

## EDUCATIONAL OBJECTIVES

After completing the continuing education activity, pharmacists and pharmacy technicians will be able to

- **DESCRIBE** the different types of inhalers currently available in the United States
- **OUTLINE** the relationship between the inhaler type and patient characteristics
- **DESCRIBE** how to order demonstration devices
- **IDENTIFY** the ideal time and place to employ a demonstration device with patients



The University of Connecticut School of Pharmacy is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education.

Pharmacists and pharmacy technicians are eligible to participate in this application-based activity and will receive up to 0.2 CEU (2 contact hours) for completing the activity, passing the post-test with a grade of 70% or better, and completing an online evaluation. Statements of credit are available via the CPE Monitor online system and your participation will be recorded with CPE Monitor within 72 hours of submission

ACPE UAN: 0009-0000-22-045-H01-P  
0009-0000-22-045-H01-T

Grant funding: **Organon LLC**  
Cost: **FREE**

INITIAL RELEASE DATE: **September 15, 2022**  
EXPIRATION DATE: **September 15, 2024**

To obtain CPE credit, visit the **UConn Online CE Center** <https://pharmacyce.uconn.edu/login.php>.

Use your NABP E-profile ID and the **session code 22YC45-ABC26 for pharmacists or 22YC45-CBA82 for pharmacy technicians** to access the online quiz and evaluation. First-time users must pre-register in the Online CE Center. Test results will be displayed immediately and your participation will be recorded with CPE Monitor within 72 hours of completing the requirements.

For questions concerning the online CPE activities, email [joanne.nault@uconn.edu](mailto:joanne.nault@uconn.edu).

**TO RECEIVE CREDIT FOR THIS CE,**  
go to

<https://pharmacyce.uconn.edu/login.php>

## You Asked for It! CE



© Can Stock Photo/marischka

## Inhalers: A Demonstration is Worth One Thousand Words

**ABSTRACT:** Asthma and chronic obstructive pulmonary disease (COPD) are chronic conditions affecting millions of people worldwide. Patients frequently have suboptimal inhaler technique, leading to less effective treatment, inadequate disease control, and reduced quality of life. Patient education and ongoing assessment and support are vital to improving outcomes, but healthcare professionals are often unable to provide this level of care effectively. This continuing education activity reviews the various types of inhaler devices along with important counseling points for each. It offers guidance on choosing appropriate devices based on patient characteristics. It also provides some guidance for how pharmacy personnel can teach, assess, and reinforce proper inhaler technique. Finally, it gives suggestions for ordering and using demonstration devices.

**FACULTY:** Gabrielle Ruggiero, PharmD, BCPS, Pharmacist, Johnson Memorial Hospital, Stafford Springs, CT, and Tiffany Vicente, 2025 PharmD Candidate, The University of Connecticut School of Pharmacy, Storrs, CT

**FACULTY DISCLOSURE:** Dr. Ruggiero and Ms. Vicente have no financial relationships with an ineligible company.

**DISCLOSURE OF DISCUSSIONS of OFF-LABEL and INVESTIGATIONAL DRUG USE:** This activity may contain discussion of off label/unapproved use of drugs. The content and views presented in this educational program are those of the faculty and do not necessarily represent those of the University of Connecticut School of Pharmacy. Please refer to the official prescribing information for each product for discussion of approved indications, contraindications, and warnings.

*The Accreditation Counsel for Pharmacy Education prefers the use of generic names in continuing education activities to eliminate bias. In this activity, we made the decision to use brand names because of the large number of drugs, combination products, and device combinations currently available.*

## INTRODUCTION

Asthma and chronic obstructive pulmonary disease (COPD) are common conditions that affect many individuals' daily functioning. Worldwide, roughly 340 million people have asthma, and 390 million people have COPD.<sup>1,2</sup> It's well-known that patients often have suboptimal inhaler technique, and numerous professional organizations have advocated for more counseling at every point in the healthcare system.<sup>3,4</sup> Although several new and improved pulmonary inhalation devices are available, inhaler use skills have lagged.<sup>5</sup>

Two systematic reviews analyzed studies of inhaler technique among patients and healthcare professionals from 1975 to 2014.<sup>5,6</sup> Each review divided the studies into an earlier (1975 to 1994) and a later (1995 to 2014) period to assess changes over time. The review of 54,354 patients over 144 studies found that approximately 30%, 40%, and 30% percent of patients had correct, acceptable, and poor technique, respectively. There was no significant difference in inhaler use skill between the earlier and later time periods.<sup>5</sup> The review of 6,304 healthcare professionals over 55 studies found that correct inhaler technique among healthcare professionals declined from around 20.5% in the earlier time period to just 10.8% in the later time period.<sup>6</sup>

Using inhalers correctly is essential to disease control. A systematic literature review found an association between inhaler use errors and worsened disease outcomes for patients with asthma and COPD in almost all included studies.<sup>7</sup> Longitudinal studies found that reductions in inhaler use errors improved disease outcomes.

Ultimately, most patients receive their inhalers from a pharmacy. Research shows that community pharmacists can positively impact inhaler technique, asthma control, quality of life, and medication adherence with educational interventions.<sup>8</sup> Pharmacy personnel are strategically positioned to improve outcomes for people with asthma and COPD by

- Being familiar with the various inhalers available, understanding how to use them, and knowing the counseling points for each
- Recognizing patient-specific factors that could impact inhaler administration
- Understanding the importance of educating and evaluating patients on inhaler technique, and planning how to best deliver this care

### Medication Classes Found in Inhalers

Several pharmacologic classes of medications (and combinations of these classes) are available in inhaler products<sup>3,4,9-12</sup>:

- Short-acting beta-agonists (SABA) and long-acting beta-agonists (LABA) relax airway smooth muscles by stimulating beta<sub>2</sub>-adrenergic receptors. Patients with asthma and/or COPD can use beta agonist medications as needed for relief of acute symptoms, and on a regular schedule for symptom prevention.
- Short-acting muscarinic antagonists (SAMA) and long-acting muscarinic antagonists (LAMA) cause bronchodilation by inhibiting muscarinic receptors in the airway smooth muscles.<sup>4</sup> Patients with COPD can use SAMA and LAMA medications as maintenance therapy. Patients with asthma who are already using a LABA and an inhaled corticosteroid (ICS) can add on a LAMA maintenance medication if needed.
- ICS reduce airway inflammation and are used as daily maintenance medications to prevent asthma exacerbations. Patients with COPD may also use ICS in combination with LABA or LABA plus LAMA as a daily maintenance medication. Prescribing information for corticosteroid inhalers advises patients to rinse their mouths with water after inhalation and to spit the water out afterward to reduce the risk of fungal infection in the mouth and pharynx.

## TYPES OF INHALER DEVICES

### Pressurized Metered Dose Inhalers

A pressurized metered dose inhaler (pMDI) has two components: a plastic actuator with mouthpiece, and a pressurized canister which may contain<sup>13,14</sup>

- the active medication
- a spray-generating propellant to move the medication out of the inhaler
- co-solvents to allow the inhaler ingredients to mix well
- surfactants to stabilize the mixture and prevent drug particles from clumping together or sticking to the canister

The propellant is typically hydrofluoroalkane (HFA), a replacement for the chlorofluorocarbon (CFC) propellants used in many early inhalers.<sup>13</sup> The Montreal Protocol of 1987 called for phasing out CFCs due to their ozone-depleting properties. The liquid inside a pMDI canister may be formulated as a solution or as a suspended micronized powder. Each time a patient actuates the inhaler (i.e., presses the button to release a spray), a metering chamber in the canister measures the correct liquid volume for that dose. The device releases large particles (about 45 micrometers) from the mouthpiece in a cloud of vapor, and particle size decreases to between 0.5 and 5.5 micrometers as the aerosol evaporates.

