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Achieving asthma control: the key role of inhalers

Educational aims

- ▶ To review the main types of hand-held inhaler available, together with current understanding about the correct inhalation techniques for each device.
- ▶ To discuss problems that can lead to poor inhaler techniques, which in turn could contribute to poor asthma control.
- ▶ To present recommendations of the Aerosol Drug Management Improvement Team (ADMIT) for inhaler selection, as well as an algorithm for asthma therapy adjustment.

Summary

Asthma remains a poorly controlled disease, despite the availability of management guidelines and effective medications. The incorrect use of inhalers contributes to a lack of asthma control. The pressurised metered-dose inhaler (pMDI) is still the most frequently used device worldwide, but many patients fail to use it correctly, even after repeated tuition. Dry powder inhalers (DPIs) are easier to use than pMDIs, as they are breath-actuated. The rationale behind inhaler choice should be evidence based, rather than empirical. Regular checking of inhalation technique is crucial, as correct inhalation is one of the cornerstones of successful asthma management.

▶ Asthma is a chronic airways disease characterised by reversible airway obstruction, allergic inflammation and airway hyperresponsiveness [1]. The symptoms of the disease are well characterised and include recurrent episodes of wheezing, breathlessness, chest tightness and coughing, particularly at night or in the early morning, all of which significantly impair patients' quality of life [1]. Worryingly, the incidence of asthma continues to rise worldwide, having doubled in the past 10 years [2, 3]. The prevalence of the condition has also increased, and it now affects 5–10% of the world's population (some 300 million people). Indeed, this figure may actually be an underestimate because of a tendency to underdiagnose asthma [3]. Asthma places a huge economic burden on healthcare resources, both in terms of direct costs (e.g. medication

and hospital costs), and indirect costs (e.g. lost productivity, absenteeism and premature deaths) that are more difficult to quantify.

Asthma management guidelines are now widely available in virtually every country. Their aim is to increase awareness of asthma, identify the reasons for its rising prevalence, reduce asthma morbidity and mortality, improve the availability and accessibility of effective asthma therapy and improve asthma management. The principles of modern asthma therapy, and the overall goal of every asthma management programme, are to achieve control of the disease with the lowest possible dose of medication prescribed [1]. According to the Global Initiative for Asthma (GINA) guidelines [1], asthma control is defined as minimal symptoms, minimal or infrequent asthma exacerbations, no emergency hospital visits, minimal

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Table 1 Treatment goals of the GINA recommendations and the AIRE results

GINA treatment goals	AIRE findings	Patients %
Minimal (ideally no) symptoms	Daytime symptoms	50
	Night-time symptoms	31
Minimal (infrequent) episodes of asthma	Reported episodes of asthma	57
	Emergency visits	11
No emergency visits	Use of as-needed β_2 -agonists	64
Minimal (ideally no) use of as-needed β_2 -agonists		
Normal professional life	Missed work	17
No limitations on activities	Limited sports	47

Modified from [2].

(ideally no) use of as-needed β_2 -agonists, no limitation to daily activities, a normal or near-normal peak expiratory flow (PEF) with <20% circadian variation, and few (or no) adverse events from medications. When asthma is controlled, patients can prevent most exacerbations, avoid day- and nighttime symptoms and remain physically active. Because of the variation in asthma severity among patients, and within each patient over time, the GINA guidelines advocate a stepwise approach to pharmacological treatment [1]. The selection of pharmacological treatment options is made on the basis of asthma severity, the patient's current treatment, pharmacological properties and the availability of asthma medications, as well as economic considerations [1]. The stepwise approach to therapy recommends that the numbers and frequency of medication increases ("step up") as asthma worsens, and decreases ("step down") when asthma is under control. Once control of asthma has been achieved and maintained for ≥ 3 months, a gradual reduction of the maintenance therapy is recommended to identify the minimum therapy required to maintain control [1].

Unfortunately, the current level of asthma control in both Europe and the USA falls far short of the goals for long-term asthma management [2], with many patients reporting day- and night-time symptoms at least once a week, and continuing to require unscheduled urgent care visits, emergency room visits and overnight hospitalisations due to asthma (table 1). The reasons for this poor control include factors such as poor compliance with the prescribed asthma therapy and failure to implement the available guidelines appropriately, as well as inherent limitations of the guidelines themselves. The Asthma Insights and Reality in Europe (AIRE) study [2] provides some evidence for this suggestion, showing that fewer than one-third of patients were taking

inhaled corticosteroids in accordance with asthma management guidelines, even those patients with severe persistent asthma.

