Getting Back to the Basics: Administering Inhaled Bronchodilators

Over the almost 3 decades I have been actively involved in pulmonary medicine, there has been a dramatic increase in the demands placed on respiratory therapists (RTs). Ventilators have become increasingly complex. In addition to the evolution in the mechanical and electronic features of ventilators, strategies for mechanical ventilation, such as low-tidal-volume ventilation for acute respiratory distress syndrome, have also become more demanding. Noninvasive ventilation has become widely accepted for hypercapnic and hypoxic respiratory failure. With the emergence of noninvasive ventilation as a readily applicable modality, RTs have seen the principles of mechanical ventilation extended from the intensive care unit to the general medical floor. Despite these remarkable changes in respiratory care, there is surprisingly little difference today, compared to my experiences in the 1970s and 1980s, in what is probably the most fundamental aspect of respiratory care: the administration of medications, particularly bronchodilators, via inhalation. In this issue of RESPIRATORY CARE, the article by Hoisington and colleagues[1] on the effect a relatively simple change in nebulizers might have on respiratory care workload should remind us that there have been important advances in the basics of administering inhaled bronchodilators.

The history of nebulizers is a fascinating story.[2,3] Medications have been administered via inhalation for thousands of years. In India and Egypt, between 2000 and 1500 BC, herbal preparations (Datura species and henbane) that contained anticholinergics were burned and the vapors inhaled. Over the centuries, the substances burned and inhaled became more creative. Paulus Aegineta, in Greece in the 7th century AD, recommended inhaled storax, pepper, mastick parsley, scruples, bayberries, and honey for cough. More recently, the inhalation devices have also become more inventive. Ceramic inhalers were designed in the early 1800s. Atomizers (developed as an outgrowth of the perfume industry) and nebulizers were invented in the mid-1800s. Hand-bulb nebulizers were first used in the early 1900s to administer a new medication, adrenalin, developed from adrenal extract. In the early 1930s an electric pneumatic nebulizer (compressor and jet nebulizer combination) was built and sold in Germany. Although the jet nebulizer is commonly used with a compressor in the home, it is usually powered with compressed oxygen in the hospital. Ultrasonic nebulizers were introduced in 1949 but have never been as widely used as compressor nebulizers.

The jet nebulizer has evolved substantially over the past 50 years. Hoisington and colleagues[1] compared a newer version of the jet nebulizer, which requires only 3 min to nebulize 3 mL of a unit dose of a short-acting inhaled β_2 agonist, to an older jet nebulizer model that requires 9 min to nebulize that same volume. They estimate substantial time savings for the RT and cost savings for the hospital with the new nebulizer.[1] I believe those estimates are reasonable. In my hospital, in which 18% of all admitted patients receive inhaled bronchodilators and 4,500-5,000 nebulizer bronchodilator treatments are administered monthly by our RTs, switching to a more time-efficient nebulizer would have important advantages.

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However, RTs should consider options other than simply switching nebulizers to make their work more efficient. One important possibility is to increase the earlier use of metered-dose inhalers (MDIs). In my experience, RTs view MDIs with some degree of skepticism, for 2 reasons. First, a nebulizer administers a larger dose of short-acting inhaled β_2 agonist than does an MDI. It is true that more albuterol will reach the lungs when a usual dose is administered via nebulizer than via MDI, as assessed with a sensitive bioassay.[4] However, numerous studies have shown that the improvement in standard measures of lung function (eg, forced expiratory volume in the first second) of adults and children admitted to the emergency department for asthma exacerbation are similar when albuterol is administered via MDI or nebulizer.[5,6] Second, it is widely recognized that patients frequently make mistakes when using their MDIs. In one large study, 78% of the patients made an error during MDI use.[7] The 2 most common errors were failure to exhale appropriately before actuation, and uncoordinated actuation and inhalation. MDI errors are made by males and females, older and younger adults, and patients with asthma and chronic obstructive pulmonary disease (COPD).[8] Similar errors are seen with children. During asthma exacerbations, 75% of children made at least one MDI error, and 45% made multiple errors.[9]

There are simple methods to improve MDI use. A holding chamber can improve coordination. Some MDIs (eg, Maxair Autohaler) are designed to minimize problems with

the coordination of inhalation and inhaler actuation. In acute asthma the Maxair Autohaler provides lung-function improvement and symptom relief similar to that of nebulized albuterol.[10] Administration time with the Maxair Autohaler was about 3 min, which is similar to that reported by Hoisington and colleagues with a newer nebulizer.[1]

RTs should also be aware of another important point: when patients with asthma or COPD leave either the emergency department or hospital after an exacerbation, they will almost certainly be given a prescription for a short-acting inhaled β_2 agonist in an MDI, as rescue therapy. Even if an MDI is not used to administer short-acting β_2 agonists during the initial hospitalization phase, it is prudent to convert from nebulizer to MDI as the patient improves prior to discharge.[11] This will save time for the busy RT and will promote teaching of proper MDI use.