**PAUSE AND PONDER:** How do you think the ban on chlorofluorocarbons impacted the inhaler market?



© Can Stock Photo/Dmitrynew83

**Table 1. Pressurized Metered Dose Inhalers<sup>9,10,15-24</sup>**

| Class         | Medication (Trade name[s]/generic availability)                  | Dose/actuation                                    |
|---------------|--|---|
| SABA          | albuterol HFA (Ventolin HFA, ProAir HFA, Proventil HFA, generic) | 90 mcg  |
|               | levalbuterol HFA (Xopenex HFA, generic)                          | 45 mcg  |
| SAMA          | ipratropium HFA (Atrovent)                                       | 17 mcg  |
| ICS           | ciclesonide HFA (Alvesco)  | 80 mcg<br>160 mcg                                 |
|               | fluticasone HFA (Flovent HFA, generic)                           | 44 mcg<br>110 mcg<br>220 mcg                      |
|               | mometasone HFA (Asmanex HFA)                                     | 100 mcg<br>200 mcg                                |
| ICS/LABA      | fluticasone/salmeterol HFA (Advair HFA)                          | 45 mcg/21 mcg<br>115 mcg/21 mcg<br>230 mcg/21 mcg |
|               | budesonide/formoterol HFA (Symbicort, generic)                   | 80 mcg/4.5 mcg<br>160 mcg/4.5 mcg                 |
|               | mometasone/formoterol HFA (Dulera)                               | 50 mcg/5 mcg<br>100 mcg/5 mcg<br>200 mcg/5 mcg    |
| LAMA/LABA     | glycopyrrolate/formoterol HFA (Bevespi Aerosphere)               | 9 mcg/4.8 mcg                                     |
| ICS/LAMA/LABA | budesonide/glycopyrrolate/formoterol HFA (Breztri Aerosphere)    | 160 mcg/9 mcg/4.8 mcg                             |

ABBREVIATIONS: HFA = hydrofluoroalkane; ICS = inhaled corticosteroid; LABA = long-acting beta-agonist; LAMA = long-acting muscarinic antagonist; SABA = short-acting beta-agonist; SAMA = short-acting muscarinic antagonist

To maximize lung deposition of medication from a pMDI, patients should take a slow, deep breath lasting about four to six seconds and actuate the inhaler at the start of (or immediately after starting) this breath.<sup>13</sup> If patients mistime the actuation or inhale too quickly, medication is more likely to deposit on the tongue or the back of the throat and patients will swallow it instead. This phenomenon—also known as oropharyngeal deposition—can reduce the effective medication dose and increase adverse effects (e.g., oral thrush and hoarseness with inhaled corticosteroids).<sup>13</sup> **Table 1** lists the medications available as pressurized metered dose inhalers.

### Spacers and Valved Holding Chambers

A spacer is a tube or bag, often made of plastic, that a patient connects to a pMDI before use.<sup>25</sup> Medication particles traveling through these devices slow down before reaching the mouth. This also allows the aerosol propellant more time to evaporate, leaving smaller particles to be inhaled. Lower velocity and smaller particle sizes reduce oropharyngeal deposition, so more medication reaches the lungs. However, patients still need to time inhalation with actuation, and they should avoid exhaling into the spacer to prevent dilution (weakening) of the dose.

Valved holding chambers (VHC) are like spacers, but they have a one-way valve between the chamber and mouthpiece.<sup>25</sup> VHCs trap the aerosols in the chamber, allowing time for patients with poor hand-breath coordination to inhale their medication. The

one-way valve blocks exhalations from reaching the aerosols in the chamber, allowing patients to use multiple inhalations or tidal (restful) breathing if needed. For doses requiring multiple medication puffs, healthcare providers should counsel patients to prepare, actuate, and inhale each puff separately rather than spraying multiple puffs into the spacer or VHC at once.<sup>13</sup>

Due to gravity, impaction, and electrostatic charge, some medication is lost in a spacer or VHC before reaching the patient.<sup>25</sup> Washing a spacer or VHC with detergent (a water-soluble cleansing agent) and letting it air dry before first use can reduce the electrostatic charge and limit drug particle loss to the device walls. Some spacers and VHCs are made with anti-static material, but often come at a higher cost to the patient.

The Global Asthma Network (which aims to improve asthma care, particularly in low- and middle-income countries) advises that people can make effective spacers from 500 mL plastic bottles if commercial spacers are unavailable or too expensive.<sup>1</sup> A cost-effectiveness analysis determined home-made spacers (most of which were made from plastic water bottles) to be more cost-effective than commercial spacers in Columbia (a middle-income country).<sup>26</sup> The study found lower overall treatment costs and no difference in hospital admission rates.

**Table 2. Soft Mist Inhalers<sup>28-31</sup>**

| Class     | Medication (Trade name)                                    | Dose/actuation      |
|-----------|--|---------------------|
| SAMA/SABA | ipratropium bromide/albuterol sulfate (Combivent Respimat) | 20 mcg/100 mcg      |
| LAMA      | tiotropium (Spiriva Respimat)                              | 1.25 mcg<br>2.5 mcg |
| LABA      | olodaterol (Striverdi Respimat)                            | 2.5 mcg             |
| LAMA/LABA | tiotropium/olodaterol (Stiolto Respimat)                   | 2.5 mcg/2.5 mcg     |

ABBREVIATIONS: LABA = long-acting beta-agonist; LAMA = long-acting muscarinic antagonist; SABA = short-acting beta-agonist; SAMA = short-acting muscarinic antagonist

### Breath-Actuated pMDIs

A breath-actuated pMDI of beclomethasone dipropionate HFA (Qvar Redihaler) is available to overcome the problem of hand-breath coordination.<sup>27</sup> This inhaler is available in 40 mcg/actuation and 80 mcg/actuation. As the name implies, it actuates when the patient takes a breath, but it does not rely on a high inspiratory flow rate to deliver the medication. An inspiratory flow rate of just 20 L/minute activates the inhaler, which then uses the HFA propellant to assist with dose delivery. Other breath-activated inhalers (discussed below) require up to 88 L/minute for activation, which may be difficult for individuals with asthma or COPD who are already having trouble breathing. Young children and adults have tidal breathing inspiratory flow rates of 8 to 16 L/minute and 13 to 18 L/minute respectively.<sup>27</sup> Therefore, a breath-activated pMDI may require only a bit more inspiratory effort than the patients' usual breathing.

### Soft Mist Inhalers

Soft mist inhalers (SMIs) do not contain a propellant.<sup>25</sup> Instead, these inhalers use a spring to create pressure and spray the drug solution through a nozzle, forming two jets of liquid that collide to create a slow-moving mist. The mist's low velocity increases drug deposition in the lungs rather than the oropharynx. An SMI's aerosol cloud lasts about six times longer than a pMDI's, increasing the window for effective inhalation in patients who have trouble coordinating actuation and inhalation. **Table 2** shows the medications available as soft mist inhalers.

### Dry Powder Inhalers

Dry powder inhalers (DPI) are breath-actuated and breath-powered inhaler devices. To improve powder flow and accurate dose metering, manufacturers combine the active medication with a carrier powder or formulate it into spherical agglomerates (small sphere-shaped particles).<sup>32</sup> Patients' inspiratory flow and the resistance inside the inhaler generate turbulent energy that disaggregates (separates) the medication. Quick inhalation optimizes this process. The resulting tiny drug particles (less than 5 micrometers) can reach the lungs, while the larger carrier particles land in oropharynx and are swallowed.

