Dyspnea (Shortness of Breath) — Causes and Symptoms

Dyspnea or shortness of breath is a normal manifestation of heavy exertion, but it can also be caused by different underlying diseases, therefore understanding the etiology, pathophysiology and differential diagnosis of dyspnea is important in the diagnosis of serious underlying clinical conditions. In this article, the etiology, pathophysiology and differential diagnosis of dyspnea will be discussed in detail.

Definition of Dyspnea

Dyspnea — The Shortness of Breath

Dyspnea is defined as the subjective sensation of chest tightness or shortness of breath. It can be caused by pulmonary and extrapulmonary causes.

Etiology of Dyspnea
Causes of Dyspnea

Dyspnea is one of the most common manifestations affecting individuals with pulmonary diseases, although it can be caused by other varieties of causes, such as heart failure, ischemic heart disease (IHD), hypobaric hypoxia, extreme anemia, metabolic acidosis, panic attacks with hyperventilation and any restrictions to the lungs such as obesity or kyphoscoliosis. Differential diagnosis of dyspnea can be broadly divided into pulmonary and extrapulmonary causes.

Clinical Anatomy of the Pulmonary System

To understand the pathophysiology and differential diagnosis of dyspnea, it is essential to understand the anatomy of different structures of the airways and the lungs. The human lungs are divided into lobes. The right lung has three lobes – upper, lower and middle lobes – while the left lung two lobes – upper and lower lobes. These lobes are
demarcated by intervening visceral pleura.

Tracheobronchial tree is a term used in describing the branching structure of the respiratory airways and includes trachea, bronchi, and bronchioles. Further anatomical division of the tracheobronchial tree into conducting airways and terminal respiratory units or acini.

Conducting Airways

These airways deliver the air from the upper respiratory passages into the lungs to the areas of gas exchange.

Terminal Respiratory Units or Acini

These are the airways and the alveoli involved in the process of gas exchange.

Proximal conducting airways (bronchi) are lined by ciliated pseudostratified columnar epithelium with secretory glands and supported by cartilage. These cilia move unidirectionally and uniformly towards the pharynx to move the mucus layer continuously outside the lungs.

Any lung disease affects the function of the cilia or increases the mucous production, or both as in chronic bronchitis, with smoker patients, will result in the accumulation of mucus in the respiratory passages. Circumferential airway smooth muscle is also present; constriction of these smooth muscles, as in patients with asthma, may result in narrowing the airways and shortness of breath.
The **smallest conducting airways** (non-respiratory bronchioles) are lined by **cuboidal epithelium** that may be ciliated, but they don’t have **circumferential smooth muscles** and cartilage support.

The lobes of the lungs are divided into lobules, which are a collection of **terminal respiratory units**. The thin epithelial walls of the **alveoli** provide the gas exchange with the **alveolar-capillary bed**.

<table>
<thead>
<tr>
<th>Conducting Airways</th>
<th>Trachea</th>
<th>Bronchi</th>
<th>Cartilage, Bronchial glands</th>
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<tbody>
<tr>
<td>Terminal Respiratory Units</td>
<td>Bronchioles</td>
<td>Non-respiratory Respiratory</td>
<td>Alveolar ducts &amp; alveoli</td>
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**Pathophysiology of Dyspnea**

Dyspnea occurs due to an **imbalance** between the **required gas exchange** and the workload on the **muscles of breathing**.
The sensation of shortness of breath can be caused by different physiological changes:

- Increased airway resistance due to any pulmonary disease will require a greater muscular effort by the intercostals muscles and chest wall to overcome this resistance, resulting in dyspnea.

- **Obstructive airway** diseases, as emphysema, may result in hyperinflation of the lungs with decreased lung compliance, thus the work of breathing increases and results in dyspnea.

- Marked airway obstruction may result in ventilation/perfusion mismatching producing arterial hypoxemia that will stimulate the central and peripheral chemoreceptors resulting in increased respiratory drive and dyspnea.

