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Inhaler device selection for people with asthma or chronic obstructive pulmonary disease

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SUMMARY

There are many types of inhaler device, each with its own characteristics, benefits and limitations.

Inhaler device selection should be individualised. Assessment of the patient's inspiratory flow, dexterity, coordination and preferences can help guide selection of a device that the patient can and will use effectively.

For patients who require multiple inhaled drugs, prescribing combination inhalers and avoiding the use of more than one type of inhaler device can reduce errors in inhaler technique and improve adherence.

Inhaler technique and adherence should be regularly reviewed.

Environmental impact of inhalers can be reduced by optimising symptom control to minimise the need for short-acting beta$_2$ agonists, and choosing inhalers with a low carbon footprint.

Introduction

The cornerstone of treatment for asthma and chronic obstructive pulmonary disease (COPD) is inhaled therapy that allows rapid and targeted drug delivery to the lungs, while limiting systemic exposure and potential adverse effects.

There is a wide range of inhaler devices available. Each device has its own intrinsic characteristics and specific disadvantages and advantages for individual patients. The increasing number of different devices allows for a person-centred approach; however, it also increases the complexity of choosing the right device for each patient.

Clinical outcomes do not differ significantly between inhaler devices when they are used correctly;[1] however, poor inhaler technique and poor adherence are associated with worse outcomes.[2-4] Therefore, the choice of device is often as important as the choice of drug(s).

This article provides an overview of factors that should be considered when selecting an inhaler device. It does not address drug selection and other aspects of asthma and COPD management.

Inhaler device types

Inhaler devices can be grouped into 3 main types (Table 1):

- pressurised metered-dose inhalers (pMDIs)
- soft mist inhalers (SMIs)
- dry powder inhalers (DPIs).

The steps required for preparation, the amount of manual dexterity and strength needed to load or actuate the device, the required inspiratory flow rate, the need for cleaning and maintenance, and the carbon footprint differ between devices.[6] Table 2 provides a summary of key advantages and disadvantages of the different inhaler types.

Choosing an inhaler device

Factors to consider when selecting an inhaler device include:

- the patient's inspiratory flow rate and volume
- the particle size and aerosol velocity generated by the device
- the patient's ability to use the device
- inhaler regimen complexity
- environmental impact.

Patient preference and shared decision-making are important, to ensure an inhaler device is selected that the patient can and will use effectively.[7,8]

Inspiratory flow rate and volume

Determining a patient's inspiratory flow rate can help with choosing an inhaler device (Figure 1).[9] Inspiratory flow rate and volume influence drug deposition in the airways. Each inhaler type has its own optimal inspiratory flow rate.

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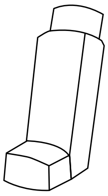
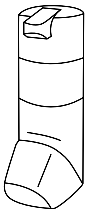
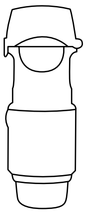
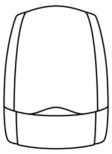
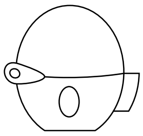
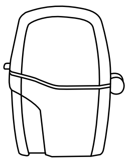
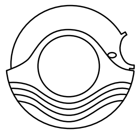
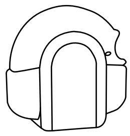
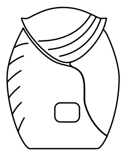
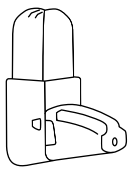
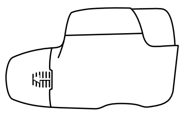
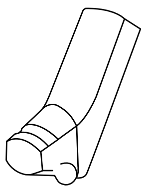
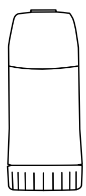
Table 1 Inhaler devices available in Australia

