

CHOOSING WISELY[®]: THINGS WE DO FOR NO REASON

Nebulized Bronchodilators Instead of Metered-Dose Inhalers for Obstructive Pulmonary Symptoms

Christopher Moriates, MD^{1*}, Leonard Feldman, MD²

¹Division of Hospital Medicine, University of California at San Francisco, San Francisco, California; ²Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland.

The “Things We Do for No Reason” (TWDFNR) series reviews practices which have become common parts of hospital care but which may provide little value to our patients. Practices reviewed in the TWDFNR series do not represent “black and white” conclusions or clinical practice standards, but are meant as a starting place for research and active discussions among hospitalists and patients. We invite you to be part of that discussion.

CASE PRESENTATION

A 54-year-old woman presented to the emergency department (ED) with shortness of breath. She reported that her primary care physician diagnosed her with chronic obstructive pulmonary disease (COPD). Her physician had prescribed her an albuterol inhaler to use “as needed” for shortness of breath. Over the past few weeks she had been “trying to use the inhaler,” but she noted that it did not seem to help her increasing wheezing, coughing, and sputum production. In the ED, she received continuous albuterol treatments via nebulizer, Solu-Medrol 125 mg intravenously, antibiotics, and a chest x-ray. She was admitted to the hospital medicine service for “COPD exacerbation” and started on nebulized bronchodilator treatments every 4 hours. By the fourth day of her hospital stay, she was discharged to home with an albuterol inhaler, oral prednisone, oral doxycycline, and a follow-up appointment. Dedicated patient education regarding proper inhaler administration did not occur during hospitalization.

WHY YOU MIGHT THINK NEBULIZED TREATMENTS IN INPATIENTS ARE HELPFUL

Inhaled bronchodilators are a mainstay of therapy for acute obstructive pulmonary diseases, including COPD and asthma exacerbations.^{1,2} Inhaled bronchodilators may be delivered by metered-dose inhalers

(MDIs) or via wet nebulizers powered by compressed air or oxygen. Current practice patterns in EDs and hospital wards tend to favor the use of nebulizers due to many apparent advantages of these devices.³ For instance, nebulizers do not require any special inhalation technique and can be effectively used by patients at any age.^{3,4} There is also a common perception that nebulizers are more effective, possibly stemming from the assumption that hospitalized patients have already failed their outpatient MDI therapy and an almost mystical belief in the healing power of mist. Moreover, many clinicians have been trained to routinely use nebulizer therapies and may lack sufficient knowledge or comfort about the relative efficacy and equivalence dosing of MDI therapies.

WHY NEBULIZERS ARE NOT BETTER THAN MDIs FOR PATIENTS HOSPITALIZED WITH OBSTRUCTIVE PULMONARY SYMPTOMS

Decades of research support that MDIs are effective, efficient, and less costly (depending on circumstances) than nebulizers for the routine treatment of obstructive pulmonary exacerbations.^{3–11} The clinical effectiveness of MDIs has been shown in studies across populations of adults with acute COPD symptoms,^{3,4,7,8} as well as children and adults with asthma exacerbations.^{3–6,9,10} A 2005 joint report by the American College of Chest Physicians (ACCP) and the American College of Asthma, Allergy and Immunology (ACAAI), concluded “none of the pooled meta-analyses showed a significant difference between devices in any efficacy outcome in any patient group for each of the clinical settings.”⁴ Many different outcomes have been investigated, including forced expiratory volumes (FEV), peak flows, symptoms and specific symptom scores, and physical findings.⁴

Compared to MDIs, there are a number of drawbacks to the use of nebulizers: nebulizers are more expensive to buy and maintain, are less portable, and take longer to set up, use, and clean following each use.¹² In addition, nebulizers have been associated with greater increases in heart rate and tremors compared to MDIs, suggesting nebulizers lead to higher systemically absorbed β -agonist doses.⁴

Of note, nearly all of the clinical effectiveness studies administered MDIs with a valved holding chamber or spacer, facilitating the delivery of drug to the airways.^{3,4} Although valved holding chambers are

*Address for correspondence and reprint requests: Christopher Moriates, MD, University of California at San Francisco, 505 Parnassus Ave., M1287, San Francisco, CA 94143-0131; Telephone: 415-476-9852; Fax: 415-502-1963; E-mail: cmoriates@medicine.ucsf.edu

Additional Supporting Information may be found in the online version of this article.

