

Digital Approaches to Promote Adherence to Treatments and Patient Education

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Imperial College
London



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

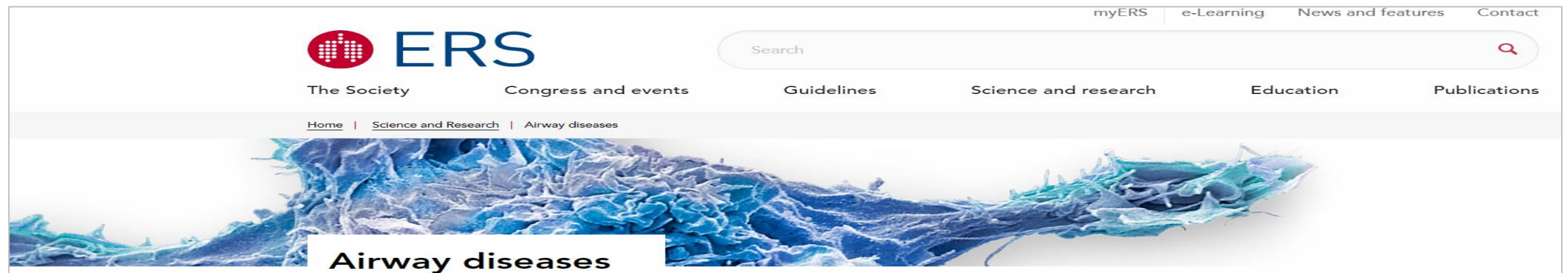
current data in digital approaches to promote treatment adherence

Identify

digital technologies in patient education and feedback

Appreciate

the future challenges for digital health



The screenshot shows the top portion of the European Respiratory Society (ERS) website. At the top right, there are links for [myERS](#), [e-Learning](#), [News and features](#), and [Contact](#). The ERS logo, consisting of a red grid icon and the letters "ERS", is on the left. Below the logo are navigation links: [The Society](#), [Congress and events](#), [Guidelines](#), [Science and research](#), [Education](#), and [Publications](#). A search bar with the text "Search" and a magnifying glass icon is positioned to the right of the logo. Below the navigation is a breadcrumb trail: [Home](#) | [Science and Research](#) | [Airway diseases](#). The main banner features a blue, textured image of airway tissue with a white box at the bottom containing the text "Airway diseases".

Suboptimal Treatment Adherence is Common and Associated with Poor Disease Control and Outcomes¹⁻³

Asthma

- Real-life adherence rates range from

8 - 70%⁵⁻⁷

- Low treatment adherence is associated with an increased risk of severe exacerbations⁴

COPD

- Real-life adherence rates range from

20 - 60%⁹

- Low treatment adherence is associated with increased mortality⁸

1. Global Initiative for Asthma (GINA). <http://ginasthma.org>; 2. Melani AS et al, *Resp Med* 2011; 3. Murphy AC et al, *Thorax* 2012; 4. Engelkes M et al, *ERJ* 2015; 5. Breekveldt-Postma NS et al, *Pharmacoepi Drug Saf* 2008; 6. Rand CS et al, *AJRCCM* 1994; 7. Horne R. *CHEST* 2006; 8. Vestbo J et al, *Thorax* 2009; 9. Moran C, et al. *Psychology & Health*. 2017

The Focus of Digital Technology



Monitoring medication use remotely to identify those patients poorly controlled in need of additional attention to help to achieve better disease control

The Digital Asthma Patient: The History and Future of Inhaler Based Health Monitoring Devices