Another reason asthma remains poorly controlled is that patients are deriving incomplete benefit from their inhaled medication, primarily because they are unable to use their inhalers correctly. The inhaled route of administration is widely accepted as being the optimal way of giving drugs, such as bronchodilators and corticosteroids, for the treatment of patients with obstructive airway diseases [4]. Compared with systemic administration, the inhalation route offers a faster onset of action and high *in situ* drug concentrations. This results in a lower required drug dose and, consequently, lower rates of side-effects [4]. There is a wide array of inhaler devices currently available on the market, classified as pMDIs, breath-actuated metered-dose inhalers (BA-MDIs), DPIs, soft mist inhalers (SMIs) and nebulised or "wet" aerosols (figure 1). Each class of inhaler device has advantages as well as disadvantages (table 2). It is now recognised that inhalers differ in their efficiency of drug delivery to the lower respiratory tract, depending on the form of the device, its internal resistance, the formulation of medication, particle size, velocity of the aerosol cloud or plume, and the ease with which patients can use the device [5]. Efficiency of drug delivery may also be influenced by patient preference, which in turn affects adherence to treatment and, indeed, long-term control of the disease [6]. There seems little point in prescribing an effective medication in an inhaler device that patients cannot use correctly. Thus, the choice of the right inhaler for the patient is just as important as choosing the most effective medication.

This article will briefly review the main types of prescribable hand-held inhalers (*i.e.* pMDI, DPI, BA-MDI and SMI), together with current understanding about the correct inhalation techniques for each device. Although nebulisers are frequently used to deliver asthma medications, most current designs are bulky and inconvenient, and treatment administration is prolonged. Therefore, they are better categorised as second-line devices for most patients. As they are not true competitors with hand-held inhalers for outpatients, they have not been considered in this article. We will also assess the problems that can lead to poor inhaler technique, which could contribute to poor asthma control. Finally, we present the recommendations of ADMIT for inhaler selection, as well as an algorithm for asthma therapy adjustment.

Key points

- Asthma affects 300 million people worldwide and its prevalence continues to rise.
- Asthma remains poorly controlled despite the availability of effective therapeutic agents.
- Inhalation is the preferred route of drug administration.
- Inhalers differ in their efficiency of drug delivery.
- Inhaler choice is just as important as drug choice.

pMDIs

pMDIs are the most widely prescribed inhaler devices as they are cheap and include a uniform technology that can deliver a variety of asthma medications. Despite numerous advantages, most patients cannot use pMDIs correctly, even after repeated tuition [7–9]. This is because pMDIs require good coordination of patient inspiration and inhaler actuation to ensure correct inhalation and deposition of the drug in the lungs [7–9]. The correct inhalation technique when using pMDIs involves firing the pMDI while breathing in deeply and slowly, continuing to inhale after firing, and then following inhalation with a breath-holding pause to allow particles to sediment on the airways [10]. However, patients frequently fail to inhale continuously, to inhale slowly after activation of the inhaler and to exhale fully before inhalation [7–9]. In addition, patients often activate the inhaler before inhalation or at the end of inhalation by initiating inhaler actuation while breath-holding [7–9]. A series of studies performed by CROMPTON and co-workers [6, 11, 12] confirmed these findings, and showed that the proportion of patients capable of using their pMDI correctly after reading the package insert fell from 46% in 1982 to 21% in 2000, while only just over half of patients (52%) used a pMDI correctly even after receiving instruction (table 3). In a large study ($n=4,078$), 71% of patients were found to have difficulty using pMDIs, and almost half of this group had poor coordination [13]. Incorrect inhalation technique was associated with poor asthma control, with poor pMDI users having less stable asthma control than good pMDI users [13]. It is worth noting that the incorrect usage of pMDIs is not confined to patients: it has been demonstrated that both nurses and physicians also use pMDIs incorrectly [7].

**Figure 1**

The types of inhaler available. a) pMDI (with spacer); b) BA-MDI; c) DPI (Diskus/Accuhaler); d) SMI (Respimat); e) nebuliser. BA-MDI © Igor Terekhov/istockphoto.

