

**Healthline Aerosol Medicine**  
**www.aerosol-medicine.com**  
**Respiratory Care Department – Sample Protocol**

**Document Title:** “Nebulized Bronchodilators”  
**Filename:** Nebulized\_Bronchodilators.doc  
**Date:** October 20, 2004  
**Scope:** Respiratory Care Department, Nursing, Pharmacy, Pulmonary Diseases  
**Author/Contact:** Michael McPeck, BS RRT FAARC

---

### **Background Information**

#### **Indications and Usage**

The use of aerosolized beta agonists and anticholinergics are the mainstay of current therapy for asthma, COPD and other diseases of increased bronchomotor tone. A variety of aerosolization devices are available including Metered-Dose Inhalers (MDIs), Dry Powder Inhalers (DPIs), some hybrid inhalers, and Small Volume Nebulizers (SVNs). While inhalers are often preferred for ambulatory and domiciliary patient populations due to their portability, SVNs are the device-of-choice for most hospital-based aerosol bronchodilator therapy because they are generally more effective for acute care and less dependent upon patient cooperation and coordination. Respiratory care with SVNs in hospitalized patients includes both “rescue therapy” during the acute exacerbation of an asthma attack and “routine therapy” for the post-rescue phase of a hospital admission for asthma or an exacerbation of COPD.

This document will describe procedures for administration of nebulized bronchodilators with the Healthline Medicator<sup>®</sup> Aerosol Maximizer for both “rescue” and “routine” treatment scenarios. The principle factors that will differentiate these two scenarios are treatment time and total mass of drug inhaled.

#### **Warnings**

The most common side effects of nebulized bronchodilators are increased heart rate, increased blood pressure, and tremor. These side effects are usually relieved by halting the treatment. The patient should be closely monitored until cardiac parameters return to pre-treatment levels. Other side effects may include fatigue, shortness of breath, dizziness, nausea and a taste of the drug in the mouth. Side effects may be more pronounced if a high-efficiency nebulizer system is used and/or the patient is also receiving beta agonist medications by the oral or parenteral route.

#### **Dosage**

For the purposes of this protocol, the term “prescribed dose” will mean the amount of drug that is prescribed by the ordering physician to be placed in the nebulizer. However, due to the well-known inefficiencies of nebulizer systems, it should be understood and appreciated that the dose placed in the nebulizer is not the “dose” that the patient actually receives (inhales). This can be confusing but is a fact of life with respect to the delivery of aerosolized medications by nebulizer systems. The inhaled dose is best described by the term “inhaled mass,” which is that fraction of the dose placed in the nebulizer that is inhaled<sup>1</sup>.

Typically, for treatment of bronchospasm and wheezing in patients with asthma, COPD and increased bronchomotor tone, a “prescribed dose” of one or more bronchodilator drugs is administered by nebulizer at various frequencies depending on the severity of the illness.

### **Policies and Procedure**

#### **Policies:**

1. Valid indications for nebulized bronchodilators include patients with .....
2. A physician’s written order stating “ \_\_\_\_\_ (drug) \_\_\_\_\_ (dose) \_\_\_\_\_ (frequency) ”

is necessary to initiate this therapy. The order must comply with applicable hospital policies and regulations.

3. A respiratory therapist may obtain the prescribed drug as a unit dose and place it in the nebulizer.
4. The respiratory therapist who assesses and treats the patient may elect to administer bronchodilator therapy by either “routine” or “rescue” treatment scenario. The treatment time for the “routine” scenario will be limited to 3 minutes. The treatment time for the “rescue” scenario will be up to 9-10 minutes, or however long it takes the patient to empty the nebulizer.
4. The prescribed aerosolized medication will be administered with a Healthline “Medicator Aerosol Maximizer” aerosol drug delivery system unless an MDI is specified. Only the Healthline “Medicator Aerosol Maximizer” aerosol drug delivery system should be used for administering nebulized bronchodilators when intentionally shortening treatment times in order to achieve an inhaled mass that is at least equivalent to conventional nebulizers operated for period of 10 minutes or more.

#### **Equipment and Supplies:**

1. Air or oxygen flow meter with wing and nipple or small portable air compressor
2. Healthline #MM-800 or AM-602 high-efficiency aerosol delivery system
3. Universal oxygen tubing
4. Optional Healthline closed aerosol mask if patient can not use a mouthpiece.
5. Optional Medicator Convenience Kit to extend mouthpiece or mask
6. Appropriate pharmacologic agent.

