Inhaled drug delivery

Inhaled drug delivery is a method of administering medications directly to the respiratory system through inhalation. This route of drug administration is particularly effective for treating respiratory conditions such as asthma, chronic obstructive pulmonary disease (COPD), and cystic fibrosis. Inhaled drug delivery offers several advantages, including rapid onset of action, targeted delivery to the lungs, and reduced systemic side effects compared to other administration routes like oral or intravenous.

There are several devices and formulations used in inhaled drug delivery:

Metered-Dose Inhalers (MDIs): MDIs are pressurized canisters that contain a specific amount of medication in aerosol form. The user activates the inhaler, releasing a measured dose of the drug into the lungs. MDIs are commonly used for bronchodilators and anti-inflammatory medications.

Dry Powder Inhalers (DPIs): DPIs deliver medication in a dry powder form. The patient breathes in forcefully through the device, drawing the powdered medication into the lungs. DPIs are often used for bronchodilators and corticosteroids.

Nebulizers: Nebulizers convert liquid medication into a fine mist or aerosol, which is then inhaled through a mask or mouthpiece. This is often used for individuals who may have difficulty using inhalers, such as young children or those with severe respiratory conditions.

Soft Mist Inhalers (SMIs): SMIs are inhalers that deliver a slow-moving soft mist of medication, providing a longer time for the patient to inhale the drug compared to MDIs. This can be helpful for patients who have difficulty coordinating their breath with the inhaler.

Inhaled drug delivery is commonly used for various types of medications, including:

Bronchodilators: These medications relax the muscles in the airways, helping to open them up and make breathing easier. Examples include albuterol and salmeterol.

Corticosteroids: Inhaled corticosteroids reduce inflammation in the airways, helping to control symptoms in conditions like asthma. Examples include fluticasone and budesonide.

Antibiotics: Inhaled antibiotics are used to treat respiratory infections, especially in individuals with chronic lung diseases like cystic fibrosis.

Anticholinergics: These medications help to open the airways and are often used in the treatment of COPD. Examples include ipratropium and tiotropium.

In addition to its therapeutic applications, inhaled drug delivery is also being explored for systemic drug delivery, as the lungs provide a large surface area for absorption into the bloodstream. This approach is under investigation for certain conditions beyond respiratory diseases. Overall, inhaled drug delivery plays a crucial role in managing respiratory conditions and improving the quality of life for patients with these disorders.

Dugernier et al. aimed to compare in vivo and in vitro the deposition of a radiolabeled aerosol generated through four configurations during invasive ventilation, including setups optimizing drug

delivery.

Thirty-one intubated postoperative neurosurgery patients with healthy lungs were randomly assigned to four configurations of aerosol delivery using a vibrating-mesh nebulizer and specific ventilator settings: (1) a specific circuit for aerosol therapy (SCAT) with the nebulizer placed at 30 cm of the wye, (2) a heated-humidified circuit switched off 30 min before the nebulization or (3) left on with the nebulizer at the inlet of the heated-humidifier, (4) a conventional circuit with the nebulizer placed between the heat and moisture exchanger filter and the endotracheal tube. Aerosol deposition was analyzed using planar scintigraphy.

A two to three times greater lung delivery was measured in the SCAT group, reaching 19.7% (14.0-24.5) of the nominal dose in comparison to the three other groups ($p < 0.01$). Around 50 to 60% of lung doses reached the outer region of both lungs in all groups. Drug doses in inner and outer lung regions were significantly increased in the SCAT group ($p < 0.01$), except for the outer right lung region in the fourth group due to preferential drug trickling from the endotracheal tube and the trachea to the right bronchi. Similar lung delivery was observed whether the heated humidifier was switched off or left on. Inhaled doses measured in vitro correlated with lung doses ($R = 0.768$, $p < 0.001$).

Optimizing the administration technique enables a significant increase in inhaled drug delivery to the lungs, including peripheral airways. Before adapting mechanical ventilation, studies are required to continue this optimization and to assess its impact on drug delivery and patient outcome in comparison to more usual settings [1].

1)
Dugernier J, Le Pennec D, Maerckx G, Allimonnier L, Hesse M, Castanares-Zapatero D, Depoortere V, Vecellio L, Reychler G, Michotte JB, Goffette P, Docquier MA, Raftopoulos C, Jamar F, Laterre PF, Ehrmann S, Wittebole X. Inhaled drug delivery: a randomized study in intubated patients with healthy lungs. Ann Intensive Care. 2023 Dec 11;13(1):125. doi: 10.1186/s13613-023-01220-y. PMID: 38072870.