Aerosol Delivery Devices for the Geriatric Population

by Helen M. Sorenson, MA, RRT, CPFT

Almost 100 million Americans have chronic conditions, and millions more will develop them as the older adult population grows.[1] One factor contributing to the increased incidence of chronic disease in older adults is smoking. About 25 percent of adults age 51 to 61 currently smoke cigarettes, but more than 60 percent have smoked at some time in their lives.[2] Smoking is a major threat to health and a causative agent in the development of chronic lung disease.

Another chronic disease common to older adults is arthritis. About 46 percent of adults over the age of 65 have arthritis.[3] While many individuals with arthritis lead active, productive lives, others need assistance for instrumental activities of daily living (IADLs). Taking medication is an IADL made more difficult by arthritis.

Chronic lung disease

The growing population of older adults is presenting multifaceted challenges to health care professionals. During the period between 1980 to 1996, there has been a 32 percent increase in the population of adults over the age of 65.[4] Accompanying this dramatic growth has been a 61.5 percent increase in deaths from chronic obstructive pulmonary disease (COPD) per 100,000 population.[4]

Traditionally, one of the mainstays of therapeutic intervention for patients with chronic lung disease has been aerosolized bronchodilators. Given that there are increased numbers of older adults with COPD, and aerosolized medications remain a primary mode of therapy, what is the most effective way to deliver aerosolized medications to geriatric patients? Given also the fact that a large number of older adults have arthritis, which impedes their ability to actuate MDIs, what would be an acceptable alternative to conventional inhalers for older adult patients?

Aerosolized drug delivery devices

Aerosol delivery devices in the hospital have changed over the years. Intermittent positive-pressure breathing (IPPB) machines were popular in the 1960s and 1970s. During the mid 1970s however, the widespread use of IPPB was questioned by physicians, therapists, and insurance providers. Small volume nebulizers (SVN) quickly replaced IPPB as the modality of choice for

delivering aerosolized bronchodilators.

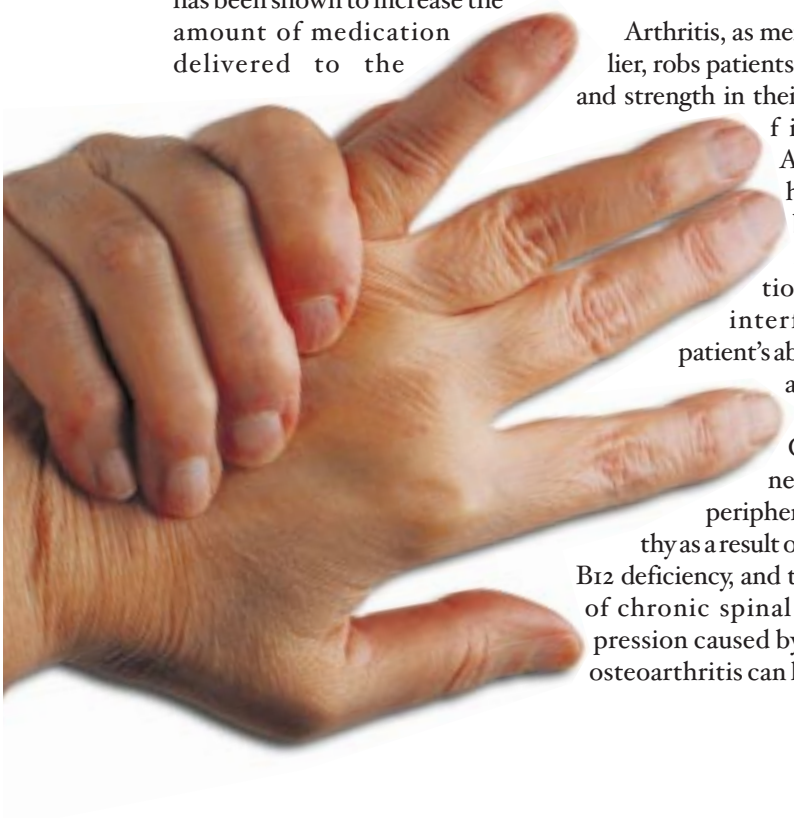
The 3M Corporation developed the first metered dose inhaler (MDI) in 1956.[5] Although not used widely until the 1970s, MDIs have become as commonly used as SVNs for in-hospital aerosolized medication delivery. The acceptance of respiratory therapy protocols by the medical staff in many institutions has allowed therapists to select the aerosol delivery device most appropriate for the patient. In many cases, this means providing training to the patient on the use of inhalers and spacers. The portability, adaptability, and ease of use have made the MDI popular with a large percentage of the COPD population.

