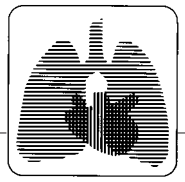

special report

Device Selection and Outcomes of Aerosol Therapy: Evidence-Based Guidelines*

American College of Chest Physicians/American College of Asthma, Allergy, and Immunology

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Background: **The proliferation of inhaler devices has resulted in a confusing number of choices for clinicians who are selecting a delivery device for aerosol therapy. There are advantages and disadvantages associated with each device category. Evidence-based guidelines for the selection of the appropriate aerosol delivery device in specific clinical settings are needed.**
Aim: **(1) To compare the efficacy and adverse effects of treatment using nebulizers vs pressurized metered-dose inhalers (MDIs) with or without a spacer/holding chamber vs dry powder inhalers (DPIs) as delivery systems for β-agonists, anticholinergic agents, and corticosteroids for several commonly encountered clinical settings and patient populations, and (2) to provide recommendations to clinicians to aid them in selecting a particular aerosol delivery device for their patients.**
Methods: **A systematic review of pertinent randomized, controlled clinical trials (RCTs) was undertaken using MEDLINE, EmBase, and the Cochrane Library databases. A broad search strategy was chosen, combining terms related to aerosol devices or drugs with the diseases of interest in various patient groups and clinical settings. Only RCTs in which the same drug was administered with different devices were included. RCTs (394 trials) assessing inhaled corticosteroid, β_2-agonist, and anticholinergic agents delivered by an MDI, an MDI with a spacer/holding chamber, a nebulizer, or a DPI were identified for the years 1982 to 2001. A total of 254 outcomes were tabulated. Of the 131 studies that met the eligibility criteria, only 59 (primarily those that tested β_2-agonists) proved to have useable data.**
Results: **None of the pooled metaanalyses showed a significant difference between devices in any efficacy outcome in any patient group for each of the clinical settings that was investigated. The adverse effects that were reported were minimal and were related to the increased drug dose that was delivered. Each of the delivery devices provided similar outcomes in patients using the correct technique for inhalation.**
Conclusions: **Devices used for the delivery of bronchodilators and steroids can be equally efficacious. When selecting an aerosol delivery device for patients with asthma and COPD, the following should be considered: device/drug availability; clinical setting; patient age and the ability to use the selected device correctly; device use with multiple medications; cost and reimbursement; drug administration time; convenience in both outpatient and inpatient settings; and physician and patient preference.** ***(CHEST 2005; 127:335–371)***

Key words: aerosols; bronchodilators; corticosteroids; drug delivery systems; dry powder inhalers; metaanalysis; metered-dose inhalers; nebulizers

Abbreviations: CFC = chlorofluorocarbon; DPI = dry powder inhaler; ED = emergency department; MDI = metered-dose inhaler; NPPV = noninvasive positive pressure ventilation; PEFR = peak expiratory flow rate; RCT = randomized controlled trial; sGaw = specific airway conductance

The use of inhaled aerosol medications for the treatment of pulmonary diseases, which became well-established in the last half of the 20th century, has advantages over oral and parenteral routes of delivery. The use of inhaled aerosols allows selective treatment of the lungs directly by achieving high drug concentrations in the airway while reducing systemic adverse effects by minimizing systemic drug levels.[1] Inhaled β_2-agonist bronchodilators produce a more rapid onset of action than oral delivery. Some drugs are only active with aerosol delivery (*eg*, for asthma patients, cromolyn and ciclesonide; for cystic fibrosis patients, dornase alfa). Aerosol drug delivery is painless and often convenient. For these reasons, the National Asthma Education and Prevention Program guidelines[2] favor aerosol inhalation over the oral route or parenteral (*ie*, subcutaneous, IM, or IV) route. Similarly, the National Heart, Lung, and Blood Institute/World Health Organization Global Initiative for Chronic Obstructive Lung Disease recommended that bronchodilator medications are central to symptom management in COPD patients and that inhaled therapy is preferred.[3]

