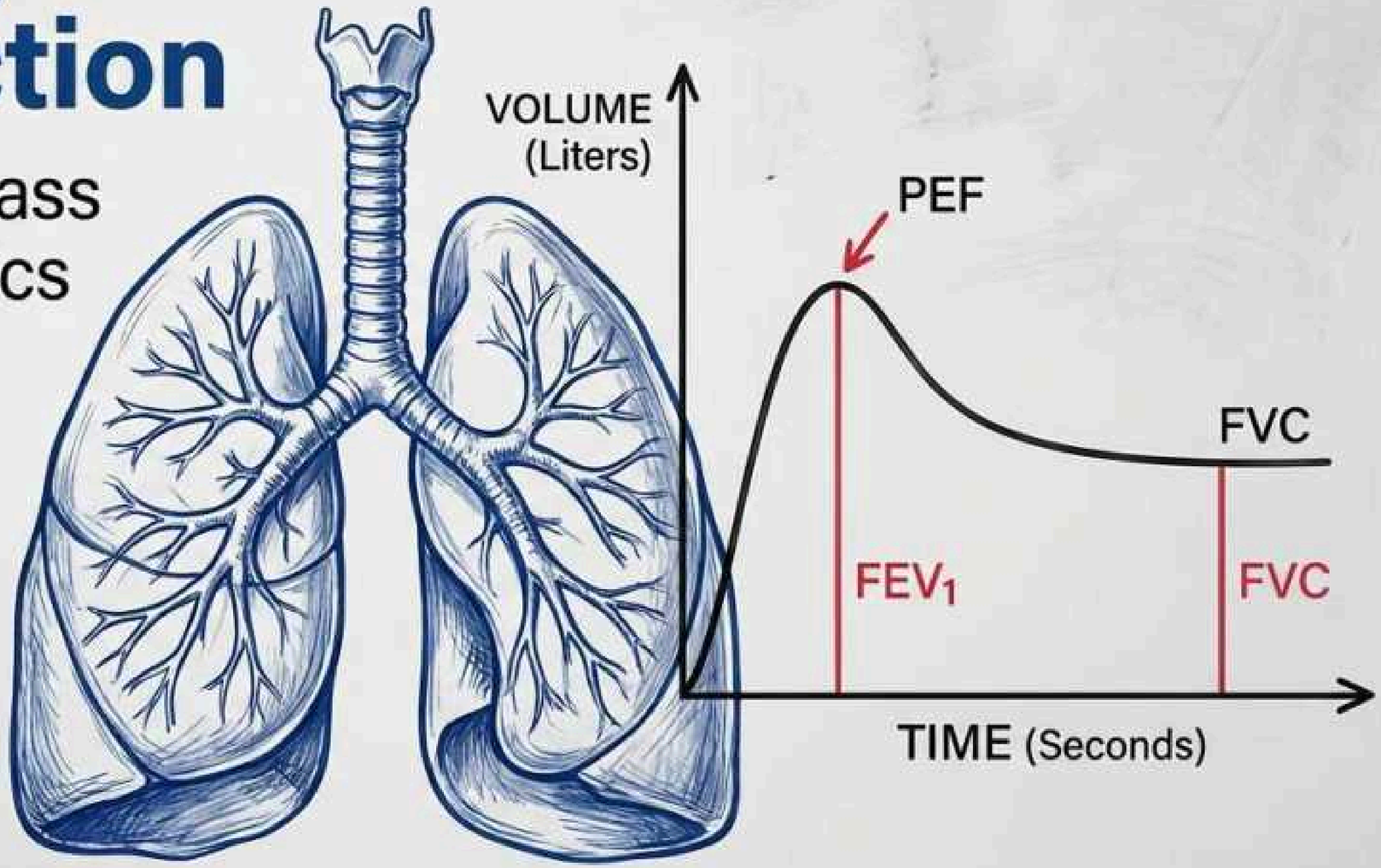
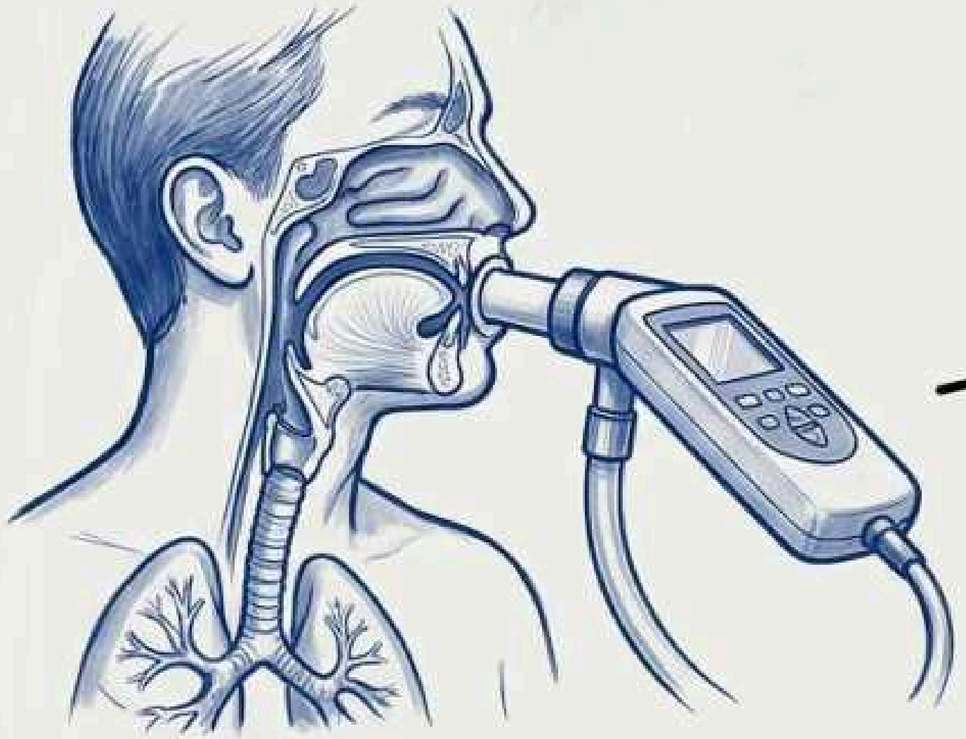
Measuring Lung Function

