NICE National Institute for Health and Care Excellence

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HealthTech Programme

Medical Technologies Advisory Committee (MTAC)

Digital technologies to support asthma self-management– 1st meeting

20 November 2025

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Link to SCM register for topic:	specialist-committee-members-2

The following documents are made available to the Committee:

1. Cover sheet
2. Final Scope [noACIC]
3. External assessment report overview (ARO) [ACIC]
4. Patient group, professional group and NHS organisation submissions
   4a. British Thoracic Society - Professional Organisation submission [no ACIC]
5. Patient Survey [REDACTED]
6. Updated External assessment report (EAR) dated 13.11.25 including track changes version and a table of change at the beginning of the document.
   6a. EAR Track changes [ACIC]
   6b. EAR clean [ACIC]
7. External Assessment Group (EAG) response to stakeholder comments on EAR and model [ACIC]
8. Register of interests [noACIC]

The EAR and economic model are also available on the NICE Docs link: NICE Docs - Digital technologies to support asthma self-management

NICE National Institute for Health and Care Excellence

NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

HealthTech Programme

Digital Technologies to Support Asthma Self-management: Early Value Assessment

Final scope

August 2025

1 Introduction

The NICE prioritisation board agreed that digital technologies to support self-management of asthma have the potential to address system needs in asthma management based on a topic intelligence briefing. This topic is being evaluated by the NICE HealthTech Programme as an early value assessment (EVA).

2 Technologies

This section describes the properties of digital technologies to support self-management of asthma based on information provided to NICE by manufacturers and experts, and publicly available information. NICE has not carried out an independent evaluation of these descriptions.

2.1 Purpose of the technologies

Asthma is a common long-term condition in the UK, and around 5.4 million people are receiving treatment and support. Despite the availability of effective treatments and national clinical guidelines, suboptimal asthma control is common and leads to emergency department visits, hospital admissions, and avoidable deaths. The NICE guideline on asthma: diagnosis, monitoring and chronic asthma management (NG245) highlights the significance of personalised asthma action plans and patient education to improve asthma control. But despite clear guidance many patients still lack

structured self-management support. Clinical experts also highlighted that they often see poor engagement with written action plans and noted that a tool to make them more easily accessible on a digital device (such as a mobile phone) could improve this. They, alongside the health innovation network, highlighted other key problems with asthma control including improper inhaler use, non-compliance with medications, and lack of tailored advice to suit individuals during acute phases. These problems are especially prevalent among young people, disadvantaged groups, and those newly diagnosed. They also noted that service availability, and inequalities were barriers to accessing care.

Key national policy documents, including Fit for the future: 10 Year Health Plan for England, highlight the increasing use of digital technology and identifies respiratory medicine as one of the priority areas. Digital health technologies are emerging as potential tools to address unmet needs in asthma self-management, particularly where traditional approaches fall short. These technologies are designed to support individuals to take a more active and informed role in managing their condition. These tools could help personalise care by tailoring recommendations to each person's symptoms and triggers. They may promote adherence to medication and personalised asthma action plans through reminders and educational content, enable real-time symptom tracking and improve access. The use of digital technologies to support asthma self-management could help to reduce exacerbations, support symptom management and improve the quality of life for people with asthma.

2.2 Product properties

The scope includes digital technologies that support self-management of asthma. These technologies vary in terms of target population, the mode of delivery (via mobile applications or online platforms), the components and functionality offered, and the frequency and level of support provided by healthcare professionals.

Inclusion Criteria

For this EVA, NICE will consider digital technologies that are in line with the NICE asthma guideline recommendations on self-management which emphasise the importance of a personalised asthma action plan (PAAP) and

education. Clinical experts highlighted that tracking or self-monitoring of symptoms or lung function would also be a key component to assist people in following their PAAPs.

The technologies should as a minimum offer an asthma supported self-management programme which must include at least the following components:

- a PAAP,
  - based on symptoms or peak expiratory flow (PEF, or both); symptom based is preferred in children
  - including approaches to minimise exposure to indoor and outdoor air pollution and personal triggers for symptoms and exacerbations
  - including treatment regimen (inhaler use) for when asthma control deteriorates, and what to do if symptoms do not improve and advice on contacting healthcare professionals
- information and evidence-based education on self-management
- symptoms and lung function monitoring/tracking.

The technologies should generally function independently of clinical oversight from healthcare professionals. Therefore, functionality such as remote monitoring by a clinician or virtual ward use will not be assessed as part of this EVA even if the technologies include this functionality.

Technologies that can be used by adults, young people, children and families or carers will be considered.

Technologies should meet or actively be working towards regulatory compliance and available or soon to be available for use within the NHS to be considered for the assessment.

For this EVA, NICE will not consider the following types of digital technologies:

- tele-healthcare or technologies whose main purpose is management/advice provided by trained healthcare professionals

- generic education without personalisation or feedback
- computerised decision support systems for people with asthma to support self-management
- technologies that collect data with no advice for action or empowering users e.g. symptom diaries
- those that aim to completely replace in-person assessments.

Nine technologies that meet the above criteria to support self-management of asthma have been identified.

Other components that were judged to be potentially useful by experts, but not essential include:

- tracking medication
- trigger/pollution alerts
- inhaler technique information or videos
- providing means of communication or support from healthcare professionals
- functionality to print or share particular elements such as sections of the PAAP with schools or other carers
- being able to tailor or personalise elements, for example education function to the user's level of understanding.

Some of the technologies identified also include some of these features.

2.2.1 Asthmahub (The Institute of Clinical Science and Technology - ICST)

Asthmahub is a class I CE marked patient app designed to support asthma self-management for adults over the age of 18. It was developed in collaboration with NHS Wales, people with asthma and asthma specialists, and is used across NHS Wales and West Yorkshire Integrated Care Board (ICB). The key features of the app include a PAAP, education videos (about inhaler technique and breathing exercises), symptom checkers, peak flow tracking dairy and medication guidance. Users can store details of their healthcare information, receive prompts and reminders for appointments, track physiological readings, record patient reported outcome measures and

access decision support tools to guide self-care and when to seek help. Physiological readings can be entered manually using built-in tools for tracking daily symptoms, medication adherence and peak flow measurements. No external device is required. The app is available in English and Welsh.

2.2.2 Asthmahub for Parents (The Institute of Clinical Science and Technology - ICST)

Asthmahub for Parents is another Class I CE marked app from ICST that aims to help parents or carers of children with asthma to learn about, monitor and manage their children's condition. The app has similar features to AsthmaHub, but is parent-focussed with child-specific education tailored towards parents.

2.2.3 AsthmaTuner (MediTuner)

AsthmaTuner is a Class IIb CE marked digital platform designed to support asthma self-management for individuals aged 6 years and over. All use by children and adolescents under the age of 18 must be under the supervision of their guardians. It is designed to support people with asthma to monitor lung function, symptoms and treatment at home. Users connect a MediTuner-compatible spirometer to the app, perform forced expiratory volume in 1 second [FEV_1] tests, answer symptom questions, and receive real-time feedback and personalised medication recommendations based on their current status. The platform also tracks environmental factors like pollen and weather, offers reminders for medication and lung testing, provides inhaler technique training and enables data sharing with healthcare providers. It delivers individual tailored treatment plans based on symptoms and lung function, which is aligned with professional guidance via its CarePortal – a web interface for healthcare professionals. The app is currently not available in the NHS but will be introduced in 2026. The app is multilingual, supporting English, Swedish, Danish and Norwegian.

2.2.4 Digital Health Passport (Tiny Medical Apps)

The Digital Health Passport is a class I CE marked app designed to support children and young people with asthma. The company noted that the primary

audience for the Digital Health Passport is young people aged 13–25 living with asthma and allergies, but it can also be used by parents of children aged 5 to 12, and people aged 26 and over. This app was co-produced by young people, school nurses, general practitioners (GPs), and asthma specialists in collaboration with NHS England, NHS Wales and Asthma + Lung UK. The key features of this app include a PAAP, emergency health plan, inhaler technique training, symptom tracking, medication reminders and reordering, environmental alerts, health education modules and ACT (Asthma Control Test) score tracking and a dashboard for clinicians to manage patients. The app also has NHS login integration. This app has been selected by the NHS England Innovation Technology Payments Evidence Generation Fund for use by Greater Manchester Health and Social Care Partnership and Sheffield Children's Hospital. It is currently used across several ICB regions in the NHS. The app is available only in English.

2.2.5 Luscii (Luscii healthtech B.V)

Luscii is a Class IIa CE-marked digital platform designed to support asthma self-management for people of all ages. The app includes features such as the Asthma Control Questionnaire, medication adherence tracking, home spirometry and fractional exhaled nitric oxide [FeNO] testing (with Bluetooth connected spirometer and FeNO device), and symptom monitoring. The app provides a PAAP based on Ardens Action plan, which is currently symptom based. Healthcare professionals can access all information via a web-based dashboard at all times. Data can be exported directly from the dashboard by users. Annual reminders can be sent to prompt annual asthma reviews. Deterioration in symptoms also prompts the patient for an asthma review. Trends over different time periods can be viewed in a graphical format to aid asthma reviews and track symptoms and response to treatment. It also delivers educational content via text and embedded videos. Luscii is providing the asthma self-management programme at NHS Dorset. The app is currently available in English, Dutch, German, French, and Portuguese.