When patients are capable of understanding and remembering the correct technique for using MDIs, the therapy is generally effective. The use of spacers and valved holding chambers has been shown to increase the amount of medication delivered to the lungs. These devices also minimize the amount of drug that impacts on the oral mucosa, which can result in systemic absorption. Thus, the key to proper medication delivery via MDIs is capability and comprehension. For many older adults, this is where the plan falls apart.

Geriatric patients and MDIs

All older adults are not feeble. Many patients in their 70s, 80s, and 90s whom we see and treat are bright, capable, and very concerned about their health care regimen. Please keep this in mind as you read on.

Twenty years from now, will we still be wondering how to effectively deliver aerosolized medications to older and/or compromised patients?



Arthritis, as mentioned earlier, robs patients of dexterity and strength in their hands and fingers. Arthritis, however, is but one of many conditions that can interfere with a patient's ability to actuate an MDI canister. Carpal tunnel syndrome, peripheral neuropathy as a result of diabetes or B12 deficiency, and the presence of chronic spinal cord compression caused by C5 and C6 osteoarthritis can lead to hand muscle atrophy, severe hand pain, or lack of peripheral sensation in the digits. Patients with dementia, either Alzheimer's or non-Alzheimer's in origin, will not be good candidates for self-actuation of MDIs.

Even without the presence of a chronic disease or disorder, there is a normal age-related decline in muscle strength. Sarcopenia is a slowly progressive process or disease characterized by weakening muscles and strength, which normally occurs in most adults between the ages of 35 and 70.

For many years the solution to lack of capability and comprehension has been to strap an aerosol mask on our older patients. Regardless of the cause, patients unable to actuate an MDI were given SVNs, either by mask or, if they were able, a mouthpiece. Articles published in the June and July issues of Respiratory Care have shed new light on the efficacy of small-volume nebulizers. A comparison of characteristics used to guide device selection demonstrates that MDIs with holding chambers have many more positive characteristics than small-volume nebulizers.[6]

One concern that directly relates to efficacy of an aerosol delivery device is the patient's ability to take in and hold a deep breath. According to Fink,

patients who do not have the ability to perform an optimal inspiratory maneuver with an MDI are seldom able to perform an optimal maneuver using a nebulizer.[6]

Alternate aerosol delivery devices

The dilemma of which aerosol delivery device to use with certain patient populations and why has never been completely solved. Far from being a random guess, most health care institutions have their own aerosol delivery device protocols. The AARC Clinical Practice Guidelines (CPGs) are an excellent reference; however, since the guidelines were written, newer devices have entered the marketplace.

One of the decisions that changed the future direction of MDI production by pharmaceutical companies was The Montreal Protocol (The Montreal Protocol on Substances that Deplete the Ozone Layer), which was codified by congressional law in the Clean Air Act. The production of chlorofluorocarbons (CFCs) in the United States was banned as of January 1996. While the U.S. Food and Drug Administration is not currently removing any CFC MDIs from the market, it is assisting the pharmaceutical industry in selecting and developing alternate propellants. Faced with a permanent, mandated CFC phase-out, drug manufacturers are developing a variety of CFC-free alternate delivery devices.

One CFC-free alternative that is being used in MDIs is hydrofluoroalkane (HFA). This new propellant, however, has resulted in a smaller aerosol particle size, which has necessitated adjustments in the delivery system. Another unique alternative, which eliminates the need for propellant, is the DPI, or dry-powder inhaler.

Dry powder inhalers

DPIs, as the name implies, rely on a fairly high inspiratory flow to draw air through a dry-powdered medication, thus creating an aerosol. DPIs are presently available in three forms. The single-dose inhaler (Spinhaler®, Rotohaler®, Inhalator Ingelheim®, Aerohaler®, Cyclohaler® and Chiesi®) require the patient to manually insert a dose of medication into the apparatus prior to inhalation. The multidose inhalers (Diskhaler® and Diskus®) contain multidose blister packs coiled inside the inhaler that are to be punctured immediately before inhalation. A third DPI design, incorporated by the Turbohaler®, Easyhaler®Clickhaler®, and Pulvinal®, contain all the doses in a bulk powder reservoir, from which a dose is made available by manipulating the device prior to inhalation.

