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ASSESSMENT OF INHALER TECHNIQUE AMONG PATIENTS WITH ASTHMA AND COPD

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Abstract

Inhaled drugs only work when the dose reaches the lungs, and that depends on how the device is handled. This narrative review draws on published reviews, observational studies and trials to describe how inhaler technique has been assessed in people with asthma and chronic obstructive pulmonary disease (COPD). It covers common errors with pressurised metered-dose and dry powder devices, the checklists and flow measurements used to score technique, links between critical errors and poor outcomes, patient and device factors, and teaching methods. Errors are frequent, have changed little over decades and are tied to worse control, yet teaching with feedback works. The evidence is limited by inconsistent scoring methods. The review reports no new data.

1. INTRODUCTION

Inhaled therapy is the backbone of treatment for both asthma and chronic obstructive pulmonary disease (COPD). The drug goes straight to the airways, so doses are small, onset is quick and systemic exposure is limited [1, 2]. That advantage is only realised if the dose actually reaches the lungs. A bronchodilator that lands on the back of the throat or escapes into the room treats nothing, however carefully the molecule was designed. For this reason the way a patient handles the device is as much a part of the prescription as the drug name and strength, and pharmacists, nurses and doctors are all expected to check it [3, 4]. In practice that check is often skipped, or reduced to a quick glance.

The scale of the problem has been described for more than forty years. Pedersen and colleagues reported frequent errors in children

with asthma in the 1980s [5], and a systematic review covering studies published between 1975 and 2014 found that a large share of patients still made at least one error, with no clear improvement over time [6]. Newer devices were meant to be easier to use, yet the review suggests that the introduction of new designs did not by itself change the pattern. Education, not engineering alone, seems to be the missing piece. Technique is also not a fixed skill. Patients who handle a device well after teaching can slip within weeks if nobody reinforces the steps [7, 8]. Part of the difficulty is practical: checking technique takes about a minute, yet it rarely features in consultations that are already pressed for time.

This review looks at what the published literature says about assessing inhaler technique among people with asthma and COPD. It describes the devices and the errors they provoke, then the tools used to score technique, the consequences of poor handling, the patient and device factors that predict it, and the interventions that have been tested. A synthesis of reported findings is given in table 1. No patients were recruited and no new measurements were made for this article. Where numbers are mentioned they come from the cited sources, and where the evidence is thin the text says so rather than filling the gap with estimates.

Table 1: Reported inhaler errors, assessment methods and teaching approaches in asthma and COPD

Device or approach	Main finding reported in the literature	Ref.
Pressurised MDI poor coordination	Pressing before or after the start of inhalation is the commonest error; breath-hold is often omitted.	[9, 10]
Pressurised MDI corticosteroid	Misuse of a corticosteroid canister was associated with less stable asthma.	[11]
Dry powder inhaler flow	Some patients with COPD cannot produce the flow needed; training helped many of them.	[3, 12]
Dry powder inhaler handling	Exhaling into the mouthpiece and incorrect dose loading are frequent mistakes.	[9, 13]
Spacer or chamber	Reduces coordination demands and throat deposition; at least as good as a nebuliser in acute asthma.	[14, 15]
Checklist scoring	Cheap and practical, but results vary with the number of steps included.	[6, 16]
Critical error approach	Errors that block drug delivery were linked to poorer control and more healthcare use.	[17, 18]
Electronic monitoring	Revealed gaps between reported and actual use; feedback improved control in severe asthma.	[19, 20]
Pharmacist teaching	A brief checklist-based intervention improved technique and asthma control.	[21, 22]
Teach-to-goal	Repeated demonstration with feedback improved technique in hospitalised patients.	[23, 24]

2. DEVICES AND COMMON ERRORS

Three broad families of hand-held device are in everyday use. Pressurised metered-dose inhalers (pMDIs) release a measured puff of drug suspended or dissolved in a propellant, and the plume leaves the canister at speed [10]. Dry powder inhalers (DPIs) hold the drug as a fine powder, in capsules, blisters or a reservoir, and rely on the patient's own inspiratory effort to disperse it [3]. Soft mist inhalers produce a slow-moving aerosol from a solution, which reduces the need for a forceful breath. Nebulisers are a fourth route, used mostly in acute care. Each design asks for a different sequence of actions, and what is right for one device can be wrong for another [4, 25].