Even with correct inhalation technique, pMDIs are inefficient since no more than 20% of the emitted dose reaches the lungs, with a high proportion of drug being deposited in the mouth and oropharynx. This can cause local, as well as systemic, side-effects due to rapid absorption [4]. pMDIs require priming if they have not been used for a lengthy period of time, and they have no inhalation control mechanism. In addition, pMDIs contain propellant gases that may cause cough, throat irritation, paradoxical bronchoconstriction and the so-called "cold Freon effect", *i.e.* stopping the patient inhaling or prompting inhalation *via* the nose when the cold blast of propellant strikes the back of the throat [4].

pMDI accessory devices: the spacers

Spacer devices are attachments to the pMDI mouthpiece with volumes ranging 50–750 mL. Many (holding chambers) have a one-way valve, which prevents the patient blowing

Table 2 Advantages and disadvantages of different inhaler devices

Device	Advantages	Disadvantages
pMDI	<ul style="list-style-type: none"> • Portable and compact • Multi-dose device • Quick to use • Relatively cheap • Cannot contaminate contents • Available for most inhaled medications 	<ul style="list-style-type: none"> • Contains propellants • Not breath actuated • Many patients cannot use it correctly (e.g. coordination difficulties) • Cold Freon effect • High oropharyngeal deposition
pMDI+spacer	<ul style="list-style-type: none"> • Easier to coordinate inhaler actuation with inspiration than pMDI alone • Large drug doses delivered more conveniently than pMDI alone • Less oropharyngeal deposition • Higher lung deposition than a pMDI 	<ul style="list-style-type: none"> • Bulkier and less portable than pMDI alone • Plastic spacers may acquire static charge
BA-MDI	<ul style="list-style-type: none"> • Portable and compact • Multi-dose device • Quick to use • Breath-actuated (no coordination needed) • Cannot contaminate contents 	<ul style="list-style-type: none"> • Additional cost to pMDIs • Contains propellants • "Cold Freon" effect • Require moderate inspiratory flow to be triggered • More bulky and noisy than pMDI
DPI	<ul style="list-style-type: none"> • Portable and compact • Quick to use • Breath actuated (no coordination needed) • Usually higher lung deposition than a pMDI • Does not contain propellants 	<ul style="list-style-type: none"> • Require high inspiratory flow to be triggered • May not be appropriate for emergency situations • Many patients cannot use them correctly (e.g. capsule handling problems for elderly) • Most types are moisture sensitive
SMI (Respimat)	<ul style="list-style-type: none"> • Portable and compact • Multi-dose device • Probably easier to use correctly than pMDI • High lung deposition • Does not contain propellants 	<ul style="list-style-type: none"> • Not breath actuated • Not currently available in most countries • Relatively expensive

the dose away after firing. Spacers constitute a volume into which the patient actuates the pMDI and from which the patient inhales, without necessarily having to coordinate the two manoeuvres [14]. By acting as an aerosol reservoir, these devices slow the aerosol velocity and increase transit time and distance between the pMDI actuator and the patient's mouth, allowing particle size to decrease, and, consequently, increasing deposition of the aerosol particles in the lungs [14]. Moreover, because spacers trap large particles comprising up to 80% of the aerosol dose, only a small fraction of the dose is deposited in the oropharynx, thereby reducing side-effects, such as throat irritation, dysphonia and oral candidiasis, associated with inhaled medications delivered by the pMDI alone [14]. Spacers may improve the clinical effect of inhaled medications, particularly in patients unable to use a pMDI properly [15]. Indeed, compared with both pMDIs alone

and DPIs, spacers may increase the response to short-acting β -adrenergic bronchodilators, even in patients with correct inhalation technique [16–19]. While spacers are good drug delivery devices, they suffer from the obvious disadvantage of making the entire delivery system less portable and compact than a pMDI alone. The size and appearance of some spacers may detract from the appeal of the pMDI to patients, especially among the young, and negatively affect patients' compliance [14]. Furthermore, spacers are not immune from inconsistent medication delivery caused by electrostatic charge of the aerosol [14]. The proportion of the drug dose that the patient inhales may vary greatly with different spacers. Data about a spacer derived from studies with one drug-pMDI combination may not apply to other drugs. Changing from one spacer to another may be unimportant with some drugs but critical for others.