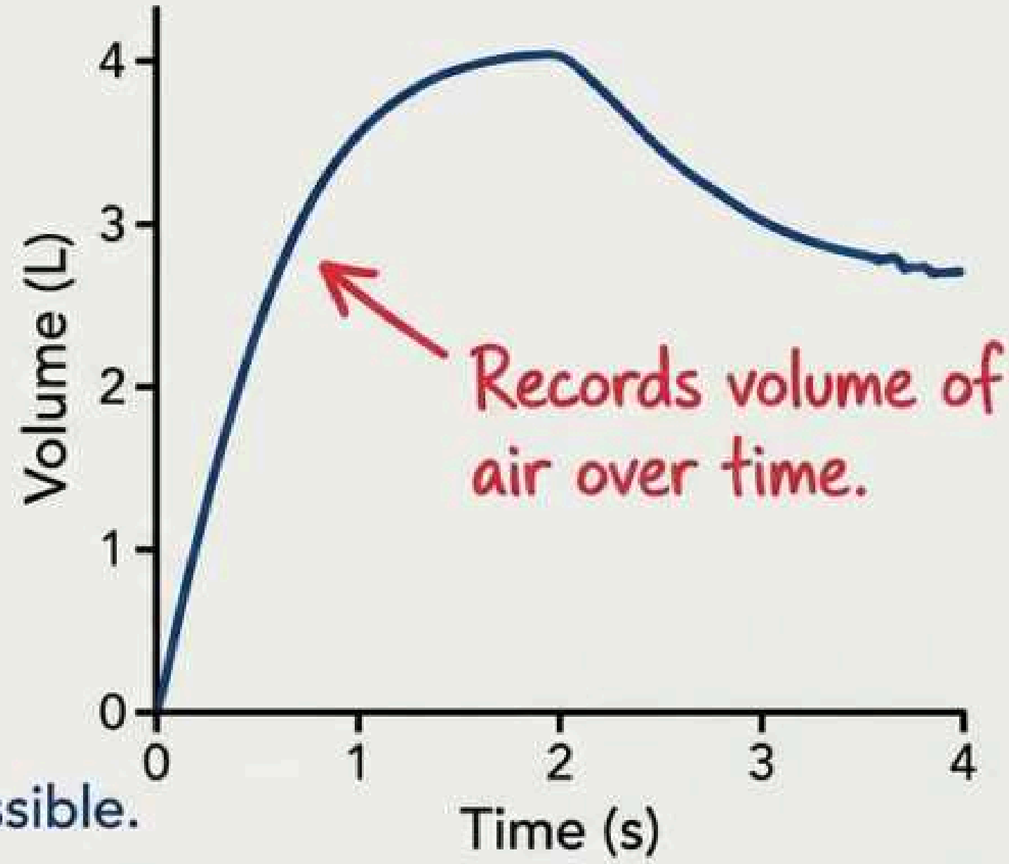
A Clinical Masterclass in Diagnostic Metrics



Lung function tests translate clinical ideas into precise numbers

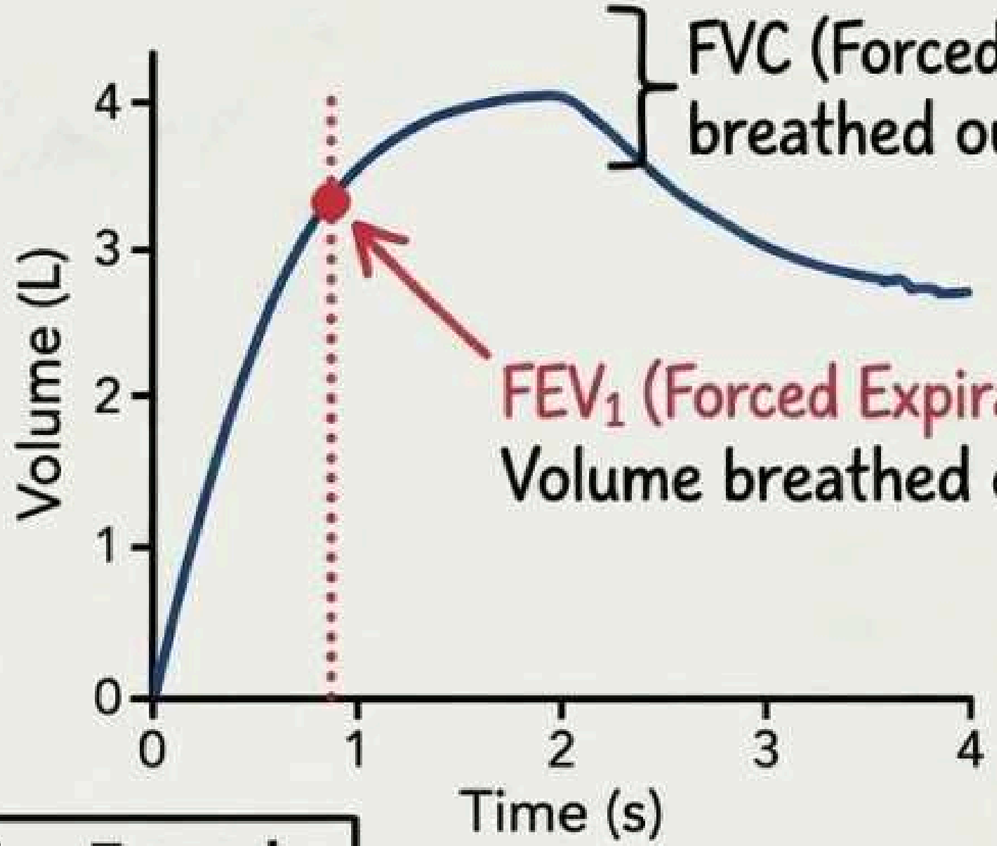
1) Diagnose disease 2) Measure severity 3) Follow course over time





