Atelectasis

It is lung collapse. So, we lose lung volume due to inadequate expansion of air spaces. Since there is a decrease in lung volume, the process of gas exchange will be affected resulting in shunting of inadequately oxygenated blood from pulmonary arteries into veins. This poorly oxygenated blood will be distributed across the body giving rise to a ventilation perfusion imbalance and tissue hypoxia. We have three types based on:
1. Underlying Mechanism
2. Distribution of alveolar collapse

A) **Resorption Atelectasis**
Occurs due to total obstruction of a bronchus, thus air cannot reach the distal airways. However, the air that was already present, is absorbed gradually until the alveoli collapse.

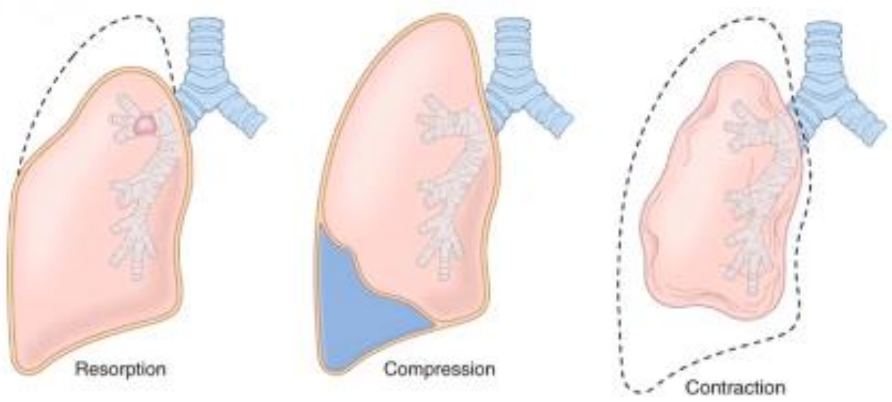
Causes: (Resorption Atelectasis)
The most common cause is Obstruction of a bronchus. It could be by:
1. **Accumulation of intrabronchial mucous or mucopurelant plugs in post-operative patients**
(especially the first 72hrs) so we always recommend these patients to do early ampulation and to use the spirometer
2. **Foreign body aspiration**
especially in children (children have poorly developed collateral ventilation so once one part is obstructed there's no secondary airway to compensate)
2. **Obstructive lung disease**
Like bronchial asthma, bronchiectasis, chronic bronchitis.
3. **Intrabronchial tumors.**

B) **Compression Atelectasis**
Occurs due to accumulation of fluid/blood/air in the pleural cavity so the increase in pressure causes mechanical collapse of the adjacent lung:

Causes: (Compression Atelectasis)
1. Pleural effusion like in Congestive Heart Failure
2. Pneumothorax: air in the pleural cavity due to an injury

C) **Contraction Atelectasis (or Cicatrization Atelectasis)**
Occurs due to local or generalized fibrosis of the lung or pleura that prevents full expansion of the lung.

Atelectasis (except when caused by contraction) is potentially reversible and should be treated promptly to prevent hypoxemia and superimposed infection of the collapsed lung



Acute Respiratory Distress Syndrome (ARDS)

The epidemiology and definition are evolving:
Previously considered to be the severe end of the spectrum of acute lung injury
But now it is defined as respiratory failure where one or both of gas exchange processes fail, as the integrity of the alveolar-capillary membrane is compromised by endothelial and epithelial injury.
It occurs within 1 week of a known trigger.

Graded based on the severity of the changes in arterial blood oxygenation.
Causes are diverse but all lead to extensive bilateral injury to alveoli known histologically as diffuse alveolar damage (DAD)

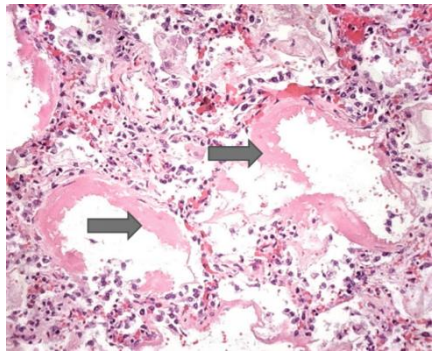
Triggers: (clinical insults)
Pneumonia (35%–45%)
Sepsis (30%–35)
Infections (includes COVID19)
Aspiration
Trauma (including brain injury, abdominal surgery, and multiple fractures)
Pancreatitis
Transfusion reactions