With pMDIs the classic problem is coordination. The patient must press the canister while starting a slow, deep breath, and many press too early or too late, or breathe in too fast [9, 10]. Other recurring errors include failing to shake the canister when the formulation is a suspension, not exhaling before the puff, and not holding the breath afterwards. Giraud and Roche found that misuse of a corticosteroid pMDI was

associated with less stable asthma [11], which is a useful reminder that these are not cosmetic lapses. Poor coordination also raises the amount of drug deposited in the mouth and throat, which matters most for inhaled corticosteroids because of hoarseness and oral candidiasis [14].

Dry powder devices shift the difficulty from timing to effort. The patient must generate enough inspiratory flow to break up the powder, and the flow needed depends on the internal resistance of the device [3, 12]. A slow, gentle breath that suits a pMDI is wrong for most DPIs, which need a hard, fast inhalation from the start. Typical mistakes are exhaling into the mouthpiece, failing to prime or load the dose correctly, tilting a device that must stay level, and stopping the breath too soon [9, 13]. Lavorini and colleagues reviewed how such errors reduce lung delivery and clinical effect in both asthma and COPD, and noted that patients with weak inspiratory muscles are especially exposed [9].

The inhalation manoeuvre itself carries several details that have been argued over for years. Levy and the ADMIT group reviewed some of the folklore, such as how long the breath must be held, whether shaking is always needed and how slow a slow breath should be, and separated points backed by data from habits passed down in clinics [26]. For a pMDI, a gentle and steady inhalation lasting a few seconds improves deposition in the lower airways, while for a DPI the aim is a brisk, forceful breath that starts at once [3, 10]. A short pause at the end of inhalation gives particles time to settle on the airway wall. Leaflets often disagree with one another, so staff should stick to the instructions for the specific product [4, 26].

Large surveys confirm that no device is immune. An observational study of several thousand primary care patients found handling errors with every device type that was examined [13], and a later multinational programme of work, the CRITIKAL study, classified errors by their likely effect on drug delivery and linked them to asthma outcomes [17]. The pattern of mistakes differs by device, so a patient who is competent with one inhaler cannot be assumed to cope with another. The main errors reported for each device group, together with the reference supporting each, are laid out in table 1, and their relative frequency by group is shown in fig. 1.

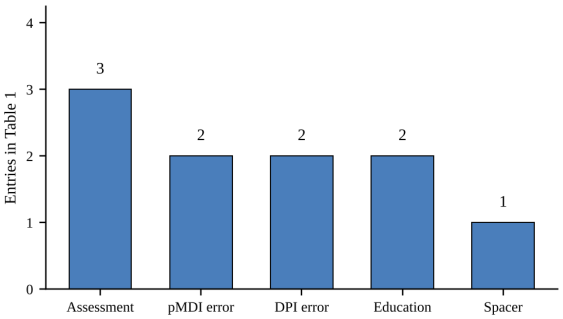


Fig. 1: Number of entries in table 1 by approach

A smaller literature deals with spacers and valved holding chambers. Attaching a chamber to a pMDI removes most of the need to coordinate actuation with inhalation, slows the plume and traps large particles that would otherwise strike the throat [14, 25]. A Cochrane review found that, for acute asthma, a pMDI with a spacer was at least as effective as a nebuliser, with some advantages in children [15]. Spacers bring their own problems, though. Static charge on plastic chambers can reduce the dose available, and patients often fire several puffs into the chamber before inhaling, which also lowers delivery [14]. They are bulky, and some patients simply stop carrying them.

3. ASSESSING TECHNIQUE

Most studies judge technique by watching the patient demonstrate their own device and scoring each step against a checklist. The checklist is usually built from the manufacturer's instructions, and steps are classed as essential or non-essential. This method is cheap and works at the counter or bedside, which is why pharmacists use it [21, 22]. It also has weaknesses. A demonstration given under observation may be better than everyday use, and different studies include different numbers of steps, so a patient can be called competent in one paper and poor in another for the same performance [6, 16]. Comparisons between studies therefore need care.

