

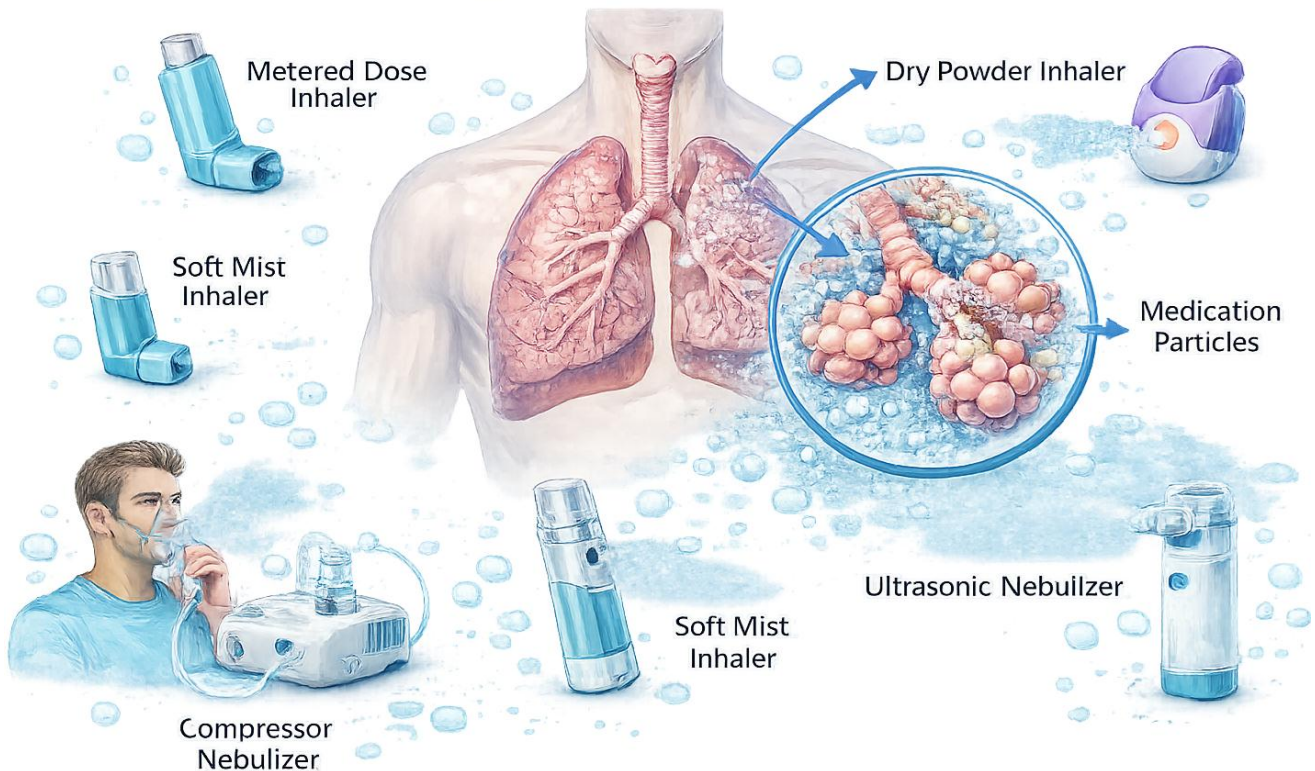
Pulmonary Drug Delivery Systems

Pulmonary Drug Delivery Systems

Introduction

- **Pulmonary drug** delivery systems are designed to deliver drugs directly into the lungs through inhalation.

