Aaron M Mulhall MD

15 Practical Guide to Correct Inhaler Use

Key Points
1. Knowledge of proper inhaler techniques enables providers to educate patients with COPD how to use their medications correctly and achieve maximal benefits.
2. Correct inhaler use is critical to obtaining maximal therapeutic benefit.
3. Repetitive inhaler education and direct observation play crucial roles in ensuring that patients use their inhalers correctly.
4. Correct use of pressurized metered-dose inhalers (pMDIs) requires coordination between activating the canister and slowly inhaling the aerosol.
5. Using a spacer with a pMDI improves effective drug delivery to the lungs.
6. Multidose dry powder inhalers (DPIs) are inhalation-triggered by the patient and do not require activation-inhalation coordination for proper use.
7. The Respimat® Soft Mist Inhaler® (SMI) provides the same level of bronchodilation as pMDIs without spacers and DPIs, but at roughly half the dose of medication. The Respimat® SMI has been shown to have greater lung and less oropharyngeal deposition of medication compared to pMDIs without spacers and DPIs.
8. Nebulizers are an alternative to short acting bronchodilator pMDIs when patients are unable to use a pMDI properly or when they are hospitalized. There is not a significant clinical therapeutic difference between medications delivered by pMDI with a spacer and by nebulizer.

15.1 Introduction

Inhaled medications have a critical role in the treatment of chronic obstructive pulmonary disease (COPD). The goals of treatment include bronchodilation, minimizing airway inflammation, preventing exacerbations, improving quality of life (QOL), and decreasing mortality (Celli, 2004). The success and potential benefits of treatment depend upon successfully delivering the drug to the appropriate location in the lungs. Inhalers, when properly used, serve to target the drug directly to the lungs (Dolovich, 2005; Ernst, 1998; Pauwels, 1997). Inhaled medications are a preferred treatment for COPD, as compared to oral or intravenous (IV) medications, because they can be distributed to the lungs as an aerosol in smaller quantities, leading to significantly fewer systemic side effects (Aerosol Consensus Statement, 1991; GOLD website).

The ability of the drug to reach the smaller, more peripheral airways of the lung is critical for inhaler efficacy. Inhaled particles that are traveling at high velocity or are too large tend to be delivered to the larger (more proximal) airways, thus not reaching their target. To reach the smaller airways, particles must be moving slowly enough
Table 15.1: Qualities that exemplify the “ideal” inhaler

<table>
<thead>
<tr>
<th>Readily able for patient to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Easy to use/learn</td>
</tr>
<tr>
<td>- Small and portable (can keep in pocket)</td>
</tr>
<tr>
<td>- Ready to use</td>
</tr>
<tr>
<td>- Breath-actuated (breath triggers drug delivery)</td>
</tr>
<tr>
<td>- Can control drug delivery based on audio/visual features (ex: dose count meter)</td>
</tr>
<tr>
<td>- Only medication delivered (no propellants or additives)</td>
</tr>
<tr>
<td>- Multidose and can be reloaded/refilled</td>
</tr>
<tr>
<td>- Environmentally safe</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drug dose and amount delivered are independent of external conditions and low inspiratory flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Able to deliver drug in small particles</td>
</tr>
<tr>
<td>- Delivers aerosol slowly</td>
</tr>
<tr>
<td>- Minimizes oropharyngeal delivery</td>
</tr>
</tbody>
</table>

and must be small enough (1–5µm) to navigate the multiple directional bifurcations within the distal airways (Burton, 1992; Dolovich, 1991).

There are a variety of available inhalational devices that deliver medication in an aerosol form. The choice of medication, as well as the ability of the patient, ultimately determines what type of inhaler to prescribe (Broeders, 2009; Hanania, 1994; Vincken, 2010) (Table 15.1). In this chapter, we will review most commonly prescribed inhalers (pressurized metered-dose inhalers [pMDIs], multidose dry powder inhalers [DPIs], Respimat® inhaler, and nebulizers), how they work, and the correct steps to use them properly.

