IN VITRO EVALUATION OF THE NOVEL SPACER DEVICE WATCHHALER™ AND MODELING OF PROBABLE DEPOSITION IN CHILDREN

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BACKGROUND AND MOTIVATION

Different inhalation devices are widely used in asthma treatment but are associated with high variability in the mass of drug delivery to the patient's lung. This variability is not only caused by the medical device but by the individual breathing pattern and the compliance of the patients with the labeled directions [5,6]. Especially for pressurized metered dose inhalation devices (MDI) it has been shown that in adults, only 25% of patients were able to perform inhalation with an MDI correctly [1,2]. In children it is even worse and lung deposition is less than 5% [3]. Commercially available spacer devices improve delivery since they overcome difficulties in coordinating actuation of the MDI with inhalation of the drug, yet the problem of dose variance remains unsolved.

Figure 1: Watchhaler

We designed a novel spacer for children to overcome this shortcoming. A silicone balloon within a transparent plastic chamber is used as a reservoir for the aerosolized drug (Fig. 2). The balloon is filled with the aerosol from an MDI through the mouthpiece of the device. The volume of the balloon limits the inhalation volume. The plastic chamber has an air inlet on the opposite side of the mouth piece. This is closed with a patented mechanical valve that restricts the inhalation flow rate [7]. During inhalation the balloon interfolds allowing visualization of a successful inhalation. This is designed to motivate the child to continue inhaling and provides feedback for parents, physicians and physiotherapists. While conventional spacers have a clinical, boring appearance, the Watchhaler has the configuration and color of a toy. This is intended to minimize the fear of treatment and to give the child the impression of a helping friend.

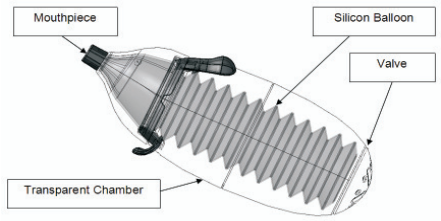

Figure 2: Details of the Watchhaler

MATERIALS AND METHODS

In-vitro drug output measurements were made using three different aerosol systems with the Watchhaler spacer. The three devices were: Berodual (Fenoterol / Ipratropium-MDI, Boehringer Ingelheim), Budiair (Budesonide MDI, Asche-Chiesi) and Respimat (Fenoterol / Ipratropium-Respimat, Boehringer Ingelheim). The simulated breathing maneuver was preset by the designed inhalation volume of the balloon (350 ml) and the inlet valve (250 ml/sec). The Watchhaler was filled with the aerosol. Immediately after filling, the drug output of the spacer was collected using a filter between a breathing simulator (Hans Rudolph, Kansas City, MO) and the mouthpiece. The breathing patterns were nearly rectangular flow volume curves with 250 ml/sec flow rate and 350 ml inhalation volume. Particle size (MMAD) was determined by Andersen Impactor measurements at 28.3 l/min. Additionally, the particle size of the MDIs was determined without the new spacer device, using the same experimental setup. Every measurement was repeated 3 times.

RESULTS

Particle sizes (MMAD ± standard deviation of the three measurements) with the three MDIs were found to be 1.0 ± 0.05 µm (Berudual), 2.9 ± 0.06 µm (Budiair) and 4.5 ± 0.12 µm (Respimat). The output at these particle sizes is shown in figure 3. The experimental setup had a variability of less than ± 2%. From these data the lung deposition was calculated for a 5 year old child using the ICRP model [4](figure 4). The lower lung deposition with 1 µm particles can be explained by higher amount of exhaled aerosols.

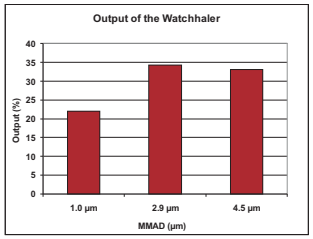

Figure 3: Output of the Watchhaler

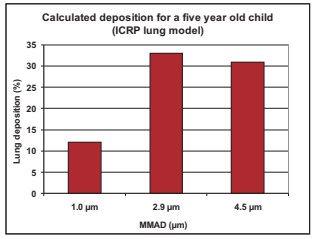

Figure 4: Calculated lung deposition (ICRP Model)

CONCLUSION

The novel spacer system was shown capable, through in vitro testing and modeling, of potentially achieving a high lung deposition and drug output with a reduced variability. This spacer's visual control features will allow parents to confirm their child's breathing maneuver as it controls the inhalation flow and volume of air inspired by the child.

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