Getting the Drug to the Lung: Using Simulation Technology to Maximize Inhaler Benefits

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Disclosure

• I will show an online educational resource for inhaler training.

• I have provided professional input in development of this resource

• No financial relationship

• I have been allowed unrestricted use of site for academic purposes
Getting the Drug to the Lung: What Part of Lung is the Target?
Getting the Drug to the Lung: Using Simulation Technology to Maximize Inhaler Benefits

Drug

↓

Device Type

↓

Particle size

↓

Insp. Flow requirements

↓

Accessories - Spacer

↓

Inhaler technique

Inhaler technique

- Magnitude of problem
- Patient education
- Provider education
- Common errors
- Addressing the problem with simulation technology
Common Inhalers Available in the United States

Anticholinergics
- Spiriva® Handihaler®
  (tiotropium bromide)
  Inhalation Powder
  Boehringer Ingelheim
  Pharmaceuticals, Inc.
- Atrovent® HFA
  (ipratropium bromide HFA)
  Inhalation Aerosol
  Boehringer Ingelheim
  Pharmaceuticals, Inc.
- Combivent®
  (ipratropium bromide and
  albuterol sulfate)
  Inhalation Aerosol
  Boehringer Ingelheim
  Pharmaceuticals, Inc.

β2-Agonists
- Foradil® Aerolizer®
  (formoterol fumarate)
  Inhalation Powder
  Merck
- Maxair™ Autohaler™
  (glyburide acetate)
  Inhalation Aerosol
  GlaxoSmithKline
- ProAir® HFA
  (albuterol sulfate)
  Inhalation Aerosol
  Teva Specialty Pharmaceuticals
- Proventil® HFA
  (albuterol sulfate)
  Inhalation Aerosol
  3M Pharmaceuticals Inc.
- Seretide® Diskus®
  (salmeterol xinafoate)
  Inhalation Powder
- Xopenex® HFA
  (levalbuterol tartrate)
  Inhalation Aerosol
- Ventolin® HFA
  (albuterol sulfate HFA)
  Inhalation Aerosol

Corticosteroids
- Aerobid®
  (flunisolide)
  Inhalation Aerosol
  Forest Pharmaceuticals, Inc.
- Alvesco®
  (fluticasone propionate)
  Inhalation Aerosol
  Mylan
- Asmanex®
  (mometasone furoate)
  Inhalation Powder
  Schering Corporation
- Azmacort®
  (triamcinolone acetonide)
  Inhalation Aerosol
  Abbott Laboratories
- Flovent® Diskus®
  (fluticasone propionate)
  Inhalation Powder
  GlaxoSmithKline
- Flovent® HFA
  (fluticasone propionate)
  Inhalation Aerosol
  GlaxoSmithKline
- Pulmicort® Flexhaler®
  (budesonide)
  Inhalation Powder
  AstraZeneca LP
- QVAR®
  (budesonide)
  Inhalation Aerosol
  Teva Specialty Pharmaceuticals

β2-Agonist/Corticosteroid Combination
- Advair Diskus®
  (fluticasone propionate and
  salmeterol xinafoate)
  Inhalation Powder
  GlaxoSmithKline
- Advair® HFA
  (fluticasone propionate
  and salmeterol xinafoate)
  Inhalation Aerosol
  GlaxoSmithKline
- Symbicort®
  (budesonide and
  formoterol fumarate
dihydrate)
  Inhalation Aerosol
  AstraZeneca
Figure 2. Drug deposition with common aerosol inhaler devices. Shown by color are the varying percentages of drug lung deposition and drug loss in the oropharynx, device, and exhaled breath.

pMDI = pressurized metered-dose inhaler; VHC = valved holding chamber; SVN = small-volume nebulizer; DPI = dry-powder inhaler
<table>
<thead>
<tr>
<th>Device</th>
<th>MDI</th>
<th>DPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breathing pattern</td>
<td>Slow and Deep</td>
<td>Fast and Deep</td>
</tr>
<tr>
<td>Hand breath coordination</td>
<td>Crucial</td>
<td>Breath actuated – major advantage</td>
</tr>
<tr>
<td>Peak Inspiratory flow needed</td>
<td>&lt; 90 L/min</td>
<td>&gt;30-60 L/min High internal resistance</td>
</tr>
<tr>
<td>Particle Size</td>
<td>&lt; 5 µm for most HFA inhalers</td>
<td>Variable – Good quality depends on high PIF generation by patient Size usually larger than HFA MDI’s</td>
</tr>
<tr>
<td>Effect of Humidity</td>
<td>Minimal</td>
<td>Clumping of particles with high humidity</td>
</tr>
<tr>
<td>Dose reproducibility</td>
<td>High dose reproducibility with HFA</td>
<td>Good. Emitted dose and fine particle fraction depends on PIF, Humidity</td>
</tr>
<tr>
<td>All Devices</td>
<td></td>
<td>Require patient education (as comp. to pills)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Require provider education</td>
</tr>
</tbody>
</table>
Getting the Drug to the Lung: Using Simulation Technology to Maximize Inhaler Benefits