Received: December 2, 2014; Revised: January 28, 2015; Accepted: February 13, 2015

2015 Society of Hospital Medicine DOI 10.1002/jhm.2386

Published online in Wiley Online Library (Wileyonlinelibrary.com).

commonly referred to as a “spacer,” a true spacer does not have a valve and is rarely used today.¹²

THE EVIDENCE EXAMINING NEBULIZERS VERSUS MDIs IN PATIENTS WITH ASTHMA OR COPD EXACERBATIONS

A 2013 Cochrane review sought to establish the relative efficacy of MDIs with holding chambers versus nebulizers for children and adults who presented to a community setting or emergency department with acute asthma.⁶ The review included a total of 1897 children and 729 adults in 39 randomized controlled trials. The authors judged the overall evidence to be of moderate quality. Children with acute asthma treated with MDIs in the ED had shorter lengths of stay in the ED (70 minutes vs 103 minutes), similar peak flow and FEV measurements, lower heart rates, and less tremor compared to children treated with nebulizers.^{5,6} There were no significant differences found between devices for the treatment of adult patients with asthma.⁶

In a separate double-blind, randomized, placebo-controlled study evaluating albuterol administered by nebulizer versus MDI with spacer for children <2 years old presenting to an ED with wheezing, the use of MDIs with a spacer and facemask was equally efficacious and may have led to fewer hospital admissions.¹⁰

Mandelberg et al. performed a double-blind, randomized, placebo-controlled trial for unselected adult patients presenting to an ED with obstructive pulmonary symptoms.⁸ Patients received either 2 puffs of a placebo MDI with a spacer along with nebulized salbutamol 0.5 mL in 1.5 mL saline solution (n = 25), or a salbutamol MDI along with a nebulized placebo saline solution (n = 25). Treatments were repeated every 15 minutes up to 3 times, unless side effects occurred. Spirometric measurements were performed following each treatment. No differences were seen between the groups at any point during the study period. The authors concluded, “Even in the setting of the unselected group of patient referrals to the [Department of Emergency Medicine] for episodes of severe airflow limitation, the clinical and objective bronchodilator responses to the administration of salbutamol are independent of the method of delivery: MDI with large spacer or aerosol nebulization.”⁸

There are surprisingly few studies examining the use of nebulizers versus MDIs in the inpatient setting for both children and adults. Dolovich et al. reviewed 6 studies that included 253 total patients and reported no significant differences in pulmonary function between devices.⁴ Based on these findings, the ACCP/ACAAI group recommended “both nebulizers and MDIs with spacers/holding chambers are appropriate for use in the inpatient setting. Quality of evidence: good.”⁴

WHY USE MDIs FOR INPATIENTS

If MDI and nebulizer treatments are equally effective, why change current practice? The use of MDIs, rather

than nebulizers, in hospitals could lead to fewer side effects such as tachycardia, arrhythmias, and tremors. MDIs are also more portable and do not require specialized set-up. Furthermore, MDI administrations during hospitalization may provide a “golden opportunity” to have respiratory therapists, pharmacists, or other health professionals spend time teaching patients proper inhaler usage, rather than providing time-consuming nebulizer treatments.¹³ In a recent study, approximately 86% of hospitalized patients with asthma or COPD could not demonstrate appropriate use of an MDI. However, 100% of patients were able to achieve mastery following a short teach-back session.¹⁴ It is conceivable that transitioning patients to MDIs earlier during hospitalization and providing them with education regarding proper MDI administration could instill confidence in their use of inhalers and result in downstream effects such as shorter lengths of stay, less frequent hospital readmissions, or improved quality of life.

MDI use may result in cost savings in certain settings, although the relative costs of nebulizer versus MDI treatments depends on many institution-specific factors. Such factors include the institutional policies on who delivers the nebulizer or the MDI and how they are compensated and staffed. For example in the Nebs No More After 24 program initiated at the University of California, San Francisco, the vast majority of the realized cost savings are due to the reduction in respiratory therapist time spent delivering MDIs, which reflects the local policies and compensation structure.¹³ Previous inpatient interventions to convert from nebulizers to MDIs also showed cost savings resulting from decreased labor needs.¹⁵ In some hospitals, nurses deliver nebulizer treatments, whereas in others only respiratory therapists are allowed to provide nebulizers. Moreover, whether the MDI can go home with the patient upon discharge depends on whether the hospital has a dispensing pharmacy or not. Formal economic evaluations specific to the local institution are necessary.