15.2 Inhaler Education and Errors in Inhaler Technique

The most commonly used inhalation devices are pMDIs, DPIs, Respimat® and nebulizers. (Table 15.2) If used properly, each of these devices can deliver a precise amount of drug in small particles that can reach the terminal airways and produce a bronchodilating effect. Incorrect inhaler use by patients decreases medication adherence and diminishes the therapeutic benefit (Crompton, 1982; McFadden, 1995). Errors in inhaler technique occur in as many as 90% of patients with COPD (Crompton, 1982; Crompton, 2006; Fink, 2005; Lavorini, 2008; McFadden, 1995; Rees, 2005; Wieshammer, 2008). Factors associated with improper inhaler use in patients with COPD include age, impaired cognitive function, and poor training of healthcare professionals responsible for teaching correct inhaler use (Leiva-Fernández, 2012). Problems are further increased when patients use multiple inhalation delivery devices, often
Inhaler Education and Errors in Inhaler Technique

Errors in inhaler technique are often a consequence of inadequate or poor education. Inhaler education prior to initiation of inhalation therapy is critical and written instruction alone are inadequate. Verbal instruction, assessing correct inhaler technique, and reassessment decrease inhaler misuse (De Boeck, 1999; Leiva-Fernández, 2012). Patients who have recurrent inhaler education have better inhaler techniques compared with those who only receive instruction at the time of prescription (Gracia-Antequera, 1999). The Global Initiative for Chronic Obstructive Lung Disease (GOLD) and the National Institute for Health and Care Excellence (NICE) both recommend inhaler education and device training when a patient is prescribed a new inhaler (GOLD, NICE websites). They also recommend that correct inhaler technique be assessed at each patient encounter. However, up to 25% of patients do not receive any verbal instruction when prescribed an inhalational device (Lavorini, 2008).

There are several modalities used to provide inhaler education and improve correct use. Demonstration of inhaler use by healthcare professionals is effective at both teaching and assessing the correct use of inhaler devices (Bosnic-Anticevich, 2010; Nimmo, 1993). However, healthcare professionals often do not know how to

<table>
<thead>
<tr>
<th>Table 15.2: Medications commonly used for the treatment of COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressurized Metered-Dose Inhalers (pMDIs) (Can use with a spacer)</strong></td>
</tr>
<tr>
<td>Albuterol</td>
</tr>
<tr>
<td>Ipratropium</td>
</tr>
<tr>
<td>Albuterol / Ipratropium</td>
</tr>
<tr>
<td>Budesonide / Formoterol</td>
</tr>
<tr>
<td><strong>Multidose Dry Powder Inhalers (DPIs)</strong></td>
</tr>
<tr>
<td>Formoterol</td>
</tr>
<tr>
<td>Mometasone</td>
</tr>
<tr>
<td>Budesonide</td>
</tr>
<tr>
<td>Tiotropium</td>
</tr>
<tr>
<td>Fluticasone / Salmeterol</td>
</tr>
<tr>
<td>Aclidinium</td>
</tr>
<tr>
<td><strong>Respimat® Soft Mist Inhaler (SMI)</strong></td>
</tr>
<tr>
<td>Ipratropium</td>
</tr>
<tr>
<td>Tiotropium</td>
</tr>
<tr>
<td>Albuterol / Ipratropium</td>
</tr>
<tr>
<td><strong>Nebulized Solutions</strong></td>
</tr>
<tr>
<td>Albuterol</td>
</tr>
<tr>
<td>Ipratropium</td>
</tr>
<tr>
<td>Albuterol / Ipratropium</td>
</tr>
</tbody>
</table>
use the inhalation device and often cannot use it correctly themselves (Guidry, 1992; Hanania, 1994; Keston, 1993). Coaching has also been used to improve the ability to use inhalers; however, many patients often quickly revert back to an incorrect inhalation technique (Crompton, 1982; Duerden, 2002). For the patient to have the optimum benefit of their inhaled medication, it is of the utmost importance that the healthcare professional educating the patient has proper knowledge of the inhaler, knows what inhalers are appropriate for individual patients, and can teach correct inhaler use.

