated with adenocarcinoma.

SMOKING STATUS OF PARTICIPANTS DIAGNOSED WITH LUNG CANCER




Two Main Types of Lung Cancer
Small Cell
Non-Small Cell
Small Cell Carcinoma (Oat Cell Cancer)
Combined Small Cell Carcinoma
Adenocarcinoma
Squamous Cell Carcinoma
Large Cell Carcinoma

Pathology

1- small- cell carcinoma:

-accounts for 15-20% of all lung cancers

- aggressive tumor

- arise in cells derived from the embryonic neural cells

- usually occur near the hilum (centrally located)

-almost exclusive to smokers

- rarely amenable to surgery because of wide dissemination by the time of diagnosis

- 5 year survival less than 10%

2- non-small-cell carcinoma:

-accounts for 80% of all lung cancers

- make up the vast majority of those treated by surgery

- three main subtypes:

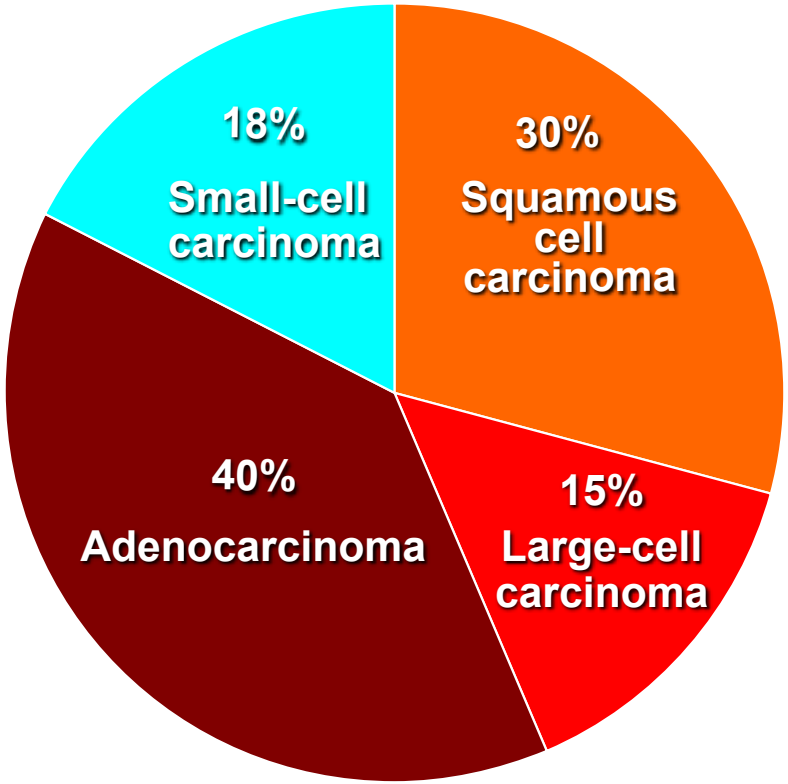
*adenocarcinoma 30-50%

* squamous cell carcinoma 20-35%

* large cell carcinoma 4-15%

LUNG CANCER

Incidence of major histologic types



Presentation

1- bronchopulmonary symptoms

2- extra pulmonary thoracic symptoms

3- Para neoplastic syndrome

4- distant metastasis

Presentation

Symptoms/signs

- Cough (80%)
- Dyspnea (60%)
- Pneumonia (post-obstructive)
- Hemoptysis
- Weight loss
- Effusion
- Advanced
  - Pancoasts/Superior Sulcus Syndrome
  - Horner's Syndrome
  - Hoarseness/Dysphagia

Paraneoplastic Syndromes

More common with SCLC

- Hypercalcemia
  - Ectopic PTH
- Cushings
- SIADH
- Eaton Lambert
- Hypertrophic Osteoarthropathy

LUNG CANCER
Screening

- Early NCI trial in high-risk population
  - sputum cytology every 4 months
  - chest radiograph annually
  - Low dose CT Scan

  - cancers identified in screened population were more often early-stage (40% versus 15% in unscreened)
  - 5-year survival of 35% versus 13% in general population

Work-Up for staging

- H&P
- Labs (CBC, KFT LFT)
- CxR - spiculated, non-calcified, notched
- CT chest/abd - assess adrenals and liver
  - (sensitivity/specificity ≈ 65%)
- PET scan (sensitivity/specificity ≈ 90%)
- MRI Brain for stage ≥ IIb
- PFT's (cut-offs for surgery FEV1 <800 ml, DLCO < 60% predicted)
- Bronchoscopy
- CT guided needle biopsy
- Mediastinoscopy/otomy
- Thoracospcopy/otomy

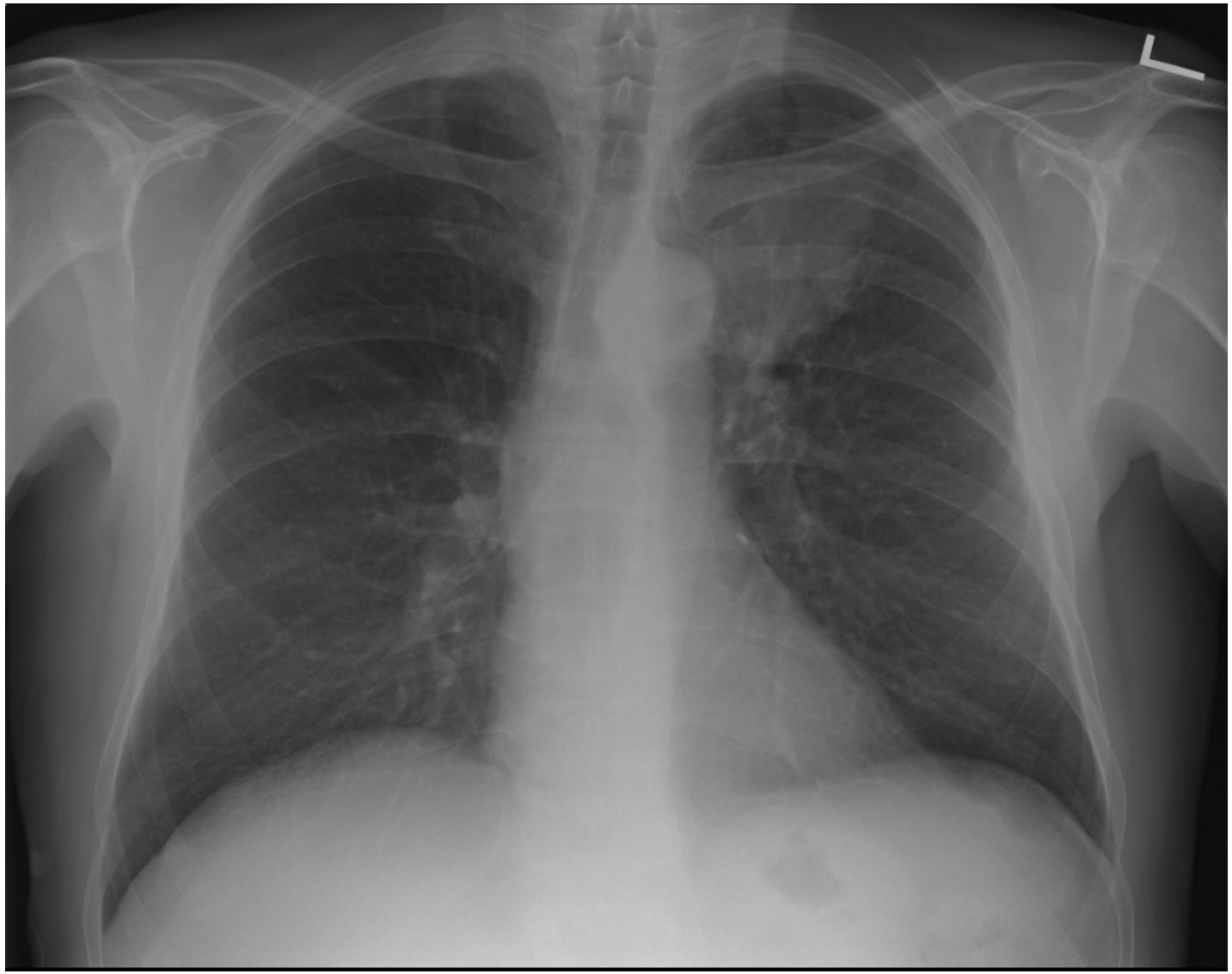
Pretreatment assessment:NSCLC
Is the patient fit for resection ?

