

3



# ASTHMA MANAGEMENT IN THE DIGITAL REALM

THE POTENTIAL OF DIGITAL TECHNOLOGY IN ASTHMA CARE

DR AMY CHAN

NZ RESPIRATORY CONFERENCE 2020



# Disclosure



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I report consultancy fees from Spoonful of Sugar Ltd, grants from Health Research Council, Innovate UK, A+ charitable trust (Auckland District Health Board), Maurice and Phyllis Paykel trust, Universitas 21, NZPERF, Auckland Academic Health Alliance, Asthma UK, University of Auckland; grants and consultancy fees from Janssen-Cilag; and am the recipient of the Robert Irwin Fellowship.

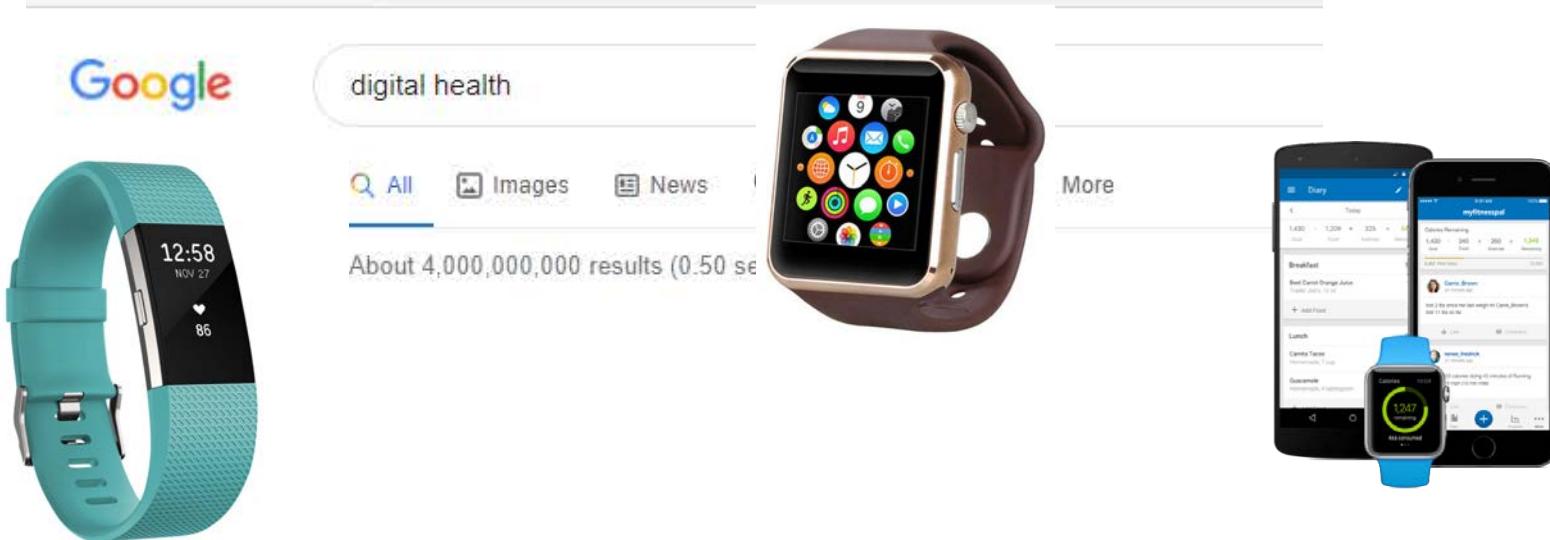
None of the relationships have influenced the content of this talk.

**Note this presentation refers to unpublished data –  
please do not distribute outside of this conference.**



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# The advent of digital innovations



A collage illustrating the theme of digital innovations in health. It includes a teal Fitbit Charge 2 fitness tracker, a Google search interface for "digital health" showing over 4 billion results, a gold Apple Watch displaying various apps, and two smartphones displaying the MyFitnessPal app interface.

Google

digital health

All Images News

About 4,000,000,000 results (0.50 sec)

More

12:58 NOV 27

86

9

myfitnesspal

Diary

Breakfast

Lunch

Guacamole

Calories

1237

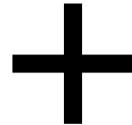
running

80% completed

# It's complicated



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“your work would be life changing”

A word cloud centered around the theme of the digital world, with words like business, network, technology, modern, digital, world, communication, cyberspace, social, media, internet, and digital tools.



# Asthma and digital interventions

All things digital...

Review Article

## Patient rem adherence:

Nancy Tran<sup>1</sup>, BA, Janet M. Co  
Pages 536-543 | Received 25 Oct 2

Download citation http://

Full Article Figure

## Abstract

**Objective:** One of the main barriers to asthma self-management is forgetfulness. Daily medication reminders via mobile phones, text messages, email, phone calls and audiovisual reminders have been used to assess the effect of digital interventions on adherence.

**Methods:** We conducted a systematic review of digital interventions which assessed the effect of digital interventions on self-management of asthma in English-language articles published between January 2000 and May 2013. We included studies of adults (16 years and over) with asthma, the comparator was usual care. Outcomes were change in medication adherence, patient-reported measures of wellbeing or quality of life. Peer-reviewed journals in English were eligible. Potential studies were screened and study characteristics were independently assessed by two researchers. Where data allowed, data were extracted using a random effects model.

**Results:** Eight papers describing 5 trials with 593 participants were included for meta-analysis. Of these, two aimed to improve adherence to oral prednisolone without worsening control, one trial showed significant improvements in adherence and a third trial showed no significant differences and extremely high heterogeneity. Mean Difference (SMD) 0.05; 95 % Confidence Interval 95 % CI -0.05 to 0.12; I<sup>2</sup> = 87.4%. The removal of the thin film coated tablets from the analysis resulted in a small improvement for both AQLQ (SMD 0.45; 95 % CI 0.13 to 0.86; I<sup>2</sup> = 0.11). No evidence of harm was identified.

**Conclusion:** Digital self-management interventions for adults with asthma show promise, with some evidence of small beneficial effects on asthma control. Overall, the evidence base remains weak due to the lack of large, robust trials.



McLean et al. BMC Pulmonary Medicine (2016) 16:83  
DOI 10.1186/s12890-016-0248-7

## RESEARCH ARTICLE

# Interactive digital interventions for self-management in adults with asthma: a systematic review and real-world evidence

Gary McLean<sup>1\*</sup>, Elizabeth Murray<sup>2</sup>, Rebecca Band<sup>3</sup>, Keltie Miller<sup>4</sup>, Mike Thomas<sup>5,6,7</sup>, Lucy Yardley<sup>3</sup> and Frances S. Mair<sup>1</sup>

## Abstract

**Background:** To identify, summarise and synthesise the evidence on the effectiveness of digital interventions to support patient self-management of asthma, and determine the potential for digital interventions to improve adherence for youth with asthma.

**Methods:** Systematic review with meta-analysis. We searched electronic databases (PubMed, EMBASE, PsycINFO, Google Scholar, Library, DoPHER, TROPHÉ, Social Science Citation Index) and conference proceedings through May 2013. We included studies of adults (16 years and over) with asthma, the comparator was usual care. Outcomes were change in medication adherence, patient-reported measures of wellbeing or quality of life. Peer-reviewed journals in English were eligible. Potential studies were screened and study characteristics were independently assessed by two researchers. Where data allowed, data were extracted using a random effects model.

**Results:** Eight papers describing 5 trials with 593 participants were included for meta-analysis. Of these, two aimed to improve adherence to oral prednisolone without worsening control, one trial showed significant improvements in adherence and a third trial showed no significant differences and extremely high heterogeneity. Mean Difference (SMD) 0.05; 95 % Confidence Interval 95 % CI -0.05 to 0.12; I<sup>2</sup> = 87.4%. The removal of the thin film coated tablets from the analysis resulted in a small improvement for both AQLQ (SMD 0.45; 95 % CI 0.13 to 0.86; I<sup>2</sup> = 0.11). No evidence of harm was identified.

**Conclusion:** Digital self-management interventions for adults with asthma show promise, with some evidence of small beneficial effects on asthma control. Overall, the evidence base remains weak due to the lack of large, robust trials.

## Results

Of the 25 interventions identified, 22 results



The Journal of Allergy and Clinical Immunology:  
In Practice

Volume 8, Issue 4, April 2020, Pages 1284-1293



019 59-68

scienceDirect

View Article

Original Article

# Systematic Review of Digital Interventions for Pediatric Asthma Management

Rachelle R. Ramsey PhD<sup>a,b</sup>, Jill M. Plevinsky PhD<sup>a</sup>, Sophie R. Kollin BA<sup>a</sup>, Robert C. Gibler MA<sup>c</sup>, Theresa W. Guilbert MD, MS<sup>b,d</sup>, Kevin A. Hommel PhD<sup>a,b</sup>

Show more ▾

<https://doi.org/10.1016/j.jcaip.2019.12.013>

Get rights and content

## Background

Pediatric patients with asthma take only approximately half of their prescribed medication. Digital interventions to improve adherence for youth with asthma exist and have the potential to improve accessibility, cost-effectiveness, and customizability.

## Objective

To systematically review published research examining digital interventions to promote adherence to the treatment of pediatric asthma.

