Aerosol therapy

Aerosol therapy refers to the delivery of a drug to the body via the airways by delivering it in an aerosolised form. Whereas the aerosolised drug may be intended for systemic use utilising the vast surface area for absorption provided by the respiratory tract, the overwhelming majority of the aerosols are meant for topical use. Modern technology along with increasing understanding of human pulmonary physiology has aided the development of improved systems of aerosol delivery. More and more bronchodilators and anti-inflammatory agents are becoming available for use as aerosol therapy.

Among other differences, the CFC based MDIs contain the drug in suspension form whereas the HFA ones have it in a solution form. Moreover, no surfactant is used in the HFA devices. However, alcohol is added for dispersal. The particle size produced by HFA based MDIs is finer and softer and is generated at slower speeds. Consequently, the oropharyngeal deposition is lesser with HFA based MDIs and delivery to lower airways is double compared to that of CFC based MDIs. It is no surprise that the major conclusion to come out of a study comparing the two different propellant-based MDIs was that only 50% of the usual dose used in CFC MDIs was required to produce the equivalent clinical effect.20 Metered dose inhalers have been popular because of ease of usage, small and compact size and the relative cost-effectiveness. On the other hand, the commonest error in the usage of an MDI is the lack of coordination between the actuation of the device and the initiation of inspiration. Many other problems can also be associated with the use of MDI. The physician who prescribes these devices should keep these things in mind and the same should be conveyed to the patient as well.. Even with the best technique, only 10% to 20% of the total drug makes it to the large airways and only 5% of the drug reaches the small airways

Various additives and cold propellant in MDIs may cause airway irritation, that may lead to cough or occasionally, bronchospasm. The medication is held in a suspension with the

propellant in the canister. To prevent undesirable layering of the medication, it is imperative to shake the canister between each actuation. It is important to keep in mind that the MDI may continue to deliver the aerosol even after the drug is finished. This aerosol consists only of the propellant at this time. This tends to occur usually in patients who do not shake the canister well as a routine. Steps for Ideal Use of an MDI

1. Shake
2. Hold the canister upright.
3. Gently exhale to functional residual capacity (do not exhale to residual volume).
4. Place the mouthpiece in mouth, between teeth, and close lips or keep the same 5 cm in front with mouth open.
5. With initiation of inhalation, actuate the canister
6. Slowly inhale up to the maximum capacity (total lung capacity).
7. Hold breath for 10 seconds or as long as possible. 8. Wait for at least 60 seconds before the next puff.

In breath-activated MDIs, coordination between breathing and actuation is not required. However, a drawback is that the elderly patient may be unable to use this device.

Valved Holding Chambers/Spacers To overcome the major problem related to coordination, a valved holding chamber may be used as an adjunct to the MDI It is also useful for old patients and those who are unable to hold breath. This adjunct has many advantages including improved coordination with the inspiratory flow of the patient. When an MDI is used with spacer devices, reduction occurs in the overall particle size of the inhaled aerosol, as larger particles tend to stick to the chamber walls/valves. This also leads to a reduction in particle velocity leading to decreased upper airway deposition. It should be explained to the patient that the aerosol must be inhaled immediately after the MDI is discharged into the chamber and only a single actuation should be discharged into the chamber for each inhalation. Following this, the patient

should be instructed to breath in and out for a few breaths before actuating another discharge of MDI.

Dry powder inhalers (DPI) consist of pharmacologically active powder as an aggregate of fine micronised particles in an inhalation chamber . These aggregates are converted into an aerosol by inspiratory airflow through the inhaler generated by the patient. This basic fact excludes the problem of coordination between the delivery of the drug and the initiation of inspiration. But the very same fact also makes it unsuitable for patients who are unable to generate high inspiratory flow rates. Lack of requirement of propellant is an advantage of DPIs over MDIs. The DPIs tend to fail in patients who cannot generate moderate to high inspiratory flow rates since unlike the MDI, they are driven by the patient's own effort. In a DPI, the aerosol needs to be generated from the powder formulation by patient's own effort. For achieving this, a high turbulence is needed to break the large agglomerates of the drug into smaller, finer and inhalable particles. Turbulence is generated by creating resistance to air flow in the DPI device and the effort required to generate adequate flow rates is dependent on the extent of resistance. This makes the use of DPI unsuitable for elderly as well as nger pediatric patients and those with severe bronchospasm. Some of the newer innovations in the field of DPI devices have attempted to circumvent this drawback.

Steps for Ideal Use of DPI

1. Check that the device is clean and the mouthpiece free of obstruction.
2. Load a dose into the device as directed (if singledose device).
3. Hold the inhaler level with the mouthpiece and facing down.
4. Tilt head back slightly, and beathe out slowly and completely without straining or breathing into the device (moisture from breath can clog the inhaler valve).
5. Place teeth over the mouthpiece and seal lips around it making sure not to block the device outlet with tongue.

6. Breathe in quickly and deeply (over two to three seconds) through the mouth to activate the flow of medication.

7. Remove the device from the mouth. Hold breath for 10 seconds (or as long as is comfortable), and then breathe out slowly against pursed lips. This step is very important. It allows the medication to get deeply into the lungs.

NEBULISATION

Nebulisers: Two types of nebulisers are available for use: jet nebuliser and ultrasonic nebuliser. These work on different principles but have many features in common. These are non-propellant based, do not require patient coordination and can be used to deliver high doses of a particular drug over a short time, such as during acute exacerbations of obstructive airway diseases in emergency settings.

A **jet nebuliser works** on the **Bernoulli's principle** where a high velocity gas (oxygen or air) is passed through a constriction that draws up liquid medication due to the relative vacuum. The result is an aerosol that breaks up into small particles by hitting the inner surface of the chamber. Smaller particles pass through the outlet to the patient whereas larger particles are retained behind in the jet chamber to be re-aerosolised. The size of the particle is directly proportional to the compressed gas flow and the size of the nozzle. It has been shown that systems that deliver 8 L/min of flow produce ideal-sized particles. Also an intermittent rather than continuous inhalation system leads to lesser loss of medication. The commonly used neublisers, however, deliver the aerosol continuously.

An **ultrasonic nebuliser** works by creating a fountain by ultrasonic energy. Aerosol is generated by means of a **piezoelectric crystal** that functions by converting electrical current into a high frequency vibration. These intense vibrations pass through the drug to be aerosolised and result in formation of droplets. The frequency of vibration determines the size of droplets. Clinical studies have indicated that size of the aerosol particles generated by ultrasonic

nebuliser is larger as compared to those from a jet nebuliser. Because of this fact drug deposition in the upper airways may be higher than that with a jet nebuliser. The major disadvantage of the nebuliser is the cost factor. Equipment is relatively expensive and a lot of drug is wasted.