2.2.6 MyAsthma (my mHealth)

MyAsthma is a class I CE marked web-based digital application that is designed to support people with asthma (including severe asthma) to manage

their condition. The app also allows clinicians to monitor and support care remotely. This is a UK based app and was co-developed by people with asthma, experts and the public and is now used as part of routine asthma management within some NHS trusts. The app is aimed at people 13 years and over. The key features include a PAAP, educational course (covering all the topics recommended by NG245), peak flow and symptom tracking, monitoring trends of lung function, recording physical activity and reporting adherence to medication. The platform facilitates the completion of assessments suitable for mild, moderate and severe asthma (Asthma Control Questionnaire, Severe Asthma Questionnaire, Exacerbation Questionnaire, Mini Asthma Quality of Life Questionnaire). Other features include environmental alerts, medical appointment diary, inhaler instruction videos, mind toolkit (10 short videos supporting anxiety management, mind exercises and meditation), smoking cessation advice and support, clinician messaging and a patient dashboard for clinicians to manage patients. For people with severe asthma, myAsthma Plus part of the myAsthma app supports the use of and monitoring of biologic therapy. This is being used by 11 severe asthma centres in the NHS. The app is available only in English.

2.2.7 NuvoAir Home (NuvoAir Medical)

NuvoAir Home is a Class Im CE-marked medical device and a digital platform to support asthma self-management for people aged 5 years and over. The platform links with other Bluetooth-enabled devices, such as a spirometer, inhaler sensors, cough monitor, and activity tracker. The key features of this app include tailored guidance and feedback on inhaler technique and symptom prevention, lung function monitoring, symptom and medication tracking, a PAAP, activity log, display air quality data, personal insights on lung health trends and data sharing with healthcare professionals for remote monitoring. The app is available only in English.

2.2.8 Respiratory Disease Management Platform (RDMP) (Aptar Digital Health)

Aptar Digital Health Respiratory Disease Management Platform (ADH RDMP) is a CE marked self-management platform designed to support people with asthma. The patient mobile app (Respi.me) connects to an inhaler sensor

(HeroTracker® Sense) that monitors medication adherence and inhaler technique. The key features of the patient app include a PAAP, real time tracking of inhaler technique, lung function recording (FEV_1, FVC and PEF via Bluetooth connected spirometer), medication adherence and reminders, symptom and trigger tracking, physical activity tracking, and tailored education. The app connects to Respi.me Connect portal, enabling real-time data sharing with healthcare professionals for remote patient monitoring. The platform is currently being evaluated in clinical studies, including one at Guy's and St Thomas' NHS Foundation Trust, to evaluate the impact on asthma patients. The app is currently available in English, German, French, Italian and Spanish.

2.2.9 Smart Asthma (Smart Respiratory Products Ltd)

Smart asthma is a class IIa CE marked app designed to help people manage their asthma. It is intended for users aged 5 and over and their carers. It is a UK based app currently used in trials and ongoing evaluations across several NHS trusts. The key features of this app include a PAAP, peak flow tracking (via a digital smart peak flow meter), inhaler technique training, inhaler and medication use tracking (with smart inhaler assistant), daily symptoms logging, education content, AI powered alerts, personalised reminders, remote monitoring and data sharing with healthcare professionals (via email) for review. The app is available in multiple languages.

3 Target condition

Asthma is a long-term condition of the airways in the lungs that can affect children, young people, and adults. It happens when the airways become swollen and narrow due to allergies or other stimuli, making it hard to breathe. This can cause symptoms such as recurring episodes of wheezing, shortness of breath, chest-tightness and coughing. The symptoms may get worse over time and can limit a person's ability to undertake daily activities. There may also be periods when people have flare-ups or exacerbations which can result in hospitalisation.

3.1 Epidemiology

Asthma is the most common lung condition in the UK, with around 8 million people (over 12% of the population) diagnosed, and 5.4 million currently receiving treatment. Asthma prevalence is thought to have plateaued since the late 1990s and has been declining over time. Wales (15.6%) and Scotland (13%) have higher asthma prevalence than England (9.7%) and Northern Ireland (7%).

There are 60,000 hospital admissions and 200,000 bed days for asthma per year in the UK. Between 2019-2022, average winter asthma hospital admissions were 130% higher than summer admissions.

Chronic lower respiratory diseases (including asthma and chronic obstructive pulmonary disease) were reported as the third most common cause of mortality in England and Wales in 2023 (Office for National Statistics, 2025). The UK still has some of the highest rates worldwide and on average 4 people a day die from asthma and someone has a potentially life-threatening asthma attack every 10 seconds. Two thirds of these deaths are preventable with better care and management.

Healthcare and societal burden and costs of asthma

Asthma poses a significant financial burden on the UK NHS. Analysis by Asthma + Lung UK estimates the direct costs to the NHS in 2023 at £1.3 billion. The majority of these costs were related to primary care services (74%), mainly 60% for prescriptions and 14% for consultations followed by 13% for disability claims and 12% for hospital care. Average management costs to the NHS of a person with uncontrolled asthma are 62% or £378 higher than someone with controlled asthma per year. In addition, the indirect costs were estimated to be £4.5 billion, mostly due to lost productivity (70%) and £833 million from reduced working hours due to sick days taken or to attend a healthcare appointment.

4 Current management and care pathway

4.1 Treatment and management of asthma

The NICE guideline on asthma: diagnosis, monitoring and chronic asthma management (NG245) and asthma pathway (NG244) provides recommendations on diagnosing, monitoring and managing asthma in adults, young people. They recommend a stepwise approach to treatment based on symptom control and severity. They emphasise diagnosis using objective tests, regular monitoring reviews, a personalised asthma action plan (PAAP), and patient education to support long-term self-management. The aims of treatment are to help people control their asthma symptoms, reduce the frequency and severity of asthma attacks, prevent sudden exacerbations, and improve longer term health outcomes and quality of life.

4.2 Care pathway

In the UK, self-management is central to the asthma care pathway. The national guidelines including NG245 and NG244 recommend that people over age of 5 diagnosed with asthma are offered a self-management programme which includes:

- A documented PAAP based on symptoms or peak expiratory flow (or both) for adults, with symptom-based plans preferred for children. It should include:
    - Information on asthma triggers, including indoor and outdoor air pollution and smoking.
    - Guidance on how to minimise exposure to these triggers.
    - Guidance for adults using inhaled corticosteroids on increasing the dose for 7 days when asthma control worsens and clear instructions on how and when to do this and what to do if symptoms do not improve.
- Review and reinforcement
    - The PAAP is reviewed during hospital admissions, virtual ward admissions, acute consultations in primary care or emergency departments, and annual reviews by trained healthcare professionals.

    - Ensure the person understands how to use the action plan.
- Self-monitoring and support
    - Advice on when to contact a healthcare professional if asthma control deteriorates.
    - Use of appointment reminders, structured asthma review protocols, and IT-based tools to support ongoing care.
    - Telephone calls to provide support and advice.
- Community and school involvement
    - In-school asthma education programmes delivered by trained personnel.
    - Support from pharmacists, community workers, and healthcare teams, especially in deprived or ethnic minority communities.
- People-centred approach
    - Education aligned with NICE guidelines on individual's experience
    - Empowers individuals and families to take an active role in managing asthma and making informed decisions about care.

The guidelines also recommend considering a self-management programme including an action plan and education for the families or carers of children under 5 with suspected or confirmed asthma.

4.3 Position of digital technologies to support asthma self-management in the care pathway

Digital technologies could be offered as an adjunct to standard asthma care, enhancing key components of self-management. Digital technologies can enhance PAAPs by providing interactive digital versions, tailored digital content and real-time symptom and medication use tracking. These tools could be offered after diagnosis, treatment initiation, and during routine reviews. They could be offered in different settings such as GP surgeries (primary care setting), hospitals or specialist clinics (secondary care setting), tertiary centres and in the community via pharmacies or schools. They could also be used by carers, parents and community workers to support children or individuals who are unable to manage their condition independently.

The use of digital technologies would not replace regular review by healthcare professionals.

5 Comparator

The comparator for this assessment is standard asthma self-management programmes compromising a written PAAP and education based on a patient's underlying asthma severity and treatment, without the use of digital tools.