Key points

- The vast majority of patients are unable to use pMDIs correctly even after instruction.
- pMDIs are difficult to use correctly since they require coordination of actuation and inhalation.
- pMDIs are inefficient in drug delivery.
- With pMDIs, drug deposition depends on technique.
- pMDIs contain propellants that may cause cough, throat irritation, paradoxical bronchoconstriction and the "cold-Freon effect".
- Spacers may compensate for many problems associated with pMDI use, such as oropharyngeal deposition.
- Spacers increase drug deposition to the lungs and improve clinical response, especially in patients unable to operate a pMDI correctly.
- Spacers are bulky and inconvenient, especially when they need to be carried, which may reduce treatment compliance.

DPIs

Modern powder inhalers were first introduced in 1970. The earliest models were single-dose devices containing the powder formulation in a gelatine capsule, which the patient loaded into the device prior to use. Since the late 1980s, multi-dose DPIs have been available, giving the same degree of convenience as a pMDI. Several prescribable DPIs are available and, generally, they have many advantages over pMDIs. DPIs are actuated and driven by the patient's inspiratory flow; consequently, DPIs do not require propellants to generate the aerosol, or coordination of inhaler actuation with inhalation [20]. However, a forceful and deep inhalation through the DPI is needed to de-aggregate the powder formulation into small respirable particles as efficiently as possible and, consequently, to ensure that the drug is delivered to the lungs [20]. Although most patients are capable of generating enough flow to operate a DPI efficiently [21], the need to inhale forcefully and generate a sufficient inspiratory flow could be a problem for very young children or patients with severe airflow limitation. For this reason, DPIs are not recommended for children aged <5 years [1].

Although DPIs, as a class of inhalation device, offer both patients and physicians advantages over pMDIs, they do have some limitations of design, cost-effectiveness and user-friendliness. For instance, some DPIs (namely single-dose

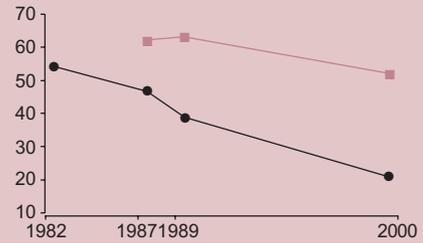
devices, such as the Handihaler (Boehringer Ingelheim, Ingelheim, Germany) and the Aerolizer (Novartis, Basel, Switzerland)) require that single doses are loaded individually into the inhaler immediately before use. This is inconvenient for patients and does not allow direct dose counting. In addition, the inhalation manoeuvre has to be repeated until the capsule is empty, which may give rise to under-dosing and to high dose variability. Other DPIs are multiple-unit dose devices (*e.g.* the Diskhaler (GlaxoSmithKline, Brentford, UK) or multi-dose devices, such as the Diskus (also called Accuhaler; GlaxoSmithKline) and the Turbuhaler (AstraZeneca, Södertälje, Sweden). These devices do not have any triggering mechanism, which makes optimal drug delivery dependent entirely on an individual patient's uncontrolled inspiratory manoeuvre.

Although DPIs are considered easier to use than pMDIs, a recent systematic literature review revealed that up to 90% of patients did not use their DPI correctly [22]. In particular, common errors made by patients were lack of exhalation before inhalation, incorrect positioning and loading of the inhaler, failure to inhale forcefully and deeply through the device and failure to breath-hold after inhalation [22]. Furthermore, unless clearly instructed, some patients did not know that they must seal their lips firmly around the mouthpiece, causing them to attempt an "open mouth" inhalation technique that will not deliver any dose [22]. All these errors may lead to insufficient drug delivery, which adversely influences drug efficacy and may contribute to inadequate disease control [22]. It is unsurprising that such a high proportion of patients was unable to use DPIs correctly, as the devices have many inherent design limitations. The Diskhaler, for instance, is a multiple unit dose device as it contains a series of foil blisters on a disc. It is complicated to use, requiring eight steps to effect one correct inhalation; it has been shown that ~70% of patients are unable to use it correctly [22]. The discs have to be changed frequently and the device must be cleaned before refilling. In addition, it provides no feedback to the patient of a successful inhalation, except a sweet taste in the mouth which may simply be indicative of oral drug deposition. The Turbuhaler, a multi-dose reservoir device, is the most frequently prescribed DPI as it produces good deposition of the drug in the lungs, provided that a sufficient (≥ 60 L per min) inspiratory flow has been achieved by the patient. However, ~80% of patients are unable to use it correctly [22]; common mistakes made by patients using this inhaler are failure to turn the base fully in

Table 3 Percentage of patients using a pMDI correctly after reading the package insert and after receiving physician instruction

Year	Pamphlet instruction	Physician instruction
1982	54%	
1987	47%	62%
1989	39%	63%
2000	21%	52%