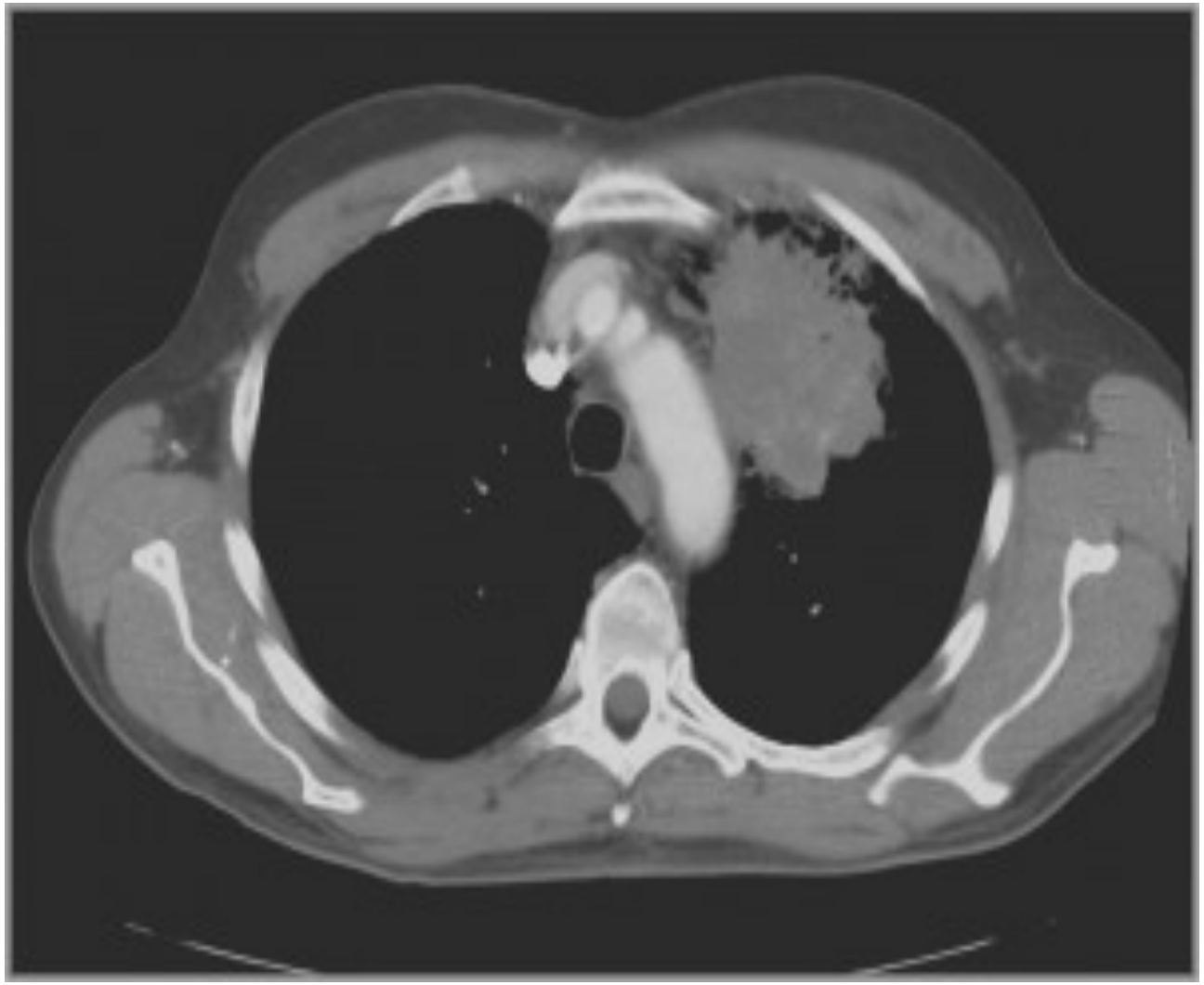
ASSESSMENT OF EXTENSION

- Chest radiograph
- Fiberoptic bronchoscopy
- CT scan: Chest + Suprarenals
- Abdominal ultrasound
- ± brain MRI
- ± bone scintigraphy
- Lab : serum calcium+…..
- ± other exams→ PET-scan if operable (if possible!)

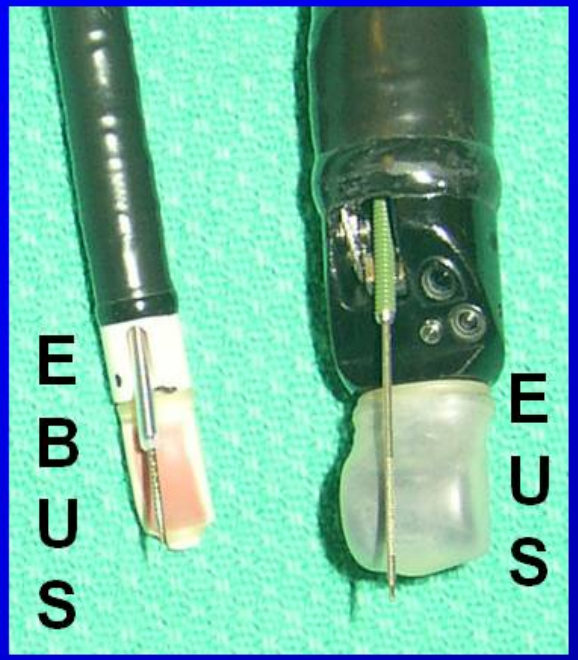
ASSESSMENT OF RESECTABILITY

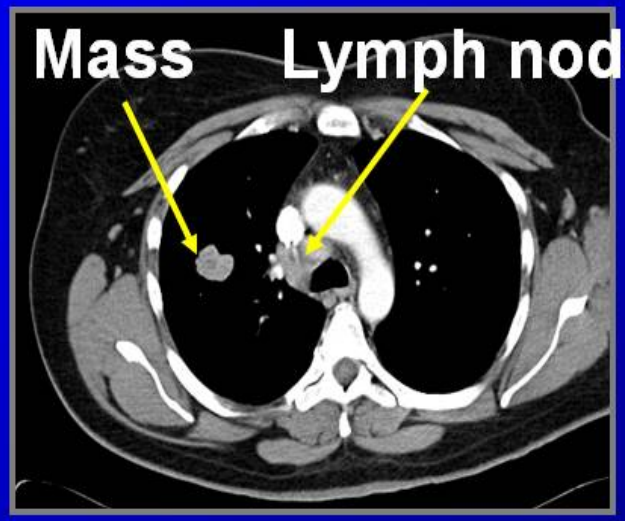
- Biological age
- General health status
- Associated diseases
- Pulm. Function test ± Blood gas analysis
- ± quantification by perfusion lung scintigraphy
- Goal : FEV1 post-op ≥ 1000 ml

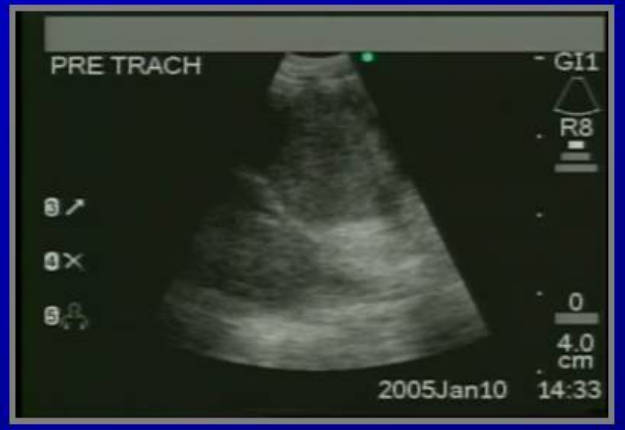




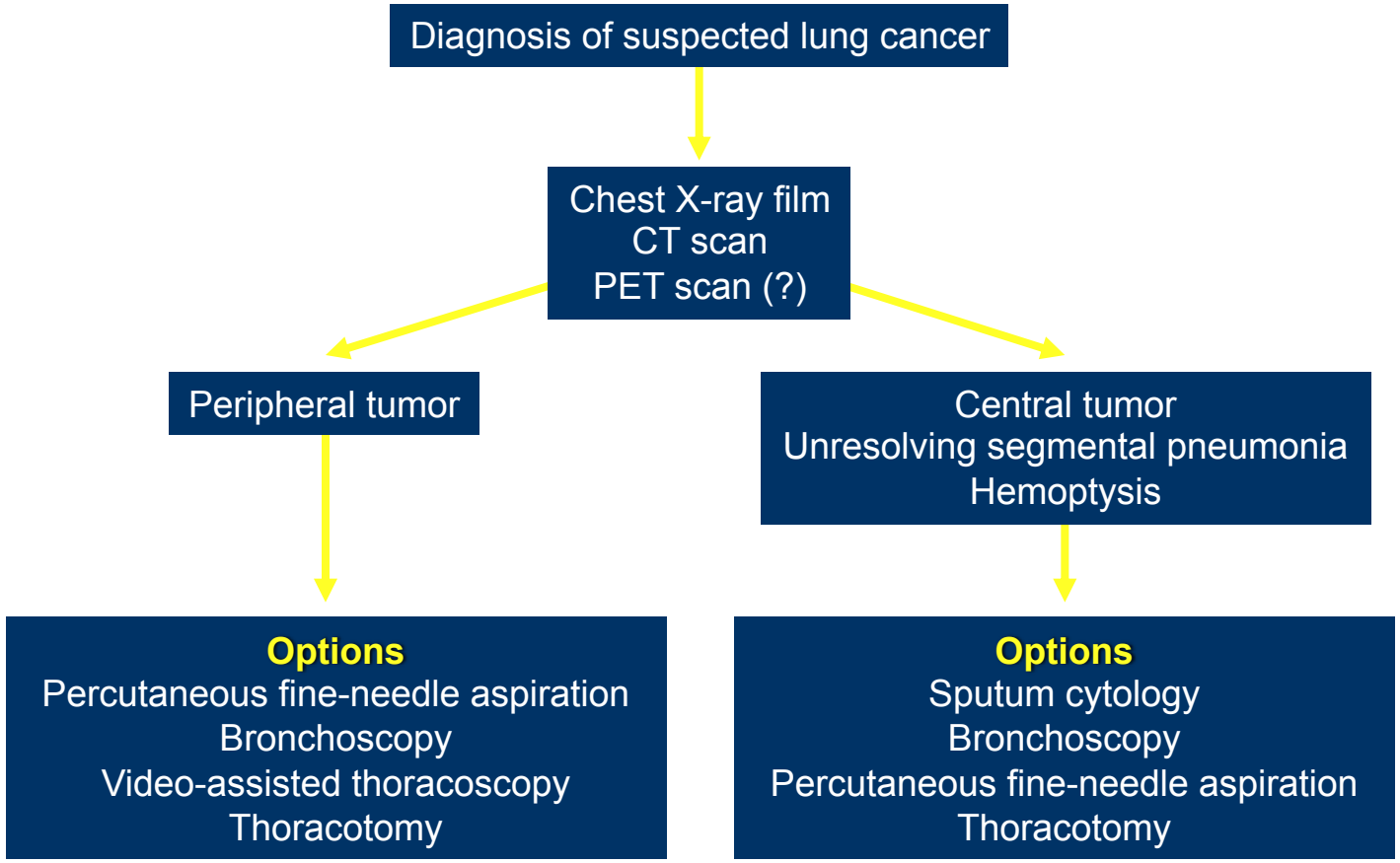
Endobronchial Ultrasound (EBUS)