## Methods

A systematic search of the PubMed, Scopus, CINAHL, PsycINFO, and reference

lists of included studies was conducted

using the following search terms:

asthma AND digital AND intervention

AND adherence AND pediatric AND

adolescent AND self-management

AND mobile AND application AND

AND smartphone AND tablet AND

AND computer AND computer-based

intervention AND digital media AND

digital technology AND digital device

AND digital communication AND

digital media AND digital media

# Interventions for Encouraging Asthma Self-Management in Adolescents:

## W

Lambert<sup>1</sup> , Ambereen Farouque<sup>1</sup>, Anne Holland<sup>2</sup>, Janet Davies<sup>3</sup>, and Karen Erbas<sup>1,\*</sup>

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<sup>2</sup> Department of Rehabilitation, Nutrition and Sport, School of Allied Health, La Trobe University, Bundoora 3083, Victoria, Australia;

<sup>3</sup> Faculty of Health, School-Biomedical Sciences, Queensland University of Technology, Brisbane 4000, Queensland, Australia; j36.davies@qut.edu.au

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Received: 13 September 2018; Accepted: 24 October 2018; Published: 29 October 2018





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Cochrane Database of Systematic Reviews

## Digital interventions to improve adherence to maintenance medication in asthma (Protocol)

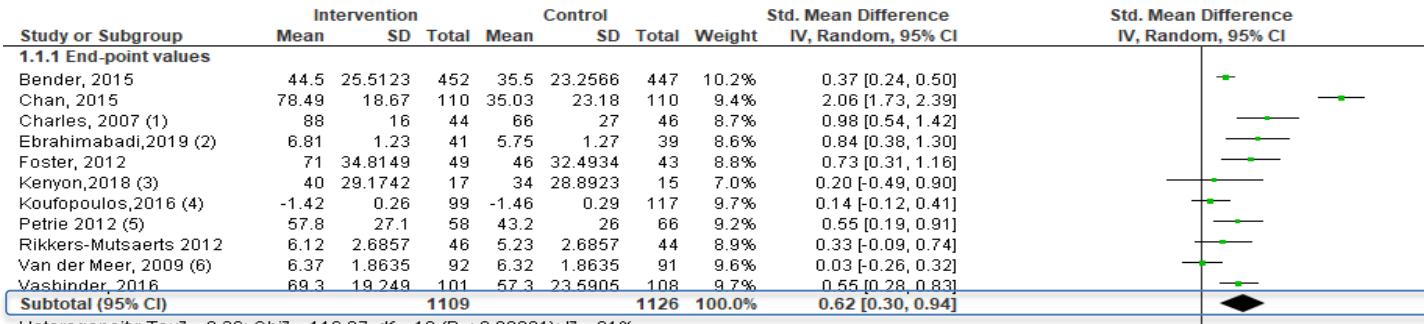
Chan AHY, De Simoni A, Wileman V, Holliday L, Chisari C, Newby CJ, Taylor SJC, Fleming LJ, Griffiths CJ, Horne R



1. Are digital adherence interventions effective in improving **adherence and asthma outcomes** to oral and inhaled asthma maintenance therapy?
  
2. Are there differences in effectiveness of the intervention on adherence, asthma control and exacerbations with different **intervention characteristics**, such as different modes of digital intervention delivery?



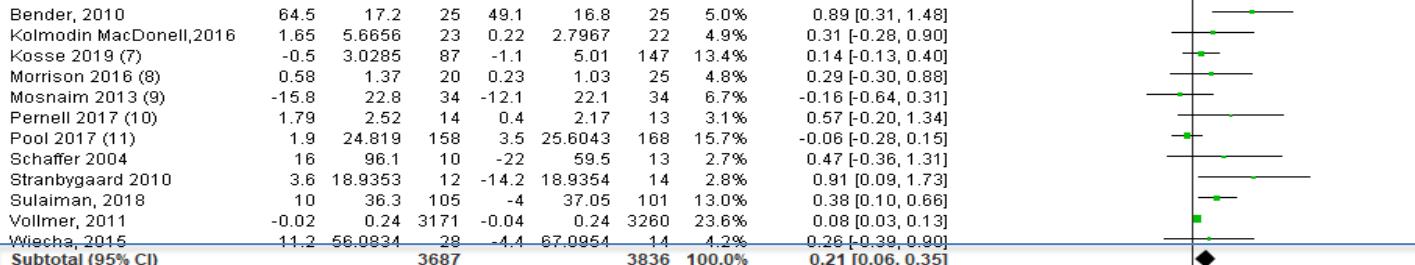
# Adherence



Heterogeneity:  $Tau^2 = 0.26$ ;  $Chi^2 = 116.97$ ,  $df = 10$  ( $P < 0.00001$ );  $I^2 = 91\%$

Test for overall effect:  $Z = 3.75$  ( $P = 0.0002$ )

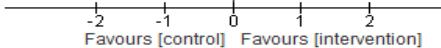
## 1.1.2 Adherence Change from Baseline



Heterogeneity:  $Tau^2 = 0.02$ ;  $Chi^2 = 21.99$ ,  $df = 11$  ( $P = 0.02$ );  $I^2 = 50\%$

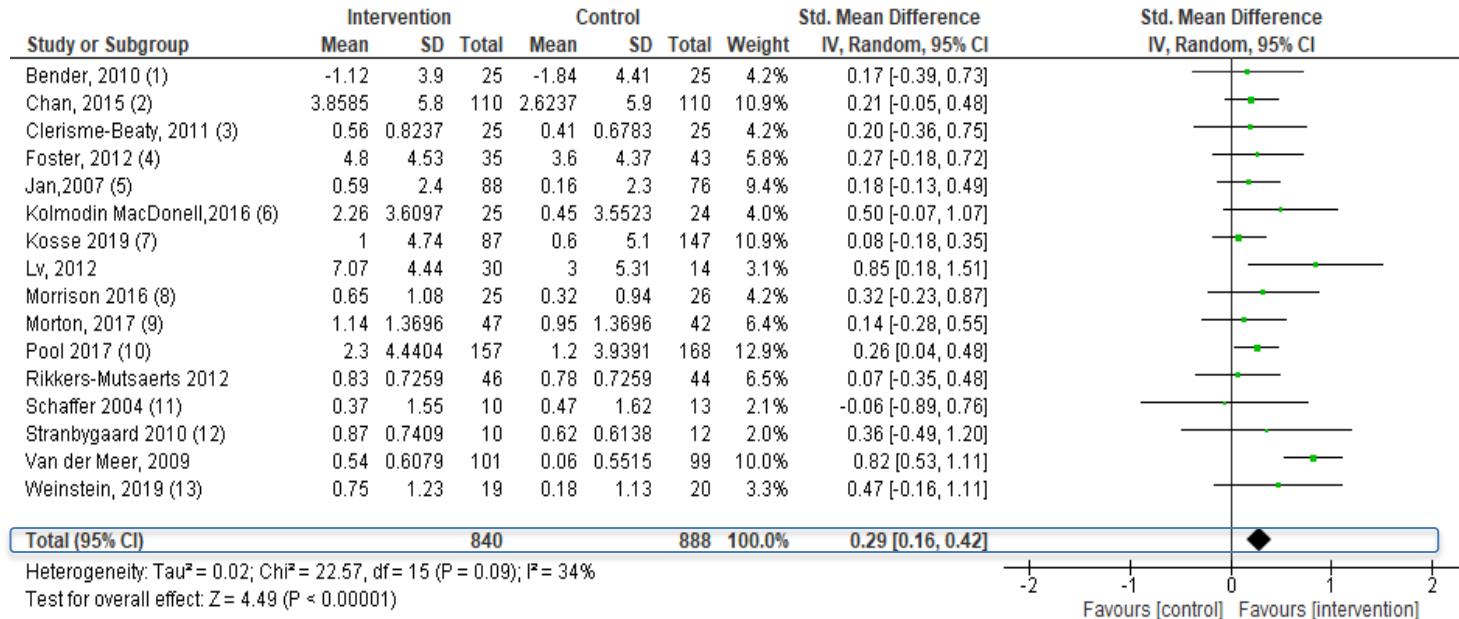
Test for overall effect:  $Z = 2.78$  ( $P = 0.005$ )

Test for subgroup differences:  $Chi^2 = 5.19$ ,  $df = 1$  ( $P = 0.02$ ),  $I^2 = 80.7\%$