There are also disadvantages to aerosol drug therapy. One of the most important disadvantages is that specific inhalation techniques are necessary for the proper use of each of the available types of inhaler device. A less than optimal technique can result in decreased drug delivery and potentially reduced efficacy.[4,5] Improper inhaler technique is common among patients.[6–8] The proliferation of inhalation devices that are available for patients has resulted in a confusing number of choices for the health-care provider and in confusion for both clinicians and patients trying to use these devices correctly. Several studies have demonstrated lack of physician, nurse, and respiratory therapist knowledge of device use.[9–13] Inhaler devices are less convenient than oral drug administration insofar as the time required for drug administration may be longer and some patients may find the device less portable. This is particularly true for conventional compressed-air nebulizers, the oldest of the currently used types of aerosol delivery devices.

Device manufacturers have long been aware of the importance of portability and ease of use with aerosol delivery devices. As a result, these devices have evolved over time. From the 19th century until 1956, compressed-air nebulizers (also called *jet nebulizers*) were the only devices that were in common clinical use for the administration of inhaled aerosol drugs. In 1955, the pressurized metered-dose inhaler (MDI) was developed at Riker Laboratories (now 3M Pharmaceuticals; St. Paul, MN).[14] Ultrasonic nebulizers, which utilize high-frequency acoustical energy for the aerosolization of a liquid, were introduced in the 1960s.[15,16] In 1971, Bell and colleagues[17] introduced the first dry powder inhaler (DPI), known as the *Spinhaler*, for the inhalation of cromolyn sodium. This and subsequent DPIs have been "breath-actuated," providing drug only when demanded by patient inhalation, thus avoiding a common error with MDI use, the improper timing of inhaler actuation. Breath-actuated MDI devices (*eg*, the Autohaler; 3M Pharmaceuticals) are also triggered by patient inhalation to release the drug on demand.

Investigators developed open-tube spacer devices, intended for use with MDIs, in the late 1970s.[18–20] The addition of a one-way valve (holding chamber)[18] or blind reservoir (*ie*, reverse-flow spacer)[21,22] al-

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Professor Dolovich has served as a speaker for Forest Laboratories, 3M Pharma, and Aventis, and as a consultant for GlaxoSmithKline and Delex Therapeutics, and has received research funding from 3M Pharma, Trudell Medical International, and Altana Pharma. Dr. Ahrens, in the past 12 months, has received research funding from or has had a consulting relationship with the following organizations with a potential financial interest in the subject of the manuscript: AstraZeneca; Aventis; Boehringer Ingelheim; GlaxoSmithKline; Innovata Biomed Limited; Medic-Aid Limited; Monaghan Medical Corporation; and 3M Corporation. Dr. Hess has served as a consultant for Pari and has received research funding from Cardinal Health. Dr. Anderson has participated in clinical trials for GlaxoSmithKline, Boehringer Ingelheim, Astra-Zeneca, and Novartis. Dr. Dhand has served as a speaker for GlaxoSmithKline and Boehringer Ingelheim, has sponsored meetings for GlaxoSmithKline, Boehringer Ingelheim, and Sepracor, and has performed research funded by Sepracor Inc and Omron. Dr. Rau has no financial interest or involvement in any organization with a direct financial interest in the subject of this article, but he has served as a consultant for Respironics, as a speaker for Sepracor Pharmaceutical, and as a consultant and speaker for and performed research funded by Trudell Medical International and Monaghan Medical Corporation. Dr. Smaldone has served as a consultant to several device and pharmaceutical companies that are connected to aerosol therapy, primarily the nebulization of drugs. Those companies with a direct financial interest in nebulization include Monaghan/Trudell Medical International, Aerogen, Pari, and Profile Therapeutics.

Manuscript received February 25, 2004; revision accepted August 25, 2004.

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