15.3 Inhalation Delivery Systems

15.3.1 Pressurized Metered-Dose Inhalers (pMDIs)

The pMDI has long been the most commonly used inhaled device because it is small, portable, inexpensive, and relatively easy to use (Vincken, 2010). Benefits of pMDIs are that they are pocket-sized, efficient, and can deliver many doses of medication quickly with precision. The pMDI is a pressurized canister filled with liquid medication placed in a chamber with a mouthpiece. Built into this system is a metering valve that delivers a specific quantity of the drug with each use. The wet aerosol is delivered to the lungs by a propellant. Historically, chlorofluorocarbon (CFC) was used as a propellant but CFC use is banned by the Montreal Protocol on Substances that Deplete the Ozone Layer because CFCs have been linked to depletion of the ozone layer in the upper atmosphere. CFCs have since been replaced by hydrofluoroalkanes (HFA), which are more environmentally friendly (Dolovich, 1999). The newer pMDIs formulated with HFAs have, in part, many of the same inhaler characteristics (smaller
Inhalation Delivery Systems

pMDIs are designed to deliver an exact dose of medication to the lungs (Wilson, 1993). When the patient presses the canister, a one-way metering valve opens. The drug is aerosolized and the patient inhales it from the mouthpiece. The particle sizes within the aerosol vary, and the larger particles are deposited more proximally and the smaller particles dispersed to the smaller airways (Finlay, 2001; Hickey, 2004; Swarbrick, 2007). (Figure 15.1) For pMDIs to deliver the medication to the lungs properly, there must be coordination between canister activation and aerosol inhalation (Crompton, 1982; Larsen, 1994). pMDIs are both a reliable and effective inhaler device when used correctly. The coordinated steps that must be taken to use the pMDI correctly are shown in Table 15.3.

Table 15.3: Correct steps for using pMDI without a spacer

1. Shake the inhaler well immediately before each use.
2. Remove cap from mouthpiece
3. Check mouthpiece for foreign objects.
4. Make sure the canister is fully inserted into the actuator.
5. Prime inhaler if using for the first time or if the inhaler has not been used for over 2 weeks. Do this by spraying the inhaler 2–3 times away from the face.
6. Breathe out gently and fully through the mouth, trying to remove as much air from the lungs as possible.
7. Open the mouth wide, and place the open end of the mouthpiece about 1–2 inches from the mouth and inhale (slowly and deeply; as if sipping hot soup). Press canister down into the mouthpiece to actuate the aerosol at the beginning of inhalation while continuing to inhale deeply.
8. At end of inspiration, hold breath for 10 seconds, or as long as possible, then breathe out slowly.
9. If more puffs are needed (albuterol and ipratropium), wait for a few seconds before repeating steps 4–8.

Determining the amount of medication remaining in the pMDI canister has been difficult to assess. The float method was used in the past to determine the amount of medication remaining in pMDIs. In the float method, the canister containing medication was placed in water. If the canister was empty if would float. How full the canister was full of medication would determine how far it would sink. Float testing is highly variable, product-specific, and a function of canister size, design, content, and method of testing (Brock, 2002). Float testing is not recommended as an appropriate method to measure medication adherence. Directly weighing the canister and dose counters are the most accurate ways to assess the medication remaining in the
Practical Guide to Correct Inhaler Use

pMDI canister. Dose counters have now been added to some pMDIs brands over the past decade. These devices display the number of doses/actuations that remain in the inhaler. The accuracy of dose counters depends upon the ability of the dose counter to decrease by one unit each time the patient actuates the inhaler. The dose counter should also be ergonomic (patient-friendly), and sustainable (lasting for the lifetime of the inhaler) (Weinstein, 2011).

