Digital Approaches to Promote Adherence to Treatments and Patient Education

Dr Omar S Usmani, MBBS PhD FHEA FRCP FERS
Reader in Respiratory Medicine, Imperial College London
& Consultant Physician, Royal Brompton Hospital

Head of ERS Assembly 5: Airway Diseases, Asthma, COPD, Chronic Cough

Digital Respiratory Medicine – Realism v Futurism
A Digital Health Summit of the ERS
Faculty Disclosure

Research Funding, Advisory Boards, Symposia Talks

- Astra Zeneca
- Boehringer Ingelheim
- Chiesi
- Cipla
- Covis
- GlaxoSmithKline
- Menarini
- Mereo Biopharma
- Mundipharma
- NAPP
- Novartis
- Orion
- Pfizer
- Roche
- Sandoz
- Trudell Medical
- Takeda
- UCB

I have no shares in any pharmaceutical company
I have no relationship of any kind with the tobacco industry
Digital Approaches to Promote Adherence to Treatments and Patient Education

**AIMS & OBJECTIVES**

*Understand*
current data in digital approaches to promote treatment adherence

*Identify*
digital technologies in patient education and feedback

*Appreciate*
the future challenges for digital health
Suboptimal Treatment Adherence is Common and Associated with Poor Disease Control and Outcomes\(^1\)\(^-\)\(^3\)

<table>
<thead>
<tr>
<th>Asthma</th>
<th>COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Real-life adherence rates range from 8 - 70%(^5-7)</td>
<td>• Real-life adherence rates range from 20 - 60%(^9)</td>
</tr>
<tr>
<td>• Low treatment adherence is associated with an increased risk of severe exacerbations(^4)</td>
<td>• Low treatment adherence is associated with increased mortality(^8)</td>
</tr>
</tbody>
</table>

Monitoring medication use remotely to identify those patients poorly controlled in need of additional attention to help to achieve better disease control.
Inhaler Sensors Can Improve Adherence in Asthma

RCT N=220 children (6-15y) with asthma randomized to receive preventer ICS inhaler sensor

Audio-visual reminder functions

enabled n=110

disabled n=110


Adherence

84% (reminder enabled) vs. 30% (reminder disabled) \( p < 0.0001 \)

Proportion of patients (%)
Inhaler Sensors Can Improve Outcomes in Asthma

RCT N=220 children (6-15y) with asthma randomized to receive preventer ICS inhaler sensor

Audio-visual reminder functions enabled n=110
Audio-visual reminder functions disabled n=110

Adherence

84% (reminder enabled) vs. 30% (reminder disabled) \( p < 0.0001 \)

Intervention may be beneficial for improving asthma control where poor asthma control is related to poor adherence

Asthma control (secondary endpoint) improved significantly

**STAAR trial** of electronic adherence monitoring, with reminder alarms and feedback, for poorly controlled asthma

N=90 children (6-16) with asthma randomized to receive inhaler sensor
- Reminder alarm enabled
- Adherence data reviewed with HCP n=47
- Reminder alarm disabled
- Adherence data not reviewed with HCP n=43

**Missed on its primary outcome of ACQ**
- But, significantly fewer courses of OCS
- Fewer hospital admissions

Incidence rate ratio 1.53 (95% CI 1.11, 2.11); p = 0.008

**Number of courses of oral corticosteroids (OCS)**

- Inhaler sensor enabled
- Inhaler sensor disabled
STAAR trial of electronic adherence monitoring, with reminder alarms and feedback, for poorly controlled asthma

Table 5  Broken, forgotten and lost devices

<table>
<thead>
<tr>
<th></th>
<th>Intervention (47 participants)</th>
<th>Control (42 participants)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device reported as ‘broken’ by child</td>
<td>23 (50%)</td>
<td>8 (19%)</td>
</tr>
<tr>
<td>Devices damaged beyond repair (when inspected by study team, requiring replacement device)</td>
<td>17 (37%)</td>
<td>2 (5%)</td>
</tr>
<tr>
<td>Participant forgot to bring device to clinic</td>
<td>10 (22%)</td>
<td>18 (43%)</td>
</tr>
<tr>
<td>Device lost completely</td>
<td>5 (11%)</td>
<td>2 (5%)</td>
</tr>
</tbody>
</table>

When overtly monitored, more likely to report broken, forgotten, lost device as the approach was disliked ... deliberate?
Errors in Inhaler Technique have a Significant Association with Poor Disease Outcomes and Greater Health-economic Burden

Critical inhaler errors in asthma and COPD: a systematic review of impact on health outcomes

Omar Sharif Usmani¹, Federico Lavorini³, Jonathan Marshall², William Christopher Nigel Dunlop², Louise Heron³, Emily Farrington⁴ and Richard Delkhijzen⁵

**Background:** Inhaled drug delivery is the cornerstone treatment for asthma and chronic obstructive pulmonary disease (COPD). However, use of inhaler devices can be challenging, potentially leading to critical errors in handling that can significantly reduce drug delivery to the lungs and effectiveness of treatment.