Spirometry Core Mechanism:
Full breath in → Blow out as hard and fast as possible.

Two core spirometry metrics define baseline lung mechanics



FVC (Forced Vital Capacity): Total volume breathed out after a full breath in.

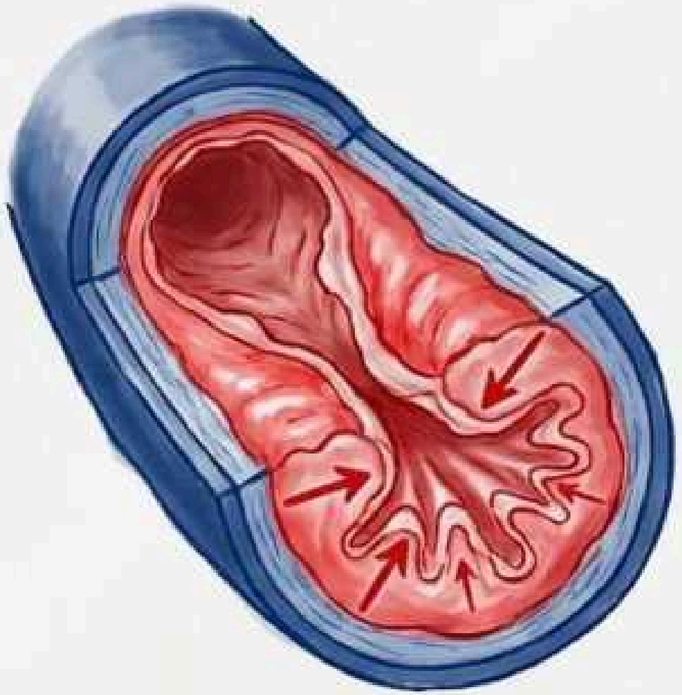
FEV_1 (Forced Expiratory Volume in 1 second): Volume breathed out in the first second.

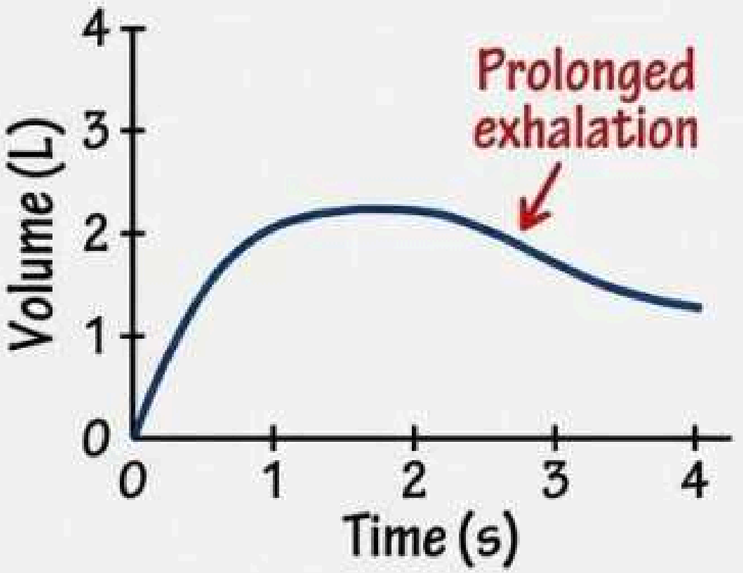
The **Healthy Baseline Formula:**

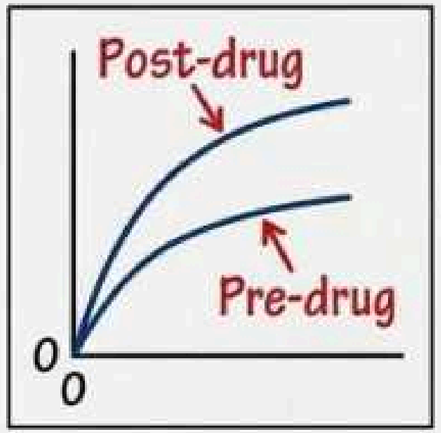
$$\frac{FEV_1}{FVC} \geq 0.75$$

(About three quarters or more of vital capacity is expelled in the first second in healthy adults)