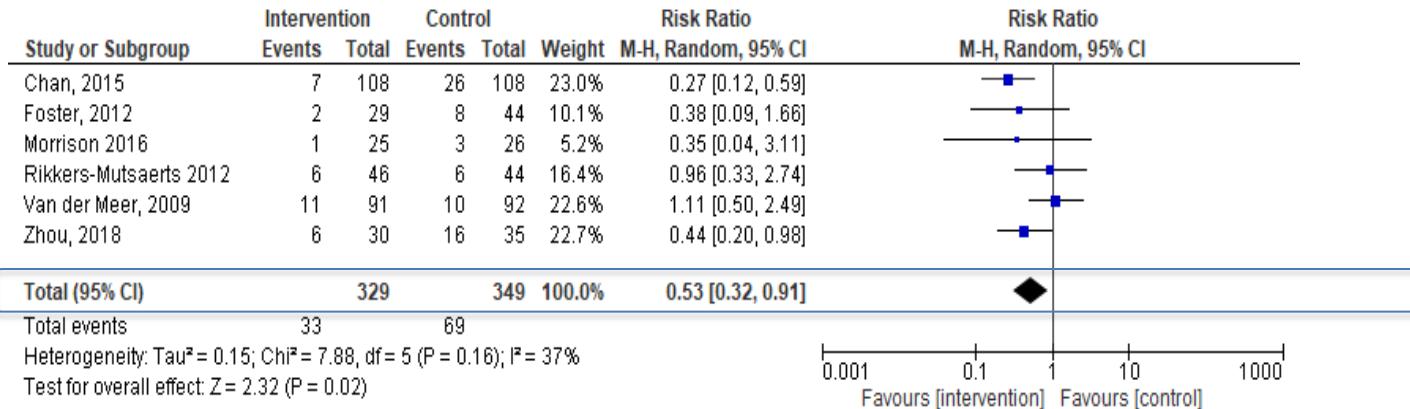
# Asthma control



# Exacerbations



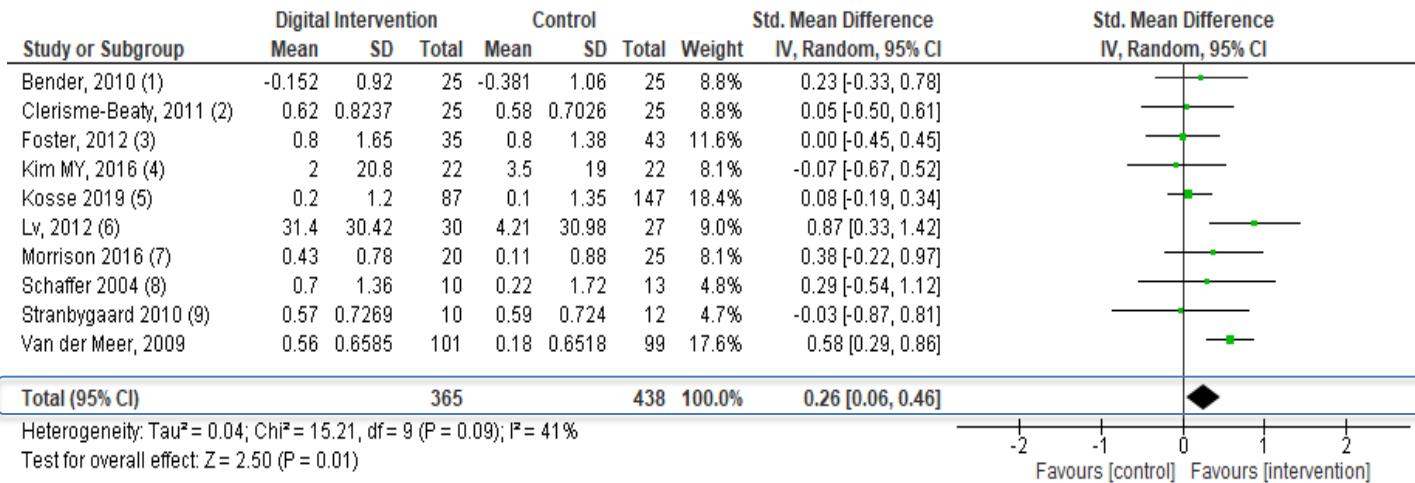
@amyhychan



# Quality of life



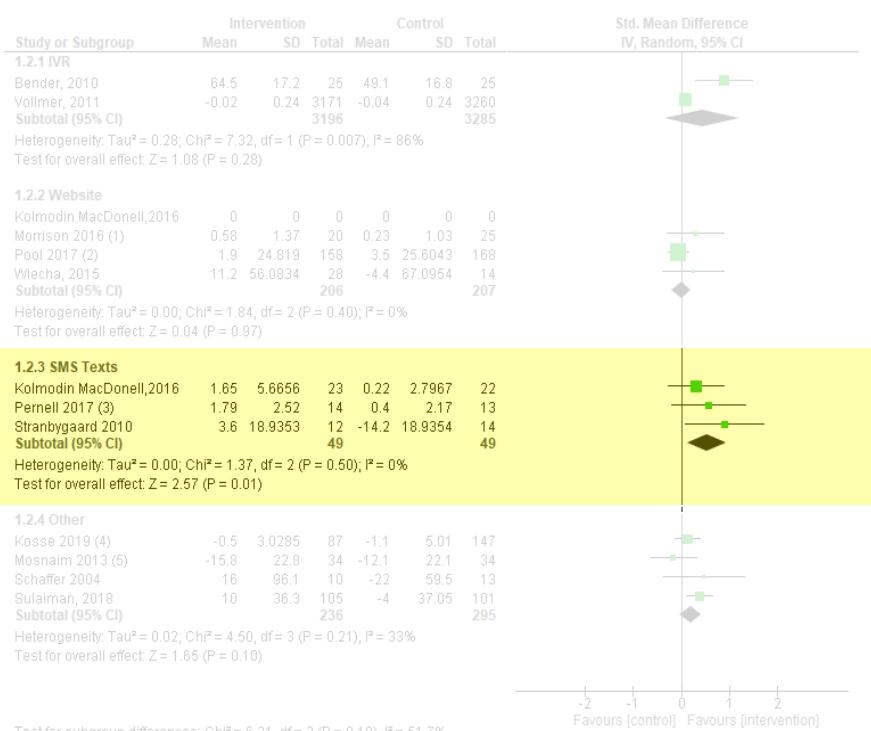
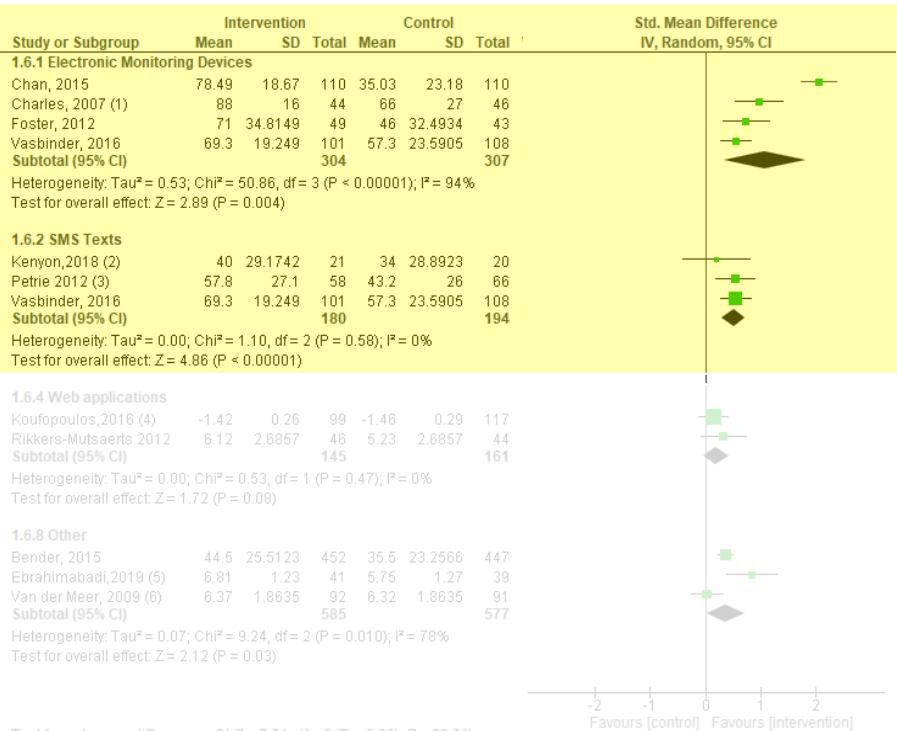
@amyhychan



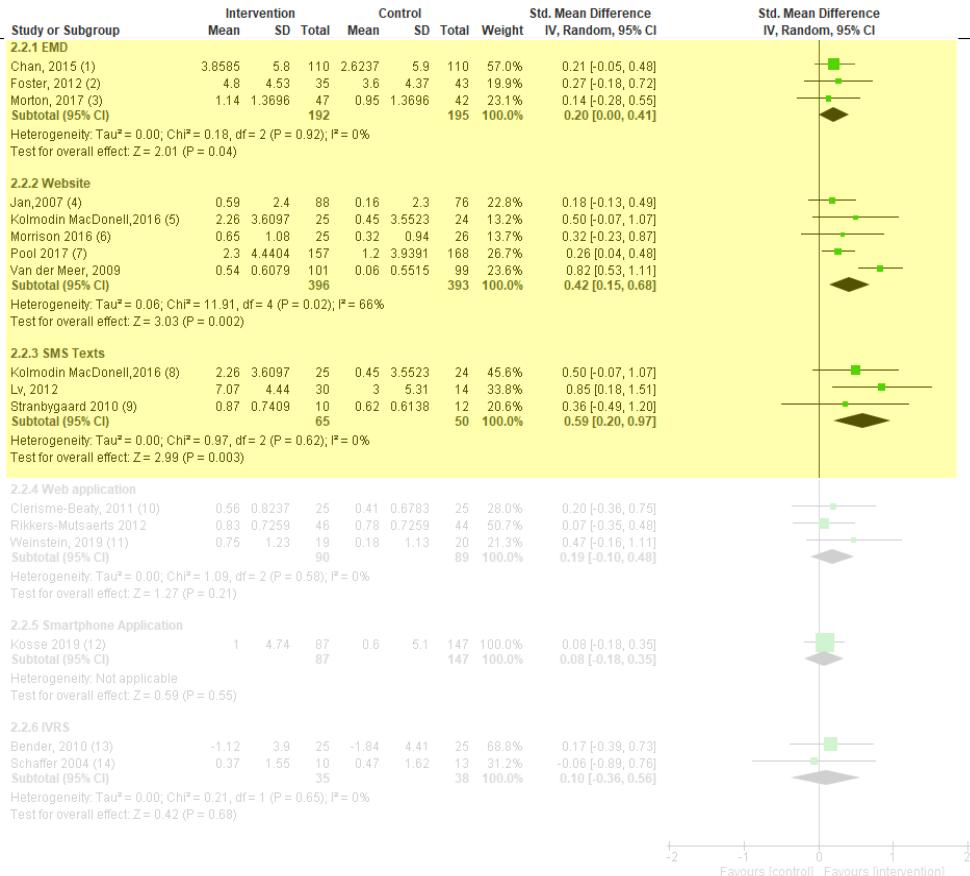


1. Are digital adherence interventions effective in improving adherence and asthma outcomes to oral and inhaled asthma maintenance therapy?
  2. Are there differences in effectiveness of the intervention on adherence, asthma control and exacerbations with different **intervention characteristics**, such as different modes of digital intervention delivery?

