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Design considerations for aerosol delivery to Children and Infants

Children and infants are not simply small adults and require special consideration when planning aerosol-mediated inhalation drug therapy. Further, the variety of presentations in children and infants is vast, and includes a disparate range that includes ~0.5kg premature infants with respiratory distress syndrome (RDS), term infants with (RSV) infection and older children with complications associated with lung infection or Pulmonary Hypertension as examples. With continual advances in formulation, aerosol generator technology, patient interventions and patient interfaces, several options are now available to both designers of drug/device combination products, and caregivers at the bedside tasked with the selection and use of these products.

Anatomical features, breathing profiles, a tendency towards nasal breathing, patient compliance and the use of 'one size fits all'- type products all conspire to reduce the efficacy of aerosol mediated drug therapy, and despite the obvious need, relatively little has been done in attempting to design systems specifically for these populations. These advances have been hindered by the difficulty in conducting trials in children and infants and rely heavily on surrogate animal models, which may share similar breathing patterns, but the effect of differences in upper airway geometries is unknown.

Droplet size is known to have a significant bearing on the ability to target drug to the airways. Smaller particles or droplets are considered better on the basis that they are less likely to see impactional losses in the nasal passages. The majority of work determining optimal MMAD has focused on adults and children greater than 9 – 10 months, with reported bench and mathematical modelling predicting that 5 micrometers remains the upper target in infants [1,2], however, more studies are now beginning to be published using anatomical models that should provide more specific size ranges [3,4].

As no aerosol generating devices were specifically designed for use with children, devices designed for adults are frequently modified by attaching small infant or child size masks, with little evidence of provided to support efficacy or benefit [5]. Face masks, nasal cannula, hoods and spacers are the most commonly used interfaces with selection dependent on age, patient's tolerance, and patient's preference. Each facilitate delivery of some aerosol, but that dose varies between each[6,7].

Choice of device is also of paramount importance. Considerations such as the effect of supplemental gas flow rate (8 to 13 LPM for a jet nebuliser for example) on the small lung must be taken into account. With the increased risk of volutrauma or barotrauma during concurrent use of a jet nebuliser during invasive mechanical ventilation, the list of appropriate and effective devices is limited. Softer considerations must also be made, for example, noise. Noise emitted from a device during therapy can result in physiological responses that can affect breath patterns, and consequently the inhaled dose [8-10].

These and several other factors shall be the focus of this presentation, which shall draw from the current literature in an effort to provide guidance on design and selection options for optimised aerosol-mediated therapy in these patients.

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