Drug

Device Type

Particle size

Insp. Flow requirements

Accessories - Spacer

Inhaler technique

• Magnitude of problem

• Patient education

• Provider education

• Common errors

• Addressing the problem with simulation technology
Effect of Particle Size

• Aerosol particles size measured using CASCADE IMPACTOR

Figure 1: Flow through a cascade impactor. At each stage, particles with sufficient inertia impact on the collection plate. Smaller particles remain entrained in the airflow and are carried to the next stage.

Deposition of medicine at back of throat.
Effect of Particle Size

- MMAD (mass median aerodynamic diameter) – the particle size below which 50% of the particle population lies
- DPI Graph – MMAD 3.0
- CFC Graph – MMAD 3.8
**Effect of Particle Size**

<table>
<thead>
<tr>
<th>Particle Size (MMAD)</th>
<th>Probable Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5.0 µm</td>
<td>Not respirable - oropharynx</td>
</tr>
<tr>
<td>&lt; 5.0 µm</td>
<td>Respirable</td>
</tr>
<tr>
<td>1-3 µm</td>
<td>“Distal Lung”</td>
</tr>
<tr>
<td>&lt;0.5 µm</td>
<td>Exhaled</td>
</tr>
</tbody>
</table>

a picture from "Using Microfine Formulations of Inhaled Corticosteroids to Treat Asthma" (by SRxA Institute for Professional Education, Inc. Sept 2009)

(Various sources)
Effect of Particle Size

TABLE I. Comparative particle sizes of inhaled corticosteroid formulations

<table>
<thead>
<tr>
<th></th>
<th>Particle size (MMAD) (mm)</th>
<th>Lung deposition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluticasone DPI†ivre</td>
<td>5.4</td>
<td>15.0</td>
</tr>
<tr>
<td>Triamcinolone acetonide†ivre</td>
<td>4.5</td>
<td>22.0</td>
</tr>
<tr>
<td>Budenoside DPI‡‡‡‡</td>
<td>4.0</td>
<td>32.0</td>
</tr>
<tr>
<td>Flunisolide CFC‡</td>
<td>3.8</td>
<td>19.7</td>
</tr>
<tr>
<td>Beclomethasone CFC¶#</td>
<td>3.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Fluticasone CFC‡‡</td>
<td>2.4</td>
<td>26.0</td>
</tr>
<tr>
<td>Flunisolide HFA‖</td>
<td>1.2</td>
<td>68.3</td>
</tr>
<tr>
<td>Beclomethasone HFA‖</td>
<td>1.1</td>
<td>56.0</td>
</tr>
</tbody>
</table>

Slower plume, smaller particles, good technique
= good lung delivery

Journal of Allergy and Clinical Immunology 2002; 109:S447-S460
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Drug

\[ \downarrow \]
Device Type

\[ \downarrow \]
Particle size

\[ \downarrow \]
Insp. Flow requirements

\[ \downarrow \]
Accessories - Spacer

\[ \downarrow \]
Inhaler technique

Inhaler technique

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Effect of Inspiratory Flow rate

- Faster inspiratory flow rates – more turbulence - inertial impaction of aerosols - oropharynx, bifurcations in the large airways.

- pMDI – Slow, deep breath (<60 L/min, slower the better.)
  - Slower breath allows time for particle size to decrease as propellant evaporates
  - Less inertial impaction
  - Deposition of radiolabeled terbutaline was reduced by a third by increasing the airflow through the MDI device from 30 to 180 l/min (mean ± standard deviation: 11.2 ± 4.0 vs 7.2 ± 2.2; p < 0.05).