# What type of digital for adherence?



# What type of digital for asthma control?



# Adherence interventions in asthma

39 RCTs

## Adherence education (20 studies)

+20% (95% CI, 7.52 to 32.74; five studies; low-quality)



## Simplified regimen (4 studies)

+4% (95% CI 1.88 to 6.16; three studies; moderate-quality)

## Electronic trackers / Reminders (11 studies)

+19% (95% CI, 14.47 to 25.26; six studies; moderate-quality)

## School-based DOT (3 studies)



# Partial or full digital for adherence?



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**1.7.1 In person component**

Study or Subgroup	Intervention			Control			Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total	
Van der Meer, 2009 (1)	6.37	1.8635	92	6.32	1.8635	91	
<b>Subtotal (95% CI)</b>	<b>92</b>			<b>91</b>			

Heterogeneity: Not applicable

Test for overall effect:  $Z = 0.18$  ( $P = 0.86$ )

**1.7.2 Fully digital**

Study or Subgroup	Intervention			Control			Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total	
Bender, 2015	44.5	25.5123	452	35.5	23.2566	447	
Chan, 2015	78.49	18.67	110	35.03	23.18	110	
Charles, 2007 (2)	88	16	44	66	27	46	
Ebrahimabadi, 2019 (3)	6.81	1.23	41	5.75	1.27	39	
Foster, 2012	71	34.8149	49	46	32.4934	43	
Kenyon, 2018 (4)	40	29.1742	17	34	28.8923	15	
Koufopoulos, 2016 (5)	-1.42	0.26	99	-1.46	0.29	117	
Petrie 2012 (6)	57.8	27.1	58	43.2	26	66	
Rikkens-Mutsaerts 2012	61.2	2.6857	46	5.23	2.6857	44	
Vasbinder, 2016	69.3	19.249	101	57.3	23.5905	108	
<b>Subtotal (95% CI)</b>	<b>1017</b>			<b>1035</b>			

Heterogeneity:  $Tau^2 = 0.27$ ; Chi $\chi^2 = 105.33$ , df = 9 ( $P < 0.00001$ ); I $\mathbf{2}^2 = 91\%$

Test for overall effect:  $Z = 3.88$  ( $P = 0.0001$ )

**1.5 L person component**

Study or Subgroup	Intervention			Control			Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total	
<b>1.5 L person component</b>							
Mosnaim 2013 (1)	-15.8	22.8	34	-12.1	22.1	34	
Sulaiman, 2018	10	36.3	105	-4	37.05	101	
Wiecha, 2015	11.2	56.0834	28	-4.4	67.0954	14	
<b>Subtotal (95% CI)</b>			<b>167</b>			<b>149</b>	

Heterogeneity:  $Tau^2 = 0.05$ ;  $Chi^2 = 3.75$ ,  $df = 2$  ( $P = 0.15$ );  $I^2 = 47\%$   
Test for overall effect:  $Z = 1.06$  ( $P = 0.29$ )

**1.5.2 Fully digital**

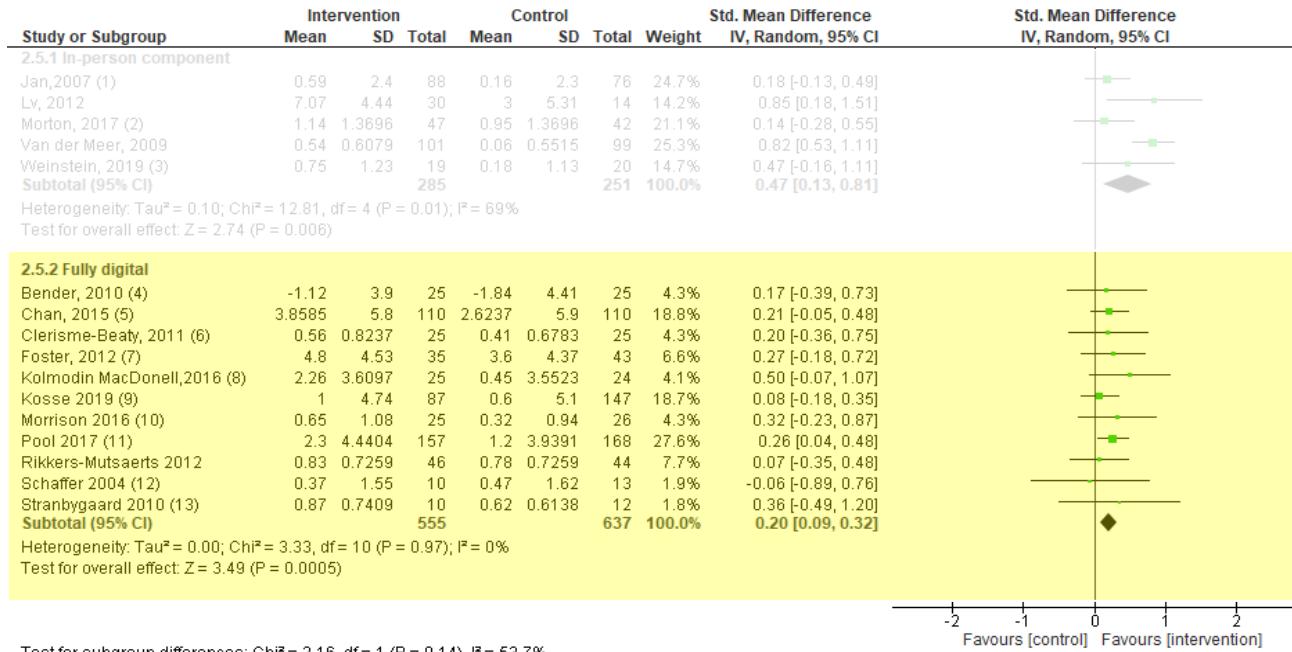
Study or Subgroup	Intervention			Control			Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total	
<b>Fully digital</b>							
Bender, 2010	64.5	17.2	25	49.1	16.8	25	
Kolmodin MacDonell, 2016	1.65	5.6656	23	0.22	2.7967	22	
Kosse 2019 (2)	-0.5	3.0285	87	-1.1	5.01	147	
Morrison 2016 (3)	0.58	1.37	20	0.23	1.03	25	
Perrelli 2017 (4)	1.79	2.52	14	0.4	2.17	13	
Pool 2017 (5)	1.9	24.819	158	3.5	25.6043	168	
Schaffer 2004	16	96.1	10	-22	59.5	13	
Stranbygaard 2010	3.6	18.9353	12	-14.2	18.9354	14	
Vollmer, 2011	-0.02	0.24	3171	-0.04	0.24	3260	
<b>Subtotal (95% CI)</b>			<b>3520</b>			<b>3687</b>	

Heterogeneity:  $Tau^2 = 0.02$ ;  $Chi^2 = 16.50$ ,  $df = 8$  ( $P = 0.04$ );  $I^2 = 52\%$   
Test for overall effect:  $Z = 2.43$  ( $P = 0.02$ )

# Partial or full digital for asthma control?



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# What about other intervention characteristics?

- Number of **digital components**
- Availability of **adherence feedback**

Neither seem to affect effectiveness of the intervention for adherence or asthma control.