LUNG CANCER
Diagnosis



Histological classification is necessary for decision making

A diagnosis of “non-small cell lung cancer”
is no longer acceptable as sufficient basis for treatment decisions:

Histology will help guide decision about which molecular analysis is performed

Molecular classification:
Present necessities and future directions

Adenocarcinoma of the lung is not a uniform disease and needs to be classified by additional molecular analysis

Present needs include EGFR mutation status and determination of EML4-ALK fusion gene

Knowledge about resistance mechanisms to available agents and the opportunity of agents against new molecular targets mandate change in the trial design

Potential driver mutations are also being identified in squamous cell lung cancer

TNM : classification by stage and prognosis

Stage	TNM	Survival at 1 year (%) : c-p	Survival at 5 years (%) : c-p
IA	T1 N0 M0	94-91	61-67
IB	T2 N0 M0	72-87	38-57
IIA	T1 N1 M0	79-89	34-55
IIB	T2 N1 M0	61-78	24-39
	T3 N0 M0	55-76	22-38
IIIA	T3 N1 M0	56-65	9-25
	T1-2-3 N2 M0	50-64	13-23
IIIB	T4 N0-1-2-3 M0	37	7
	T1-2-3 N3 M0	32	3
IV	All T all N M1	20	1

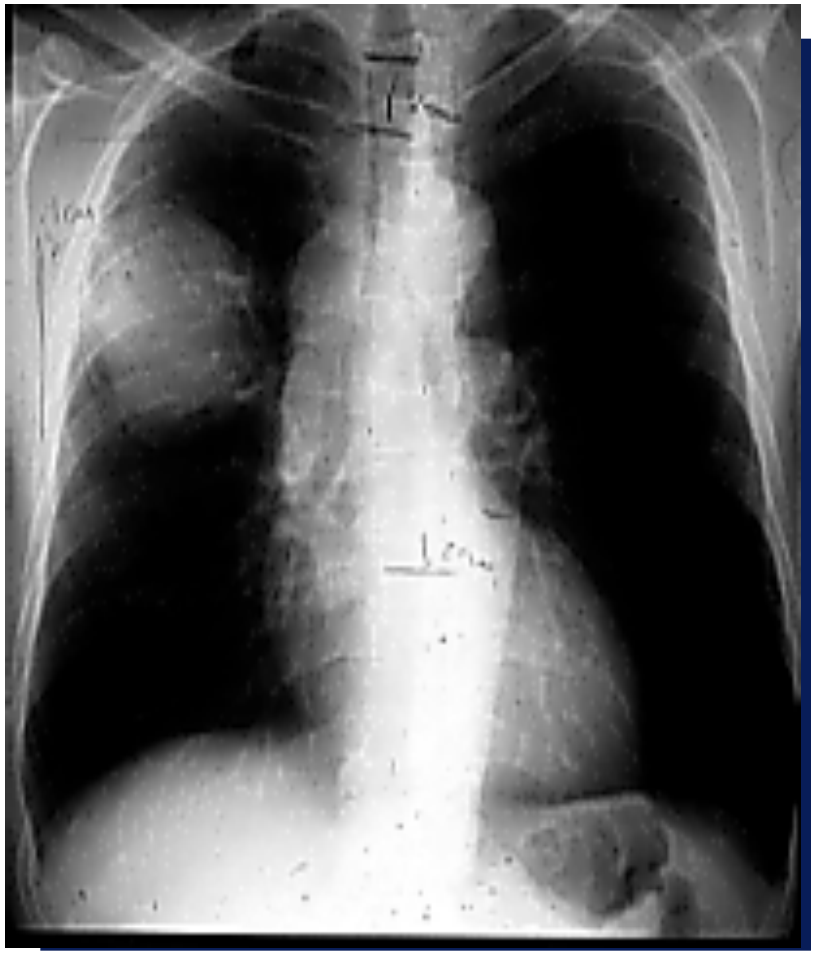
TNM 8th - Primary tumor characteristics

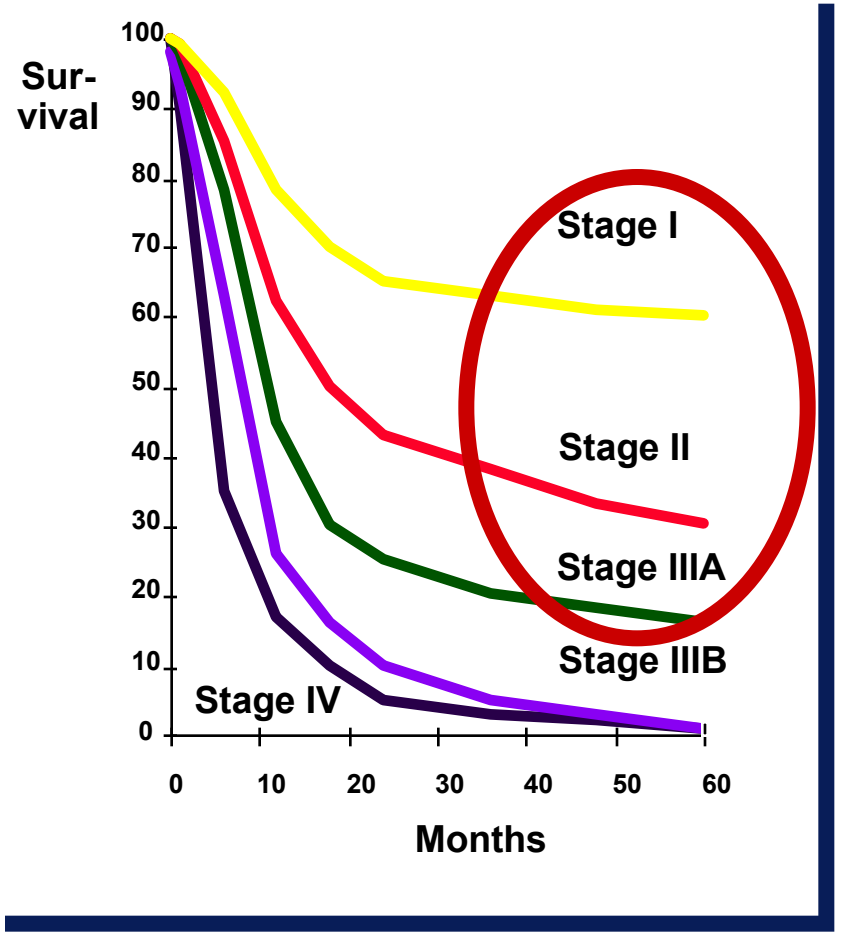
T_x	**Tumor in sputum/bronchial washings but not be assessed in imaging or bronchoscopy**
T_0	**No evidence of tumor**
T_{is}	**Carcinoma in situ**
T_1	≤ 3 cm surrounded by lung/visceral pleura, not involving main bronchus
$T_{1a(mi)}$	**Minimally invasive carcinoma**
T_{1a}	**≤ 1 cm**
T_{1b}	**> 1 to ≤ 2 cm**
T_{1c}	**> 2 to ≤ 3 cm**
T_2	> 3 **to ≤ 5 cm** *or* **involvement of main bronchus without carina, regardless of distance from carina** or invasion visceral pleural *or* atelectasis or post obstructive pneumonitis extending to hilum
T_{2a}	**>3 to ≤4cm**
T_{2b}	**>4 to ≤5cm**
T_3	**>5 to ≤7cm in greatest dimension** *or* tumor of any size that involves chest wall, pericardium, phrenic nerve *or* satellite nodules in the same lobe
T_4	**> 7cm in greatest dimension** *or* any tumor with invasion of mediastinum, **diaphragm**, heart, great vessels, recurrent laryngeal nerve, carina, trachea, oesophagus, spine *or* separate tumor in different lobe of ipsilateral lung
N_1	Ipsilateral peribronchial and/or hilar nodes and intrapulmonary nodes
2	Ipsilateral mediastinal and/or subcarinal nodes
3	Contralateral mediastinal or hilar; ipsilateral/contralateral scalene/ supraclavicular
M_1	Distant metastasis
M_{1a}	Tumor in contralateral lung or pleural/pericardial nodule/malignant effusion
M_{1b}	**Single extrathoracic metastasis, including single non-regional lymphnode**
M_{1c}	**Multiple extrathoracic metastases in one or more organs**

How is Lung Cancer Treated?