15.3.2 Spacer Utilization

pMDIs are good inhalational devices for patients with COPD, but medication effectiveness using this type of inhaler is limited by the coordination of multiple steps, fine motor control, hand / finger strength, arthritis or other hand deformity, and, most importantly, precise hand-breath coordination. One way to minimize the issue of hand-breath coordination with a pMDI is to use a spacer. These devices improve drug delivery to the patient who is either non-co-operative with pMDI use without the spacer, or unable to master correct pMDI usage. Spacers improve effective drug delivery when using the pMDI (Brennan, 2005; Melani, 2004). A spacer consists of a holding chamber with a one-way valve that connects to the mouthpiece of the pMDI. After activation of the pMDI, the medication aerosol is contained within the holding chamber and slowly inhaled by the patient. The one-way valve opens during inspiration and closes during expiration. This valve helps prevent drug loss which commonly occurs when patients cannot coordinate activating the canister and inhaling the aerosol (Dolovich, 1983). The spacer can also help to deliver the medication effectively to the smaller, more peripheral airways by slowing down the smaller particles and holding them in suspension for about one second, allowing some of the propellant surrounding the drug to evaporate. (Figure 15.2) Larger drug particles are also retained or deposited within the spacer during inhalation, thus limiting the inhaled aerosol to small particles that can reach the terminal airways (Ahrens, 1995; Barry, 1996). Another benefit is that larger particles will not reach the oropharynx, decreasing potential side effects. Spacers decrease oropharyngeal candidiasis associated with inhaled corticosteroid use; however, they do not decrease the rate of dyspho-
Inhalation Delivery Systems

Despite the benefits of spacer use, they are infrequently prescribed or used. This reduced adherence may be due to the size of the spacer (they are long, bulky, and not conveniently transported), and patients are often embarrassed to use them in public. Another disadvantage of the spacer is that it requires frequent cleaning by a standard procedure (Bisgaard, 2007; Van der Palen, 1999). (Table 15.4)

Table 15.4: Correct steps for using pMDI with spacer

1. Shake the inhaler well before use (3–4 shakes)
2. Remove the cap from the inhaler, and from the spacer, if it has one
3. Attach the inhaler to the spacer
4. Breathe out, away from the spacer
5. Insert the spacer mouthpiece in mouth, putting the mouthpiece between teeth and closing lips around it
6. Activate the pMDI by pressing the top of the inhaler once; the aerosol will be sprayed into the holding chamber of the spacer
7. Breathe in slowly (as if sipping hot soup) until a full breath is taken. If the spacer whistle sounds, decrease the inspiratory speed.
8. Hold breath for about ten seconds or for as long as is comfortable, and then breathe out slowly.
9. If more puffs are needed (albuterol and ipratropium), wait for a few seconds before repeating steps 4–8.

To clean the spacer:

1. Take the spacer apart (usually by removing the cap or flange containing the pMDI attachment port).
2. Clean the parts by washing in warm water with mild dish detergent. Never use boiling hot water, rubbing alcohol, or disinfectant.
3. Rinse the parts well in clean water.
4. Let spacer air dry.
5. Put the spacer back together.

DPIs were developed as alternative inhalers for patients who have difficulty using pMDIs and as environmentally friendly alternatives to CFC containing pMDI. DPIs specifically address issues with actuation-inhalation synchronization as well as potential allergic reactions to the propellants in the pMDIs (Beaucage, 2002). They resolve actuation-inhalation difficulties by being inhalation-triggered. They deliver medication, in the form of a dry powder, to the smaller airways. The medication is released in the form of small particles that are inhaled into the airways when the patient takes a breath. The factors that determine the amount of medication delivered by DPIs are the inspiratory volume and flow produced by the patient. There are a variety of DPIs, and
Figure 15.3: Aerolizer® multidose dry powder inhaler (DPI)

Figure 15.4: Handihaler® multidose dry powder inhaler (DPI)

Figure 15.5: Twisthaler® multidose dry powder inhaler (DPI)
Inhalation Delivery Systems

with each one the amount of inspiratory flow needed to deliver the medication to the correct location varies. Examples of DPIs include the Twisthaler®, Handihaler®, and Aerolizer®. (Figures 15.3–15.5) The correct steps for commonly used DPIs are shown in Tables 15.5–15.7.

The main advantages of DPIs include: they do not requiring a propellant for aerosolization and are ecologically friendly; they are breath-triggered and do not require the precise hand-inhalation coordination of pMDIs (Melani, 2007; Virchow, 2008).