The obstructive pattern is defined by narrowed airways and slow exhalation







Diagnostic Formula:

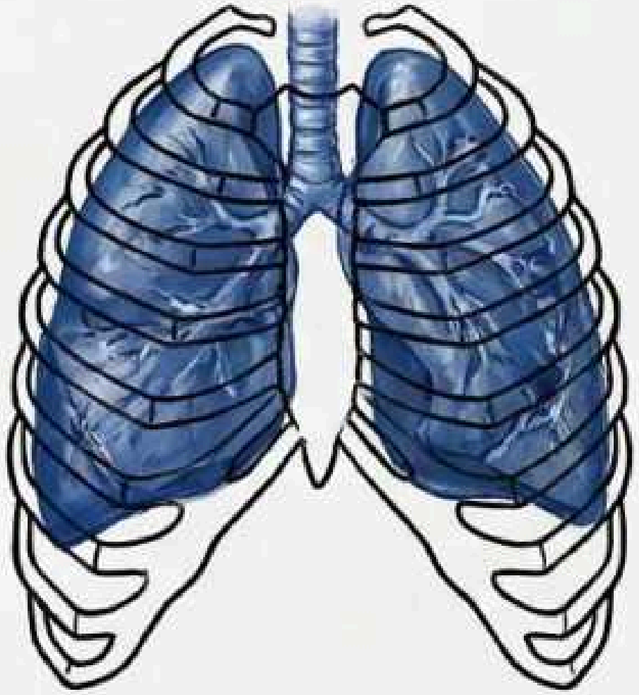
$$\frac{\text{FEV1 (falling fast)}}{\text{FVC (falling)}} = \text{Ratio} < 0.7$$

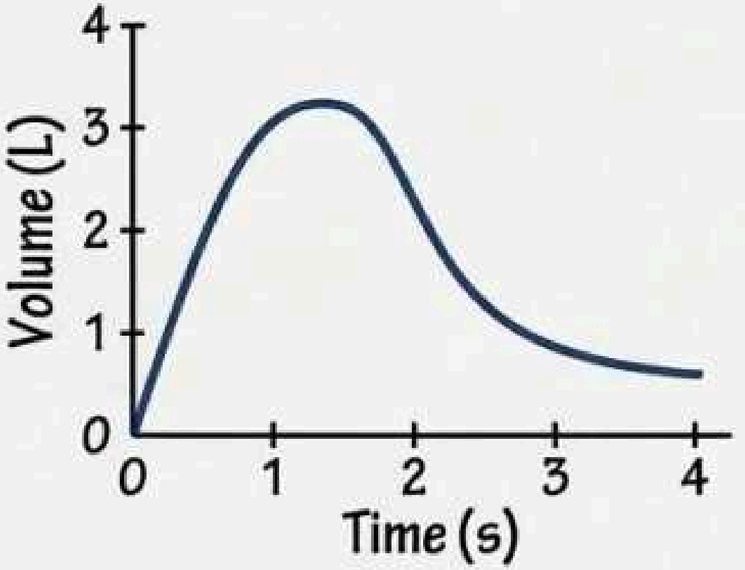
Mechanism: Airways are narrowed; air comes out slowly. FEV_1 falls more drastically than FVC.

Pathology: Asthma and Chronic Obstructive Pulmonary Disease (COPD).

Reversibility: Substantial improvement after inhaling airway-widening drugs strongly suggests asthma.

The restrictive pattern is defined by stiff tissues and constrained filling





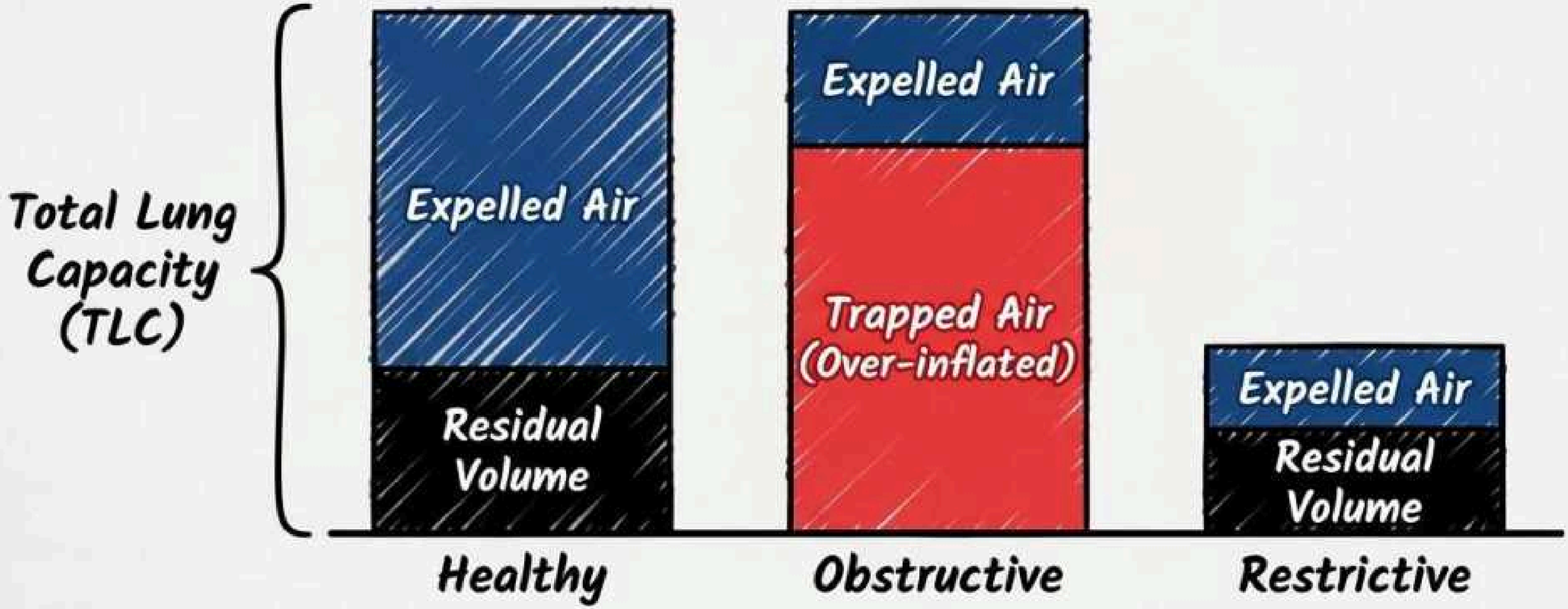
Diagnostic Formula:

$$\frac{\text{FEV1 (falling)}}{\text{FVC (falling)}} = \text{Ratio} >= 0.7 \text{ (Normal or High)}$$

Mechanism: Lungs cannot fill fully. Tissue is stiff, or chest wall/muscles cannot expand it. FEV1 and FVC fall in strict proportion.

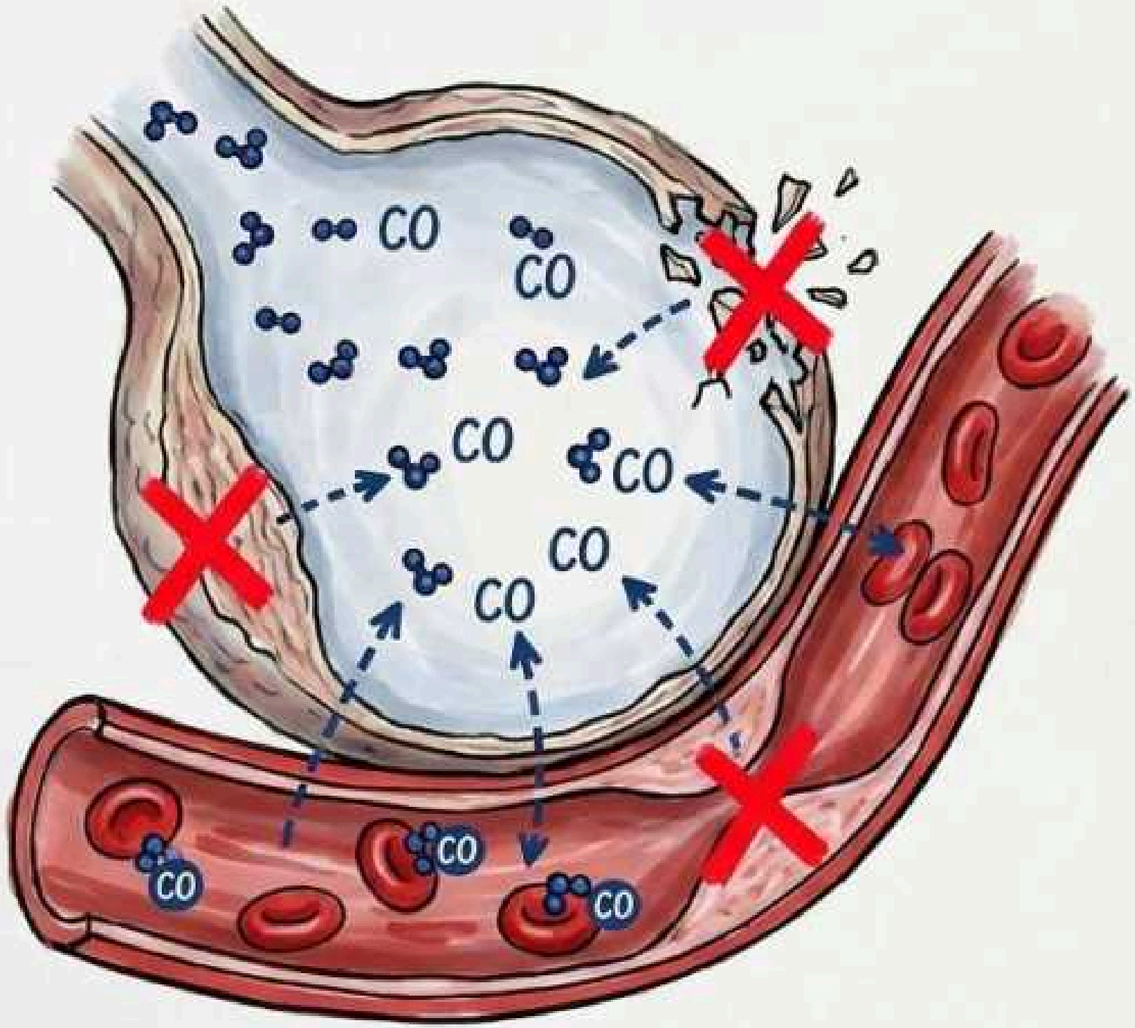
Pathology: Lung scarring, severe obesity, and weakness of breathing muscles.

