Thoracic surgery

Lung cancer is divided into ***small-cell lung cancer* (SCLC) (25%)** and ***non-small-cell lung cancer* (NSCLC) (75%)**:

surgery is rarely indicated for SCLC, which is generally treated with systemic chemotherapy,

while NSCLC in amendable to surgery as part of stage-specific therapy.

- **SCLC includes *oat cell* and *intermediate* types.**
- **NSCLC includes *squamous cell* (30%), *adenocarcinoma* (35%), *bronchopulmonary neuroendocrine* tumors (BPNET), and other tumor types, e.g., *bronchoalveolar*, *adenosquamous*, and *mucoepidermoid* and *adenoid cystic* tumor (5%).**
- **BPNET includes *small-cell*, *large-cell* (10%), and *carcinoid* tumors**

1 200 000 cases diagnosed annually worldwide. In the USA there are 170 000 new cases with 160 000 deaths per year: it is the number one cancer killer of both men and women. By 2025, 80% of all lung cancers will be in Asia.

- More lung cancer deaths than colon, breast, and prostate cancer combined.

- There is a rising incidence of adenocarcinoma, and a rising incidence of lung cancer in never-smokers.

Etiology

- 87% of lung cancers are due to smoking: 90% in men and 85% in women. A smoker is defined as someone who has smoked
  - 100 cigarettes in their lifetime.
- 3000 lung cancer deaths/year due to second-hand smoke.
- The lifetime risk of cancer in smokers is 17% in men and 11.6% in women: if an individual stops smoking, their chance of developing lung cancer decreases.

Pathology of small-cell lung cancer

- • Considered a systemic disease, with very little role for surgery:
- Often metastatic at the time of surgery.
- Treated with systemic chemotherapy.
- Characterized histologically by cells with scant cytoplasm in fi brous stoma, and abundant neurosecretory granules.

Pathology of non-small-cell lung cancer

NSCLC: adenocarcinoma (35%)

- Most common lung cancer.
- Generally caused by smoking or other tobacco products.
- New data suggests the presence of epidermal growth factor receptor mutations in never-smokers.
- Young age, Asian, female.
- Often peripherally located, or associated with scar and fibrosis,

especially in COPD (so-called *scar carcinoma*).

- Histology: acinar or glandular patterns.

Bronchopulmonary neuroendocrine tumors are often centrally located.

NSCLC: squamous cell carcinoma (30%)

- Generally caused by smoking or other tobacco products.
- 2/3 are centrally located.
- They can obstruct airways, causing postobstructive pneumonia.
- 10–20% develop central necrosis and cavitation.
- Histology: intercellular bridge formation and keratinization.

NSCLC: carcinoid tumor (1%)

- **BPNET often centrally located.**
- **Not associated with smoking.**
- **Carcinoid syndrome is seldom seen (<1%).**
- **Two subtypes:**
- ***Typical:* often endobronchial, rare to have vascular invasion, 10% incidence of nodal or distant metastasis, infrequent cellular mitosis, 90% 5-year survival**
- ***Atypical:* often peripheral, frequent cellular mitosis, frequent vascular invasion, 50% incidence of nodal or distant metastasis, 25–69% 5-year survival.**

Metastatic disease

- 40–50% of patients with newly diagnosed lung cancer have metastatic disease at time of diagnosis.
- Modes of spread: direct invasion, lymphatics, hematogenous.
- More common sites of spread include liver, adrenal, brain, and bone.

Others: skin, heart, thyroid, small intestine, ovary, spleen, kidney, parathyroid, pituitary.

Diagnosis of lung cancer

Key facts

- 95% of patients are symptomatic at diagnosis, most are male >60 years.
- Symptoms may be local, regional, or systemic (see Box 14.1).
- Chest CT, PET, brain MRI, bronchoscopy, and usually needle biopsy are necessary for diagnosis and staging, with mediastinal staging by mediastinoscopy or less invasive modalities, e.g., EBUS.