- Treatment depends on the stage and type of lung cancer
- Surgery
- Radiation therapy
- Chemotherapy (options include a combination of drugs)
- Targeted therapy
- Lung cancer is usually treated with a combination of therapies
- Multidisplinary team plan for treatment

First Choice of Therapy: Surgery





Treatment Guidelines

- I
  - IA T1N0
  - IB T2N0
- Surgical resection: OS-5: 65-70%
  - Lobectomy + mediastinal nodal mapping
    - Adj chemo or RT not beneficial
- RT alone OS-5: 30%
- Pt refuses surgery or medically inoperable

Treatment Guidelines

- II
  - IIA T1N1
  - IIB T2N1,T3N0
- Surgical Resection OS-5: 35-50%
  - Adjuvant CT prolongs OS
  - Adjuvant RT
    - Close or positive margins or ?pos. hilar nodes
- Definitive RT alone: same as stage I

Stage III A: T3 N1 M0
T1, T2 N2 M0

T3N1M0: N1

- *Surgery alone in operable patients without bulky lymphadenopathy.*
- *Adjuvant chemotherapy.*
- *Chemo radiotherapy for patients who are not suitable for surgery.*

T1, T2 N2M0: N2

- *Preoperative chemotherapy is standard for resectable stage IIIA. In randomized trials the survival of stage IIIA patients was significantly better with induction chemotherapy plus surgical resection than with resection alone.*
- *Radiation therapy alone, for patients who are not suitable for neoadjuvant chemotherapy plus surgery.*
- *Platinum-based chemotherapy and thoracic radiotherapy is the standard treatment for medically inoperable stage IIIA NSCLC.*

Survival After Resection for Stage I NSCLC

- Martini, et al 1995
  - 598 patients with stage 1 NSCLC
    - 291 T1 & 307 T2
    - 5 yr minimum follow up

	stage T1 N0	*stage T2 N0*	*p-value*
5-yr OS rate	82%	68%	0.004
10-yr OS rate	74%	60%	0.004

Factors affecting survival

- **Tumor size**
- **Visceral pleura involvement** may be a significant prognostic factor in stage I.
- **The histological type of tumor** is a determinant of survival and time to recurrence in completely resected stage I patients, with worse results in nonsquamous histology tumors.
- Typically, in a Lung Cancer Study Group series, the 5-year survival for T1N0 patients
- 83% for squamous carcinomas
- 69% for adenocarcinomas

Surgical goals

- To achieve complete resection of the primary tumor with no macroscopic tumor remaining and microscopically free margins.
- Only patients in whom a complete resection is anticipated are selected for surgery.
- These include patients with T1 to T4 and N0 to N1 tumors, and selected N2 patients

Surgical Principles

- Whenever possible, the tumor and all intrapulmonary lymphatic drainage should be removed com- pletely, most frequently by lobectomy or pneumo- nectomy.
- The tumor should not be disrupted during dissection to avoid spillage.
- In case of direct invasion of extrapulmonary structures, en bloc resection is the treatment of choice rather than discontinuous resection.

Surgical Principles

- Resection margins should be checked with frozen
- Section analysis, including bronchial, vascular, and any other margins with close proximity to the tumor. If positive margins are encountered, wider excision should be performed when possible.
- All accessible mediastinal lymph node stations should be removed for pathological evaluation. These should be clearly identified by the surgeon and properly labeled.

PANCOAST TUMOR

- Definition: Lung tumor localized in the pulmonary apex with invasion of pleural and adjacent structures. It has clear symptoms and signs.

EMPYEMA LUNG ABSCESS (SURGICAL LUNG INFECTIONS)

EMPYEMA THORACIS

- Definition: Invading of the pleural space with bacteria which result in accumulation of pus .
- Classification :(American Thoracic Society)
- Stage 1 :Exudative , with swelling of the pleural membranes as a result of ↑ permeability of swollen membranes (Uncomplicated Acute stage)
- Stage 2:Fibropurulent (Transitional) with heavy fibrin deposits.
- Stage 3:Organizing or Chronic phase. With ingrowth of fibroblasts and deposition of collagen

ETIOLOGY:

- PARAPNEUMONIC (secodary to a pneumonia)the most common
- Post trauma.
- Post surgery(esophageal or pulmonary)
- Subphrenic Abscess

Etiology	No. of patients	% of Patients	Perioperative Mortality
Simple parapneumonic	112	65.0%	0025.4%
Complicated Parapneu-monic			
Transplant patients	11	6%	9%
Postresection	11	6%	18%
Traumatic	8	5%	0.0%
Post-cardiac surgery	5	3%	18%
Malignant empyema	5	3%	0.0%
Local cause of empyema			
Esophageal	12	7%	8%
Subphrenic causes	6	2%	0.0%

Bacteriology

- Before ABO 10% of Pts survived pneumonia developed EMPYEMA(Streptococci & Pneumococci are the most frequent)
- After ABO the incidence as well as the mortality↓. Staph become more prevelent ,90% of empyema in children .

Incidence of Empyema according to Bacteria causing pneumonia

Aerobic *G +VE* *Strep pneumonia* *CAP*	*EFFUSION* *50%*		*EMPYEMA* *<5%*
Staph Aureus *CHILDREN* *ADULT*	 *70%* *40%*		 *80%* *20%*
G –VE *HAP VAP* *Anaerobes*	*50%* *35%*		*90%* *90%*

Clinical presentation

- Pleuritic chest pain ,fever, S.O.B ,Tacycardia AS Pneumonia.If prolonged symptoms SUSPECT EMPYEMA.
- Anaerobic :indolent

- P/E:Toxic anxiouspt, tacycardia, tacypnea, restricted chest wall excursion, ↓ air entry,dullness on percussion.
- Chronic pt Clubbing, Anaemia, wt loss.

DIAGNOSIS:

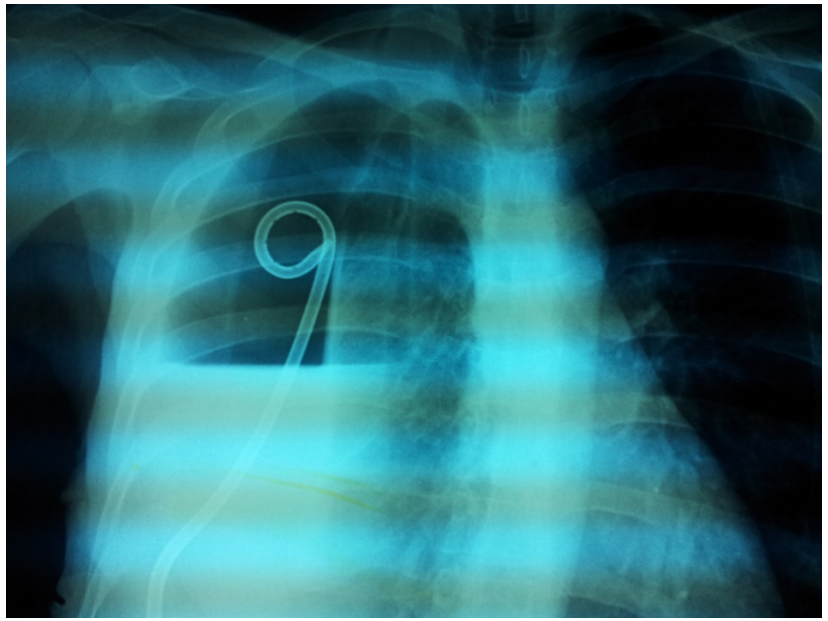
- CBC:↑ WBCwith shift to left,↑ CRP ESR.
- CXR:Effusion,↑thickness of the pleura, Air fluid level.