Kikidis et al, JAMPDD 2016, Vol 29; No. 3

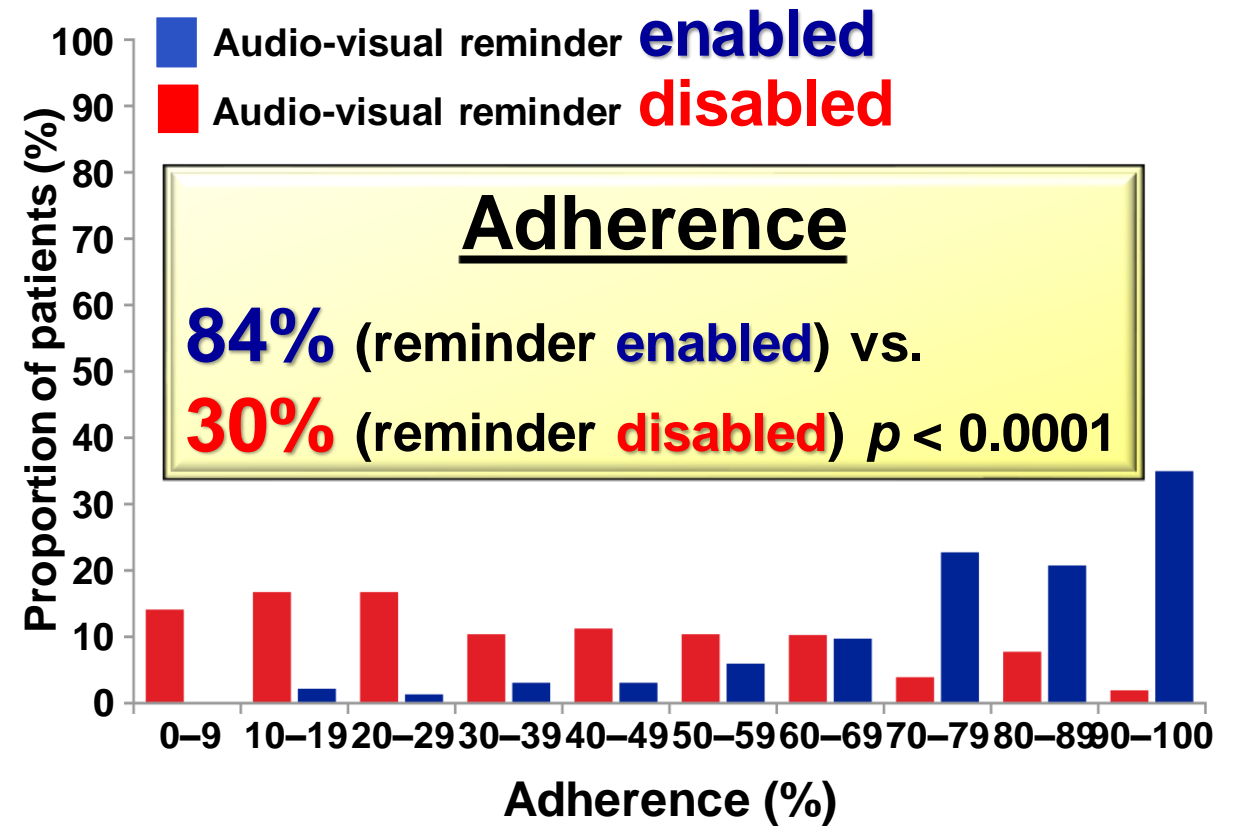
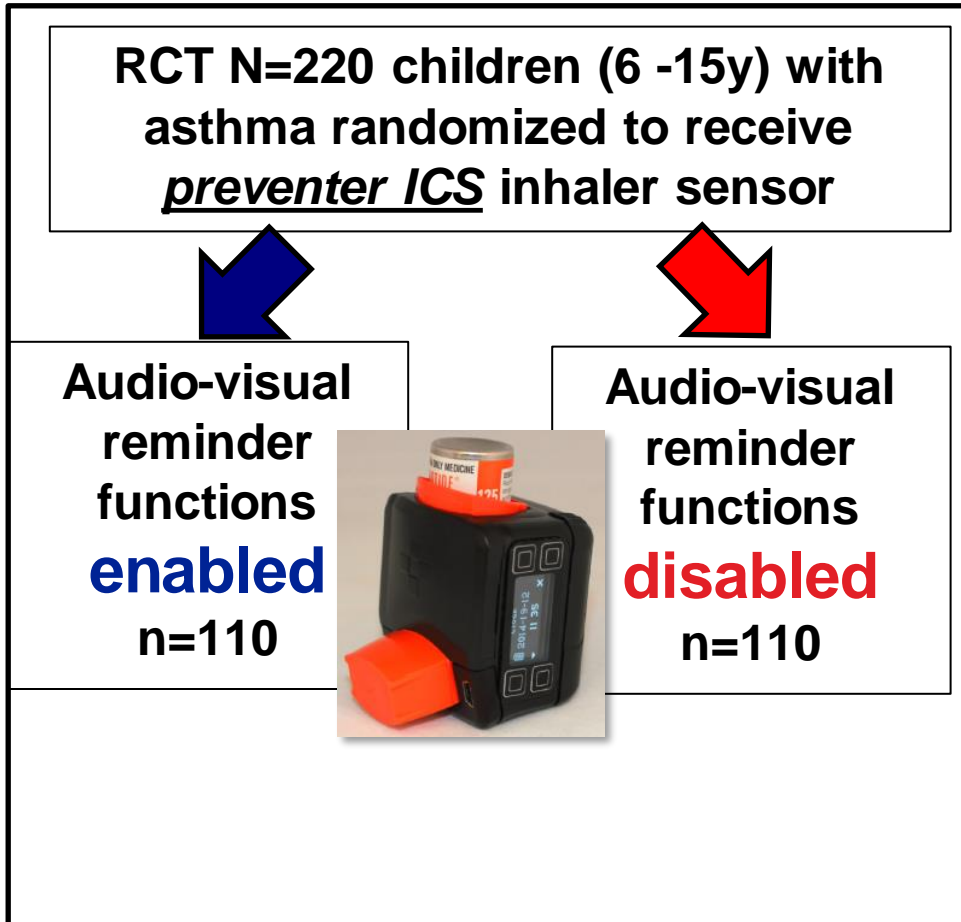
Monitoring components

Self-management components

	myAirCoach	Sensohaler	Propeller	Chameleon	GeckoCap	SmartInhaler	T-haler
Time Tracking of Inhaler Use	✓	✓	✓	✓	✓	✓	✓
Location Tracking of Inhaler Use	✓	✓	✓	✓	✓	✓	✗
Proper Inhaler Device Use	Acoustical Sensing	Acoustical Sensing	✗	✗	✗	✗	Accelerometer Inhalation flow
Environment Sensing	Temp. Humid. Pollut.	✗	✗	✗	✗	✗	✗
Clinical State Monitoring	FeNO, PH, Acoustic (Wheeze)	✗	✗	✗	✗	✗	✗
Lifestyle Monitoring	Accelerometer Pedometer	✗	✗	✗	✗	✗	✗
Reminders	✓	✓	✓	✓	✓	✓	✓
Doctor/Patient Communication	Collaboration on community basis	✓	✓	✓	✓	✗	✗
Information Visualization	Novel Visual Analytics	✗	✗	✗	✗	✗	✗
Predictive Decision Support	Doctor and Patient Support	✗	✗	✗	✗	✗	✗
Education and Feedback Support	Risks, Medication and Devices	✗	✗	Child Oriented Gamification	Child Oriented Gamification	✗	✗
Patient and Lung Function Models	Novel modeling approaches	✗	✗	✗	✗	✗	✗
Customised/Personalised Treatment	Co-design of interventions	✗	✗	✗	✗	✗	✗
Patient Community Platform	mHealth2.0 Support	✗	✗	✗	✗	✗	✗