6 Decision problem

Decision question	Does the use of digital technologies to support self-management of asthma have the potential to be clinically and cost-effective in the NHS?
Population	People with a confirmed diagnosis of asthma, their families, or carers
Subgroups	Depending on the availability of evidence, the following subgroups may be considered: • adults (aged 17 and over) including families or carers • young people/adolescents and children aged 5 to 16 including families or carers • families or carers of children under 5 • people newly diagnosed • severe asthma • uncontrolled asthma/at risk of poor outcomes.
Intervention	Digital technologies to support self-management: • Asthmahub • Asthmahub for Parents • AsthmaTuner • Digital Health Passport • Luscii • MyAsthma • NuvoAir Home • Respiratory Disease Management Platform • Smart Asthma
Comparator(s)	Standard asthma self-management programmes without digital support
Healthcare setting	Community, primary or secondary care, tertiary centres
Outcomes	The outcome measures to consider include:

	Intermediate outcomes
	• Inhaler technique (using checklists or standardised scoring tools like 'inhaler technique assessment tool')
	• Medication use (including use of rescue/reliever medication and type of inhaler)
	• Adherence/attrition rates
	• Number of referrals to specialists
	Clinical outcomes
	• Changes in symptoms/symptomatic improvement
	• Lung function (such as change in FEV_1 and FCV values, PEF or FeNO)
	• Asthma control (measured using validated tools such as childhood asthma control test [C-ACT], asthma control test [ACT], asthma control questionnaire [ACQ] or St George's respiratory questionnaire [SGRQ])
	• Symptom free days
	• Exacerbations or attacks
	• Mortality
	• Adverse events (such as respiratory infection)
	Patient-reported outcomes
	• Time off work (adults/parents/carers)/school (children/young people)-number of work/school days missed
	• Quality of life
	• Ease of use and acceptability
	• Patient perception of technology
	Costs and resource use
	Costs will be considered from an NHS perspective and Personal Social Services perspective. Costs for consideration may include:
	• Cost of the technologies including software, device, license fees, staff training, patient education, implementation, and ongoing operational costs
	• Costs and healthcare resource use associated with managing asthma and exacerbations such as:
	  ○ unscheduled hospital presentations such as emergency department visits or urgent consultations, adverse events, or complications
	• healthcare appointments/visits in all settings (community, primary, or secondary care) including tertiary asthma services
	  ○ length of hospital stay
	  ○ number of treatments and extent of treatments
	• staff time (including remote care).

Time horizon	The time horizon for estimating the clinical and cost effectiveness should be sufficiently long to reflect any differences in costs or outcomes between the technologies being compared.
Evidence gap analysis	Evidence gaps in clinical evidence and cost modelling should be identified to help direct further evidence generation.

6.1 Patient issues and considerations

The use of digital technologies could be helpful for people who have limited access to in-person care due to time restrictions, mobility or health issues, or geographical barriers such as living in rural areas. Some people may prefer the convenience of remote care from their home. Digital tools could enhance accessibility by offering flexible support and education for asthma management.

However, not everyone may feel confident using digital technologies. Users would prefer technologies that are easy to use, and are as inclusive and accessible as possible to all audiences. For example, by being available in different languages, digitally accessible and customisable to individual needs. Patient experts noted that digital technologies will not be accessible to everyone so should present an additional option rather than replace standard of care.

With an increasing move towards digital apps for self-management, patient experts emphasised the value of apps that also address co-existing conditions particularly for those with complex asthma.

Some people may worry about privacy, data security and consent. Others may be concerned about internet access, mobile data costs, or reduced contact with healthcare professionals. Digital tools should complement, not replace, face-to-face care, and it is important that the information they provide is accurate and up to date.

6.2 Implementation issues

System and infrastructure

Purchasing and subscribing to digital tools and ongoing technical support and updates would be needed. Interoperability and data sharing between devices and patient management systems is important but this might be limited due to different management systems used in primary and secondary care. For technologies that include a clinician-facing component, initial set up may require investment in IT infrastructure (devices, servers, secure networks, and internet connectivity) and integration with existing NHS systems.

Staff training

Staff would need training on using and supporting people to use digital tools. This may include attending training courses or watching training videos.

Costs

There would be ongoing operational costs such as maintenance, data storage, cyber security, and system and software updates.

Companies may offer different pricing models (per user, per licence). They may include additional fees for updates, support, and training.

Smaller service areas including rural areas may have higher costs per user due to not needing as many licences for the technology.

6.3 Equality issues and considerations

NICE is committed to promoting equality of opportunity, eliminating unlawful discrimination, and fostering good relations between people with particular protected characteristics and others. Age, sex, disability, race, ethnicity and religion or belief are protected characteristics under the Equality Act 2010.

Gender and age: Male sex is a risk factor for asthma in pre-pubertal children or childhood. Female sex is a risk factor for the persistence of asthma in the transition from childhood to adulthood and women may experience more severe symptoms and higher rates of hospitalisations. The prevalence of asthma increases as age increases because of hormonal differences, comorbidities, and environmental triggers. Asthma management strategies are tailored for different age groups. The digital technologies also differ by the populations they are intended for. Some tools are designed specifically for

children, adolescents, or adults based on usability, safety, and regulatory considerations.

Geographical health disparity and socioeconomic status: People from deprived areas are three times more likely to have asthma, and have significantly worse outcomes and are more likely to be hospitalised than people from affluent areas. Also, they may have greater exposure to environmental triggers such as poor air quality, poor housing, and higher rates of smoking. People in these areas may face challenges with health literacy, which could make it more difficult for them to effectively self-manage their asthma.

Digital access: Digital technologies may improve asthma care by offering an alternative support format to in person appointments for those with mobility issues, poor transport access and geographical barriers. Regular access to a device with internet access is needed to use the technologies, but some people may not have access to appropriate equipment or internet. Some people may also prefer to use non-digital methods because of low health literacy or they may be less comfortable or skilled at using digital technologies. Additional support and resources may therefore be needed for people who are unfamiliar with digital technologies or people who do not have access to smart devices or the internet. The NHS England RightCare asthma toolkit highlights that self-management support should be equitable and accessible to people with varying levels of health literacy.

Ethnicity: In the UK, people of South Asian origin experience excess morbidity and three times higher hospitalisation rates compared with the White British population. South Asian children are more likely to have uncontrolled symptoms and hospital admissions with acute asthma compared with White British children.

People's ethnic, religious, and cultural background may affect their views of digital technologies for supported self-management. The NHS RightCare asthma toolkit highlights that self-management support should be culturally appropriate and available in different languages. Including accessible

language and culturally relevant content helps reduce health inequalities and promotes access for all.

Sexual orientation and gender reassignment: LGBTQ+ individuals may experience higher rates of asthma diagnosis and poorer health outcomes compared to heterosexual people. Lung function tests (like peak flow and FEV_1) may use sex-based reference values that risk misrepresenting results for transgender individuals.

Disability: Some individuals with more severe asthma, especially those with comorbidities may be covered by the Equality Act 2010 if their condition has had a substantial adverse impact on normal day to day activities for over 12 months or is likely to do so.

People with a visual, hearing, or cognitive impairment, problems with manual dexterity, a learning disability, mental health difficulties, those with language and communication difficulties (including people who cannot read English or understand health related information) or people with neurodivergent conditions may need additional support to use digital programmes for self-management.

6.4 Other issues for consideration

Asthma seasonal variation

Seasonal variation significantly affects asthma self-management, as symptoms often worsen during certain times of the year due to triggers like pollen, cold weather, viral infections, and air pollution. These fluctuations can make it harder for people to maintain consistent control and anticipate exacerbations. Digital technologies may be able to support better self-management by tracking symptoms over time, providing personalised alerts based on seasonal risks, and offering tailored guidance to adjust treatment plans accordingly. This may help people stay proactive and better manage their asthma throughout the year.

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August 2025

Early-value assessment

GID-HTE10063 Digital technologies to support asthma self-management

Assessment report overview

This overview summarises key information from the assessment and sets out points for discussion in the committee meeting. It should be read together with the final scope, the external assessment report. List of abbreviations used in this overview is in appendix A.

1. The technology

Digital technologies aim to support asthma self-management by providing personalised asthma action plans, tailored education and tools for tracking symptoms and medication. These features may improve adherence, asthma control, reduce exacerbations and improve quality of life.

Technologies included in the scope vary in terms of target population, the mode of delivery (apps, online platforms and additional hardware requirements), and the components and functionality offered. The scope specified that as a minimum, the technologies should include access to a personalised asthma action plan (PAAP), information and evidence based education on self-management, and symptom and lung function tracking/monitoring. It also specified that they should function independently of clinical oversight from healthcare professionals such as remote monitoring.

Digital tools are offered after diagnosis, treatment initiation, and during routine reviews and can be offered in different settings such as GP surgeries (primary care setting), hospitals or specialist clinics (secondary care setting), tertiary centres and in the community via pharmacies or schools. They could also be used by carers, parents and community workers to support children or individuals who are unable to self-manage their condition.

Nine technologies are included in the scope of this assessment. One technology, NuvoAir, has been excluded because it did not meet the inclusion criteria specified in the scope. The evidence for the remaining 8 technologies is presented in this document and EAR (shown in table 1). Seven technologies are currently in use within the NHS and 1 (AsthmaTuner) reported a planned release in 2026. The technologies included in this assessment are shown in table 1.

Table 1:Interventions

Technology (Company)	CE/UKCA mark	Target users	Mode of delivery/function	Additional device	Upfront costs inc hardware	Per patient/ year costs
Asthmahub & Asthmahub for parents (ICST)	Class I	18 years and over Children and their parents.	Mobile app	Smartphone	£33.42	£7.46†
Digital Health Passport (Tiny Medical Apps)	Class I	5 years and over and their carers	Mobile app	Smartphone	£81.42	£7.46†
MyAsthma (myAsthma plus/myAsthma Biologic for severe asthma] (my mHealth Limited)	Class I	13 years and over	Both mobile app and web-based access	Smartphone or web enabled device, compatible with wearable devices, smart inhalers.	£39.42	£37.46†
Respiratory Disease Management Platform (RDMP with BreatheSmart/Respi.me) (Aptar Digital Health)	Class I	16 years and over and clinicians	Patient mobile app - limited offline features) and clinician web app.	Smartphone, smart inhaler-(Herotracker Sense).	£116.42	£187.46†
Luscii (Luscii healthtech B.V)	Class IIa	All age groups and clinicians	Patient mobile app (limited offline function);	Smartphone, compatible with smart inhalers.	£12.92	£187.46†

Technology (Company)	CE/UKCA mark	Target users	Mode of delivery/function	Additional device	Upfront costs inc hardware	Per patient/ year costs
			web-based clinician dashboard.			
Smart Asthma (Smart Respiratory Products Ltd)	Class IIa	5 years and over and their carers.	Mobile app (limited offline function) and clinician (telemedicine dashboard).	Smart mobile device, portable spirometer (smart Peak Flow Peak Expiratory Flow Meter), Bluetooth adapter.	£71.07	£7.46†
AsthmaTuner (MediTuner)	Class IIb	6 years and over and clinicians.	Patient facing mobile app and clinician web portal.	Smartphone, portable spirometer (Peak Flow Meter), Bluetooth adapter.	[redacted]	[redacted]
[redacted] Cost of technology, applied per patient per year (fixed annual cost covering software and maintenance): two technologies (DHP and Asthmahub) were assumed to be free for patients. Other costs have been included for these technologies (fee is charged up front per area i.e. per integrated care system).						