Pathogenesis:
In the early phase of ARDS, the first 30mins after the acute insult, the pulmonary macrophages increase the synthesis of IL8, IL1, TNF, resulting in neutrophils activation, chemotaxis, sequestration into the alveoli, and also the activation of endothelial cells in the pulmonary capillaries
Activated neutrophils release ROS, proteases that damage the alveolar epithelium and endothelium causing vascular leakiness, hyaline membrane formation, accumulation of edema fluid and loss of surfactant.
As a result, the alveolar unit loses its ability to expand.

The destructive forces are counteracted by endogenous antiproteases and anti-oxidants. The macrophages secrete fibrogenic cytokines (TGF-B, PDGF) which stimulate the fibroblasts to grow with collagen deposition which is the healing phase
In the end, it is the balance between the destructive and protective factors that determines the degree of tissue injury and clinical severity of the ARDS.

Neutrophils have an important role in the pathogenesis. Even early lung biopsies show increased neutrophils, in the capillaries, interstitium and alveoli

Clinical features (of severe ARDS)
[] Characterized by rapid onset of life-threatening:
[] Respiratory insufficiency (profound/intense dyspnea and tachypnea) followed by:
1. Cyanosis
2. Severe arterial hypoxemia that may progress to multisystem organ failure.
Hypoxemia may be refractory to oxygen therapy
[] Findings of bilateral opacities on chest imaging. The chest imaging finding is NOT fully explained by effusions, atelectasis, cardiac failure or fluid overload.

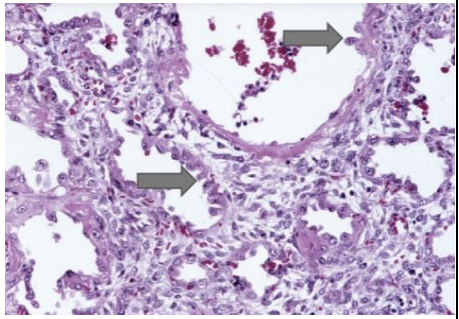


Microscopically,
In the acute phase:
[] Lungs are dark red, firm and heavy
[] Capillary congestion,
[] Necrosis of alveolar epithelium
[] Interstitial and intra-alveolar edema and hemorrhage
[] Collections of neutrophils in the capillaries
[] Some alveoli are collapsed while others are distended
[] Many alveolar spaces are lined by bright pink hyaline membrane

[] However, the most characteristic finding is the presence of hyaline membranes. The hyaline membrane consists of fibrin-rich edema fluid mixed with remnants of necrotic epithelial cells (similar to respiratory distress syndrome of the newborn)

In the organizing phase (Healing stage):

[] Type II pneumocytes proliferate to regenerate alveoli. Resolution is unusual.
[] Hyaline membrane resorption (bright pink membrane no longer seen)
[] Intra-alveolar fibrosis due to organization of the fibrin-rich exudates.
[] Marked thickening of the alveolar septa due to proliferation of interstitial inflammatory cells and collagen deposition.



Prognosis:
85% of cases develops within 72hrs of the initial insult. Mortality rate (38.5%):
Mild 27%
Moderate 32%
Severe 45%

Most patients who survive the acute insult recover normal respiratory function within 6 to 12 months, but the rest develop diffuse interstitial fibrosis leading to chronic respiratory insufficiency

Poor prognosis:
1. advanced age
2. bacteremia (sepsis)
3. development of multiorgan failure