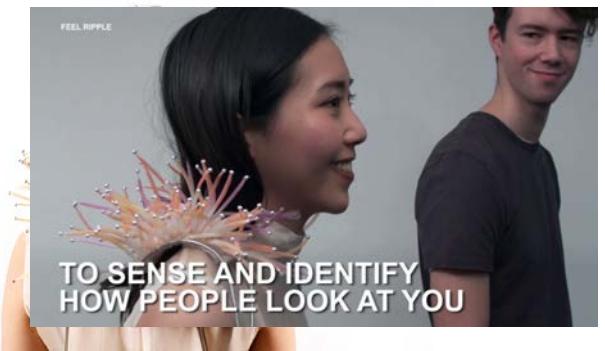
# Asthma and Electronic monitors

The role of electronic adherence monitoring in asthma

# Electronic monitors – lifestyle and wellbeing

A wearable **device** or other **digital application** that records physical **activity or other data relating to health** and wellbeing (e.g. water intake, sleep, diet etc)

Usually includes some of **biosensor** – a device that converts a biological response into an electrical signal





# Electronic monitors – medication

Electronic adherence monitors are  
**stand-alone electronic containers**  
(in which pills, inhalers, or other  
products are dispensed) which can  
**measure medication-taking.**

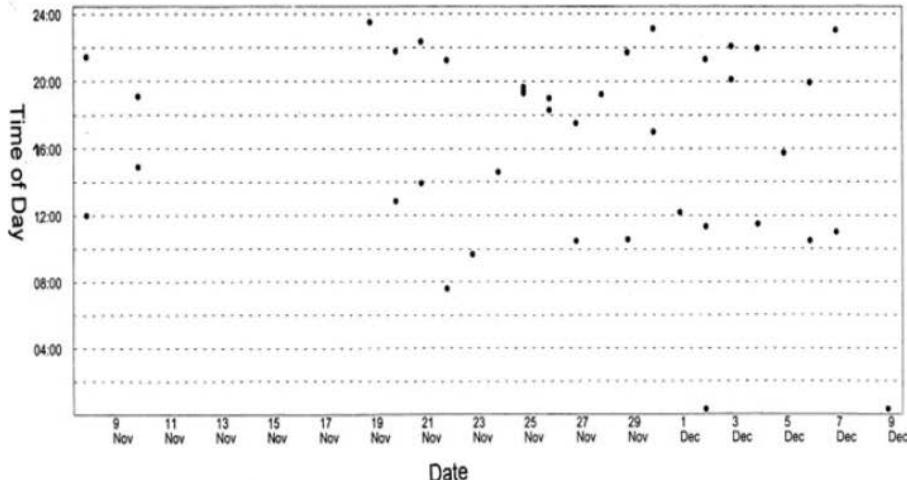


- **Time and date** stamp of every medication dose taken
- Medication **support** functions
  - e.g. reminders, visual feedback, link to apps



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# Medication tracker read-outs



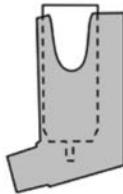
Each • represents one medication event



# Timeline of medication monitoring devices



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1980s



2006



2010



2013



1975

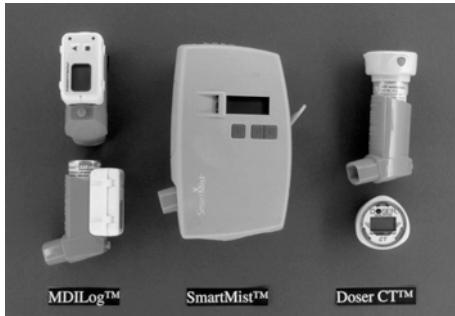
1990s

2009

2014

2015

2018 and beyond??!!



Note: Exact dates approximate as data not publicly available on all devices

Julius et al. CHEST 2002; 121:871–876;

<https://www.safeguard.com/2017/09/06/breath-fresh-air-oral-history-propeller-health/>

Kikidis D, Konstantinos V, Tzovaras D, Usmani OS. Journal of aerosol medicine and pulmonary drug delivery. 2016 Jun 1;29(3):219-32.

# Expectation versus reality



VS.



# Performance of electronic medication monitors



RCT involving 220 people, with at least 2-4 devices each



**Quantitative measures used for device performance**



Most devices passed testing

527/628 (84%) passed pre-issue tests

591/678 (87%) passed post-issue tests



Four categories of **device failure**

1) Data recording;

2) Reminders;

3) Data upload

4) Battery



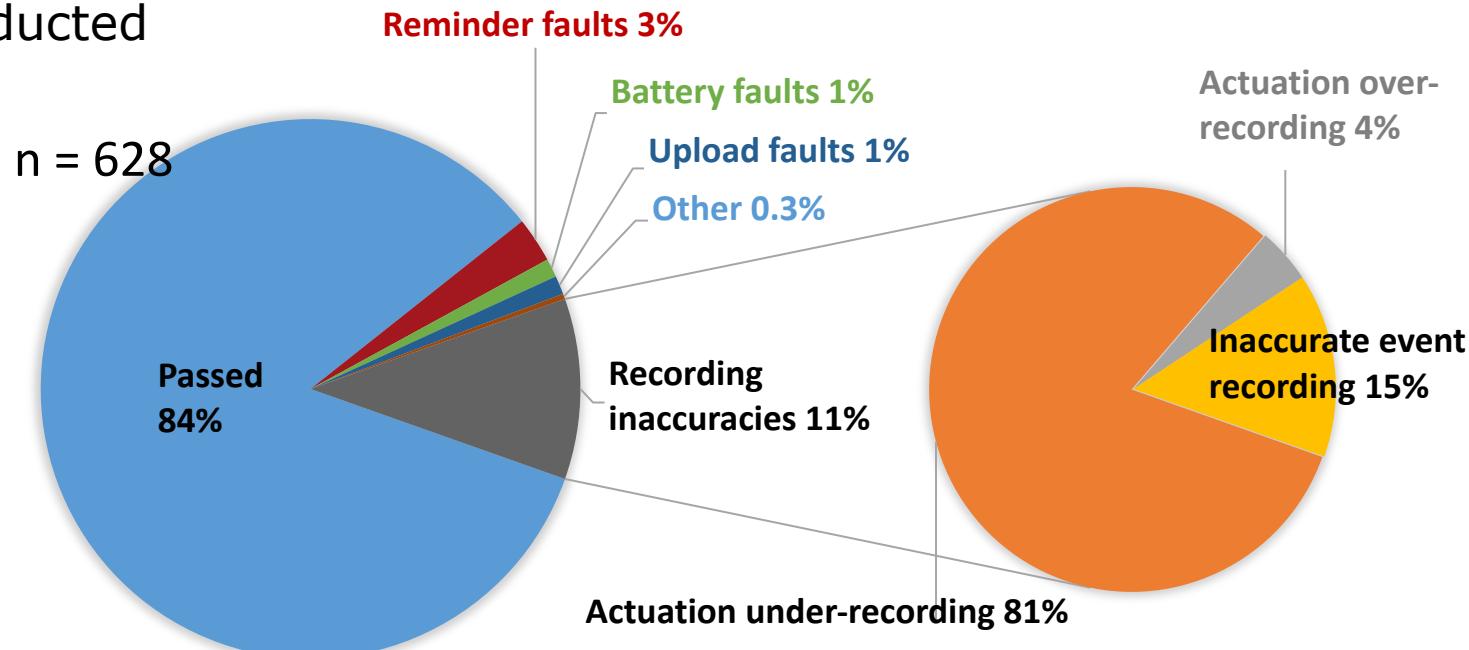
Most common failure reason – **actuation under-recording**