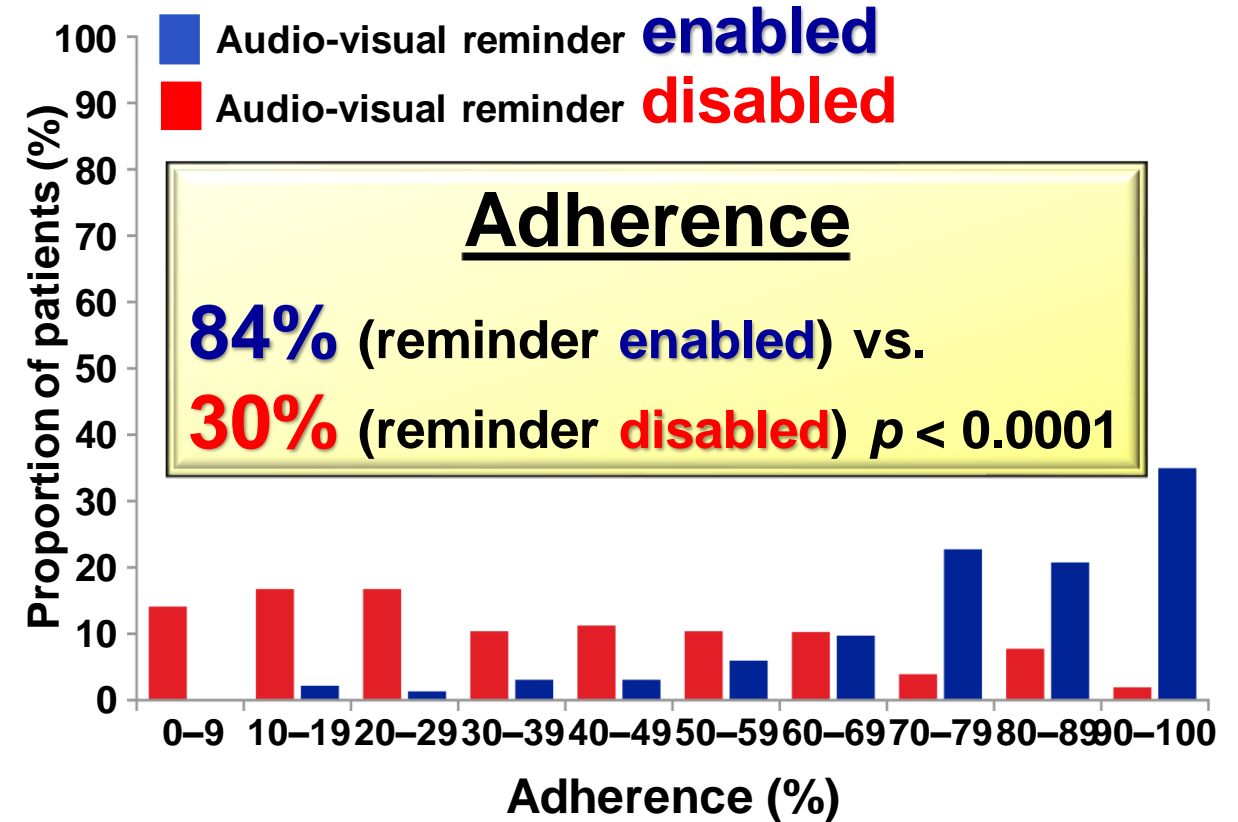
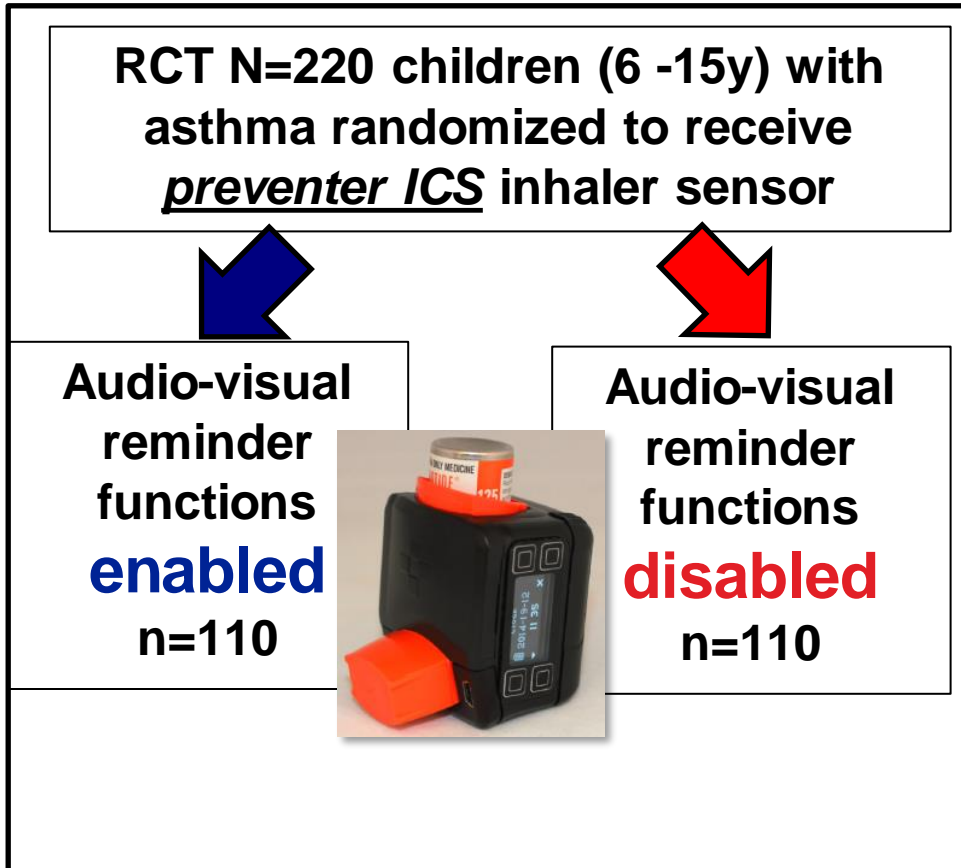
Inhaler Sensors Can Improve Adherence in Asthma