Obstructive vs Restrictive

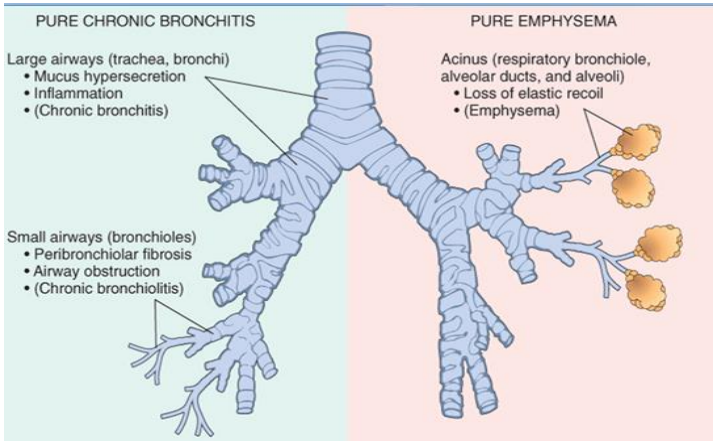
Diffuse pulmonary disease can be classified into two Categories:
1- **Obstructive airway disease:**
Characterized by an increase in resistance to airflow caused by partial or complete obstruction at any level causing expiratory obstruction (emphysema, chronic bronchitis, asthma)

2- **Restrictive airway diseases**:
Characterized by reduced expansion of lung parenchyma and decreased total lung capacity. And are divided to:
A. Chest wall disorders in the presence of normal lungs:
(Severe obesity, diseases of the pleura, and neuromuscular disorders that affect the respiratory muscles such Guillan Barre syndrome)
B. Acute or chronic interstitial lung diseases:
The classic acute restrictive disease is ARDS.
Chronic restrictive diseases include pneumoconioses, interstitial fibrosis of unknown etiology, and sarcoidosis.

Chronic Obstructive Pulmonary Disease(COPD)

Emphysema and chronic bronchitis are often diagnosed together in one patient. This is called chronic obstructive lung disease (COPD). Especially the fact that both are caused by smoking. They can still be present alone though.
For example: pure emphysema in alpha antitrypsin deficiency

Both diseases are irreversible especially if compared with asthma

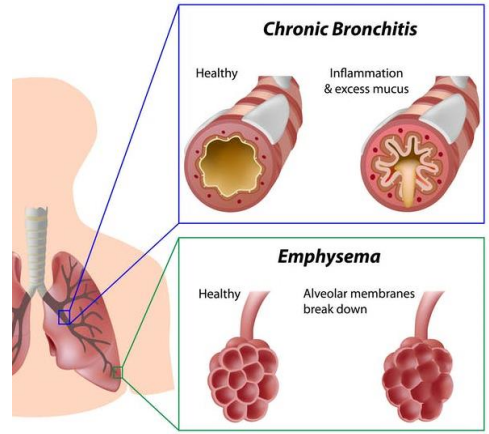


In obstructive lung diseases, its hard to get the air out (exhale), So the air accumulates in the lung → lung hyperinflation. So, lung capacity is either normal or increased
Imagine this like a pair of socks, when you stretch them they go back to their shape, However, old socks will stretch but won't go back to their shape (obstructive diseases)

So the lungs are easy to fill with air but hard to get out so we will have air trapping due to the decreased elastic recoil and increased compliance

Emphysema is diagnosed on the basis of morphologic and radiologic features
Chronic bronchitis is diagnosed on the basis of clinical features

Notice in this photo, the affected location for each disease



Emphysema

Permanent enlargement of the airspaces distal to the terminal bronchioles with destruction of their walls mainly due to nicotine, it also destructs the capillaries. Has no significant fibrosis.

Site: Airways distal to terminal bronchioles + Acini are irreversibly damaged
• Classified according to its anatomic distribution
(The significant airway obstruction is mainly associated with the first two types)

1. Centriacinar (centrilobular) emphysema:
• affects the central or proximal parts of the acini first and more severly, formed by respiratory bronchioles, while distal alveoli are spared.
• cigarette smokers - associated with chronic bronchitis
• more common and severe in the upper lobes, particularly in the apical segments

2. Panacinar (panlobular) emphysema:
• the acini are uniformly enlarged, from the level of the respiratory bronchiole to the terminal blind alveoli.
• associated with α1-antitrypsin deficiency (genetic disease may affect lung or liver)
• affects entire lung but more prominently in the lower lung zones

3. Distal Acinar (Paraseptal) Emphysema:
• involves the distal portion of the acinus while the proximal part is normal.
• present adjacent to the pleura, along the lobular connective tissue septa, at the margins of the lobules
• adjacent to fibrosis, scarring or atelectasis.
• more severe in the upper half of the lungs.
• The cause is unknown.
• The presence of multiple, enlarged air spaces may form large cystic structures that give rise to bullae.
• the most common cause of spontaneous pneumothorax in young adults due to rupture of emphysematous bullae

4. Irregular emphysema:
• The acinus is irregularly involved
• almost invariably associated with scarring
• clinically it's asymptomatic
• considered the commonest form of emphysema.