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both directions and failure to keep the device upright until loaded. In addition, due to its high intrinsic resistance, patients who have a reduced inspiratory flow may encounter problems using this device. The Diskus/Accuhaler is another example of a multi-dose device that uses a foil strip of drug-containing blisters. As many as 50% of patients use this DPI incorrectly, and common errors include failure or difficulty in loading the device before inhalation, and exhaling into the device [22]. The Diskus has a low intrinsic resistance but, like the Turbuhaler, does not have any triggering mechanism, which makes optimal drug delivery entirely dependent on an individual patient's uncontrolled inspiratory manoeuvre [22]. Additionally, as with other DPI devices employing drug blisters, incomplete emptying of the metered dose may occur, which could reduce the amount of drug delivered to the lung and hence reduce clinical efficacy [22].

Key points

- DPIs have many advantages over pMDIs:
 - no need to coordinate activation with inspiration
 - more efficient drug delivery to the lungs
 - environmentally friendly
- The majority of patients use DPIs incorrectly, since many DPIs have inherent limitations.
- Failure to exhale before inhalation is the most common error associated with DPI use.
- Other errors associated with DPI use are device specific, but they include most commonly incorrect dose metering and failure to breath-hold.

BA-MDIs

BA-MDI are an alternative to standard pMDIs for patients unable to use the latter devices adequately. Breath-actuated MDIs contain a conventional pressurised canister, and have a flow-

triggered system driven by a spring, which releases the dose during inhalation, so that firing and inhaling are automatically coordinated. These inhalation devices can achieve good lung deposition and clinical efficacy in patients unable to use a pMDI correctly because of coordination difficulties [23]. Errors when using BA-MDI are less frequent than when using standard pMDIs [6, 24]. However, BA-MDI do not solve the cold Freon effect, and would be unsuitable for a patient who has this kind of difficulty using a pMDI. In addition, these devices require a relatively higher inspiratory flow for triggering than pMDIs.

SMIs

The development of SMIs has opened up new opportunities for inhaled drug delivery. These inhalation devices use liquid formulations similar to those in nebulisers, but are generally multi-dose devices that have the potential to compete with pMDIs and DPIs in the portable inhaler market. The only SMI currently marketed in some European countries is the Respimat device (Boehringer Ingelheim). This device does not require propellants since it is powered by a compressed spring inside the inhaler. Individual doses are delivered *via* a precisely engineered nozzle system as a slow-moving aerosol cloud (hence the term "soft mist") [25]. Scintigraphical studies have shown that lung deposition is higher than that from a CFC-based pMDI [25]. Although the Respimat has been used relatively little in clinical practice to date, clinical trials seem to confirm that drugs delivered by the Respimat are effective in correspondingly smaller doses in patients with obstructive airway disease [26]. Respimat is a "press and breathe" device, and the correct inhalation technique closely resembles that used with a pMDI. However, although coordination between firing and inhaling is required, the low spray velocity and long duration of the aerosol

cloud (typically 1-1.5 s) could enable patients to coordinate firing and inhaling more easily than with a pMDI [25].

Choice of an inhaler device for asthma therapy

More than 100 inhaler-drug combinations are available for the treatment of asthmatic patients. The number is likely to increase as more CFC-free pMDIs become available, and companies develop devices for generic drugs. This choice increases the level of confusion experienced by clinicians, nurses and pharmacists when trying to choose the most appropriate device for each patient. Thus, physicians' experience is among the most important factors that influence inhaler choice in asthma therapy. In fact, inhalers are often prescribed empirically rather than using an evidence-based approach. Following their own experience, doctors are much more likely to prescribe the same old inhaler they have always prescribed rather than new, improved inhalers entering the market. Current asthma management guidelines give some guidance on the class of inhaler to prescribe to children, but they offer non-specific advice regarding inhaler choice for adult patients. The GINA guidelines recommend pMDIs with spacer and facemask for children aged <4 years (or pMDIs with spacer and mouthpiece for those aged 4-6 years) and, in addition to pMDIs alone, DPIs or BA-MDIs for children aged >6 years [1]. However, for adults, the same guidelines state that inhalers should be portable and simple to use, should not require an external power source, should require minimal cooperation and coordination and should have minimal maintenance requirements [1]. The British Thoracic Society [27] guidelines also include patient's preference and ability to use the device



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correctly. However, the advice relating to patient preference is not supported by any evidence that patients will correctly use an inhaler that they like. For instance, although many patients like the apparently easy-to-use pMDIs, the latter is the most difficult of all current inhaler devices to use effectively and, therefore, is used suboptimally by the vast majority of patients [9].