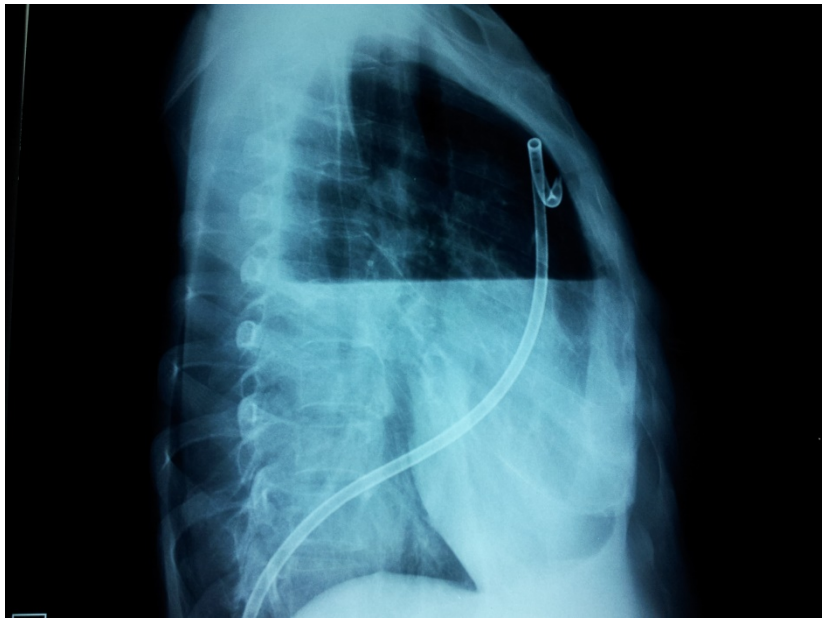
THORACOCENTESIS:

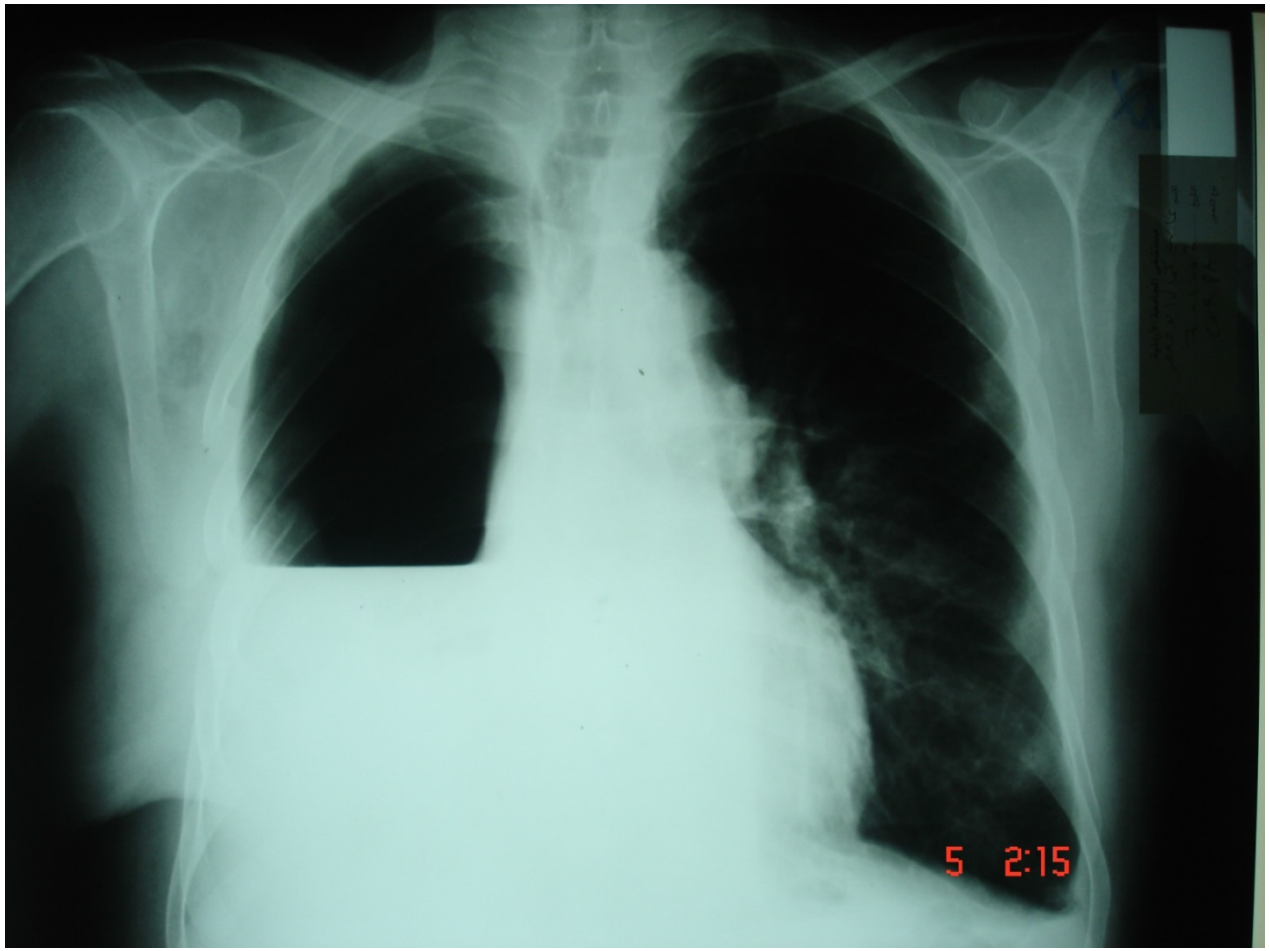
- Empyema fluid
- PH <7.2
- Glucose < 40 mg/dL
  LDH > 1000 IU/dL
  Positive Gram stain
  Positive culture (50%)
  Specific gravity > 1.018
  WBC > 500 cells/mm3
  Protein > 2.5 g/dL

PPE

- Clinically, are classified as
- simple PPE, pH > 7.20
- complicated PPE, and frank empyema. complicated PPE are exudates with glucose level <2.2 mmol/l and pH < 7.20.



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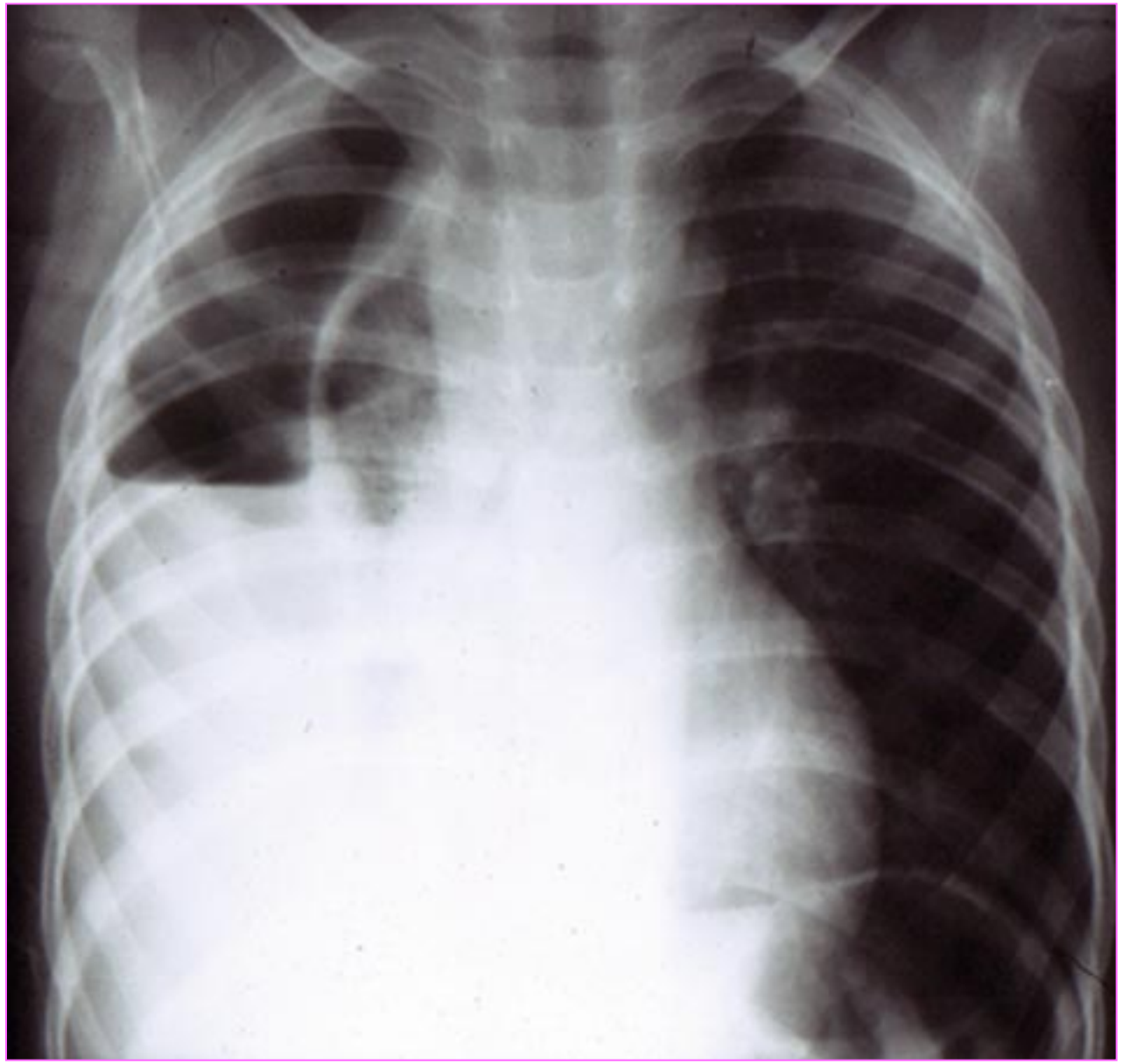