Chan AHY et al, Lancet Res Med 2015; 3:210-9



Inhaler Sensors Can Improve Outcomes in Asthma

Chan AHY et al, Lancet Res Med 2015; 3:210-9



Asthma control (secondary endpoint) improved significantly

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

Inhaler Sensors Can Improve Outcomes in Asthma

Morton RW et al. Thorax 2017;72:347-54

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

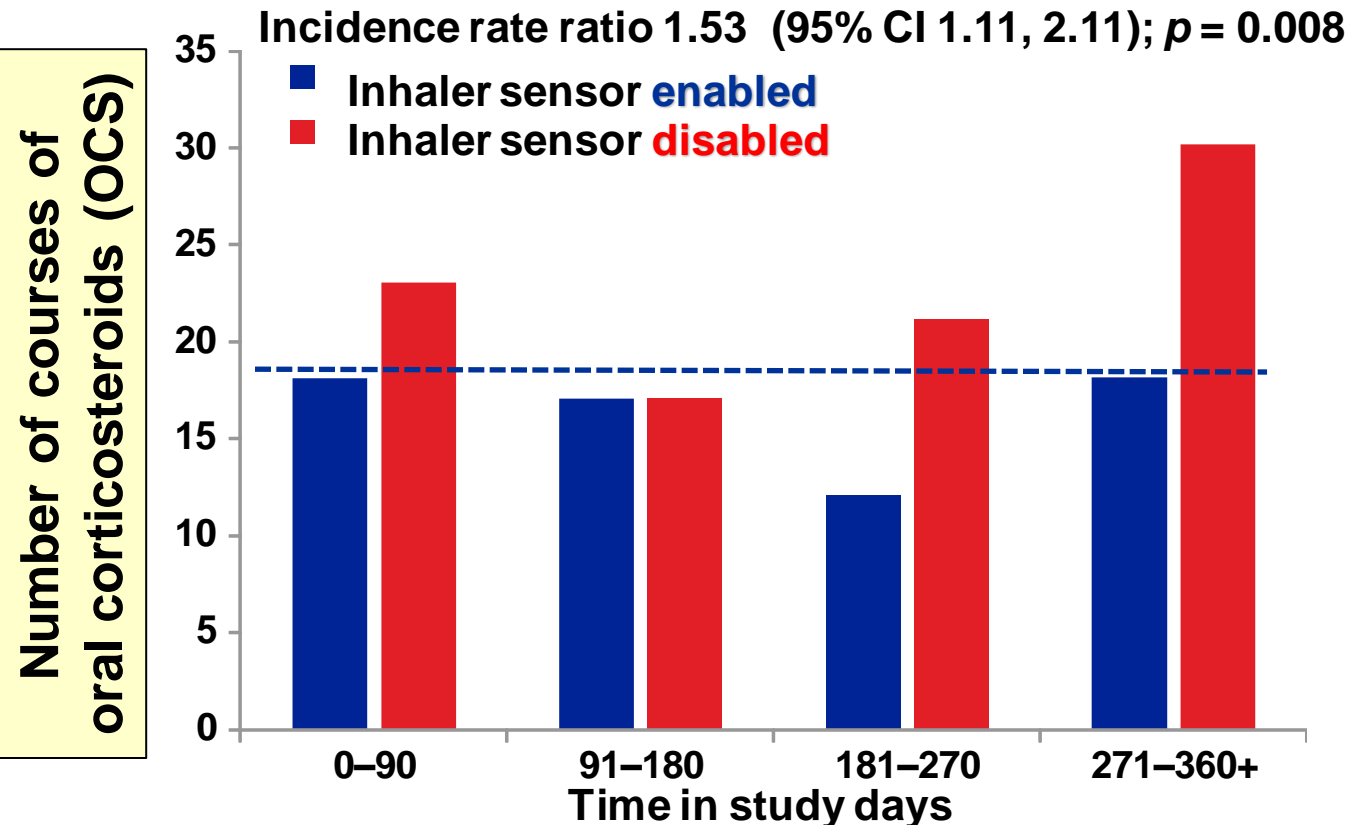
sensor

- 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



However

Morton RW et al. Thorax 2017;72:347–54

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

When overtly monitored, more likely to report broken, forgotten, lost device as the approach was disliked ... deliberate?

Table 5 Broken, forgotten and lost devices

	Intervention (47 participants)	Control (42 participants)
Device reported as 'broken' by child	23 (50%)	8 (19%)
Devices damaged beyond repair (when inspected by study team, requiring replacement device)	17 (37%)	2 (5%)
Participant forgot to bring device to clinic	10 (22%)	18 (43%)
Device lost completely	5 (11%)	2 (5%)



Not Just Monitoring Adherence - Also Inhaler Technique

Errors in Inhaler Technique have a Significant Association with Poor Disease Outcomes and Greater Health-economic Burden

REVIEW

Open Access

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



Omar Sharif Usmani^{1*}, Federico Lavorini², Jonathan Marshall³, William Christopher Nigel Dunlop³, Louise Heron⁴, Emily Farrington⁴ and Richard Dekhuijzen⁵

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 error. 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.

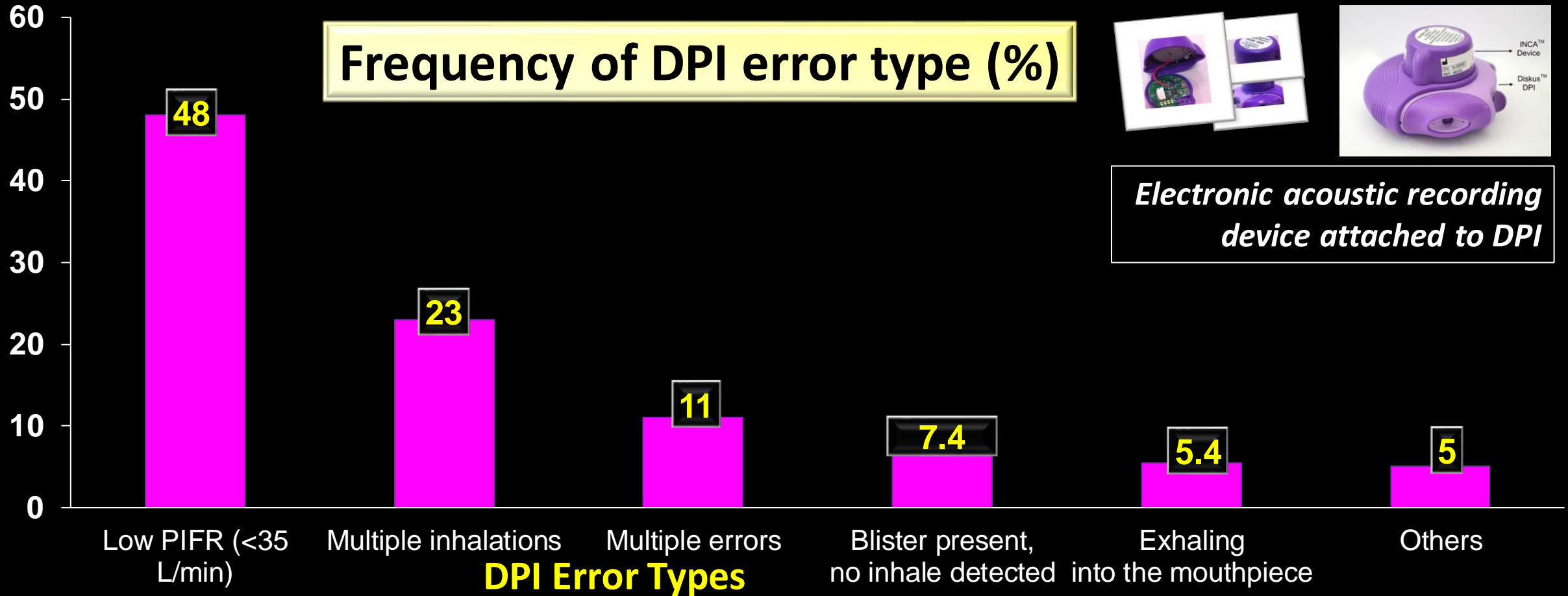
Keywords: Obstructive lung diseases, Adherence, Errors, Aerosols, Inhalers