DPIs typically require an inspiratory flow rate of at least 30 to 60 L/minute, which some patients may have difficulty achieving.<sup>25</sup>

There is also a possibility of decreased medication delivery from a DPI during disease exacerbations (periods of worsening), when patients' ability to generate a forceful inspiration may be impaired.<sup>32</sup> **Table 3** (next page) lists available DPIs.

### INHALER TECHNIQUE EDUCATION

Consider that participants in most randomized controlled trials receive thorough education on inhaler use, must demonstrate competence to be included, and receive ongoing evaluations of their technique.<sup>4</sup> This is the context in which inhaler efficacy is established. Ideally, all patients would have access to similar standards of care to ensure maximum benefit of inhaled medications. Inhaler technique support can also improve adherence. If patients are using inhalers incorrectly and not seeing clinical improvement, they may discontinue them due to perceived lack of efficacy.<sup>47</sup> A survey of patients with COPD found significantly greater adherence and confidence in treatment among patients whose inhaler technique had been checked by a healthcare professional within the past two years.<sup>48</sup>

Healthcare providers must consider patient preferences, health literacy, and language barriers when choosing appropriate education methods.<sup>47</sup> A survey of inhaler-using adults seen at a pulmonary clinic or outpatient pharmacy compared education preferences between English and non-English speakers.<sup>49</sup> Both groups shared a preference for in-person, active learning methods but had low interest in participating in education sessions outside of regular clinic visits. The aforementioned survey of patients with COPD found that 83% thought a demonstration was "very helpful" for learning inhaler technique.<sup>48</sup> Only 58% and 34% thought the same about a video or leaflet, respectively.

### Pharmacists Can Improve Inhaler Use

Pharmacists are best placed to provide in-person, active demonstrations to patients where they already come to pick up their medications. Research shows that pharmacists can provide effective inhaler use education (if and when their workflow allows for it). A 2017 systematic review of critical inhaler errors in asthma and COPD found that pharmacist-led inhaler education interventions produced statistically significant improvements in patients' inhaler technique in seven out of eight studies.<sup>50</sup>

**Table 3. Dry Powder Inhalers<sup>15,33-46</sup>**

| Class         | Medication (Trade name[s]/generic availability)                       | Dose/actuation                                     |
|---------------|---|--|
| SABA          | albuterol (ProAir RespiClick, ProAir Digihaler)                       | 117 mcg  |
| LABA          | salmeterol (Serevent Diskus)  | 50 mcg   |
| ICS           | budesonide (Pulmicort Flexhaler)                                      | 90 mcg<br>180 mcg                                  |
|               | fluticasone propionate (Flovent Diskus)                               | 50 mcg<br>100 mcg<br>250 mcg                       |
|               | fluticasone furoate (ArmonAir Digihaler)                              | 55 mcg<br>113 mcg<br>232 mcg                       |
|               | fluticasone furoate (Arnuity Ellipta)                                 | 50 mcg<br>100 mcg<br>200 mcg                       |
|               | mometasone (Asmanex Twisthaler)                                       | 110 mcg<br>220 mcg                                 |
| ICS/LABA      | fluticasone/salmeterol (Advair Diskus, Wixela Inhub, generic)         | 100 mcg/50 mcg<br>250 mcg/50 mcg<br>500 mcg/50 mcg |
|               | fluticasone/salmeterol (AirDuo RespiClick, AirDuo Digihaler, generic) | 55 mcg/14 mcg<br>113 mcg/14 mcg<br>232 mcg/14 mcg  |
|               | fluticasone/vilanterol (Breo Ellipta, generic)                        | 100 mcg/25 mcg<br>200 mcg/25 mcg                   |
| LAMA          | acclidinium bromide (Tudorza Pressair)                                | 400 mcg  |
|               | tiotropium bromide (Spiriva Handihaler)                               | 18 mcg (per capsule)                               |
|               | umeclidinium (Incruse Ellipta)  | 62.5 mcg   |
| LAMA/LABA     | umeclidinium/vilanterol (Anoro Ellipta)                               | 62.5 mcg/25 mcg                                    |
| ICS/LAMA/LABA | fluticasone/umeclidinium/vilanterol (Trelegy Ellipta)                 | 100 mcg/62.5 mcg/25 mcg<br>200 mcg/62.5 mcg/25 mcg |

ABBREVIATIONS: ICS = inhaled corticosteroid; LABA = long-acting beta-agonist; LAMA = long-acting muscarinic antagonist; SABA = short-acting beta-agonist

Published studies of pharmacist-led interventions provide examples of counseling methods that have proven effective. A pre- and post-intervention study of 211 patients with COPD in Vietnam examined the efficacy of face-to-face inhaler training with a pharmacist. Training followed this format<sup>51</sup>:

- Patients demonstrated technique on a placebo inhaler device
- Pharmacists corrected each mistake and explained why the correction was important
- Pharmacists demonstrated every step verbally and physically with a placebo inhaler
- Patients performed the technique again
- Patients and pharmacists repeated this process until patients could complete all steps correctly

training monthly for three months, once at six months, and once at 12 months. They also included label stickers on inhalers with a summary of the steps for use. The percentage of patients using correct inhaler technique increased by over 40% from baseline to six months but declined somewhat between six and 12 months. The researchers concluded that patients benefit from an initial intensive period of repeated training sessions, followed by long-term follow-up at least every three months.<sup>51</sup>

**PAUSE AND PONDER:** Why might a live demonstration provide better training than a video demonstration of the same time duration?

This procedure took about six minutes for initial training and three minutes for follow-up trainings.<sup>51</sup> Pharmacists provided

**Table 4. Priming Requirements for pMDIs<sup>10,15-24</sup>**

| Product(s)   | Prime before first use and if not used for more than: | Number of Sprays |
|--|---|------------------|
| Advair HFA <sup>a</sup>  | 28 days   | 4 sprays         |
| Proventil HFA<br>Ventolin HFA <sup>b</sup>   | 14 days   |                  |
| Bevespi Aerosphere <sup>b</sup><br>Breztri Aerosphere <sup>b</sup><br>Flovent HFA <sup>a</sup> | 7 days  |                  |
| Asmanex HFA<br>Dulera  | 5 days  |                  |
| Xopenex HFA  | 3 days  |                  |
| ProAir HFA <sup>b</sup>  | 14 days   |                  |
| Alvesco  | 10 days   |                  |
| Symbicort <sup>a</sup>   | 7 days  | 2 sprays         |
| Atrovent HFA   | 3 days  |                  |

<sup>a</sup>Also need to be primed if dropped; <sup>b</sup>Also need to be primed after cleaning.  
ABBREVIATION: HFA = hydrofluoroalkane



The 2022 GINA report emphasizes the importance of providing patients with ongoing inhaler technique training and assessment. The report recommends that pharmacists, nurses, and other healthcare workers<sup>3</sup>

- physically demonstrate using placebo inhalers (and spacers or VHCs, if applicable)
- check against a device-specific checklist as patients demonstrate technique
- supply a take-home handout with steps for inhaler use (ideally including pictures)
- check and re-train patients at every opportunity, as errors frequently recur four to six weeks after training