PATHOGENESIS

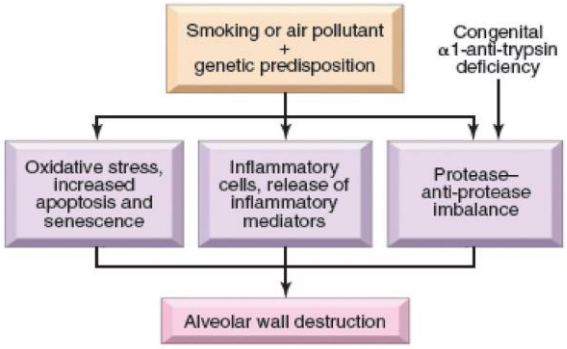


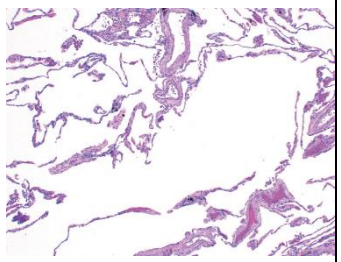
Fig. 13.6 Pathogenesis of emphysema. See text for details.

ROBBINS BASIC PATHOLOGY, 10TH EDITION

1% of patients with emphysema have alpha1 antitrypsin defciency

Clinical features:
• **Panacinar emphysema:**
Pale, voluminous lungs
• **Centriacinar emphysema**
Less impressive changes
Deeper pink and less voluminous lungs (late stage)
• **Classic presentation of emphysema with no bronchitic component**
Dyspnea
Barrel-chested (increase in anterior-posterior diameter of chest wall)
Prolonged expiration
Sitting forward in a hunched-over position (trying to squeeze the air out in expiration)
Hyperventilation (which is why in early stages, the gas exchange is adequate and they have prominent dyspnea = "pink puffers.") pink refers to the face and ts good oxygenation while puffer refers to difficult breathing and breathing through lips
Cough and wheezing if coexistent asthma and chronic bronchitis.

Microscopically,
• Enlarged air spaces due to destruction of alveolar walls and septa (see photo)
• No significant fibrosis
• small airways collapse due to loss of elastic tissue in the surrounding alveolar septa during expiration (chronic airflow obstruction).
• Bronchiolar inflammation and submucosal fibrosis in advanced cases



Emphysema with pronounced chronic bronchitis and a history of recurrent infections:

• Less dyspnea
• Absence of increased respiratory drive (lungs retain CO2) →more hypoxia & cyanosis
• For unclear reasons, patients with chronic bronchitis tend to be obese hence the designation "blue bloaters" BLUE = carbon dioxide retention, hypoxia, and cyanosis BLOATER = overweight

Complications:

• Destruction of the walls distal to the terminal bronchioles (=acini mainly affected) →Hypoxia → Hypoxia-induced pulmonary vascular spasm →gradual development of secondary pulmonary Hypertension over years → in 20-30% right-sided congestive heart failure (cor pulmonale).
• Death from emphysema is related to either respiratory failure or right-sided heart failure.

Conditions related to emphysema:

Compensatory emphysema:

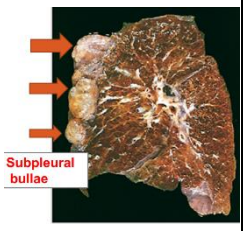
• Compensatory dilation of alveoli in response to loss of lung substance elsewhere.
• As hyper-expansion of residual lung parenchyma following surgical removal of a diseased lung

Obstructive overinflation:

• Lung expands because air is trapped within it.
• Commonly caused by subtotal obstruction of an airway by a tumor or foreign object.
• Can be Life-threatening emergency if extension increases to compress the remaining normal lung.

