“Inhalers: patients do the silliest things……..”

(Inhaler Devices and Inhaler Technique)

Tuesday 29th April 2008
Jon Bell
Who?

Pharmaceutical companies – sales & marketing, then clinical research

Medical device company – peak flow, spirometry, inspiratory (In-Check)

Present – independent research

“inspiratory” – measurement & training

(Asthmatic; triggers - cat dander + lime cordial)

Aims / Goal?

1. Promote improved care through better understanding of basic aerosol science and device characteristics
2. Minimise waste with inhaled drug therapies
3. Suggest that objective measurement of inhaler technique can help rationalise prescribing and improve patient outcomes.
Asthma and Pets

ALLERCA has produced the world’s first scientifically-proven hypoallergenic cats. These cats allow some of the millions of people with feline allergies to finally enjoy the love and companionship of a household pet without suffering from allergic symptoms.

CAT ALLERGIES

Commonest cause (up to 85%) for cat allergies found in association, allergy shots, and pharmaceuticals. This section provides more information on how to avoid the effects of the ALLERCA cats. The choice has been either to live without a pet or make considerable alterations to one’s living environment.

HYPO-ALLERGENIC CATS

ALLERCA has produced the world’s first scientifically-proven hypoallergenic cats. This section provides more information on how to ensure a pet that is hypoallergenic. This includes taking care of your own and your fellow neighbors. Visit the ALLERCA website for more information.

DEVELOPMENT

This ALLERCA research and development team has placed ALLERCA in a unique position to
Guideline recommendations
(NICE COPD 2004)

Chronic obstructive pulmonary disease
Management of chronic obstructive pulmonary disease in adults in primary and secondary care

Delivery systems
Inhalers
- Most patients, whatever their age, can learn how to use an inhaler unless they have significant cognitive impairment.
- Hand-held devices are usually best, with a spacer if appropriate. D
- If a patient cannot use a particular device, try another. D
- Teach technique before prescribing an inhaler, and check regularly. D
- Titrate the dose against response for each patient. D

...but what if the half the dose is wasted each time the inhaler is used....
UK: MDI and DPI Inhalation technique – inhalation too fast for pMDI, or too slow for DPI

- MDI: 59.5%
- Accuhaler: 4.9%
- Turbohaler: 14.2%
- HandiHaler: 57.0%

163 COPD patients
average age 72.5 years
FEV1 47.8% predicted

“How do you inhale” challenge

Quick test of how you would inhale through two commonly-used devices

• pMDI
• one of the DPI available

Need to:
1. Simulate resistance of device
2. Measure speed of inhalation

“How you would you (or how would you instruct the patient) to inhale through an MDI / DPI”

Single measurement
Health Professionals speed of inhalation when asked to inhale as if using an MDI - "Slowly and Deeply"

- 91 L/min and above (n=2825)
- 61 to 90 L/min (n=267)
- 60 L/min or less (n=179)

General Practitioners, Practice Nurses, Respiratory Nurses (Primary & Secondary Care), Pharmacists (Community, Retail and Hospital), Pharmacy Dispensers, Prescribing Advisors, Physiotherapists, Hospital Physicians (General Medicine and Thoracic), Pharmaceutical Company Employees (Representatives, Medical Advisors, Educational Staff)

Presented at ERS Annual Scientific Meeting, Stockholm 2007 (No. 91, Primary Care Day, 15/9/07): Jon Bell, Canday Medical Ltd. data collected between 1st June 2006 and 5th September 2007

Total = 3271 tests conducted: over 94% inhaled too fast
Asthmatics - speed of inhalation through Metered Dose Inhaler

Total = 476 individuals tested: over 92% inhaled too fast

Speed of inhalation

90 L/min or less  (n=36)

91 L/min and above  (n=440)

Why are there problems?

- **Design of inhalers vary**
  - Formulation of drug
  - Mechanical activation
    (passive MDI vs active DPI)
  - Internal resistance to airflow

- **Patients vary**
  - Pulmonary function
    (reversible Vs irreversible disease)
  - Ability to learn / be taught the correct technique
  - Physical size of lungs (child vs adult)
  - Effort varies from dose to dose

inappropriate selection and/or incorrect inhaler technique
Fate of inhaled drugs – Good Technique