Total lung volume measurements confirm the spirometry patterns



Key Insight: *These tests measure the air remaining after the deepest breath out, confirming the initial spirometry findings.*

Gas transfer tests isolate the alveolar-capillary barrier



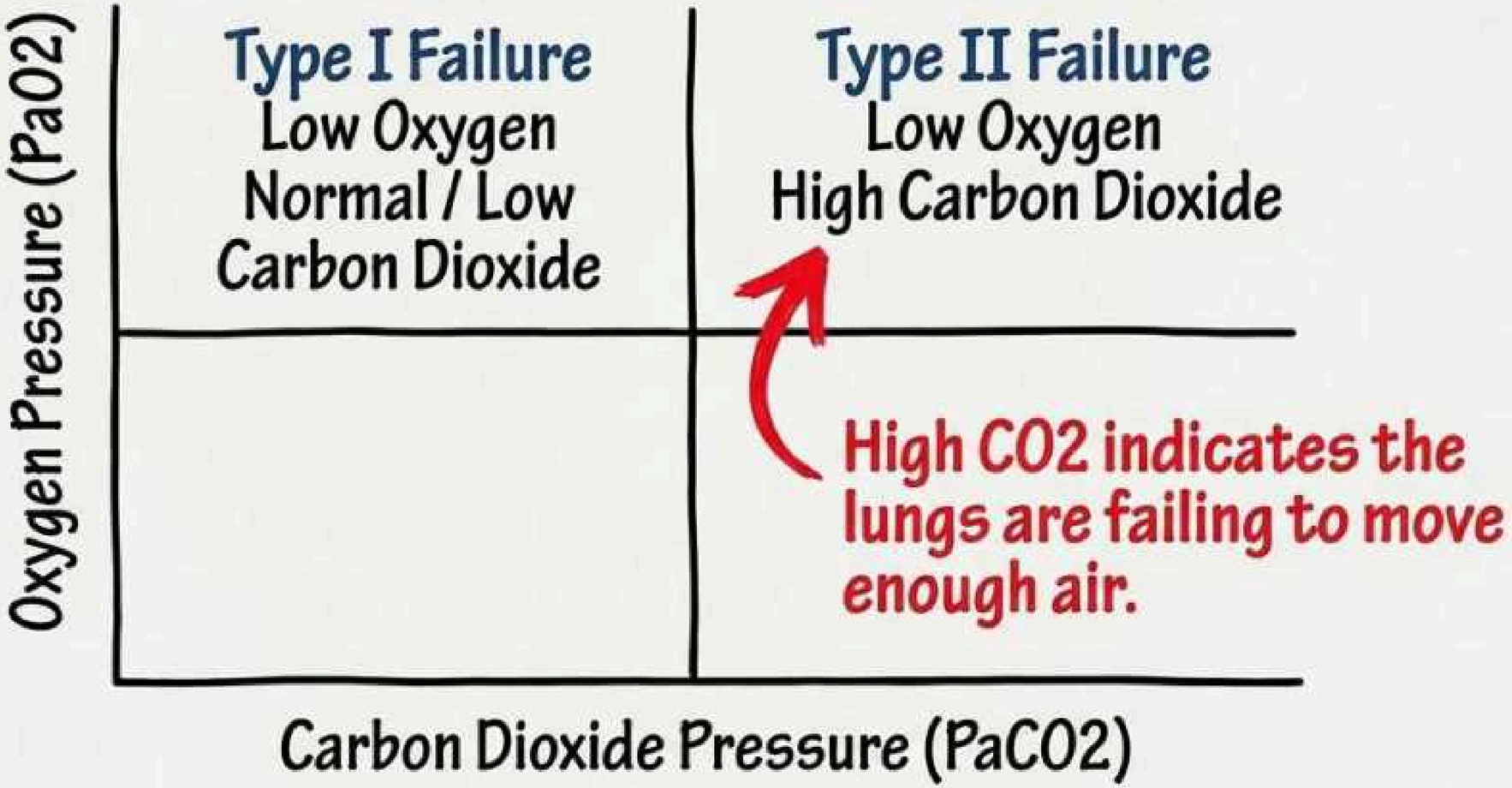
The Mechanism: Patient breathes a harmless trace amount of CO, which binds strongly to hemoglobin, allowing uptake to be measured.

The Failure Points:

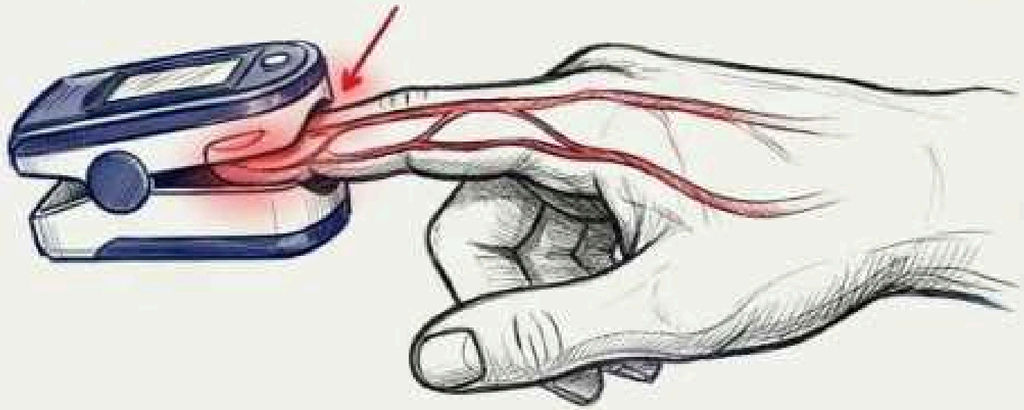
1. Thickened alveolar walls (Lung scarring).
2. Destroyed alveolar walls (Emphysema).
3. Insufficient blood flow through the capillary bed.