The criteria to be considered when choosing an inhaler device differ depending on the audience addressed [28]. From the viewpoint of the inhalation technologist, consistent and safe dosing, sufficient drug deposition and clinical effect guide inhaler choice. The patient's ability to inhale through the device, the intrinsic airflow resistance of the device and the degree of dependence of drug release on inspiratory airflow variability are all important determinants when considering constancy of dosing [28]. From the viewpoint of the clinician, clinical efficacy and safety should be the most important determinants to consider when choosing an inhaler [28]. However, in the real world, clinical efficacy must be balanced against cost-effectiveness, and inhalers with insufficient performance may be prescribed simply because they are cheap. The patient's preferences and acceptance of the inhaler should also be considered when deciding on a specific inhaler, since these will have major implications for compliance.

Several general principles of inhaler selection

Table 4 Suitability of inhaler devices according to the patient's inspiratory flow rate and ability to coordinate inhaler actuation and inhalation

Inhalers	Good hand-lung coordination		Poor hand-lung coordination	
	Inspiratory flow >30 L per min	Inspiratory flow <30 L per min	Inspiratory flow >30 L per min	Inspiratory flow <30 L per min
	pMDI	pMDI	pMDI+spacer	pMDI+spacer
	BA-MDI		BA-MDI	
	DPI		DPI	
	Nebuliser	Nebuliser	Nebuliser	Nebuliser
	SMI	SMI	SMI	SMI

Modified from [30].

and use have recently been reviewed in detail by a joint committee of the American College of Chest Physicians and the American College of Asthma, Allergy and Immunology [29]. In brief, pMDIs are convenient for delivering a wide variety of drugs to a broad spectrum of patients. For patients who have trouble coordinating inhalation with inhaler actuation, the use of a spacer may obviate this difficulty, though most of these devices are cumbersome to store and transport [29]. The use of a spacer, however, is mandatory for infants and young children. DPIs are usually easier for patients to handle than pMDIs and a growing number of drug types are available in several DPI formats [29]. The key issue for dry powder inhalation is adequate inspiratory flow rate. The most ill patients and the very young may not be candidates for a DPI. While not included in this review, a nebuliser could be used as an adequate alternative to a pMDI with a spacer by almost any patient in a variety of clinical settings from the home to the intensive care unit. However, nebulisers are more expensive, cumbersome, and relatively time-consuming to use compared with hand-held inhalers. These attributes should limit the use of nebulisers, whose effect can be matched by hand-held devices in almost all clinical settings.

Recently, CHAPMAN *et al.* [30] proposed an algorithmic approach to inhaler selection that considers the patient's ability to generate an inspiratory flow rate >30 L per min, to coordinate inhaler actuation and inspiration, and to prepare and actuate the device (table 4).

When choosing an inhaler for a child, it is essential that the individual child receives appropriate instructions and training necessary for the management of the disease [31]. Furthermore, the child should be prescribed the correct medication tailored to the severity of the disease and, most importantly, the prescribed inhaler should suit the individual needs and preference of the child [31]. Contrary to general opinion, using an inhaler may be difficult for children [31]; many children with asthma use their inhaler incorrectly, which may result in unreliable drug delivery, even after instruction and training for correct inhalation. In addition, previous inhalation instructions may be forgotten and, therefore, training should be repeated regularly to maintain correct inhalation technique [31].

Key points

- Inhaler choice should be evidence-based rather than empirical.
- Treatment guidelines provide little information on specific inhaler choice or correct inhalation technique.
- Choose an inhaler that:
 - is easy to use
 - requires minimal cooperation and coordination
 - has minimal maintenance requirements
 - patients can use correctly
 - patients prefer
- Constant training and monitoring of inhaler technique is essential to achieve and maintain correct technique.