# Device performance – ‘off the shelf’



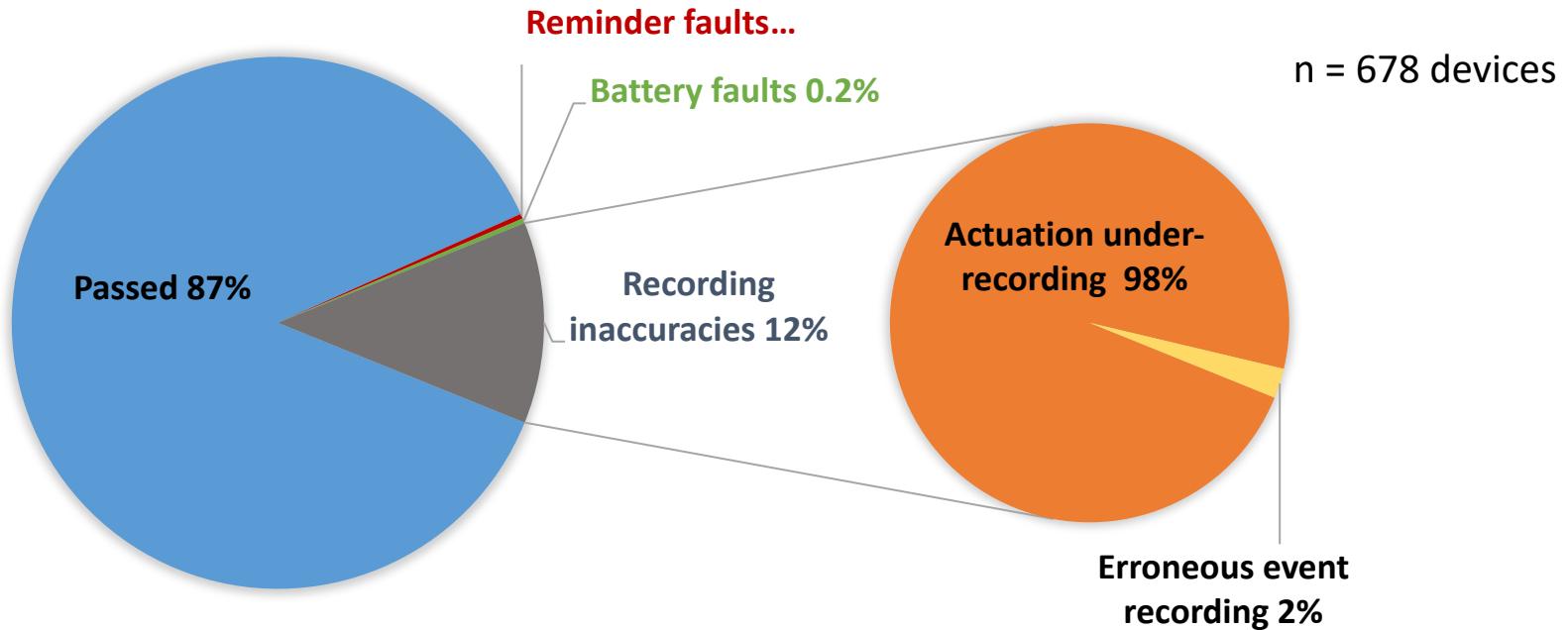
@amyhychan

1306 quality control tests  
conducted



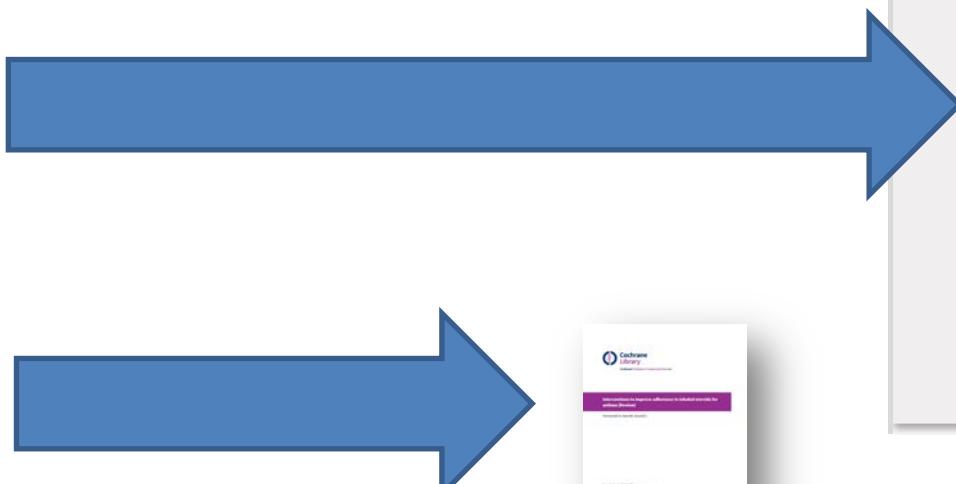


# Performance in the 'real-world' – checks post-use

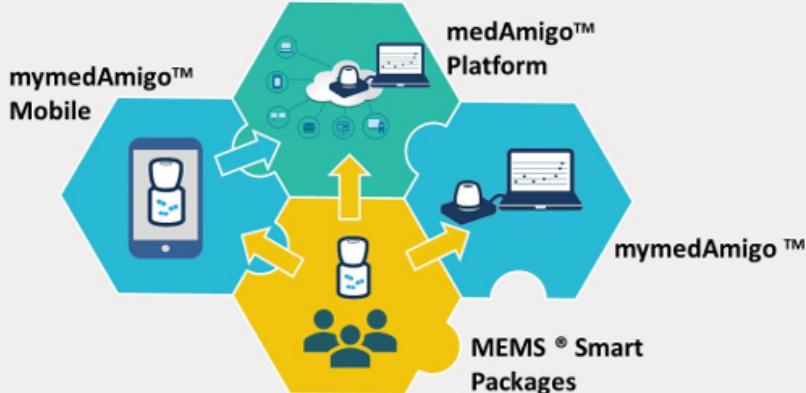




# The Advent of Connected Devices – The vision



A versatile ecosystem to monitor medication adherence



Clinical Commentary Review



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## Adherence Monitoring and E-Health: How Clinicians and Researchers Can Use Technology to Promote Inhaler Adherence for Asthma

Amy Hai Yan Chan

Michelle Eakin, PhD

Philadelphia, Pa; c

ORIGINAL RESEARCH



### Electronic adherence monitoring device performance and patient acceptability: a randomized control trial

Amy Hai Yan Chan <sup>b,a,b</sup>, Alistair William Stewart<sup>c</sup>, Jeff Harrison<sup>a</sup>, Peter Nigel Black<sup>d†</sup>, Edwin Arthur Mitchell<sup>b</sup> and Juliet Michelle Foster<sup>e</sup>

Clinical

## Using Electronic Monitoring Devices to Measure Inhaler Adherence: A Practical Guide for Clinicians

Amy Hai Yan Chan, BPharm(Hons)<sup>a,b</sup>, Jeff Harrison, PhD<sup>a</sup>, Peter N. Black, FRACPT<sup>d</sup>, Edwin A. Mitchell, FRSNZ<sup>b</sup>, and Juliet M. Foster, PhD<sup>c</sup> Auckland, New Zealand; Sydney, Australia

# Towards a practical solution



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*"Interventions that are **workable in daily practice** and that are **easy** for both **professional and patient**, appear to be most promising in furthering patients' adherence"*

*"The research in this field needs advances, including improved design of **feasible** long-term interventions, **objective** adherence measures, and sufficient study power to detect improvements in patient-important **clinical outcomes**."*

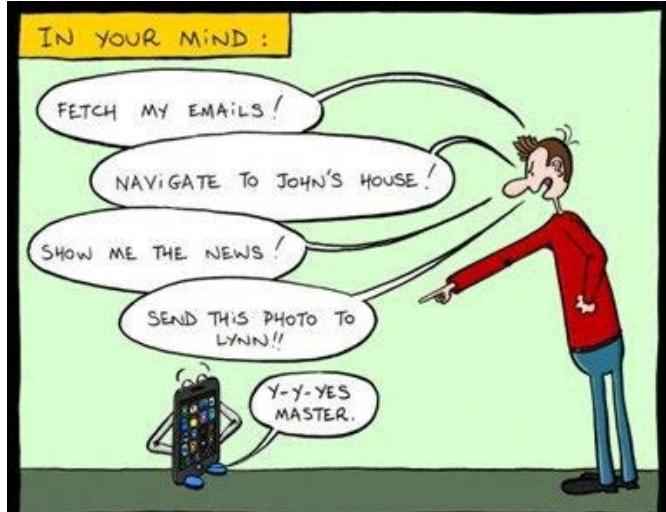


# Evidence barriers (assuming we need evidence)

- **Quality** of studies generally low
  - Many underpowered
- Difficulties with **measuring adherence** - comparisons are difficult
- Do not assess **outcomes**
- Effective interventions are often **complex**
  - Do not report interventions in sufficient detail
  - Resource intensive
  - Questions re: sustainability and cost-effectiveness



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# What are the pros and cons of electronically monitoring inhaler use in asthma? A multistakeholder perspective

---

Sam Howard,<sup>1</sup> Alexandra Lang,<sup>1</sup> Sarah Sharples,<sup>1</sup> Dominick Shaw<sup>2</sup>

# It's a matter of perspective





# Payer



My name is Anna. As a payer and commissioner of health services, I want to know what my return on investment is if I spend my money funding a smart monitoring technology. I need to know how best to spend tax payer money to get best out of treatment.

## Smartinhaler for asthma

Medtech innovation briefing

Published: 11 January 2017

[nice.org.uk/guidance/mib90](https://www.nice.org.uk/guidance/mib90)

- Key uncertainties are that some of the available studies were either not designed to, or were not adequately powered to, show whether improved adherence is associated with significantly improved outcomes.
- The cost of Smartinhaler devices is £100 per unit (exclusive of VAT), plus £14.17 per month for each healthcare professional to access cloud-based data.

The key points from the evidence summarised in this briefing are from 5 randomised controlled trials from the UK, Australia and New Zealand, including a total of 589 people with asthma (adults and children) using Smartinhaler in a community setting. The authors conclude that Smartinhaler devices were more effective than standard care in improving adherence to

- The resource impact would be greater than standard care, because of the cost of the device and software access, unless reductions in GP and hospital visits were realised.

The cost of Smartinhaler devices is £100 per unit (exclusive of VAT), plus £14.17 per month for each healthcare professional to access cloud-based data.

# Health professional



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My name is Dr Jackson. As the responsible clinician looking after my patients, I need to know how to interpret the data from the electronic monitors, and what to do with it. I'm also worried who is responsible for checking and looking after the data.



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# Patient



My name is Fiona. As a busy person, I want to be able to stay on top of my health conditions and keep track of my medication, in a way that isn't intrusive and doesn't make my friends think I'm weird.



With opportunity comes responsibility.

— *Winston Churchill* —

# A Balancing Act



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- Practice
  - Sustainability in everyday use
  - Cost effectiveness
  - Governance
  - Reliability
  - Training
  - Effect on workflows
  - Designing smartinhalers with health systems in mind
- Research
  - Clear role for adherence monitoring
  - Need for validation - quality control
  - Device choice
  - Relationship with device manufacturer
  - Patient and provider training
  - Interpreting adherence data
  - Need to focus on outcomes
  - Real-world usability data



# Asthma and online media

The influence of online press on asthma



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# Asthma in the press

PostScript  
Letter

Hold that space(r): asthma in the press

Richard J P G Chavasse

Author affiliations +

[View Full Text](#)