- **Mouth pharynx**
  - Swallowed
  - 80% swallowed

- **GI tract**
  - Absorption from gut
  - 20% deposited in lung

- **Lungs**
  - Metabolism or absorption from the lung
  - 20%

- **Liver**
  - First-pass metabolism
  - Oral bioavailability

- **Systemic Circulation**

- **Mucociliary clearance**

**Summary:**
- 80% swallowed
- 20% deposited in lung
- 20% metabolism or absorption from the lung

Fate of inhaled drugs – *Poor* Technique

- **Swallowed**
  - 95%
  - Gastrointestinal tract
  - Deposited in lung
  - Metabolism or absorption from the lung
  - Absorption from gut
  - Liver
  - First-pass metabolism

- **Mouth pharynx**
  - 5%
  - Lungs
  - Mucociliary clearance
  - Oral bioavailability
  - Systemic circulation
External shape hides internal differences

High resistance

Low resistance
Mean resistance of various DPIs

How changes in inspiratory flow affect output

Inspiratory flow

Metered Dose Inhaler (MDI)

Dry Powder Inhaler (DPI)

Low

High

Lactose

Drug
How changes in inspiratory flow affect output
Aerosol Deposition at varying Particle Size

- Pharynx & Upper respiratory tract
- Optimal tracheobronchial deposition
- Optimal alveolar deposition
- Particles exhaled if <0.5 micron
Lower oropharyngeal deposition with HFA-BDP
Gamma scintigraphic lung images of single study volunteer after inhalation

C.L. Leach, P.J. Davidson, B.E. Hasselquist, R.J. Boudreau.
Poster Presentation, ATS 2000
Facio-Maxillary View (lateral) and Right Bronchogram

n.b. note the angles of the airways
Particle Deposition In Respiratory Tract

Three mechanisms of aerosol kinetics govern the majority of particle deposition within the respiratory tract.

1. Inertial impaction  2. Sedimentation  3. Diffusion

90%  9%  1%

Trachea
Bronchi
Bronchioles
Direction of flow
IMPACT
Particle Deposition In Respiratory Tract

Three mechanisms of aerosol kinetics govern the majority of particle deposition within the respiratory tract.

1. Inertial impaction  
   90%

2. Sedimentation  
   9%

3. Diffusion  
   1%

* Whitley Bay Smoke Chamber

Mass

Speed

Gravity

Brownian motion*

* Whitley Bay Smoke Chamber

Canday Medical Limited
What have sherbet fountains got in common with inhalers .......

Twisthaler

pMDI

Handihaler

Accuhaler

Turbohaler
Common mistakes
Errors in Technique

Too slow an inhalation (Dry powder inhaler)
Lung deposition from a DPI is influenced by inspiratory flow.

Dry Powder Inhaler (DPI)

Errors in Technique  No. 6

Poor coordination (Inhaling too fast)

Metered Dose Inhaler

Click here to play again
Lung deposition from pMDIs is influenced by inspiratory flow


Total lung deposition (% of inhaled dose)

- 20% VC
- 50% VC
- 80% VC

30L/min 90L/min

10 second breath hold

Metered Dose Inhaler (MDI)
Errors in Technique

No. 3

Not using a Spacer as directed
Spacer Devices – How they help

1. Capture aerosol avoiding coordination problems
2. Reduces large aerosol particles (associated with s/e)
Errors in Technique  No. 2

Asthma patient audit: 1 patient, Male 55yr
28 salbutamol MDI Rx in last 12 months
2000 mcg BDP
Poor inhaler technique
L. Vol. Spacer repeatedly prescribed
Application of device information and ability to measure speed of inhalation
Please tell me the right technique for each of the inhalers below……

Aerosol produced for you –
inhale SLOWLY
Please tell me the right technique for each of the inhalers below……

You create aerosol –
inhale FORCEFULLY
Respimat®
Boehringer Ingelheim’s New Generation Inhaler
“SMI” (Soft Mist Inhaler)

1. **Cloud duration** of 1.5 seconds

2. **Velocity of cloud** many times slower than pMDI

3. **High fine particle fraction** enables therapy to reach deep into lungs
Tiotropium
Via HandiHaler (DPI) or Respimat “SMI” (Soft Mist Inhaler) ?