Inhaler type	Illustration	Example drugs – generic (brand) name
PRESSURISED METERED-DOSE INHALERS (pMDIs)		
Standard pMDI ('puffer')		• salbutamol (Asmol, Ventolin, Zempreon) • budesonide+formoterol (Symbicort Rapihaler, Rilast Rapihaler) • budesonide+glycopyrronium+formoterol (Breztri Aerosphere) • fluticasone propionate (Axotide, Flixotide, Fluticasone Cipla) • fluticasone propionate+formoterol (Flutiform) • fluticasone propionate+salmeterol (Seretide, Evocair, Fluticasone+Salmeterol Cipla, Pavtide, SalplusF) • ipratropium (Atrovent) *Extra-fine particle pMDIs:* • beclometasone (QVAR) • beclometasone+formoterol (Fostair) • beclometasone+glycopyrronium+formoterol (Trimbow) • ciclesonide (Alvesco)
Breath-actuated pMDI (Autohaler)		• salbutamol (Airomir Autohaler) • beclometasone (QVAR Autohaler)
SOFT MIST INHALERS (SMIs) [NB1]		
Respimat		• tiotropium (Spiriva Respimat) • tiotropium+olodaterol (Spiolto Respimat)
DRY POWDER INHALERS (DPIs) [NB2]		
Single-dose capsule DPIs – a capsule needs to be inserted into the device for each dose		
Breezhaler		• glycopyrronium (Seebri Breezhaler) • indacaterol (Onbrez Breezhaler) • indacaterol+glycopyrronium (Ultibro Breezhaler) • mometasone+indacaterol (Atectura Breezhaler) • mometasone+glycopyrronium+indacaterol (Enerzair Breezhaler)
Handihaler		• tiotropium (Spiriva Handihaler)
Zonda		• tiotropium (Braltus Zonda)

Continued over page

Table 1 Inhaler devices available in Australia *(continued)*

Inhaler type	Illustration	Example drugs – generic (brand) name
DRY POWDER INHALERS (DPIs) [NB2] *(continued)*		
Multi-unit DPIs – each actuation releases one dose from pre-loaded individual blisters		
Accuhaler		• fluticasone propionate (Axotide Accuhaler, Flixotide Accuhaler) • fluticasone propionate+salmeterol (Seretide Accuhaler, Pavtide Accuhaler) • salmeterol (Serevent Accuhaler)
Ciphaler		• fluticasone propionate+salmeterol (Fluticasone Salmeterol Ciphaler)
Ellipta		• fluticasone furoate (Arnuity Ellipta) • fluticasone furoate+vilanterol (Breo Ellipta) • fluticasone furoate+umeclidinium+vilanterol (Trelegy Ellipta) • umeclidinium (Incruse Ellipta) • umeclidinium+vilanterol (Anoro Ellipta)
Multidose reservoir DPIs – each actuation meters out one dose from a pre-loaded reservoir		
Easyhaler		• budesonide+formoterol (Bufomix Easyhaler) • fluticasone propionate+salmeterol (Salflumix Easyhaler)
Genuair		• aclidinium (Bretaris Genuair) • aclidinium+formoterol (Brimica Genuair)
Spiromax		• budesonide+formoterol (DuoResp Spiromax)
Turbuhaler		• budesonide (Pulmicort Turbuhaler) • budesonide+formoterol (Symbicort Turbuhaler, Rilast Turbuhaler) • formoterol (Oxis Turbuhaler) • terbutaline (Bricanyl Turbuhaler)