- DPI – “as deep and as hard as you can” (> 30-60 L/min – device dependent) –
  - PIF dependent “quality of emitted dose”.
  - A threshold needed to activate device
Can all patients with COPD use the correct inhalation flow with all inhalers and does training help?

Raid A.M. Al-Showair\textsuperscript{a}, Walid Y. Tarsin\textsuperscript{a}, Khaled H. Assi\textsuperscript{a}, Stanley B. Pearson\textsuperscript{b}, Henry Chrystyn\textsuperscript{a},\textsuperscript{*}

<table>
<thead>
<tr>
<th></th>
<th>Fine particle dose</th>
<th>Total emitted dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>30</td>
<td>76</td>
<td>92</td>
</tr>
<tr>
<td>60</td>
<td>55.9</td>
<td>57.3</td>
</tr>
<tr>
<td>72</td>
<td>88</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{1}Diskus, \textsuperscript{12}Handihaler, \textsuperscript{1}Turbuhaler

Table 1  In vitro dose emission from dry powder inhalers (values expressed as a % of the nominal dose).
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### Table 2  
Resistance of the dry powder inhalers.

<table>
<thead>
<tr>
<th>Device</th>
<th>Mean (CV) resistance (cm$^2$)</th>
<th>Inhalation flow ($L\text{ min}^{-1}$) for a $H_2O^{0.5}\text{ L min}^{-1}$ +P of 4 kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flixotide Diskus</td>
<td>0.078 (0.77)</td>
<td>81.5</td>
</tr>
<tr>
<td>Pulmicort</td>
<td>0.120 (0.25)</td>
<td>53.1</td>
</tr>
<tr>
<td>Turbuhaler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seretide Diskus</td>
<td>0.078 (0.32)</td>
<td>82.4</td>
</tr>
<tr>
<td>Spiriva</td>
<td>0.158 (5.88)</td>
<td>40.4</td>
</tr>
<tr>
<td>Handihaler</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbicort</td>
<td>0.110 (0.50)</td>
<td>58.3</td>
</tr>
<tr>
<td>Turbuhaler</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Respiratory Medicine (2007) 101, 2395–2401*
Can all patients with COPD use the correct inhalation flow with all inhalers and does training help?

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<table>
<thead>
<tr>
<th>Table 3</th>
<th>Demographic data and PIF values.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
</tr>
<tr>
<td>(N)</td>
<td>163</td>
</tr>
<tr>
<td>Age (years)</td>
<td>72.5 (9.9)</td>
</tr>
<tr>
<td>(\text{FEV}_1) (% predicted)</td>
<td>47.8 (22.2)</td>
</tr>
<tr>
<td>PIF—peak inhalation flow (L min(^{-1}))</td>
<td>Pre</td>
</tr>
<tr>
<td>MDI</td>
<td>110 (75, 120)</td>
</tr>
<tr>
<td>PMTBH</td>
<td>45.9 (14.1)</td>
</tr>
<tr>
<td>SDSK</td>
<td>57.5 (17.9)</td>
</tr>
<tr>
<td>SHAND</td>
<td>28.6 (10.0)</td>
</tr>
<tr>
<td>STBH</td>
<td>47.8 (14.7)</td>
</tr>
</tbody>
</table>

All values are mean (S.D.) except PIF for MDI which are median (interquartile range).
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Table 4  Number of patients achieving a set PIF through each inhaler.