Table 15.5: Correct steps for Using Formoterol (Foradil Aerolizer®) DPI

1. Hold the base of the inhaler firmly and twist the mouthpiece in the direction of the arrow to open.
2. Push the buttons in on each side to make sure that you can see 4 pins in the capsule-chamber of the inhaler.
3. Remove one capsule from the blister packer by peeling off the paper backing that covers one capsule, and pushing the capsule through the foil.
4. Place the capsule in the capsule-chamber in the base of the inhaler and twist the mouthpiece back to the closed position.
5. Hold the mouthpiece of the inhaler upright and press both buttons at the same time. Only press the buttons ONCE. There will be a click as the capsule is being pierced.
6. Release the buttons.
7. Keep the inhaler level, with the blue buttons to the left and right (not up and down).
8. Breathe out and exhale fully.
9. Place the mouthpiece in mouth and close lips around it.
10. Breathe in quickly and deeply. This will cause the capsule to spin around in the chamber and deliver the dose of medicine. There will be a whirring noise and a sweet taste due to the sugar filler in the capsule.
11. Remove the inhaler from mouth and continue to hold breath as long as possible, and then exhale.
12. Open the inhaler to see if any powder is still in the capsule. If any powder remains in the capsule repeat steps 8 to 11. Most people are able to empty the capsule in one or two inhalations.
13. After use, open the inhaler, remove and discard the empty capsule. Do not leave a used capsule in the chamber.
14. Close the mouthpiece and replace the cover.

Table 15.6: Correct steps for using Tiotropium (Spiriva Handihaler®) DPI

15. Open Handihaler by lifting the cap and the mouthpiece on the top to reveal capsule insertion site.
16. Separate one of the blisters from the blister card, open, and remove the capsule.
17. Insert the capsule and close the mouthpiece firmly against the gray base until it clicks shut.
18. Press the green piercing button once until it is flat (flush) against the base, then release.
20. Place Handihaler mouthpiece in mouth and breathe in deeply until lungs are full. The capsule will vibrate (rattle).
21. To take a full daily dose, inhale twice from the same capsule by repeating steps 5 and 6.
Disadvantages of DPIs include: inability to use them with non-cooperative patients or those being ventilated via endotracheal tube or tracheotomy tube; cannot use a spacer to improve effective drug delivery; the amount of drug delivered is not as accurate, or reproducible, compared to pMDIs; patients who cannot generate appropriate inspiratory volume or flow will receive inadequate drug doses; each individual DPI has its own steps for correct use requiring dexterity and understanding of each inhaler (Clark, 1993; Fuller, 1995; Olsson, 1998; Robbins, 2005; Tarsin, 2006).

15.3.4 Respimat® Soft Mist Inhaler® (SMI®)

The Respimat® SMI® is the most recent inhaler delivery system to be developed as an alternative to pMDIs. The Respimat® SMI® forces a solution carrying the medication through a series of channels with two nozzles on the end. These nozzles focus two fluid jets at a convergence, producing a vapor of medication-containing droplets of a precise size that can be inhaled (Dalby, 2004; Dalby, 2011; Panos, 2013). (Figure 15.6) This inhaler was also developed to deliver the vapor at a slower velocity, thus increasing the window of time for successful inhalation, decreasing drug deposition in the oropharynx, and increasing the amount of medication successfully reaching the lungs. A number of studies have confirmed less oropharyngeal and greater lung deposition with the Respimat® SMI® compared to pMDIs without spacers and DPIs (Brand, 2008; Khachikian, 2012; Newman, 1996; Newman, 1998; Pitcaim, 2005). Another benefit of the Respimat® SMI® is that it provides the same level of bronchodilation that pMDIs offer at a much lower dose (Iacono, 2000; Kilfeather, 2004; Ram, 2011; Zuwallack, 2010).