Of note, devices exist to evaluate patients' inspiratory flow and inhalation technique when prescribing, training, or assessing.<sup>47</sup> Although these may not be feasible to use in most community pharmacy settings (and are outside the scope of this continuing education activity), they may be very useful in other settings (e.g., a pulmonary clinic). Devices include the AIM (Aerosol Inhalation Monitor), the In-Check DIAL, and the 2-Tone trainer.<sup>47</sup>

## Inhaler Administration Counseling

### *pMDIs*

Most pMDIs require users to prime (release sprays into the air) before first use (see [Table 4](#)).<sup>17-20</sup> When priming a pMDI, users should spray it in the air away from the face. If the inhaler requires shaking, they should also be sure to shake well before each priming spray. Most pMDIs require shaking prior to actuation but some, including Atrovent HFA and Alvesco, do not.<sup>9,10</sup> Patients should always avoid spraying pMDIs into their eyes; the package insert for Atrovent HFA instructs users to close their eyes during inhaler actuation.<sup>9</sup>

Another study of 72 subjects examined the efficacy of different inhaler training methods by assigning patients to do one of the following<sup>52</sup>:

- Read an MDI package insert pamphlet
- Watch a Centers for Disease Control and Prevention video demonstrating technique
- Watch a YouTube video demonstrating technique
- Receive direct instruction from a pharmacist

Only two minutes were allotted for the interventions (to mimic what might be feasible in a community pharmacy setting).<sup>52</sup> The pharmacist-led counseling sessions were loosely scripted based on a checklist of proper inhaler technique. After a pharmacist explained and demonstrated inhaler use, subjects could ask questions if time permitted. Study investigators (including the pharmacists performing the direct instruction sessions) used a standardized checklist to assess all participants immediately following the training. There was a statistically significant difference between pharmacist-led instruction and each of the other interventions but not between any of the three other intervention groups. More than 70% of patients in the pharmacist-led intervention group demonstrated correct inhaler use after training compared with less than 20% of patients in the other intervention groups.<sup>52</sup>

**PAUSE AND PONDER:** In your workplace, would it be feasible to provide two minutes of counseling with every inhaler refill? How might you identify patients who most need inhaler use training?

The following are general administration instructions for pMDIs<sup>17-20</sup>:

1. Check for a firm fit of the canister in the actuator
2. Remove cap from mouthpiece and check mouthpiece for any foreign objects
3. If product requires shaking, shake well (typically for 5 seconds)
4. Facing away from the inhaler, exhale completely
5. Holding inhaler upright with mouthpiece down, place mouthpiece in mouth
6. Form a tight seal with lips, keep tongue below mouthpiece, and tilt head back slightly
7. While breathing in deeply and slowly through the mouth, press down on the canister until it stops moving and has released a puff and remove finger from the canister
8. Continue to breathe in as long as possible, then remove the mouthpiece
9. Hold breath as long as is comfortable (up to 10 seconds)
10. Breathe out gently, away from the inhaler
11. Replace cap right away

Patients should never use the canister of one inhaler with the actuator of another inhaler.<sup>9,23,24</sup> Patients should clean pMDIs at least once a week. Cleaning instructions for pMDIs vary by product (see [Table 5](#)).

All available MDI inhalers have dose counters built into either the canister or the actuator. For most products, the dose counter's numbers or background will change to red when the inhaler is running low, reminding patients to refill their medication. Healthcare providers should counsel patients not to use inhalers after the dose counter reads zero, even if the canister does not feel empty and still operates. People should not put canisters in water to see if they float as a means of gauging whether medication remains (an old trick that is no longer recommended) or try

to alter dose counters. They should also never use a sharp object to unblock an actuator or throw a pMDI into a fire or incinerator. All pMDI inhalers require storage at room temperature, and most should be stored with the mouthpiece down so that the tip of the canister valve is facing down. This keeps the gasket inside of the canister wet so that it does not become brittle and allow outside moisture to enter the canister.<sup>53</sup>

In addition to general counseling for pMDIs, specific counseling points for breath-actuated pMDIs include four points<sup>54</sup>:

- There is no button to press; opening the cap prepares the dose. If patients leave the cap open for more than two minutes, they will need to close and reopen the cap before inhaling their dose.
- Do not shake (especially not with the cap open, as this may actuate the inhaler). Do not prime or use with a spacer or VHC.
- Clean weekly with a clean, dry tissue or cloth
- Do not take the inhaler apart

### SIMs

To set up an SIM (Respimat inhaler), remove the clear base, label the cartridge with the discard date (three months from first use), and insert the narrow end of the cartridge into the inhaler.<sup>28-31</sup> With the inhaler on a firm surface, push down until the cartridge clicks into place (this often takes more force than patients expect). Replace the clear base so that it clicks into place. Do not take the inhaler apart after assembly. To actuate the inhaler, patients should remember the acronym TOP:

- **T**urn the clear base half a turn in the direction of the arrows until it clicks
- **O**pen the cap fully
- **P**ress the dose-release button and close the cap.

**Table 5. pMDI Cleaning Requirements<sup>10,15-24</sup>**

| Product  | Cleaning instructions  |
|--|--|
| Atrovent HFA<br>Breztri Aerosphere<br>Bevespi Aerosphere<br>ProAir HFA<br>Proventil HFA<br>Ventolin HFA<br>Xopenex HFA | Remove the canister from the actuator; DO NOT let the canister get wet. Remove the cap from the mouthpiece. Run warm water through the top and bottom of actuator for 30 seconds in each direction. Thoroughly shake dry. Check the mouthpiece for remaining medication buildup. Let air-dry completely (overnight if possible).<br><br>If not fully air-dried before next dose, shake the plastic actuator as dry as possible, insert the canister, shake the inhaler, and actuate it twice. Repeat the original cleaning procedure after taking the necessary dose(s). |
| Advair HFA<br>Flovent HFA  | Clean after evening dose. DO NOT remove the canister from the actuator. Use a water-dampened cotton swab to clean the small circular opening where medicine sprays out of the canister, twisting in a circular motion. Repeat with a new damp swab. Wipe the inside of the mouthpiece with a clean, damp tissue. Let air dry overnight.  |
| Alvesco<br>Asmanex HFA<br>Dulera<br>Symbicort  | DO NOT remove the canister from the actuator. Wipe inside and outside surfaces of the actuator with a dry, lint-free tissue or cloth. DO NOT wash or put any parts in water.<br><br>Use a dry folded tissue to wipe over the front of the small hole where the medicine comes out of the Alvesco inhaler.  |