Localizing symptoms of lung cancer

- **Bronchopulmonary symptoms:**
- Cough.
- Hemoptysis.
- Chest pain.
- Dyspnea.
- Wheezing.

- **Paraneoplastic syndromes (2%).**

- **Symptoms from distant metastatic spread.**

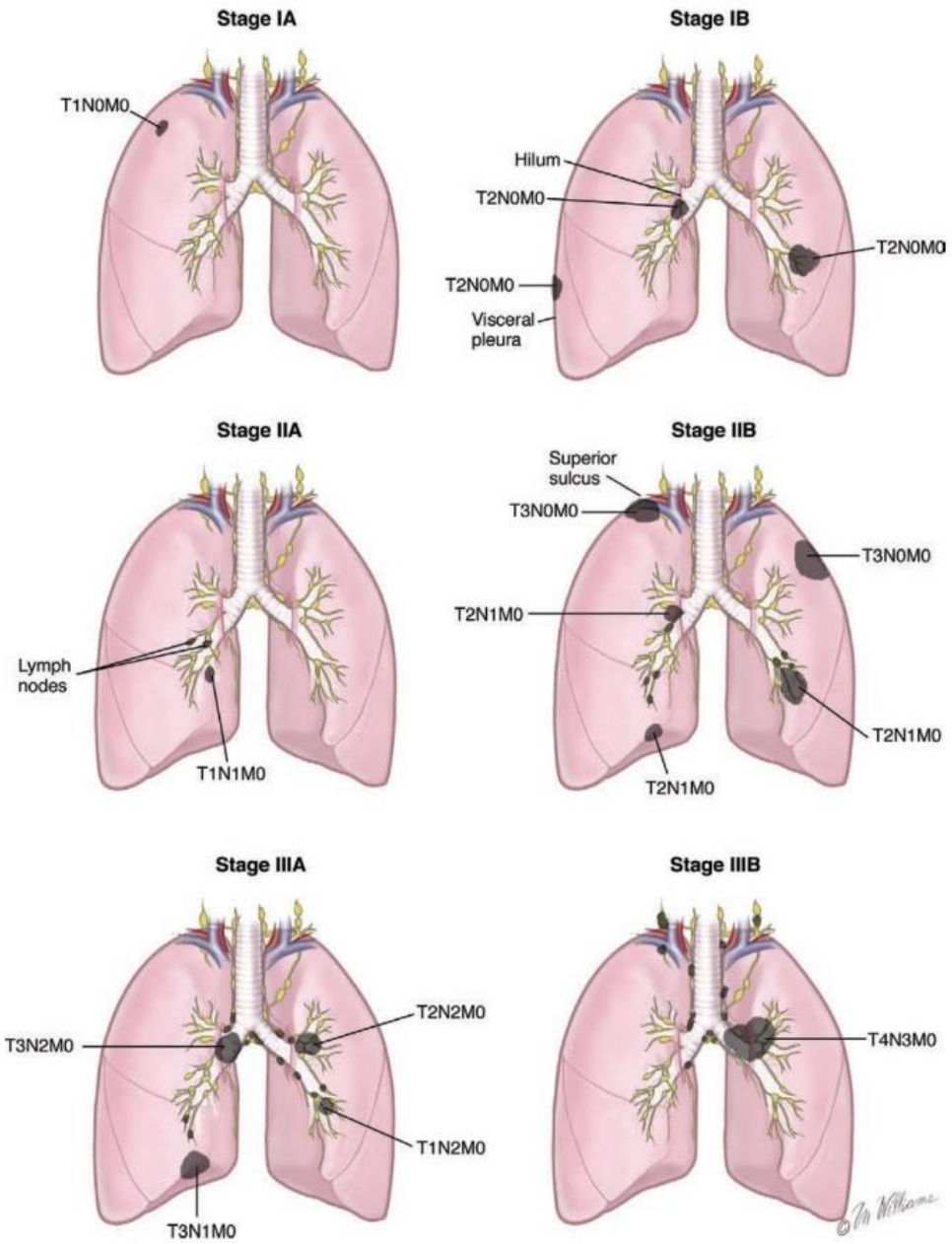
- **Intrathoracic symptoms:**
- Pleural effusion (10%).
- Hoarseness (recurrent laryngeal nerve).
- SVC syndrome.
- Chest wall pain.
- Arm pain (brachial plexus).
- Horner's syndrome.
- Dysphagia.
- Phrenic nerve paralysis.