#### **Procedure:**

1. Verify the exact order in the patient's medical record.
2. Obtain proper dosage of drug and place in nebulizer reservoir.
3. Introduce yourself and ask the patient what his or her name is and check the identification band on the patient's wrist for confirmation.
4. Conduct appropriate patient/family education and explain the specific details of the procedure you are about to have the patient do. Explain to the patient the need to keep the mouthpiece properly situated to avoid leakage of the drug. Instruct the patient to signal you to turn off the gas flow to the nebulizer before removing it from their mouth if he/she wishes to remove the

mouthpiece for rest or cough. Instruct the patient to attempt to warn caregivers prior to a cough and how to cough into tissue to preclude the spread of exhaled droplets and particles.

5. During the treatment, assess the patient for physiological response to the medication, presence of adverse effects, presence and degree of pain, and the presence of appropriate cooperation and psychomotor coordination necessary to receive a satisfactory treatment.

6. Assemble the Healthline Medicator aerosol delivery system making sure that all connections are tight. Attach the nebulizer that has just been filled with the prescribed amount of medication to the nebulizer port on the Medicator manifold and hook up the supply gas source.

7. If a filtered device is being used (AM-600 series), ascertain that the appropriate filter is connected to the exhalation port of the Medicator manifold.

8. When the patient is ready to begin inhaling the medication, adjust the air or O<sub>2</sub> flowmeter to 7 L/min and allow the patient to begin breathing from the system.

9. Coach the patient to breathe slowly and deeply, if possible. Instruct the patient to signal you if he/she wishes to temporarily stop the treatment in order to rest. Turn off the flowmeter just before the mouthpiece or mask is removed. Optionally, if necessary and if the patient tolerates it and is cooperative, place noseclip on the patient's nose to encourage only mouth breathing.

10. Observe the patient for signs and symptoms of adverse reactions to the medication and/or the procedure:

a. If the pulse rate changes by more than 25% during the treatment, stop the therapy, notify the nurse to help monitor the patient, notify the physician to report the adverse reaction, and include the details of the adverse reaction (including who was notified) in your written treatment note.

b. If bronchospasm or wheezing increases, stop the therapy, notify the nurse to help monitor the patient, notify the physician to report the adverse reaction, and include the details of the adverse reaction (including who was notified) in your written treatment note.

11. At the conclusion of the treatment, assess the patient for achievement of therapeutic outcomes, ability to cooperate, and for any adverse events occurring during the treatment:

a. If applicable, assess the patient for dyspnea or breathlessness according to hospital-accepted dyspnea scale.

b. If applicable, assess the patient for pain according to hospital-accepted pain assessment scale.

c. If applicable, assess the patient for the presence or absence of wheezing and bronchospasm and how it has changed from the pre-treatment assessment.

Include the results of all applicable patient assessments in your written treatment note.

12. At the conclusion of the treatment, any residual medication remaining in the nebulizer must be rinsed out of the nebulizer reservoir with sterile water. Shake as much of the residual water out of it as possible. Dry the nebulizer reservoir and jet with air or oxygen, reattach the nebulizer to the Medicator manifold, and store the entire assembly in a plastic bag labeled with the

patient's name and room number. It is not necessary to rinse the Medicator manifold or reservoir bag.

13. Complete the necessary forms and records for recording patient therapy in the patient's medical record and/or hospital or departmental computerized information system.

### Recommended Delivery System: Healthline Medicator® "Aerosol Maximizer"

This protocol specifies the "Medicator® Plus Aerosol Maximizer," Cat # MM-800, a high efficiency aerosol drug delivery system, specifically designed for targeted delivery of bronchodilators to central and peripheral airways while protecting the healthcare worker from occupational exposure as much as possible without full expiratory filtration. It is available from:

Healthline Aerosol Medicine  
4610 Littlejohn Street  
Baldwin Park, CA 91706  
Tel: (877) 626-2626; Fax: (626) 960-8700