**Methods:** A systematic review was conducted to define ‘critical’ errors and their impact on health outcomes and resource use between 2004 and 2016, using key search terms for inhaler errors in asthma and COPD (Search-1) and associated health-economic and patient burden (Search-2).

**Results:** Search-1 identified 62 manuscripts, 47 abstracts, and 5 conference proceedings (n=114 total). Search-2 identified 9 studies. We observed 299 descriptions of critical errors; age, education status, previous inhaler instruction, comorbidities and socioeconomic status were associated with worse handling error frequency. A significant association was found between inhaler errors and poor disease outcomes (exacerbations), and greater health-economic burden.

**Conclusions:** We have shown wide variations in how critical errors are defined, and the evidence shows an important association between inhaler errors and worsened health outcomes. Given the negative impact diminished disease outcomes impose on resource use, our findings highlight the importance of achieving optimal inhaler technique, and a need for a consensus on defining critical and non-critical errors.

**Keywords:** Obstructive lung diseases, Adherence, Errors, Aerosols, Inhalers

Usmani OS et al, Resp Res 2018
Objective E-Measurement of Inhaler Technique

INCA™ Technology: Identifying Inhaler Technique Errors

Frequency of DPI error type (%)

- Low PIFR (<35 L/min): 48%
- Multiple inhalations: 23%
- Multiple errors: 11%
- Blister present, no inhale detected: 7.4%
- Exhaling into the mouthpiece: 5.4%
- Others: 5%

Electronic acoustic recording device attached to DPI

Sulaiman I et al, AJRCCM 2017
Monitored adherence, including inhaler technique and regularity of use, with personalised (bio)feedback on inhaler use, significantly increased and sustained adherence in patients with severe uncontrolled asthma.

Clinical outcomes at the end of the study show that after the monitored adherence programme, only 27% of patients needed additional medication as the next step.
AIM: Determine perspectives of asthma patients and HCPs on the use and functionality of mHealth systems for asthma self-management
What *Patients* would like from an mHealth system? *A Device / system* ...

1... to help patients monitor their asthma over time
2... to collect data that patients can show their doctor/healthcare professional to demonstrate how their asthma has been
3... that detects and alerts patients and/or healthcare professionals to a deterioration in their asthma control before they would normally notice
   ... that can take measurements and update a patient's medical record
   ... that offers advice regarding when additional medical attention should be sought
   ... that can be used to call for emergency help during an asthma attack
   ... for patients to use as their asthma action plan
   ... that provides instructions on how to manage their asthma in an emergency
   ... to record treatment side effects
   ... that can tell if changes to patient's asthma medication have improved their asthma control
   ... that could replace routine (e.g. annual) asthma check-ups
   ... to offer educational materials about asthma

*Sequential exploratory mixed methods study using focus groups and online questionnaires in 186 patients with asthma and 63 HCPs*

*Simpson A et al, ERJ 2017*
### What HCPs believe would be useful functions in an mHealth system?

A Device/system...

<table>
<thead>
<tr>
<th>Function</th>
<th>Proportion of Patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1... that offers advice regarding when additional medical attention should be sought</td>
<td>* significant difference vs patients (p &lt; 0.05)</td>
</tr>
<tr>
<td>2... that detects and alerts patients and/or healthcare professionals to a deterioration in their asthma control before they would normally notice</td>
<td>*</td>
</tr>
<tr>
<td>3... that provides instructions on how to manage their asthma in an emergency</td>
<td>*</td>
</tr>
<tr>
<td>... to help patients monitor their asthma over time</td>
<td>*</td>
</tr>
<tr>
<td>... for patients to use as their asthma action plan</td>
<td>*</td>
</tr>
<tr>
<td>... to collect data that patients can show their doctor/healthcare professional, to demonstrate how their asthma has been</td>
<td>*</td>
</tr>
<tr>
<td>... that can tell if changes to patient’s asthma meds have improved their asthma control</td>
<td>*</td>
</tr>
<tr>
<td>... to offer educational materials about asthma</td>
<td>*</td>
</tr>
<tr>
<td>... that can be used to call for emergency help during an asthma attack</td>
<td>*</td>
</tr>
<tr>
<td>... that can take measurements and update a patient’s medical record</td>
<td>*</td>
</tr>
<tr>
<td>... to record treatment side effects</td>
<td>*</td>
</tr>
<tr>
<td>... that could replace routine (e.g. annual) asthma check-ups</td>
<td>*</td>
</tr>
</tbody>
</table>