Usmani OS et al, Resp Res 2018

Objective E-Measurement of Inhaler Technique

INCA™ Technology : Identifying Inhaler Technique Errors

Frequency of DPI error type (%)



Monitored Adherence, Inhaler Technique & Patient Outcomes

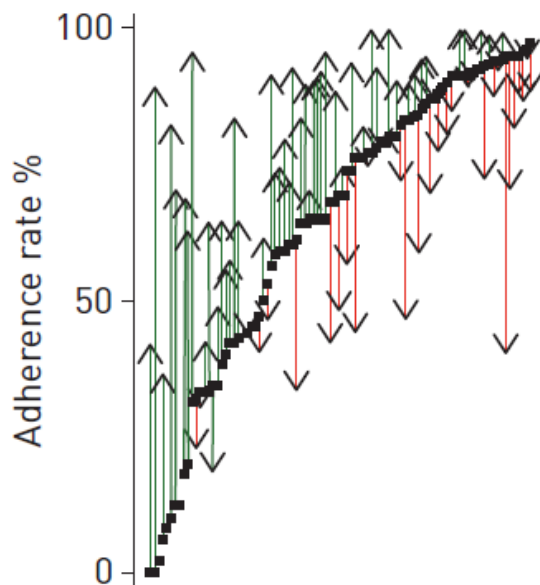
A randomised clinical trial of feedback on inhaler adherence and technique in patients with severe uncontrolled asthma

Sulaiman I et al, ERJ 2018

Mean rate of adherence; $P=0.02$

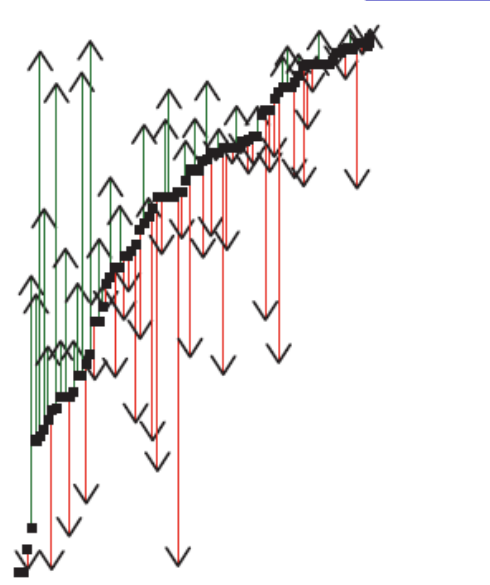
73%

(Bio)Feedback



Intensive education

63%

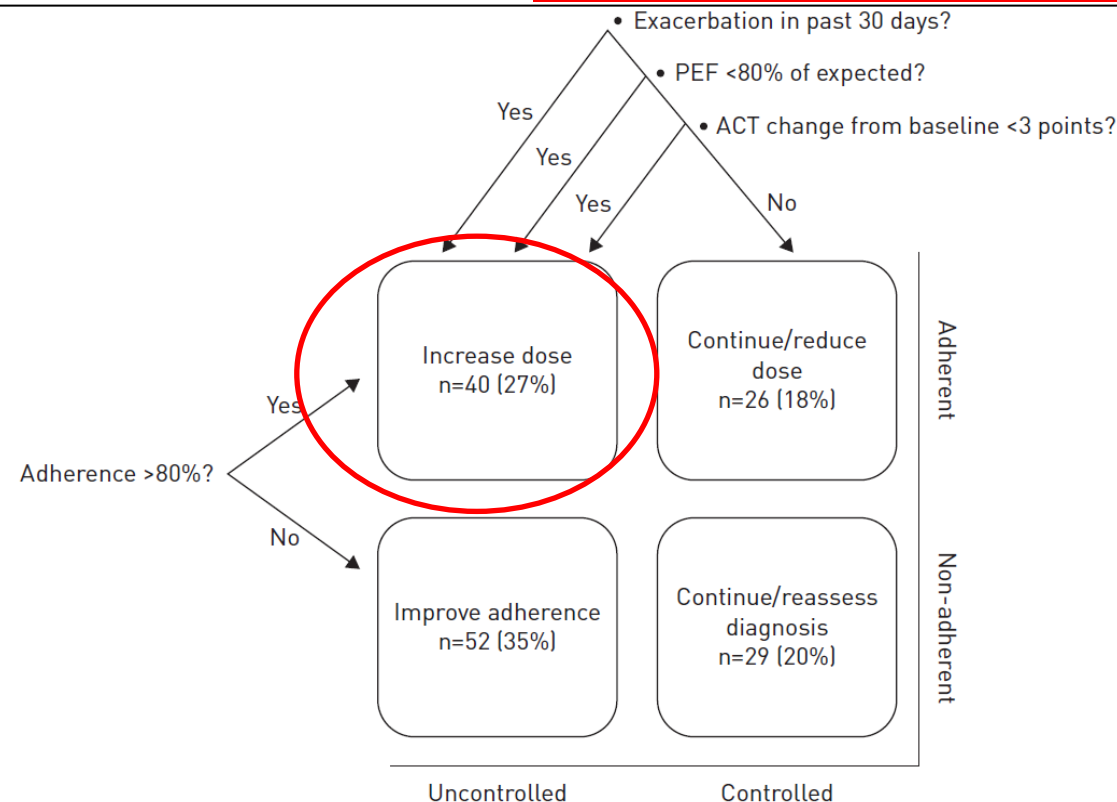


Individual patients

→ Adherence increased

→ Adherence decreased

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

Start with the End-user : Patient-centered Design



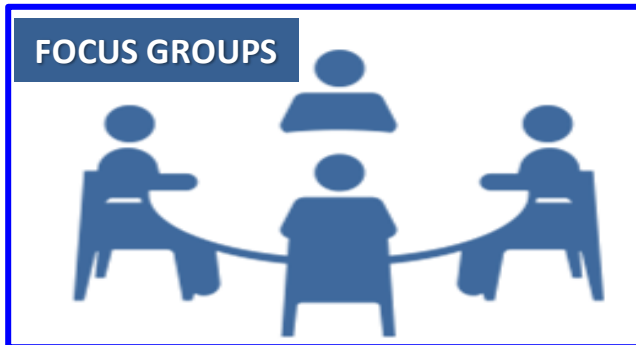
Perspectives of patients and healthcare professionals on mHealth for asthma self-management