A brief consultation can still produce a useful check if it follows a fixed order. The patient is

first asked to demonstrate the device as they normally use it, without prompting, so that the real pattern of errors is seen and not the steps the patient has just been reminded of. The observer then ranks what was seen, giving priority to critical errors, and corrects only the one or two that matter most instead of listing every fault [18, 21]. Correction is best combined with a second demonstration by the patient, and the outcome is recorded against the device name so that the next review begins from known problems. Reviews of training describe repeated demonstration with feedback as the feature most often linked to improved technique [7]. Whoever performs the check should know the correct steps for that device first.

A more informative approach separates critical errors, which are expected to prevent a useful dose reaching the lungs, from minor ones. Usmani and colleagues applied this idea in a systematic review and found that critical errors were associated with poorer control and more healthcare use in asthma and COPD [18]. Critical errors tend to differ between devices. For a pMDI they include no actuation during inhalation, and for a DPI they include a failure to load a dose or an inhalation that is far too weak. Classifying steps this way gives clinicians a short list of what must be fixed first, instead of a long list of faults to correct at one visit [17, 18].

Observation can be supplemented with objective measures. In-check style devices and other flow-measuring tools estimate peak inspiratory flow through resistances that mimic common inhalers, so that staff can tell whether a patient can power a particular DPI [12, 27]. Al-Showair and colleagues showed that a proportion of patients with COPD could not produce the flow needed for some devices, and that training improved flow in many but not all of them [12]. Electronic add-on sensors go a step further, recording the time of use and, in some cases, the quality of the inhalation. They moved the field from asking whether a patient could use the device to asking whether they actually did [19, 20].

Assessment is also affected by who does the scoring. Studies of health professionals have repeatedly found that many could not demonstrate the devices they were asked to teach. Interiano and Guntupalli reported this for pMDIs in the early 1990s [28], and Hanania and colleagues extended the finding to spacers and dry powder devices in a mixed group of medical personnel [27]. If the person doing the check does not know the correct steps, the check is meaningless. Reliable assessment therefore depends on trained observers, written criteria for each device and, ideally, a second look at intervals rather than a single review at diagnosis. Training of staff is an intervention in its own right [7, 29].

How often technique should be reviewed is not settled. Studies of single-session teaching show that skills decay, with a fall in correct steps over the following weeks or months, and the pharmacy comparison of two educational formats suggested that repetition helped keep the gains [8, 22]. Reasonable practice, in the absence of firm trial data, is to check at the start of treatment, at the first follow-up, after any exacerbation and whenever the device or the drug is changed. Many services add a check at each annual review. The point is to make assessment a routine part of care rather than an event triggered only when control is already poor [6, 7].

Videotaped scoring has been used to reduce observer bias. Rootmensen and colleagues applied a validated video method to patients with asthma or COPD and used the scores to look for predictors of incorrect inhalation [16]. The advantage is that two raters can review the same performance independently and disagreements can be resolved afterwards. The cost is time and equipment, which makes the approach better suited to research than to a busy community pharmacy. Practical compromises exist, such as a short device-specific checklist that is completed during the consultation and recorded in the patient's notes, so that the next professional can see which steps were wrong last time [21, 30].

4. CLINICAL CONSEQUENCES

The case that poor technique matters rests on observational data linking errors to symptoms and service use. In a cross-sectional study of adults with asthma, improper technique was associated with poor control and frequent

emergency department visits [31]. Melani and colleagues, working in a mixed population of patients with respiratory disease, found that mishandling was common in routine practice and tied to reduced disease control, as well as to more hospitalisations and unscheduled care [29]. These designs cannot prove that errors cause worse outcomes, since a sicker patient may also be less able to perform the manoeuvre. Even so, the direction of the association is consistent across settings and devices [17, 18].