#### Features:

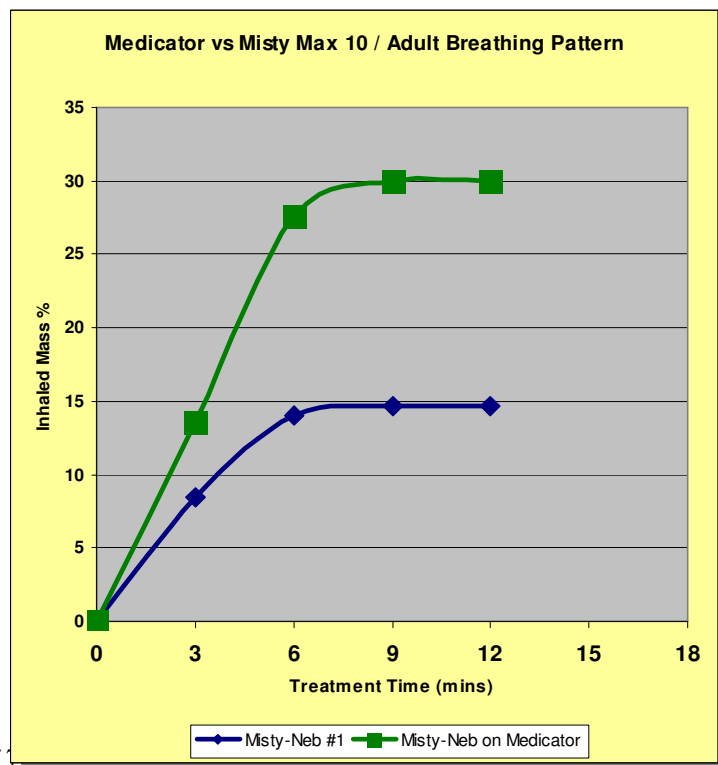
- Latex-free 1 L. reservoir bag (insures nebulized drug is inhaled rather than vented and wasted; promotes consistency of delivery to reduce variability of response and correct for differences in breathing pattern)
- Fine-particle nebulizer Allegiance AirLife Misty Max 10 (MMAD of ~1.25  $\mu\text{M}$  insures appropriate particle size for both central and peripheral deposition)



Use of the Medicator has been described in the peer-reviewed literature<sup>2-4</sup>.

#### Aerosol Delivery and Dosing Strategies with the Medicator Aerosol Maximizer:

With the use of the Medicator Aerosol Maximizer, a number of different dosing strategies are available. This is due to the fact that it is a high-efficiency device that delivers a greater total amount of drug, and has a higher delivery rate. The graph on the right shows inhaled mass (as % of nebulizer charge) against time, for the Healthline Medicator Aerosol Maximizer with an AirLife Misty-Neb nebulizer (green line) and the Misty-Neb on a Tee (blue line).



From the graph above, the performance of the Medicator with the *AirLife* Misty Max 10 nebulizer at different treatment times (green line) can be summarized thusly:

Inhaled Mass in 3 minutes = 13.6% of prescribed dose (amount placed in nebulizer)

Inhaled Mass in 9 minutes = 30.0% of prescribed dose (amount placed in nebulizer)

Therefore, the delivered dose (inhaled mass of drug in mg) can be approximated for different unit dose medications and treatment times:

Prescribed Drug & Dose	Treatment Time (mins)	Inhaled Mass (%)	Inhaled Mass (mg)
albuterol 2.5 mg/ 3 mL	3	13.6	0.34
albuterol 2.5 mg/ 3 mL	9	30.0	0.75
Xopenex 1.25 mg / 3 mL	3	13.6	0.17
Xopenex 1.25 mg / 3 mL	9	30.0	0.375
Xopenex 0.63 mg / 3 mL	3	13.6	0.086
Xopenex 0.63 mg / 3 mL	9	30.0	0.189

### Dosing Strategies Based Upon Performance of Medicator Maximizer

The use of the Healthline Medicator Maximizer, with the *AirLife* Misty-Neb or Misty-Max 10 nebulizer, can provide two different dosing strategies, depending upon patient requirements.

A time-saving strategy may be appropriate for most of the routine therapy that is done in the post-acute phase of hospitalization or in children who will not tolerate lengthy treatment times or in debilitated patients who may fatigue quickly with conventional nebulizer therapy. With this strategy, the goal is to deliver an amount of drug in 3 minutes that is equivalent to the amount of drug delivered by conventional devices in 10 or more minutes of therapy.

A maximum drug delivery strategy (rescue scenario) may be appropriate in patients being treated for an acute exacerbation of asthma in the emergency department or other settings. With this strategy, the goal is to deliver the maximum amount of medication possible from the nebulizer charge.