While the DPIs eliminate the problem of canister actuation, they have not been adaptable to

references

1. The Robert Wood Johnson Foundation. (1996). *Chronic care in America: A 21st century challenge.* Princeton, NJ.
2. National Academy on an Aging Society. (2000). *At risk: Developing chronic conditions later in life. Vol. 4.* Washington, DC.
3. National Academy on an Aging Society. (2000). *Arthritis: A leading cause of disability in the United States. Vol. 5.* Washington DC.
4. U.S. Bureau of the Census. (1997). *Statistical abstract of the United States* (117th ed.). Washington, DC: U.S. Government Printing Office.
5. Doyle, T. (2000). *Canada approves QVAR inhaler, effective at half the dose of other inhalers* [Online]. Available: http://www.pslgroup.com.
6. Fink, J.B. (2000). Aerosol device selection: Evidence to practice. *Respiratory Care, 45*(7), 874-885.
7. Fink, J.B. (2000). Metered-dose inhalers, dry *powder inhalers, and transitions. Respiratory Care, 45*(6), 623-635.
8. *Sheffield announces positive phase II results for albuterol delivery system* [Online]. Available: http://respiratorycare.medscape.com.
9. Everard, M.L. (2000). Aerosol therapy past, present, and future: A clinician's perspective. *Respiratory Care, 45*(6), 769-776.
10. U.S. Bureau of the Census. (1992). *Current population reports, special studies, sixty-five plus in America.* Washington, DC: U.S. Government Printing Office.

all patient populations. The manipulations needed to load or activate the DPI, and the high flow rates needed to deliver the aerosols (30–120 L/min.)[7] serve as barriers to many older patients.

Breath-actuated inhalers

In an effort to overcome the need for hand and breath coordination, the breath-actuated MDIs were designed to self actuate in response to the patient's inspiratory efforts. A flow in excess of 30 L/min. will trigger the device and deliver a metered dose of medicine. The only drug currently available in a breath-actuated inhaler is pirbuterol.

Metered-solution inhaler

Currently in research and development by Sheffield Pharmaceuticals is the metered solution inhaler (MSI). The MSI is designed to rapidly nebulize albuterol, using ultrasonic waves, through a mouthpiece in as few as two to three seconds.[8] According to Sheffield, this pocket-size inhaler is designed for ease of use and may be particularly appropriate for both pediatric and senior populations.

MDI assistive devices

The lack of strength needed to actuate MDIs, either age-associated or disease-associated, has not gone unnoticed by the industry. Many years ago, an assistive device called the VentEase was available to patients who needed MDIs but also had arthritis. The VentEase is no longer available. A newer assistive device called the MDI Ease is available for use with Combivent and Atrovent inhalers. Some manipulation of the device is still needed; but when assembled, the MDI Ease allows the patient to use handgrip strength instead of finger strength to actuate the canister.

Overview

A review of recent literature and the CPGs provides some interesting, thought-provoking information. Although giving nebulizer treatments by mask to older adults who are determined incapable of actuating an MDI is standard in many institutions, the treatment may not be all that effective. Under ideal circumstances, small volume nebulizers should be able to deliver up to 50 percent of the intended dose. Because SVNs operate continuously, though, there is a lot of wasted medication when the patient either exhales or performs a breath-hold maneuver.

One intervention might be to use a nebulizer with an attached reservoir bag. Increasing the volume of diluent in the nebulizer (fill volume should be at least 4–6 mL/s) will also increase the amount of drug that is nebulized.

Patients not capable of actuating MDIs in the hospital may be sent home with a prescription for home care to set up the patient with a portable compressor. It is important to match the compressor with the nebulizer based on data supplied by the SVN manufacturer. Too low a flow from the home compressor, coupled with the wrong type of nebulizer, can result in little or no drug being delivered to the patient.

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Inhaling through the nose will greatly decrease drug delivery. Unfortunately, patients who are not alert enough to use a mouthpiece are frequently not alert enough to inhale with their mouth open, even when coached. One intervention may be to increase the initial drug dosage in the SVN. However, the use of high-dose inhaled sympathomimetics in older patients who may have significant ischemic heart disease remains a cause for concern.[9]

When comparing the efficacy of MDIs used in conjunction with valved holding chambers (HCs) versus SVNs with aerosol masks, the MDI/HC system delivers a larger dose of drug to the lungs. The addition of a mask to the MDI/HC drug delivery system will compensate for the lack of breath-hand coordination. Would this solve the problem of the patient's inability to actuate the drug canister? Probably not. MDI/HC systems with masks are recommended by the AARC CPGs as being appropriate for patients less than three years of age who are unable to use a mouthpiece. Would this same system, with a large mask, also be appropriate for older compromised patients?

Clearly, more research needs to be conducted. The growing numbers of geriatric patients demand our attention. The increased incidence of COPD in our older patients requires that we collectively find a way to deliver aerosolized medications in a consistent and efficient manner. Continuing to deliver aerosolized therapeutic agents inefficiently is a waste of time and money. The proactive stance taken by our professional organization over the past few years is setting the stage for both a retrospective and introspective look at our current aerosolized therapeutic modalities.

In 1970, less than 10 percent of the population of the United States was over the age of 65. By the year 2020, it is projected that about 18 percent of the U.S. population will be in that category.[10] Twenty years from now, will we still be wondering how to effectively deliver aerosolized medications to older and/or compromised patients? Hopefully not.

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