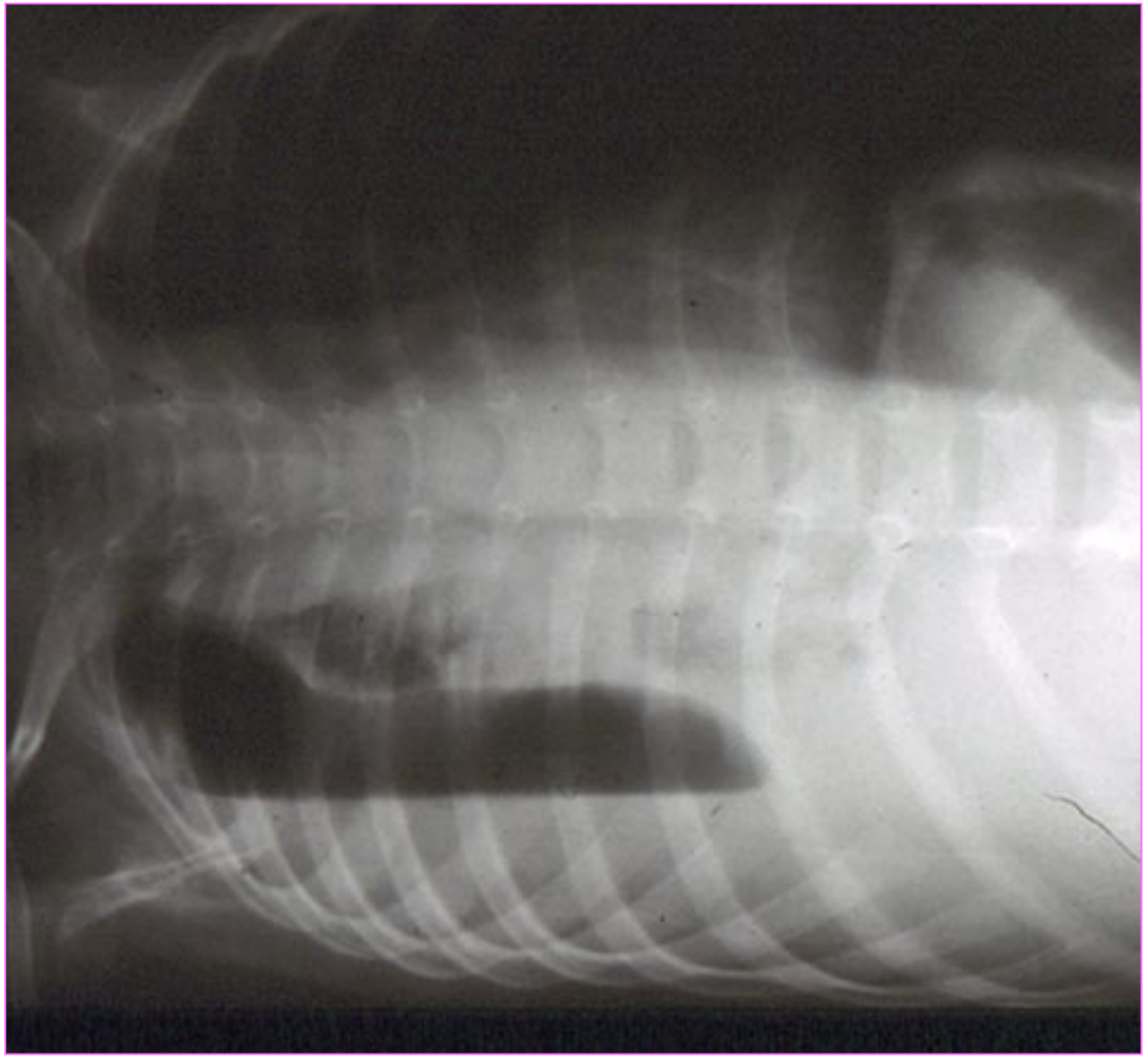

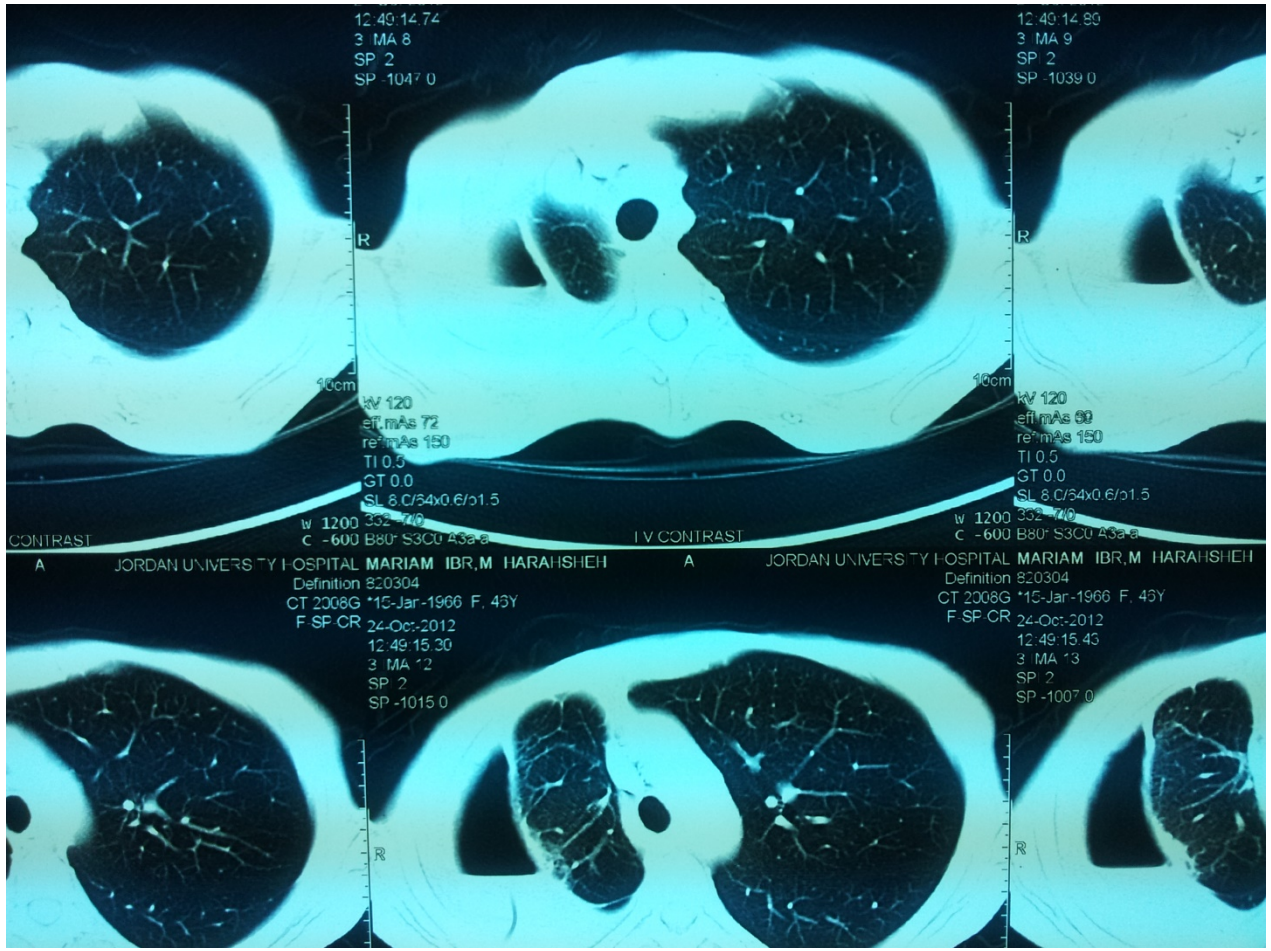
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□CT Scan:

- ✓ Localize collection.
- ✓ Identify the underlying parenchymal disease,.
- ✓ Distinguish it from lung abscess.
- ✓ Fluid density,loculations.
- ✓ Therapeutic:CT-guided aspiration.