#### Time-saving strategy (routine scenario):

For albuterol, for example, from the chart above it can be seen that a 3 minute treatment with a “prescribed dose” of 2.5 mg in the Misty-Neb on the Medicator will achieve approximately 0.34 mg of albuterol inhaled. This is about roughly equivalent to the nominal dose delivered by a Misty-Neb on a Tee in 9-10 minutes (0.37 mg).

#### Maximum drug delivery strategy (rescue scenario):

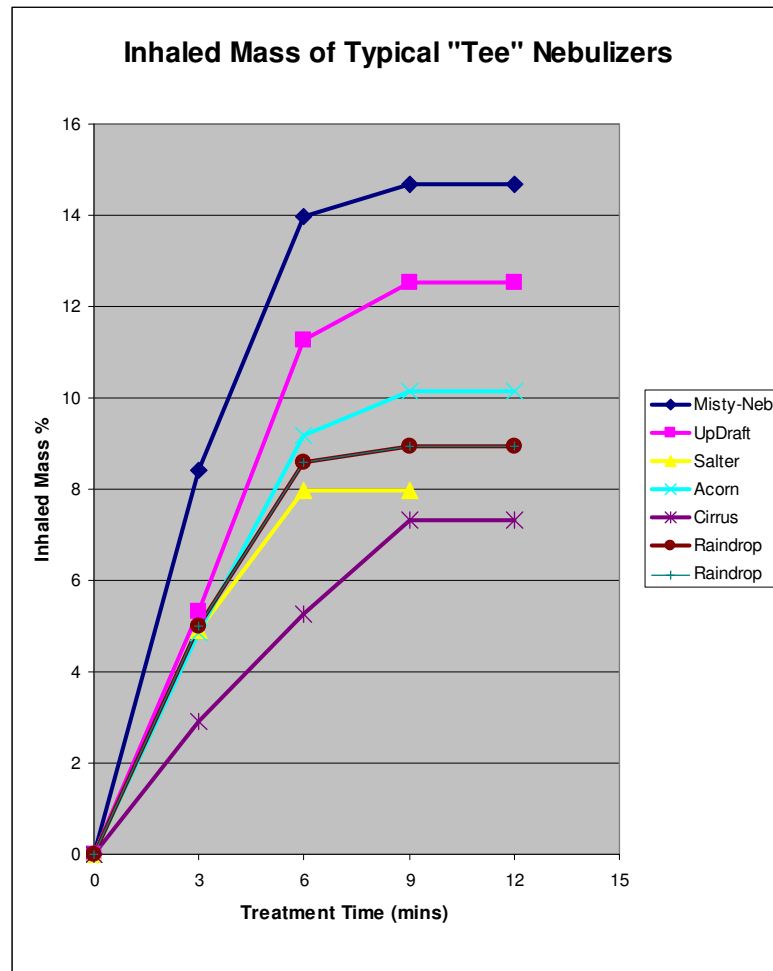
For albuterol, for example, from the chart above it can be seen that a 9 minute treatment with a “prescribed dose” of 2.5 mg in the Misty-neb on the Medicator will achieve approximately 0.75 mg of albuterol inhaled. This is about 203% of the nominal dose delivered by a Misty-Neb on a Tee in 9-10 minutes (0.37 mg).