Bullous emphysema:

• Any form of emphysema, that produce large subpleural blebs or bullae
• Most are subpleural
• Pneumothorax if bullae rupture



Mediastinal (interstitial) emphysema:

•Caused by the entry of air in connective tissue of the lung (interstitium) where it can extend to the mediastinum and subcutaneous tissue

Chronic Bronchitis

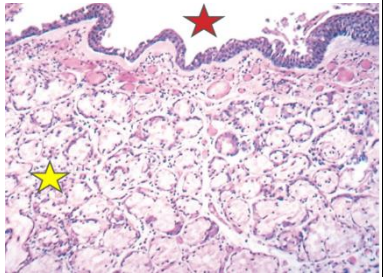
Common in cigarette smokers; air pollutants also contribute.
Persistent productive cough for AT LEAST 3 consecutive months in AT LEAST 2 consecutive years. ← Diagnosis is clinical as mentioned before
22-25% of men in their 40-65yrs have the disease
• In early stages the cough raises (kicks out) the mucoid sputum so the airflow is not obstructed.
• Heavy smokers: develop chronic outflow obstruction, usually with associated emphysema COPD
• May coexist with hyper-responsive airways with intermittent bronchospasm and wheezing → this is called asthmatic bronchitis

Pathogenesis

Depends mainly on mucus hypersecretion and airflow obstruction:

Mucus hypersecretion begins in the large airways mainly caused by cigarette smoking or other air pollutants (SO2, NO2). The exposure to these chemicals causes hypertrophy of mucous glands in the trachea and bronchi and increase goblet cells in the epithelial surfaces of smaller bronchi and bronchioles. These irritants can also cause inflammation mainly composed of macrophages, neutrophils and lymphocytes but WITHOUT eosinophils.

Airflow obstruction results from:
1. Small airway disease (chronic bronchiolitis): results in early and mild airflow obstruction. Induced by mucus plugging of the bronchiolar lumen, inflammation, and bronchiolar wall fibrosis
2. Coexistent emphysema: The cause of significant airflow obstruction.



Clinical features:

Prominent cough with production of sputum
• chronic bronchitis and COPD patients show frequent exacerbations, rapid disease progression, and poorer outcomes than emphysema alone.
• Progressive disease is marked by the development of pulmonary hypertension, cardiac failure, recurrent infections;and ultimately respiratory failure

Morphology:
• Mucosal lining is hyperemic and swollen due to accumulation of edema fluid
• Layers of mucinous or mucopurulent secretions, smaller bronchi and bronchioles also may be involved
Photo: The lumen of the bronchus is above. Note the marked thickening of the mucous gland layer (approximately twice-normal) and squamous metaplasia of lung epithelium which is one of the adaptive mechanisms to protect smoker's lining The yellow star (below) show the enlarged mucus glands (twice the size) and this is the diagnostic feature in the trachea and larger bronchi. Lymphocytes can be seen.

Microscopically, Enlargement of the mucus-secreting glands
• Inflammatory cells, largely mononuclear and neutrophils.
• Chronic bronchiolitis (small airway disease), characterized by goblet cell metaplasia, mucous plugging, inflammation, and submucosal fibrosis
• Bronchiolitis obliterans in severe cases: complete obliteration of the lumen as a consequence of fibrosis
• Changes of emphysema often co-exist

Asthma

Chronic inflammatory disorder of the airways
Causes recurrent episodes of wheezing, Dyspnea, chest tightness and cough particularly at night and/or early in the morning

• its hallmarks are:
a) Intermittent and reversible airway obstruction (bronchospasm)
b) Chronic bronchial inflammation with eosinophils
c) Bronchial smooth muscle cell hypertrophy and hyperreactivity.
d) increased mucus secretion.

Risks:
ü Genetic predisposition to type I hypersensitivity (atopy)
ü Acute and chronic airway inflammation
ü Bronchial hyperresponsiveness to a variety of stimuli

Triggers:
ü respiratory infections (especially viral)
ü airborne irritants (smoke, fumes)
ü cold air
ü Stress or exercise

Pathogenesis:
Upon exposure to the allergen for the first time, the allergen is recognized by APCs or dendritic cells in the epithelium lining. As a result, T helper cells are activated and start secreting inflammatory mediators resulting in IGE production (IL4, IL13) and eosinophils recruitment and activation (IL5). IL13 stimulates production of mucus. IGE coats the submucosal mast cells. On re-exposure of the mast cell to the same antigen, two waves of action happen (early/immediate phase and late phase):

