



A Patient's Guide to **Aerosol Medication Delivery** 4th Edition

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A PATIENT'S GUIDE TO AEROSOL MEDICATION DELIVERY

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With a Foreword by
The American Association for Respiratory Care

Produced by the American Association for Respiratory Care



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FOREWORD

Gaining as much information as possible about your aerosol delivery devices is essential. You have taken a positive first step by obtaining this fourth edition of "A Patient's Guide to Aerosol Medication Delivery." The American Association for Respiratory Care (AARC) asked respiratory therapists who were noted aerosol delivery experts to write this guide. This guide was written with you in mind. As you know, the number of medications and the devices that deliver them change often. That is why it is important for you to understand the critical differences between these devices and, more importantly, how to use your device(s) correctly so that you can maximize the intended result that the medication delivers. We encourage you to become proficient in the use of your aerosol delivery devices and never hesitate to ask questions of your physician or respiratory therapist.

This Patient Guide will provide you with step-by-step education on all available devices on the U.S. market today. Currently, there are five basic types of delivery systems which include nebulizers, metered-dose inhalers, soft-mist inhalers, dry-powder inhalers, and nasal inhalers. All four have their own specific characteristics and delivery capabilities that require your physician to determine which was the most appropriate for you.

We hope that you find this Patient Guide useful. The American Association for Respiratory Care invites you to learn more about better self-management of lung disease through other online resources that have been created to help and to allow you to practice a higher level of self-management. Visit us at aarc.org, where you will find our online magazine, "Allergy and Asthma Health", smoking cessation information, and so much more.. There you will find "Allergy and Asthma Health," (an online magazine), smoking-cessation information, and so much more. We encourage you to learn as much as you can about your lung health.

INTRODUCTION

Perhaps the shortness of breath, coughing, excessive phlegm, chest tightness and/or difficulty catching your breath has recently been diagnosed as a lung disease. The good news is that your physician, respiratory therapist, or nurse professional provided you with a brief description of your condition — explained what it is, the causes, and the treatment options. He/she also probably recommended that you start taking medication in the form of a breathing treatment.

You may have already received a few treatments and found that they make your breathing easier. You may also have learned by now that taking control of your lung disease is the only way to improve your health to the point where you can do all the things you need and want to do. You may also know that controlling your condition will involve understanding as much as possible about these breathing treatments. Breathing treatments, along with smoking cessation and pulmonary rehabilitation, are recognized ways of improving your overall respiratory health.

You no doubt still have a lot of unanswered questions: What is an aerosol? What are these breathing devices? What is in them? How do they work? And, why do I have to use them? These are just a few of the questions that this Patient Guide has been developed to help answer. It is written in language that is easy to understand and in a conversational style format that is easy to follow.

This Patient Guide was prepared for you by the American Association for Respiratory Care (AARC), a professional organization of over 47,000 competent, caring, and compassionate respiratory therapists dedicated to the detection, management, and treatment of lung diseases.

Respiratory therapists are the front line caregivers for patients with asthma, pulmonary fibrosis, cystic fibrosis, chronic bronchitis, emphysema, chronic obstructive pulmonary disease (COPD), and many other respiratory diseases. They are committed to helping you control and manage your condition. We hope you will find our Patient Guide to be a valuable resource. It will help you understand how medications enter your lungs and decrease your symptoms.

It is important to note that this Patient Guide is not a substitute for medical information or treatment options provided by your physician. The Guide is intended to describe the devices used to deliver breathing treatments by explaining what they are, how they work, and how to use them correctly.

1. AEROSOL MEDICATION DELIVERY: THE BASICS



WHAT IS AN AEROSOL?

Remove the top from a perfume bottle, hairspray, room deodorizer, or household air freshener and press the button. What you see is an aerosol — a small cloud of tiny particles floating in the air. Did you know that aerosols exist everywhere there is air to breathe? Aerosols such as pollen, fog, and steam naturally occur in the air we breathe every day. Other types of man-made aerosols are harmful, such as cigarette smoke, automobile emissions, and pollution from factories and coal mines.

Some aerosols seem beneficial. They make us smell fresh, eliminate odors, clean, and disinfect. However, any aerosol we breathe in has the potential to cause our lung diseases to flare up. The aerosols we will address in this Guide are medical aerosols that are designed to help you breathe better.

MEDICAL AEROSOLS

A *medical aerosol* is a mixture of medication particles and gas. When you take your breathing treatment, which we will call an *aerosol treatment*, you are breathing in an aerosol that will help you breathe easier. Aerosol treatments can be delivered through:

1. Pressurized metered-dose inhalers (MDI), dry-powder inhalers (DPI), and soft-mist inhalers (SMI) — these are portable, hand-held devices that you can carry in your purse or pocket.
2. Small-volume nebulizer (SVN) — a portable device that has a small plastic tube and cup (nebulizer) to connect to a small machine that pumps air (air compressor). Liquid medication is put into the cup and the machine turns the liquid into an aerosol.
3. Atomizers – inhalers used to inhale particles into your nose to treat nasal issues such as congestion, inflammation, and even narcotic overdose.

We will discuss all of these devices in more detail throughout this Guide. But first, let us explain some of the terms you need to know about aerosol medication delivery. The most important terms for you to know are listed on page 4.

COMMON TERMS

Aerosol: A mix of liquids and solids produced by an aerosol machine such as the small-volume nebulizer (SVN), pressurized metered-dose inhaler (MDI), a dry-powder inhaler (DPI), or a soft-mist inhaler (SMI).

Aerosol Deposition: This is what happens when the medication lands on the inside of your air passages. This is how the medication is absorbed into the body after breathing it in from the device.

Aerosol Generator: A device used for producing the aerosol.

Aerosol Output: All the particles that make up the cloud or mist that you see coming from your aerosol device. It is a collection of little droplets of liquid or particles of medication.

Aerosol Therapy: Delivery of aerosol to your lungs for the purpose of treating your breathing problem.

Atomizer: A device used to deliver particles larger than those from a nebulizer; usually used for nasal mists.

Dry-Powder Inhaler (DPI): A device that delivers the medication in a fine powder form. With DPIs, the medication is pulled into your lungs as you take in a fast breath. This means that you need to breath in fast and deep from the device to get the medication deep into your lungs.

Flare-up: A sudden appearance or worsening of the symptoms of a disease or condition.

Hydrofluoroalkane (HFA): A liquefied gas that pushes the medication out of the meter-dosed inhaler.

Inhaler: A term for any type of self-contained medication delivery device (e.g., dry-powder inhaler or metered-dose inhaler). Either type of inhaler delivers a single dose of medication for inhalation. You are possibly carrying one type of inhaler in your purse or pocket right now. With an inhaler, you can take a dose of inhaled medication any time.

Medication Formulation: The ingredients in the medication “recipe.”

Nasal Spray: A liquid spray that can be inhaled into or through the nose. Administered by an atomizer.

Pressurized Metered-Dose Inhaler (MDI): A medication delivery device that contains multiple doses of your medication and dispenses a single dose. The outlet of the device is put into your mouth and when you spray it, a dose of medication is delivered. Remember, you still need to breathe in at the same time with a slow, deep breath.

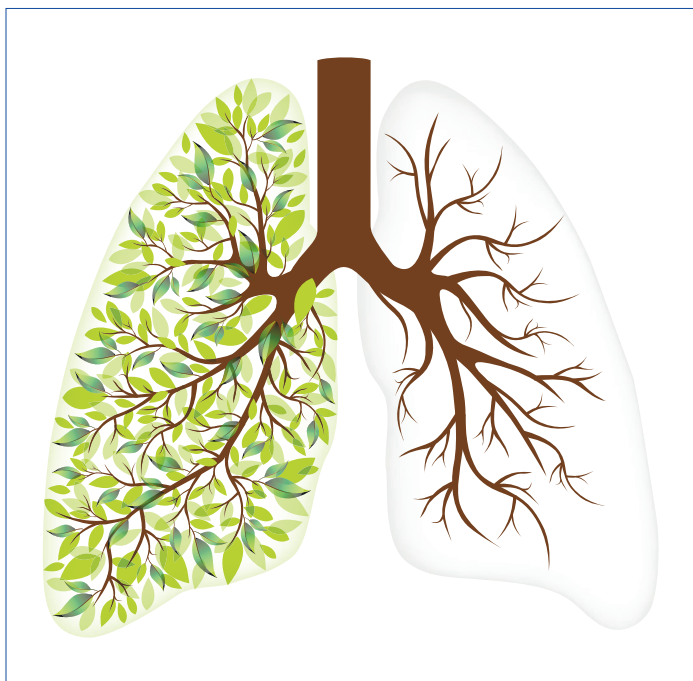
Respiratory Therapist: A health care professional educated in respiratory medicine who works directly with people who have lung disease.

Side Effect: An undesirable effect of a medication or treatment.

Small-Volume Nebulizer (SVN): A device that converts a liquid medication into an aerosol. An SVN includes (1) an air compressor (either electrically or battery powered) and (2) a small plastic nebulizer cup that connects to the compressor with a plastic tube. When the liquid medication is placed into the nebulizer cup and the compressor is turned on, an aerosol/mist is created.

Soft-Mist Inhaler: Respimat® is an inhaler that produces a mist with a slower speed than a MDI, so that less aerosol may remain in your mouth when you breathe in.

Spacer: A plastic tube that is placed between the MDI and your mouth. The spacer helps coordination and timing so that more of the aerosol gets into your air passages.



HOW DOES THE AEROSOL GET INTO MY AIR PASSAGES?

If you imagine the structure of the lung as an upside-down tree, you can begin to picture the size and design of the lung and its air passages (breathing tubes). The base of the tree (the trunk) represents the trachea or windpipe, which is about an inch in diameter in adults and smaller in kids. Just as a tree continues to branch out into smaller limbs, so do the breathing tubes (air passages). The major tubes are called bronchi and the smaller tubes are called bronchioles. These branches will eventually end in tiny air sacs. The inhaled medication needs to reach *all* of these air passages.

AIR PASSAGES

Asthma and COPD are lung diseases that cause air passages to narrow from the size of a dime to the width of a pencil, or even smaller in severe cases.

Airway obstruction occurs when your asthma or COPD flares up and it is important to get the aerosol medication as far into the lungs as possible. For this reason, the size and speed of the particles become important to achieve optimal medication deposition.

BREATHING PATTERN

The way we take a breath is important to getting medicines deep into the air passages. You must breathe in slowly when using an MDI and fast when using a DPI. Then, hold your breath for about 10 seconds. This helps the medication get farther into the air passages where the medicine works the best. Once the medication reaches the desired location, it lands on the inside surface of the air passages.

MEDICATION PARTICLE DEPOSITION

Medication particle deposition is a rather complex process since so many things have to work right to have a successful deposit of the medication. In addition to not having the right size of aerosol particles, there is also the common problem of blocked air passages. For example, a sudden asthma attack can cause wheezing and an increased amount of mucus and narrowing or blockage of the air passages. When this happens, the medication may not reach as far into the lungs as it needs to. You can begin to see what we mean about this being a complicated process.



WHAT ARE THE DIFFERENT TYPES OF AEROSOL DEVICES?

There are 4 different types of devices used for breathing treatments.

- Pressurized metered-dose inhaler (MDI)
- Dry-powder inhaler (DPI)
- Soft-mist inhaler (SMI)
- Small-volume nebulizer (SVN)

A description of each device can be found in the Common Terms list on page 4. Note that MDIs, DPIs, and SMIs are called *inhalers*, whereas the SVN is called a *nebulizer*.

When used correctly, all 4 types of aerosol devices can provide good breathing treatments. However, there are differences in how each device makes the aerosol. What follows is a brief description of how each device differs from the others. A more detailed explanation of how each type of device works appears later in this Guide.

PRESSURIZED METERED-DOSE INHALER (MDI)

A MDI is a small, aluminum canister that contains a mixture of both medication and pressurized propellant. The pressure from the expanding propellant forces the medication from inside the canister through the device each time MDI is pressed (activated) (See Figure 1).

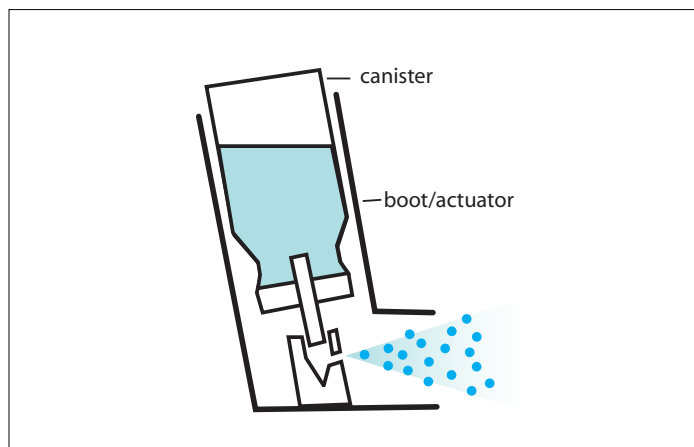


Figure 1. Parts of a MDI

DRY-POWDER INHALER (DPI)

A DPI is a different type of inhaler that delivers medication as a fine, dry powder. Instead of being forced in by a propellant, the energy needed to move the medication is provided by you taking a fast, deep breath through the DPI mouthpiece. This deep breath also helps to carry the powdered medication farther into the lungs. There are many different types of DPIs available today (see Figure 2).



Figure 2. Various aerosol devices

SOFT-MIST INHALER (SMI)

A SMI or Respimat inhaler produces a mist with a slower speed than an MDI so that less aerosol may remain in your mouth when you breathe in (see Figure 3).



Figure 3. Soft-mist inhaler

SMALL-VOLUME NEBULIZER (SVN)

While there are many different types of SVNs, they all do the same thing: change a dose of liquid medication into an aerosol. SVNs do this in one of two ways — by using gas (the traditional way) or by using a power source (the newest way).

The traditional SVN is actually two separate parts: a tabletop electric air compressor and a small plastic medication cup connected by a piece of tubing (see Figure 4). The two parts are connected together with a piece of tubing. The compressor provides the pressurized gas that the nebulizer needs to turn the liquid into an aerosol mist.