ABBREVIATION: HFA = hydrofluoroalkane

**Table 6. Preparing and Administering DPI Doses<sup>15,33-37,39-46</sup>**

| DPI Type   | Dose Preparation and Related Notes  |
|------------|---|
| Digihaler  | Holding inhaler upright, open cap fully until it clicks (the click can be felt and heard). Built in sensors track adherence and inspiratory flow rates. The inhaler sends information to an application using Bluetooth technology. The inhalers work even if they are not wirelessly connected to the mobile application.  |
| Diskus     | Hold inhaler in left hand with thumb of right hand in thumb grip. Push thumb grip away to snap mouthpiece into place. Hold in a level, flat, horizontal position. Slide lever away from mouthpiece until it clicks. Keep holding Diskus level during inhalation. To close after inhalation, patients put their thumb in the thumb grip and pull back towards themselves until the inhaler clicks shut over the mouthpiece. Do not close before inhaling, tilt, play with the lever, or move the lever more than once; doses may be lost.  |
| Ellipta    | Open the cover until it clicks. If patients open and close the cover without inhaling the medicine, the dose will be lost inside the inhaler, but patients will not receive a double dose.  |
| Flexhaler  | Hold brown grip in one hand and use the other to twist off white cover. Hold inhaler upright with one hand still on brown grip and the other in the middle of the inhaler. Twist brown grip as far as possible in one direction, and then back all the way in the other direction. Priming is required before first use (follow instructions for preparing a dose twice). The inhaler will click in the process of preparing a dose. Do not click the brown grip multiple times without inhaling. The dose indicator will count down with each click. However, it is not possible to receive more than one dose at a time. Do not shake the inhaler after preparing a dose.   |
| Handihaler | Press green button and pull cap away to uncover mouthpiece. Then pull mouthpiece away to uncover center chamber. Remove a capsule from blister packaging (without using sharp instruments) and place it in the center chamber. (Discard unused capsules accidentally exposed to air. Close mouthpiece until it clicks. With mouthpiece pointing up, press green piercing button until flat against base only once, then release. Do not shake. When the capsule is pierced, small pieces of gelatin may be created. These may end up in the mouth or throat and are not harmful. Hold inhaler horizontally when inhaling and inhale twice from the same capsule. The capsule should rattle during inhalation. Do not swallow or manually open capsules. |
| Pressair   | Hold inhaler horizontally with green button on top. Press and release the green button to prepare dose. Do not tilt inhaler. Check that control window changes to green. Do not hold green button down when inhaling. Correct inhalation causes an audible click and control window changes from green to red. Pushing green button multiple times before inhaling does nothing; patients will not lose a dose or get a double dose.  |
| RespiClick | Holding inhaler upright, open cap fully until it clicks (the click can be felt and heard). Always close the cap after each inhalation. Patients will waste the medication if they open and close the cap without inhaling.  |

Before first use, repeat the actuation steps until a mist is visible.<sup>28-31</sup> Then repeat three more times. To take an inhalation

1. Turn the base and open the top
2. Fully exhale away from the inhaler
3. Put mouthpiece in mouth and form a tight seal with lips, keeping mouthpiece above the tongue and pointing towards the back of the throat; be sure not to block air vents with lips or fingers
4. While taking a slow, deep breath through the mouth, press the dose-release button and breathe in as long as possible
5. Remove inhaler from mouth and hold breath as long as is comfortable (up to 10 seconds)
6. Breathe out slowly away from the inhaler
7. Close cap

Pharmacists should counsel patients to prime the device with one puff if not used for more than three days or four visible puffs if not used for more than 21 days.<sup>28-31</sup> Patients should clean the SMI's mouthpiece (including the metal part inside) once a week with a damp cloth or tissue. These inhalers have dose indicators and automatically lock when empty. Patients should not spray

the device into their eyes or use the SMI with a spacer or VHC. SMIs require room temperature storage.

### ***DPIs***

To administer DPIs<sup>33-36</sup>

1. Open cover or remove cap and check mouthpiece for foreign objects
2. Prepare dose (see [Table 6](#))
3. Fully exhale away from the inhaler
4. Put mouthpiece in mouth and form a tight seal with lips, keeping tongue below mouthpiece; be sure not to block air vents with lips or fingers
5. Breathe in quickly and deeply, generating a forceful breath right from the start of inhalation
6. After breathing in all the way, remove inhaler from mouth and hold breath for as long as is comfortable (up to 10 seconds)
7. Breathe out slowly away from the inhaler
8. Cover mouthpiece

Patients may or may not taste or feel the powder from a DPI upon inhalation. It is fine if they do, and they should not take an extra dose if they don't. Patients cannot use spacers, VHCs, or



masks with DPIs. Manufacturers formulate most DPIs with lactose powder as an ingredient, so patients with severe milk protein allergies should not use them.

Individuals should not wash DPIs. If cleaning is necessary, using a dry tissue or cloth is appropriate. Patients should store DPIs at room temperature and protect them from heat and humidity; they are more sensitive to humidity than are other inhalers. They should not store the Tudorza Pressair inhaler on a vibrating surface.

## MATCHING DEVICES TO PATIENT NEEDS

Individualizing delivery device selection is crucial for optimizing outcomes of aerosol drug therapy. Healthcare professionals must consider patient-, drug-, device-, and environmental-related factors. A good starting point may be to observe a patient's natural inhalation.<sup>55</sup> For example, if the patient instinctively takes slow, deep breaths, a pMDI or SMI might be a good fit. If the patient tends to inhale quickly and deeply, a DPI may be ideal. **Table 7** discusses other important factors to consider.

Patients often use multiple inhaled medications for asthma and COPD. Prescribing the same inhaler type for all a patient's inhaled medications eliminates confusion over varying administration techniques.<sup>59</sup> Clinicians can also prescribe combination products where appropriate to simplify treatment regimens.

### Consider the Cost

Affordability is another vital consideration and will depend on the patient's insurance status. While most inhalers are brand-name only, a few generic inhalers are available (see examples in **Tables 1-3**). Prioritizing patient preference when selecting inhalers can improve adherence.<sup>60</sup> Central to patient satisfaction are issues such as simplicity of use, treatment time, comfort, portability, cleaning requirements, taste, and effect on the throat. If a patient remains unable to use a device effectively after several training visits, consider switching to another inhaler type.

## INHALER USE MISTAKES

A literature review and meta-analysis of inhaler use errors in patients with asthma and COPD found that 50% to 100% of patients made at least one error when using their inhaler. Error rates were higher for patients<sup>61</sup>

- using MDIs compared to those using DPIs
- with COPD compared to those with asthma
- with a longer history of device use compared to patients new to inhaler treatment
- using multiple inhalers compared to those using only one inhaler

Errors are also common in patients using SMIs. A systematic literature review and meta-analysis of patients with COPD, bronchitis, or emphysema found that nearly 60% made at least one error

**Table 7. Inhaler Suggestions Based on Patient-Specific Factors**<sup>25,27,56-58</sup>

| For people with...  | ...Consider   |
|---|---|
| Inability to achieve a good lip seal around an inhaler's mouthpiece (e.g., pediatric, facial weakness, cognitive impairment)  | pMDI with spacer/VHC and facemask   |
| Inability to learn and perform specific breathing techniques  | pMDI with VHC   |
| Difficulty generating an inspiratory flow rate of at least 30 to 60 L/min (e.g., older age, female gender, airflow limitation, respiratory muscle weakness, lung hyperinflation, history of COPD exacerbations requiring hospitalization) | pMDI; breath-actuated pMDI; SMI   |
| Poor manual dexterity or limited hand strength  | Breath-actuated pMDI; SMI (may need help with initial cartridge installation); DPI (one that does not require complicated manipulations for dose preparation) |
| Difficulty with hand-breath coordination  | Breath-actuated pMDI; pMDI with VHC; DPI; SMI   |
| Inability to store inhaler away from heat and humidity  | Non-DPI inhaler (particularly sensitive to heat and humidity)   |

ABBREVIATIONS: COPD = chronic obstructive pulmonary disease; DPI = dry powder inhaler; pMDI = pressurized metered dose inhaler; SMI = soft mist inhaler; VHC = valved holding chamber

when using a SMI.<sup>62</sup> Other factors associated with higher error rates include<sup>50,61</sup>

- older age
- lower education level
- female gender
- lower socioeconomic status
- having two or more comorbidities

While perfect inhaler use is ideal, patients often have complex medication regimens and healthcare professionals often have heavy workloads. It's vital to prioritize the most essential steps in the inhaler use process, including those that have a proven impact on patient outcomes. The CRITIKAL study used data from the iHARP asthma review service (a multicenter cross-sectional