2. The condition

Asthma is a long-term condition of the airways in the lungs that can affect children, young people, and adults. It happens when the airways become swollen and narrow due to allergies or other stimuli, making it hard to breathe. This can cause symptoms such as recurring episodes of wheezing, shortness of breath, chest-tightness and coughing. The symptoms may get worse over time and can limit a person's ability to undertake daily activities. There may also be periods when people have flare-ups or exacerbations which can result in hospitalisation.

3. Current practice

Asthma self-management is described in the national guidelines including NG245 and NG244 which includes a number of recommendations. A key recommendation is that people over the age of 5 diagnosed with asthma are offered a self-management programme that includes:

- A Personalised Asthma Action Plan (PAAP) based on symptoms or peak expiratory flow (or both), with symptom-based plans preferred for children. It should include information on minimising exposure to asthma triggers, and guidance on increasing their inhaled corticosteroids dose when asthma control worsens with clear instructions on how and when to do this and what to do if symptoms do not improve. This should be reviewed regularly.
- Advice on when to contact a healthcare professional if asthma control deteriorates.
- Education aligned with NICE guidelines on individual's experience.

The guidelines also recommend considering a self-management programme including an action plan and education for the families or carers of children under 5 with suspected or confirmed asthma.

The comparator used in the assessment is standard asthma self-management programmes comprising a written PAAP and education based on a patient's underlying asthma severity and treatment, without the use of digital tools.

4. Unmet need

Suboptimal asthma control is common and leads to emergency department visits, hospital admissions, and avoidable deaths. Many patients lack structured self-management support and clinical experts report poor engagement with written action plans, incorrect inhaler use/technique, non-adherence with medications, and lack of tailored advice, especially among young people, disadvantaged groups, and those newly diagnosed. They also noted that service availability, and inequalities were barriers to accessing care.

Digital health technologies offer a solution by providing personalised, accessible tools that support key aspects of self-management. These include interactive or digital PAAPs, tailored educational content, medication adherence including inhaler technique, and real-time tracking of symptoms and medication use. These technologies can improve access through personalised support, reduce inequalities in care, engage younger patients through user friendly platforms. They aim to improve adherence to PAAPs and medication, improve asthma control, reduce exacerbations and improve quality of life.

5. Innovative aspects

Digital technologies designed to support asthma self-management include a range of features and functionality, such as interactive PAAPs, sensors/smart inhalers to detect inhalation technique and communicate with apps or software platforms, tailored notifications and reminders to promote adherence, environmental and trigger alerts, personalised education and support, real time symptom monitoring, lung function and medication tracking, and data sharing with healthcare professionals (HCPs) to enable informed clinical decision making.

These technologies also vary considerably across several other areas including target population (children, adults with those with varying disease severity), mode of delivery (mobile applications, web-based platforms),

duration and frequency of intervention (short term versus long term support), and level of healthcare professional involvement (ranging from regular feedback to automated systems and teleconsultations). Further details, including descriptions of the interventions, comparator, care pathway and outcomes, are in the final scope.

6. Clinical effectiveness

The external assessment group (EAG) did a search to identify relevant published clinical evidence, which was supplemented by company responses to requests for information from NICE. The search and selection methods are described in section 4.1 of the external assessment report (EAR).

6.1 Overview of key studies

The EAG reviewed evidence on digital technologies that support self-management of asthma compared with standard asthma self-management. A total of 25 studies were identified. Of these, 20 studies reported quantitative data, primarily focusing on clinical effectiveness, while 7 studies (on 4 technologies) provided qualitative data exploring patient perspectives, usability, and acceptability. Quantitative evidence was available for all technologies included. An overview of these are presented in table 2.

Table 2 key studies included in evidence

Technology	Number of studies	Type of study	Country	Population (n)	Setting	Follow-up
Asthmahub	3 (1 published study and [redacted])	Retrospective cohort (pre versus post; Barry 2025)	UK (Wales)	11,062 (assumed adults, over 18 years)	Primary and secondary care	4 or more months
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Asthmahub for parents	1 unpublished report	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
AsthmaTuner	1 publication	Pilot cross-over RCT (Ljungberg (2019)	Sweden	90 children aged ≥ 6 years and adults 77 assessed	Primary care and specialised paediatric healthcare	8 week, with a 2-4 week washout, then another 8 weeks.
RDMP (BreatheSma	5 (1 full publication, 2	Prospective cohort (pre versus post, Ramsey 2022)	USA	26 in Step 1 and 17 in Step 2; with moderate or severe persistent	Unclear	Step 1: 7 to 11 weeks; step 2: 12 to 16 weeks.

Technology	Number of studies	Type of study	Country	Population (n)	Setting	Follow-up
rt/Respi.me app)	published conference abstracts and [redacted]			asthma; (mean14.7 years)		
		RCT abstract (Simoneau 2019)	USA	75 children aged 8 to 17 with confirmed asthma. (intervention, n=50, standard care, n=25); mean age 12 years	Paediatric pulmonary clinic	3-6 months
		Prospective cohort (pre versus post; Biljani 2024) abstract	USA	104 adults	Unclear	3 months
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Digital Health Passport (DHP)	4 1 published and ***	Prospective cohort: pre versus post (service evaluation, UCL Partners 2024)	UK	1,106 users (80% over 13 years old)	Unclear	3 months
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Technology	Number of studies	Type of study	Country	Population (n)	Setting	Follow-up
Luscii	1 published abstract	Prospective cohort (Gijisen 2024)	The Netherlands	40 children and young people aged 6 to 18.	Unclear	12 weeks
myAsthma	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Smart Asthma	3 studies (1 prospective cohort study and 2 published abstracts)	1 prospective cohort study (Thamjamratsri 2024).	Thailand	77 children (aged 7 to 17 years old)	Secondary and tertiary care.	3 months.
		1 abstract (Ananth 2023); study design unclear.	UK (based on author affiliations).	App users who were sent two surveys in August 2022 (n=343) and December 2022 (n=42) (no demographic information reported).	Unclear	August 2022 and December 2022.
		1 service evaluation (Antalffy 2025, abstract).	UK and Ireland	Adults and children (n=182 families) using app across 26 NHS and Health Service Executive Ireland centres.	Unclear whether primary, secondary or tertiary care.	Unclear (appears to be 12 weeks).

Technology	Number of studies	Type of study	Country	Population (n)	Setting	Follow-up

Among the 5 full publications, study designs included, 1 pilot crossover RCT, 3 prospective cohort studies, and 1 retrospective pre–post cohort study, with sample sizes ranging from 26 to more than 11,000 participants. The studies were conducted across varied healthcare settings. Two studies were based in the UK, with Asthmahub (Barry 2025) in primary and secondary care and DHP (UCL partners 2024) in an unspecified setting. The other 3 studies (Ljungberg, 2019, Ramsey, 2022,Thamjamratsri 2024) were conducted in international settings (Sweden, USA and Thailand) across primary care, secondary and tertiary care and unspecified settings, limiting direct generalisability of their findings to UK NHS practice. There was limited reporting on healthcare setting in conference abstracts and unpublished reports.

Demographic and clinical details (age, sex, ethnicity, socioeconomic status, asthma control, comorbidities) were poorly reported across all studies. Populations varied by age (6 to 69 years), disease severity, and socio-demographics. Where reported, adults were included in 2 studies, children in 5 and mixed populations in 3, (of these one study using DHP targeted adolescents and their carers). In 10 studies the age of the study population was either not reported or unclear. Disease severity reporting was inconsistent across studies. Asthma control status also varied, with some studies including individuals with uncontrolled or partly controlled asthma.

Reported outcomes varied widely, focusing on clinical measures (asthma control, lung function) and patient-reported outcomes (quality of life), with fewer studies assessing intermediate outcomes (e.g., adherence, medication use). Four studies included and reported on parent/carer outcomes. Follow-up varied across studies and ranged from 7 to 16 weeks (short-term) in 8 studies to 4 to 6 months (medium-term) in 4 studies, with 4 unpublished studies reporting follow-up over 12 months. Four studies had unclear follow-up time.

Seven qualitative studies were identified for 4 technologies: AsthmaTuner (1 study), DHP (3 studies), myAsthma (2 studies) and Smart Asthma (1 study). Three were UK-based, 2 were assumed to be UK based due to contextual details, One study was based in both the UK and Ireland (Smart Asthma) and

1 in Sweden (AsthmaTuner). No qualitative evidence was found for other technologies.