The CRITIKAL analysis brought more precision. Looking at patients with asthma who used several device types, it reported that certain errors were associated with a higher risk of exacerbation or of hospital attendance, while minor lapses were not [17]. The result fits the concept of critical errors: a slip that still lets most of the dose reach the airway is unlikely to matter much, but a failure to inhale properly at all is another matter. Because the analysis was observational, residual confounding remains possible. Nonetheless, it gives a rational basis for ranking errors, and teaching priorities can follow from it [18].

In COPD, evidence is thinner but points the same way. Objective monitoring in the work of Sulaiman and colleagues showed that patients' real use often differed from their reports, and that non-adherence and poor technique were linked to exacerbations and readmission [19]. Technique and adherence are partly separate problems. A patient may take every scheduled dose and still deliver little to the lung, or may handle the device perfectly but forget it half the time. Studies that measure only one of the two can therefore miss the true cause of poor control, which is one reason that adherence aids and technique checks are usually advised together [32, 33].

There are cost consequences as well. If a patient appears not to respond, the usual reaction is to step up treatment, adding a second or third inhaled drug, or an oral agent, or in severe asthma a biologic. In many cases a simple technique review would have been cheaper and safer. Sulaiman and colleagues tested feedback on adherence and technique in people with severe uncontrolled asthma and found that this approach improved adherence and asthma control, which suggests that some apparent treatment failure is really a delivery problem [20]. That is an uncomfortable finding for prescribers, but it supports a routine check before any escalation is considered [1, 30].

Guidelines have taken note. Both the asthma and the COPD strategy documents tell clinicians to check inhaler technique and adherence before concluding that treatment has failed, and they advise that the device should be one the patient is willing and able to use [1, 2]. The wording is brief, and the practical detail of how to do the check is left to local services. Price and colleagues reviewed common errors, the barriers that stop patients using inhalers well and possible solutions, and pointed out that barriers sit with patients, professionals and the health system alike [34]. Shortage of consultation time, no placebo devices and no payment for the service are examples at system level.

Local side effects offer another angle. When a corticosteroid pMDI is used without a spacer and with poor coordination, a larger fraction of each dose lands in the mouth, which increases the chance of oral thrush and a hoarse voice [14, 33]. Patients who experience these effects may cut back their doses or stop altogether, which then worsens control. Mouth rinsing after use and spacer use are simple measures that are well established in guidance, yet they are often left out of counselling because the conversation focuses on the main steps of the device [1, 25].

5. PATIENT AND DEVICE FACTORS

Age is the factor most often mentioned. Older adults with COPD may have reduced hand strength, arthritis, poor vision, tremor and some degree of cognitive decline, any of which can make a device hard to prepare or operate [35, 36]. Lavorini and colleagues argued that delivery devices should be chosen for the elderly with these limits in mind, and that the cognitive screen, grip strength and inspiratory flow of each patient should inform the choice [35]. Children, at the other end of the age range, need an adult to supervise and often a spacer with a mask, because their

breathing patterns do not match what most devices expect [5].

Disease severity and lung function matter too. Patients with severe airflow limitation may be unable to generate the flow that a high-resistance DPI demands, particularly during an exacerbation, when inspiratory capacity falls [3, 12]. In such patients a pMDI with a spacer, a soft mist inhaler or a nebuliser may deliver more reliably. The choice of device is not just a matter of preference, and the ability to generate flow can be measured in clinic. Dolovich and colleagues proposed evidence-based criteria that tie device choice to the patient's ability to use it, the drug available in that format and the setting in which it will be used [25].

Breathlessness itself interferes with technique. A person with COPD who is struggling to breathe may rush the manoeuvre, cough during inhalation or be unable to hold the breath afterwards, and these effects are worst at the very moment the inhaler is most needed. Cough can expel a powder dose before it has deposited [3, 12]. Teaching is best done when the patient is stable and then reviewed after an exacerbation, when inspiratory capacity may have changed and the earlier device choice may no longer be suitable [2, 36]. Pharmacists who dispense a reliever after an acute episode are in a good position to ask quickly how it is actually being used.

Device variety is a problem in itself. People with both asthma and COPD, or with several comorbidities, are often given two or three different inhalers, each with its own steps. Mixing a pMDI with a DPI invites confusion, since the first needs a slow breath and the second a quick one. Studies have linked the use of multiple device types with more errors and poorer control [37, 38]. Dekhuijzen and colleagues suggested a more rational prescribing path that keeps the number of device types low, and Bjermer discussed the value of continuity of device so that patients are not retrained every time a prescription changes [37, 38].