Staging of lung cancer

Key facts

- The TNM classification is used: 7th edition of the AJCC/IUAC cancer staging manual (2010).
- The TNM class is based on *tumor* size and location, *node* size, and presence of *metastases* .
- Regional lymph nodes include double digit

N1 (ipsilateral) or N3 (contralateral) nodes that are outside the pleural envelope, and single digit mediastinal N2 (ipsilateral) or N3 (contralateral).


Stage IA
T1N0M0
Stage IB
Hilum
T2N0M0
T2N0M0
T2N0M0
Visceral pleura
Stage IIA
Lymph nodes
T1N1M0
Stage IIB
Superior sulcus
T3N0M0
T3N0M0
T2N1M0
T2N1M0
T2N1M0
Stage IIIA
T3N2M0
T2N2M0
T1N2M0
T3N1M0
Stage IIIB
T4N3M0

Treatment

- **Chemoradiotherapy**
- **Key facts**
- • For operable patients with stage I and II lung cancer, upfront therapy is
- surgical resection.
- • Platinum-based adjuvant chemotherapy is reserved for pathologic
- node-positive stage IIA and IIB disease.

Pulmonary resection overview

Key facts

- **Anatomic lobectomy is the standard of care for pulmonary resection of primary NSCLC.**
- **Lobectomy can be performed through a *posterolateral thoracotomy*, muscle sparing thoracotomy, axillary thoracotomy, or by *VATS*.**
- **Sublobar resection (*segmentectomy* or non-anatomic wedge) is used for patients with impaired pulmonary function, or small (<2cm) ground glass opacities such as bronchoalveolar carcinoma, or secondary or metastatic tumors to the lung as part of a metastectomy.**
- **Bronchoplasty or pulmonary arterioplasty (sleeve) procedures should be considered to avoid *pneumonectomy*.**
- **A mediastinal lymph node sampling or dissection should be performed as part of any pulmonary resection for primary lung cancer.**
- ***VATS lobectomy* is becoming more prevalent for the resection of early stage lung cancer, less so for larger and central tumors.**

Superior sulcus tumors

Key facts

• Superior sulcus tumors are essentially apical lung tumors that invade the chest wall, and so by definition these are all T3 tumors.

• *Pancoast tumors* are superior sulcus tumors, but a superior sulcus tumor is not necessarily a Pancoast tumor.

• Curative resection involves adjuvant chemoradiotherapy and en bloc resection including chest wall resection, possible hemi-vertebrectomy, and possible excision of the T1 nerve root of the brachial plexus.

Lung abscess

Etiology

• *Primary:* direct infection via aspiration, esophageal disease, necrotizing

pneumonia, primary tuberculosis, or fungal infections.

• *Secondary:* bronchial obstruction, malignancy, hematogenous bacterial

spread, such as endocarditis, cystic disease, collagen vascular disease

such as Wegner granulomatosis.

Presentation

- Productive cough, fever, rigors, fatigue, malaise, pleuritic chest pain, dyspnea, hemoptysis.
- Absence of fever or leucocytosis may suggest non-infectious causes of abscess, such as malignancy.