To use the Respimat® SMI®, a medication-containing cartridge must be inserted into the delivery system. This device is activated by twisting the base 180° (half a turn) until it clicks. This twisting loads the fluid into the dosing chamber. The patient then
presses the dose-release button sending the fluid through the series of channels with nozzles at the end producing an inhalable particle vapor that exits the device. The coordinated steps that must be taken to use the Respimat® SMI® correctly are shown in Table 15.8.

15.3.5 Nebulized Solutions

Prior to the development of pMDIs and DPIs, inhaled medications were delivered via nebulizer. They transform the liquid form of medication into an aerosol of particles of various sizes that can be inhaled by mouthpiece or mask. The medication is inhaled while the patient is tidal breathing and does not require a deep, coordinated inspiration. To use a nebulized solution, one must have a nebulizer, air or oxygen compressor, and a mask or mouthpiece. (Figure 15.7) (Table 15.9) The types of medication delivered via nebulizer vary (steroids, short acting bronchodilators, and long acting...
bronchodilators), and their delivery will depend on the drug’s solubility and if they are in a solution or a suspension.

The ability of a nebulizer to deliver medications to the lungs successfully depends upon many factors, especially the patient’s breathing pattern and the nebulizer output. As the drug is nebulized, its concentration in solution increases, leaving up to 50% of the drug in the reservoir (Johnson, 1989). The flow of gas in the nebulizer can alter the amount of drug delivered by changing particle size and nebulizer time. A flow rate between 6 and 10L/min can deliver approximately 2.5 mL of drug solution over 5–10 minutes (Muers, 1997). The patient should have a tidal (slow and regular) breathing pattern while inhaling the aerosol. It is also important to note these medications should be inhaled by breathing in and out through the mouth. Nebulizers are widely popular, often used, and are thought to be the most effective way to deliver inhaled medication. This, however, is not the case as only about 5% of the nebulized medication makes it to the smaller airways (Johnson, 1989). The rest of the medication is either delivered proximally, exhaled, or lost in the form of condensation in the reservoir, tubing, mouthpiece, or on the face.

There are a number of disadvantages to using a nebulizer. The process of delivering an inhaled medication to the lungs is long, inconvenient, and cumbersome (Melani, 2007). It is almost impossible to precisely deliver a set dose of medication with a nebulizer (Johnson, 1989). Nebulizers need to be cleaned frequently to prevent

---

Table 15.8: Correct steps for using Respimat® SMI®

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Remove cartridge from box and push the narrow end of the cartridge into the inhaler. The cartridge will not sit flush with the inhaler, with 1/8 of an inch of the cartridge sticking out of the inhaler.</td>
</tr>
<tr>
<td>2.</td>
<td>Place clear base over the top of the cartridge.</td>
</tr>
<tr>
<td><strong>To Prime</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Prime inhaler if using for the first time, or if it has not been used in 3 weeks.</td>
</tr>
<tr>
<td>2.</td>
<td>To prime, hold the inhaler upright, with the orange cap closed. Turn the clear base in the direction of the white arrows on the label until it clicks (half a turn). Flip the orange cap until it snaps fully open. Point inhaler toward the ground and press the dose release button. Repeat three more times.</td>
</tr>
<tr>
<td><strong>To Use</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Hold the inhaler upright with the orange cap closed, so it does not accidentally discharge a dose of medicine.</td>
</tr>
<tr>
<td>2.</td>
<td>Turn the clear base in the direction of the white arrows on the label until it clicks (half a turn / 180°).</td>
</tr>
<tr>
<td>3.</td>
<td>Flip the orange cap until it snaps fully open.</td>
</tr>
<tr>
<td>4.</td>
<td>Breathe out slowly and fully, and then close lips around the end of the mouthpiece without covering the air vents.</td>
</tr>
<tr>
<td>5.</td>
<td>Point inhaler to the back of throat.</td>
</tr>
<tr>
<td>6.</td>
<td>While taking in a slow, deep breath by mouth, press the dose release button and continue to breathe in slowly for as long as possible.</td>
</tr>
<tr>
<td>7.</td>
<td>Hold breath for 10 seconds or for as long as comfortable.</td>
</tr>
</tbody>
</table>
contamination of the nebulized aerosols. Contamination has occurred frequently with the following microorganisms: methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, *Burkholderia* species, and *Stenonotrophomonas* species (Berlinski, 2006; Melani, 2001). Most nebulizers are not portable.