If they cost the same – which device is best for your patients?
Respimat®
How to get the best from the new “SMI” (Soft Mist Inhaler)

1. Rotate lower housing through 180° until it clicks
2. Open lid to reveal mouthpiece
3. Exhale fully
4. Place mouthpiece in mouth, seal lips around (avoid blocking vents)
5. Start to breathe in SLOWLY, and press the dose-release button
6. Continue to breathe in SLOWLY for 2 seconds
7. Hold your breath for a count of 10 (or as long as is comfortable)
8. Breathe normally again
Aerosol Generation
Inhaler Devices

Energy from device

Metered Dose Inhalers
- Threshold release
  - With or without Spacer
- Manual release
  - With or without Spacer

Nebulisers
- Compressed Air
  - Standard or “breath-enhanced”
- Ultrasonic
  - Direct or Indirect

Soft Mist Inhalers
- Coiled Spring

Dry Powder Inhalers
- Passive release
  - Multiple or Single Dose
- Threshold release

Energy from patient

Respimat

Aerosol produced for you – inhale SLOWLY

( Upper and Lower Sections of Case )

You create aerosol – inhale FORCEFULLY
Errors in Technique

No. 5

Priming in the wrong position

**MDI** — priming for next dose occurs when canister is depressed

**DPI** — device designed to prime correctly when horizontal / vertical.

e.g. Accuhaler – hold horizontally
    Turbohaler – hold vertically
Errors in Technique

No. 5

How to use each device?

HandiHaler

Respimat
Errors in Technique

No. 4

Misunderstandings

• Where the drug needs to go to work

• How to look after the inhaler

• What not to do
Errors in Technique  No. 1

The way we teach

The way others learn

Our understanding of what’s important

How much time we set aside

What we want to achieve

“Tell me and I’ll forget.
Show me and I’ll remember
Involve me and I will understand”
(Traditional Chinese Proverb)
Assessment & Training Devices
Monitoring inspiratory flow rate through the device

- Vitalograph’s Aerosol Inhalation Monitor (AIM)
- Clement Clarke’s In-Check and In-Check DIAL
- Fyne Dynamic’s MagFlo
- Canday Medical’s “2-Tone” Trainer
  (www.2ToneTrainer.com)

- 60 L/min
- 35 L/min
- Schering-Plough’s Twisthaler Trainer
- AstraZeneca’s Turbenthaler Usage Trainer & Turbutesters
1. Turn the DIAL to select the inhaler resistance

(Diskus / Accuhaler) Multiple-dose powder inhaler

(Common pMDI) Metered Dose Inhaler and MDI spacers with low resistance (e.g. AbleSpacer)

(Easibreathe) Automatic pMDI

(Turbuhaler) Turbulent flow inhaler

(Autohaler) Automatic pMDI
2. Measure, then compare the inspiratory flow achieved with the optimum recommended for that device.

<table>
<thead>
<tr>
<th>Device</th>
<th>Optimum Inspiratory Flow Range (l/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple-dose powder inhaler</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>Accuhaler</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
<tr>
<td>Turbulent flow inhaler</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>(old style) Turbuhaler®</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
<tr>
<td>Turbulent flow inhaler</td>
<td><img src="image3.png" alt="Image" /></td>
</tr>
<tr>
<td>(Symbicort®) Turbuhaler®</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
<tr>
<td>Auto inhaler</td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
<tr>
<td>Autohaler®</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
<tr>
<td>Auto inhaler</td>
<td><img src="image5.png" alt="Image" /></td>
</tr>
<tr>
<td>Easi-Breathe®</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
<tr>
<td>Multiple-dose powder inhaler</td>
<td><img src="image6.png" alt="Image" /></td>
</tr>
<tr>
<td>Clickhaler®</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
<tr>
<td>Low-resistance aerosol</td>
<td><img src="image7.png" alt="Image" /></td>
</tr>
<tr>
<td>pMDI</td>
<td>10 20 30 40 50 60 70 80 90 100 110</td>
</tr>
</tbody>
</table>

"Optimum" or "Effective"
AQLQ improvement without therapeutic change

0.5 change regarded as of clinical significance (Juniper et al, 1994)

Control
Verbal counseling
2Tone Trainer

Asthma Quality of Life Questionnaire (Juniper et al, 1999)

Inhale Too Fast…. (e.g. pMDI)

High-speed aerosol cloud impacts in oropharynx
Inhale Too Slowly…. (e.g. DPI)

Reduced emitted dose and quality of aerosol at low speed
Inhale Optimally (e.g. pMDI)

Optimal PIF for inhaler efficiency and aerosol dynamics
Points to take away?

1. **Different types of inhalers require different techniques** to get the full dose to the lungs, and minimise side-effects and waste.

2. **Speed of inhalation** changes device efficacy and deposition, and is affected by device resistance, effort of inhalation and disease.

3. **Many patients do not use their existing inhalers to best effect**; consider other inhaler designs and different ways of teaching technique to improve outcomes and reduce waste.
Poor Technique?

Misunderstanding by patient?
Could our explanation be better?

Jon Bell
Canday Medical Ltd.

For a copy of these slides, wait 24 hours, then visit
www.2ToneTrainer.com