• The early-phase reaction is dominated by:
ü bronchoconstriction (by mast cell mediators such as histamine, prostaglandinD2, leukotrienes, and also by reflux neural pathways)
ü increased mucus production
ü vasodilation.
The early phase occurs after re-exposure to antigen → immediate reaction triggered by Ag-induced cross-linking of IgE bound to Fc receptors on mast cells. mast cells release previously formed mediators that directly and via neuronal reflexes induce: (bronchospasm, increased vascular permeability, mucus production, leukocytes recruitment)

• The late-phase reaction is inflammatory:
Inflammatory mediators stimulate epithelial cells to produce chemokines (Eotaxin, a potent chemotactic and attractant to eosinophils). This recruits TH2 cells, eosinophils, and other leukocytes amplifying the inflammatory reaction.

Leukocytes recruited to the site of reaction (neutro, eosino, basophils, lymphocytes, monocytes) release mediators that initiate the late phase of asthma.
Eosinophils release major basic protein and eosinophil cationic protein that causes damage to the epithelium
• Repeated bouts of inflammation lead to structural changes in the bronchial wall. This is called airway remodelling, including:
ü hypertrophy of bronchial smooth muscle
ü hypertrophy of Mucus glands
ü increased vascularity
ü deposition of subepithelial collagen

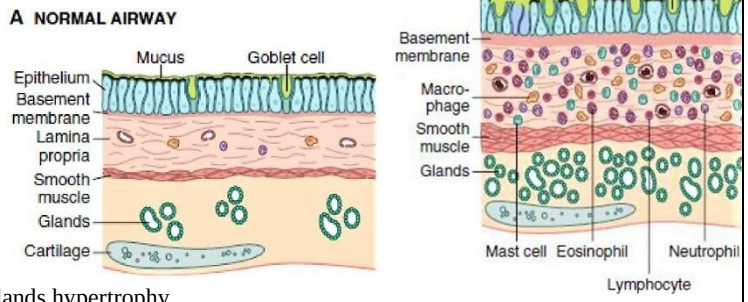


Photo: In asthma we have marked mucus accumulation, goblet cells hyperplasia, basement membrane thickening, intense chronic inflammation in the lamina propria with different inflammatory cells, smooth muscle hypertrophy and hyperplasia, submucosal glands hypertrophy

The details described in the previous photo are important and will reflect on the bronchial lumen as a whole.

Types of Asthma:

I. Atopic Asthma (Allergic Asthma)

• The most common type
• Classic example of type I IgE–mediated hypersensitivity reaction
• Starts in childhood
• Positive family history of atopy and/or asthma is common (Atopy is the genetic tendency to develop allergic diseases)
• attacks are preceded by allergic rhinitis, urticaria, or eczema
• Attacks are triggered by allergens in dust, pollen, animal Dander (material shed by animals), or food, or by infections.

[] Pathogenesis (of Atopic Asthma):

• Exposure to the antigen causes excessive activation of type 2 helper cells → Cytokines production which include:
IL-4 and IL-13 stimulate IgE production
IL-5 activates eosinophils
IL-13 also stimulates mucus production
• IgE coats submucosal mast cells → release of Mast cell–derived mediators (upon reexposure) → produce two waves of reaction:
The early (immediate) phase of reaction
The late phase of reaction

[] Diagnosis (of Atopic Asthma)

• Skin test with the antigen: immediate wheal-and-flare reaction
Skin prick test is the most common allergic skin test
What do we do? a tiny drop of a possible allergen—something you are allergic to— is pricked or scratched into the skin. If you are allergic to this substance, you will develop a red and itchy rash
Can also be diagnosed by serum radioallergosorbent tests (RASTs) which uses radioimmunoassay to detect IgE antibodies

II. Non-Atopic Asthma

• No evidence of allergen sensitization, Negative skin test
• A positive family history of asthma is less common.
• Triggered by:
viral respiratory infections (rhinovirus, parainfluenza virus)
inhaled air pollutants (sulfur dioxide, ozone, nitrogen dioxide).