Recommendations from ADMIT for inhaler choice and correct inhalation technique

- > Inhalers should be matched to the patient as much as possible.
- > If pMDIs are prescribed to young children, they should be used with a spacer device.
- > An alternative to a pMDI should be considered in elderly patients with a mini mental test score <23/30 or an ideomotor dyspraxia score <14/20, as they are unlikely to have correct inhalation technique through a pMDI.
- > The patient's peak inspiratory flow values should be considered before DPI prescription. Patients with severe air flow obstruction, children and the elderly would benefit from an inhaler device with a low airflow resistance.
- > Before prescribing a DPI, check that the patient can inhale deeply and forcibly at the start of the inhalation manoeuvre, as airflow profile affects particle size produced and hence drug deposition and efficacy.
- > Where possible, each patient should have a single type of inhaler.
- > Establish an official board to compile instructions for correct inhalation technique for each inhaler device currently on the market.
- > Instructions for correct inhaler use should be made readily accessible on a dedicated website.
- > Training in correct inhalation technique is essential for patients and healthcare professionals.
- > Inhalation technique should be checked and reinforced at regular intervals.
- > Teaching correct inhalation techniques should be tailored to the patient's needs and preferences: group instruction in correct inhalation technique appears to be more effective than personal one-to-one instruction and equally effective to video instruction; younger patients may benefit more from multimedia teaching methods; elderly patients respond well to one-to-one tuition.

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Table 5 Level of asthma control

Characteristic	Controlled	Partly controlled (any present in any week)	Uncontrolled
Daytime symptoms	None (≤ 2 per week)	≥ 2 per week	3 or more features of partly controlled asthma present in any week
Limitations of activities	None	Any	
Nocturnal symptoms, awakening	None	Any	
Need for rescue treatment	None (≤ 2 per week)	≥ 2 per week	
Lung function (PEF or FEV ₁)	Normal	$< 80\%$ predicted/personal best (if known) on any day	
Exacerbation	None	≥ 1 per year	1 in any week

FEV₁: forced expiratory volume in one second. Reproduced from [9], with permission from the publisher.

ADMIT recommendations and protocol

Many physicians in Europe are fully aware of the difficulties that patients have using prescribed inhaler devices correctly and the negative impact that this may have on asthma control. ADMIT, a consortium of European respiratory physicians with a common interest in promoting excellent delivery of inhaled drugs, was formed with the remit of examining ways to improve the treatment of asthma and chronic obstructive pulmonary disease in Europe.

ADMIT recommends that instructions for correct inhalation technique for each inhaler device currently on the market should be compiled by an official board, with instructions made readily accessible on the internet. Local asthma associations and patient groups could also be involved in promoting the importance of, and teaching and reinforcing, correct inhalation technique. Information could be disseminated using dedicated literature, through school visits by healthcare professionals and *via* pharmacists and patient advocacy groups. Other evidence-based recommendations are summarised in the box opposite.

ADMIT has also proposed a practical algorithm (figure 2) in order to improve the instruction given to patients regarding optimal inhalers use. At each consultation, the physician should establish the patient's level of symptoms and control, ideally using a composite measure such as the GINA control assessment (table 5); if the condition has been well controlled for ≥ 3 months, therapy should be stepped down gradually according to treatment guidelines. Conversely, if the patient answers "no" to any of these checklist questions, compliance and aggravating (trigger)

factors should be assessed. Most importantly, inhalation technique should be assessed. If the patient is unable to use a particular inhaler correctly despite repeated attempts, a change in inhaler device should be considered. In cases where ongoing uncontrolled asthma persists in the face of correct inhaler technique, asthma therapy should be stepped up according to treatment guidelines and another appointment scheduled in order to check symptoms.

Conclusions

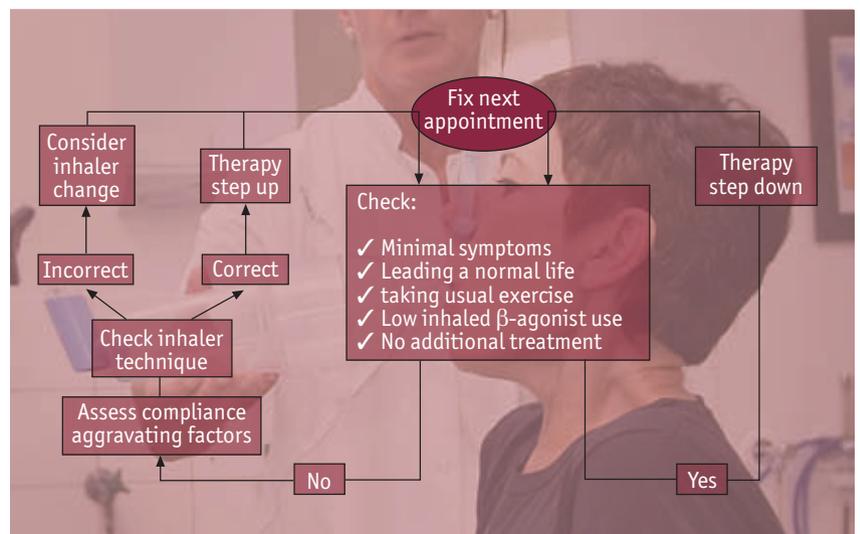
The prevalence of asthma is continuing to rise throughout the world, particularly among children. Despite the implementation of both national and international guidelines and the widespread availability of effective pharmacological therapy, asthma is frequently uncontrolled, and may still cause death. The reasons for this anomaly are numerous. First, the guidelines themselves are complex and too long for most physicians to absorb and utilise. Secondly, patients frequently do not adhere to their