EUROPEAN RESPIRATORY *journal*
OFFICIAL SCIENTIFIC JOURNAL OF THE ERS

Andrew J. Simpson¹, Persijn J. Honkoop², Erika Kennington³,
Jiska B. Snoeck-Stroband², Ian Smith², Jessica East³, Courtney Coleman³,
Ann Caress¹, Kian Fan Chung⁴, Jacob K. Sont², Omar Usmani⁴ and
Stephen J. Fowler¹

Simpson A et al, ERJ 2017



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

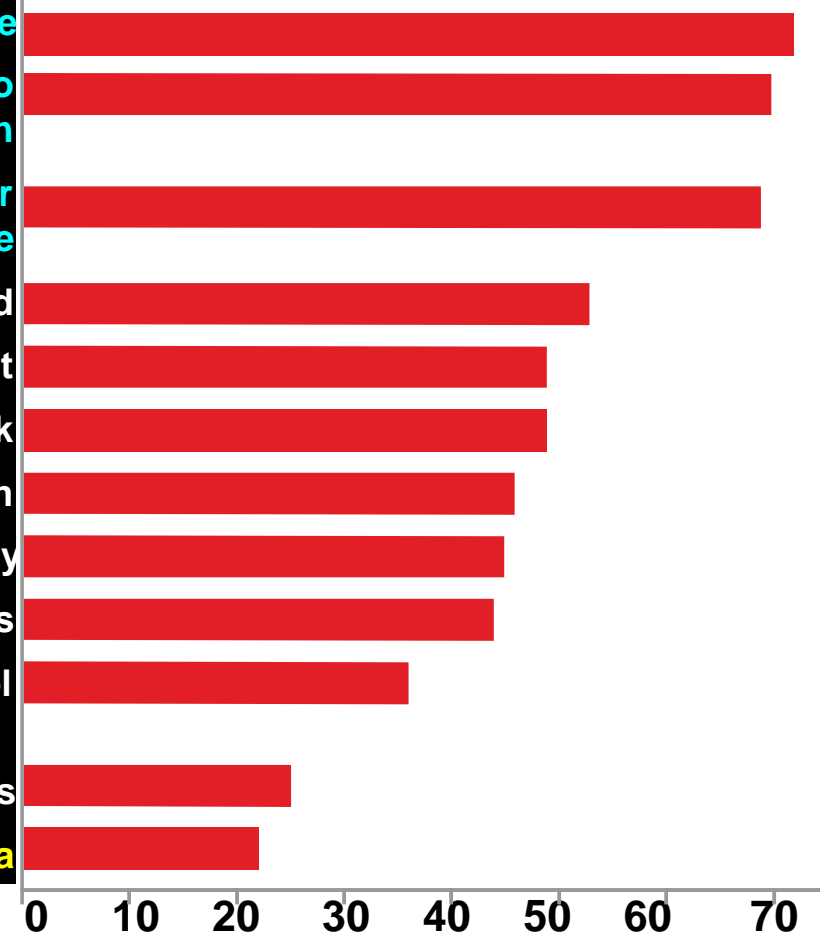
... that provides instructions on how to manage their asthma in an emergency

... 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



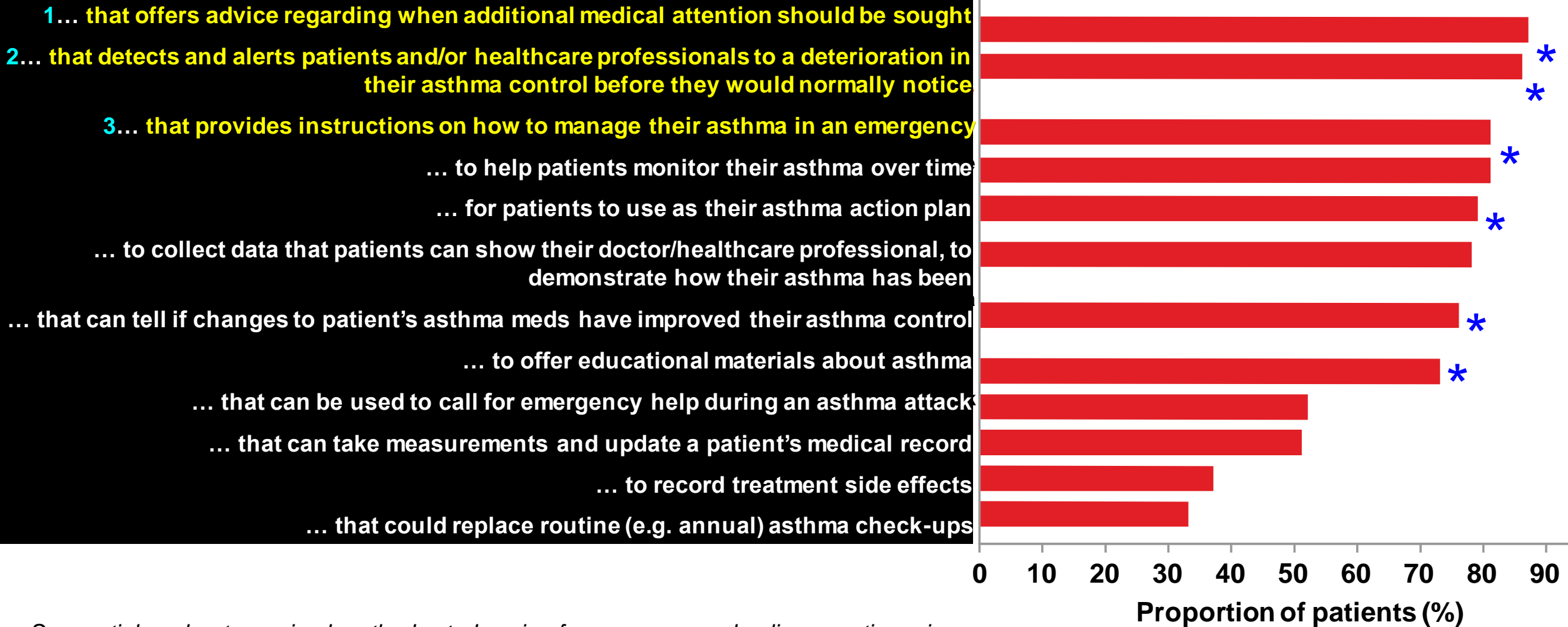
Proportion of patients (%)

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

What **HCPs** believe would be useful functions in an mHealth system ? **A Device / system ...**



* significant difference vs patients (p < 0.05)



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

PATIENT

“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]

HEALTHCARE PROFESSIONAL

“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?