Switching devices without telling the patient is a related risk. Pharmacies and health systems sometimes substitute one brand for another to save costs. If the new device operates differently, technique that was adequate yesterday may be wrong today, and nobody may notice until control deteriorates [38, 39]. Haughney and colleagues discussed the research still needed on device selection and noted how rarely patient preference is recorded [39]. Preference counts, because people who like their inhaler tend to use it more consistently. A shared decision, followed by a demonstration, is better than a silent change at the dispensing counter [30, 37].

Beliefs and health literacy shape technique as well as hands and lungs do. Rau described how patients' understanding of the purpose of each inhaler, their worries about steroids, and the complexity of the regimen affect adherence to an aerosol plan [32]. Cochrane and colleagues made a related point about inhaled corticosteroids, noting that compliance, device and technique together determine the benefit seen in practice [33]. A person who believes the reliever is the only 'real' medicine will not bother learning the preventer device. Counselling should therefore explain why each device is there before it shows how to use it [32, 34].

6. TEACHING AND INTERVENTIONS

Teaching works, though how it is delivered matters. Press and colleagues reviewed interventions for pMDI and Diskus technique and concluded that methods using demonstration with feedback, particularly where the patient repeats the steps until correct, were more effective than leaflets or verbal advice alone [24]. A randomised trial in hospitalised patients with asthma or COPD found that teaching with a 'teach-to-goal' approach improved technique compared with usual care [23]. The common thread is active practice. Watching a demonstration is not the same as holding the device and doing it, and patients who have not done it themselves tend to overrate their skill [7, 23].

Community pharmacists are well placed to deliver such teaching because they see patients regularly and can reinforce the message at each refill. Basheti and colleagues showed in an Australian study that a brief intervention by pharmacists, using a checklist and a placebo device, improved technique and

was linked to better asthma control [21]. A later comparison of two educational formats over time found that the gains persisted for different periods depending on the method used [22]. Their results suggest that a single session is rarely enough, and that follow-up at later visits maintains the benefit of the first teaching [8, 22].

The teacher needs skill, too. Basheti and co-workers followed pharmacists after a training programme and examined how well their own demonstration skills were retained over time, finding that refresher training was needed to keep standards up [8]. This echoes the earlier findings on poor knowledge among health professionals [27, 28]. A pharmacy that wants to run an inhaler check service therefore needs regular in-house practice with each device, not just a one-off course. Placebo devices for every product stocked, written checklists and a quick reference chart on the wall are cheap supports that make the service more consistent [7, 21].

Teach-back deserves a mention. After demonstrating, the professional asks the patient to show the steps again and corrects mistakes immediately, repeating the cycle until the technique is right. Capstick and Clifton reviewed training in asthma and COPD and found that repeated instruction was associated with better technique, though effects on clinical outcomes were less consistently reported [7]. Written or video prompts, such as manufacturer videos or QR links on the box, can help between visits. Their value is not firmly established in controlled trials, but they are low-cost and acceptable to many patients, particularly those who are comfortable with phones [24, 30].

Who delivers the teaching seems to matter less than how consistently it is done. Nurse-led, pharmacist-led and physician-led sessions have all been associated with improved technique in various studies, so the effective ingredient appears to be structured content and hands-on practice rather than the job title [7, 24]. What does vary is access. A person with COPD may see a respiratory nurse once a year but visit a pharmacy every month. Kaplan and Price argued that primary care teams should take a leading role in matching devices to patients and in reviewing technique routinely, drawing on other professionals for repeat checks [30].

Technology may add something. Electronic monitors that record use and give feedback were tested in a randomised trial in severe asthma, where feedback on adherence and technique was linked to improved control [20]. In COPD, objective monitoring has exposed discrepancies between what patients report and what they do [19]. Cost, privacy and access limit routine use, but the technology could help identify those who need the most intensive teaching. For now, the cheapest and best-evidenced intervention is still a trained person watching the patient use the device and correcting what they see [21, 24].