Investigation and management

- ***Investigation:*** **sputum and blood cultures, CXR and chest CT, bronchoscopy for BAL.**
- **Avoid FNA, as may contaminate the pleural space and result in empyema.**

Medical management is 6–8 weeks appropriate antibiotics: 90% of patients respond to targeted antibiotic therapy alone and do not require surgical intervention, and aggressive chest physiotherapy.

- 1/3 of percutaneous drainage attempts fail, and should be avoided if possible.

Indications for surgery:

- Failed medical therapy.
- Persistent endobronchial obstruction.
- Formation of an empyema.
- Hemorrhage.
- Bronchopleural fistula.
- Inability to rule out malignancy.

Surgical options

- Anatomic lobectomy.
- Pneumonectomy (avoid where possible for benign disease).
- All bronchial stumps should be covered with viable tissue.
- Intercostal muscle, omentum, pleural fl ap, pericardial fat pad.
- Cavernostomy.
- Thoracoplasty is rarely required to obliterate an apical space.

Hydatid pulmonary disease

- Caused by tapeworm infestation of *Echinococcus*. Results of invasion of lung and/or rupture of hydatid cyst into the pleural space from adjacent structures (such as transdiaphragmatic from the liver).

Presentation:

cough, dyspnea, hemoptysis, expectoration of cyst

material, acute pleural drainage can cause pain and *anaphylactic shock*.

- *Diagnosis*: serology (IgG, IgM, hemagglutination), Casoni skin test, CXR

and chest CT.

Treatment

: albendazole is drug of choice (3–6 months).

Surgery:

avoid spillage. Cystectomy anatomic resection, may require concurrent liver resection or cystotomy and capitonnage, concurrent albendazole therapy.

Empyema

- Defined as *pus in the pleural space*: often from the lung parenchyma or translocated through the chest wall, mediastinum, or abdomen.

Pathology

- A *parapneumonic pleural effusion* is common.

. *Postpneumonic empyema* forms when bacteria infect the pleural fluid or pleural space. It is the commonest cause of an empyema.

- *Postsurgical empyema* accounts for 20% of cases
- Empyema may also follow rupture of a lung abscess
- Empyema may also result form thoracic trauma, ruptured esophagus, pericarditis, abdominal processes such as cholangitis and diverticulitis with translocation of bacteria across the diaphragm,

mediastinitis, chest wall or spine osteomyelitis, rupture of lung abscess or infected pleural bleb, and inhaled foreign body.

- *Stage I: acute exudative phase*
- • Typically occurs 2–5 days after a pneumonia.
- *Stage II: fi brinopurulent phase*
- • Typically occurs 5–14 days after a pneumonia.
- *Stage III: chronic organizing phase*
- • Lung trapping by collagen, visceral and parietal pleural peel with
- ingrowth of fi broblast and capillaries.

Presentation

Patients may complain of fever, productive cough, dyspnea, chest wall pain, malaise, fatigue.

Physical examination may reveal decreased ipsilateral chest wall expansion, egophony, dullness to percussion, chest wall tenderness.

Complications include *empyema necessitans* (discharge of empyema through the chest wall), pulmonary fibrosis, chest wall contractures, osteomyelitis, pericarditis, subphrenic, or mediastinal abscesses.

Investigation

- CXR,
- Chest CT:
- Thoracentesis: Gram's stain and culture, *Light's criteria* distinguishes

transudative effusion from exudative:

- **Exudative if specific gravity is >1.02, protein content >2.0 g/dL, and at least one of the following: ratio of pleural fluid protein to serum >0.5, ratio of pleural fluid LDH and serum >0.6, total pleural fluid LDH >2/3 upper limit of normal, ratio of pleural fluid albumin and**

blood <1.

Management

Stage I

- Sensitivity-appropriate antibiotics.

Stage II

- Chest tube drainage (small or large bore).
- Thrombolytics most likely to be effective during early stage empyema,

and should be reserved for patients who are poor surgical candidates.

Stage III and failure of stage II to resolve

Decortication

Bronchiectasis

Bronchiectasis is irreversible dilatation of the bronchi usually associated with inflammation.

