The effect of inhalation duration on lung deposition with a pressurized metered-dose inhaler (pMDI)

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Rationale
Although the guidance for using a pMDI is to inhale ‘slow and deeply’, many patients inhale fast over a short duration. The ERS/ISAM Task Force suggested ‘slowly’ equates to inhaling over 4-5 seconds (s) for adults (Laube B.L. et al. ERJ 2011; 37(6):1308–417), a much clearer instruction. This study therefore examined the influence of inhalation time on total lung deposition (TLD) using Functional Respiratory Imaging (FRI).

Methods
Three-dimensional airway models of 6 asthma patients (mean FEV\textsubscript{1} 83\%), treated with an ICS/LABA combination, were included. The lung deposition characteristics of an HFA-based pMDI (MMAD ~3.0\textmu m; fine particle fraction (FPF) ~40\%) were assessed using FRI. Simulations were performed on 3 different inhalation profiles matched for the same inspiratory volume (3L) with durations of 1s, 3s and 5s and actuation at start of inhalation.

Results
For the 1s, 3s and 5s profiles, the TLD values were 22.81\pm 3.71\%, 36.13\pm 2.51\% and 41.61\pm 3.11\% of nominal dose respectively, and were predicted using a concave down quadratic model (R\textsuperscript{2} = 0.87, p<0.001). The central to peripheral deposition ratios were 1.58, 0.81 and 0.57 respectively.

Conclusions
A 5 s inhalation led to highest TLD with greatest peripheral deposition. Increased deposition with longer times mainly reflected increased peripheral deposition, central deposition was less affected
by flow rate. These data support ERS/ISAM guidance for inhaling over 4-5 sec to optimize deposition, although similar TLD were achieved with 3s. These data also suggest that high FPF pMDIs can achieve reasonable deposition even with short, fast inhalations.

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