Response options	Asthma [#]	HCPs [¶]	p-value ⁺	Asthma		p-value ^{##}
				Uncontrolled [§]	Controlled ^f	
Measurements of environment conditions (e.g. pollution, allergens, temperature and humidity)	70	68	0.81	75	65	0.16
Measurements of lung function (e.g. peak flow and measurements of airway inflammation)	71	75	0.58	71	70	0.82
Measurements of breathing (e.g. breathing rate and details of how often you cough)	64	60	0.60	68	60	0.29
Measurements of heart rate and activity levels	46	37	0.18	49	43	0.39
Measurements of stress levels	53	37	0.03	57	49	0.27
Measurements of medication adherence	48	89	<0.001	52	44	0.32
Measurements of inhaler technique	42	87	<0.001	43	43	0.98
Measurements of diet	32	32	0.94	36	24	0.09
Measurements of quality of sleep	54	44	0.20	58	48	0.16
Measurements of self-reported symptoms	34	57	<0.001	40	30	0.19



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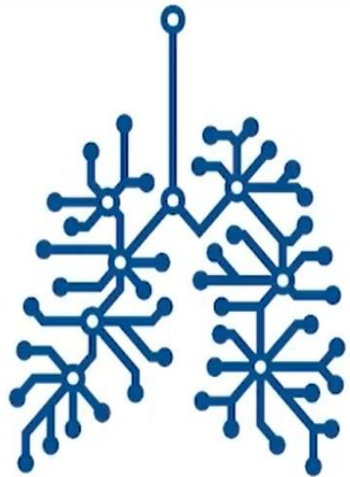
Data security

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 ?

ERS Congress 2020

Digital Health A Brave New World



INTERNATIONAL
CONGRESS 2020
v i r t u a l

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



Patient trust

**HCP-Patient
relationship**

Challenges for Digital Health : Going Forward

We need high quality evidence

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

McCartney, BMJ 2017

“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) *a priori***

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



MAGNIFY : A Pragmatic Cluster Randomised Trial of Adherence Support in COPD

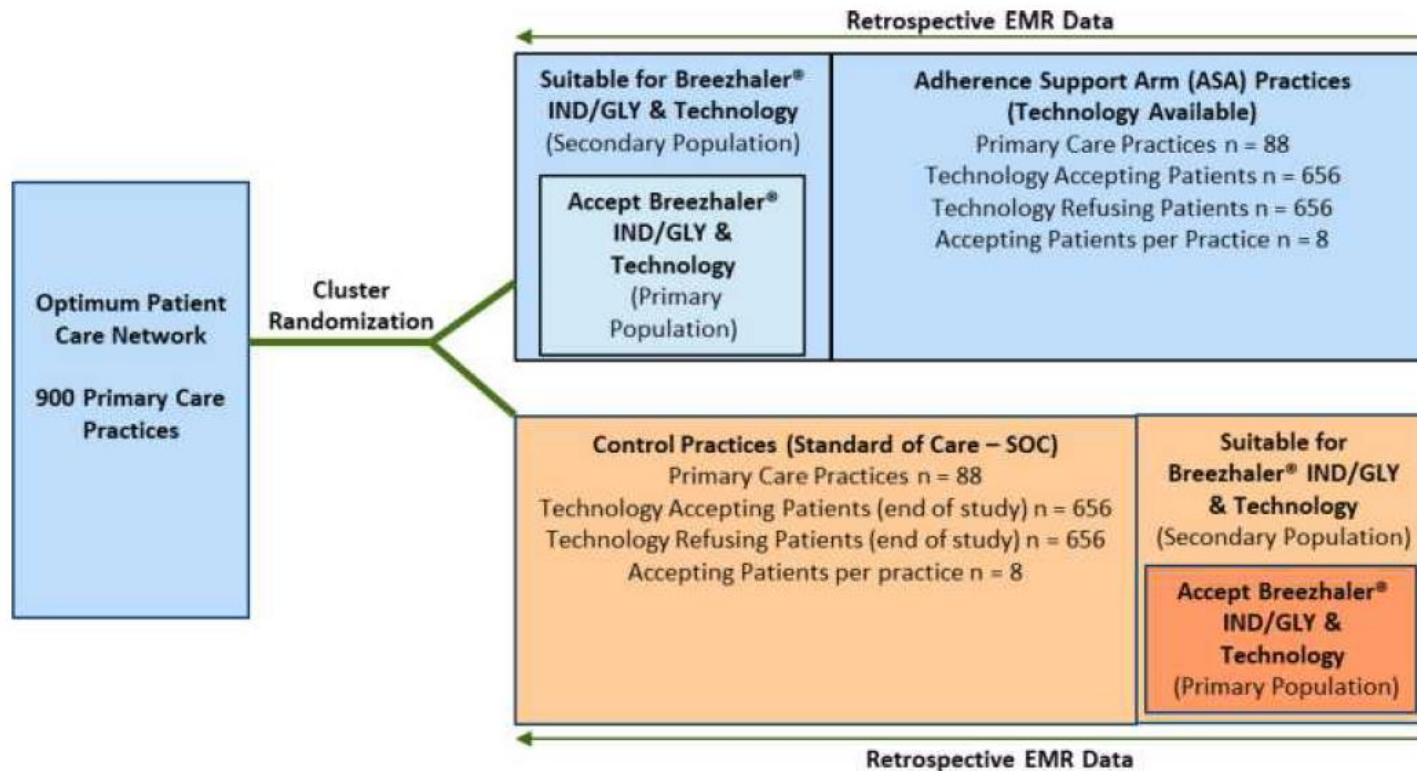
Price D et al, Prag Obs Res 2021

Open Access Full Text Article

STUDY PROTOCOL

Maximizing Adherence and Gaining New Information For Your Chronic Obstructive Pulmonary Disease (MAGNIFY COPD): Study Protocol for the Pragmatic, Cluster Randomized Trial Evaluating the Impact of Dual Bronchodilator with Add-On Sensor and Electronic Monitoring on Clinical Outcomes

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

A composite image for an Asthma UK video series. The top left shows a woman holding an inhaler. The top right shows Dr. Omar Usmani, a Consultant Respiratory Physician. The bottom left shows a woman helping a young child use an inhaler. The bottom right shows a woman using an inhaler. A central white box contains the following text:

3 minutes to better inhaler technique!

A new, definitive series of short videos from Asthma UK in collaboration with the UK Inhaler Group.