- It is caused by the destruction of the elastic and muscular components of the bronchial wall and is either a localized or diffuse process.

Pathology

Three main types are described: *cylindrical*—often seen with TB, *varicose*, and *saccular*—usually seen after infection or obstruction.

Congenital

Congenital bronchiectasis usually results in diffuse disease.

Congenital bronchiectasis may be due to a congenital immunoglobulin deficiency, cystic fibrosis, ciliary dysmotility disorders, or connective tissue disorders.

Acquired

- Bronchiectasis secondary to tuberculous infection usually affects the upper lobe and that secondary to any other bacterial or viral chest infection affects the lower lobes.

More common causative organisms include adenovirus, influenza virus, HIV, *Staphylococcus aureus*, *Haemophilus influenzae*, anaerobes,

- Chronic external compression of a bronchus, due to tumor mass (carcinoid more common than malignancy) or enlarged lymph nodes.
- Gastric aspiration, pneumonia secondary to foreign body aspiration and inhalational injury, e.g., ammonia.
- Allergic bronchopulmonary aspergillosis.
- Other diseases: rheumatoid arthritis, ulcerative colitis, Sjogren syndrome.

Presentation

Recurrent productive cough. Sputum is purulent. More advanced disease may present with hemoptysis. If disease affects the upper lobes the cough may be non-productive.

Investigations

- CXR: may be normal or may show cystic lesions with air–fluid levels. Bronchial wall thickening may be evident.
- CT scan: high-resolution scans routinely used to demonstrate the dilated airways.
- *Sputum culture:* pathogens often identified. Commonly *H. influenzae, P. aeruginosa, S. pneumoniae*.

Management

The aim of therapy is to treat any infection, any underlying cause for bronchiectasis, optimize clearance of secretions, and reduce air flow limitation with bronchodilators. Physiotherapy is very important, using postural drainage techniques, chest percussion, and vibration. Aggressive antibiotic therapy for acute exacerbations prolongs periods of remission.

Surgical options

- **Lung resection, e.g., lobectomy or segmentectomy is indicated in those patients with sufficient pulmonary reserve who remain symptomatic despite optimal medical therapy. Massive hemoptysis may also necessitate surgical resection of the affected lung.**
- **The aim is to preserve as much normal lung parenchyma as possible, hence surgical candidates tend to be those with limited disease.**
- **In those with insufficient pulmonary reserve embolization may be an option but is associated with rebleeding.**

Emphysema

- Pulmonary emphysema results from the destruction of air spaces, with a loss of elastic recoil of the lungs and alveolar capillary surface for gas exchange.
- The only medical therapy that has shown to impact survival is O2

therapy: surgery is indicated for selected patients.

Pathology

- Destruction of pulmonary parenchyma reduces functional lung mass, resulting in impaired gas exchange; as well as loss of elastic recoil which leads to hyperinflation (bullae), loss of the mechanical advantages seen in normal lung volumes, and compression of relatively normal areas.

Presentation

Patients present with insidious onset of dyspnea. Chronic productive cough is common. Cyanosis. May present with acute infective exacerbation, pneumothorax. Smoking history is common. Physical examination reveals characteristic barrel chest, widened intercostal spaces.

Investigation

- • *CXR:* large bullae may be visible, fl attened diaphragm, reduction in lung markings.
- • *CT chest:* destruction of lung parenchyma, bullous disease.
- • *Lung function:*

Treatment

- Medical management is supportive, (smoking cessation, physiotherapy, bronchodilators and steroids, home O2) and associated with poor functional and prognostic outcomes.
- surgery is that removal of hyp
- erinflated and underperfused lung parenchyma will allow expansion of functional ventilated and perfused lung, restoring mechanical advantage by normalizing lung volume and diminishing dyspnea.