**PAUSE AND PONDER:** In your workplace, would it be feasible to provide training and technique assessment with every inhaler refill? If not, how might you identify and prioritize patients who most need inhaler use training?

study of adults with asthma) to identify inhaler use errors associated with worsening asthma control.<sup>63</sup> Investigators used data from 3660 patients to pinpoint these critical errors which included<sup>63</sup>

- not opening the cover or removing cap from mouthpiece
- insufficient inspiratory effort
- incorrect position of head
- not breathing out before inhalation
- not holding breath after inhaling medication, or holding for less than three seconds
- not sealing lips around mouthpiece
- incorrectly priming, timing, or inhaling the second dose (if needed)

## Demonstration Devices

Demonstration devices are placebo inhalers, meaning they contain no active medication. They may be available free of charge from device manufacturers. These are ideal for training since the lack of active drug allows for repeated cycles of education and patient demonstration (“teach-back”). Many demonstration inhalers are specifically marked as “only for use by a single patient” to prevent the possible spread of disease.<sup>64</sup> Keep demonstration inhalers in a separate area of the pharmacy, and do not send them home with patients to avoid any confusion.<sup>65</sup>

We collected the following information by calling inhaler manufacturers directly. Typically, anyone in a healthcare provider’s office or pharmacy is allowed to order demonstration devices on behalf of a prescriber or pharmacy. To order demonstration devices

1. Determine the patient population and disease state you will be addressing
2. Generate a list of common devices your patients use
3. Identify the manufacturer of each device and visit the manufacturer’s website or the website for the specific product
4. Obtain the email and phone number for customer service representatives and note days and times available (keep in mind the time zone)
5. Reach out to the company’s local representative or customer care representative to request demonstration devices
6. Provide all information required (generally your full name, title, state license number, phone number, address of the pharmacy or office you plan to have the devices delivered to and the facility’s secondary contact information [e.g., fax, email])

When making a demonstration device request, pharmacy staff should allow several weeks for processing and device delivery. The number of devices available also varies. For example, one inhaler manufacturer provides 15 or 20 demonstration devices in response to requests, while another requires a manager review of any request for more than three devices.

**Appendix 1** provides contact information for the manufacturers of several inhaler devices. Demonstration device availability can change over time; some companies have demonstration devices in stock only periodically and will advise calling back another time. Companies may also stop carrying demonstration devices for their older products. The GOLD report identifies a lack of placebo inhalers as a common barrier to educating patients.<sup>4</sup> However, if efforts to obtain demonstration devices are unsuccessful, pharmacists can teach patients using their own devices instead.

Manufacturers may also provide patient assistance programs and co-pay assistance to help with affordability. Patients with commercial or private health insurance are often eligible to participate in co-pay assistance programs and receive a savings card to help lower the cost of the prescription. Healthcare providers can also request additional educational materials and pamphlets to hand out. Referring patients who may be struggling with affording their medications to the manufacturer for assistance and to investigate the patients’ benefits to determine discounts available is highly recommended.

## CONCLUSION

Pharmacy personnel are well positioned to help patients maximize the benefit of their inhaled medications. An awareness of available inhalers and the requirements and techniques for their use can help healthcare professionals identify whether patients and their devices are a good match. Recognizing the importance of ongoing training and assessment, pharmacy staff can encourage brief yet frequent counseling sessions with patients as they refill their inhaled medications. Pharmacy personnel should proactively order inhaler demonstration devices from manufacturers (if available) to facilitate patient education.

**Figure 1** summarizes key points from this continuing education activity.

**Figure 1. Increasing the Likelihood that Patients Will Use Inhalers Correctly**

**Best**

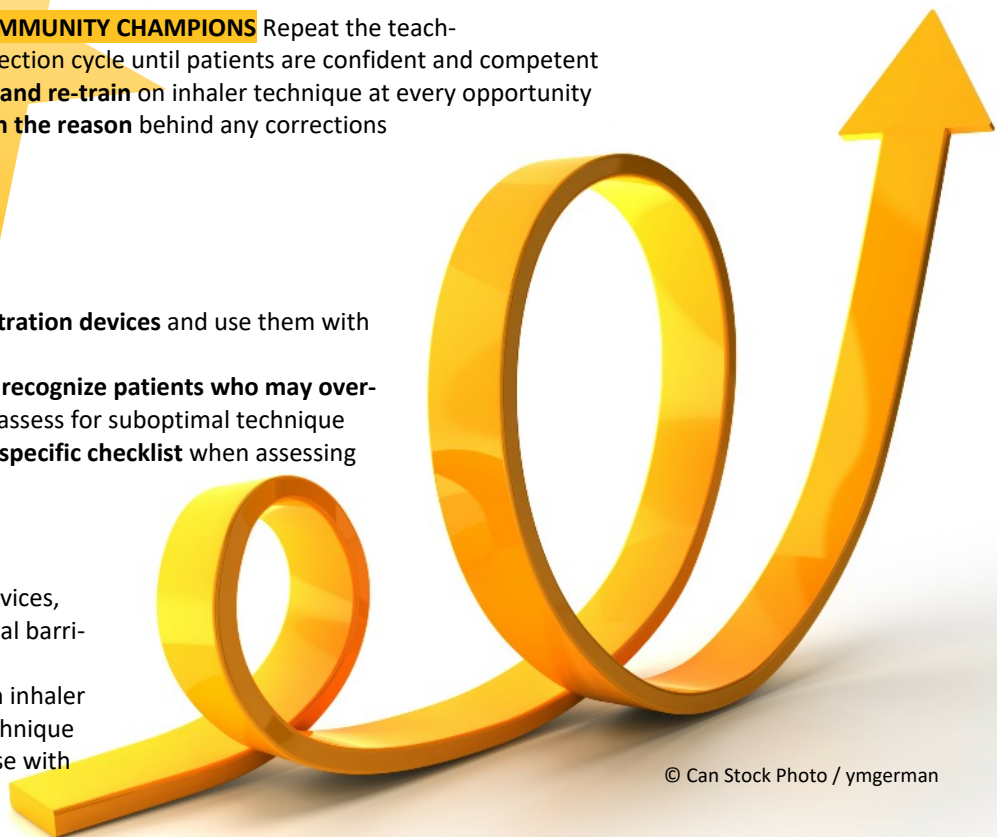
- 1 **Be COMMUNITY CHAMPIONS** Repeat the teach-back/correction cycle until patients are confident and competent
- 2 **Check and re-train** on inhaler technique at every opportunity
- 3 **Explain the reason** behind any corrections

**Better**

- 1 **Obtain inhaler demonstration devices** and use them with patients
- 2 Based on refill patterns, **recognize patients who may over- or under- use inhalers** and assess for suboptimal technique
- 3 **Check against a device-specific checklist** when assessing patient technique

**Good**

- 1 **Be familiar** with different inhaler devices, including counseling points and potential barriers to use for each
- 2 **Encourage** any patient picking up an inhaler to speak with the pharmacist about technique
- 3 **Provide pictorial instructions** for use with every inhaler