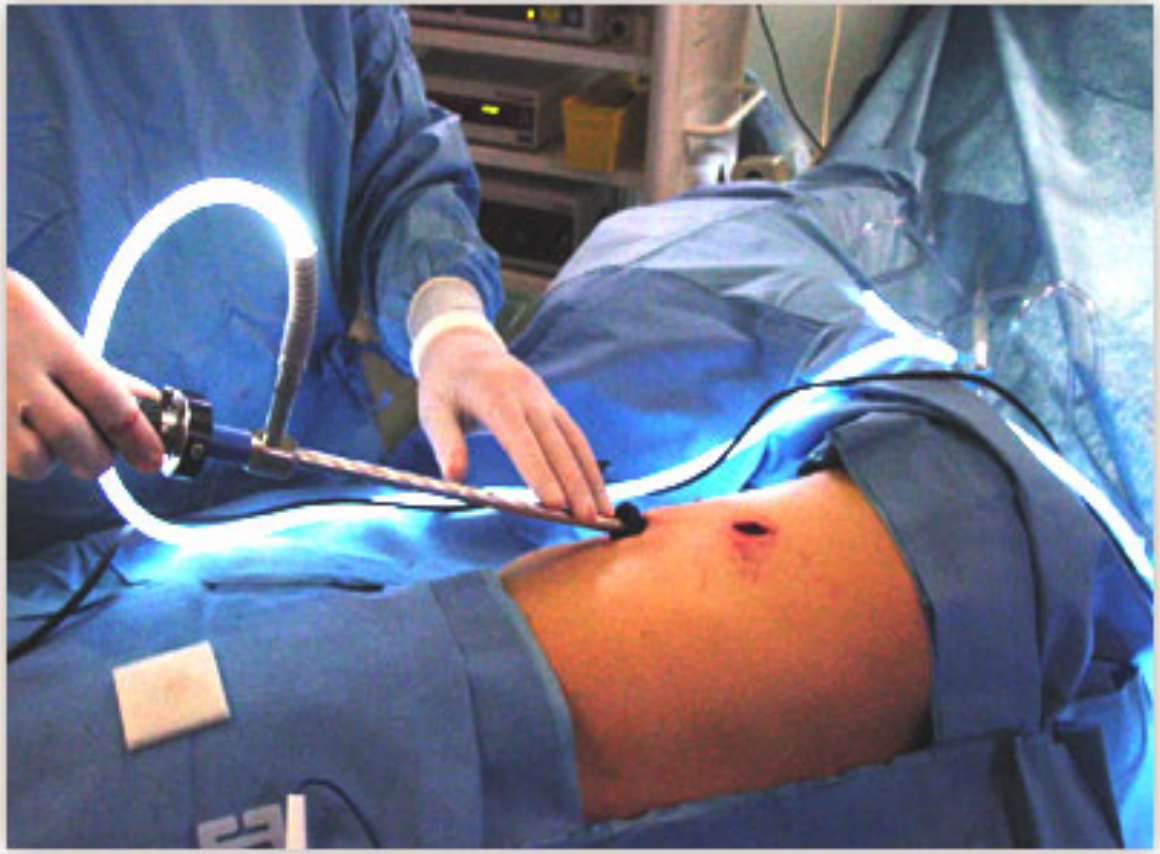
Managment

1. Antibiotics.3rd generation cephalosporine,clindamycin till the result of G stain ,C&S.
2. Evacuation of pus from the pleural space. In stage 1 thoracocentesis,other wise Chest tube insertion
3. Obliteration of the empyema cavity.

- Clinical improvement within 48 hrs.
- ≥80% of stage 1 managed conservatively.
- Stage 3 80% require thoracotomy.
- Intrapleural Fibrinolytic therapy; STK or Urokinase OR tPA to break loculations produced by membranes composed of fibrin.
- **Intrapleural DNase**
  - reduce pus viscosity and break down loculations
  - combination with thrombolytic therapy to enhance pus drainage

Surgical management of empyema

- V.A.T .S.
- THORACOTOMY: decortication.



- Epmyema thoracis is associated with high mortality ranging between 6% to 24%.

LUNG ABSCESS

- **Definition**:Sub acute pulmonary infection in which the chest X ray shows cavity within the lung parenchyma.
  - ✓ Before ABO era ,high mortality,.
  - ✓ ACUTE &CHRONIC: if duration< 6 weeks.
  - ✓ PRIMARY &SECONDARY
- **PRIMARY**:
  1. Aspiration: The most frequent .
  2. Post-Pneumonic

Secondary:

1. Obstructing carcinoma.
2. COPD
3. Metastatic from extrathoracic source septisemia.
4. F.B aspiration.
5. Pulmonary infarctions.

- The individuals with high risk: ALCOHOL ABUSE, hx of Aspiration, Old TB, Epilepsy, drug abuse,COPD.
- In endemic areas TB:20% of lung abscesses have TB.

BACTERIOLOGY:

- ANAEROBES:75-80%
  - Bacteroid fragilis.
  - Fusibacterium bacilli.
  - Peptostreptococci.
  - Provetella.
- AEROBIC:
  - Kleibsiella &Pseudomonus:IN obstructive infections &Nasocomial.
  - Staph.Auereus.
  - S. pneumonia
  - H.influenza.

DIAGNOSIS:

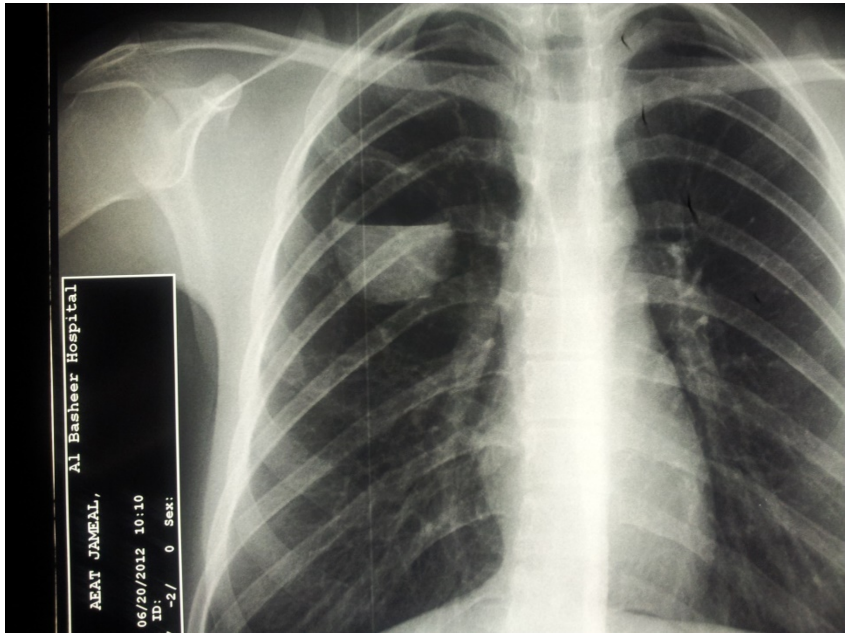
A. Symptoms:Fever intermittent &night sweats chills.Purulent Foul-smelling sputum is highly suggestive.