## Performance of Conventional Low-Efficiency Aerosol Delivery Devices

### Aerosol Delivery

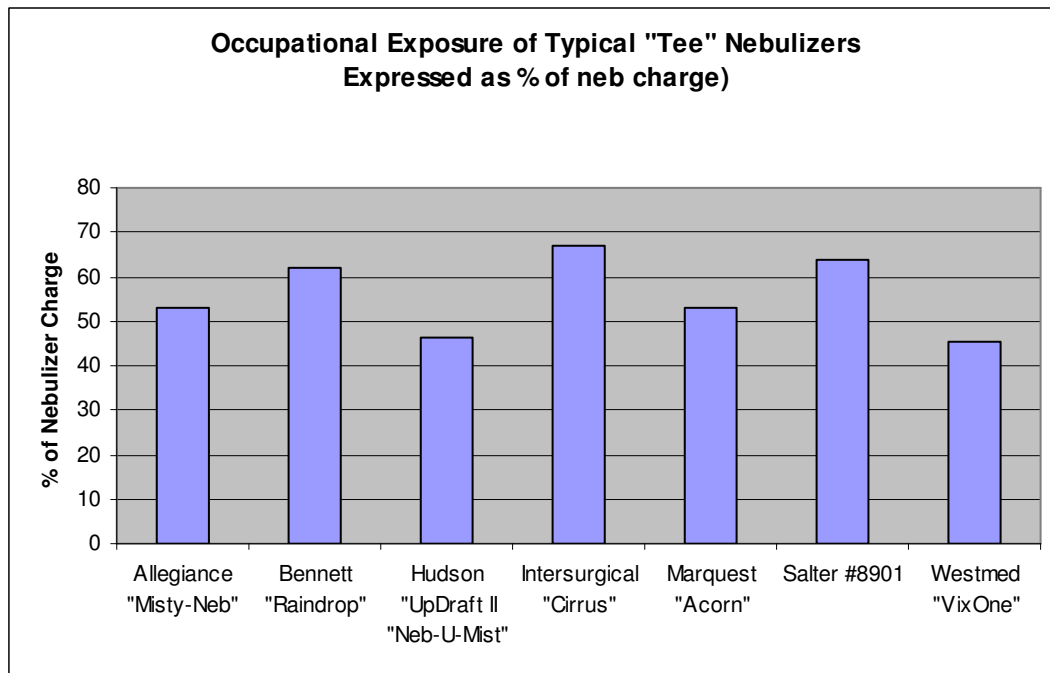
The inhaled dose or “inhaled mass” is dependent upon the performance of the nebulizer system and the patient’s breathing pattern (rate, depth, inspiratory time fraction). Nebulizers differ greatly in their ability to deliver aerosolized medication to the airway. From the inhaled mass data plotted against time below, it can be seen that many conventional small volume plastic, disposable pneumatic jet nebulizers are very inefficient. Their inhaled mass is in the order of 7 to 15% and most treatment times run generally to 9 minutes or longer in order to inhale as much drug as the device will allow. The impact upon actual drug delivery is significant. For example, the Salter nebulizer has an inhaled mass of 8% in 6 minutes. Thus, for a prescribed dose of 2.5 mg of albuterol placed in the nebulizer, an adult with a normal breathing pattern would inhale only 0.2 mg. Extending the treatment time beyond 6 minutes will not improve aerosol delivery because the nebulizer has reached its “residual volume,” and is incapable of emitting any more aerosol. A rapid/shallow breathing pattern would result in even less medication delivery.

As another example as shown on the graph below, the Misty-Neb, the best of the tested group, has an inhaled mass of ~15% in 9 minutes. Thus, for a prescribed dose of 2.5 mg of albuterol placed in the nebulizer, an adult with a normal breathing pattern would inhale only 0.375 mg. And it can be seen from the graph, that the rate of delivery is also higher than the Salter nebulizer. Arguably, a higher rate of drug delivery is appropriate for rescue therapy with bronchodilators.



## Drug Waste and Occupational Exposure

Not only are conventional “Tee” type nebulizers inefficient and slow, they also emit a large percentage of the prescribed dose of medication into the atmosphere. It is this wastefulness that accounts for their inefficiency. For every unit of drug that’s wasted to the atmosphere, that’s one less unit of drug that the patient does not receive. Further, the emission of aerosolized drugs to the ambient air causes needless occupational exposure of respiratory therapists and other caregivers to drugs that they probably not be breathing.



## References

1. Smaldone GC. Drug delivery via aerosol systems: Concept of “aerosol inhaled.” J Aerosol Med 1991;4:229-235.
2. Laube BL, Benedict GW and Dobs AS. Time to Peak Insulin Level, Relative Bioavailability, and Effect of Site of Deposition of Nebulized Insulin in Patients with Noninsulin-Dependent Diabetes Mellitus. J. Aerosol Med. 1998; 11: 153-173.
3. Laube BL, Jashnani R, Dalby RN and Zeitlin PL. Targeting Aerosol Deposition in Patients with Cystic Fibrosis: Effects of Alterations in Particle Size and Inspiratory Flow Rate. Chest. 2000; 118: 1069-1076.
4. Corcoran TE, Shortall BP, Kim IK, Meza MP and Chigier N. Aerosol Drug Delivery Using Heliox and Nebulizer Reservoirs: Results from an MRI-Based Pediatric Model. J. Aerosol Med. 2003; 16: 263-271.
5. Internal studies. Healthline Medical, Inc. Baldwin Park, CA. May 2004.

//