© Can Stock Photo / ymgerman

## REFERENCES

1. Global Asthma Network. The Global Asthma Report 2018. 2018. Accessed July 6, 2022. [http://globalasthmareport.org/resources/Global\\_Asthma\\_Report\\_2018.pdf](http://globalasthmareport.org/resources/Global_Asthma_Report_2018.pdf)
2. Adeloye D, Song P, Zhu Y, et al. Global, regional, and national prevalence of, and risk factors for, chronic obstructive pulmonary disease (COPD) in 2019: a systematic review and modelling analysis. *Lancet Respir Med*. 2022;10(5):447-458. doi:10.1016/S2213-2600(21)00511-7
3. Global Initiative for Asthma. Global strategy for asthma management and prevention. 2022. Accessed July 6, 2022. <https://ginasthma.org/wp-content/uploads/2022/07/GINA-Main-Report-2022-FINAL-22-07-01-WMS.pdf>
4. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: 2022 report. 2021. Accessed July 6, 2022. <https://goldcopd.org/2022-gold-reports-2/>
5. Sanchis J, Gich I, Pedersen S; Aerosol Drug Management Improvement Team (ADMIT). Systematic review of errors in inhaler use: has patient technique improved over time?. *Chest*. 2016;150(2):394-406. doi:10.1016/j.chest.2016.03.041
6. Plaza V, Giner J, Rodrigo GJ, et al. Errors in the use of inhalers by health care professionals: a systematic review. *J Allergy Clin Immunol Pract*. 2018;6(3):987-995. doi:10.1016/j.jaip.2017.12.032
7. Kocks JWH, Chrystyn H, van der Palen J, et al. Systematic review of association between critical errors in inhalation and health outcomes in asthma and COPD. *NPJ Prim Care Respir Med*. 2018;28(1):43. Published 2018 Nov 16. doi:10.1038/s41533-018-0110-x
8. Mahdavi H, Esmaily H. Impact of educational intervention by community pharmacists on asthma clinical outcomes, quality of life and medication adherence: A systematic review and meta-analysis. *J Clin Pharm Ther*. 2021;46(5):1254-1262. doi:10.1111/jcpt.13419
9. Atrovent HFA [package insert]. Ridgefield, CT: Boehringer Ingelheim Pharmaceuticals, Inc.;2020
10. Alvesco [package insert]. Zug, Switzerland: Covis Pharma; 2020.
11. Flovent Diskus [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2022.
12. Asmanex Twisthaler [package insert]. Jersey City, NJ: Organon & Co.; 2021.
13. Blake K, Lang J. Chapter 43:Asthma. In: DiPiro JT, Yee GC, Posey L, Haines ST, Nolin TD, Ellingrod V. eds. *Pharmacotherapy: A Pathophysiologic Approach, 11e*. McGraw Hill; 2020:32-38. Accessed July 6, 2022. <https://accesspharmacy.mhmedical.com/content.aspx?bookid=2577&sectionid=228901475>
14. Myrdal PB, Sheth P, Stein S. Advances in metered dose inhaler technology: formulation development. *AAPS PharmSciTech*. 2014;15(2):434-455
15. Albuterol. Lexi-Drugs. Lexicomp Online. Lexicomp; 2020. Updated August 6, 2022. Accessed August 16, 2022. <https://online.lexi.com>.
16. Levalbuterol. Lexi-Drugs. Lexicomp Online. Lexicomp; 2020. Updated July 6, 2022. Accessed August 16, 2022. <https://online.lexi.com>.
17. Flovent HFA [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2021.
18. Asmanex HFA [package insert]. Jersey City, NJ: Organon & Co.; 2021
19. Advair HFA [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2021.
20. Symbicort [package insert]. Wilmington, DE: AstraZeneca Pharmaceuticals LP; 2017
21. Budesonide and Formoterol. Lexi-Drugs. Lexicomp Online. Lexicomp; 2020. Updated August 6, 2022. Accessed August 16, 2022. <https://online.lexi.com>.
22. Dulera [package insert]. Jersey City, NJ: Organon & Co.; 2021.
23. Bevespi Aerophere [package insert]. Wilmington, DE: AstraZeneca Pharmaceuticals LP; 2019.
24. Breztri Aerophere [package insert]. Wilmington, DE: AstraZeneca Pharmaceuticals LP; 2021.
25. Hess D, Dhand R. The use of inhaler devices in adults. In: Post TW, ed. *UpToDate*. UpToDate; 2022. Last Updated September 29, 2020. Accessed July 6, 2022. <https://www.uptodate.com/contents/the-use-of-inhaler-devices-in-adults>
26. Rodríguez-Martínez CE, Sossa-Briceño MP, Sinha IP. Commercial valved spacers versus home-made spacers for delivering bronchodilator therapy in pediatric acute asthma: a cost-effectiveness analysis. *J Asthma*. 2021;58(10):1340-1347. doi:10.1080/02770903.2020.1784195
27. Teva Respiratory LLC. About QVAR RediHaler® (beclomethasone dipropionate HFA Maintenance Inhaler). Updated February 2022. Accessed July 6, 2022. <https://hcp.qvar.com/about-qvar-redihaler/>
28. Combivent Respimat [package insert]. Ridgefield, CT: Boehringer Ingelheim Pharmaceuticals, Inc.; 2021.
29. Spiriva Respimat [package insert]. Ridgefield, CT: Boehringer Ingelheim Pharmaceuticals, Inc; 2021.
30. Striverdi Respimat [package insert]. Ridgefield, CT: Boehringer Ingelheim Pharmaceuticals, Inc; 2021.
31. Stiolto Respimat [package insert]. Ridgefield, CT: Boehringer Ingelheim Pharmaceuticals, Inc.; 2021.
32. Azouz W, Chrystyn H. Clarifying the dilemmas about inhalation techniques for dry powder inhalers: integrating science with clinical practice. *Prim Care Respir J*. 2012;21(2):208-213. doi:10.4104/pcrj.2012.00010
33. Serevent Diskus [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2022.
34. Pulmicort Flexhaler [package insert]. Wilmington, DE: AstraZeneca Pharmaceuticals LP; 2019.
35. ArmonAir Digihaler [package insert]. Parsippany, NJ: Teva Pharmaceuticals USA; 2020.
36. Arnuity Ellipta [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2018.
37. Advair Diskus [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2020.
38. Wixela Inhub [package insert]. Morgantown, WV: Mylan Pharmaceuticals Inc.; 2021.
39. AirDuo RespiClick [package insert]. Parsippany, NJ: Teva Pharmaceuticals USA, Inc.; 2021.
40. AirDuo Digihaler [package insert]. Parsippany, NJ: Teva Pharmaceutical USA, Inc.; 2021.
41. Breo Ellipta [package insert]. Research Triangle Park: GlaxoSmithKline; 2019.
42. Tudorza Pressair [package insert]. Wilmington, DE: AstraZeneca Pharmaceuticals LP; 2019.
43. Spiriva Handihaler [package insert]. Ridgefield, CT: Boehringer Ingelheim Pharmaceuticals, Inc.; 2021.
44. Incruse Ellipta [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2019.
45. Anoro Ellipta [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2020.
46. Trelegy Ellipta [package insert]. Research Triangle Park, NC: GlaxoSmithKline; 2020.
47. Kaplan A, Price D. Matching inhaler devices with patients: the role of the primary care physician. *Can Respir J*. 2018;2018:9473051. Published 2018 May 23. doi:10.1155/2018/9473051
48. Price D, Keininger DL, Viswanad B, et al. Factors associated with appropriate inhaler use in patients with COPD - lessons from the REAL survey [published correction appears in *Int J Chron Obstruct Pulmon Dis*. 2018 Jul 25;13:2253-2254]. *Int J Chron Obstruct Pulmon Dis*. 2018;13:695-702. Published 2018 Feb 26. doi:10.2147/COPD.S149404