<http://dx.doi.org/10.1136/archdischild-2018-316494>

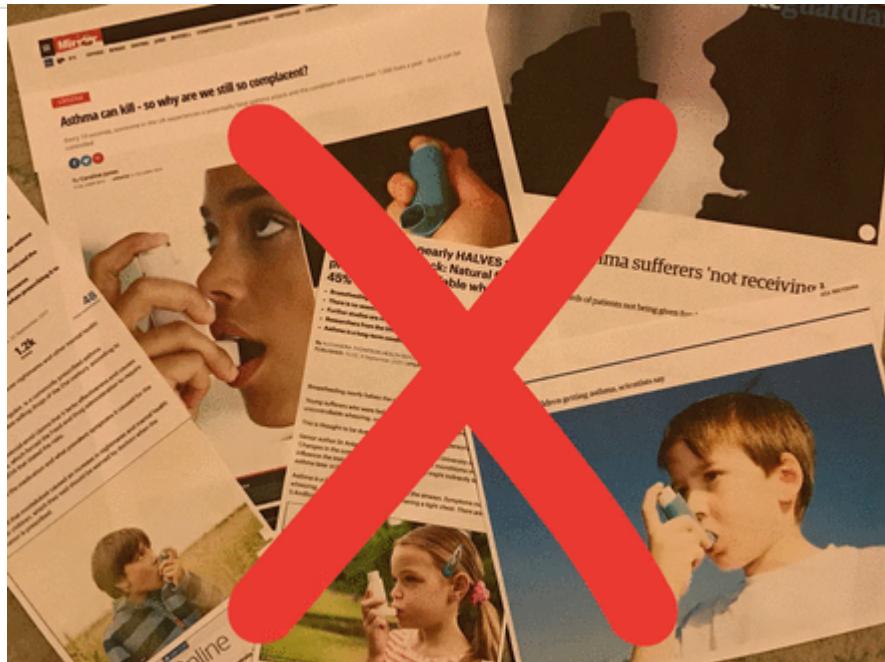
Statistics from Altmetric.com



Tweeted by 36

1 readers on Mendeley

[See more details](#)



# Portrayal of asthma in online media

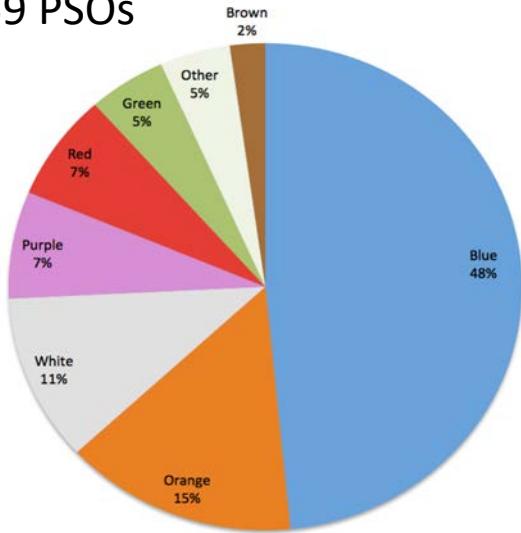
To explore the portrayal of asthma and its inhaled treatment in freely accessible public facing online mass media in NZ over the past 5 years

- Design a coding instrument
- Mixed method analysis of online documents from mass media
- Compare and contrast asthma portrayal

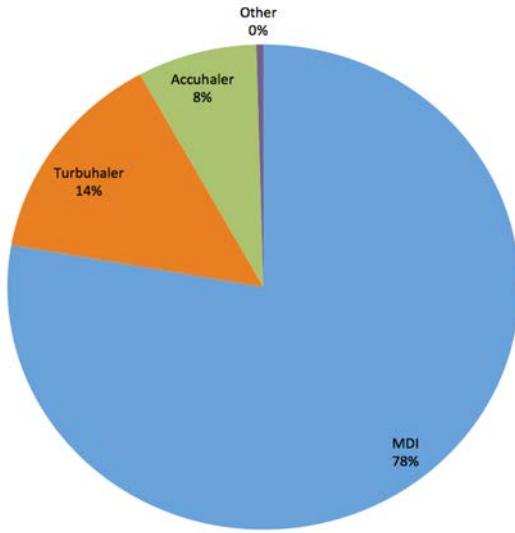


# Overall findings from images

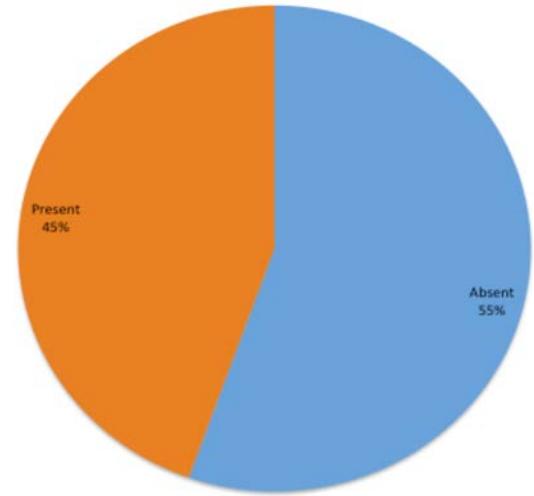
- 65 online press documents
- 59 PSOs



- Colour of inhalers



- Type of inhalers



- Spacer present in an image with a MDI



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# PSOs vs Online press

<b>Depictions in inhaler images</b>	<b>Online press</b>	<b>PSOs</b>
	<b>Online press</b>	<b>PSOs</b>
<b>Exacerbating factors</b>	Poor air quality Temperature Housing	Allergens Exercise Respiratory infections
MDI attached to a spacer	17	61

# PSOs vs Online press

Mentioned in documents at least once	Online press % (n=65)	PSOs % (n=52)
Stigma	45	0
Challenge themes	51	29
Fear themes	35	0

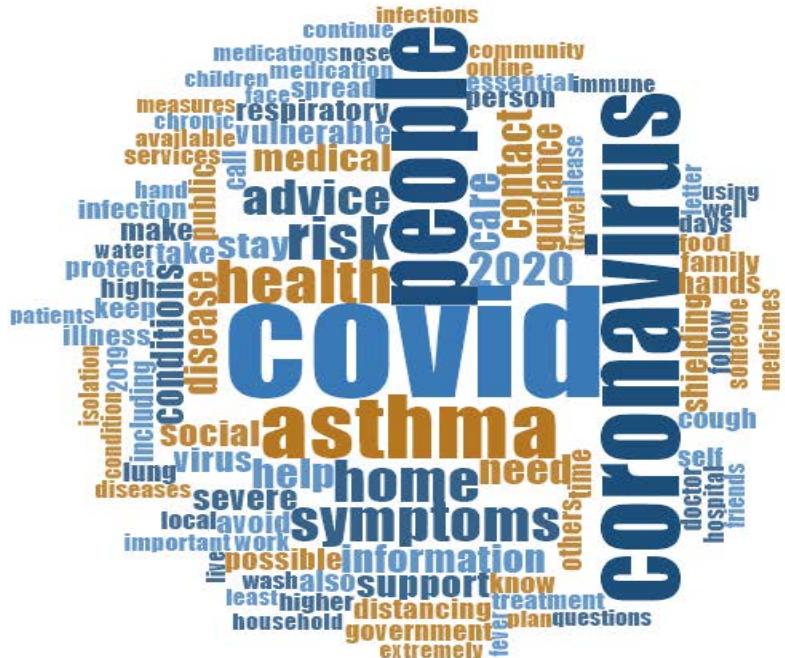
“James is considered a brittle asthmatic”.  
*Online press 37*

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“Alex’s asthma is serious, but it’s never stopped him from pursuing his passion for sport!”  
*PSO 4*

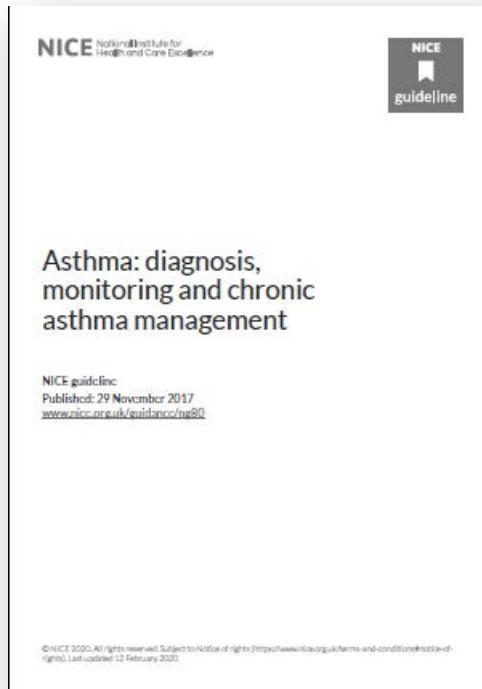
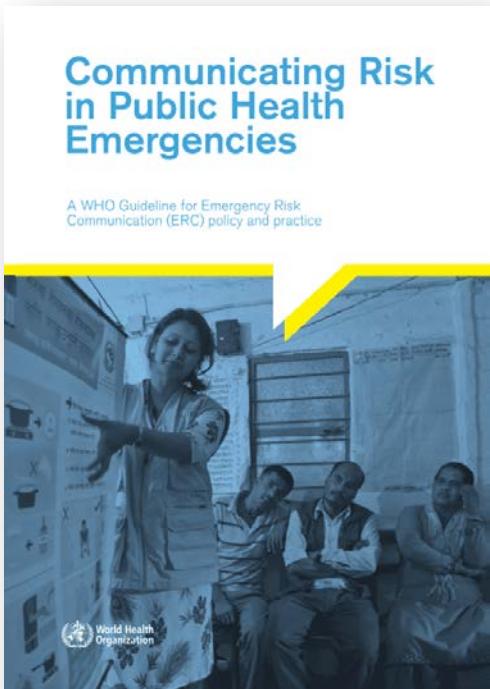
“Asthma is a killer and it destroys families, just like car crashes and everything else”.  
*Online press 32*

# Online asthma information and COVID-19



- A rapid review of COVID-19 information currently available online for people with asthma
- Global level and in five majority native English-speaking countries (NZ, Australia, Canada, UK, US)

# Methods



Downloaded online COVID-19 information aimed at people categorised as high-risk/those with respiratory conditions on 20 April 2020, and repeated 18 May 2020 to assess changes

Readability assessed using Flesch-Kincaid (F-K) grade level formula and the Simple Measure of Gobbledygook (SMOG) grade formula.