6.2 Results

Full details of the outcomes of the clinical review are in section 5 and Appendix A and D in the EAR.

A summary of evidence reported for each technology is presented here.

Asthmahub

Evidence in adults

Evidence comprises 1 retrospective pre-post cohort study of 11,062 users (Barry 2025[8]) in UK and [redacted][9,10]).

Asthma control:

In a retrospective cohort study, among a subset of users who had at least one recorded app use, follow-up data available 4 or more months after their first use, and who completed the monthly asthma checker including the Royal College of Physicians 3 questions [RCP3Q] (n=1581), good asthma control scores of zero statistically significantly increased by 14% (from 26.5 to 41%; 95% CI 11.3 to 17; p<0.0001). A paired analysis in a further subset of users with RCP3Q scores available at baseline and at 1 year follow-up (n=133) confirmed a statistically significant improvement in asthma control (MD −0.31, 95% CI −0.52 to −0.09; p=0.0052) (Barry 2025).

[redacted]

Exacerbations

[redacted]

Medication use

There was a statistically significant increase in the proportion of people reporting zero weekly reliever inhaler use by 10.1% (95% CI 7.2 to 13.0;

p<0.0001) from 29.1 to 39.2%. The number of participants assessed was not reported (Barry 2025).

Overall, results suggest Asthmahub improves medication use and asthma control and reduction in GP visits, but evidence is limited to observational studies without comparator and self-reported outcomes reducing certainty.

Asthmahub for parents

Evidence in children (under 18 years)

Evidence is limited to [redacted][11]).

Exacerbations

[redacted]

Overall, Asthmahub for parents may improve exacerbations in children, but evidence is limited to one unpublished service evaluation.

AsthmaTuner

Evidence on children and adults

Evidence is limited to 1 small physician blinded crossover RCT (with 2 weeks of washout) comparing AsthmaTuner (for 8 weeks) with printed personalised treatment plans in 77 participants (37 adults and 40 children) with partially controlled and uncontrolled asthma (Ljungberg 2019[12]) and 1 qualitative study (Schoultz 2022[33]).

Asthma control

The crossover RCT reported that ACT/C-ACT scores statistically significantly improved in AsthmaTuner group overall (n=77) at end of visit (MD 0.70; 95% CI 0.06 to 1.34; p=0.03) and in paediatric populations (n=40, MD 0.97; 95% CI 0.13 to 1.81; p=0.02), but not in adults (n=37, MD 0.33, 95% CI −0.68 to 1.35; p=0.51). The study also showed no statistically significant ACT differences in symptom control after accounting for the crossover period in all participants (p=0.63) and in both adults (p=0.49) and children (p=0.23) (Ljungberg

2019).This study also noted that the proportion of participants with uncontrolled asthma decreased from 37% to 8% between weeks 1 and 9.

Medication use:

The crossover RCT found no improvement in adherence to medication in all participants using AsthmaTuner compared with those using printed plans. Among those who used AsthmaTuner once a week or more, no statistically significant improvement in MARS adherence scores were reported compared to conventional treatment (MD 0.27; 95% CI 0 to 0.55; p = 0.5). However, a statistically significant improvement was observed among adults in primary care settings (n=27, MD 0.45; 95% CI 0.13 to 0.77; p=0.01) (Ljungberg 2019).

Ease of use and perception

Qualitative evidence from a descriptive study of 5 nurses (using semi-structured interviews and content analysis) suggests AsthmaTuner may help patients recognise impaired asthma control earlier and make more timely medication adjustments, though engagement varied and some patients lost interest. Nurses reported the app was easy to use and perceived its measurement values as more reliable than PEF (Schoultz 2022).

Overall, AsthmaTuner appears acceptable and evidence in both adults and children suggests that it may improve asthma control and adherence to medication among engaged users, but evidence is limited to 1 small RCT and 1 qualitative study.

BreatheSmart/Respi.me (RDMP)

The evidence base is limited to 5 studies (4 in the USA and 1 in the UK).

Evidence in children (2 studies):

One published prospective cohort study in children with moderate to severe persistent asthma (n=30) evaluated a two-step intervention involving daily medication reminders via MedaCheck Habit (n=26), followed by telehealth behavioural support using the BreatheSmart (RDMP) app for those with low adherence (n=17) (Ramsey 2022[25]). Additionally, a small RCT (n=75)

compared the RDMP intervention (n=50) to standard care (n=25) over 6 months in children aged 8–17 years (trial record, Simoneau 2019 abstract[26]).

Asthma control

In the RCT (trial record[30], Simoneau 2019 abstract[26]), ACT scores improved at 3 months in both app and control groups but declined by 6 months remaining below 20, indicating uncontrolled asthma (app: 18.9 at baseline, 21.2 at 3 months and 19.7 at 6 months; control: 17.9 at baseline, 20 at 3 months and 17.9 at 6 months). No statistical testing was reported for ACT changes as data were derived from the clinical trial record[30]. ACT scores improved in the prospective study from baseline to follow-up but were not statistically significant. The two-step intervention including additional behavioural support makes it unclear whether any effects were attributable to the app alone (Ramsey 2022[25]).

Exacerbations

In the RCT, emergency department (ED) visits at 6 months were reported in 3 out of 50 participants in the intervention group and 3 out of 25 in the control group. Caregiver-reported ED visits for exacerbations classified as adverse events by authors) were similarly distributed (app: 3/50; control: 4/25). No additional data were available (clinical trial record[30], Simoneau 2019 abstract[26]).

Medication adherence

In the RCT (trial record[30], Simoneau 2019 abstract[26]), medication adherence at 3 months based on pharmacy records was statistically significantly higher in the app group compared with the control group (56% [16/29] versus 31% [6/14]; p = 0.05). However, by 6 months adherence declined, with similar mean proportion of days medication available between the groups indicating that improvement was not sustained over time (0.39 versus 0.33). In contrast, the prospective study (n=30) reported a statistically significant improvement in overall medication adherence from baseline to study end (MD 0.19; p = 0.048) but adherence declined in participants receiving reminders only at 11 weeks

(69 to 46%; p = 0.013).Those completing both steps (n=17) showed a statistically significant increase at 16 weeks (30 to 65%; p < 0.001) (Ramsey 2022[25]).

Lung function

In the RCT (trial record[30], Simoneau 2019 abstract[26]), lung function (measured by FEV_1 % predicted and FVC) remained within normal range (more than 80%) in both app and control groups throughout follow-up period. In the prospective study, lung function was maintained within normal range at 16 weeks but changes were not statistically significant (FEV_1% from 94.8 to 85.7, MD 6.7, 95% CI −3.04 to 16.44, p=0.163; FVC from 110.6 to 103.4, MD, 2.12, 95% CI 10.53 to 14.78, p= 0.730) (Ramsey 2022[25]).

Days off school/work

In the RCT, days off school increased in both groups with a mean 2.1 days in the app group (n=50) and 3.3 days in the control group (n=25) across a 30 day period at follow-up (trial record[30], Simoneau 2019 abstract[26]).

Ease of use/perception/acceptability

In the prospective study, among 26 participants who completed the study, satisfaction with the app was moderate, with 64% reporting they were satisfied (Ramsey 2022[25]).

Evidence in adults (3 studies)

One prospective cohort study (n=104) (Bijlani 2024 abstract[21]) and [redacted] were included.

Medication use

In a prospective cohort study (n=104), rescue medication use decreased by 44% at 3 months (95% CI: 14.1 to 63.5; p = 0.008) (Bijlani 2024 abstract[21]). Similarly,[redacted]

In the prospective cohort study (n=104), adherence to controller medication use was 45% higher than unspecified U.S. data and 17% higher than global data (the specific comparators were not clearly defined). However, adherence to controller medication use declined by 10.7% at 3 months (95% CI: 6.4 to 15.1) (Bijlani 2024 abstract[21]).

Asthma control

In the prospective study (n=104), there was a statistically significant improvement in ACT scores in 96 adults of 2.8 points (95% CI: 2.0 to 2.6; $p < 0.001$), indicating better asthma control (Bijlani 2024 abstract[21]). [redacted]

Medication adherence

[redacted]

Changes in symptoms/symptom improvement

[redacted]

Quality of life

[redacted]

Ease of use/acceptability/perception

In the prospective cohort study (n=104) user feedback indicated high acceptability with a mean rating 7.83/10; 82.5% found the platform easy to use and 92.5% found alerts helpful (Bijlani 2025 abstract[21]). [redacted]

Overall, BreatheSmart (RDMP) appears acceptable and may improve asthma control, quality of life, and reduce rescue medication use in adults, though adherence to medication findings are mixed. Evidence in children is limited and shows inconsistent effects on adherence and asthma control, with short-term gains that were not sustained. Most data are observational or unpublished, with unclear comparators, attrition, and methodological limitations. While user feedback indicates strong engagement and

satisfaction, interpretation of clinical impact is constrained by reliance on unpublished data, unclear definitions, and wide confidence intervals.