Arterial blood gases differentiate the two types of respiratory failure

Blood gases measure O2 pressure, CO2 pressure, and blood acidity.



Pulse oximetry offers rapid screening but carries significant blind spots



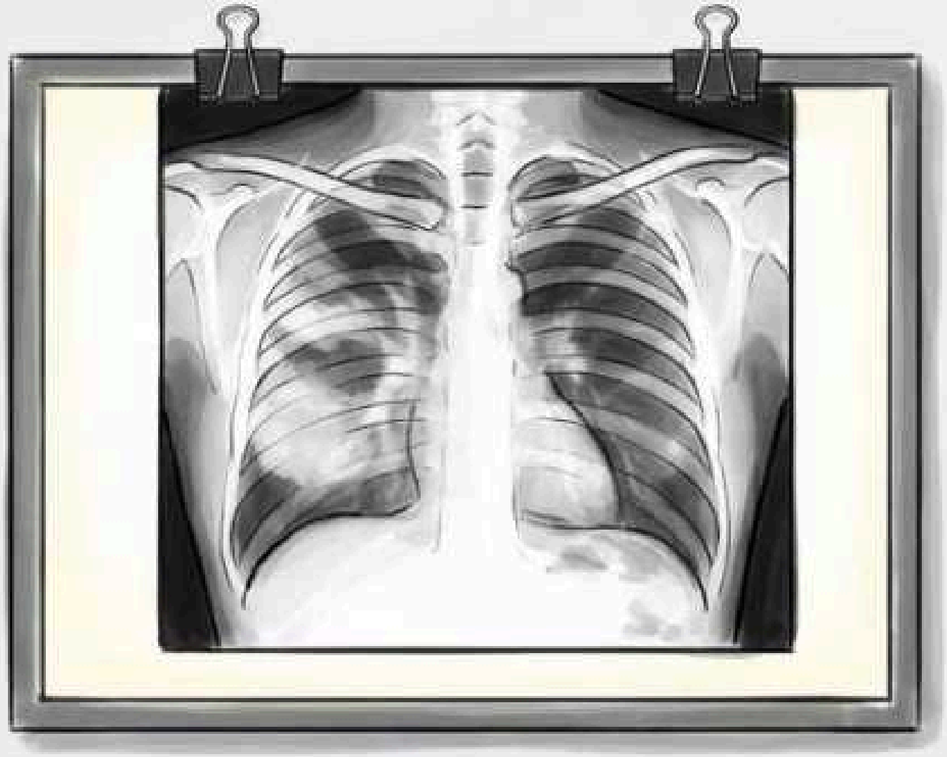
Clinical Utility

- Quick, painless estimate of oxygen saturation.
- Ubiquitous from outpatient clinics to intensive care units.

Critical Limits

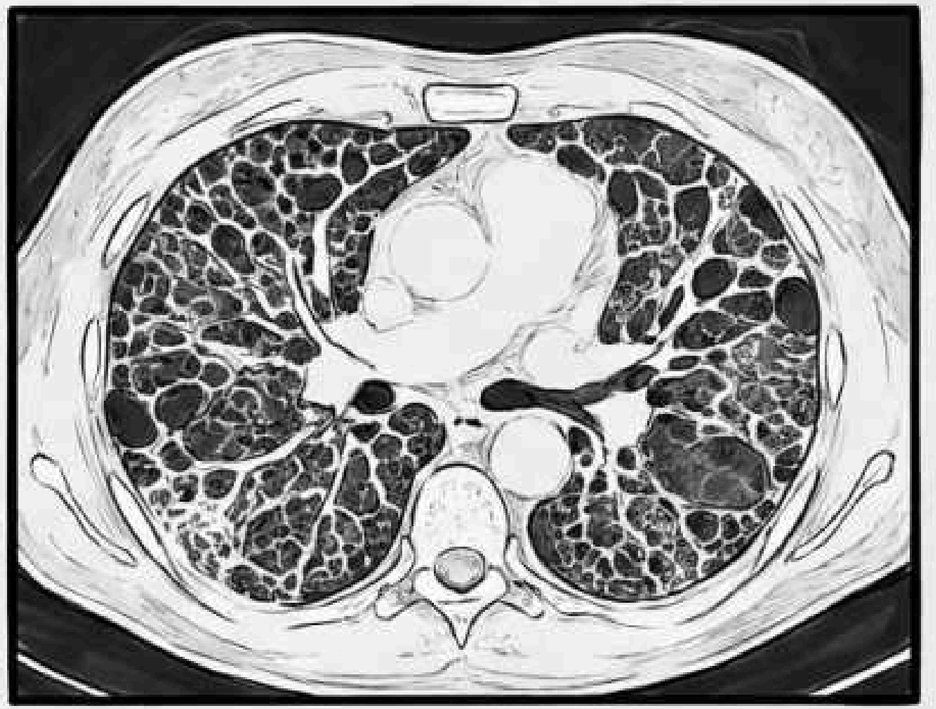
- Can be less accurate in individuals with darker skin tones (a major shortcoming highlighted by data during the COVID-19 pandemic).
- Completely blind to Carbon Dioxide levels (cannot detect Type II respiratory failure).