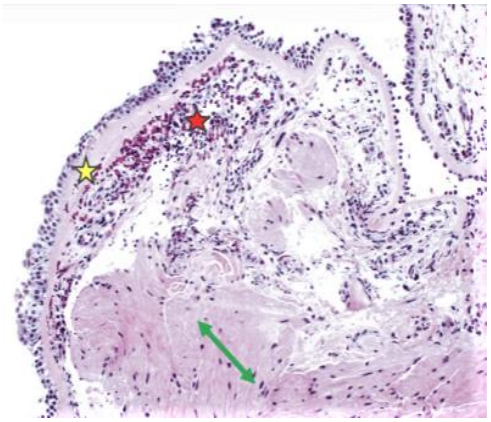
The ultimate humoral and cellular mediators of airway obstruction of both Atopic and Non-Atopic Asthmas are the same, so they are treated similarly

III. Drug-Induced Asthma

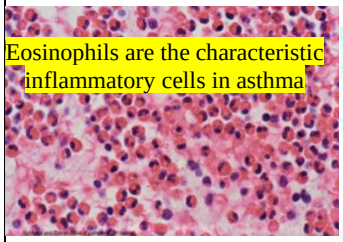
• Eg: Aspirin induced asthma
Such patients present with recurrent rhinitis, nasal polyps, urticaria, and bronchospasm.
• The precise pathogenesis is unknown. It may involve some abnormality in prostaglandin metabolism from inhibition of cyclooxygenase (by aspirin)

IV. Occupational Asthma

• Asthma attacks usually develop after repeated exposure to the triggering antigen.
• triggered by fumes (epoxy resins, plastics), organic and chemical dusts (wood, cotton, platinum), gases (toluene), and other chemicals
People at risk are farmers, animal-handlers, manufacturers of mattresses or metals, bakers, food processors, cotton workers



Morphology:
-Sub-basement membrane fibrosis (yellow)
-Eosinophilic inflammation (red)
-Smooth muscle hypertrophy and hyperplasia (green)
-Occlusion of bronchi and bronchioles by thick mucous plugs
-Mucous plugs contain whorls of shed epithelium called Curschmann spirals
-The characteristic Airway remodelling, includes:
• Thickening of airway wall
• Sub-basement membrane fibrosis
• Increased submucosal vascularity
• An increase in size of the submucosal glands and goblet cell
• Metaplasia of the airway epithelium
• Hypertrophy and/or hyperplasia of the bronchial muscles
- In fatal cases distention of lungs due to air trapping, with small areas of atelectasis



Eosinophils are the characteristic inflammatory cells in asthma

Curschmann Spirals

Charot-Leyden crystals are another finding, made up of the eosinophilic protein galectin-10c

An attack of asthma is characterized by:
-Dry cough which is worse at night
-Wheezing which is a whistling sound especially during expiration
-Chest tightness (feeling of chest squeezing or as if something is on the chest)
-Dyspnea or shortness of breath (cant breathe enough)
-Difficulty of expiration
Wheezing, chest pain and dyspnea mainly in the early morning
Asthmatic attacks last 1 to several hrs and subside either spontaneously or with an intervention, the intervals between the attacks are free from respiratory difficulties.
Remember asthma is REVERSIBLE except in advanced severe cases

Status asthmaticus: is a severe paroxysm that does not respond to therapy, it lasts from days to weeks, may be associated with hypercapnia (CO_2 retention), acidosis and severe hypoxia, this can be fatal

Treatment: Standard therapies include:
• Anti-inflammatory drugs (glucocorticoids)
• Bronchodilators (beta-adrenergic drugs)
• Leukotriene inhibitors (potent bronchoconstrictors. However, can block immune mediators such as IL4, IL5 which can be helpful in some patients)

Bronchiectasis

Permanent dilation of bronchi and bronchioles caused by destruction of smooth muscle and the supporting elastic tissue so its an irreversible dilation.

Site: Bronchi and Bronchioles

Diagnosis: appropriate history and radiographic demonstration of bronchial dilation.