<table>
<thead>
<tr>
<th>Inhaler device</th>
<th>PIF (L min\textsuperscript{-1})</th>
<th>Mild (N (%))</th>
<th>Moderate (N (%))</th>
<th>Severe (N (%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDI</td>
<td>30–59</td>
<td>2 (5.6)</td>
<td>9 (13.8)</td>
<td>6 (9.7)</td>
</tr>
<tr>
<td></td>
<td>60–90</td>
<td>6 (16.7)</td>
<td>19 (29.2)</td>
<td>24 (38.7)</td>
</tr>
<tr>
<td></td>
<td>&gt; 90</td>
<td>28 (77.8)</td>
<td>37 (56.9)</td>
<td>32 (51.6)</td>
</tr>
<tr>
<td>Diskus</td>
<td>20–29</td>
<td>0</td>
<td>4 (6.2)</td>
<td>4 (6.5)</td>
</tr>
<tr>
<td></td>
<td>30–59</td>
<td>15 (41.7)</td>
<td>32 (49.2)</td>
<td>32 (51.6)</td>
</tr>
<tr>
<td></td>
<td>60–90</td>
<td>19 (52.8)</td>
<td>26 (40)</td>
<td>24 (38.7)</td>
</tr>
<tr>
<td></td>
<td>&gt; 90</td>
<td>2 (5.6)</td>
<td>3 (4.60)</td>
<td>2 (3.2)</td>
</tr>
<tr>
<td>Turbuhaler</td>
<td>&lt; 20</td>
<td>0</td>
<td>1 (1.5)</td>
<td>3 (4.8)</td>
</tr>
<tr>
<td></td>
<td>20–29</td>
<td>1 (2.8)</td>
<td>10 (15.4)</td>
<td>8 (12.9)</td>
</tr>
<tr>
<td></td>
<td>30–59</td>
<td>27 (75)</td>
<td>45 (69.2)</td>
<td>42 (67.7)</td>
</tr>
<tr>
<td></td>
<td>60–90</td>
<td>8 (22.2)</td>
<td>9 (13.8)</td>
<td>9 (14.5)</td>
</tr>
<tr>
<td>Handiholder</td>
<td>&lt; 20</td>
<td>2 (5.6)</td>
<td>14 (21.5)</td>
<td>16 (25.8)</td>
</tr>
<tr>
<td></td>
<td>20–29</td>
<td>11 (30.6)</td>
<td>28 (43.1)</td>
<td>22 (35.5)</td>
</tr>
<tr>
<td></td>
<td>30–59</td>
<td>23 (63.9)</td>
<td>23 (35.4)</td>
<td>24 (38.7)</td>
</tr>
</tbody>
</table>
Can all patients with COPD use the correct inhalation flow with all inhalers and does training help?

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\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Mean (S.D.) and median (upper quartile) peak inhalation flows through each DPI and the MDI, respectively, before and after training in the verbally trained (VT) (a) and the non-trained (NT) (b) groups.}
\end{figure}

Inspiratory Flow - conclusions

• >30 to 60 L/min flow needed

• More severe obstruction – DPI less suitable (advanced disease, during acute exacerbations)

• If DPI not effective – same drug thru MDI or nebulizer may still work

• TRAINING and EDUCATION HELPS
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**SPACERS – Not a magic solution**

- Recommended for most patients but not as widely used as they should be.

- Not needed if inhaler technique is good – esp with HFA inhalers.

- Volume of 100-200 ml (more imp with children).

- Use *Non Electrostatic material*, or wash with soapy water frequently and air dry.

- Use of VHC (valved holding chamber) recommended.

- Technique still important.
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Inhaler Technique - Magnitude of Problem

Problems With Inhaler Use: A Call for Improved Clinician and Patient Education

James B Fink MSc RRT FAARC and Bruce K Rubin MEng MD MBA FAARC

- $25 billion spent on inhalers
- $10 billion wasted due to poor technique
Pentagon braces for furloughs in sequester: How big a hit to economy?

800,000 civilian employees to work four days - resulting savings of about $5 billion
Assessment of Handling of Inhaler Devices in Real Life: An Observational Study in 3811 Patients in Primary Care

M. MOLIMARD, M.D., Ph.D., 1 C. RAHERISON, M.D., Ph.D., 2 S. LIGNOT, M.Sc., 1 F. DEPONT, M.Sc., 1 A. ABOUELFATH, M.Sc., 1 and N. MOORE, M.D., Ph.D. 1

Département de Pharmacologie, CHU Pellegrin Carreire, Bordeaux, France.