B. Hx of Aspiration,.Sepsis→Respiratory failure.

C. Signs:Tachpnea,consolidation,local chest wall tenderness.

D. CXR:

- Pneumonitis pattern early→Air-fluid level.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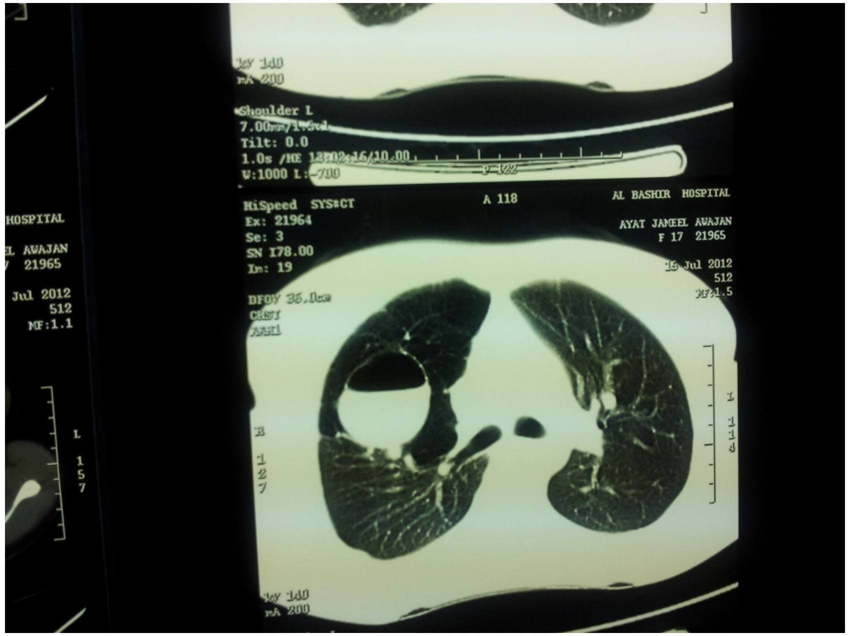
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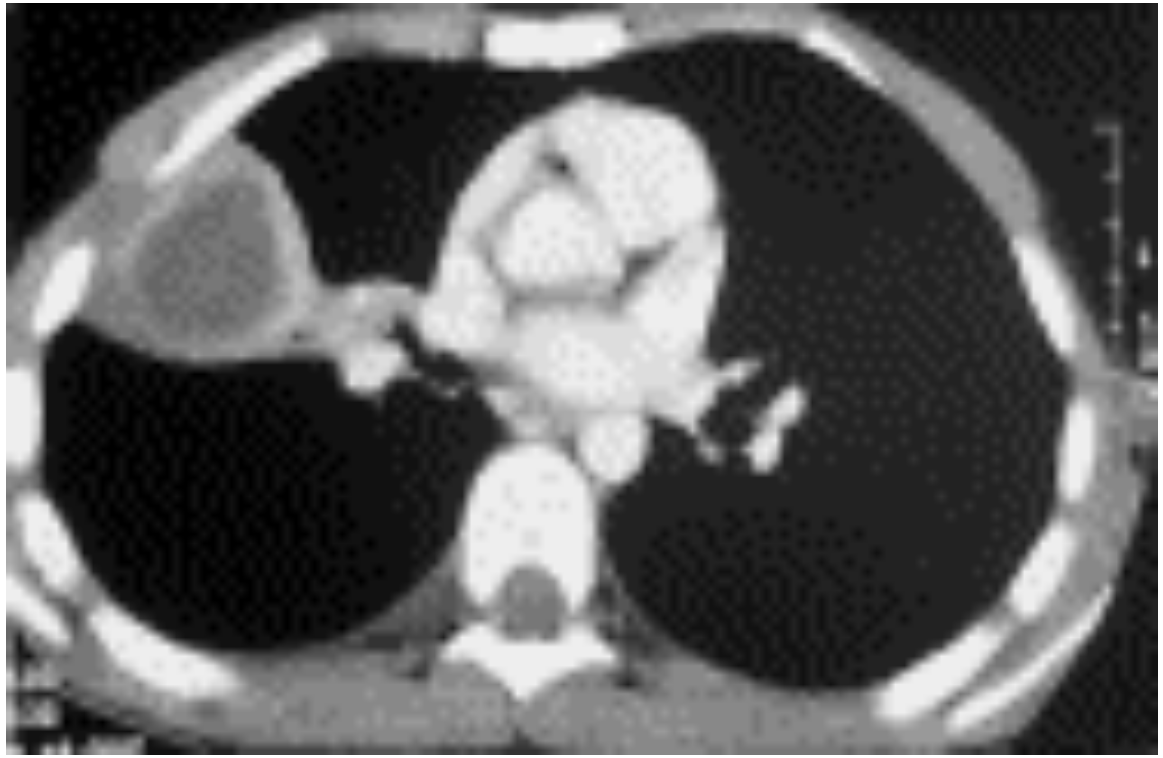

- SPUTUM analysis & culture Aerobic, anaerobic,fungal &TB.
- CT-scan.
- Fibrooptic Bronchoscopy:is mandatory
  - Take samples for culture.
  - R/O endobronchial tumour or obstruction.
  - To assess if can be drained internally.

- SITES:
  - Superior segment of Rt lower lobe.
  - Lat. Part of Post. Segment of R.U.L.
  - Superior segment of L.L.L.
- D.Dx of cavitary lung lesion:
  1. Cavitary carcinoma.
  2. T.B or fungal abscess.
  3. Pyogenic lung abscess.
  4. Empyema with bronchopleural fistula.

- **Managment:** Principles of therapy:

  - Identify the organism→proper ABO therapy for 6-8 wks.
  - Drainage:
    I. Chest physiotherapy.
    II. Bronchoscopy=internal darainaige or indwelling transbronchial catheter drainage.
    III. Percutaneous cath. Drainage.
  - SURGERY.

- 80-90%of Lung abscess respond to medical tt. Flagyl or Clindamycinfor anaerobes.
- Gentamicin or 3rd generation cephalosporines for aerobes.

External drainage:

I. If remain septic.
II. Failure to wean from mechanical ventilation.
III. Soiling of the contralateral lung.
IV. Abscess cavity >4 cm& under tension on CXR.
V. ↑ size while on ABO.

1) Chest tube thoracostomy.
2) CT-guided catheter.
3) Open pneumonostomy.

- 30% of Pt will need definitive surgery.

- Clinical improvement within 48 hrs.

INDICATIONS FOR SURGERY:

1. Acute : for complications
   - Bronchopleural fistula.
   - Empyema.
   - Hemoptysis.(Massive)
2. Chronic =Definitive.
   - Persistant symtoms despite long term ABO therapy.
   - Suspecius of carcinoma.
   - Complications:Empyema,bronchopleural fistula.
   - Persistant cavity >6 cm after ABO therapy.

- Lobectomy is the standard procedure.
- Mortality:
  - 2.5% after community acquired pneumonia.
  - 66% with Nasocomial infections.
  - Underlying diseases.
  - Size of the abscess >6 cm.
  - Organism: Pseudomonus & G –ve the highest.

QUESTIONS

SUMMARY

Pneumothorax

- Defined as air in the pleural space which can occur through a number of mechanisms

Traumatic pneumothorax

- Penetrating chest trauma
  - Common secondary to bullet or knife penetration
  - Chest tube is usually adequate to treat.
  - May require surgery if bleeding is severe

- Blunt trauma
  - Broken ribs puncture lung with air escape into pleura.
  - Chest tube is all that is generally required.

Pneumothorax (cont.)

- Blunt trauma (cont.)
  - Tracheal fracture and esophageal rupture
    - These are two special causes of pneumothorax that require surgical repair.

- Iatrogenic
  - Most common cause of traumatic pneumothorax
  - Common iatrogenic causes are
    - Needle aspiration lung biopsy
    - Thoracentesis
    - Central venous catheter placement

Pneumothorax (cont.)

Neonatal

- Spontaneous pneumothorax occurs in 1–2% of infants
- Likely caused by high transpulmonary pressures and transient bronchial blockage (i.e. meconium)
- Recognition is difficult
  - Contralateral heart sounds may be a clue.
  - Transillumination of thorax may be useful.
- Most neonates with this condition require chest tubes.

Pneumothorax (cont.)

Spontaneous

- Pneumothorax with no obvious cause

- Primary spontaneous pneumothorax
  - Occurs with no underlying lung disease
  - Most (80%) have small subpleural blebs
  - Typically happens in tall, thin, young adults
  - >90% have had short-term smoking history
    - Smoking cessation recommended

Pneumothorax (cont.)

- Secondary spontaneous pneumothorax
  - Occurs with underlying lung disease
    - Most common associated disease is COPD
    - Also seen during exacerbations of asthma and CF
    - Interstitial lung diseases with normal lung volumes
      - Sarcoidosis, BOOP
  - Depending on extent of disease, pneumothorax can be devastating
    - 43% 5-year mortality
  - Evacuation, not observation, should be the standard of care with these patients.

Pneumothorax (cont.)

Complications

- Tension pneumothorax
  - Pleural air pressure exceeds atmospheric pressure
  - Radiographic appearance
    - Mediastinal shift, diaphragmatic depression, flattened ribs
  - Clinical presentation
    - Venous return and cardiac output decrease with hypotension and tachycardia
    - Hypoxemia due to alveolar collapse
  - Treatment: emergency needle decompression

Pneumothorax (cont.)

Complications

- Reexpansion pulmonary edema
  - Occurs following rapid lung reexpansion particularly:
    - From low lung volumes
    - Long duration pneumothorax
    - High pressure gradient across lung
  - May be related to reperfusion injury
  - Lung reexpansion should be slow
    - First, just waterseal, no suction
    - If lung fails to reexpand, then apply suction

Pneumothorax (cont.)

Diagnosis

- Chest radiography
  - Requires good quality film
  - In ICU, 30% of pneumothoraces are missed due to:
    - Low-quality film
    - Supine position of patient on AP film
    - Air hidden behind thoracic or mediastinal structures

- CT may be used to confirm size and presence of pneumothorax.

Pneumothorax (cont.)

Therapy

- Oxygen
  - Should be administered to all patients
  - Supplemental O_2 speeds absorption of air from pleural space

- Observation of stable patients
  - Primary: observe 4 hours, if no enlargement: home
  - Secondary and iatrogenic: hospitalize and observe carefully,
    - If there is any deterioration (SpO_2, RR, etc) - drain

Pneumothorax (cont.)

Therapy

- Simple aspiration
  - Small catheter placed in pleural space
  - Connect to three-way stopcock
  - Slowly evacuate until no more air can be removed
  - This works as many leaks heal between time of leak and its drainage.

Pneumothorax (cont.)

Therapy

- Chest tubes buy time
  - Resolution is mostly determined by lung healing
  - Small bore: placed via small incision in second intercostal space (ICS), midclavicular line or laterally, fifth-ICS
    - Connected to underwater seal or Heimlich valve
  - Large bore: placed via blunt dissection, usually connected to "three-bottle" chest drainage system
  - Chest tubes are sutured in place

- Pleurodesis: consider with recurrent pneumothoraces

Pneumothorax (cont.)

Bronchopleural fistula

- Usually used to refer to large, persistent air leaks
- Most are on MV
  - PPV perpetuates the leak
- May require more than one chest tube
  - Aids restoring lung proximity to chest wall and promotes healing
- Avoid auto-PEEP, consider thoracoscopic surgery

Thank you for your attention