Risks: (predisposing conditions,

1. Bronchial obstruction:
Caused by tumors, foreign bodies, and impaction of mucus OR as a complication of atopic asthma and chronic bronchitis. bronchiectasis is localized

Congenital or hereditary conditions:
2. Cystic fibrosis:
Widespread severe bronchiectasis due to obstruction caused by abnormally viscid (thick and sticky) mucus and secondary infections

3. Immunodeficiency states:
Due to recurrent bacterial infections, could be localized or diffuse

4. Primary ciliary dyskinesia (immotile cilia syndrome):
Rare autosomal recessive disorder of abnormalities in cilia, causing persistent infections. It causes both bronchiectasis + sterility in males (immobility of sperms)

5. Necrotizing, or suppurative, pneumonia:
• particularly with virulent organisms such as Staph Aureus or Klebsiella spp.

Pathogenesis:
Typically results from or is associated with chronic necrotizing infections, so it is not primary, it is always secondary to infection or obstruction

Two intertwined processes contribute to bronchiectasis:

1. OBSTRUCTION impairs clearance of secretions causing superimposed infections → inflammatory damage to the bronchial wall + the accumulating exudate which causes airway distention and irreversible dilation.

2. PERSISTENT NECROTIZING INFECTION in the bronchi or bronchioles thus we have poor clearance of secretions, obstruction, and inflammation with peribronchial fibrosis and traction on the bronchi → irreversible dilation

Morphology:
Affects lower lobes of lungs bilaterally
The most severe involvement is found in the distal bronchi and bronchioles.
The airways may be dilated to as much as four times their usual diameter
Microscopically,
• ***In full-blown active cases:***
• intense acute and chronic inflammatory exudate within the walls of the bronchi and bronchioles → desquamation of lining epithelium and extensive ulceration
• mixed flora are cultured from the sputum.

• ***When healing occurs:***
- The lining epithelium may regenerate completely however the injury cannot be repaired completely and the abnormal dilation and scarring persist
-Fibrosis of bronchial and bronchiolar walls and peribronchiolar fibrosis
-In some cases, necrosis destroys the bronchial and bronchialor walls forming an abscess cavity

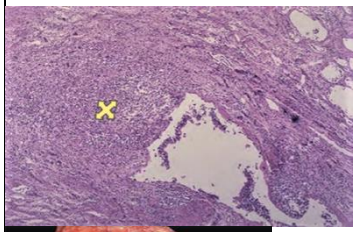


Photo: microscopic dilated bronchus in which the mucosa and bronchial wall are not seen clearly because of the necrotizing inflammation with tissue destruction. Mostly it is desquamated (come off in scales or flakes)

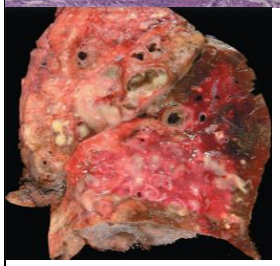


Photo: markedly dilated bronchi filled and stuffed with purulent mucus

Clinical features:

• cough and expectoration of copious amounts of purulent sputum (made of WBCs, cellular debris and mucus = yellow/green in color.)
• severe, persistent cough with mucopurulent sputum.
• Other symptoms: dyspnea, rhinosinusitis, and hemoptysis.
• Symptoms are often episodic, precipitated by URTI (upper respiratory tract infections)
• Severe widespread bronchiectasis may lead to significant obstructive ventilatory defects which can be associated with hypoxemia, hypercapnia, pulmonary hypertension, and cor pulmonale

With current treatments, severe complications such as brain abscess or cor pulmonale are less frequent

Table 13.1 Disorders Associated With Airflow Obstruction: The Spectrum of Chronic Obstructive Pulmonary Disease

Clinical Entity	Anatomic Site	Major Pathologic Changes	Etiology	Signs/Symptoms
Chronic bronchitis	Bronchus	Mucous gland hypertrophy and hyperplasia, hypersecretion	Tobacco smoke, air pollutants	Cough, sputum production
Bronchiectasis	Bronchus	Airway dilation and scarring	Persistent or severe infections	Cough, purulent sputum, fever
Asthma	Bronchus	Smooth muscle hypertrophy and hyperplasia, excessive mucus, inflammation	Immunologic or undefined causes	Episodic wheezing, cough, dyspnea
Emphysema	Acinus	Air space enlargement, wall destruction	Tobacco smoke	Dyspnea
Small airway disease, bronchiolitis*	Bronchiole	Inflammatory scarring, partial obliteration of bronchioles	Tobacco smoke, air pollutants	Cough, dyspnea

*Can be present in all forms of obstructive lung disease or by itself.