Pulmonary tuberculosis

- Airborne infection caused by *Mycobacterium tuberculosis*, more rarely *M. bovis* or *M. africanum*, transmitted as aerosol, or in the case of *M. bovis* by ingestion of contaminated milk.
- Increased incidence in patients with HIV infection. Low socioeconomical status, substance abuse, immigrants, inhabitants of nursing homes and prisons.
- Surgery is indicated for failure of medical therapy to remove destroyed lung, deal with secondary infections, e.g., *Aspergillus*, and complications such as massive hemoptysis and bronchopleural fistula.

Pathology

- The characteristic lesion is *tuberculous granulomas* with *central caseation*. The primary infection is characterized by a *Ghon focus*, usually at the apex of the upper lobe.
- Later reactivation results in growth of mycobacterium within the liquefied caseum. Bronchial involvement results in expectoration of infected material. Seeding via the bloodstream also occurs.
- Following primary infection healing a *dormant phase* follows, which may last many decades. During this phase the patients are asymptomatic and the only evidence of infection is radiographical visualization of the Ghon focus and a *positive tuberculin skin test*.
- There is a 10–15% reactivation rate, usually involving the lungs.

Presentation

- Presentation is extremely variable, but classically symptoms include low grade fever, weight loss, night sweats, malaise, productive cough, hemoptysis, chest pain, and dyspnea. Complications include destroyed or cavitated lung, bronchostenosis with middle lobe atrophy (Lady Windermere or middle lobe syndrome) bronchopleural fistula, and secondary infection with aspergillosis.

Investigation

- For definitive diagnosis one of the described *Myocbacteria* species must be cultured, most commonly from sputum (which can be obtained by bronchoalveolar lavage, bronchial washings), but also from pus, CSF or biopsied tissue (FNA, mediastinoscopy, etc.).
- For detection of acid-fast bacilli, fluorescence microscopy is more sensitive than conventional Zieh–Nielson staining, confirmed by PCR.
- CXR may show consolidation or cavities in the upper lobes, with mediastinal and hilar lymphadenopathy and pleural effusions in active pulmonary TB. Miliary TB described as many sub-cm nodules throughout both lungs.
- CT is used to identify parenchymal destruction, caseous granulomas, Ghon foci, lymphadenopathy.

A +ve tuberculin skin test (*Mantoux test*) of more than 5mm induration indicates TB infection, except in people previously immunized with the BCG vaccine where there is a high number of false positives. Thoracentesis for pleural effusion: pleural fluid analysis may demonstrate protein >5.0gm/dL, 50% lymphocytes, high ednosine deaminase level.

Management

Medical

- Avoid chest tubes in TB pleural effusion as high rate of superinfection and they generally resolve with appropriate antibiotic therapy.
- 2–3 months of triple therapy (isoniazid, rifampin, and pyrazinamide) followed by 4 months of dual therapy (isoniazid and rifampin).

Two months of triple therapy (isoniazid, rifampicin, and pyrazinamide) followed by 4 months of dual therapy (isoniazid and rifampicin).

Drug resistance may require alternative drugs such as ethambutol or streptomycin.

Multidrug resistant TB is often responsible for lesions in patients requiring surgery.

All surgical patients should be on antituberculous medical therapy for 3 months preoperatively, and undergo aggressive nutrition and physiotherapy to correct their anabolic state where clinical presentation permits.

Indications for surgery

- **Surgery is indicated for**
- **failure of medical therapy to remove destroyed lung, deal with secondary infections, e.g., *Aspergillus*, and complications such as massive hemoptysis, bronchopleural fistula, bronchostenosis, and re-expansion of trapped lung.**

Surgery

The aim of surgery is complete resection of diseased lung tissue along with conversion of sputum. Should be complemented with neo- and adjuvant antituberculous multidrug therapy. Surgery may be hazardous due to previous infection/surgery.

May require extrapleural lobectomy or pneumonectomy.

Care is needed not to contaminate pleural space.