Digital Health Passport

Evidence in adults and children

Evidence is from 1 published real-world service evaluation of DHP (n=1,106) (UCL Partners 2024[13]) and [redacted]

Asthma control

In a real-world service evaluation of DHP (n=1,106), 200 users with uncontrolled asthma (177 adults, 23 children) completed ACT at baseline and 3 months. There was a statistically significant improvement in ACT scores in adults (mean 15.9 to 17.4, p<0.01), but not in children (mean 18.5 to 18.4, p=0.84). Adults were also considered in a stratified analysis where they considered adults self-reporting (n=162) and carers (n=15) separately, while the statistical significance was maintained for the self-reporting adults (p<0.01), this was not the case for carers (p=0.23). This is likely due to the reduced sample size (UCL Partners 2024)[13]. Participants interviewed (n=38) about the DHP reported mixed experiences: some noted fewer asthma attacks, attributing this to better inhaler use and risk minimisation, while others saw no clear link between app use and improved control (UCL Partners 2024)[13].

[redacted]

Exacerbations

In the real-world service evaluation no statistically significant changes were observed in exacerbation-related outcomes, including asthma attacks (from 1.02 to 0.93, p=0.48), number of steroids received (0.76 to 0.92, p=0.23), or urgent/ED visits (0.47 to 0.45, p=0.84) at 3 months (UCL Partners 2024)[13].

[redacted]

Days off school/work

In the real-world service evaluation, there was no statistically significant difference in days off school/work from baseline to 3 months (mean 2.23 to 1.77, p=0.29). (UCL Partners 2024)[13]. [redacted]

Quality of life

In the real-world service evaluation quality of life measured by EQ-5D showed no statistically significant improvement for adults (n=157; 0.69 to 0.68, p=0.88) or children using the EQ-5D-3L(n=10; 0.83 to 0.87, p=0.35) at 3 months follow-up. Quality of life in this evaluation was measured using a generic tool (EQ-5D) rather than a condition-specific instrument (UCL Partners 2024)[13].[redacted]

Ease of use/acceptability/perception and other qualitative findings

Qualitative findings in one study (n=38 users/parents/carers interviews) indicate high acceptability of DHP with 100% finding it easy to use, 97% intending continued use and 95% very satisfied with its overall functionality. Users reported improved asthma knowledge and self-management, flexibility to review data such as peak flow, and found inhaler technique videos highly useful and found medication reminders helpful for adherence and habit-building. Engagement varied, with some relying on alerts, while others used the app more actively during worsening symptoms. While most feedback was positive, a few users noted navigation challenges and conflicting advice (such as inhaler use in an emergency) and questioned the app's impact on asthma control. (UCL Partners 2024)[13].

[redacted]

Overall, limited observational evidence on the DHP suggests modest improvements in asthma control (ACT scores) among adults and users with uncontrolled asthma, but no significant change in exacerbation-related outcomes or quality of life. DHP shows acceptability with most users intending to continue use and reporting improved self-management knowledge. Studies lack clarity on population characteristics and long-term impact.

Luscii

Evidence in children

Evidence is limited to 1 prospective cohort study of 40 children (between 6 to 18 years) (Gijsen 2024-conference abstract[17]).

Asthma control

The study reported no significant improvement in asthma control from baseline at 3-month follow-up (median C-ACT score 22.5 to 24, p=0.063) (Gijsen 2024-conference abstract).

Lung function

The study reported no significant improvement in lung function at 3 month follow-up compared to baseline (Gijsen 2024-conference abstract).

Overall, the 1 small conference abstract suggests that there is no improvement in lung function and asthma control when using Luscii.

myAsthma

Evidence is from [redacted]

Evidence in adults

Exacerbations

[redacted]

Medication use

[redacted]

Ease of use/acceptability/perception and qualitative findings

[redacted]

[redacted]

Overall, myAsthma appears acceptable and evidence of clinical effectiveness particularly in adults is limited and based on unpublished data. Both evaluations reported reductions in exacerbation-related hospitalisations, ED visits, and acute care use, though lack of patient data limits interpretation. Mixed findings were observed for medication use, with one study showing reduced inhaler use and another showing no difference. User acceptability was consistently high across evaluations, with many reporting improved confidence in asthma management, though satisfaction varied among those with long-term conditions.

Smart Asthma

Evidence is limited to 3 studies: 1 prospective cohort study (Thamjamratsri 2024[27]) and 2 abstracts (Ananth 2023[28], Antalffy 2025[29]).

Adherence to peak flow monitoring

A prospective cohort study assessing Smart Asthma in 71 children (aged between 7 to 17 years) found decreasing adherence to peak flow monitoring over 3 months. Once daily adherence decreased from 86.7 to 70% at 3 months ($p < 0.001$) and twice daily adherence decreased from 50 to 39.9% at 3 months ($p < 0.001$) (Thamjamratsri 2024)[27]. Another study (abstract) found that 53.7% (22/41) of Smart Asthma users stated that their usage of the digital peak flow meter after 6 months was similar compared to initial use (Ananth 2023)[28]. Finally, a service evaluation (abstract) of 276 families showed that 66% (182/276) continued to use the Smart Asthma Virtual Monitoring Service but the proportion of families recording peak flow, symptoms and inhaler use declined over time. However, it was not possible to determine exact figures from the graphs provided in the abstract due to limited reporting (Antalffy 2025)[29].

Quality of life

The prospective cohort study of 71 children assessed quality of life with the Paediatric Asthma Quality of Life Questionnaire (PAQLQ), grouping participants by good (minimum of 45 readings over 3 months; n = 27) or poor

(n = 44) adherence to digital peak flow monitoring. For those with good adherence, there were statistically significant improvements in PAQLQ measures from baseline to 3 months follow up for overall PAQLQ scores and the domains of symptoms, activities and emotions. For those with poor adherence, no statistically significant differences were reported for any PAQLQ scores. 32.29% (23/71) of participants achieved the MCID (a change of 0.5 points) and 15 of them were in the poor adherence group ($p < 0.001$) (Thamjamratsri 2024).

Medication use qualitative findings

The service evaluation (abstract) stated that clinicians who had used Smart Asthma strongly agreed that the Smart MDI Sensor helped avoid unnecessary step ups in medication by identifying poor adherence. They strongly agreed that it empowered their patients to manage their asthma and to have better asthma control (Antalffy 2025)[29]. However, details in this abstract were limited and it is unclear how many clinicians were included and how this information was collected.

Ease of use/acceptability/perception

The prospective cohort study (n=71 children) reported the digital peak flow and Smart Asthma app were generally easy to use and accepted by the majority of patients, whether they had good or poor adherence.Device issues were reported, requiring replacements in 22 children, mainly due to display defects (44.4%), propeller defects (22.2%), and Bluetooth problems (11.1%), broken devices (7.4%), power defects (7.4%), charging defects (3.7%), and lost devices (3.7%) (Thamjamratsri 2024).

The UK based prospective cohort study (abstract) surveyed patients at two timepoints (August 2022, n = 343; December 2022, n = 41). In August (343 patients), 84.5% reported that it was easy to detect asthma deterioration based on peak flow data within the app (84.5%). By December (41 patients) 85.4% found digital peak flow meter was more useful than an analogue assessment, 65.9% shared their data to a healthcare professional and 44.4% reported that it led to changes in treatment (Ananth 2023)[28].

The service evaluation (abstract) across 26 NHS and HSE Ireland centres (including children and adults) found that patients reported the digital system more convenient than paper records and valued the ability to share data with clinicians and receive notifications (Antalffy 2025)[29].

Overall, most findings relate to the use of the digital peak flow meter and not specifically the Smart Asthma application, although both are likely to be used together. Three studies assessed Smart Asthma, focusing on adherence and patient-reported outcomes (quality of life, ease of use, acceptability), with no clinical outcomes reported. Two studies showed a decline in adherence to peak flow monitoring over time, while one found over half of users maintained similar usage at six months. Overall, patients found the app convenient, helpful for detecting deterioration, and preferred it to paper records, though device reliability issues were noted. Clinician feedback suggested potential benefits for asthma control despite unclear data collection methods.

Summary and interpretation of clinical evidence

Overall, the evidence suggests that digital asthma tools may improve asthma control and medication use. However, the evidence base is limited, with most studies being observational, unpublished, or lacking comparators. Reported improvements are often based on self-reported outcomes, short-term follow-up, and small sample sizes, reducing certainty. While some tools show promise, findings on medication adherence and exacerbation outcomes are mixed and inconsistent. Acceptability is generally high, but clinical impact is difficult to interpret due to methodological limitations, unclear definitions, and sparse data in children and adults.

Data on subgroups

Most studies focused on individuals with uncontrolled asthma, with limited evidence available for other subgroups such as those with severe asthma, newly diagnosed patients, children under 5, and their families or carers. Due to this lack of subgroup-specific data, subgroup analysis was not conducted.

6.3 Ongoing studies and evidence gap analysis

A total of 11 ongoing studies were identified from 5 manufacturers (6 technologies). An overview of ongoing studies can be found in table 16 in the EAR.

Table 17 in the EAR presents an evidence gap analysis for each technology based on the outcomes specified in the scope. This only considers quantitative evidence and the EAG considered the availability of comparative data, the quality of observational data, as well as the generalisability of this data to the UK NHS.