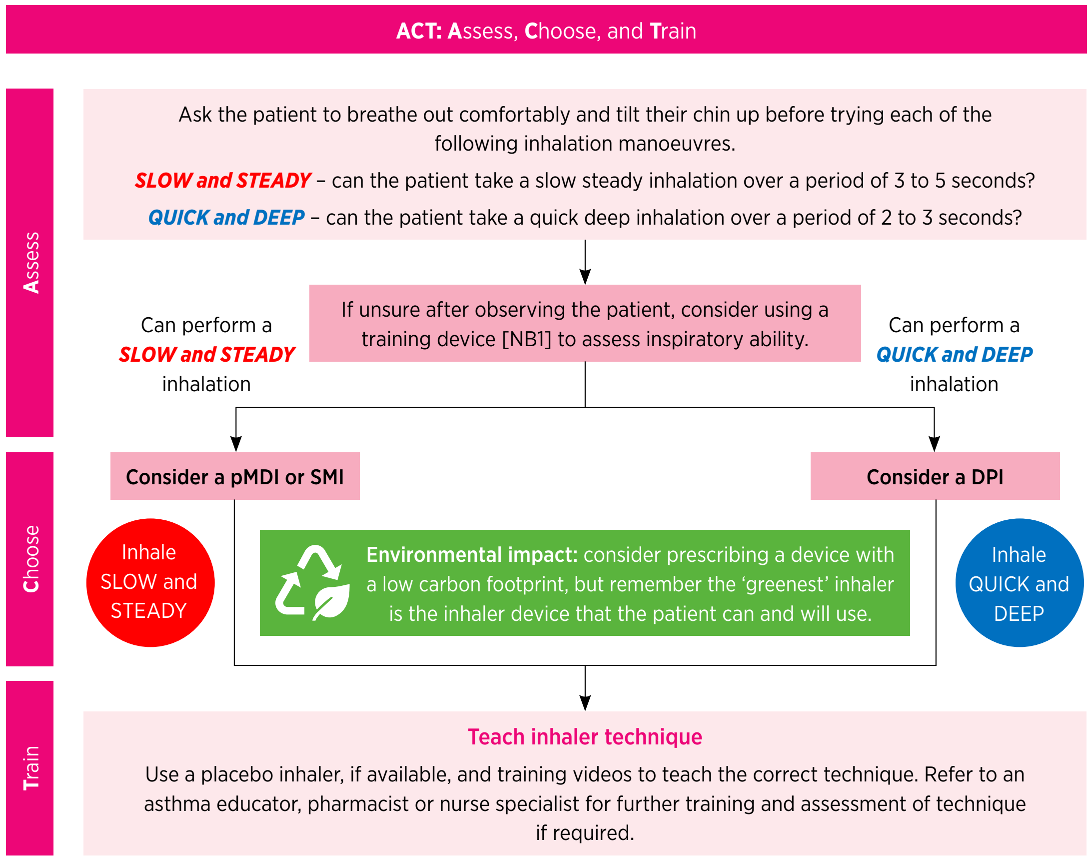
NB1: The Respimat soft mist inhaler is propellant-free. It uses the energy of a compressed spring inside the inhaler to generate a slow-moving aerosol cloud or 'mist'.[5]

NB2: Dry power inhalers are propellant-free. They derive the energy for delivering the dose from the user's inspiratory flow.[5]

Table 2 Advantages and disadvantages of the different inhaler devices

Inhaler device type	Advantages	Disadvantages
Pressurised metered-dose inhaler (pMDI)	• available for wide range of drugs • dose delivered and particle size are independent of inhalation manoeuvre • suitable for use in children (with spacer) • suitable for emergencies • compact • less expensive than most other inhalers *pMDI with extra-fine particle aerosol:* • reduced oropharyngeal deposition and greater lung deposition compared with standard pMDI formulations (lower drug doses required and fewer side effects)	• coordination of inhalation and actuation required (unless used with spacer). *Exception*: breath-actuated pMDI • high oropharyngeal deposition of larger particles (unless used with spacer) • dose counter not available in all devices to assess remaining doses • contains propellant (high carbon footprint) • most need to be shaken well before each inhalation, and primed if not used within a specified period • plastic case and mouthpiece require regular cleaning *Breath-actuated pMDI:* • cannot be used with spacer • limited range of drugs available • more expensive than standard pMDIs
Soft mist inhaler (SMI)	• less coordination of inhalation and actuation required compared with pMDIs, because of low-velocity aerosol cloud • high fine-particle fraction (reduced oropharyngeal deposition and greater lung deposition compared with pMDIs) • spacer not required • dose-count indicator • no propellant (lower carbon footprint than pMDIs) • can replace cartridge once empty, allowing device to be reused up to 5 times	• needs to be primed when cartridge loaded into device, and if not used for over 21 days
Dry powder inhaler (DPI)	• breath-actuated, so coordination of inhalation and actuation not required • spacer not required • dose-count indicator • no propellant (significantly lower carbon footprint than pMDIs)	• moderate to high inspiratory flow rate required • not suitable for young children • may not be suitable for emergencies • needs proper dose preparation and loading to achieve optimal available dose for inhalation • patient must not breathe into device (to ensure powder remains dry) *Single-dose capsule DPIs:* • manual insertion of capsule into device required before each use • continued or repeated inhalation required until capsule is empty, which can cause dose variability • risk that capsules may be taken orally • Handihaler requires regular cleaning *Multi-unit DPIs:* • device needs to be kept horizontal following dose preparation until after inhalation *Multidose reservoir DPIs:* • more sensitive to humidity than other DPIs

Figure 1 The assess, choose, and train (ACT) algorithm for choosing an inhaler device