There have been many studies comparing pMDIs (with a spacer) to nebulizers, showing that both are equally effective. Some studies favor pMDI use with a spacer over nebulizers in acute care and hospital settings, citing similar efficacy and potential cost savings (Comargo, 2000; Idris, 1993). The GOLD guidelines do not recommend the use of nebulizers for regular maintenance therapy in the treatment of COPD (GOLD website). The American Thoracic Society (ATS) and the European Respiratory Society (ERS) guidelines suggest that nebulizers can be used in the following situations for COPD: when using short acting bronchodilators; when patients cannot use an inhaler properly; and when patients are hospitalized (easier to deliver by respiratory therapist and requires little patient effort) (Celli, 2004).

Table 15.9: Correct steps for using nebulizer

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Remove 1 vial from the foil pouch.</td>
</tr>
<tr>
<td>2.</td>
<td>Twist cap off vial and squeeze contents into nebulizer reservoir.</td>
</tr>
<tr>
<td>3.</td>
<td>Connect nebulizer reservoir to the facemask/mouthpiece.</td>
</tr>
<tr>
<td>4.</td>
<td>Connect nebulizer to the compressor.</td>
</tr>
<tr>
<td>5.</td>
<td>Sitting upright, in a comfortable position, place mouthpiece into mouth and turn on compressor.</td>
</tr>
<tr>
<td>6.</td>
<td>Breathe slowly and regularly until no more mist is in the nebulizer chamber.</td>
</tr>
</tbody>
</table>

To clean weekly:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Remove the mask/mouthpiece from the reservoir. Remove the tubing and set it aside. The tubing should not be washed or rinsed. Wash the mask/mouthpiece with a mild dishwashing soap and warm water.</td>
</tr>
<tr>
<td>2.</td>
<td>Rinse under a strong stream of water for 30 seconds.</td>
</tr>
<tr>
<td>3.</td>
<td>Rinse the nebulizer parts under warm running water for 1 minute. Use distilled or sterile water, if possible.</td>
</tr>
<tr>
<td>4.</td>
<td>Shake off excess water and air dry.</td>
</tr>
<tr>
<td>5.</td>
<td>Put the mask/mouthpiece, reservoir, and tubing back together and connect the device to the compressed air machine. Run the machine for 10 to 20 seconds to dry the inside of the nebulizer thoroughly.</td>
</tr>
<tr>
<td>6.</td>
<td>Disconnect the tubing from the compressed air machine. Store the nebulizer.</td>
</tr>
<tr>
<td>7.</td>
<td>Clean the surface of the compressed air machine with a damp, soapy cloth, sponge, or an alcohol or disinfectant wipe. Never place the air compressor in water. Place a cover over the compressed air machine.</td>
</tr>
</tbody>
</table>
15.4 Reminders to Increase Adherence

The goals of COPD treatment are to control disease symptoms, prevent chronic complications related to the disease, and prevent exacerbations. Patient adherence with inhaled medications helps to achieve these goals (GOLD website; Restrepo, 2008). Adherence is concordance between the healthcare provider’s recommendations and the patient’s actual behavior. This concordance requires that the patient assumes an active role in their treatment. Over half of patients with COPD adhere poorly with their treatment regimens (Bender, 2006; Haupt, 2008; Krigsman, 2007a; Krigsman, 2007b; Krigsman, 2007c; Lareau, 2010; WHO website). There are a number of reasons for poor adherence, including: the number of chronic co-morbidities; the number of prescribed medications; decreased adherence over time with chronic use of medications; impaired physical and cognitive function; lack of patient understanding about chronic nature of COPD and use of medications to prevent exacerbations; and discontinuation of medication in response to a decline in symptoms (Dolce, 1991; Krigsman, 2007b; Lareau, 2010; Meckenberg, 2008; Restrepo, 2008). Poor adherence is associated with increased risk of exacerbations and greater healthcare utilization (Isamlia, 2014; van Boven, 2014). Patients who adhere to their treatment regimens >80% of the time survive longer than less adherent patients (Vestbo, 2009).