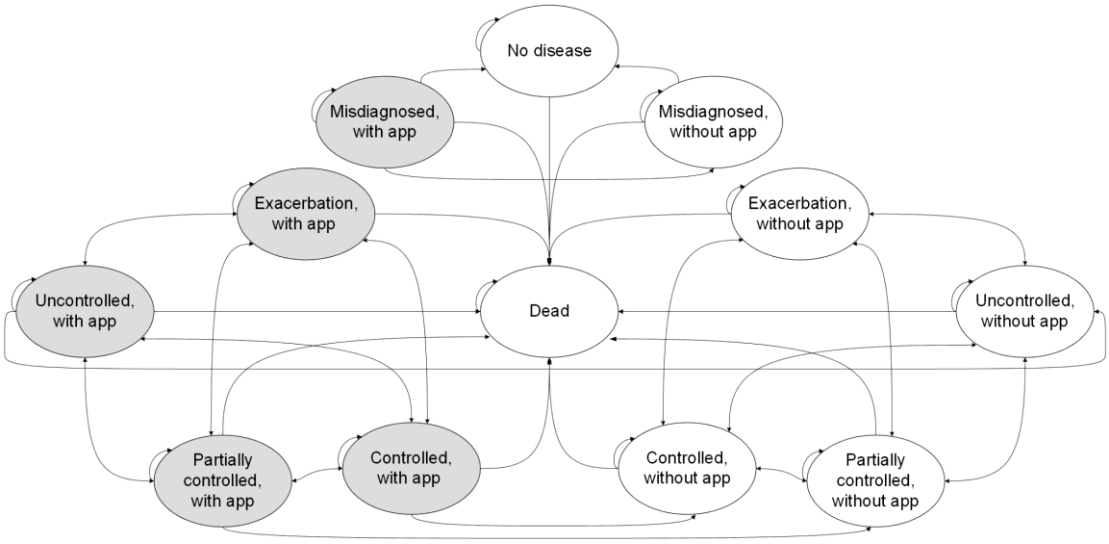
7. Health economic evidence

The external assessment group (EAG) did a review to identify existing health economic evidence, including relevant health economic models. They found 5 economic evaluations specific to the technologies (Asthmahub, AsthmaTuner, DHP, Smart Asthma) and relevant to the decision problem. The EAG also reviewed 5 additional economic evaluations, and the economic model that was developed for NICE guidance (NG245), which were not directly relevant to the decision problem but supported the development and parameterisation of a de novo economic model. An overview of these is in section 6.1 and appendix B2 of the EAR.

7.1 Health economic model

The EAG developed a conceptual Markov model in R with the aim of identifying key drivers of differences in costs and utilities and areas of uncertainty associated with digital technologies for asthma self-management compared with standard care. Due to data limitations the EAG notes that the model could not be fully parameterised and so is intended to guide data collection and highlight uncertainties rather than provide cost-effectiveness estimates. Analyses were conducted from a UK NHS and Personal Social Services perspective over a 5-year time horizon with monthly cycles and is in line with NICE reference case. Sensitivity analyses explored time horizons between 1 to 10 years.

Figure 1 Markov model



The EAG developed a Markov model which included 12 health states to capture asthma control and asthma management with and without digital technologies ('with app' and 'without app'):

- With app states: controlled, partially controlled, uncontrolled, exacerbation, misdiagnosed.
- Without app states: controlled, partially controlled, uncontrolled, exacerbation, misdiagnosed.
- Other states: no disease (false positive) and dead (absorbing state).

All patients entering the model have asthma diagnosis , including true positives (90% in the base case), false positives, and those diagnosed without objective testing. True positive cases are split in the intervention arm into "with app" and "without app" based on uptake of the app. For both arms, the group is then distributed across "Controlled", "Partially controlled" and "Uncontrolled" states.

The arrows in figure one denote how patients can move between health states. Transitions allow movement between symptom control levels, exacerbations, misdiagnosis correction, dropout from app use, and death. When the comparator arm is run, "with app" states are switched off, reducing

the model to 7 states. The model is flexible and adaptable, enabling future modelling to reflect various scenarios if new data become available.

The model aims to enable modelling of multiple value propositions including:

- Improving asthma control (more time spent with controlled symptoms)
- Reduction in the number of exacerbations
- Reduction in the severity of exacerbations
- Detection of misdiagnosis

Further details of the economic modelling are in 6.2 of the EAR. Detection of misdiagnosis was only made as a claimed benefit for NuvoAir (which was deemed out of scope post EAR report). However, the EAG judged that this value proposition could be plausible for other technologies.

Key assumptions

Several assumptions have been made in the model

- It is assumed that the level of control of the disease does not influence whether a patient begins using the app or not. That is, the initial control levels (controlled, partially controlled, uncontrolled) are equal across arms. Alternative distributions were tested in sensitivity analysis.

- Patients can stop using the app only at cycle end and cannot restart. Dropout rates are assumed the same across control levels in base case but are varied in sensitivity analyses. This refers to patients completely stopping use of the app and not those using it sporadically perhaps depending on their asthma control.

- Patients cannot transition between levels of control of asthma at the same time as they stop using the app for self-management. That is, they complete the transition from “with app”, to “without app” at the same level of control, before being able to move between levels of control “without app” in the next cycle.

- Base case assumes equal treatment costs across arms and control levels. Model does not consider explicitly biologics. Different treatment costs explored in sensitivity analyses.

- For exacerbations a weighted average cost is applied upfront on transition into the state to reflect the different severities. There are no additional costs for prolonged occupancy, but quality of life is applied during occupancy of the state.

- Baseline utilities are age-adjusted (under-16 assumed same as 16-year-old). Adults and children are modelled separately; for a child maximum time horizon is at 10 years. Exacerbation utilities were adjusted using a utility multiplier based on NG245 and Zafari et al.

- Mortality: it is assumed that those with asthma have increased mortality risk (applied using a hazard ratio) compared to those without and it may differ across levels of disease control, and exacerbation.

Clinical parameters

The clinical parameters of the conceptual model in an asthma population (separated by adults and children) are described in table 8 in the EAR.

Initial uptake of the app is assumed to be 75% and annualised dropout rates are 50% both based on expert opinion. Exacerbation rates are assumed to increase with worse asthma control based on NG245.

Population

The modelled population includes 100,000 patients diagnosed with asthma and receiving treatment. The starting age was 47 years for adults and 6 years for children, with 36% of the population identified as male (an assumption applied equally to both adults and children).

The split of patients between control states upon entering the model are 20.7% controlled, 39.2% partially controlled and 40.1% uncontrolled. This is varied in sensitivity analysis.

Comparator

The comparator in the economic model was standard of care (without app).

Costs and resource use

Technology and other costs

Technology costs for 7 technologies in scope were applied on a per-patient basis in the model including upfront costs for hardware, platform, integration, and training of the patient. Where costs were reported by companies to be paid per area rather than per patient these were distributed across an assumed minimum of 1,000 users per Integrated Care System (formerly Integrated Care Board). Importantly, if fewer patients were enrolled to use the app, upfront costs would be greater than those used in the model. Some technologies also incur recurring annual or monthly fees. Training costs include manufacturer supplied training but staff training time was excluded due to variability. For technologies incurring annual fees, it is assumed that when a person drops out of using the app, no further costs are incurred from the start of the following year. It is assumed that upfront costs for hardware cannot be recouped (devices are not returned and reused).

Device and connectivity cost were included in sensitivity analysis, assuming 5% of users require provision of mobile device or tablet (£100) and internet connection (£21), adding £17.60 per patient/year. Costs of standard care (monitoring and treatment costs) were based on NG245, with reduced nurse time (5 minutes) for monitoring costs assumed for app users. Costs of exacerbations were also based on NG245.

All costs were inflated to the latest year and are described in table 9 and 10 in EAR. See also appendix C2 for a further breakdown of costs. Costs for each technology applied in the model including one off upfront costs and per patient per year costs are shown in table 1 in this document.

Health-related quality of life

Utility values in the model were based on age and sex-specific baseline utilities from the general population, derived from the NICE decision support

unit dataset. These were adjusted using utility multipliers for different asthma control states found in NG245 and Zafari et al (2014). For adults, multipliers were 0.880 for controlled, 0.837 for partially controlled, and 0.783 for uncontrolled asthma. For children, multipliers were 0.96, 0.913, and 0.855. Utility multipliers for exacerbations were applied as a weighted average between moderate and severe events (0.725 and 0.678 for adults, 0.787 and 0.740 for children). QALY loss from misdiagnosis was set to zero in the base case but is explored in the sensitivity analysis.

7.2 Model results

The results are exploratory only and intended to highlight key drivers and uncertainties. They provide only a rough estimate of plausible cost-effectiveness rather than definitive conclusions.

Results of the economic modelling were reported separately for adults and children. Due to limited clinical data, 4 independent value propositions to define the base case were explored:

(1) improved symptom control, modelled by reducing transition rates to worse control;

(2) reduced exacerbations, applying a relative reduction to the exacerbation rate used in the comparator arm;

(3) reduced exacerbation severity, by reducing costs and adjusting utilities for the exacerbation state in the intervention arm;

(4) improved detection of misdiagnosis, stopping treatment costs when identified as misdiagnosis and applying a small utility decrement for people being on treatment unnecessarily (0.01). Upfront and annual technology costs already incurred remain non-recoverable even if misdiagnosis is corrected.

Asthma (adults)

Base case

The EAG compared the 4 value propositions and found notable differences in cost-effectiveness. See section 6.3.1 and table 12 in the EAR.

Increasing time spent with controlled symptoms

Clinical evidence supports improved asthma control for some technologies, making this value proposition most plausible despite uncertainty in magnitude and duration.