DPI = dry powder inhaler; pMDI = pressurised metered-dose inhaler; SMI = soft mist inhaler
NB1: Training device refers to, for example, the In-Check Dial Inspiratory Flow Meter.
Figure adapted from reference 9

Least inspiratory effort is required for pMDIs and SMIs. These require a slow and steady inhalation over 3 to 5 seconds to minimise deposition of the drug in the oropharynx and optimise delivery to the lungs.[10]

More inspiratory effort is needed for DPIs, because they rely on the patient's ability to produce sufficient airflow to break up and disperse the powder and deliver the dose. This requires a full breath out (exhalation to the patient's functional residual capacity or residual volume), followed by a forceful, deep inhalation over 2 to 3 seconds.[10] Exhalation to functional residual capacity increases peak inspiratory flow rate and inhaled volume, which may facilitate fine particle generation from the DPI.[11] If the patient is unable to exhale fully before inhalation, or cannot manage a quick and deep inhalation, they may be better suited to a pMDI (with or without a spacer) or an SMI.

Particle size

Particles greater than 5 micrometres in diameter are most likely to deposit in the oropharynx and be swallowed.[10] Particles 1 to 5 micrometres will deposit in the large and conducting airways; and particles less than 1 micrometre are likely to reach the peripheral airways and alveoli, or be exhaled.[12] Extra-fine particle corticosteroid-containing pMDIs (median particle size less than 2 micrometres) (Table 1) have significantly higher odds of achieving asthma control, with lower exacerbation rates, at significantly lower doses than other corticosteroid-containing pMDIs.[13]

Aerosol velocity

Aerosol velocity also influences the degree of impaction in the oropharynx and deposition in the lungs. For example, the dose from a Respimat SMI is expelled over about 1.2 seconds, compared with

0.1 second from a pMDI, leading to higher lung deposition than with most pMDIs. The lower aerosol velocity also allows extra time for hand–breath coordination without the need for a spacer.[5,14]

Patient ability to use the device

A patient's ability to correctly use a device can be influenced by manual dexterity, hand strength, cognitive function and hand–breath coordination. Comorbidities in older people may present physical challenges to manipulating a device, and children may lack the ability to perform a correct inhalation manoeuvre without the use of a spacer.[5,7]

Inhaler regimen complexity

Inhaler device polypharmacy should be minimised by use of single-inhaler dual and triple therapy.[15] If multiple inhalers are indicated, where possible they should be the same type of device, to avoid the patient having to remember and master the different steps for multiple inhaler types. Changing devices or using multiple devices may lead to confusion and poorer disease control.[16] Patients prescribed inhaler devices requiring a similar inhalation technique show better outcomes than those prescribed multiple devices requiring different techniques.[17]

Environmental impact

Inhalers contribute significantly to greenhouse gas emissions, primarily due to the potent global warming potential of hydrofluorocarbon propellants in pMDIs.[18] New propellants are under development with significantly lower global warming potential, but these are not yet available.[19] DPIs and SMIs are propellant-free and have as much as a 100-fold to 200-fold lower carbon footprint than pMDIs.[19]

However, it is important to note that poorly controlled asthma significantly contributes to greenhouse gas emissions, with these patients contributing 8 times more emissions than those with well-managed asthma.[20] Therefore, ensuring respiratory disease and symptoms are well controlled is the highest priority for improving both patient and environmental outcomes.[9]

Overreliance on short-acting beta$_2$ agonist (SABA) pMDIs (e.g. salbutamol) contributes to poor clinical and environmental outcomes. In Australia, 83% of total inhaler use is for SABAs, and these inhalers contribute 87% of total inhaler-related greenhouse gas emissions.[21] In patients with mild asthma, as-needed anti-inflammatory reliever (AIR) therapy, using a budesonide+formoterol DPI, can reduce the carbon footprint of asthma therapy by over 90%, by avoiding SABA pMDI use.[22]

Ensuring correct inhaler technique

Up to 94% of patients do not use their inhaler devices correctly, resulting in inadequate dosing, suboptimal disease control, worsening of quality of life, increased oral corticosteroid and antimicrobial use, and increased hospital admissions and mortality.[3,23] Australian data suggest that only 10% of people with asthma can competently use their inhalers.[24]

Older age, cognitive impairment, multiple different devices and lack of training are all risk factors for poor inhaler use and adherence.[25]

There are 7 basics steps to using an inhaler device, pertinent to all devices (Box 1). Errors in any step may lead to inadequate drug delivery to the lungs.