WHAT WE SHOULD DO INSTEAD: ENCOURAGE THE USE OF MDIs FOR INPATIENTS

For effective inpatient MDI treatments, MDI technique must be good. Thus, it is vital to enlist the right people to provide proper MDI teaching and supervision. Respiratory therapists are generally trained for this task, and may be complemented by appropriately trained physicians, nurses, or pharmacists. Many institutions have successfully implemented respiratory therapist-driven protocols for the administration of MDIs, which has led to measurable improvements in the utilization of appropriate respiratory care resources.^{15,16} At University of California, San Francisco, this was accomplished by recruiting respiratory therapists and nurses to help support the transition of patients from nebulizers to MDIs and to provide bedside teaching on proper MDI usage. The institution then launched a Nebs No More After 24

campaign that sought to transition patients from nebulizers to MDIs within 24 hours of hospitalization. This campaign included an educational program for physicians, prepared facilitator guides to assist attending physicians with teaching about the new initiative, publicity efforts including pens and strategically placed posters, and regular feedback regarding nebulizer utilization on the pilot ward. Although the evidence suggests that patients can be started on MDIs immediately upon presentation to the ED, the UCSF campaign focused on transitioning patients within 24 hours so to alleviate concerns about transitions in care between the ED and the medical ward, as well as between overnight and day teams. MDIs are only as or more effective than nebulizers if the correct administration technique is employed. The 24-hour transition period allows for MDI teaching and transition during regular daytime hours.

Inpatient use of nebulizers may be more appropriate than MDIs for patients with dementia or altered mental status, as well as those in extreme distress resulting in an inability to coordinate inhaler usage. Very low health literacy may be an additional barrier to appropriate MDI teaching and usage.

RECOMMENDATIONS

In patients with obstructive pulmonary symptoms, transition patients from nebulizers to MDIs early in their hospital course, unless the patient is unable to use an inhaler due to altered mental status, dementia, or other circumstances. Ensure that patients are instructed and supervised on proper MDI technique. Enlisting respiratory therapists and appropriately trained staff (pharmacists, nurses, physicians) is key to the successful use of MDIs. Frequency and dosage of MDIs used should be comparable to that of nebulized treatments. Although studies have used a relatively wide range of albuterol MDI dosing, prior programs have determined a dose of albuterol 4 puffs via MDI as being equivalent to the standard albuterol 2.5 mg nebulizer dosage.^{17,18} Some studies have advocated for using a range of 2 to 10 puffs albuterol MDI, with the actual dose based on clinical response.¹⁷ One study in children with mild acute asthma found that 2 puffs of albuterol by MDI was just as effective as higher doses delivered by MDI (6–10 puffs) or by nebulizer.¹⁹

CONCLUSION

MDIs with holding chambers are clinically equivalent to nebulizer therapy for the treatment of both children and adults with obstructive pulmonary symptoms, as long as MDI technique and MDI dosing is adequate. This is based on good data in the ED setting but fewer studies in adult inpatients. There are a number of advantages to the use of inpatient MDIs over nebulizers; MDIs are more portable, often less expensive to use, may result in fewer side effects, and will hopefully improve outpatient MDI technique. The delivery of MDIs during hospitalization should be accompa-

nied with patient education regarding proper administration technique.

Disclosure: Nothing to report.