The newer electronic SVNs use sound waves or vibrations to turn the liquid medication into an aerosol mist. This type of nebulizer is called a *vibrating mesh nebulizer*. However, electronic SVNs cost two to three times more than traditional SVNs.

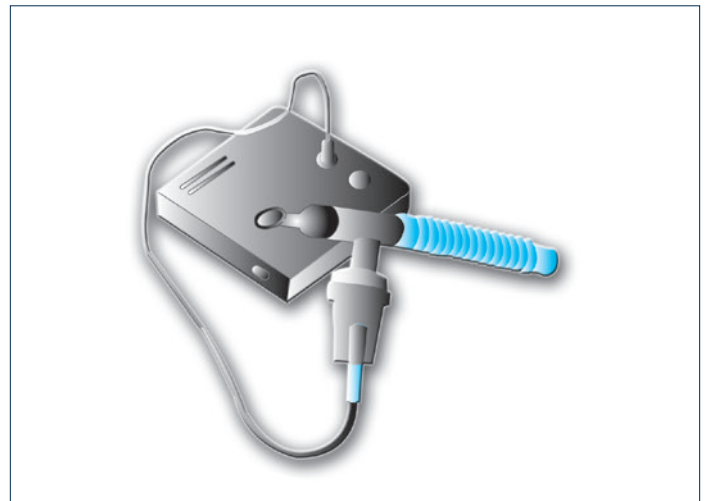


Figure 4. Small-volume nebulizer

WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF INHALED AEROSOL MEDICATIONS?

When it comes to treating your lung disease, there are a number of advantages and disadvantages of aerosol medications when compared to oral medications or needle injections. The most important advantages are:

- ✓ Smaller doses (you do not need as much)
- ✓ Quicker action (they work faster)
- ✓ Direct delivery to the lung (medication is going directly to the problem area)
- ✓ Fewer unwanted side effects (because you use smaller doses)
- ✓ No pain (no needles)

Just like anything else in life, there are some disadvantages as well. Some of the disadvantages are:

- ✓ The lung does not absorb medication well— only about 10–15% of what is delivered is absorbed by the lung! That is why correct inhaler use and technique are so important
- ✓ Your breathing ability could create a problem (recall that with certain inhalers you may have to breathe in slowly and deeply, something you are not likely able to do when you are having a flare-up)
- ✓ Some people have trouble pressing the device and breathing at the same time
- ✓ With so many different types of devices, people can get confused with how each one works
- ✓ There is a lack of standard technical information on how to use devices and instructions on how to use the drug can be confusing.

In order to get the best effect from aerosol medications, it is important to listen to and follow the instruction and guidance given to you by your health care provider.

2. AEROSOL MEDICATIONS: THE MAJOR CATEGORIES

WHAT ARE THE CURRENTLY AVAILABLE AEROSOL MEDICATIONS?

Your breathing medications come in different forms. Some are liquids that you place into your small-volume nebulizer (SVN) cup. Some come in a metered-dose inhaler (MDI) or soft mist inhaler (SMI) and some are sprayed directly into your nose. You just spray the medicine into your mouth or nose and breathe in slowly and deeply. Some come in a dry-powder inhaler (DPI).

We will talk later about how to use these devices. Table 1 shows currently available aerosol medications — their generic names, brand names, delivery devices, strengths, doses, and cost. Cost may vary by insurance coverage. You may also want to refer back to the list of Common Terms on page 4 for a definition of each device.

Table 1. Currently available aerosol medications, brand names, and corresponding inhaler devices for use in the United States. Cost information from www.goodrx.com. Retail prices used were from WalMart in 2023

Short-Acting Bronchodilator						
Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Albuterol Sulfate HFA	AccuNeb®	SVN	0.63	25	\$45.00	\$1.80
			1.25	25	\$45.00	\$1.80
	Albuterol Sulfate	SVN	5mg	25	\$59.00	\$2.36
	ProAir® HFA	MDI		200	\$35.00	\$0.18
	ProAir RespiClick®	DPI		200	\$67.23	\$0.34
	Proventil® HFA	MDI		200	\$73.74	\$0.37
	Ventolin® HFA	MDI		200	\$68.00	\$0.34
Levalbuterol	Xopenex® Inhalation Solution	SVN	0.31/3ml	25	\$114.00	\$4.56
			0.63/3ml	25	\$171.00	\$6.84
			1.25/3ml	25	\$183.00	\$7.32
			1.25/0.5ml	60	\$214.00	\$3.56
	Xopenex HFA™	MDI	45mcg	200	\$54.00	\$0.27

Short-Acting Bronchodilator (continued)

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Ipratropium Bromide	Ipratropium Bromide Atrovent HFA®	SVN	vial	25	\$9.00	\$0.36
		MDI		200	\$482.23	\$2.41
Ipratropium Bromide and Albuterol Sulfate	Ipratropium Bromide and Albuterol Sulfate	SVN		120	\$45.00	\$0.38
	DuoNeb	SVN		120	\$284.54	\$2.37
	Combivent® Respimat®	MDI		120	\$533	\$4.44

Long-Acting Bronchodilator

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Acclidinium Bromide	Tudorza Pressair®	DPI	400 mcg	30	\$329.80	\$10.99
Arformoterol	Brovana®	SVN	15 mcg/2ml	30	\$114.07	\$3.80
				60	\$213.29	\$3.55
Formoterol	Perforomist®	SVN	20 mcg/2ml	60	\$623.45	\$10.39
Indacaterol	Arcapta®	DPI	75 mcg	30	\$227.70	\$7.59
Salmeterol	Serevent®	DPI	50 mcg	60	\$446.06	\$7.43
Tiotropium	Spiriva®	DPI	18 mcg	30	\$538.00	\$17.93
	Spiriva Respimat®	MDI	1.5 mcg	30	\$500.35	\$8.34
	Spiriva Respimat®	MDI	2.5 mcg	30	\$500.35	\$8.34
Olodaterol	Striverdi Respimat®	MDI	2.5 mcg	60	\$250.83	\$4.18
Umeclidinium	Incruse® Ellipta®	DPI	62.5 mcg	30	\$374.07	\$12.47
Glycopyrrolate	Seebri Neohaler	DPI	15.6 mcg	60	\$313.67	\$5.23
Glycopyrrolate	Lonhala Magnair	VMN	25mcg	60	\$1314.00	\$21.90

Combination Drugs

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Fluticasone and Salmeterol	Advair HFA®	MDI	45/21 mcg	120	\$285.26	\$2.38
			115/21 mcg	120	\$352.74	\$2.94
			230/21 mcg	120	\$461.72	\$3.85
	Advair Diskus®	DPI	100/50 mcg	60	\$229.00	\$3.82
			250/50 mcg	60	\$138.00	\$2.30
			500/50 mcg	60	\$191.00	\$3.18
	AirDuo RespiClick®	DPI	55/14 mcg	60	\$100.99	\$1.68
			113/14 mcg	60	\$99.00	\$1.65
			232/14 mcg	60	\$101.00	\$1.68
Budesonide and Formoterol	Symbicort®	MDI	80/4.5 mcg	120	\$451.00	\$3.76
			160/4.5 mcg	120	\$303.00	\$2.53
Mometasone/Formoterol	Dulera®	MDI	100/4 mcg	120	\$389.00	\$3.24
			200	120	\$290.54	\$2.42
Fluticasone furoate/Vilanterol	Breo® Ellipta®	DPI	100/25 mcg	60	\$438.00	\$7.30
Tiotropium/ Olodaterol	Stiolto® Respimat®	MDI	2.5/2.5 mcg	60	\$531.00	\$8.85
Umeclidinium/ Vilanterol	Anoro® Ellipta®	DPI	62.5/25 mcg	30	\$374.07	\$12.47
Formoterol/Glycopyrrolate	Bevespi Aerosphere®	MDI	9/4.8 mcg	120	\$484.00	\$4.00
Budesonide/Glycopyrrolate/ Formoterol Fumarate	Breztri Aerosphere	MDI	160/9/4.8mcg	120	\$730.00	\$6.08
Fluticasone Furoate/ Umeclidinium/Vilanterol	Trellegy Ellipta	MDI	100/62.5/25mcg	60	\$657.87	\$10.96
			200/62.5/25mcg	60	\$734.00	\$12.33

Corticosteroids

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Beclomethasone dipropionate	QVAR™ 40	MDI	40 mcg	120	\$233.00	\$1.73
	QVAR™ 80	MDI	80 mcg	120	\$308.00	\$2.57
Budesonide	Pulmicort Respules	SVN	0.25 mg	30	\$309.00	\$10.30
			0.5 mg	30	\$393.00	\$27.60
			1.0 mg	30	\$828.00	\$15.53
	Generic	SVN	0.25 mg	30	\$164.00	\$5.46
			0.5 mg	30	\$184.00	\$6.13
			1.0 mg	30	\$466.00	\$15.53
	Pulmicort® Flexhaler®	DPI	90 mcg	120	\$229.00	\$1.90
			180 mcg	120	\$306.00	\$2.55
Ciclesonide	Alvesco®	MDI	80 mcg	60	\$307.00	\$5.00
			160 mcg	60	\$315.00	\$5.25
Fluticasone Propionate	Flovent Diskus®	DPI	50 mcg	60	\$165.03	\$2.75
			100 mcg	60	\$238.00	\$3.96
			250 mcg	60	\$319.00	\$5.32
	Flovent HFA®	MDI	44 mcg	120	\$237.00	\$1.97
			110 mcg	120	\$319.00	\$2.66
			220 mcg	120	\$237.00	\$1.98
	ArmonAir® RespiClick®	DPI	55 mcg	60	\$298.00	\$4.96
			113 mcg	60	\$305.00	\$5.08
			232 mcg	60	\$375.00	\$6.25
Fluticasone Furoate	Arnuity® Ellipta®	DPI	100 mcg	30	\$241.00	\$4.01
			200 mcg	30	\$322.00	\$10.70

Corticosteroids (continued)

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Mometasone Furoate	Asmanex® HFA	MDI	50 mcg	120	\$219.00	\$1.82
			100 mcg	120	\$191.68	\$1.60
			200 mcg	120	\$224.06	\$1.87
	Asmanex®	DPI	110 mcg	30	\$233.00	\$7.76
			220 mcg	120	\$396.00	\$3.30

Mucoactive Drugs

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Dornase Alpha	Pulmozyme®	SVN	1.0 mg/ml	30	\$4112.00	\$137.00
			2.5mg/2.5ml	30	\$3173.13	\$105.77
			4ml/10%	1	\$25.00	\$25.00
			10ml/10%	3	\$59.00	\$19.60
			30ml/10%	3	\$83.00	\$27.60
			4ml/20%	25	\$428.00	\$17.12
			10ml/20%	3	\$93.00	\$31.00
			30ml/20%	3	\$68.49	\$22.83
Hyperosmolar Saline	HyperSal®	SVN	3.5%	60	\$52.99	\$0.88
			7%	60	\$91.94	\$1.03
	PulmoSal™ (ph 7.4)	SVN	7%	60	\$51.94	\$0.87

Other Drugs

Drug	Brand	Device	Strength	Doses	Cost	Cost/Dose
Zanamivir	Relenza®	DPI	5 mg	20	\$79.00	\$3.95
Tobramycin generic Bethkis Tobi Podhaler	TOBI®	SVN	300mg/5ml	56	\$7,578.95	\$135.33
			300mg/5ml	56	\$1590.21	\$28.40
		SVN	300mg/4ml	56	\$5862.93	\$209.40
		DPI	28 mg	224	\$9152.54	\$40.85
Aztreonam	Cayston®	SVN	75 mg	84	\$8254.28	\$98.27
Cromolyn Sodium		SVN	20mg/2ml	60	\$211.63	\$3.53
Ribavirin	Virazole®	SPAG	6g	1	\$25766.30	\$25766.30

HFA = hydrofluoroalkane;
MDI = pressurized metered-dose inhaler;
SVN = small-volume nebulizer;
DPI = dry-powder inhaler

Cost information from www.goodrx.com. Retail prices used were from WalMart in 2023

HOW DO AEROSOL MEDICATIONS WORK?

Table 1 (page 9) lists most of the aerosolized medications in use (at the time of publication) for the treatment of respiratory illness due to air passage narrowing, inflammation, and infection. However, it is common practice to group all of these medications into the following 5 major groups:

- ✓ Short-acting bronchodilators/rescue/quick-relievers
- ✓ Long-acting bronchodilators/controllers
- ✓ Inhaled corticosteroids/anti-inflammatory/controllers
- ✓ Combination medications/controllers
- ✓ Others

We will use this list as a guide to explain how each medication works to treat your lung disease.

The main goal of all the medications used for your lung disease is to open your air passages. In the example given earlier in this guide, we described how lung disease can cause air passages to narrow from the size of a dime to the width of a pencil. These medications help to reverse that effect and widen the air passages back to the size of a dime to make it easier for you to breathe.

Shrinkage and blockage of air passages associated with lung disease can cause three different effects to happen all at the same time: inflammation, bronchoconstriction, and mucus obstruction (Figure 5).

Inflammation, the primary issue with asthma, is when the inside of the air passages are irritated and swollen (similar to what happens when you burn your skin, or get dust or smoke in your eyes). Bronchoconstriction is when the muscles surrounding the outside of the air passage gets smaller. Finally, mucus obstruction is when the inside of the air passages fill with mucus, which may cause a rattling sound when breathing.

Having a basic idea of these three bad effects (or symptoms) will better prepare you to understand the five medication types we are about to discuss.