Imaging techniques locate structural pathology from gross to microscopic



Chest X-Ray

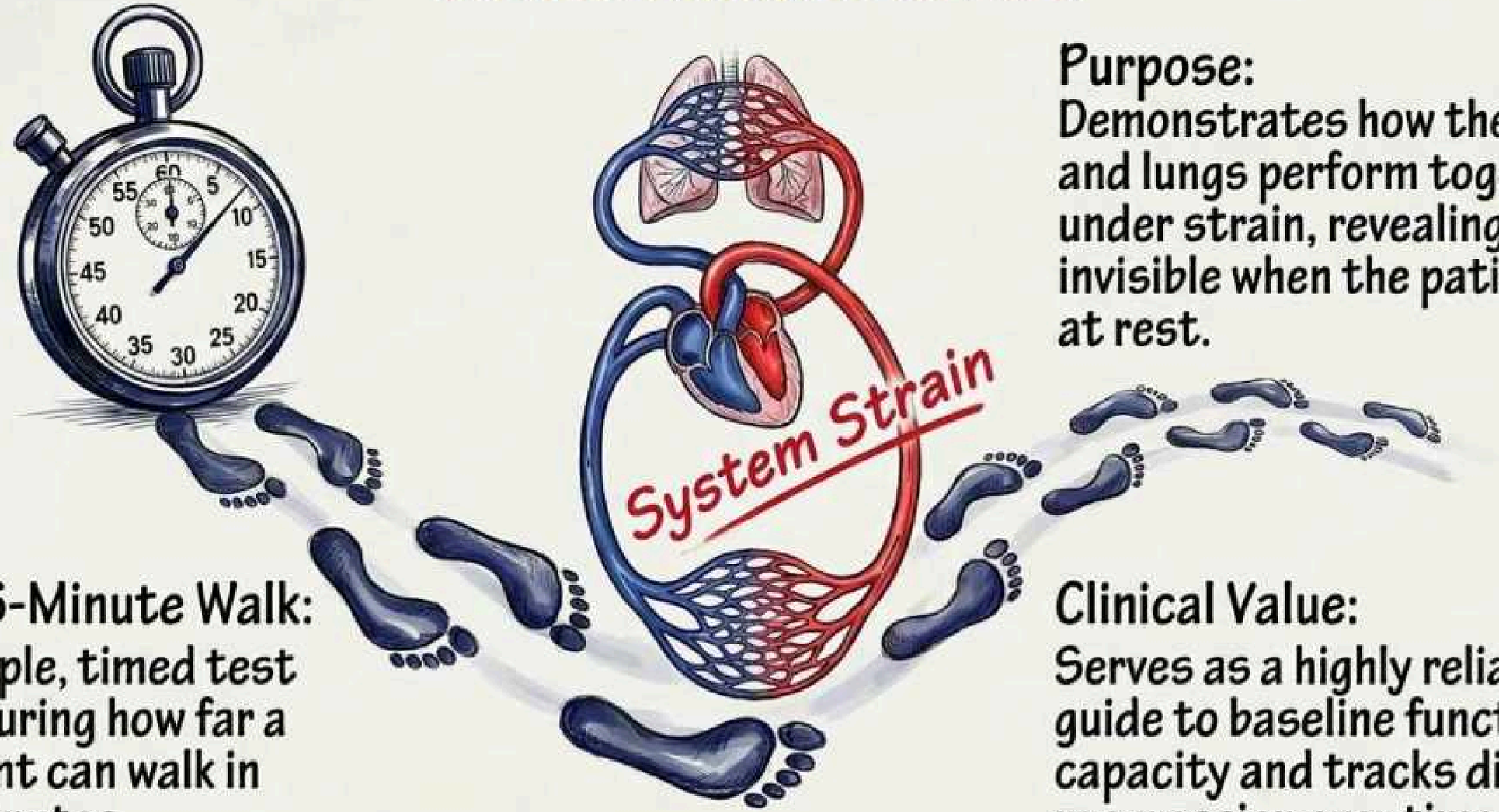
- Available since Wilhelm Röntgen's 1895 discovery.
- Remains the first-line diagnostic test.
- Shows gross pathology: pneumonia, fluid, collapsed lung, and many tumors.



Computed Tomography (CT)

- Provides vastly superior detail of lung tissue architecture.
- Used to examine fine scarring, emphysema, and small nodules.

Exercise testing exposes cardiopulmonary deficits hidden at rest



Purpose:

Demonstrates how the heart and lungs perform together under strain, revealing problems invisible when the patient is at rest.

The 6-Minute Walk:

A simple, timed test measuring how far a patient can walk in six minutes.

Clinical Value:

Serves as a highly reliable guide to baseline functional capacity and tracks disease progression over time.

The complete functional assessment locates and grades the problem

[Spirometry & Volumes]

Separates Obstructive from Restrictive

[Gas Transfer & Blood Gases]

Measures Chemical Exchange

[Imaging]

Provides Structural Context

Locate and Grade the Disease.

Next Lecture: Examining the commonest Obstructive Diseases.