Pulmonary Drug Delivery Systems



- **This route** is mainly used for treating **respiratory diseases** such as:
 - Asthma
 - Chronic Obstructive Pulmonary Disease (COPD)
 - Tuberculosis
 - Lung infections
- **It can also be** used for systemic drug delivery, as drugs can enter the bloodstream through **lung tissues** due to:
 - Large surface area of the lungs
 - Rich blood supply

Advantages

- **Pulmonary drug delivery** offers **several benefits**:
 - Rapid onset of action
 - Direct delivery to the lungs

- Large surface area for absorption
- Rich blood supply enhances drug uptake
- Lower dose required
- Reduced Systemic Side Effects
- Avoids first-pass metabolism (liver)

Limitations

- **Despite its advantages, this route has some challenges:**
 - Requires proper inhalation technique
 - Drug deposition depends on particle size
 - Possible irritation of airways

Aerosols (Pulmonary Drug Delivery)

Definition / Introduction

- **An aerosol is a system in which:**
 - Fine solid particles or liquid droplets are dispersed in a gas
 - The gas is usually air or a propellant
- **In pulmonary drug delivery:**
 - Aerosols are inhaled into the lungs
 - They deliver drugs directly to the respiratory tract

Ideal Characteristics of an Aerosol

- **Proper particle size:**
 - 1–5 μm for effective lung deposition
- Uniform dose delivery
- Stability during storage

Types of Aerosols



1. Pressurized Metered Dose Inhalers (pMDIs)

- Deliver a fixed dose of drug per actuation
- Use propellents to expel the drug
- Drug is released when the valve is pressed
- Compact and portable

2. Dry Powder Inhalers (DPIs)

- Deliver drug in dry powder form
- No propellents required
- Activated by patient's inhalation

3. Nebulizers

- Convert liquid drug into fine mist (aerosol)
- Used in hospitals or home care
- **Suitable for:**
 - Children
 - Elderly
 - Severe conditions
- **Types of Nebulizers:**
 - Jet nebulizers
 - Ultrasonic nebulizers
 - Mesh nebulizers

Components of Aerosol Systems

- Drug (active ingredient)
- Propellant (in MDIs)
- Container
- Valve system

Particle Size and Deposition

- **Particle size plays a crucial role in determining where the drug is deposited in the respiratory tract:**
 - $>10\ \mu\text{m}$ → Deposited in mouth and throat
 - $5\text{--}10\ \mu\text{m}$ → Upper airways
 - $1\text{--}5\ \mu\text{m}$ → Lower respiratory tract (ideal range)
 - $<1\ \mu\text{m}$ → May be exhaled

Propellents (in Aerosol Systems)

Introduction / Definition

- **Propellents are substances used in aerosol systems to:**
 - Generating pressure
 - Expel the drug from the container
- **They play an essential role in:**
 - Generating pressure
 - Producing a fine spray (aerosol)
 - Delivering an accurate and consistent dose

Types of Propellents



1. Liquefied Gas Propellents

- **Exist as both:**
 - Liquid
 - Gas inside the container
- Maintain constant pressure during use
- Provide uniform drug delivery
- **Examples:**
 - Hydrofluoroalkanes (HFAs)
 - HFA-134a
 - HFA-227
 - Hydrocarbons

2. Compressed Gas Propellents

- Present only in gaseous form
- Pressure decreases as the product is used
- **Examples:**
 - Nitrogen

- Carbon dioxide

3. Chlorofluorocarbons (CFCs)

- Previously widely used propellents
- **Now restricted due to:**
 - Ozone layer depletion
- **Replaced by safer alternatives such as:**
 - Hydrofluoroalkanes (HFAs)

Ideal Properties of Propellents

- **An ideal propellant should have the following characteristics:**
 - Non-toxic
 - Non-flammable
 - Chemically stable
 - Compatible with drug and container
 - Provide consistent pressure
 - Environmentally safe

Containers (Aerosol Systems)

Introduction

- **Containers are used to:**
 - Store aerosol formulations under pressure
 - Ensure safe and effective drug delivery

Types of Containers

1. Metal Containers

- **Made of:**
 - Aluminum
 - Stainless steel
- Strong and resistant to high pressure
- Durable and lightweight
- Most commonly used in aerosol systems

2. Glass Containers

- Chemically inert



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