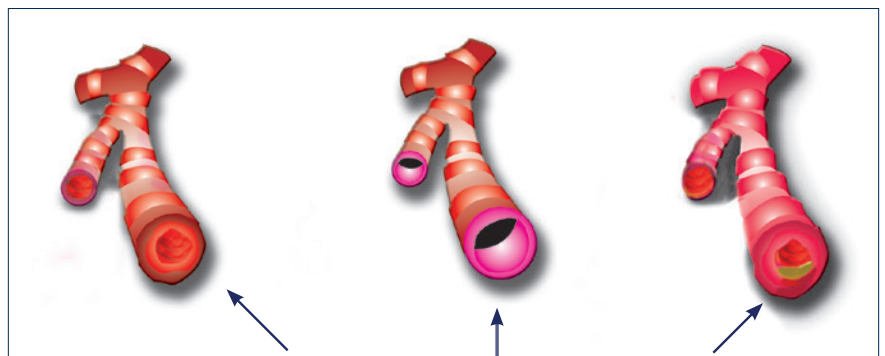


Figure 5. Illustration of inflammation, bronchoconstriction, and mucus obstruction

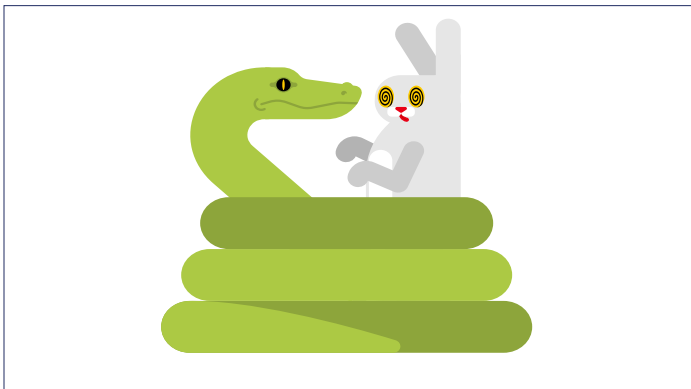
NOTE:

Medication companies continue to develop new aerosol medications and medication delivery devices for the control of symptoms of lung diseases. This section describes the medications available at the time of this publication. Newer medications may not be included.

MEDICATION TYPES:

QUICK-RELIEF MEDICATIONS

- **Also known as short-acting beta agonists (SABA)**
Quickly relax tight muscles around the outside of your air passages. This helps make the air passages bigger. Picture in your mind what happens when a snake wraps its long body around another animal. As the snake squeezes around the body of the animal, the animal's ability to breathe is cut off. A quick-relief medication loosens the squeeze of the muscle surrounding the air passages.



- **Quick-relief medications** are considered the main medications for sudden symptoms. This means that they are quick-acting. The action starts within a few minutes and lasts 2 to 4 hours. You should use a quick-relief medication when you have increased symptoms, such as shortness of breath, wheezing, coughing, or chest tightness and need fast relief.
- **For those with Asthma:**
 - You should not be using quick-relief medication every day.
 - A quick-relief medication should be needed no more than twice a week during the daytime or twice a month during the nighttime.
 - **If you need a quick-relief medication more often,** talk to your doctor about using a controller medication such as an inhaled corticosteroid.
- **For those with COPD,** ask your doctor about using a long-acting bronchodilator if you use a quick-relief medication often.

CONTROLLER MEDICATIONS

- **LABA, ICS, Mast Cell Stabilizers and Combination Medications are ALL Controllers**
- **Also known as long-acting beta agonists (LABA) and long-acting muscarinic agents (LAMA)**
- Relax the muscles around the air passages (much like the snake example). The air passages get bigger and breathing is easier.
- The effect lasts 12-24 hours depending on the medication used.
- Taken either once or twice a day depending on the medication used.
- Used on a daily basis for long-term control.
- It takes time to start to work (sometimes 1-2 weeks).
- **Not** to be used when quick-relief is needed.
- **Not** to be used when you are having an active asthma attack or increase in your asthma symptoms.
- If you have asthma, the long-acting bronchodilator should *always* be prescribed with an inhaled corticosteroid.

INHALED CORTICOSTEROIDS (ICS)

- Reduce the swelling (inflammation) inside of the air passages.
- Are taken daily; It may take a few weeks before they start to work.
- Are **not** good for sudden changes in symptoms or increases in symptoms.
- Are not the same as steroids taken by athletes, weight lifters, or bodybuilders who are trying to add muscle to their bodies.
- Side effects are minimal when taken properly
- Are recommended for children with persistent asthma, as long-term swelling harms the air passages.

MAST CELL STABILIZER

- Prevents asthma symptoms.
- Blocks the release of chemicals in the body that cause swelling.
- Does not work quickly.
- Must be taken many times a day over a period of time.
- Not as effective as inhaled corticosteroids

COMBINATION MEDICATIONS

- Consist of 2 or 3 medications combined into one inhaler or solution.
- Easier to take when your doctor has prescribed multiple medications

3. AEROSOL MEDICATION DELIVERY DEVICES: SMALL-VOLUME NEBULIZERS

WHAT ARE SMALL-VOLUME NEBULIZERS?

A small-volume nebulizer (SVN) is a device that turns a liquid medication into a mist that can be breathed in. SVNs are often used by respiratory therapists in the hospital to deliver breathing treatments to patients. SVNs can also be used at home.

WHAT ARE THE DIFFERENT TYPES OF SVNS?

There are three different types of small-volume nebulizers: jet nebulizers, ultrasonic nebulizers, and vibrating mesh nebulizers.

JET NEBULIZERS

There are many different types or models of small-volume medication nebulizers on the market. The jet nebulizer is the most common (see Figure 6). Jet nebulizers work by using a compressor to turn liquid medicine into a fine mist that can be inhaled easily. Jet nebulizers are designed for only one patient to use. Do not share your jet nebulizer with another person. Jet nebulizers are also disposable devices. You simply throw them away when you are advised by your respiratory therapist to replace it with a new one.

ULTRASONIC NEBULIZERS

Besides the standard jet nebulizer, there are several other types of handheld, portable SVNs called ultrasonic nebulizers.

Unlike other nebulizers, ultrasonic nebulizers do not use

a compressor. Instead, they use electrical energy to create ultrasonic sound waves that turn the liquid medication into a mist. Ultrasonic nebulizers are small, quiet, and are powered by batteries.

Normally, nebulizers allow medications to be placed directly in the cup of the nebulizer. MAGNAIR (see Figure 7) uses a sealed container that is inserted into the top of the device and broken open once the top is closed. This reduces the chance for medication to be wasted or spilled. The nebulizer is portable and powered by 4AA batteries or an AC adapter.

The MAGNAIR treatment takes less than 3 minutes. You are initially prescribed a starter kit with a 30-day supply of medicine and the nebulizer system. Future prescriptions are supplied as a refill kit containing a 30-day supply of medication and a new nebulizer. The old nebulizer should be discarded at the end of each 30-day cycle. The nebulizer should only be used to nebulize the prescribed medication; no other medication should be used in the nebulizer.

VIBRATING MESH NEBULIZERS

This type of nebulizer uses vibration to push the medication through a mesh material, breaking the medication down into very small droplets. This allows the medication to be deposited deeper into the lungs. Aerogen® Pro-X is one of the most commonly used, but there are several others on the market (i.e. Philips Respironics InnoSpire, Omron MicroAir, etc.) These nebulizers are small, lightweight, battery operated and very portable.



Figure 6. A jet nebulizer



Figure 7. The MAGNAIR is an ultrasonic nebulizer



Figure 7B. A vibrating mesh nebulizer



WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF SVNS?

Small-volume nebulizers are the oldest devices still used to deliver breathing treatments in the hospital. When patients arrive in the emergency department short of breath and struggling to breathe, respiratory therapists will sometimes use an SVN to quickly deliver medication to the air passages.

Table 2 (below) shows the advantages and disadvantages of small-volume nebulizers and will be helpful in determining if they are the best choice for you.

SVNs are helpful for people who are unable to operate or correctly use a metered-dose or dry-powder inhaler, because minimal cooperation or coordination is needed from the patient.

There are also a few disadvantages to the small-volume nebulizer. These devices can be noisy, and take time to use. They also require an electrical outlet to run the compressor. This makes it more difficult to use when traveling. Some of the new portable SVNs have a rechargeable battery. Unfortunately, this type of SVN is usually not covered by insurance.

Table 2. Advantages and disadvantages of SVNs	
ADVANTAGES	DISADVANTAGES
✓ Works with many medications.	✗ Treatment times last from 15–25 minutes.
✓ Allows more than one medication to be used at the same time.	✗ Device required to take medications.
✓ Minimal patient cooperation or coordination is needed.	✗ Power source needed.
✓ Useful when patients cannot use MDI or DPI.	✗ Medication may get into the eyes if a face mask is used.
✓ Medication concentrations and dose can be modified.	✗ Assembly and cleaning are required. Germs can collect in the medication cup if not cleaned well.
✓ Normal breathing pattern can be used, and a breath-hold is not required.	
	

When using any SVN, the following tips will help you get the best medication delivery possible during a breathing treatment.

You should:

1. Read and follow all written instructions and handouts.
2. Pay attention and ask questions during all training sessions. Ask for additional training if necessary.
3. Make sure that the medication cup is cleaned, dried, and put away between uses.
4. Make sure that the medication cup parts are put together correctly.
5. Make sure that the medication cup is in the upright position during use.

HOW DO I USE THESE SVNS?

ADULTS AND ADOLESCENTS

Your breathing pattern has a big influence on the amount of medication that reaches your air passages.

For best results, sit up straight. Breathe normally during your treatment. Every once in a while, take a slow, deep breath and hold the breath for 5–10 seconds before you breathe out. This helps deliver more medication into your lungs.

You can take your breathing treatment using either a mouthpiece or a face mask. The mouthpiece is considered the best connection and is more comfortable. With a face mask, medication can stick to the skin of your face or get in your eyes. A tight-fitting mask reduces this risk. A tight fitting mask reduces the risk of medication getting into your eyes.

INFANTS AND SMALL CHILDREN

A mouthpiece cannot be used with infants or small children. Instead, an infant or pediatric face mask attached to the SVN must be used. Giving breathing treatments to infants and smaller children can sometimes be difficult, especially if the child is uncooperative or crying. Crying greatly reduces the amount of medication that gets into the lungs. Forcing a face mask on an uncooperative, crying child does not work.

Some people use a *blow-by* method of delivering an aerosol to infants. This involves holding the aerosol device close to the face of the squirming/crying infant or child. The theory behind this is the crying child will take deep breaths, but ultimately the medication is lost. Blow-by *does not work* and its practice is *strongly* discouraged.

Instead, turn the breathing treatment session into a game. Spend extra time with the infant or small child, letting them play with the nebulizer parts. Let them see an older sibling or parent or favorite stuffed animal “use” the SVN without turning on the machine. Also, several manufacturers now have SVNs and face masks specially designed and decorated for pediatric patients. Chapter 7 of this Guide, called Special Applications, provides additional suggestions for giving breathing treatments to small children and infants.

Technique Box 1 (page 21) lists the steps for correct use of jet and electronic nebulizers. Helpful hints for using all types of SVNs are shown in the sidebar on the right.

Technique Box 1. Steps for Correct Use of Small-Volume Nebulizers

Technique for jet nebulizers

When a jet nebulizer is used, you should:

1. Wash and dry your hands
2. Gather the compressor (with tubing), jet nebulizer, and mouthpiece (or face mask).
3. Open the medication cup.
4. Twist the top off the medication container and empty **all** the contents into the medication cup.
5. Close the medication cup.
6. Connect one end of the plastic tubing to the medication cup and the other end to the compressor.
7. Plug the compressor's power cord into an electrical outlet.
8. Turn on the compressor's power button. Mist should appear.
9. Sit in an upright position, put the mouthpiece into your mouth, and breathe normally. Remember to also keep the medication cup in the upright position during use.
10. Occasionally take a deep breath and hold it for 5–10 seconds.
11. If the treatment must be interrupted, turn off the compressor to avoid medication waste.
12. Continue these steps until the jet nebulizer starts to sputter or rattle. Tap the nebulizer to make droplets stuck to the top of the nebulizer drop into the bottom of the nebulizer, then continue the treatment. This is usually done once during a treatment.
13. Turn off the nebulizer compressor and store per manufacturer's instructions.
14. Take the jet nebulizer apart and rinse under warm running water; allow the parts to air dry. When dry, store in a clean place until the next treatment.
15. At least once a week, wash and disinfect your nebulizer parts.
 - Wash all nebulizer parts (except the clear tubing that connects to the compressor) in mild dish soap. Use a small bottle brush to clean the nebulizer parts.
 - After soaking, rinse well in warm water.
 - Allow the parts to air dry before putting them back together.
16. Replace jet nebulizer every 6 months or as often as your health care provider recommends.

Technique for Ultrasonic or Vibrating Mesh nebulizers

When an ultrasonic or vibrating mesh nebulizer is used, you should:

1. Wash and dry your hands.
2. Correctly assemble the electronic nebulizer.
3. Follow manufacturer's instructions to properly test the new nebulizer prior to its first use.
4. Twist the top off the unit dose medication container and empty the contents into the medication cup. Do not exceed the volume recommended by the manufacturer.
5. Turn on the electronic nebulizer. You should see the mist coming out of the mouthpiece, you will **not** hear any noise.
6. Sitting in a relaxed, upright position, put the mouthpiece into your mouth and breathe normally.
7. Hold the electronic nebulizer in the position recommended by the manufacturer.
8. Refer to your device's instructions for specific breathing times.
9. If the treatment must be interrupted, turn off the unit to avoid medication waste.
10. Continue these steps until you no longer see any mist. Electronic nebulizers do **not** make a sputtering sound.
11. At the completion of the treatment, disassemble and clean as recommended by the manufacturer.
NOTE: Electronic nebulizers are more delicate than jet nebulizers. Use caution when handling and cleaning.
12. When cleaning a vibrating mesh nebulizer, do not touch the vibrating mesh as this will damage the unit. Replacement parts are very expensive.
13. Several times a week, disinfect the nebulizer parts by following the manufacturer's instructions.

WHAT ARE COMMON PROBLEMS AND SOLUTIONS TO THE USE OF SMALL-VOLUME NEBULIZERS?

There are some problems you may face when using a small-volume nebulizer. The most common problems are absence of any aerosol or failure of the unit to operate at all. Below is a basic troubleshooting guide that lists some causes and solutions to common problems. Be sure to use the manufacturer's instructions as well as seek help from your respiratory therapist, home care equipment provider, or health care provider. You should always keep a spare jet nebulizer cup and tubing on hand in case the troubleshooting does not correct the problem.

WHEN IS MY TREATMENT OVER?

When using a jet nebulizer, you will know that the treatment is coming to an end when you hear a sputtering or rattling sound. Sputtering happens when there is only a tiny bit of medication left in the medication cup.