# Overall data



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- **102 webpages from 43 unique organisations** providing COVID-19 information for those categorised as high-risk
- Variation across/within organisations in **describing risk** e.g. high risk; increased risk; severe risk; more vulnerable.
- Categories used to describe those **who are at risk** varied across/within organisations
  - Asthma; severe asthma; respiratory conditions; long-term conditions; not well-controlled conditions.



# Findings

- All but one of the organisations provided information relevant to the WHO ERC guideline.
- **Average readability** equated to approximately a US Grade level 10 (15-16 years) (F-K:  $M=10.4$ , range=4.7-15.5; SMOG:  $M=9.9$ , range=5.5-15.8).
- **Changes to Information 4-weeks on:** Most (32 of 43, 74.4%) organisations stated to have reviewed or had updated their information by the second download date (18 May 2020)



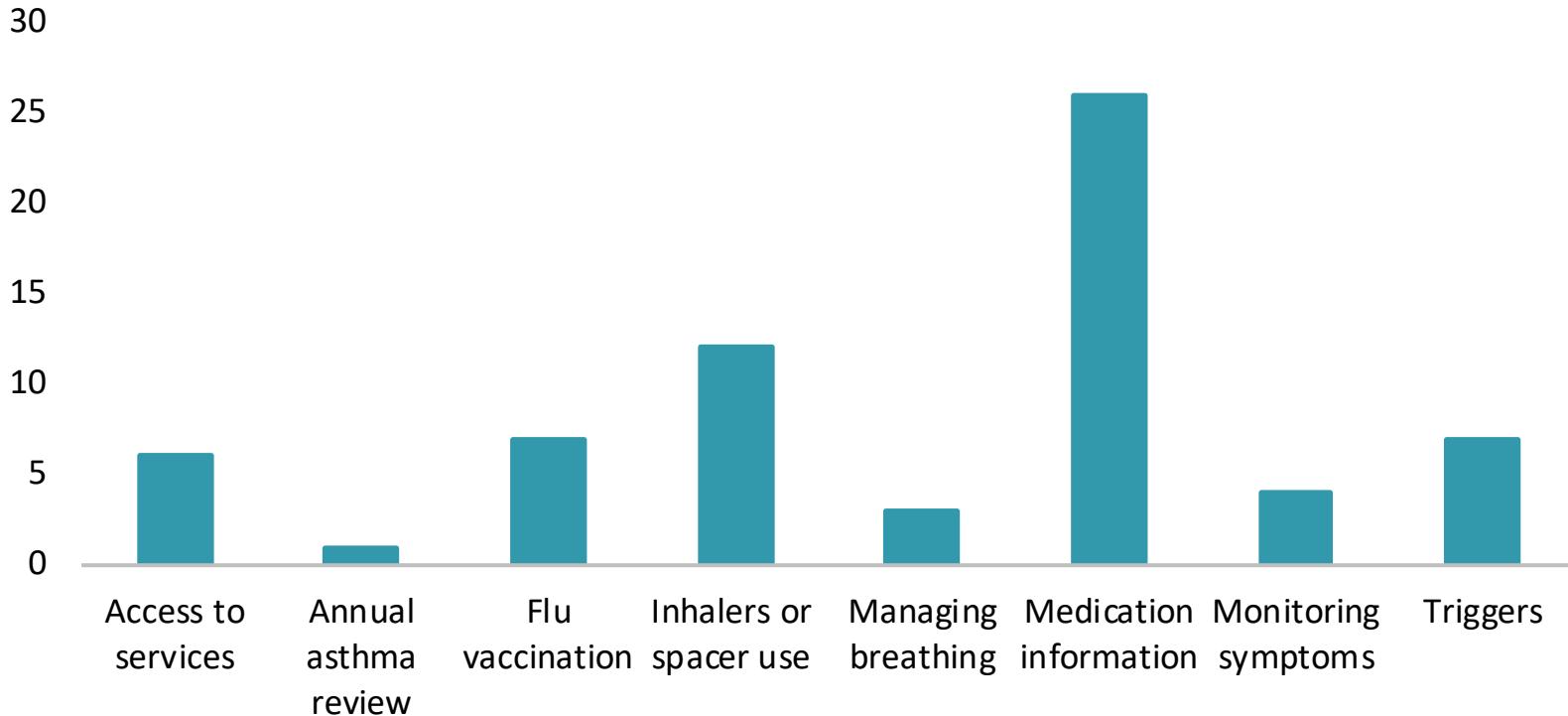
# Key themes

**Supported asthma self-management:** All but seven of the 43 information organisations provided information to support asthma self-management with their COVID-19 information (n=36, 83.7%)

**Over half (56%)** provided information that **was relevant to NICE asthma guidelines**, and only 14 (32.6%) referenced following an asthma action plan.

79% of information organisations provided other relevant asthma self-management information

# Relevant Asthma Self-management Information Themes



# Discussion

- Overrepresentation of blue and MDI inhalers in online press
- Absence of spacers with MDIs
- Online information sources can be powerful influencers of asthma care
- Awareness of what information patients and public have access to important
- PSOs continue to be a good resource



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# ARE WE READY FOR THE DIGITAL REALM?

WHAT DOES THIS LOOK LIKE?



Did I take my medication  
today?

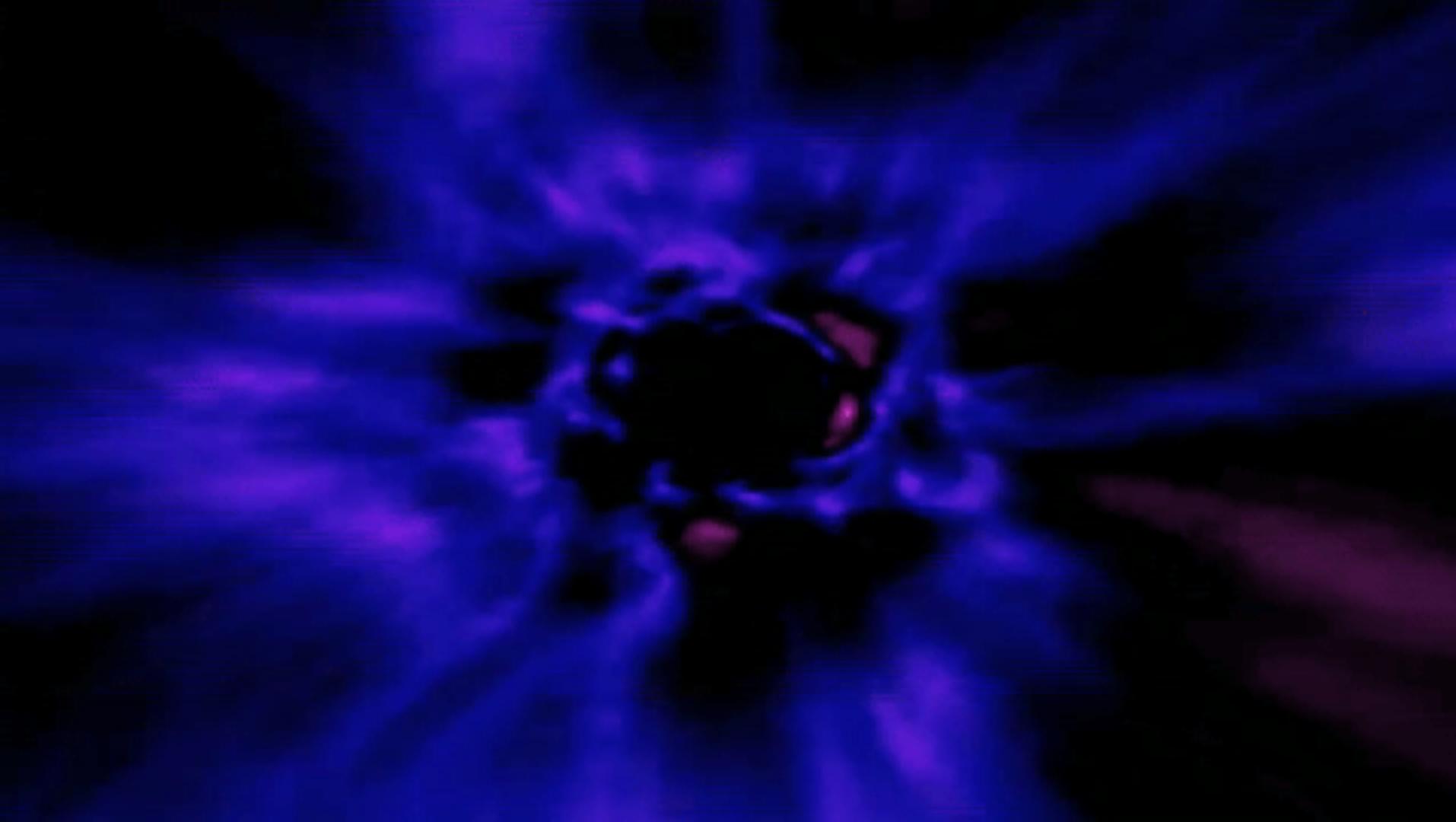


I'm not sure that's important  
Siri.



Thank you Siri.





# Information apocalypse



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