### Table 1. Patient Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Aerolizer</th>
<th>Autohaler</th>
<th>Diskus</th>
<th>PMDI</th>
<th>Turbuhaler</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>769</td>
<td>728</td>
<td>894</td>
<td>552</td>
<td>868</td>
<td>3811</td>
</tr>
<tr>
<td>Male/female (%)</td>
<td>54/46</td>
<td>53/46</td>
<td>51/49</td>
<td>54/46</td>
<td>52/48</td>
<td>53/47</td>
</tr>
<tr>
<td>Age, mean (years) ± SD</td>
<td>50 ± 20</td>
<td>47 ± 21</td>
<td>50 ± 21</td>
<td>47 ± 21</td>
<td>48 ± 21</td>
<td>49 ± 21</td>
</tr>
<tr>
<td>Age distribution (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥30 years</td>
<td>19.4</td>
<td>27.8</td>
<td>21.7</td>
<td>29.3</td>
<td>25.7</td>
<td>24.4</td>
</tr>
<tr>
<td>31 to 65 years</td>
<td>53</td>
<td>46.6</td>
<td>47.6</td>
<td>42.2</td>
<td>45.8</td>
<td>47.3</td>
</tr>
<tr>
<td>≥65 years</td>
<td>27.6</td>
<td>25.7</td>
<td>30.7</td>
<td>28.6</td>
<td>28.6</td>
<td>28.3</td>
</tr>
<tr>
<td>Disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma (%)</td>
<td>72</td>
<td>70.1</td>
<td>68.6</td>
<td>75.6</td>
<td>68.1</td>
<td>70.5</td>
</tr>
<tr>
<td>COPD (%)</td>
<td>26.1</td>
<td>25.2</td>
<td>28.3</td>
<td>21.1</td>
<td>27.9</td>
<td>26.1</td>
</tr>
<tr>
<td>Active drug inhaled for the test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-acting β2</td>
<td>/</td>
<td>298</td>
<td>/</td>
<td>376</td>
<td>210</td>
<td>884</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>/</td>
<td>442</td>
<td>175</td>
<td>109</td>
<td>411</td>
<td>1,117</td>
</tr>
<tr>
<td>Long-acting β2</td>
<td>755</td>
<td>/</td>
<td>170</td>
<td>40</td>
<td>/</td>
<td>965</td>
</tr>
<tr>
<td>Corticosteroids + long-acting β2</td>
<td>/</td>
<td>/</td>
<td>543</td>
<td>12</td>
<td>231</td>
<td>786</td>
</tr>
</tbody>
</table>
Assessment of Handling of Inhaler Devices in Real Life: An Observational Study in 3811 Patients in Primary Care

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Table 2. Percent Patients Who Were Scored “No” to Key Features of the Inhalation Technique Checklist by Inhaler

<table>
<thead>
<tr>
<th></th>
<th>Aerolizer (n = 769) %</th>
<th>Autohaler (n = 728) %</th>
<th>Diskus (n = 894) %</th>
<th>PMID (n = 552) %</th>
<th>Turbuhaler (n = 868) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shake the inhaler</td>
<td>32.8</td>
<td>22.3</td>
<td>29.5</td>
<td>30.4</td>
<td>29.5</td>
</tr>
<tr>
<td>Insert capsule</td>
<td>3.8</td>
<td>6.2</td>
<td>7</td>
<td>2.5</td>
<td>18.1</td>
</tr>
<tr>
<td>Press and release the 2 buttons</td>
<td>0.7</td>
<td></td>
<td></td>
<td>14.9</td>
<td></td>
</tr>
<tr>
<td>Raise lever to vertical position</td>
<td>1.4</td>
<td></td>
<td></td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td>Hold mouthpiece towards them</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Slide the lever as far as possible</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Hold inhaler upright (tolerance of ±45°)</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Rotate grip and back until “click”</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Exhale before inhalation</td>
<td>36.9</td>
<td>30.2</td>
<td>26.4</td>
<td>31</td>
<td>25.4</td>
</tr>
<tr>
<td>Exhale away from mouthpiece</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Inhale slowly and press canister</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Press canister only once per inhalation</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Inhale through the mouthpiece</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Inhale through the mouthpiece inhaler held correctly</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Continue slow and deep inhalation after puff release</td>
<td>5.4</td>
<td></td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Hold breath a few seconds</td>
<td>28.4</td>
<td>30.2</td>
<td>26.4</td>
<td>31</td>
<td>25.4</td>
</tr>
</tbody>
</table>

a Device-independent item.

b Considered “critical error” if quoted “no.”
Assessment of Handling of Inhaler Devices in Real Life: An Observational Study in 3811 Patients in Primary Care

M. MOLIMARD, M.D., Ph.D.,¹ C. RAHERISON, M.D., Ph.D.,² S. LIGNOT, M.Sc.,¹ F. DEPONT, M.Sc.,¹ A. ABOUELFATH, M.Sc.,¹ and N. MOORE, M.D., Ph.D.¹

<table>
<thead>
<tr>
<th>Table 3. Error Summary by System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerolizer</strong> (n = 769), %</td>
</tr>
<tr>
<td>At least one error</td>
</tr>
<tr>
<td>[50–57]</td>
</tr>
<tr>
<td>At least one device-dependent error</td>
</tr>
<tr>
<td>[10–14]</td>
</tr>
<tr>
<td>At least one critical error</td>
</tr>
<tr>
<td>[10–14]</td>
</tr>
<tr>
<td>GPs opinion (patient inhaled the right dose)</td>
</tr>
<tr>
<td>[77–83]</td>
</tr>
<tr>
<td>Overestimation by GPs</td>
</tr>
<tr>
<td>[8–13]</td>
</tr>
</tbody>
</table>

*p < 0.05 compared to the best result adjusted by age and gender. Results are mean % [IC 95%].