There is no sputtering with electronic nebulizers. Instead, an empty medication cup and the absence of any mist will be your signal that the breathing treatment is finished. With some electronic devices, a buzzer sounds to signal the end of treatment.

Troubleshooting	
Problems with Jet Nebulizers: Absent or Low Aerosol Output	
Causes	Solutions
Loose connection or disconnection	Check the connections and make sure that they are firmly attached.
Obstruction in the opening of the jet nebulizer	Check the opening of the jet nebulizer and clear obstructions when needed.
The compressor does not operate.	The compressor needs to be plugged in to a working electrical outlet. If it is plugged in and the outlet has power but you still have this problem, you may need a new compressor.
The output of the compressor is low.	Clean or replace the inlet filter pad. (Consult the manual.) If the compressor has been used for several years, output will decrease and the compressor should be replaced. Your home care provider can check compressor output.
The nebulizer does not create mist.	Clean the nebulizer jet or obtain another nebulizer.

Troubleshooting

Problems with Vibrating Mesh and Ultrasonic Nebulizers: The Unit Does Not Operate

Problems	Solutions
Incorrect battery installation (seen in both vibrating mesh and ultrasonic nebulizers)	Check the battery installation and reinstall if needed.
External power source connection (seen in both vibrating mesh and ultrasonic nebulizers)	Check the connections with the AC adapter and the electrical outlet.
Overheated unit (seen in ultrasonic nebulizers)	Turn off the unit, wait until it cools down, and restart the unit.
Incorrect connection of the control module cable (seen in vibrating mesh nebulizers)	Check the connections with the control module cable and reattach them properly, if needed. Consult the owner's manual.
Mesh holes blocked with medication due to poor cleaning	Clean according to the manufacturer's instructions.

4. AEROSOL MEDICATION DELIVERY DEVICES: ATOMIZERS FOR NASAL DRUGS

WHAT ARE ATOMIZERS?

Nasal sprays are liquid medications that are released in your nose to relieve feelings of congestion or irritation. These medications can be over-the-counter or prescribed by a physician. There are many variations of the same medications which can make choosing the best one to meet your needs overwhelming. Speak to your healthcare provider or pharmacist to pick the best nasal spray option for you.

Atomizers are effective devices for the delivery of nasal medications. They work by making the particles of medication the optimal size for rapid absorption through the nasal mucosal membranes and into the bloodstream. In this chapter, we will cover the following nasal medications:

- Saline (sodium chloride)
- Nasal decongestants
- Nasal antihistamines
- Nasal steroids
- Nasal Antidotes (Narcan)

HOW DO I USE MY NASAL SPRAY?

1. Read instructions carefully before you use your nasal spray
2. Store sprays at room temperature away from heat and moisture
3. Wash your hands before and after you use the spray
4. Blow your nose gently before you use the nasal spray so medicine can get deeply into the nose
5. Remove the cap and shake bottle if instructed by the package instructions
6. Prime the bottle by spraying one time if instructed in the package instructions
7. Tilt your head forward until your chin is about halfway to your chest. Insert the nozzle into your nostril.
8. Point the nozzle slightly toward the side of your

nostril, away from the middle of your nose

9. Squeeze the bottle or push down on the top to spray the medicine into your nostril
10. As you spray, breathe in slowly through your nose for a steady flow of medication
11. Repeat these steps for the other nostril as directed
12. If possible, do not sneeze or blow your nose for a few minutes after you use the nasal spray



*SPECIAL NOTES:

- Leaning your head back makes the medicine run down your throat, will waste medication and cause discomfort
- Inhale gently and breathe out through your mouth after each spray

WHEN SHOULD I CONTACT MY HEALTHCARE PROVIDER?

- Your nose burns, stings, becomes irritated or bleeds after you use the spray
- You have questions or concerns about your condition or care

SALINE SPRAY

Saline, which is made of sodium chloride, is used to treat dry or irritated nose passages or to thin fluid. These sprays are to be used only in the nose, not in the mouth or eyes. Before using saline, blow your nose first to clear the passage.

Allergic reactions are very rare, but watch for signs that include:

- Rash
- Hives
- Itching
- Red, swollen, blistered or peeling skin with or without fever
- Wheezing
- Tightness in the chest or throat
- Trouble breathing or talking
- Unusual hoarseness
- Swelling of mouth, face, lips, tongue, or throat
- Very bad nose irritation

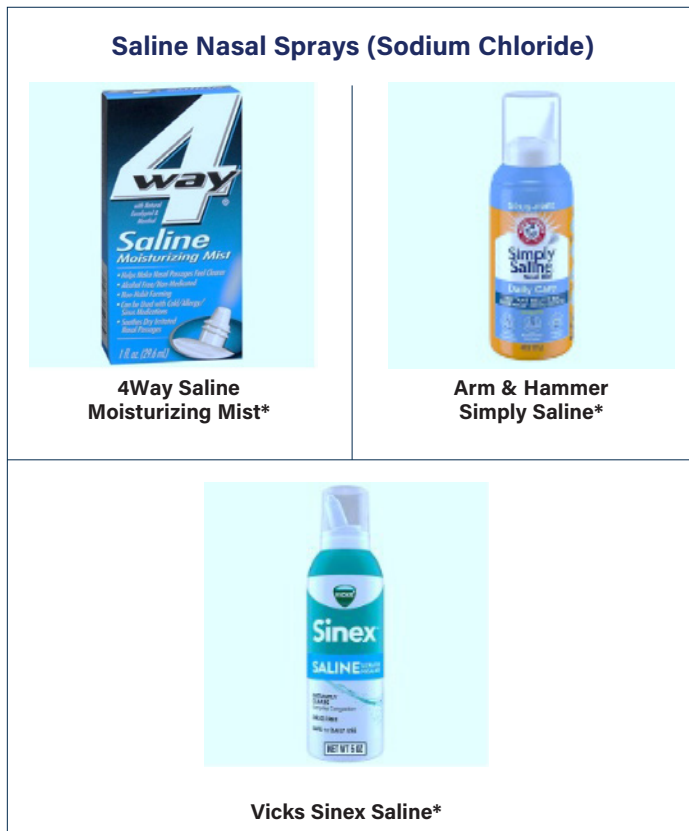


Figure 8-A. Common Nasal Saline Sprays Available in the United States

NASAL DECONGESTANTS

Congestion is another word for stuffy head or nose. It is usually caused by a common cold, upper respiratory infection or allergies. Congestion occurs when blood vessels lining the nose become large, making it hard to breathe and trapping mucous (phlegm or nasal drainage). Nasal decongestants narrow dilated blood vessels in the nose to reduce swelling and allow air to flow more freely.

Nasal sprays work faster than oral decongestants, but using them for longer than recommended can result in irritated nasal passages and worsening of congestion. Always follow the dosage instructions on the label or from your health care provider.

Uses:

- Allergies (hay fever)
- Viruses (colds, flu, etc.)
- Other illnesses

***Nasal decongestants may treat some symptoms of respiratory illness caused by a bacterial infection, but antibiotics may be needed.**



Figure 8-B. Common Nasal Decongestant Sprays Available in the United States

NASAL ANTIHISTAMINES

Histamine is a molecule that causes blood vessels to become large, inflamed, or itchy, all of which are symptoms of an allergic reaction. Antihistamine nasal decongestants block histamine and provide relief for those suffering from allergies.

Side effects include:

- Increased heart rate and blood pressure

***Check with your healthcare provider or pharmacist if you have the following:**

- Glaucoma
- Heart problems or high blood pressure
- Enlarged prostate

Or, if you are:

- Taking MAO inhibitors
- Pregnant or breastfeeding

Nasal Antihistamines



***Azelastine Nasal**
(Astepro, Astelin, Astepro Allergo)



Azelastine/Fluticasone Nasal
(Dymista) – combination of antihistamine and steroid for sneezing, runny or stuffy nose, itching, and other symptoms of allergies



Olopatadine Nasal
(Patanase)



Cromolyn Nasal
(NasalCrom)

Figure 8-C. Common Nasal Antihistamines Sprays Available in the United States

NASAL STEROIDS (NASAL CORTICOSTEROIDS)

Nasal steroids reduce inflammation caused by allergies. They relieve symptoms such as nasal and sinus congestion, mucus production, and nasal swelling caused by hay fever or allergic rhinitis. They are also used to prevent nasal polyps from growing back after they have been removed by surgery.

***Note:** the use of dexamethasone is not recommended in nursing mothers because it passes into breast milk and can affect infant growth.

Nasal Steroids (Nasal Corticosteroids)			
 <p>Budesonide Nasal (Rhinocort Allergy)</p>	 <p>Azelastine / Fluticasone Nasal</p>	 <p>Mometasone Nasal (Nasonex, Propel, Sinuva)</p>	
 <p>Triamcinolone nasal (Nasacort Allergy 24hr, Nasacort AQ, Tri-Nasal)</p>	 <p>Beclomethasone Nasal (Beconase AQ, Qnasl, Vancenase)</p>	 <p>Ciclesonide Nasal (Omnaris, Zetonna)</p>	
			
<p>Fluticasone Nasal (Flonase, Veramyst, Xhance)</p>			<p>Flunisolide Nasal (Nasalide, Nasarel)</p>

Figure 8-D. Common Nasal Steroids Available in the United States

NALOXONE (NARCAN NASAL SPRAY, KLOXXADO)

Naloxone is a prescription medicine used for the treatment of a known or suspected opioid emergency. It is a chemical that counteracts (neutralizes) the effects of another drug or poison. Examples of opioids are codeine, oxycodone (Oxycontin), heroin morphine, hydrocodone (Vicodin, Lortab), fentanyl, methadone, oxycodone, meperidine, tramadol, buprenorphine, and hydromorphone.

***Note:** do not use NARCAN Nasal Spray if you are allergic to naloxone hydrochloride

Often, people take opioids to manage pain and are unaware of the adverse reactions that can occur. Opioid overdose emergencies can occur at any time, even when the medication is used as directed by a physician.

Signs of an opioid overdose:

- Unusual sleepiness or unresponsiveness
- Slow or absent breathing
- Slow heartbeat or low blood pressure
- Skin feels cold and clammy
- Tiny pupils
- Blue nails and lips

How to use:

1. Peel back the packaging to remove the device. Hold device with your thumb on the bottom of the plunger and two fingers on nozzle.
2. Place and hold the tip of of nozzle in either nostril until your fingers touch the bottom of the nose.
3. Press the plunger firmly to release the dose into the patient's nose. Two atomizers are included in each package. If a second dose is needed, put the second dose into the other nostril.



Figure 8-E. Common Narcan Nasal Spray

How to administer Narcan Nasal Spray



Table 3: NAME TBD - all further table #s to be updated +1

Generic name	Brand names	Classification	# Sprays	Cost/unit \$/spray
Oxymetazoline	Afrin, Zycam, Sinex and others	decongestant	Not specified (squeeze bottle)	\$6.79
Phenylephrine	Neosynephrine	decongestant	Not specified (squeeze bottle)	\$6.99
Azelastine	Astepro	antihistamine	120	\$29.49 \$0.24
Triamcinolone	Nasacort	corticosteroid	120	\$24.79 \$0.21
Mometasone	Nasonex	corticosteroid	60	\$29.49 \$0.49
Fluticasone	Flonase	corticosteroid	144	\$30.49 \$0.21
Budesonide		corticosteroid	120	\$20.79 \$0.17
3% Saline Solution		wetting agent	continuous spray	\$7.49-11.99
Naloxone	Narcan	opioid antidote	1 spray/inhaler	2 inhalers for \$52.10

5. AEROSOL MEDICATION DELIVERY DEVICES: PRESSURIZED METERED-DOSE INHALERS

WHAT ARE INHALERS?

The term “inhaler” describes devices used to give a dose of inhaled medication. There are 3 types of inhalers —

- pressurized metered-dose inhalers (MDIs)
- dry-powder inhalers (DPIs)
- soft-mist inhalers (SMIs)

All inhalers may be carried around in your purse or pocket and used anywhere. Several inhalers may be prescribed to you, each having a different method of use. Incorrect use can reduce the amount of medication you receive. Your health care provider should show you how to use each of them. You may also follow the manufacturer’s instructions.

WHAT COMMON INHALERS ARE AVAILABLE IN THE UNITED STATES?

Common inhalers are shown in Figure 10 (page 31). You should always use your device and medication as prescribed by your provider. Remember that each medication has a different action. Tell your doctor or health care provider about any uncomfortable side effects.

Figure 10. Common Inhalers Available in the United States

Anticholinergics/ β_2 -Agonist Combination

COMBIVENT[®] RESPIMAT[®]

(ipratropium bromide and albuterol sulfate)

Inhalation Spray

Boehringer Ingelheim Pharmaceuticals, Inc.



STIOLTO[®] RESPIMAT[®]

(tiotropium bromide and olodaterol)

Inhalation Spray

Boehringer Ingelheim Pharmaceuticals, Inc.



UTIBRON[™] NEOHALER[®]

(indacaterol and glycopyrrolate)

Inhalation Powder

Sunovion Pharmaceuticals Inc.



ANORO[®] ELLIPTA[®]

(umeclidinium and vilanterol)

Inhalation Powder

GlaxoSmithKline



BEVESPI AEROSPHERE[™]

(glycopyrrolate and formoterol fumarate)

Inhalation Aerosol

AstraZeneca Pharmaceuticals



Anticholinergics

SPIRIVA[®] HANDIHALER[®]

(tiotropium bromide)

Inhalation Powder

Boehringer Ingelheim Pharmaceuticals, Inc.



ATROVENT[™] HFA

(ipratropium bromide HFA)

Inhalation Aerosol

Boehringer Ingelheim Pharmaceuticals, Inc.



TUDORZA[™] PRESSAIR[™]

(aclidinium bromide)

Inhalation Powder

Forest Pharmaceuticals, Inc.



INCROUTE[®] ELLIPTA[®]

(umeclidinium)

Inhalation Powder

GlaxoSmithKline



SEEBRI[™] NEOHALER[®]

(glycopyrrolate)

Inhalation Powder

Sunovion Pharmaceuticals Inc.



β_2 -Agonists

PROAIR[®] HFA

(albuterol sulfate)

Inhalation Aerosol

Teva Specialty Pharmaceuticals



ProAir[®] RespiClick[®]

(albuterol sulfate)

Inhalation Powder

Teva Specialty Pharmaceuticals



PROVENTIL[®] HFA

(albuterol sulfate)

Inhalation Aerosol

3M Pharmaceuticals Inc.