Video instructions are available to assist with training people to use their inhaler correctly:

- How-to videos - National Asthma Council Australia
- Resources - Lung Foundation Australia.

Common errors with inhaler technique

Incorrect inspiratory effort (insufficient inspiratory flow for DPIs, and not slow and steady for pMDIs and SMIs) is a common error.[27] The National Asthma Council Australia, in collaboration with the Pharmaceutical Society of Australia, has developed supplementary labels, to be affixed by pharmacists to inhalers in addition to the dispensing label, to indicate the correct inspiratory flow rate for each device.[28]

Errors that are common to all devices include not having the head tilted with chin up during inhalation, not breathing out to empty the lungs before inhalation, and not holding the breath for 5 to 10 seconds after each inhalation.

Box 1 The 7 steps to correct use of an inhaler device

1. Prepare inhaler device, check dose-counter (where present), shake inhaler if applicable
2. Prepare or load dose
3. Breathe out, fully and gently, away from mouthpiece
4. Place inhaler mouthpiece in the mouth, tilt chin up and seal lips around mouthpiece
5. Breathe in:
   - pMDI and SMI – slow and steady
   - DPI – quick and deep
6. Remove inhaler from mouth and hold breath for 5 to 10 seconds [NB1]
7. Close inhaler or replace cap, and repeat steps 1 to 7 as necessary

DPI = dry powder inhaler; pMDI = pressurised metered-dose inhaler; SMI = soft mist inhaler

NB1: Holding the breath increases lung deposition through the process of sedimentation.[12] While the breath-holding capacity of patients with COPD may be limited, it is important that patients are advised to hold their breath for 5 seconds or as long as possible after inhalation.[26]

Other errors associated with specific inhaler types are summarised below.

Pressurised metered-dose inhalers

Actuation before inhalation and incorrect preparation of the second dose are common errors with pMDIs.[27] Spacers can be used with pMDIs to overcome the difficulty of coordinating inhalation and actuation.

Spacers also reduce aerosol velocity and facilitate vaporisation of particles to an optimal size, which reduces oropharyngeal deposition and increases deposition in the lungs.[29]

All patients using a pMDI should be advised to use a spacer for both regular and emergency doses. This is particularly important for patients who have difficulty coordinating actuation of the pMDI with inhalation; this includes children and people with cognitive impairment or reduced manual dexterity.[30] Children below the age of 3 years need to use a face mask with their spacer.

Collapsible and disposable cardboard spacers are available; these can be convenient for when people need to use a pMDI when they are away from their home.

Dry powder inhalers

Aside from inadequate inspiratory flow, common errors with DPIs include incorrect dose preparation, failure to exhale before placing the mouthpiece in the mouth, and incorrect positioning of the inhaler in the mouth.[23]

Soft mist inhalers

Common errors with Respimat SMIs are not holding the device upright and turning the base until it clicks, and not taking a slow, steady and deep inhalation during actuation (pressing the dose-release button).[31]

Follow-up and monitoring of inhaler technique

Follow-up over time is essential to maintain correct inhaler technique. Research has shown that it is necessary to repeat instructions several times to achieve effective inhalation skills in patients with asthma and COPD. Technique can decline in as little as 1 to 2 months after mastering correct technique.[24]

Multidisciplinary care

With an increasing array of inhaler devices to choose from, a multidisciplinary approach is recommended. Pharmacists, asthma nurse specialists and asthma educators play an increasingly important role in assisting prescribers and patients to select the right inhaler, providing inhaler device training, and assessing inhaler technique and adherence.[32]

Inhaler disposal

Most inhalers in Australia are discarded to landfill, where greenhouse gas propellants from pMDIs continue to leak into the atmosphere. High-temperature incineration of pMDIs in medical waste degrades the propellant into by-products with lower global warming potential.[33] Patients should be encouraged to take empty and unwanted inhalers to their community pharmacy for safe and responsible disposal.

Conclusion

Selecting an inhaler device that a patient can and will use effectively is critical to achieving optimal clinical control of asthma and COPD, and reducing environmental impact. Selecting the best device requires an understanding of the differences between inhaler devices, and the factors that determine whether an inhaler is suitable for a particular patient. Inhaler device technique should be reviewed and optimised at every opportunity. A multidisciplinary approach can help to ensure optimal outcomes.

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