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At least one critical error according to age class

![Graph showing frequency of critical errors by device according to age class.]

**FIG. 1.** Frequency of critical errors by device according to age class.
Medical Personnel's Knowledge of and Ability to Use Inhaling Devices*

Metered-Dose Inhalers, Spacing Chambers, and Breath-actuated Dry Powder Inhalers

Nicola A. Hanania, M.D.; Richard Wittman; Steven Kesten, M.D., F.C.C.P.; and Kenneth R. Chapman, M.D., F.C.C.P.

Table 3—Percent Mean (± SD) Demonstration and Knowledge Scores*

<table>
<thead>
<tr>
<th>Knowledge Score</th>
<th>Demonstration Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MDI</td>
</tr>
<tr>
<td>RT</td>
<td>67 ± 5</td>
</tr>
<tr>
<td>RN</td>
<td>39 ± 7</td>
</tr>
<tr>
<td>MD</td>
<td>48 ± 7</td>
</tr>
</tbody>
</table>

*MDI = metered-dose inhaler; RT = respiratory therapist; RN = registered nurse; MD = house staff physician.

(Chest 1994; 105: 111-16)
Provider Knowledge is Low in 2013

- A questionnaire about inhaler use administered to 21 internal medicine residents
Provider Knowledge is Low in 2013

- Color images of six commonly used MDIs & DPIs were provided. Only **47%** were correctly identified.

- **57%** provided education by some method >**50%** of the time.

- **28%** were able to correctly list 4 of 7 steps considered crucial.

- **None** were able to list all steps.
Provider Knowledge is Low in 2013

- Constraints in educating patients:

- 91% reported that additional training would increase the frequency of patient teaching in their practice.
Improper Inhaler Technique is a Serious Problem

- **Devices vary**
  - Different types of inhalers require different techniques

- **Patients vary**
  - The ability to learn the correct inhaler technique

- **Teachings vary**
  - Lack of clear instructions on correct use of inhaler device
  - In 20-25% pts, total lack of instructions in some studies
What are the Major Issues?

- Too many inhaler devices - Complex instructions
  - Patient and provider knowledge needs improvement.
- Inhaling Skills can't be learned easily from written or verbal instructions
  - “only 21% of pts able to use MDI after reading package insert”
- Patient’s don’t fully recognize the importance of technique
- Busy providers – not able to devote the time needed
- Need reinforcement training to be maintain good technique
A New Approach to Asthma Inhaler Education Using Simulation Technology

**Common Problems**

- **Understanding Breathing patterns** – e.g. inability to operationalize “breathe out fully”, “slow and deep breath”

- **Verbal/Written Instructions, 1:1 Demonstration**
  - Access problems – busy healthcare providers
  - Written instruction not handy at time of inhaler use
  - Too many steps perceived too complicated, tedious, boring.
  - Not “cool” for younger subjects

- **Hand–Breath Coordination** – e.g. inability to identify the time point for MDI actuation in breathing cycle, stop inhaling with actuation
  - No self assessment in real time

- **Poor retention** of instructions, technique deterioration over time

- **Education** on key points

**Solution**

- Simulation with “How to Inhale” tool,
  - Internet/Mobile devices - anytime, anywhere
  - Simulation Instructor – “How to Use Inhaler” tool – Always available, inexpensive, Interactive, walks pt’s thru complex steps.
  - “Hi - Tech”

- **Practice tool using WEBCAM** – real time visual feedback enhances learning and self-efficacy

- Easy reinforcement of learning
  - “Assist me” tool

- “Take a Quiz”, Asthma education
www.use-inhalers.com

About Inhalers

Need for inhaler training:
- Errors in the inhalation technique have been reported to range up to 65% now. Not only various patients' characteristics but also the device that patients use to inhale the medicine has an effect on correct inhalation technique.
- Many patients derive incomplete benefit from their inhaled medication because they do not use their inhaler devices correctly or they fail to maintain the correct inhaler technique. This is clearly one of the major limitations in treating Asthma COPD and allergies.
- Further, there is evidence that the use of multiple inhaler types confuses the patient and increases the risk of errors in their inhaler use. In order to deal with it, there is a clear need for specific inhaler technique education and training of patients.