Sequential exploratory mixed methods study using focus groups and online questionnaires in 186 patients with asthma and 63 HCPs

Simpson A et al, ERJ 2017
“It would be handy having an app so that you can monitor (asthma) yourself... to show your consultant and respiratory nurse exactly how your asthma has been... because often when they ask you can’t remember”. [Patient #7, London]

“It's a very powerful tool to be able to show (patients) the data and say this is what is happening... rather than just saying you've got to keep taking your medication... you are empowering them with their treatment”. [HCP #3]
Asthma patients *less likely than HCPs* to believe measuring adherence, inhaler technique, respiratory symptoms could help them achieve better asthma control.

**Simpson A et al, ERJ 2017**

Which of the following measurements do you think could help you/your patients achieve better asthma control?

<table>
<thead>
<tr>
<th>Response options</th>
<th>Asthma</th>
<th>HCPs</th>
<th>p-value</th>
<th>Asthma Uncontrolled</th>
<th>Controlled</th>
<th>p-value*#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurements of environment conditions (e.g. pollution, allergens, temperature and humidity)</td>
<td>70</td>
<td>68</td>
<td>0.81</td>
<td>75</td>
<td>65</td>
<td>0.16</td>
</tr>
<tr>
<td>Measurements of lung function (e.g. peak flow and measurements of airway inflammation)</td>
<td>71</td>
<td>75</td>
<td>0.58</td>
<td>71</td>
<td>70</td>
<td>0.82</td>
</tr>
<tr>
<td>Measurements of breathing (e.g. breathing rate and details of how often you cough)</td>
<td>64</td>
<td>60</td>
<td>0.60</td>
<td>68</td>
<td>60</td>
<td>0.29</td>
</tr>
<tr>
<td>Measurements of heart rate and activity levels</td>
<td>46</td>
<td>37</td>
<td>0.18</td>
<td>49</td>
<td>43</td>
<td>0.39</td>
</tr>
<tr>
<td>Measurements of stress levels</td>
<td>53</td>
<td>37</td>
<td>0.03</td>
<td>57</td>
<td>49</td>
<td>0.27</td>
</tr>
<tr>
<td>Measurements of medication adherence</td>
<td>48</td>
<td>89</td>
<td>&lt;0.001</td>
<td>52</td>
<td>44</td>
<td>0.32</td>
</tr>
<tr>
<td>Measurements of inhaler technique</td>
<td>42</td>
<td>87</td>
<td>&lt;0.001</td>
<td>43</td>
<td>43</td>
<td>0.98</td>
</tr>
<tr>
<td>Measurements of diet</td>
<td>32</td>
<td>32</td>
<td>0.94</td>
<td>36</td>
<td>24</td>
<td>0.09</td>
</tr>
<tr>
<td>Measurements of quality of sleep</td>
<td>54</td>
<td>44</td>
<td>0.20</td>
<td>58</td>
<td>48</td>
<td>0.16</td>
</tr>
<tr>
<td><a href="#">Measurements of self-reported symptoms</a></td>
<td>34</td>
<td>57</td>
<td>&lt;0.001</td>
<td>40</td>
<td>30</td>
<td>0.19</td>
</tr>
</tbody>
</table>
Asthma patients *less likely than HCPs* to believe measuring adherence, inhaler technique, respiratory symptoms could help them achieve better asthma control.

Which of the following measurements do you think could help you/your patients achieve better asthma control?

<table>
<thead>
<tr>
<th>Response options</th>
<th>Asthma</th>
<th>HCPs</th>
<th>p-value</th>
<th>Asthma</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurements of environment conditions (e.g., pollution, allergens, temperature and humidity)</td>
<td>70</td>
<td>68</td>
<td>0.81</td>
<td>75</td>
<td>65</td>
</tr>
<tr>
<td>Measurements of lung function (e.g., peak flow and measurements of airway inflammation)</td>
<td>71</td>
<td>75</td>
<td>0.58</td>
<td>71</td>
<td>70</td>
</tr>
<tr>
<td>Measurements of breathing (e.g., breathing rate and details of how often you cough)</td>
<td>64</td>
<td>60</td>
<td>0.60</td>
<td>68</td>
<td>60</td>
</tr>
<tr>
<td>Measurements of heart rate and activity levels</td>
<td>46</td>
<td>37</td>
<td>0.18</td>
<td>49</td>
<td>43</td>
</tr>
<tr>
<td>Measurements of stress levels</td>
<td>53</td>
<td>37</td>
<td>0.03</td>
<td>57</td>
<td>49</td>
</tr>
<tr>
<td><strong>Measurements of medication adherence</strong></td>
<td>48</td>
<td>89</td>
<td>&lt;0.001</td>
<td>52</td>
<td>44</td>
</tr>
<tr>
<td><strong>Measurements of inhaler technique</strong></td>
<td>42</td>
<td>87</td>
<td>&lt;0.001</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Measurements of diet</td>
<td>32</td>
<td>32</td>
<td>0.94</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>Measurements of quality of sleep</td>
<td>54</td>
<td>44</td>
<td>0.20</td>
<td>58</td>
<td>48</td>
</tr>
<tr>
<td><strong>Measurements of self-reported symptoms</strong></td>
<td>34</td>
<td>57</td>
<td>&lt;0.001</td>
<td>40</td>
<td>30</td>
</tr>
</tbody>
</table>