ARCAPTA[™] NEOHALER[®]

(indacaterol)

Inhalation Powder

Novartis Pharmaceuticals



Striverdi[®] Respimat[®]

(olodaterol)

Inhalation Spray

Boehringer Ingelheim Pharmaceuticals, Inc.



XOPENEX[®] HFA

(levalbuterol tartare)

Inhalation Aerosol

Sunovion Pharmaceuticals Inc.



Ventolin[®] HFA

(albuterol sulfate HFA)

Inhalation Aerosol

GlaxoSmithKline



SEREVENT[™] DISKUS[™]

(salmeterol xinafoate)

Inhalation Powder

GlaxoSmithKline



Serevent[™] HFA

(salmeterol xinafoate)

Inhalation Aerosol

GlaxoSmithKline



Corticosteroids

ALVESCO[®]

(ciclesonide)

Inhalation Aerosol

Nycomed



ASMANEX TWISTHALER[®]

(mometasone)

Inhalation Powder

Schering Corporation



FLOVENT[™] DISKUS[™]

(fluticasone propionate)

Inhalation Powder

GlaxoSmithKline



ARMONAIR[™] RESPICLICK[™]

(fluticasone propionate)

Inhalation Powder

Teva Specialty Pharmaceuticals



ARNUITY[®] ELLIPTA[®]

(fluticasone furoate)

Inhalation Powder

GlaxoSmithKline



FLOVENT[™] HFA

(fluticasone propionate)

Inhalation Aerosol

GlaxoSmithKline



PULMICORT[™] FLEXHALER[®]

(budesonide)

Inhalation Powder

AstraZeneca LP



QVAR[®]

(beclomethasone dipropionate)

Inhalation Aerosol

Teva Specialty Pharmaceuticals



AEROSPAN[®]

(flunisolide)

Inhalation Aerosol

Mylan Pharmaceuticals



β_2 -Agonist/Corticosteroid Combination

ADVAIR[®] DISKUS[™]

(fluticasone propionate and salmeterol)

Inhalation Powder

GlaxoSmithKline



ADVAIR[®] HFA

(fluticasone propionate and salmeterol xinafoate)

Inhalation Aerosol

GlaxoSmithKline



BREO[®] ELLIPTA[®]

(fluticasone furoate and vilanterol)

Inhalation Powder

GlaxoSmithKline



DULERA[®]

(mometasone furoate/formoterol fumarate dihydrate)

Inhalation Aerosol

Merck



SYMBICORT[®]

(budesonide and formoterol fumarate dihydrate)

Inhalation Aerosol

AstraZeneca



AIRDUO RESPICLICK[™]

(fluticasone propionate and salmeterol)

Inhalation Powder

Teva Specialty Pharmaceuticals



Other

RELENZA[®]

(zanamivir)

Inhalation Powder

GlaxoSmithKline



TOBI[®] PODHALER[®]

(tobramycin)

Inhalation Powder

Novartis Pharmaceuticals



WHAT ARE MDIs?

The first metered-dose inhaler (MDI) was invented in 1955 by Dr. George Maisson. He came up with the idea for the device because his asthmatic teenage daughter wanted a better way to take her breathing treatment. A MDI is designed to deliver an exact (metered) amount (dose) of medication in a fine mist that can be breathed directly into the air passages.

HOW DO MDIs WORK?

The MDI is the most popular way to deliver inhaled medication. The medication is moved from the canister, through the device, and out through the mouthpiece. The parts of the MDI include the canister, medication/propellant, metering valve, actuator (or boot), and usually a dose counter. Figure 11 is a picture of a MDI with each part labeled and the medication spraying from the boot. Table 4 further explains each part of a MDI.

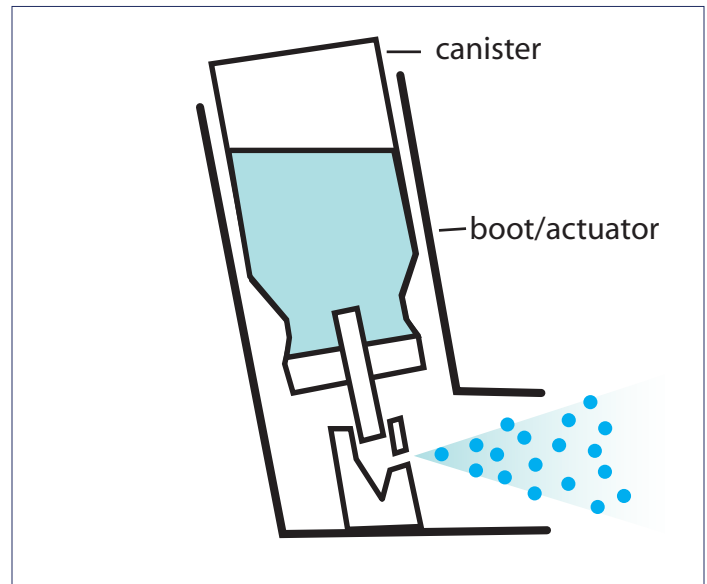


Figure 11. Parts of MDI

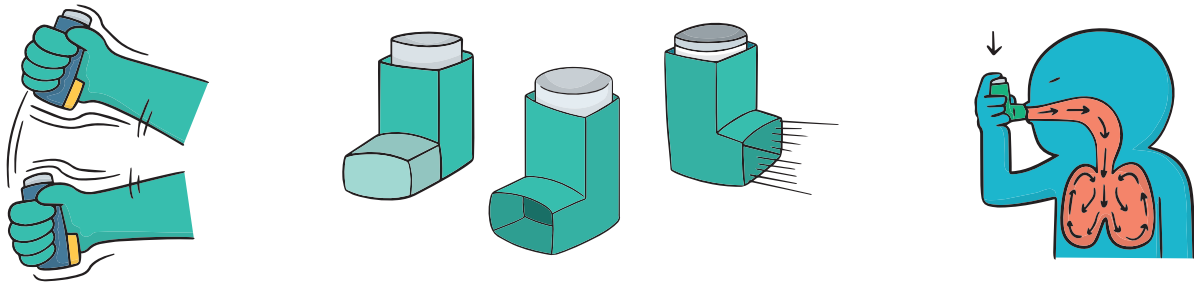
Table 4. MDI parts	
Part	Explanation
Canister	A metal can that holds the medication and propellant.
Propellant	Pushes the medication into the lungs.
Medication	The active ingredient that has the desired effect on the lungs.
Metering Valve	Measures the dose of medication.
Actuator	Frequently referred to as the "boot," delivers the medication. Each boot is unique to a specific MDI/medication.

HOW DO I USE MY MDI?

Technique Box 2

Instructions for Correct Use of Metered-Dose Inhalers

1. If the canister is cold, warm it in your hand.
2. Take the mouthpiece cover off and make sure there are not any loose parts inside the mouthpiece.
3. Shake the MDI for 5 seconds.
4. Prime the MDI into the air according to the MDI instructions, if necessary.
5. Sit up straight or stand up.
6. Breathe all the way out and hold the MDI so the mouthpiece is at the bottom and the canister is at the top of the MDI.
7. Put the MDI mouthpiece between your lips. Make sure that your tongue is flat under the mouthpiece and does not block the outlet of the MDI.
8. Seal your lips around the mouthpiece.
9. Press down on the canister as you begin to slowly take in a breath.
10. Breathe all the way in, slow and deep.
11. Hold your breath for 10 seconds. If you cannot hold your breath for 10 seconds, then for as long as you can.
12. If you take more than one spray, wait 15 to 30 seconds (or as directed in the package insert) before taking the next puff. Then repeat steps 5-11.
13. If taking an inhaled corticosteroid, rinse your mouth after the last puff of medicine and spit the water out — do not swallow.
14. Put the mouthpiece cover back on.



WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF MDIs?

Table 5. Advantages and disadvantages of the MDI

Advantages	Disadvantages
✓ Portable, light, and compact	✗ Hand-breath coordination is required. The canister has to be pushed down by the patient. Proper breathing pattern and breath-hold are required.
✓ Easy to use	✗ Unwanted substances in the mouthpiece, such as dirt or bacteria, may be breathed in.
✓ Short treatment time	✗ Medicine may land inside the mouth and back of throat instead of the lungs.
✓ Same dose every time	
✓ Nothing to mix	
✓ Difficult to get it dirty	

WHAT FACTORS AFFECT MDI PERFORMANCE AND MEDICATION DELIVERY?

For best results from your inhaler:

- Store the canister at or near room temperature. If a MDI is left in a cold car overnight, it might not work until it returns to room temperature.
- **Shake the Canister:** If your MDI is left sitting for an extended period of time between uses, the medication and the propellant separate. You will need to shake the canister before you use the MDI.
- Keep the nozzle clean. Follow your provider's instructions for periodic nozzle cleaning. Do not use the boot of one medication for another medication.
- Prime the MDI if necessary. MDIs that are brand new or have not been used for an extended period of time should be primed. Shake the MDI and spray the correct number of doses into the air (see Table 6). Refer to the manufacturer's recommendations if you have questions.
- Allow for a pause between each puff from the inhaler. You should wait about 30-60 seconds between each puff for best results.

Table 6. Priming MDIs

Generic Name	Brand Name	Time To Prime	# Puffs
Short-Acting Bronchodilators			
Albuterol Sulfate HFA	ProAir HFA	New & when not used for 2 weeks	3
	Proventil HFA	New & when not used for 2 weeks	4
	Ventolin HFA	New & when not used for 14 days	4
Levalbuterol HCl	Xopenex HFA	New & when not used for 3 days	4
Ipratropium Bromide HFA	Atrovent HFA used for 3 days	New & when not used for 3 days	2
Ipratropium Bromide/Albuterol Sulfate Combination	Combivent HFA	New & when not used for 24 hours	3
Inhaled Corticosteroids			
Beclomethasone Propionate HFA	QVAR	New & when not used for 10 days	2
Flunisolide Hemihydrate	Aerospan™ HFA	New & when not used for 2 weeks	2
Fluticasone Propionate	Flovent HFA	New	4
		Not used more than 7 days or if dropped	1
Mometasone furoate	Asmanex HFA	New & when not used 5 days	4
Combination Medications			
Budesonide in combination with Formoterol	Symbicort HFA	New & not used more than 7 days or if dropped	2
Fluticasone in combination with Salmeterol	Advair HFA	New	4
		Not used more than 4 weeks or if dropped	2
Mometasone & Formoterol	Dulera	New & not used more than 5 days	4

WHAT ARE COMMON PROBLEMS AND SOLUTIONS TO THE USE OF MY METERED-DOSE INHALER?

Sometimes you may have a problem when using your MDI. The most common problem is low or no mist output after pressing down on the canister. The chart below will help you identify the cause as well as the solution for several problems. You should also follow the instructions provided in the manufacturer's guide as well as those given by your respiratory therapist or health care provider.

HOW DO I KNOW IF MY MDI IS EMPTY?

When MDIs first came out, you couldn't tell how many puffs of medication were left in the canister. People thought that as long as they heard or felt something inside the canister when it was shaken, then there was medication left. However, there is more propellant than medication. Even if you still feel/hear something inside the canister when shaken, it may only be propellant.

Table 7. Problems with the MDI: Absent or Low Mist Output	
Causes	Solutions
MDI put together incorrectly	Check that the canister/cartridge is correctly seated in the boot.
MDI & spacer attached incorrectly	Check that the MDI mouthpiece is pushed into the spacer inlet.
MDI is empty	Check the dose counter or daily log sheet to make sure there is enough medicine in the canister. If not, get a new MDI.

WITH A DOSE COUNTER:

Most MDIs have a dose counter. The dose counter tells you how many puffs are left in the MDI (see Figure 12).

1. Check the product label or literature and determine the number of puffs that the MDI has when it is full.
2. Learn to read the counter display. Each dose counter has a specific way of displaying the number of puffs that remain in the canister. For example, some devices will turn red as an indication that the number of puffs is less than 20 puffs and it is nearing time to get a new MDI. Again, be certain to read the instructions on how to interpret the counter display.
3. Recognize that when the last puff is given (dose counter reads 0), the MDI should be thrown away.

The U.S. Food and Drug Administration (FDA) requires all new MDIs to have a dose counter. The dose counter is set to the total number of puffs. With each puff, the number is decreased until no more puffs are left.



Figure 12. Examples of built-in dose counters

WITHOUT A DOSE COUNTER:

If there is no dose counter, manually count and record on a paper every individual puff given, including both priming and therapy doses. This number is then subtracted from the total number of puffs listed on the product label until all have been used.

1. Check the product label or literature and determine the number of puffs that the MDI has when it is full.
2. When using medications on a daily basis, calculate how long the MDI will last by dividing the total number of puffs in the MDI (often 120) by the total puffs used per day. For example, if used twice a day with 2 puffs per treatment, this would calculate to a total of 4 puffs per day. If you divide this by the number of puffs available (120 divided by 4), the canister will last 30 days. Also, you must remember that the medication will run out sooner if the MDI is used more often than planned.
3. Identify the date that the medication will run out and mark it on the canister or on the calendar.
4. Keep track of how many puffs of medicine are administered on a daily log sheet and subtract them to determine the amount of medication left in the MDI.
5. Keep the daily log sheet in a convenient place.
6. Replace the MDI when all of the puffs have been administered.

For example, if a new MDI has 200 puffs when full, you will need a new one when the total number of puffs used (including priming) reaches 200. At that time the old MDI should be thrown away. The manual counting of doses may not be practical and/or dependable, especially if you are using your medication as a quick reliever and are always on the go.

The FDA requires that all MDIs without dose counters must be used with an external dose-counting device. There are two types of external dose counters. In one type, the canister of the MDI is inserted into a new boot that has the dose counter built-in. The other type fits over the end of the canister. Both types record each puff. Figure 13 shows an example of each type of external dose counter.

Your provider can check to make sure your external dose counter works with your MDI. Improper attachment or a poor fit with the canister can result in improper dosing. This could lead to little or no medication being released, as well as an incorrect count of remaining doses. "Although obtaining an external dose counter will be an added expense, it only needs to be purchased once. Without an external dose counter, you must follow the instructions in the manufacturer's guide on how to count doses.