Endorsed by UK Inhaler Group

Dr. Omar Usmani
Consultant Respiratory Physician

<https://www.asthma.org.uk/advice/inhaler-videos/>

Inhaler Adherence During COVID-19 Pandemic

Kaye et al, JACI in Practice 2020

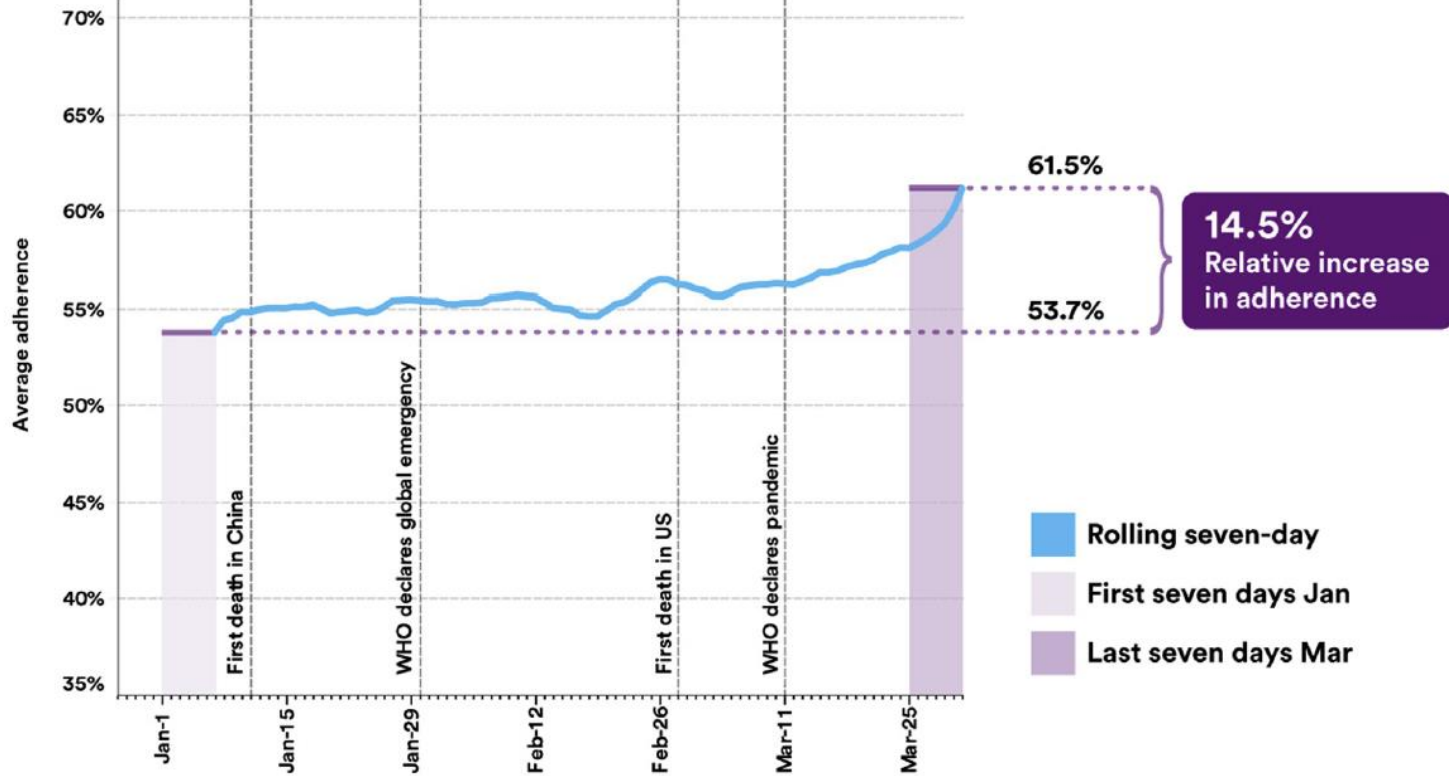


FIGURE 1. Mean daily controller adherence in asthma and chronic obstructive pulmonary disease before and during the coronavirus disease 2019 pandemic.

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

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

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

Impact of Digital Technology Use on the Environment



Search

ERS Vision, May 5th 2021

The Society

Congress and events

Guidelines

Science and research

Education

ERS publishes position statement on asthma and environment

A screenshot of a live video conference. The background is dark blue with teal bokeh light effects. In the top left corner, there is a small ERS logo and the text "Asthma and climate change". In the top right corner, there is a "Watch later" icon and the text "ERS | VISION live". The conference features six participants in a 2x3 grid of video windows. The top row shows a woman with red hair and glasses, a man with dark hair wearing a headset, and a woman with dark hair. The bottom row shows a man with short hair, a woman with blonde hair wearing a yellow top, and a man in a suit and tie. The ERS logo is also visible in the center of the top row of windows.

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SUMMARY

Understand

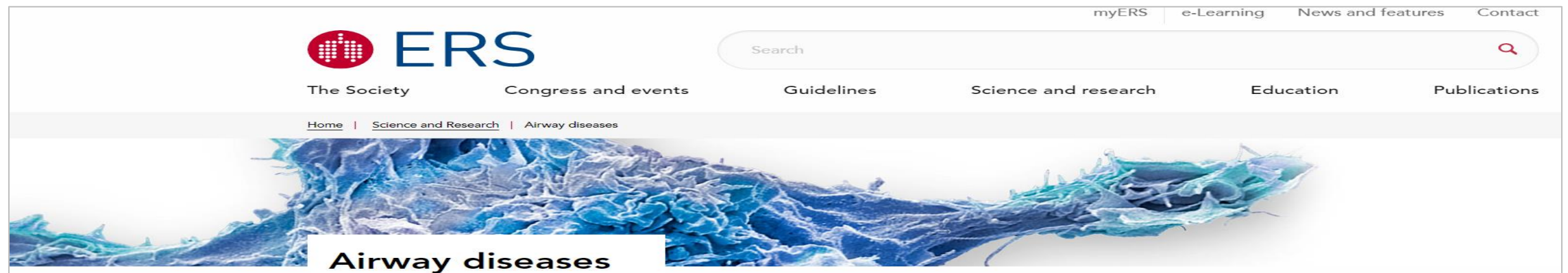
current data in digital approaches to promote treatment adherence

Identify

digital technologies in patient education and feedback

Appreciate

the future challenges for digital health



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A Digital Health Summit of the ERS