Data security was a common theme across focus groups. Patients expressed opposing views with regards to data security, with some patients unconcerned with how their data was managed and some insistent that data security is of utmost importance. Participants of the focus groups expressed unanimous support for their data to be used in an anonymous format for research purposes, whilst questionnaire results suggest just over half (58%) of patients were happy for anonymous data to be used for research purposes.
Patient Trust: Digital Health - A Brave New World?

Symposium: Digital Health: a brave new world?

Let’s start with the end user:
Patients and digital: impact on patient’s life and care

Dominique Hamerlijnck, MPhil, MBA, EUPATI fellow
Patient expert, person with severe asthma

ERS Congress 2020
Are decision makers rushing to introduce tele-monitoring in pressure to reduce hospitalisations without weighing up all the evidence?

"It’s not that I don’t think technology has potential. It does. But we need high quality evidence, which should mean high quality trials”

Studies are of moderate quality
- Short term (< 3 - 6 months)
- Show high heterogeneity in study end-points
- Varied study designs, difficult to compare
- Lack of defining minimal clinical difference (MCID) \textit{a priori}

We need high quality evidence

Margaret McCartney: Innovation without sufficient evidence is a disservice to all

\textit{McCartney, BMJ 2017}
Aim: To evaluate the impact of an enhanced adherence package (inhaled dual bronchodilator + add on inhaler sensor + mobile app) on time to treatment failure and other clinical outcomes in exacerbating COPD patients with poor adherence to mono or dual therapy over 1 year

Key inclusion criteria:
- COPD diagnosis
- ≥2 COPD exacerbations in the last 24 months
- Smoking history
- Poor adherence to single/dual COPD therapy
Using Virtual Consultations in the Fight Against COVID-19

Greenhalgh T, The Health Foundation Mar 2020

News

Millions of patients benefiting from remote consultations as family doctors respond to COVID-19

28 May 2020

Emergency Preparedness, Resilience and Response: General practice | Primary care

Millions of patients have been getting expert support from family doctors from the comfort of their own homes while the NHS responds to COVID-19.

Education and Training of Patients

https://www.asthma.org.uk/advice/inhaler-videos/
Inhaler Adherence During COVID-19 Pandemic

Using electronic medication data on controller medication there were positive increases (~15%) in medication adherence

- Digital inhaler tracker
- US study, Jan-Mar 2020
- n= 7578, 77% asthma
- Assess 75% adherence to controller medication

Kaye et al, JACI in Practice 2020
Delivering Health Education to HCPs During a Pandemic in LMICs

Locally appropriate blended-learning technologies requiring minimal data, power and IT skills exist and can be widely used

In LMICs, traditional face-to-face healthcare education is:
- resource intensive
- low impact
- time and cost prohibitive

Online training is difficult re:
- cost & availability of mobile data
- IT hardware
- electricity
- expert tutors

The system overcomes many of the practical obstacles encountered in providing large scale health education allowing high quality teaching, in sustainable programmes with inbuilt rigorous and rapid evaluation.

Rupert Jones et al 2021, in submission
ERS publishes position statement on asthma and environment
Digital Approaches to Promote Adherence to Treatments and Patient Education

**SUMMARY**

*Understand* current data in digital approaches to promote treatment adherence

*Identify* digital technologies in patient education and feedback

*Appreciate* the future challenges for digital health
Digital Approaches to Promote Adherence to Treatments and Patient Education

Dr Omar S Usmani, MBBS PhD FHEA FRCP FERS
Reader in Respiratory Medicine, Imperial College London
& Consultant Physician, Royal Brompton Hospital
Head of ERS Assembly 5: Airway Diseases, Asthma, COPD, Chronic Cough

Digital Respiratory Medicine – Realism v Futurism
A Digital Health Summit of the ERS