Figure 13. Examples of external dose counters for a MDI

WHAT ARE SPACERS?

A spacer is a plastic or metal tube that adds space and volume between the MDI and your mouth. The MDI aerosol is sprayed directly into the spacer where the mist is temporarily held.

A spacer:

- gives the speed of the mist time to slow down before it is breathed in
- increases the amount of medication delivered to the lungs
- helps people who have difficulty timing the pressing of the inhaler with their breath (Table 8).

Once you press the MDI, you need to breathe in immediately. Waiting longer than 2–3 seconds can decrease the amount of medication inhaled. Some spacers make a noise when you inhale too fast. If you hear the noise, breathe in more slowly next time. Remember, MDIs work best when you take a slow, deep breath.

Children may need to take about 6 breaths from the spacer to inhale all the medication from a single puff. This is most often delivered with a mask on the spacer. **Do not** remove the mask from the child's face until after 5–6 breaths.

Spacers can be purchased from a pharmacy or from your home care company.



Figure 14. Example of a MDI attached to a spacer

HOW DO I USE A SPACER?

Using a spacer incorrectly can decrease medication delivery or, in some cases, cause the dose to be lost completely.

Several problems can arise when giving an inhaled medication treatment to kids using an MDI. These can include poor mask fit, crying, or that the spacer volume is too large for the child. The treatment must be given correctly, which is covered in Technique Box 3 on the next page.

Table 8. Advantages and disadvantages of using spacers with MDIs	
Advantages	Disadvantages
✓ Less medication remains in the mouth and more medication goes to the air passages.	✗ Large compared to the MDI alone.
✓ 2–4 times more medication is inhaled with a spacer than with a MDI alone.	✗ More expensive than a MDI alone.
✓ Allows use of MDI when the patient is short of breath.	✗ May require assembly.
✓ Makes timing of MDI press and inhalation easy.	✗ Patient may make the mistake of putting multiple puffs into the chamber before inhaling, or waiting too long between putting a puff in the chamber and breathing it in.
	✗ Must be cleaned every week.

Technique Box 3

How to give a treatment using a MDI with spacer

When using a spacer, you should:

1. Wash and dry your hands thoroughly.
2. If the canister is cold, warm the MDI canister in your hand.
3. Remove the MDI mouthpiece cover and make sure there are not any loose parts inside the mouthpiece.
4. Shake the MDI several times.
5. Prime the MDI into the air if it is new or has not been used for several days.
6. Attach the MDI to the spacer.
7. Keep the canister in an upright position.
8. Sit up straight or stand up.
9. Breathe out fully.
10. Follow the instructions below based on if a mouthpiece or mask is being used:

With the mouthpiece:

- Put the spacer mouthpiece between your lips. Keep your tongue flat under the mouthpiece so it does not block the opening. Seal your lips around the mouthpiece.
- Press the MDI and begin to breathe in slowly. If the device produces a noise, you are breathing in too fast. Slow your breathing.
- Move the mouthpiece away from your mouth and hold your breath for 10 seconds or for as long as you can.

With the mask:

- (Used primarily for kids or if the patient cannot use the mouthpiece)
- Place the mask completely over the nose and mouth and make sure it fits firmly against the face.
 - Hold the mask in place and press the MDI as the person begins to breathe in. If the device produces a noise, be aware that the person is breathing in too rapidly.
 - Hold the mask in place while the person takes 6 normal breaths (including breathing in and out) and remove the mask from the person's face.

11. Wait 30–60 seconds if another puff of medication is needed.
12. Repeat the steps above until the prescribed number of puffs is reached.
13. If taking a corticosteroid, you should rinse your mouth after the last puff of medicine and spit the water out. Do not swallow it.
14. Put the mouthpiece cover back on the MDI after each use.

GENERAL INSTRUCTION TO RECEIVE THE FULL DOSE FROM MDIs WITH A SPACER

When using MDIs with a spacer, the following steps should be taken to receive the full dose of medication. You should:

1. Assure that the MDI fits properly into the spacer.
2. Remove the cap from the MDI boot.
3. After use, clean and reassemble the MDI spacer according to the manufacturer's instructions.

6. AEROSOL MEDICATION

SOFT-MIST INHALERS

WHAT ARE SOFT-MIST INHALERS?

A soft-mist inhaler (SMI) or Respimat® inhaler (Figure 15) is an inhaler that produces a mist at a slower speed than a pressurized metered-dose inhaler so that there may be less aerosol remaining in your mouth when you breathe in. The mist that comes out of the SMI is referred to as a “soft mist.” Several medications can be used with the Respimat®. As seen in the picture below, the Respimat® comes in two pieces: the medication cartridge and the inhaler. Instructions for loading the cartridge into the inhaler and taking a dose of medication from the SMI can be found on the next page. The SMI is not



Figure 15. The Respimat® soft-mist inhaler

used with a spacer.

HOW DO SOFT-MIST INHALERS WORK?

The medication in the SMI is stored inside the cartridge. When the clear base is turned, a spring inside the SMI is

pressed. When the dose release button is pressed, the energy from the spring pushes the medication through the nozzle, releasing the fine mist you breathe in. There are no parts to fix, so once the cartridge is properly inserted, individual medication doses will be given each time the base is rotated half a full turn and the dose-release button pressed. When the last dose is given, the base can no longer be rotated and the Respimat should be replaced.

WHAT ARE THE ADVANTAGES OF THE SMI?

The mist comes out of the Respimat® much slower than the mist from a MDI. This allows for more medication to reach the air passages and less medication to be left in the mouth. If the Respimat® dose release button is pressed outside the mouth, there is more of a chance of spray in the eyes or face.

OPTIMIZING SMI PERFORMANCE AND MEDICATION DELIVERY

- Keep the Respimat® at room temperature: 68°F to 77°F (20°C to 25°C).
- Do not freeze your Respimat® cartridge and inhaler.
- If the Respimat has not been used for more than 3 days, prime it by releasing 1 puff towards the ground (see Table 8).
- If the Respimat® has not been used for more than 21 days, prime the inhaler according to the manufacturer’s instructions until a mist is visible.
- Clean the mouthpiece, including the metal part inside the mouthpiece, with a damp cloth or tissue only at least once a week. Any minor discoloration in the mouthpiece does not affect your Respimat® inhaler.

Table 9. Priming the Respimat® SMI

1. Rotate the base of the inhaler half a full turn. Open the cap. Point the inhaler toward the ground.
2. Press the dose-release button.
3. Close the cap.
4. If you do not see a mist, repeat the first three steps until a mist is seen.
5. After a mist is seen, rotate the base and press the dose release button three more times.
6. Prime the inhaler a total of four times, seeing a mist each time.
7. After complete preparation of your inhaler, it will be ready to deliver the number of puffs on the label.

Technique Box 4

Instruction for Correct Use of Respimat® Soft-Mist Inhalers

When preparing the Respimat® for first use (to load the cartridge), you should:

- | | |
|--|--|
| <ol style="list-style-type: none">1. With the cap closed, press the safety catch while pulling off the base. (Be careful not to touch the piercing element located at the bottom of the clear base.)2. Write the "discard by" date on the label of the inhaler. The discard by date is 3 months from the date the cartridge is inserted.3. Take the cartridge out of the box. Push the narrow end of the cartridge into the inhaler. The base of the cartridge will not sit flush with the inhaler. About 1/8 of an inch will remain visible when the cartridge is correctly inserted. | <ol style="list-style-type: none">4. Put the clear base back into place.5. Hold the inhaler upright with the cap closed to avoid accidental release of dose.6. Turn the clear base in the direction of the white arrows on the label until it clicks (half a turn).7. Flip the cap until it snaps fully open.8. Prime the SMI by pointing the inhaler toward the ground. Press the release button. Close the cap. Repeat the process until a spray is visible (see Table 9 above). |
|--|--|

To take a dose from the Respimat®, you should:

- | | |
|---|---|
| <ol style="list-style-type: none">1. Sit up straight or stand up.2. Turn the clear base in the direction of the white arrows on the label until it clicks (half a turn).3. Breathe out fully and hold the SMI so the mouthpiece is horizontal to the ground.4. Place the SMI between your lips and point your inhaler towards the back of your throat.5. Make sure that your tongue is flat under the mouthpiece and does not block the mouthpiece. | <ol style="list-style-type: none">6. Seal your lips around the mouthpiece.7. While taking in a slow breath through your mouth, press the dose-release button and continue to breathe in slowly as long as you can.8. Hold your breath for 10 seconds or for as long as you can.9. Wait 30–60 seconds if another dose of medicine is needed, then repeat steps 1-8.10. Replace the mouthpiece cover on the SMI after each use. |
|---|---|

WHAT ARE COMMON PROBLEMS AND SOLUTIONS WITH THE USE OF MY RESPIMAT® SMI?

It is difficult to insert the cartridge deep enough:

Did you accidentally turn the clear base before inserting the cartridge? Open the cap, press the dose-release button, then insert the cartridge.

Did you insert the cartridge with the wide end first?

Insert the cartridge with the narrow end first.

I cannot press the dose-release button:

Did you turn the clear base? If not, turn the clear base in a continuous movement until it clicks (half a turn).

Is the dose indicator on the Respimat® pointing to zero?

The Respimat® inhaler is locked after 120 puffs (120 doses). If you have a sample, the Respimat® inhaler is locked after 60 puffs (60 doses). Prepare and use your new Respimat® inhaler.

I cannot turn the clear base:

Did you turn the clear base already? If the clear base has already been turned, follow instructions for "Open" and "Press" under "Daily use" to get your medicine.

The dose indicator on the Respimat® reaches zero too soon:

Did you use Respimat® as indicated (1 puff four times daily?)

Respimat® will deliver 120 puffs and last 30 days if used at 1 puff four times daily. If you have a sample, Respimat® will deliver 60 puffs and last 15 days if used at 1 puff four times daily.

Did you turn the clear base before you inserted the cartridge?

The dose indicator counts each turn of the clear base regardless whether a cartridge has been inserted or not.

Did you spray in the air often to check whether the Respimat® is working?

Once you have prepared Respimat®, no test-spraying is required if used daily.

Did you insert the cartridge into a used Respimat®?

Always insert a new cartridge into a NEW Respimat®.

My Respimat® sprays automatically:

Was the cap open when you turned the clear base?

Close the cap, then turn the clear base.

Did you press the dose-release button when turning the clear base?

Close the cap so the dose-release button is covered, then turn the clear base.

Did you stop turning the clear base before it clicked?

Turn the clear base in a continuous movement until it clicks (half a turn).

My Respimat® does not spray:

Did you insert a cartridge? If not, insert a cartridge.

Did you repeat Turn, Open, Press (TOP) less than three times after inserting the cartridge?

Repeat Turn, Open, Press (TOP) three times after inserting the cartridge.

Is the dose indicator on the Respimat® pointing to 0?

You have used up all of your medicine and the inhaler is locked.

Is my Respimat® empty?

The dose counter is at zero (0) and you are no longer able to rotate the clear base.

7. AEROSOL MEDICATION DRY-POWDER INHALERS

WHAT ARE DPIS?

A dry-powder inhaler (DPI) is another portable device used to deliver aerosol medications to the air passages. The medication inside of a DPI is made of tiny powder particles. When you take a fast, deep breath through the DPI, you pull the medication out of the device and into your air passages.

HOW DO DPIS WORK?

All DPIS have three parts:

1. An air inlet
2. A chamber for the medication to rest before it is breathed in
3. A mouthpiece.

The DPI has a chamber for the powdered medication. Some medication chambers are inside of the DPI where you cannot see them, while others have medication stored in a small capsule that you place into the chamber. When a capsule is used, the capsule must be punctured (or poked) by the device before breathing in.

It is important to take a fast, deep breath through the mouthpiece to breathe in the medication. The fast breath

pulls the medication powder into your air passages. A slow or shallow breath prevents you from receiving the full amount of medication. Make sure that you do not block the air vents on your DPI while breathing in.

WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF DPIS?

Table 10 below lists the advantages and disadvantages of DPIS. You should discuss these with your respiratory therapist or health care provider at the time the DPI is prescribed. Do not hesitate to ask additional questions at future clinic appointments.

HOW DO I USE MY DPI?

The steps for using DPIS vary for each device. Carefully review the steps for your own DPI. Following each step will help you get the most medication into your airways. You can also speak with a respiratory therapist prior to using your dry-powder inhaler. Do not hesitate to ask additional questions at future clinic appointments. Technique Box 5 (page 43) contains the steps for correctly using the most popular DPIS.

Table 10. Advantages and disadvantages of DPIS

Advantages	Disadvantages
✓ Small and portable	✗ Full dose of medication is not delivered if you breathe in slowly
✓ Built-in dose counter	✗ You cannot feel medication entering the air passages
✓ Breathing in does not need to be coordinated simultaneously with another step	✗ Room humidity or breathing out into the mouthpiece may make it difficult to separate medication in future doses
✓ Quick breathing treatment	✗ Not available for all medications
	✗ Different styles of DPIS for different medications it can be confusing

Technique Box 5

Steps for Use of Common Dry-Powder Inhalers

Spiriva® HandiHaler®

1. Wash and dry your hands thoroughly.
2. Peel back the aluminum foil from the blister pack and remove one capsule.
3. Open the dust cap by pulling it upward to expose the mouthpiece.
4. Open the mouthpiece.
5. Place the capsule into the center hole.
6. Close the mouthpiece firmly until you hear a click (leave the dust cap open).
7. Press the piercing button once and release. This makes holes in the capsule and allows the medication to be released when you breathe in.
8. Sit up or stand. Keep your head facing forward.
9. Breathe out fully away from the HandiHaler®.
10. Place the mouthpiece between your lips and close tightly around the mouthpiece.
11. Breathe in fast until your lungs are full. You should feel/hear the capsule vibrating in the chamber.
12. Take the mouthpiece away from your mouth and hold your breath for 10 seconds, or as long as comfortable.
13. Breathe out slowly away from the mouthpiece.
14. Open the mouthpiece, remove and discard the used capsule.
15. Close the mouthpiece and dust cap.
16. Store the HandiHaler and capsules in a cool, dry place.



