

Spacers and Valved Holding Chambers in Asthma Drug Delivery: How Many Breaths Are Needed to Achieve Adequate Lung Deposition?

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Schultz A, Le Souëf TJ, Venter A, et al.: Aerosol inhalation from spacers and valved holding chambers requires few tidal breaths for children. *Pediatrics* 2010; 126(6):e1493–8.

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Introduction: Wheezing disorders are more common among young children than any other group. As symptoms are primarily treated with inhaled medications, a need exists to find simple, efficient, and inexpensive methods of drug delivery. Spacers and valved holding chambers (VHCs) are devices commonly used to deliver asthma medications to young children that are simple to use and can reduce cost and side effects associated with inhalers. Previously, however, no data existed with regard to how many breaths are required to achieve adequate medication deposition in the lung.

Aims: This study was designed with two aims. The first was to determine the number of tidal breaths required to inhale medication effectively through different types of spacers/VHCs. The second was to determine the efficacy of a single maximal inhalation for drug delivery for preschool-aged children.

Methods: The study was conducted as a substudy of a larger clinical trial. It included children 2 to 6 years of age who had physician-diagnosed asthma and were receiving inhaled steroids as treatment. The ethics were approved through the institutional ethics committee, and informed consent/assent was given by the children and parents or guardians. Three groups were recruited through local advertisements, flyers, and from the emergency department and clinics. In the first group, 34 individuals were given small-volume VHCs, either an Aerochamber Plus (Trudell Medical International; London, Ontario, Canada) or a Funhaler (Visiomed; Perth, Australia), and drug delivery was compared with 2 tidal breaths and 9 tidal breaths. The second group contained 84 children who were screened for their ability to perform a single maximal inhalation. The third group compared tidal breaths with single maximal breaths and was made up of 10 children who were the first 2 for each year of age who could perform a single maximal inhalation. In this group, tidal breathing and single maximal breathing patterns were recorded and simulated using four different spacers/VHCs: the small-volume Aerochamber Plus and Funhaler, the large-volume Volumatic VHC (GlaxoSmithKline, Melbourne, Australia), and a modified soft drink bottle. None of the VHCs/spacers used in this study had masks. A custom-built device was used to record breathing patterns. All breathing patterns were transferred to a breathing simulator (Hans Rudolph, Shawnee, KS). This study was funded by a research grant from the Princess Margaret Hospital for Children Foundation and a fellowship from the Telethon Foundation in Perth, Australia.

Results: No significant difference in drug delivery was seen between two and nine tidal breaths with small-volume VHCs (Funhaler, 39% and 38%; Aerochamber Plus, 40% and 41%). No significant difference in drug delivery

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between three and nine tidal breaths was seen with the Volumatic VHC (mean, 40%). The valveless, modified soft drink bottles showed no significant difference in drug delivery among two, five, and nine tidal breaths (~48%, 47%, and 49%, respectively). The inhalation volumes of the single maximal breath maneuver were approximately double the tidal volumes (Aerochamber Plus, 515 ± 164 vs 393 ± 247 mL; Funhaler, 550 ± 239 vs 432 ± 225 mL; Volumatic, 503 ± 213 vs 384 ± 185 mL; soft drink bottle, 448 ± 259 vs 445 ± 167 mL). As expected, the ability to perform a single maximal breath maneuver varied considerably by age (age 7 years, 100%; age 6 years, 84%; age 5 years, 76%; age 4 years, 36%; age 3 years, 20%). Girls were able to perform a single maximal breath maneuver earlier than boys. Finally, nine tidal breaths resulted in greater drug delivery compared with single maximal inhalation for the Funhaler and the Volumatic; however, no significant difference was seen in drug delivery between single maximal inhalation and nine tidal breaths for the Aerochamber Plus and modified soda drink bottle.

Discussion: This study offered three new observations with regard to inhaled drug delivery. First, young children breathing tidally through the mouthpiece of a spacer/VHC take larger breaths than normal tidal breaths. Second, this study showed that only two or three breaths are needed to adequately achieve lung deposition of asthma medications given via inhaler. Finally, this study showed that a single maximal inhalation does not improve drug delivery when compared with tidal breathing for young children. The major limitation of this study was that the filter dose captured

during breathing represents the total drug dose that would reach a patient, but not necessarily the lung. Furthermore, this study was conducted with inhalers without masks, and children are likely to have different breathing patterns when using inhalers with masks.

Comments

The benefit of spacers and VHCs have long been recognized in the pediatric medical community. This study provides practical evidence to guide clinicians when educating families on VHC technique. Admittedly, our practice has not changed because of these results, as our youngest children are almost exclusively given spacers with masks. We continue to recommend 10 breaths through the VHC; however, we find this study to be reassuring that in preschool-aged children, who can have very short attention spans, adequate drug deposition is likely even if they only remain still for a few breaths. In addition, we were impressed with the overall performance of the modified soft drink bottle, which may be an alternative when commercial VHCs are not available.

Disclosure

Dr. Portnoy has served as a consultant for Phadia AB and has received honoraria from Phadia AB, Merck & Co., and UCB India.

Dr. Ciaccio reported no potential conflicts of interest relevant to this article.