Perceptual reasons for resistance to change in the emergency department use of holding chambers for children with asthma

• The need for sufficient human resources and deal with the perceived increase in work load

• Concern about increased cost of equipment needed to deliver care

• Need for a focused educational campaign to dispel myths and engender acceptance of therapy

• The need to define professional roles

Hurley 2008
Comparison of SVN and MDI-VHC Costs

Jan-May 06
8,021 cases
10
17

Jan-May 05
8,046 cases
11
63

Jan-May 04
9,915 cases
12
25

Salyer 2008
Spacers (no valves)

Valved holding Chambers VHC
Sources of aerosol loss within the spacer

- Impaction
- Sedimentation (time dependent)
- Electrostatic attraction (time dependent)
- Dead space
- Valve insufficiency
The effect of spacer length on dose delivery

Budesonide pMDI-metal spacer

Percentage

- coarse > 4.7 um
- fine < 4.7 um

Bisgaard 2002
Electrostatic Attraction

✓ Aerosolization induces a static electric charge on particles; plastic devices carry random electrostatic charges

✓ Electrostatic attraction causes a continuous and rapid disappearance of the aerosol

✓ Electrostatic attraction reduces the initial dose available and the aerosol half-life

✓ In plastic spacers half-life increases if the static charge is abolished

*Because of short residence time in plastic spacers, the inhalation must be coordinated with actuation of pMDI to obtain optimal dose. This negates one of the major advantages of spacers*
**Fine-Particle (<6.8 um) Percentage of Albuterol Emitted From an Untreated Versus a Pretreated (Detergent-Washed) Babyhaler Nonconducting**

<table>
<thead>
<tr>
<th>Inhalation delay sec</th>
<th>0</th>
<th>1</th>
<th>5</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine particles %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>untreated</td>
<td>32.9 (1.5)</td>
<td>19.5 (1.9)</td>
<td>12.3 (0.6)</td>
<td>8.6 (1.0)</td>
</tr>
<tr>
<td>treated</td>
<td>56.3 (2.0)</td>
<td>57.2 (1.4)</td>
<td>55.2 (1.5)</td>
<td>53.7 (1.2)</td>
</tr>
</tbody>
</table>

*Wildhaber 1996*
INFLUENCE OF ELECTROSTATIC CHARGE AND DESIGN.
Dose delivered to filter during 100 consecutive acutations of BUD-Nebuchamber (nonelectrostatic) and FP-Babyhaler (electrostatic)

Increase 0.8% in day

Berg 1998
% of nominal dose
Drug output of FLU-CFC 50μg from untreated spacers:

Fluticasone dose to patient (μg)

1s 5s 10s Babyhaler
1s 5s 10s Volumatic
1s 5s 10s Aerochamer

Barry 1999
Drug output of FLU-CFC 125µg from untreated spacers

Fluticasone dose to patient (µg)

1s Babyhaler
1s Volumatic
1s Aerochamer

Barry 1999
Total Emitted Mass with No pretreatment from HC-Albuterol-HFA (90ug)

Total Emitted Mass ug/actuation

Aerochamber, Vortex, OptiChamber, ProChamber, Breathrite, PoketChamber, ACE

2 seconds: Blue bars
5 seconds: Red bars

Rau Respir Care 2006
Cleaning Your Spacer

1. Remove rubber end where MDI fits.
2. Fill a sink or deep bowl with warm water. Add one drop of liquid detergent.
3. Place both pieces in the warm soapy water, and gently shake both pieces back and forth.
4. Rinse only the mouthpiece in running water.
5. Shake to remove the water.
7. Put rubber end back on spacer when completely dry.
Electrostatic Attraction

- Electrostatic charges in plastic spacers cause a clinically significant reduction in lung dose

- Possible priming procedures for available plastic spacers should be studied with respect to stability, toxicity, drug interactions and impact on patient compliance

- Only nonelectrostatic devices should be used
Dead Space

✓ Volume common to the inspiratory and expiratory lines in device, this volume will not contribute to the lung dose but will be lost in each breath.

✓ A certain amount of dead space cannot be avoided in a face mask but should be minimized by reducing the volume of the mask.
Valves

✓ An inefficient inspiratory valve blows aerosol out of the spacer during expiration

✓ An inefficient expiratory valve dilutes the inspiration with air from outside the spacer, resulting in delayed aerosol delivery and increased loss due to passive fallout of aerosol in the spacer

✓ Leakage through valves reduces drug delivery, common through low-resistance valves.
NebuChamber:
High resistance valves
No dead space

Babyhaler:
Low-resistance valves
40-ml dead space

Dose obtained by evacuating the spacer by a constant flow by a ventilator

Tidal volume 195 ml;
respiratory frequency 20;
Inspiratory:expiratory ratio 1:2

95% vs 60%

Berg 1998
Spacers are not considered to be medial products and can therefore be marked without any documentation.

The performance characteristics of pMDIs are required to be strictly documented before approval by drug regulatory authorities; considering the significant influence of spacers on pMDI performance, it would seem logical to require similar documentation of pMDI-spacer combination before approval and marketing.