**Grades of Dyspnea**

**Classification of Dyspnea**

The **Medical Research Council (MRC)** has classified dyspnea due to lung diseases into four degrees depending on its severity. It is also known as the **MRC breathlessness scale**.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>Grade 0</td>
<td>Dyspnea occurs only during strenuous exercise.</td>
</tr>
<tr>
<td>Grade I</td>
<td>Dyspnea is only caused by brisk walking.</td>
</tr>
<tr>
<td>Grade II</td>
<td>Brisk walking is not possible because of the shortness of breath.</td>
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<tr>
<td>Grade III</td>
<td>Stopping is needed due to dyspnea after 100 m of walking.</td>
</tr>
<tr>
<td>Grade IV</td>
<td>One does not leave the house due to shortness of breath.</td>
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### Pulmonary Causes of Dyspnea

#### Obstructive lung diseases

- Upper airway stenosis
- Chronic Obstructive Pulmonary Diseases (COPD)

**Obstructive pulmonary diseases** are characterized by increased resistance to airflow during inspiration and expiration.

**History:**
- Cigarette smoking for years suggests strongly diagnosis of COPD.
- Atopy (allergy), with episodes of wheezes, suggests asthma.
- Instrumentation (e.g. prolonged endotracheal tube) suggests upper airway stenosis.
- Dyspnea is exaggerated by exercise, not by changing body position.

**Examination:** Auscultation reveals wheezes all over the lungs, in contrast to restrictive lung diseases where normal lung auscultation is observed.

**Pulmonary function tests:** ↓ FEV1, FVC is stable, ↓ FEV1/FVC

#### Restrictive lung diseases

They are characterized by decreased lung compliance as a result of:

1. Inflammation: pneumonia
2. Fibrosis: pulmonary fibrosis
3. Occupational: pneumoconiosis
4. Neoplastic infiltration: lung tumor

**History:**
- History of occupational exposure to harmful dust
- Risk factors for lung tumors

**Examination:** Auscultation: Normal lung fields, pulmonary function tests are used to differentiate restrictive from obstructive pulmonary diseases.

**Pulmonary function tests:** ↓ FEV1, ↓ FVC more than FEV1, ↑ FEV1/FVC

#### Vascular lung diseases

Most common disorder affecting pulmonary vessels is pulmonary emboli.

**History:**
- Sudden onset of shortness of breath and clear lungs in patients with risk factors, such as bed rode patients with DVT

**Examination:** No specific clinical findings for pulmonary embolism; clear lung fields

**Standard investigation:** CT angiogram

### Extrapulmonary Causes of Dyspnea

#### Cardiac dyspnea

Occurs mainly due to left-sided heart failure, caused by:
- Coronary artery heart disease
- Hypertensive or valvular heart disease
- Cardiomyopathy

- Impeded blood flow to left-sided heart → blood accumulated in pulmonary vascular bed → transudation of fluid resulting in interstitial and alveolar edema

**History:**
- Orthopnea: Dyspnea increases in supine position due to the aggravation of pulmonary congestion.
- Paroxysmal nocturnal dyspnea awakens patients from sleep

**Examination:** Lung auscultation reveals bilateral basal rales.

#### Anemia

**Acute loss of blood** leads to hypovolemic shock and dyspnea due to impaired tissue oxygenation. **Chronic anemia** is well tolerated and produces dyspnea only with strenuous exercise.
Metabolic acidosis

Stimulates the brain stem resulting in alveolar hyperventilation and deep breathing to compensate acidosis by washing out the CO₂. Most common causes:

1. Ketoacidosis in diabetes
2. Acidosis in renal insufficiency
3. Intoxication: overdose of salicylate

Anxiety

Panic attacks commonly occur in young females in different situations, often presents with shortness of breath, chest pain, and dizziness with a feeling of inability to take enough deep breaths. Hyperventilation associated with anxiety may lead to acute respiratory alkalosis manifested as:

1. Paresthesia at the fingertips and around the mouth
2. Tetanic cramps in severe cases

Extrapulmonary restrictions

Can be caused by:

1. Pleural effusions
2. Pleural thickening
3. Tumors (e.g., mesothelioma)
4. Deformities of the thorax
5. Weakness of the diaphragm

References


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