Medication adherence among patients with COPD is affected by a number of variables related to the patient, the treatment, and society (Bourbeau, 2008; Restrepo, 2008). Patient-related factors include their physical abilities, cognitive function, and mental capabilities. For example, patients with COPD and depression adhere less well with their inhalers than those who are not depressed (DiMatteo, 2007; Lareau, 2010). An important treatment-related factor is the use of multiple inhalers, each of which often has a different inhalation technique. Societal factors include the relationship between the patient and the healthcare provider, access to medications, financial resources, ability to receive adequate inhaler education, and the patient’s familial and social support system.

Assessing medication adherence can be difficult as there is no clear definition of what would be an appropriate level of compliance. A variety of methods to assess adherence have been described, including pill counting or weighing, reviewing pharmacy records, patient self-reporting, estimations made by the healthcare provider, electronic monitoring, and biological monitoring (Lareau, 2010). Each of these have their advantages and disadvantages.

Providers can perform a variety of interventions to increase inhaler adherence in patients with COPD. One of the most important factors is effective communication between the healthcare provider and the patient, as low patient satisfaction with their physician is associated with decreased adherence (George, 2005; Restrepo, 2008). Proper inhaler education for the patient is paramount in helping patients understand their drug regimen, and the reasons for taking the medication (Falvo, 1980; George, 2007; Hulka, 1976). Healthcare providers must also be well-educated
about COPD treatment guidelines to educate their patients about all aspects of their disease. Adherence can also be improved by tailoring drug therapy to each patient’s needs, preferences, and capabilities. Patients who are unable to use their inhalers regularly or have complex medication regimens may benefit from simplified, once-daily treatments if possible (Breekveldt-Postma, 2007). Patients who also forget to take medications might benefit from behavioral therapy, such as cueing (for example, placing inhaler on the nightstand) and self-monitoring. Patients who have issues with depression, anxiety, or cognitive impairment should be given written instructions on medication use, as they are prone to have difficulty remembering instructions. Finally, patients who intentionally do not take medication can benefit from further education, review of patient’s personal goals of therapy, and medication negotiation with the patient.

15.5 Conclusions

In this chapter we have discussed commonly used inhalers and how to use them correctly, the importance of inhaler education for correct inhaler technique, and how to increase inhaler compliance / adherence. There are various advantages and disadvantages associated with each type of inhaler. Inhaler device selection depends on the type of medication selected, as well as the patient’s preferences and abilities. The healthcare provider should have adequate knowledge of the inhalational devices being prescribed. Inhaler education including the correct steps to use the device should be provided to the patient when receiving the inhaler, and should be re-addressed at follow-up visits. If medication adherence is an issue, the healthcare provider should search for reasons why, and intervene. Finally, successful inhaler education and adherence rely on effective communication between the healthcare provider and the patient.

15.6 Summary Points

1. Providers should know how to use inhaled medications for COPD correctly, as well as educate patients with COPD how to use their medications appropriately.
2. Repetitive inhaler education and direct observation of inhaler technique should occur in patients with COPD.
3. A pressurized metered-dose inhaler (pMDI) should be used with a spacer. If the patient does not use a spacer, then we recommend the open-mouth technique for pMDI use (Table 15.3).
4. Nebulizers can be used as an alternative to short acting bronchodilator pMDIs when patients cannot use a pMDI properly or when they are hospitalized. A sig-
significant clinical therapeutic difference has not been shown between medications delivered by pMDI with a spacer versus a nebulizer.

5. Inhaler adherence should be addressed by the provider at every patient encounter.

References

Ahrens. R., Lux, C., Bahl, T., & Han, S.H. (1995). Choosing the metered dose inhaler spacer or holding chamber that matches the patient’s need: evidence that the specific drug being delivered is an important consideration. *J Allergy Clin Immunol*, 96(2), 288–294.