Educational questions

Are the following statements true or false?

1. The majority of patients can use their inhaler(s) correctly.
2. Incorrect inhaler technique results in reduced therapeutic efficacy and poor control of symptoms.
3. pMDIs are easy to use.
4. The major problem with pMDIs is that patients need to coordinate inhaler actuation with their inspiration.
5. Most patients can use DPIs correctly.
6. High inhaler intrinsic resistance is preferred as this makes it easy for patients to achieve the necessary inspiratory flow through the device.
7. Relative independence of drug fine particle fraction and patient inspiratory flow rate is a desirable inhaler characteristic.
8. Inhaler choice is just as important as drug choice.

Figure 2 Asthma therapy adjustment flow chart. Reproduced from [9], with permission from the publisher.



Useful weblink

www.admit-online.info
The ADMIT Webpage is a European source of information about the different inhalation systems, inhalation training advice for asthma, and recent literature on this topic. The ADMIT reviews published evidence to examine ways to improve the treatment of obstructive pulmonary diseases in Europe.

treatment regimen for a variety of reasons, including incorrect inhaler use and underestimation of disease severity. Indeed, asthma severity is often misclassified in the first instance, and inappropriate or insufficient therapy is prescribed. Finally, although guidelines agree on the most appropriate therapy to control asthma, detailed descriptions of the method by which this therapy should be delivered to the lungs are often lacking.

To date, advances in asthma management have been pharmacologically driven, rather than device driven. Since it is likely that in the future inhaled bronchodilators and corticosteroids will remain the cornerstone of asthma therapy, the development of inhaler devices may become more important than the development of new drugs. Problems with drug delivery have been identified due to the inappropriate use of inhaler devices, particularly pMDIs where patients need to coordinate inhaler activation with inspiration. However, as inhalation is likely to remain the delivery route of choice for the foreseeable future, there is a need to develop inhaler devices that are easy to use and deliver a consistent dose of drug to the lungs. This may improve patient compliance with treatment, leading to better control of asthma.

Continued and repeated education of both healthcare professionals and patients in correct inhalation technique is essential, and the results

should be checked at regular intervals by a member of medical staff. Substantial changes in educational efforts are clearly required and should be particularly addressed towards general practitioners and asthma nurses who in turn teach patients how to use their inhaler correctly. Finally, it is important to remember that continually changing inhaler devices which deliver the same drug is not the answer, as patients lose confidence in both the device and the drug, and compliance with therapy drops. An inhaler should only be prescribed with the absolute certainty that the patient can use it correctly.

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The ERS School will be organising a course on **Medical aerosols**, to be held in Amsterdam, the Netherlands, on November 12–14, 2009. Details will be available soon at www.ersnet.org/schoolcourses

Further reading

Sestini P, Cappiello V, Aliani M, et al. Prescription bias and factors associated with improper use of inhalers. *J Aerosol Med* 2006; 19: 127–136.

Sestini and colleagues collected data on inhalation technique and factors associated with misuse from 1,126 patients and showed that inhaler misuse was common for both pMDIs and DPIs. Prescription of newer DPIs may be subject to sex, socio-economic and instruction bias.

Molimard M, Le Gros V. Impact of patient-related factors on asthma control. *J Asthma* 2008; 45: 109–113.

This study assessed the impact of patient baseline characteristics, compliance and inhaler device manipulation on Asthma Control Score. Results showed that smoking, poor compliance and critical errors in device manipulation had a significant negative impact on asthma control. This could be addressed by patient education.

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Suggested answers

1. False.
2. True.
3. False.
4. True.
5. False.
6. False.
7. True.
8. True.