Technique for using the Advair®, Serevent®, or Flovent® Diskus®

1. Wash and dry your hands thoroughly.
2. Open the device by placing your thumb or finger in the notch and rotating the cover.
3. Hold the device horizontal (like a hamburger) with the dose counter facing upward.
4. Slide the lever from left to right until you hear a click.
5. Breathe out fully away from the Diskus®.
6. Place the mouthpiece between your lips and close tightly around the mouthpiece.
7. Breathe in quickly and deeply.
8. Remove the mouthpiece from your mouth and hold your breath for 10 seconds or as long as comfortable.
9. Breathe out slowly away from the Diskus®.
10. Store the Diskus® in a cool, dry place.
11. Observe the counter for the number of doses remaining and replace the device when appropriate.
12. After each dose of Flovent® or Advair®, rinse your mouth with water to reduce the risk of developing a fungal infection. Do not swallow the rinsing water.



Technique Box 5 (continued)

Steps for Use of Common Dry-Powder Inhalers

Technique for using Asmanex® Twisthaler®

1. Wash and dry your hands thoroughly.
2. Hold the inhaler straight up with the pink base on the bottom.
3. Hold the pink base and twist the cap in a counterclockwise direction to remove it.
4. As the cap is lifted off, the dose counter on the base will count down by 1. This action also loads the dose.
5. Make sure the indented arrow located on the white portion (directly above the pink base) is pointing to the dose counter.
6. Breathe out away from the Twisthaler®.
7. Place the mouthpiece between your lips and close tightly around the mouthpiece." to match steps 10 and 6 in the previous tables.
8. Breathe in fast and deep while holding the Twisthaler® horizontal.
9. Remove the mouthpiece from your mouth and hold your breath for 5–10 seconds or as long as comfortable.
10. Breathe out slowly away from the Twisthaler®.
11. Immediately replace the cap, turn in a clockwise direction, and gently press down until you hear a click.
12. Firmly close the Twisthaler® to ensure that the next dose is properly loaded.
13. Be sure that the arrow lines up with the dose-counter window.
14. Store the Twisthaler® in a cool, dry place.
15. After each dose, rinse your mouth with water to reduce the risk of developing a fungal infection. Do not swallow the rinsing water.



Technique for using Pulmicort® Flexhaler®:

1. Wash and dry your hands thoroughly.
2. Hold the Flexhaler® in the upright position (mouthpiece up) to load a dose.
3. Twist the cover and lift it off the Flexhaler®.
4. Twist the brown grip fully in one direction as far as it goes. (It does not matter which way you turn it first.)
5. Twist it back in the other direction as far as it will go until you hear a click.
6. Breathe out away from the Flexhaler®.
7. Place the mouthpiece in your mouth, seal the mouthpiece with your lips, and breathe in deeply and forcefully from the Flexhaler®.
8. Remove the mouthpiece from your mouth and hold your breath for 5–10 seconds or as long as comfortable.
9. Breathe out slowly away from the Flexhaler®.
10. If more than 1 dose is required, repeat Steps 2–9 above.
11. Put the cover back on the Flexhaler® and twist it shut.
12. Store the Flexhaler® in a cool, dry place.
13. After each dose, rinse your mouth with water to reduce the risk of developing a fungal infection. Do not swallow the rinsing water.



Technique Box 5 (continued)

Steps for Use of Common Dry-Powder Inhalers

Technique for using the Tudorza™ Pressair®:

1. Wash and dry your hands thoroughly.
2. Remove the cap by gently squeezing the marked arrows on each side of the cap and pulling outward.
3. Hold the inhaler with the mouthpiece facing toward you and the green button on top. DO NOT place in your mouth yet.
4. Press the green button all the way down and release it. DO NOT hold the button down.
5. Check the control window on the device (above the mouthpiece) to ensure the color has changed from red to green, indicating the dose and device are ready for use.
6. Breathe out away from the device.
7. Place the mouthpiece into your mouth and breathe in quickly and deeply.
8. You will hear a CLICK when the dose is delivered, but continue with your deep breath until your lungs are filled.
9. Remove the device from your mouth and breathe out.
10. Check the control window on the device (above the mouthpiece) to ensure the color has changed from green to red. IF NOT, repeat Step 7.
11. Replace the cap on the mouthpiece.



Technique for using the Ellipta®:

1. Wash and dry your hands thoroughly.
2. Open the cover by sliding it downward until you hear a click.
3. Hold the device without blocking the air vents with your fingers.
4. Breathe out fully away from the device.
5. Place the mouthpiece into your mouth and breathe in quickly and deeply.
6. Hold your breath for at least 10 seconds.
7. Remove the device from your mouth and breathe out away from the device.
8. Close the Ellipta® by sliding the cover over the top of the mouthpiece.
9. If you are taking Arnuity®, Trelegy, or Breo®, rinse your mouth with water after completing your dose to reduce the risk of developing a fungal infection..



Technique Box 5 (continued)

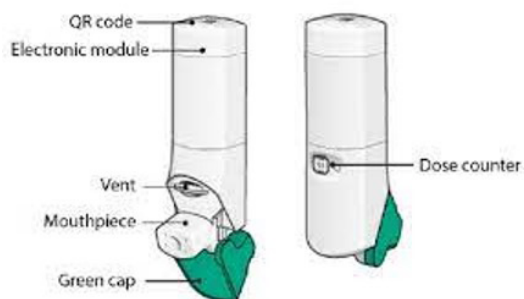
Steps for Use of Common Dry-Powder Inhalers

Technique for using the ArmonAir and Airduo Digihalers

Note: Even though the Digihaler looks like a metered dose inhaler, it is really a dry powder inhaler, so a fast breath in is important.

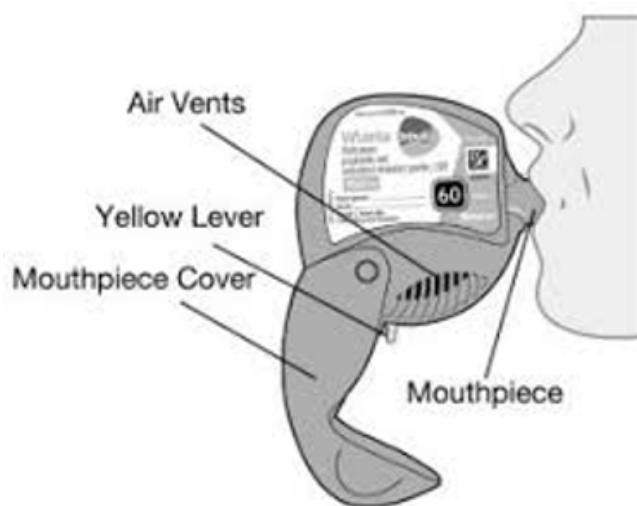
1. Wash and dry your hands thoroughly
2. Before using the inhaler, be sure the cap is closed from the previous dose.
3. Hold the inhaler upright (as shown) and open the green cap all the way back until it clicks. This prepares the dose.
4. Breathe out through your mouth away from the inhaler and push as much air from your lungs as you can.
5. Put the mouthpiece in your mouth and close your lips tightly around it. Do not block the vent.
6. Breathe in quickly and deeply through your mouth to deliver the dose of medicine to your lungs
7. Remove the inhaler from your mouth.

8. Hold your breath for 10 seconds, or as long as comfortable.
9. Close the green cap after each inhalation so that the inhaler will be ready for your next dose.
10. After each dose, rinse your mouth with water to reduce the risk of developing a fungal infection. Do not swallow the rinsing water.



Technique for using the Wixela Inhub

1. Wash and dry your hands thoroughly.
2. Before using the inhaler, be sure the mouthpiece cover is closed from the previous dose.
3. Open the mouthpiece cover until it stops (as shown).
4. Push the yellow lever down until it stops.
5. Breathe out through your mouth away from the inhaler and push as much air from your lungs as you can.
6. Put the mouthpiece in your mouth and close your lips tightly around it.
7. Breathe in quickly and deeply through your mouth to deliver the dose of medicine to your lungs. Do not block the vent.
8. Remove the inhaler from your mouth.
9. Hold your breath for 10 seconds, or as long as comfortable.
10. Close the cover over the mouthpiece.
11. After each dose, rinse your mouth with water to reduce the risk of developing a fungal infection. Do not swallow the rinsing water.



Technique Box 5 (continued)

Steps for Use of Common Dry-Powder Inhalers

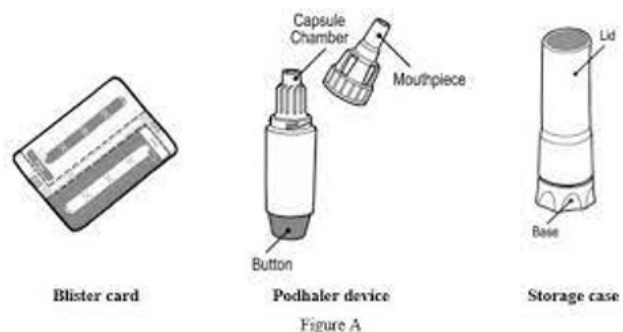
Technique for using the Tobi Podhaler

Note: The Podhaler is a single-dose inhaler. For each two breaths in, a new capsule is loaded.

1. Wash and dry your hands thoroughly
2. Just before use, hold the base of the storage case and unscrew the lid by turning it to the left (counterclockwise). Set the lid nearby.
3. Leave the Podhaler device in the base of the storage case while you prepare your dose.
4. Hold the body of the Podhaler device and unscrew the mouthpiece by turning it to the left (counterclockwise direction). Set the mouthpiece nearby.
5. Each medicine blister card contains 8 TOBI Podhaler capsules: 4 capsules for inhalation in the morning and 4 capsules for inhalation in the evening.
6. Peel the foil that covers 1 TOBI Podhaler capsule by rolling it back on the blister card. Always hold the foil close to where you are peeling.
7. Take out 1 TOBI Podhaler capsule from the blister card. Only peel back the foil from 1 capsule at a time and remove the capsule just before you are going to use it in the device to protect the capsules from moisture.
8. Place the TOBI Podhaler capsule in the capsule chamber at the top of the Podhaler device right away. **Do not** put the capsule directly into the top of the mouthpiece.
9. Put the mouthpiece back on your Podhaler device and screw the mouthpiece on by turning it to the right (clockwise) until it is tight.
10. Remove the Podhaler device from the base of the case. Hold the Podhaler device with the mouthpiece pointing down.
11. Put your thumb on the blue button and press the blue button all the way down. Let go of the blue button. Do not press the blue button more than 1 time. The chances of the capsule breaking into pieces will be increased if the capsule is accidentally pierced (a hole put in it) more than 1 time.

Note: You will need to repeat steps 11 through 15 for each capsule so that you breathe in two times to empty the capsule.

12. Breathe out through your mouth away from the Podhaler..
13. Place your mouth over the mouthpiece and close your lips tightly around it.
14. Breathe in deeply with a single breath.
15. Remove the Podhaler device from your mouth and hold your breath for about 5 seconds.
16. Exhale and take a few normal breaths away from the Podhaler device. Do not blow or exhale into the mouthpiece. Repeat Steps 11 to 15 as noted.
17. Unscrew the mouthpiece by turning it to the left (counterclockwise) and remove the TOBI Podhaler capsule from the capsule chamber.
18. Hold the used capsule up to the light and look through it. It should be empty with only a fine coating of powder remaining on the inside surface of the capsule. If the capsule is empty, throw it away and go to Step 18.
19. Put the mouthpiece back on to your Podhaler device and screw the mouthpiece on by turning it to the right (clockwise) until it is tight.
20. Place your Podhaler device back in the storage case base and place the lid back on the case. Screw the cover on by turning it to the right (clockwise) until it is tight.



WHAT ARE COMMON PROBLEMS AND SOLUTIONS FOR THE USE OF MY DRY-POWDER INHALER?

Three problems occur with using DPIs:

1. The person cannot breathe in quickly enough to pull the medication out of the device. Ask your therapist about training to breathe in better.
2. Moisture gets into the DPI and causes the medication to clump together. This reduces the medication that can be breathed in.
3. Equipment malfunction.

A respiratory therapist can easily determine if you can breathe in fast enough to use your DPI. Avoid problems with humidity and moisture by taking the following steps:

1. Do not store your DPI in bathrooms, shower areas, and areas with little or no air conditioning.
2. Never breathe out into any DPI. Breathe out *away* from the DPI prior to breathing in from the DPI. After you breathe in, remove the DPI from your mouth and slowly breathe out away from the DPI.

If your equipment malfunctions, speak with your respiratory therapist or health care provider for help.

HOW DO I KNOW MY MULTI-DOSE DRY-POWDER INHALER IS EMPTY?

It is very important to know the number of doses remaining in your DPI. Some DPIs have dose counters. The table below lists information about dose counters.

Table 11. Dose counter information for selected DPI devices			
	Flexhaler®	Twisthaler®	Diskus®
Number of Medication Doses	60 or 120	30	60
Type of Dose Indicator	Numbered	Numbered	Numbered
Meaning of Dose Indicator	Although the indicator counts down each time a dose is loaded, it is not likely that you will see the dose indicator move each time you use about 5 doses.	The dose display showing "01" indicates the last dose of medicine is in the Twisthaler® and the medicine must be refilled.	The numbers turning red in the dose display indicates that there are 5 doses left.
	The indicator is marked in intervals of 10 doses with alternating numbers and dashes. When it is down to "0", it should be thrown away.		When the dose window shows "0", there is no medicine left and the Diskus® should be thrown away.

Table 11B. Dose counter information for selected DPI devices				
	Pressair	Ellipta	Digihaler	Inhub
Number of medication doses	60	30	60 (ArmonAir)	60
Type of dose indicator	Numbered	Numbered	Numbered	Numbered
Meaning of dose indicator	When there are no doses left (red "0"), the device locks and cannot be prepared for another dose.	When you have fewer than 10 doses remaining (10 days), the left half of the indicator is red.	When there are 20 doses left, the numbers turn red. At "0", there is no medicine left.	After 51 doses, the indicator will be red. At "0", the lever cannot be fully pushed, there is no medicine left.