49. Kher S, Landau H, Hon SM, et al. Inhaler use and education characteristics among English and non-English speaking patients: A pilot needs assessment survey. *Patient Educ Couns*. 2019;102(5):932-936. doi:10.1016/j.pec.2018.12.016
50. Usmani OS, Lavorini F, Marshall J, et al. Critical inhaler errors in asthma and COPD: a systematic review of impact on health outcomes. *Respir Res*. 2018;19(1):10. Published 2018 Jan 16. doi:10.1186/s12931-017-0710-y
51. Nguyen TS, Nguyen TLH, Van Pham TT, et al. Pharmacists' training to improve inhaler technique of patients with COPD in Vietnam. *Int J Chron Obstruct Pulmon Dis*. 2018;13:1863-1872. Published 2018 Jun 11. doi:10.2147/COPD.S163826
52. Axtell S, Haines S, Fairclough J. Effectiveness of various methods of teaching proper inhaler technique. *J Pharm Pract*. 2017;30(2):195-201. doi:10.1177/0897190016628961
53. Cogan P, Sucher B. Appropriate use of pressurized metered-dose inhalers for asthma. *US Pharm*. 2015;40(7):36-41. Accessed August 16, 2022. <https://www.uspharmacist.com/article/appropriate-use-of-pressurized-metereddose-inhalers-for-asthma>
54. Qvar Redihaler [package insert]. Parsippany, NJ: Teva Pharmaceuticals USA, Inc.; 2021.
55. Haughney J, Price D, Barnes NC, et al. Choosing inhaler devices for people with asthma: current knowledge and outstanding research needs. *Respir Med*. 2010;104(9):1237-1245. doi:10.1016/j.rmed.2010.04.012
56. Choosing an inhaler device to suit the individual. National Asthma Council Australian Asthma Handbook. Accessed July 6, 2022. <https://www.astmahandbook.org.au/management/devices/device-choice>
57. Gardenhire DS, Burnett D, Strickland S, Myers TR. A guide to aerosol delivery devices for respiratory therapists, 4<sup>th</sup> edition. American Association for Respiratory Care. 2017. Accessed July 6, 2022. <https://www.aarc.org/wp-content/uploads/2018/03/aersol-guides-for-rt.pdf>
58. Petite SE, Hess MW, Wachtel H. The role of the pharmacist in inhaler selection and education in chronic obstructive pulmonary disease. *J Pharm Technol*. 2021;37(2):95-106. doi:10.1177/8755122520937649
59. Price D, Chrystyn H, Kaplan A, et al. Effectiveness of same versus mixed asthma inhaler devices: a retrospective observational study in primary care. *Allergy Asthma Immunol Res*. 2012;4(4):184-191. doi:10.4168/aair.2012.4.4.184
60. Dekhuijzen PN, Lavorini F, Usmani OS. Patients' perspectives and preferences in the choice of inhalers: the case for Respimat or HandiHaler. *Patient Prefer Adherence*. 2016;10:1561-1572. Published 2016 Aug 18. doi:10.2147/PPA.S82857
61. Chrystyn H, van der Palen J, Sharma R, et al. Device errors in asthma and COPD: systematic literature review and meta-analysis. *NPJ Prim Care Respir Med*. 2017;27(1):22. Published 2017 Apr 3. doi:10.1038/s41533-017-0016-z
62. Navaie M, Dembek C, Cho-Reyes S, et al. Device use errors with soft mist inhalers: A global systematic literature review and meta-analysis. *Chron Respir Dis*. 2020;17:1479973119901234. doi:10.1177/1479973119901234
63. Price DB, Román-Rodríguez M, McQueen RB, et al. Inhaler errors in the CRITIKAL study: Type, frequency, and association with asthma outcomes. *J Allergy Clin Immunol Pract*. 2017;5(4):1071-1081.e9. doi:10.1016/j.jaip.2017.01.004
64. Weller T. Placebo inhaler devices and infection risks. *Nursing Times*. 2005;101(42):50. Accessed August 16, 2022. <https://www.nursingtimes.net/archive/placebo-inhaler-devices-and-infection-risks-18-10-2005/>
65. Institute for Safe Medication Practices (ISMP). Correct use of inhalers: help patients breathe easier. July 14, 2016. Accessed July 6, 2022. <https://www.ismp.org/resources/correct-use-inhalers-help-patients-breathe-easier>

## Appendix I. Inhaler Manufacturer Contact List (Current as of July 1, 2022)

| Company                                    | Products<br><i>(demo device unavailable)</i>  | Business Contact  |
|--|---|---|
| AstraZeneca                                | Bevespi Aerosphere<br>Breztri Aerosphere<br>Pulmicort Flexhaler<br>Symbicort HFA  | 1-800-236-9933<br>Monday-Friday, 8 am-6 pm ET<br><br><a href="https://www.astrazeneca-us.com/az-in-us/Contact-us.html">https://www.astrazeneca-us.com/az-in-us/Contact-us.html</a><br><br>Discount card eligibility:<br><a href="https://www.azandmeapp.com/home.html">https://www.azandmeapp.com/home.html</a> |
| Boehringer Ingelheim Pharmaceuticals, Inc. | Combivent Respimat<br>Spiriva Respimat<br>Stiolto Respimat<br>Striverdi Respimat<br><i>Atrovent HFA</i><br><i>Spiriva Handihaler</i>  | Direct Representative Line: 1-800-243-0127<br><br><a href="https://www.boehringer-ingelheim.us/contact-form">https://www.boehringer-ingelheim.us/contact-form</a><br><br>Patient assistance program:<br>1-800-556-8317 or <a href="http://www.bipatientassistance.com">www.bipatientassistance.com</a>          |
| GlaxoSmithKline (GSK)                      | Breo Ellipta<br>Trelegy Ellipta<br>Anoro Ellipta<br>Incruse Ellipta<br>Arnuity Ellipta<br><i>Advair Diskus</i><br><i>Advair HFA</i><br><i>Flovent Diskus</i><br><i>Flovent HFA</i><br><i>Serevent Diskus</i><br><i>Ventolin HFA</i> | GSK Response Team: 1-888-825-5249<br>Monday-Friday, 8:30 am-5:30 pm ET<br><br><a href="https://www.contactus.gsk.com/callback/hcp.html">https://www.contactus.gsk.com/callback/hcp.html</a><br><br>Discount card eligibility:<br><a href="http://www.gskforyou.com">www.gskforyou.com</a>                       |
| Organon & Co.                              | <i>Asmanex HFA</i><br><i>Asmanex Twisthaler</i><br><i>Dulera HFA</i>  | Service Center: 1-844-674-3200<br><br>Coupons for patients with private insurance:<br><a href="http://www.asmanex.com">www.asmanex.com</a> ; <a href="http://www.dulera.com">www.dulera.com</a>   |
| Mylan                                      | Wixela Inhub  | Customer Relations Team: 1-800-796-9526<br><br>Discount card eligibility: <a href="http://www.wixela.com">www.wixela.com</a>  |
| Sunovion                                   | <i>Xopenex HFA</i>  | Customer Service (Respiratory):<br>1-844-276-8262   |
| Teva                                       | albuterol sulfate HFA (generic)<br>ProAir RespiClick<br><i>fluticasone propionate/salmeterol inhalation powder, USP</i><br><i>levalbuterol tartrate HFA (generic)</i><br><i>QVAR Redihaler</i>                                      | Clinician Support Line: 1-877-867-3034<br><br>Patient assistance program: 1-800-896-5855  |

ABBREVIATION: HFA = hydrofluoroalkane

All information was obtained by calling companies directly and was up to date as of July 1, 2022.