Do you think this is a low-value practice? Is this truly a “Thing We Do for No Reason”? Share what you do in your practice and join in the conversation online by retweeting it on Twitter (#TWFDFNR) and Liking It on Facebook. We invite you to propose ideas for other “Things We Do for No Reason” topics by emailing TWFDFNR@hospitalmedicine.org

References

1. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for the diagnosis, management, and prevention of COPD. Available at: <http://www.goldcopd.org/guidelines-global-strategy-for-diagnosis-management.html>. Updated January 2015. Accessed September 25, 2014.
2. National Heart Lung and Blood Institute. National Asthma Education and Prevention Program. Expert panel report 3: guidelines for the diagnosis and management of asthma. Available at: <http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm>. Published 2007. Updated April 2012. Accessed September 25, 2014.
3. Turner MO, Patel A, Ginsburg S, FitzGerald JM. Bronchodilator delivery in acute airflow obstruction. A meta-analysis. *Arch Intern Med*. 1997;157(15):1736–1744.
4. Dolovich MB, Ahrens RC, Hess DR, et al. Device selection and outcomes of aerosol therapy: Evidence-based guidelines: American College of Chest Physicians/American College of Asthma, Allergy, and Immunology. *Chest*. 2005;127(1):335–371.
5. Castro-Rodriguez JA, Rodrigo GJ. Beta-agonists through metered-dose inhaler with valved holding chamber versus nebulizer for acute exacerbation of wheezing or asthma in children under 5 years of age: a systematic review with meta-analysis. *J Pediatr*. 2004;145(2):172–177.
6. Cates CJ, Welsh EJ, Rowe BH. Holding chambers (spacers) versus nebulisers for beta-agonist treatment of acute asthma. *Cochrane Database Syst Rev*. 2013;9:CD000052.
7. Berry RB, Shinto RA, Wong FH, Despars JA, Light RW. Nebulizer vs spacer for bronchodilator delivery in patients hospitalized for acute exacerbations of COPD. *Chest*. 1989;96(6):1241–1246.
8. Mandelberg A, Chen E, Noviski N, Priel IE. Nebulized wet aerosol treatment in emergency department—is it essential? Comparison with large spacer device for metered-dose inhaler. *Chest*. 1997;112(6):1501–1505.
9. Deerojanawong J, Manuyakorn W, Prapphal N, Harnruthakorn C, Sritippayawan S, Samransamruajkit R. Randomized controlled trial of salbutamol aerosol therapy via metered dose inhaler-spacer vs. jet nebulizer in young children with wheezing. *Pediatr Pulmonol*. 2005;39(5):466–472.
10. Delgado A, Chou KJ, Silver EJ, Crain EF. Nebulizers vs metered-dose inhalers with spacers for bronchodilator therapy to treat wheezing in children aged 2 to 24 months in a pediatric emergency department. *Arch Pediatr Adolesc Med*. 2003;157(1):76–80.
11. Turner MO, Gafni A, Swan D, FitzGerald JM. A review and economic evaluation of bronchodilator delivery methods in hospitalized patients. *Arch Intern Med*. 1996;156(12):2113–2118.
12. Rottier BL, Rubin BK. Asthma medication delivery: mists and myths. *Paediatr Respir Rev*. 2013;14(2):112–118.
13. Moriates C, Noveler M, Quinn K, Khanna R, Mourad M. “Nebis no more after 24”: a pilot program to improve the use of appropriate respiratory therapies. *JAMA Intern Med*. 2013;173(17):1647–1648.
14. Press VG, Arora VM, Shah LM, et al. Misuse of respiratory inhalers in hospitalized patients with asthma or COPD. *J Gen Intern Med*. 2011;26(6):635–642.
15. Tenholder MF, Bryson MJ, Whitlock WL. A model for conversion from small volume nebulizer to metered dose inhaler aerosol therapy. *Chest*. 1992;101(3):634–637.
16. Kallam A, Meyerink K, Modrykamien AM. Physician-ordered aerosol therapy versus respiratory therapist-driven aerosol protocol: the effect on resource utilization. *Respir Care*. 2013;58(3):431–437.
17. Hendeles L, Hatton RC, Coons TJ, Carlson L. Automatic replacement of albuterol nebulizer therapy by metered-dose inhaler and valved holding chamber. *Am J Health Syst Pharm*. 2005;62(10):1053–1061.
18. Salyer JW, DiBlasi RM, Crowell DN, Cowan CA, Carter ER. The conversion to metered-dose inhaler with valved holding chamber to administer inhaled albuterol: a pediatric hospital experience. *Respir Care*. 2008;53(3):338–345.
19. Schuh S, Johnson DW, Stephens D, Callahan S, Winders P, Canny GJ. Comparison of albuterol delivered by a metered dose inhaler with spacer versus a nebulizer in children with mild acute asthma. *J Pediatr*. 1999;135(1):22–27.