7. LIMITATIONS AND FUTURE DIRECTIONS

Several limits affect how far the literature can be trusted. Scoring systems differ between studies, so the percentage of patients labelled as making errors varies with the checklist as much as with the population [6, 16]. Most studies look at technique at a single time point, usually in a clinic or pharmacy where the patient is aware of being observed. Few follow patients over a year or more, and fewer still link teaching to hard outcomes such as exacerbations and admissions [23, 24]. Publication bias is likely, since positive teaching trials are easier to publish than neutral ones. Readers should treat pooled error rates as rough indicators.

Newer devices complicate matters. Evidence on soft mist inhalers, breath-actuated pMDIs and multi-drug dry powder inhalers is growing, but head-to-head comparisons of error rates with realistic training are still few. The older Health Technology Assessment review found no convincing proof that any one device was superior when used correctly [40], and later syntheses have not overturned that view. If devices are broadly similar in efficacy, the main question becomes which one a given patient can use properly. This points research toward matching, not toward ever more elaborate engineering, and it requires trial designs that measure technique at baseline and follow-up [30, 37].

Future work could usefully address a few gaps. Standard definitions of critical errors for each device, agreed by professional societies, would make studies comparable. Trials in primary care and low-resource settings are needed, since much of the existing work comes from specialist clinics in high-income countries. Cost-effectiveness analyses of pharmacist-led technique services would help commissioners decide whether to fund them. Finally, the interaction of technique with adherence needs to be measured together in the same patients, using objective tools, so that the contribution of each to poor control can be separated [19, 20].

Equity and language deserve a mention. Most published checklists and videos are in English, and patients with low literacy or limited English may not be able to follow written leaflets. Pictorial instructions and interpreter-supported sessions have received little formal evaluation. Likewise, few studies report sex, ethnicity or socioeconomic status in enough detail to show whether technique problems cluster in particular groups [6, 34]. Without that information, services cannot aim teaching at those most likely to need it, and gaps in care may go unnoticed for years. Interpreter-supported teaching and pictorial leaflets are cheap to provide and deserve proper evaluation [30, 34].

Practice points follow naturally from the evidence. Check technique at every opportunity and in particular before stepping up therapy. Match the device to the patient's strength, cognition and inspiratory flow rather than to the formulary alone. Keep the number of device types as low as practical. Teach by demonstration and teach-back, and repeat at later visits. Record the steps that were wrong, so that the next person knows where to look. None of these needs new technology, and most can be done in a few minutes at the counter or bedside [1, 2, 37].

8. CONCLUSION

Inhaler technique is one of the most common reasons for poor response to inhaled treatment in asthma and COPD, and the problem has persisted despite decades of new device design. Errors differ by device, so assessment has to be device specific, and critical errors deserve attention before minor ones. Observational studies tie such errors to poorer control and greater use of healthcare, although causation cannot be proved from these designs [6, 17, 18, 31]. Spacers remove much of the coordination burden for pMDIs, while flow measurement helps decide whether a DPI is a sensible choice for a given person [3, 12, 14].

The practical message is direct. Technique should be checked at every review, taught by demonstration and teach-back, and repeated, with devices matched to what each patient can do. Pharmacists have a real part to play in this work, provided they are themselves trained and retrained [8, 21, 22]. Better standardisation of scoring and more trials with clinical endpoints would strengthen the evidence base, but waiting for those should not delay a simple check at the next visit [1, 2, 24]. Effective programmes share a few features: a demonstration with a placebo device, a return demonstration by the patient, correction on the spot and follow-up at later visits [23, 24, 34].

9. ABBREVIATIONS

COPD-Chronic obstructive pulmonary disease, pMDI-Pressurised metered-dose inhaler, DPI-Dry powder inhaler, GINA-Global Initiative for Asthma, GOLD-Global Initiative for Chronic Obstructive Lung Disease, CRITIKAL-Critical inhaler errors and asthma outcomes study, MDI-Metered-dose inhaler, HTA-Health Technology Assessment

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11. AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

12. CONFLICT OF INTERESTS

Declared none

13. REFERENCES

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