8. AEROSOL MEDICATION SPECIAL APPLICATIONS

HOW DO I HELP INFANTS AND YOUNG CHILDREN TAKE INHALED MEDICATIONS?

Infants and young children need others to help them take their inhaled medications.

Two things affect how you proceed. The child's:

- Physical ability
- Thinking ability.

Let's talk about these two issues.

PHYSICAL ABILITY

Most children under the age of 3 years will not hold a mouthpiece in their mouths. Therefore, they need to use a face mask. Make the following adjustments:

- Small-volume nebulizer: place the mask with a round outlet on top of the medication cup.
- Metered-dose inhaler (MDI): use a spacer with a mask.
- Dry-powder inhaler (DPI): not appropriate for children less than age 4 years.

A mask needs to be the correct size for the child's face. The top of the mask should not touch the child's eyes. The bottom of the mask should not be below the bottom of the chin.

THINKING ABILITY

Most children younger than 5 years of age do not have hand/breath coordination. They cannot breathe in at the same time that they press their MDI. Therefore, they need to use a spacer with their MDI. Thinking skills also affect how much responsibility a child should have. An adult should make sure that children under age 15 years¹ take their medication at the correct time. Adults also need to watch how young children breathe in their medication. Medication will not enter the air passages if children breathe in wrong.

Table 12 (page 51) lists the appropriate ages to begin using different types of aerosol devices. Notice that the small-volume nebulizer and MDI with spacer are recommended for children up to 5 years of age. Remember to ask your respiratory therapist or other health care professional for additional help.

AEROSOL MEDICATION DELIVERY IN DISTRESSED OR CRYING INFANTS

Children need to be calm when taking inhaled medications. A crying child spends more time breathing out than in. The child needs to be calm to breathe in the medication. Ways to keep the child calm include:

- Comforting babies by rocking or wrapping snugly in a blanket.
- Playing games with the child.
- Distracting the child with toys or music.
- It is fine to give a sleeping baby inhaled medication. Be careful not to wake up the baby.

¹Orrell-Valente JK, Jarlsberg LG, Hill LG, Cabana MD. At what age do children start taking daily asthma medicines on their own? *Pediatrics* 2008; 122(6):e1186-e1192.

Table 12. Recommended age guidelines for aerosol medication devices

Aerosol Generator	Age
Small-volume nebulizer with mask	less than 3 years
Small-volume nebulizer with mouthpiece	4 years or older
MDI with spacer and mask	less than 4 years
MDI with spacer	4 years or older
Dry-powder inhaler (DPI)	4 years or older
Metered-dose inhaler (MDI)	5 years or older
RespiClick®	5 years or older
Breath-actuated nebulizers	5 years or older

SELECTING THE BEST AEROSOL DEVICE FOR YOUR CHILD

Babies and young children have their own preferences. The best device is one that works for both the caregiver and child. The following qualities may affect your decision:

- Ease of use
- Effort to clean
- Time required to take treatment
- Portability
- Cost

Mouthpiece or face mask? A frequently asked question is whether to use a mouthpiece or face mask. If the caregiver is able to get the 2-3 year-old child to accept a mouthpiece, that is fine. All patients breathe-in more medication with a mouthpiece. If the child will not use a mouthpiece, using a mask is the alternative.

Importance of a properly sized face mask: It is important to have the correct size of face mask for your child. Small leaks around the mask decrease the amount of medication breathed in. Half of the medication could be wasted if the mask size is wrong.

Many children do not want to wear a face mask. This happens more often when they feel sick. Be persistent and offer encouragement. Use games, play activities, or have your child hold the mask. Give your child lots of positive words for

each success. Consider trying a mask that looks like a fish or other animal to make wearing the mask “fun”.

Face mask or blow-by? *Blow-by* describes the practice where the medication mist that is coming out of the nebulizer is directed toward the child’s face. In the past, blow-by was used for crying babies or unhappy children. The blow-by method should be avoided, as the medication does not enter the air passages when this method is used. Use a face mask instead.

Caregiver and patient education

Children may need to change their aerosol device as they grow. Both the caregivers and children will need to learn about their new devices. This instruction should include how to use the device and how to clean it. Do not hesitate to ask questions about your new devices; your respiratory therapist or other health professionals will be happy to assist.

TAKING AEROSOL MEDICATIONS TO TREAT PULMONARY ARTERIAL HYPERTENSION

Although it is a rare disease, there are five types of Pulmonary Arterial Hypertension (PAH). PAH happens more often in women than in men and more often in younger women of child-bearing age. Symptoms of PAH include shortness of breath not explained by other diseases (like COPD, asthma, or lung infection), weakness, fainting, and leg swelling. It is diagnosed by measuring the pressure in the blood vessels that lead away from the heart and into the lungs. In PAH, the blood vessels leading to the lungs are narrowed, preventing blood from getting to the lungs normally. The treatment for PAH involves oral, intravenous and aerosol drugs that allow those blood vessels to relax. The PAH specialist doctor will decide what drug or drugs should be used depending on disease severity.

If your doctor has decided that an aerosol drug should be used, it is usually either iloprost (trade name Ventavis) or treprostinil (trade name Tyvaso). These drugs can be very expensive and it is important that you use them correctly. That is why your patient educator or your patient caregiver should take plenty of time to teach you and your caregivers how to use the device.

VENTAVIS

Ventavis is breathed in using a nebulizer that was made specifically for this drug, called the I-neb ADD (Figure 16). AAD stands for Adaptive Aerosol Delivery. VENTAVIS should be breathed in as your doctor prescribes, usually 6-9 times a day, but no more often than every 2 hours.



Figure 16. The I-neb ADD for breathing in Ventavis.

TO USE THE I-neb ADD:



Make sure the battery is charged. The I-neb AAD System, when fully charged, will last for up to 40 treatments before recharging is needed.



Align the blue dot on the VENTAVIS ampule with the dot on the ampule breaker and then insert into the ampule breaker. Gently break open the neck of the ampule by levering away from the dot on the ampule.



After removing the medication lid, put the dosing guide over the medication chamber. Use the small tube (pipette) supplied with VENTAVIS to draw VENTAVIS out of the ampule. Carefully squeeze the entire contents of the ampule into the medication chamber. The amount of VENTAVIS you receive will be controlled by either the dosing disc or the medication chamber. Throw away the top of the ampule and the open ampule in a safe container. Keep both the ampule and the pipette away from children.

Replace the lid, cover the latch, and attach the mouthpiece.

If you will use the I-neb ADD nebulizer, your patient educator will give you enough teaching sessions to be sure you know how to use it. It is beyond the scope of this guide to give you everything you need to know about this nebulizer.

TYVASO

Tyvaso is breathed in from a dry powder inhaler like those described in an earlier chapter of this guide, and is simply called the Tyvaso DPI. (Figure 17)



Figure 17. Tyvaso DPI and ampules for different doses of Tyvaso.

A video explaining how to use the Tyvaso DPI can be found at: <https://www.tyvaso.com/dpi/>

To use the Tyvaso DPI:

1. Remove a Tyvaso ampule from the blister pack. Be sure the inhaler and ampule are at room temperature for 10 minutes.
2. On a flat surface, open the top latch of the inhaler. Insert the ampule into the slot in the inhaler. Close the inhaler until it snaps. Don't tip the inhaler once it is loaded.
3. Remove the mouthpiece cover. Breathe out fully away from the inhaler. Put the mouthpiece in your mouth and tilt it slightly downward. Breathe in fully. Hold your breath for as long as possible. Take the mouthpiece out of your mouth and breathe normally.
4. Put the mouthpiece cover back on to the DPI. Open the DPI as before, and remove the ampule and throw it away. Repeat steps 1-3 if prescribed for a larger dose.

Doses are usually taken 4 hours apart while awake. The inhaler is thrown away every seven days and replaced. No cleaning is needed. Your patient educator will give you enough teaching sessions to be sure you know how to use the Tyvaso DPI.

9. AEROSOL MEDICATION DELIVERY: MAINTENANCE AND PROBLEM SOLVING

HOW DO I CLEAN MY AEROSOL MEDICATION DEVICE?

INFECTION CONTROL PLAN IN AEROSOL MEDICATION DELIVERY

Research has shown that medication delivery devices used at home are frequently contaminated with bacteria. Ask your respiratory therapist or health care provider how to clean and maintain your inhaler device. Request written instructions and review them frequently.

In the hospital, medication delivery devices are replaced for you. However, at home the cleaning is your job. Even with cleaning, your disposable small volume nebulizer should be replaced every 1-2 weeks. Reusable nebulizers should be replaced every six months.

CLEANING AND MAINTENANCE OF MEDICATION DELIVERY DEVICES

You can prevent aerosol medication delivery devices from becoming infected or malfunctioning at home by following the cleaning instructions given below for the different types of aerosol medication delivery devices:

Pressurized metered-dose inhalers (MDIs): The plastic container (holder or boot) of the MDI should be cleaned at least once a week as described in the directions in Table 13.

When a spacer is used with a MDI, it should be cleaned before first use and then periodically cleaned based on the manufacturer's recommendations. Table 14 provides the steps for cleaning spacers and holding chambers.

Table 13. Cleaning instructions for the MDI

Cleaning the MDI	
1.	Frequency of cleaning: Once a week and as needed. Check for powder in and around the hole where medication sprays out of the inhaler. If you see powder, the inhaler should be cleaned.
2.	Remove the MDI canister from the plastic container so it does not get wet.
3.	Rinse the plastic container with warm water and shake out to remove excess water.
4.	Place it on a clean paper towel and let it air dry overnight.
5.	Place the canister back inside the MDI and recap the mouthpiece.

Table 14. Cleaning instructions for the MDI spacer and holding chamber

Cleaning the Chamber Device	
1.	Frequency of cleaning: per manufacturer’s recommendation and as needed.
2.	Take the device apart for cleaning.
3.	Soak the spacer parts in warm water with liquid dish soap and gently shake both pieces back and forth.
4.	Rinse with warm water.
5.	Shake to remove excess water.
6.	Air dry the spacer parts in an upright position overnight. Do not towel dry the spacer.
7.	Reassemble the spacer when it is completely dry.

Dry-powder inhaler (DPI): Your DPI should NOT be submerged in water. It must be kept dry because moisture will decrease the amount of medication delivered. You should wipe the mouthpiece of the DPI with a clean, dry cloth and follow the manufacturer’s recommendations for periodic cleaning.

Jet nebulizers: Your nebulizer should be cleaned after every treatment. The longer a dirty nebulizer sits and is allowed to dry, the harder it is to thoroughly clean it. Rinsing and washing the nebulizer immediately after each treatment helps reduce infection risk.

All parts of the jet nebulizer, except the air tubing should be rinsed with hot water after the treatment. Take care not to damage any parts of the nebulizer or compressor. Table 15 provides the daily and weekly cleaning instructions for the jet nebulizer. Electronic nebulizers should be cleaned and disinfected based on the manufacturer’s recommendations.

Table 15. Cleaning instructions for the jet nebulizer

Cleaning After Each Use	Cleaning Once Or Twice A Week
1. Wash your hands before handling equipment.	1. Wash your hands before handling equipment.
2. Take the nebulizer apart and rinse the nebulizer cup and mouthpiece with warm running water.	2. Remove the tubing from the compressor and set it aside. The tubing should not be washed or rinsed.
3. Shake off excess water.	3. Wash nebulizer parts in warm water with liquid dish soap.
4. Air dry.	4. Disinfect the nebulizer based on the manufacturer’s recommendations. The nebulizer parts may be disinfected at home using one of the following methods: Cold methods: <ul style="list-style-type: none"> • Soak in 70% isopropyl alcohol for 5 min. • Soak in 3% hydrogen peroxide for 30 min. Heat methods: <ul style="list-style-type: none"> • Boil in water for 5 min. • Microwave in water for 5 min. • Wash in a dishwasher if the dishwasher achieves a temperature of 158°F or 70°C for 30 min. • Use an electric steam sterilizer.
5. Wrap the dry nebulizer in a clean paper towel.	5. After soaking, rinse (if using cold method, rinse the parts with sterile water after soaking).
	6. Shake off excess water and allow to air dry.
	7. Put together the nebulizer and wrap in a clean, dry paper towel.

Disinfection: You should periodically disinfect and replace your jet nebulizer in order to minimize the risk of infection. Each manufacturer suggests a different method of disinfection for its product, and those steps should be followed. It is also important to note that all solutions should be discarded after disinfection.

Drying and maintenance: Because bacteria grow in wet, moist places, nebulizers should be thoroughly dried and stored in a clean, dry place between treatments. Allowing gas flow from the compressor to the nebulizer for a short time after it is rinsed can reduce drying time. It has been reported that nebulizer performance may change over time due to incorrect cleaning, maintenance, or disinfection procedures. Nebulizers can be kept from becoming contaminated by following the manufacturer’s instructions for care and cleaning. This is necessary for all aerosol devices used for inhaled medication.

TROUBLESHOOTING AND PROBLEM SOLVING

Most of the problems associated with aerosol therapy are equipment related. Table 16 shows the common problems with aerosol devices and how they may be fixed.

Table 16. Problem Solving for Aerosol Delivery Devices	
Problem	Solution
<p>Jet nebulizer Compressor does not run when turned on</p>	<p>Gas powered nebulizer Check to see that it’s plugged-in . If it still will not run, the compressor needs to be replaced.</p>
Compressor filter discolored (brown, gray or black)	Replace filter with a new one
Compressor is running, but aerosol output is absent or poor	<ul style="list-style-type: none"> ▪ Check the tubing for holes and replace if necessary. ▪ Make sure the tubing is properly connected by pushing the tubing and nebulizer together firmly. ▪ Make sure that the nebulizer is clean. If it is not, clean it. <p>If these solutions do not fix the issue, the compressor may need to be replaced.</p>
<p>Metered Dose Inhaler No output</p>	<p>Metered Dose Inhaler</p> <ul style="list-style-type: none"> ▪ Check the boot for blockage; clean per instructions ▪ Check the dose counter; if it is empty, replace the MDI
<p>Dry Powder Inhaler Inhaler will not advance to next dose</p>	<p>Dry Powder Inhaler</p> <ul style="list-style-type: none"> ▪ Check the dose counter; if it is empty, replace the DPI ▪ If the DPI is not empty, review your technique and instructions for use

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