Choose your inhaler and start the training

Step 1: How to Inhale
- First learn how to breathe in correctly.
- The breathing instructor will teach you the right breathing technique.
- Synchronizing your breath with the breath bar tool will help to gain control on your breathing pattern.

Step 2: How to use inhalers
- Once you have learned the correct breathing technique, you need to learn how to use your inhaler device.
- The Doctor in this video will teach you the right inhaling steps.
- Follow each step with the Doctor to learn the right inhaler technique.

Step 3: Take a Quiz
- Test what you have learned and practiced by taking this quiz section.
- Understand the importance of the common mistakes while inhaling.
- Choose the right answers and get the useful tips to perfect your inhaling.

Step 4: Assist Me with inhalers
- Download Assist Me app for your inhaler from the app store.
- Get timely medicine reminders and audio instructions on each dosage.
- Never forget your inhaler technique.
Problem: Different breathing patterns needed

Solution: “How to Inhale” App

“Breath Bar” to pace breathing speed, identify the empty lung, full lung and correct actuation points.

Practice actuation with pen or empty inhaler.

Practice with WEBCAM
How to Inhale App

**How to Inhale for MDI Closed Mouth** is a simple 6 step activity.

- Learn and observe the instructor performing the steps in "Learn" mode
- Practice what you have learnt using the "Practice" mode

This activity involves syncing your breath with the following tools:

- **Tool 1**: The Instructor
- **Tool 2**: The Breath Bar
- **Tool 3**: The Audio
- **Tool 4**: Pressing of Inhaler
- **Tool 5**: Holding Breath
- **Tool 6**: Without Breath Bar

Continue
Problem: Different breathing patterns needed
Solution: “How to Use Inhaler” App

Step by Step demonstration.

Practice actuation with placebo or empty inhaler.

Practice with WEBCAM.
Problem: Different breathing patterns needed
Solution: “How to Use Inhaler” App
Problem: Understanding key aspects
Solution: “Take a Quiz”

Interactive questions, answers using animations
Problem: Understanding key aspects
Solution: “Take a Quiz”

What happens when?
You breathe in quickly and deeply
Problem: Poor retention
Solution: “Assist Me” App

App for smartphone, tablets – Complements and reinforces above, personalized care plan with reminders to improve adherence.
Take Home Messages - 1

1. A number of factors affect drug delivery to distal lung – Device type, particle size, device resistance, inspiratory flow, technique.

2. Proper drug selection for pt. should address these factors beyond pharmacologic class

3. Cost of poor inhaler technique is high – may become more important to providers with “pay for performance”

4. Current education methods (including no education) are not very successful
Take Home Messages - 2

1. Web/mobile device based patient education using simulation technology is likely to be more effective and accessible for teaching inhaler technique.

2. This may improve asthma outcomes, reduce healthcare costs, save time for busy providers – Outcomes studies needed.

3. Many potential ways to use the technology
   • Patient education – in provider office – “inhaler kiosk”, In patient, ER, Pharmacies, Patient home, schools
   • Provider Education – for office/hospital staff, accreditation requirements, CME,
   • Vision to allow physician’s computer (and care plan) to communicate with patient devices and vice versa.
“Management of chronic airways disease is 10% medication and 90% education.”

Which Intervention will be most effective in improving inhaler technique?

1. Repealing Obamacare
2. Increasing RT salaries
3. Patient Education
4. Don’t ask, Don’t tell approach
Is patient education always helpful?

- Proper education rather than any education (Like use-inhalers.com)
- Reinforcement
QUESTIONS?

http://www.use-inhalers.com/

How To Use Inhalers
Learn with engaging animations

Get Started by choosing your inhaler

Learn Quick Play

Learn and Practice Start

Learn In-Depth Start

MDI with Spacer

An interactive step by step instructions on how to properly use your inhaler.

Take an in-depth tour of how to inhale, how to use an inhaler and a quiz.

Subscribe
Get monthly updates on new releases

How to Use Inhalers
• An all in one app
• Available on the Chrome and iPad

Get our FREE Assist Me with Inhalers