Which Device in Asthma?

The ideal way to deliver drugs in asthma or chronic obstructive pulmonary disease (COPD) is by inhalation. A standard dose of salbutamol for inhalation is 100 micrograms compared with 2 or 4 mg in tablet form. Hence, if drugs can be delivered directly to the lung they will act faster and at a lower dose (20- to 40-fold in the case of salbutamol) which will reduce the incidence of side-effects. However, if the device fails to deliver the drug to the correct place it is of no value at all.

Devices

There are various devices available but they can be classified generically as metered-dose inhalers (MDIs), MDIs with spacers, dry powder inhalers (DPIs), breath-actuated MDIs (BA-MDIs) and nebulisers.

Basic principles

The anatomy of the airways is such that particles tend to be filtered out before they reach the lungs but small particles between 1 and 7 µm in diameter will reach the relevant parts[1]. Larger particles will be filtered out higher up. The speed of the particles and the competence of the inhaler technique are also important.

Metered-dose inhalers (MDIs)

MDIs are the standard mechanism for delivering drugs to the small airways in asthma or COPD. However, it is essential that the patient is educated in the use of the device and that this competence is checked[2].

As well as education, adequate coordination is required. This must be checked and not assumed. Lack of co-ordination between activation of the device and inspiration is a major cause of failure of these devices and it is not limited to children[3]. It is the main cause of poorly controlled asthma[4]. If used properly, an MDI is at least as effective as any other form of delivery and much cheaper[4]. An American review of the evidence concluded that MDIs are no more or less effective that other systems of delivery and so the least expensive should be chosen[5]. However, if a cheaper system fails to deliver the drug it is very poor value.

Because of the phasing out of chlorofluorocarbons (CFCs), other propellants have been developed for these inhalers and the evidence suggests that they are just as efficient as the old type[6]. In fact, a study using a human upper airway model linked to a computer suggests that CFC-free inhalers, combined with a smaller nozzle (0.25 mm instead of 0.5 mm) may be more efficient because of the smaller particles produced[7]. The dosage of CFC-free beta agonist inhalers is equivalent to CFC-containing inhalers.

The dosage of CFC-free steroid inhalers may be different from those which contained CFCs.

Spacers with MDIs

Most spacers are of large volume, around 750 ml, made of plastic and inconvenient to carry around. Smaller spacers exist but are probably less effective although this is disputed[8]. Large spacers usually have a valve system that permits the drug to stay in suspension whilst it is inhaled. The dose may be reduced by accumulation of electrostatic charge so that the drug is absorbed on to the plastic. This can be avoided by periodic washing of the device in soapy water or detergent.

Spacer devices slow down the particles and make co-ordination of actuation and inhalation much less critical. The main advantage of the spacers is that they increase the proportion of the dose delivered to the airways (where the drugs produce the desired effect), while reducing the proportion absorbed into the body (which is usually the cause of unwanted effects). MDIs with large-volume spacers deposit at least 30% more drug in the lung but deposit 60% less drug in the patient, because of reduced oropharyngeal deposition.

Any drug that gets into the body but not into the lungs is undesirable. Beta agonists cause tremor and tachycardia. Steroid inhalers can produce oropharyngeal candidiasis and systemic side-effects of steroids, including restriction of growth in children.

The British Thoracic Society (BTS) guidelines recommend the use of an MDI plus spacer in preference to a nebuliser for the treatment of a mild-to-moderate acute asthma attack[9]. This approach is also supported by a Cochrane review which found that nebulisers were not significantly any better than MDIs[10].

Benefits from the use of large-volume spacers include:

- More effective treatment with fewer side-effects because of better pattern of deposition.
- Problems of poor inhaler technique largely overcome but spacers need to be used properly too.
- Easily used by children and the elderly (except those with weak or arthritic hands).
- As effective as a nebuliser in treatment of acute attacks but light, cheap, maintenance-free, portable and available on prescription.
- Useful for treatment of first attacks of wheezing in patients who have not used inhalers before.
- Useful for administration of bronchodilator when testing reversibility in the surgery to establish the diagnosis of asthma.
- Reduced prescribing costs by basing treatment on the much cheaper MDIs.
Cough after use of a spacer and MDI is a poorly understood problem that may affect compliance. In one study it affected 30% of children after beta agonists and 54.5% of children after a steroid inhalation[11].

**Dry powder inhalers (DPIs)**
These devices can be as small and portable as an MDI but requiring less co-ordination. Drug delivery to the lungs is dependent upon the patient’s peak inhaled flow rate. They are more expensive than MDI plus spacer and BTS guidelines state that they are no more effective. However, they may be preferred by some patients. The most recent devices may still be under patent. Evidence suggests newer DPIs are no more effective than older types [9].

DPIs do not have any propellant, whether CFC or otherwise. Sometimes patients complain that they are not certain if they have taken a dose and devices may be discarded well before they are empty.

**Breath-actuated MDIs (BA-MDIs)**
These allow patients to prime the inhaler and when the patient takes a breath the inhaler is activated. This avoids the need to co-ordinate release of the metered dose with breathing. BA-MDIs are as effective as MDIs [9]. They can be used as second-line inhaler devices if there are co-ordination problems with the MDIs after full instruction.

**Nebulisers**
The BTS guidelines state that there is insufficient evidence to make recommendations about the use of nebulisers in the emergency situation but, as mentioned above, they do recommend their use in severe asthma attacks. There are, furthermore, insufficient data to recommend nebulisers in standard therapy, although some patients prefer to use them. Nebulisers are no longer recommended as first-line treatment for acute asthma [9].

A wide variety of nebulisers are available. Conventional jet nebulisers waste a great deal of the drug during expiration. Breath-assisted open vent systems have considerably reduced this but it is dependent upon the patient having an adequate expiratory flow.

Ultrasonic nebulisers produce a high mass output and have a shorter time for treatment but are inefficient for delivering suspensions or viscous liquids. Adaptive aerosol-delivering devices release a precise dose that is tailored to the individual’s breathing pattern [12].

Both nebulisers and spacers used for small children employ face masks. There are some significant differences between the characteristics of the various masks affecting efficacy.
Choosing the correct device

It is essential to choose the device that is most suited to the patient. The following points should be considered:

- The choice of device may be determined by the choice of drug.
- If the patient is unable to use a device satisfactorily an alternative should be found.
- The patient should have their ability to use an inhaler device assessed by a competent healthcare professional.
- The medication needs to be titrated against clinical response to ensure optimum efficacy.
- In children aged 0-5 years, MDI and spacer are the preferred method of delivery of beta agonists. A face mask is required until the child can breathe reproducibly using the spacer mouthpiece. Where this is ineffective a nebuliser may be required.

Use and care of spacers

When using a spacer:

- The spacer should be compatible with the MDI being used.
- The drug should be administered by repeated single actuations of the MDI into the spacer, each followed by inhalation.
- There should be minimal delay between MDI actuation and inhalation.
- Tidal breathing is as effective as single breaths.
- Spacers should be cleaned monthly rather than weekly as per manufacturer's recommendations or performance is adversely affected. They should be washed in detergent and allowed to dry in air. The mouthpiece should be wiped clean of detergent before use.
- Drug delivery may vary significantly due to static charge. Metal and other antistatic spacers are not affected in this way.
- Plastic spacers should be replaced at least every 12 months but some may need changing at six months.

Further reading & references

- Global Initiative for Asthma (GINA)
- Why asthma still kills; Royal College of Physicians, August 2015


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