The most important recent advance in bronchodilators has been the development of long-acting inhaled agents. Currently, there are 2 available long-acting inhaled β_2 agonists and one long-acting inhaled anticholinergic. Formoterol fumerate is the preferred long-acting β_2 agonist because it provides rapid onset of bronchodilation (within minutes) and a $>$ 12-hour duration of effect, and it can be administered via either dry-powder inhaler (DPI) or nebulizer. The available long-acting inhaled anticholinergic is tiotropium, which has a 24-hour duration of bronchodilation and is administered via DPI. Both formoterol fumerate and tiotropium are indicated as maintenance agents, not for management of exacerbations of asthma or COPD.

However, I and others at my hospital believe that introducing maintenance bronchodilator as early as possible is a reasonable approach, so for hospitalized patients with asthma and COPD we developed bronchodilator protocols that incorporate formoterol fumerate and tiotropium. The protocols rely on nebulized short-acting bronchodilator for initial management of the acutely ill patient, but RTs found that patients could relatively quickly learn to use DPIs for administering the long-acting β_2 agonist and anticholinergic. RTs have the option of adding short-acting inhaled β_2 agonist or short-acting inhaled anticholinergic in addition to the long-acting agents, as rescue therapy if the patient becomes symptomatic.[12,13]

With these protocols we have seen a dramatic decrease in the need for short-acting rescue agents, and, correspondingly, the RT time spent administering bronchodilators. Although we have not rigorously monitored changes in lung function over time with this approach, we believe that the long-acting inhaled agents benefit our patients. For instance, there were fewer adverse events related to bronchodilators because the short-acting agents were used much less.[12] Duration of stay of patients with COPD exacerbations significantly decreased after we introduced tiotropium into the bronchodilator protocol.[13]

Expectations of RTs have increased substantially. Mechanical ventilators are remarkably sophisticated, and strategies of mechanical ventilation have been developed for different types of lung injury. "Maestros" are needed to coordinate effective operation of ventilators with these new ventilation strategies. Noninvasive ventilation extends the principles of mechanical ventilation outward from the intensive care unit. However, RTs should appreciate that attention to basics, particularly the delivery of inhaled bronchodilators, can provide important benefits in patient care and workload efficiencies. Newer, more efficient nebulizers and early conversion from nebulizer to MDI or DPI can allow more efficient administration of bronchodilators and save RTs substantial time. Bronchodilator protocols, especially those that include long-acting inhaled bronchodilator, can reduce workload and benefit patients.

Gene L Colice MD
Pulmonary, Critical Care and Respiratory Services
Washington Hospital Center
George Washington University School of Medicine
Washington DC

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Dr Colice has had relationships with GlaxoSmithKline, Teva, SP Pharmaceuticals, Lilly, Pfizer, Boehringer Ingelheim, Adams Laboratories, Laboratories Almirall, Forest Laboratories, MedImmune, and Dey.

Correspondence: Gene L Colice MD, Pulmonary, Critical Care, and Respiratory Services. Washington Hospital Center, 110 Irving Street NW, Washington DC 20010. E-mail: gene.colice@medstar.net.

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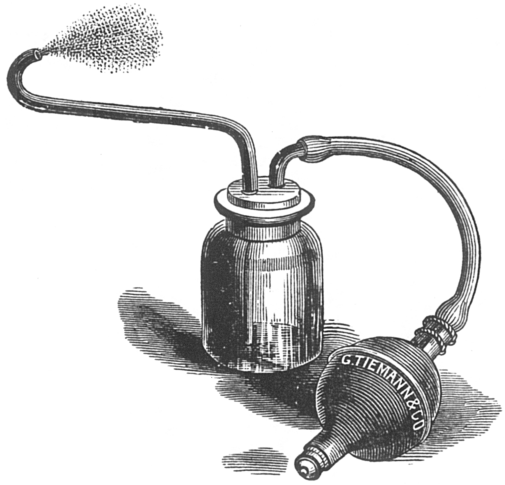

Robison's Powder Blower from *The American Armamentarium Chirurgicum.*
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