The base case assumed a 33% reduction in transitions to worse symptom control. This resulted in an estimated QALY gain compared with standard care of 0.0019 over a 5 year time horizon. Incremental costs varied widely depending on the technology with Asthmahub having the lowest cost and BreatheSmart (RDMP) having the highest cost. ICERs ranged from dominant to £153,766.

Table 3: ICER and NMB comparison across technologies

Technology	Total cost £	Total QALYs	Incremental cost £	Incremental QALYs	ICER £/QALY	Incremental NMB £
Intervention + cost of RDMP	655	3.36	294	0.0019	153,766	-256
Intervention + cost of Asthmahub	357	3.36	-4.28	0.0019	Dominant	43
Intervention + cost of Luscii	578	3.36	216	0.0019	113,146	-178
Intervention + cost of AsthmaTuner	[redacted]	3.36	[redacted]	0.0019	[redacted]	[redacted]
Intervention + cost of myAsthma	415	3.36	53	0.0019	27,745	-15

Intervention + cost of DHP	393	3.36	32	0.0019	16,598	7
Smart Asthma	386	3.36	24	0.0019	12,536	14

The EAG explored different values for the assumed reduction in transitions to worse symptom control using the costs for Smart Asthma as an example (results shown in table 4). The results of this suggested that, for this technology, if the percentage reduction in transitions falls below 23% the ICER exceeds £20,000/QALY.

Table 4: Results when modelling increasing time with controlled symptoms (Smart Asthma technology costs)

Scenario	Description	Total cost £	Total QALYs	Incremental cost £	Incremental QALYs	ICER £/QALY	Incremental NMB £
Reduction in transitions to lower control states with intervention	10% reduction	385	3.355	23.91	0.0015	44,223	-13.1
	25% reduction	386	3.355	23.94	0.0014	17,064	4.1
	33% reduction	386	3.356	23.96	0.0019	12,536	14.3
	50% reduction	386	3.357	24	0.0029	8,008	35.9

Other value propositions

All other value propositions had less impact on cost-effectiveness outcomes or were supported by limited evidence. Using the technology price of Smart Asthma as an example:

- A reduction of over 50% in the number of exacerbations was required to achieve an ICER below £20,000.An unpublished real world evaluation for one of the technologies (myAsthma) reported a reduction in hospitalisations by 26% in the technology pilot practices compared to an increase of 30% in

practices not using the app indicating this could be plausible however the evidence is very limited.

- A 75% reduction in exacerbation severity still resulted in an ICER above the £20,000 threshold, largely due to the small utility differences between moderate and severe exacerbations, suggesting limited potential for cost-effectiveness.
- Detecting 50% of misdiagnoses produced a favourable ICER of £7,819, but again, the evidence supporting this scenario was limited, introducing considerable uncertainty around its plausibility.

Scenario and sensitivity analyses

The EAG used extensive univariate sensitivity analyses to determine the key drivers and uncertainties associated with technologies being used to support self-management of asthma when compared with standard care in the NHS.

The EAG identified maintaining higher levels of symptom control as the most plausible value proposition, supported by clinical evidence where asthma control was the most commonly reported outcome. Therefore, all sensitivity analyses used a base case assuming a 33% reduction in transitions to worse control and technology costs for Smart Asthma with other parameters varied to explore impact.

The model was most sensitive to univariate variations in the technology costs, costs of monitoring in standard care and identification of misdiagnoses (see Appendix B5 in EAR).

- Increasing technology costs by £17.60 per patient per year (to account for device and monthly data plan) raised the ICER to £24,617/QALY, exceeding the £20,000/QALY threshold. Reducing this to £8.00 per patient per year (using alternative device and data plans proposed by a company at stakeholder consultation) reduced the ICER to £18,034/QALY.

- Pricing approach had a substantial impact: applying costs upfront resulted in more favourable ICERs.

- Doubling monitoring costs in the comparator arm made the intervention dominant. This scenario may reflect differences in asthma populations or variations in healthcare delivery across settings.

The base case was relatively insensitive to changes in dropout rates unless extreme values such as 75% were used. It was also relatively insensitive to changes in proportions starting in each level of symptom control. Dropout had a different impact when different pricing models were used (see table 14 in the EAR).

Overall, longer time horizons and upfront pricing were most favourable for cost-effectiveness.

Scenario/sensitivity analysis results are in section 6.3.1.2 and table 13 in the EAR.

Asthma (children)

Base case

The same overall trends as reported in adults with asthma (in section 6.3.1 of the EAR), were observed when modelling children with asthma (see section 6.3.2.1 and **Error! Reference source not found.** in the EAR).

Across all four value propositions, results followed the same direction as in adults: incremental QALYs were higher, and therefore ICERs were reduced when compared with adults. The EAG considered maintaining higher levels of symptom control as the most plausible scenario.

Increasing time spent with controlled symptoms

Assuming a 33% reduction in transitions to worse symptom control, the estimated QALY gain for children was 0.0023 compared with standard care. Again, costs varied depending on the technology with Asthmahub having the lowest cost and BreatheSmart (RDMP) having the highest cost. ICERs ranged from dominant to £129,878.

Table 5: ICER and NMB comparison across technologies

Technology	Total cost £	Total QALYs	Incremental cost £	Incremental QALYs	ICER £/QALY	Incremental NMB £
Intervention + cost of RDMP	727	3.87	295	0.0023	129,878	-249
Intervention + cost of Asthmahub	428	3.87	-4.39	0.0023	Dominant	50
Intervention + cost of Luscii	649	3.87	217	0.0023	95,655	-172
Intervention + cost of AsthmaTuner	[redacted]	3.87	[redacted]	0.0023	[redacted]	[redacted]
Intervention + cost of myAsthma	485	3.87	53	0.0023	23,381	-8
Intervention + cost of DHP	464	3.87	32	0.0023	13,938	14
Smart Asthma	456	3.87	24	0.0023	10,516	22

Results using Smart Asthma costs as an example and varying the assumed reduction in transitions to worse asthma control are shown in table 6. A reduction of below 23% resulted in an ICER above £20,000/QALY.

Table 6: Results when modelling increasing time with controlled symptoms (Smart Asthma technology costs)

Scenario	Description	Total cost £	Total QALYs	Incremental cost £	Incremental QALYs	ICER £/QALY	Incremental NMB £
Reduction in transitions to lower control states with intervention	10% reduction	456.2	3.873	23.8	0.0006	37,117	-11
	25% reduction	456.2	3.874	23.83	0.0016	14,317	9.5
	33% reduction	456.2	3.874	23.85	0.0022	10,516	21.5
	50% reduction	456.2	3.876	23.89	0.0035	6,714	47.3

Other value propositions

All other value propositions had less impact on cost-effectiveness outcomes or were supported by limited evidence.

Scenario and sensitivity analysis

Univariate changes were applied to the base case (assuming a 33% reduction in transition to lower control levels in the intervention arm, and technology cost of Smart Asthma) to assess the magnitude and direction of impact.

Similar to adults, the model was most sensitive to changes in technology costs, monitoring costs, and misdiagnosis detection.

Utilities for younger patients were assumed equal to age 16; using true values (which are expected to be higher than the values used) may further reduce the ICER (more favourable).

The base case was cost-effective at a 3-year time horizon.

Scenario/sensitivity analysis results are in section 6.3.2.2 and table 16 in the EAR.

Summary and interpretation of economic evidence

This conceptual modelling work has highlighted key evidence gaps and several key drivers of differences in costs and utilities of digital technologies used to support self-management of asthma, when compared with standard care alone.

Key drivers of cost-effectiveness included technology costs which significantly influenced ICERs. The pricing approach also influenced outcomes, with upfront costs yielding more favourable ICERs than recurring payments. Incremental QALYs were very small, making ICERs highly sensitive to minor changes in costs. The cost per patient of the technologies had the potential to increase the ICER above £20,000/QALY, when applied as upfront costs or recurring annual or monthly costs. Where an upfront hardware or platform

cost is applied and shared across an organisation (for example, across an Integrated Care System as observed with AsthmaHub, DHP, Luscii), this is sensitive to the number of patients who will use the technologies, with greater uptake per organisation (e.g., GP practice or Integrated Care System) bringing the cost per patient down.

8. Equality considerations

The final scope and the scoping equality impact assessment describe equality considerations for this assessment. Demographic information such as age, sex, ethnicity, socioeconomic status (e.g. measured by Index of Multiple Deprivation or income), asthma control at baseline, concomitant medications and comorbidities were poorly reported across almost all included studies, making it challenging to ascertain potential differences in populations or whether specific population groups were more in the evidence base than others. The EAG did not identify additional equality issues.

9. Key points, limitations and considerations

9.1 Clinical effectiveness

Key points

- Most technologies show potential benefits in asthma control, medication adherence, with positive feedback from users.
- Evidence is limited, and the amount and quality of evidence, particularly peer-reviewed, varies between technologies.
- Evidence is mainly in uncontrolled asthma populations. Reporting on asthma severity and demographic details such as age is limited.
- Long term effectiveness remains unclear.

Limitations

- Most of the evidence is from observational cohort studies. Ten studies were unpublished and 5 were conference abstracts. Some studies had small sample sizes and self-reported outcomes may introduce bias. The

qualitative evidence also had limitations in generalisability, reporting, and demographic transparency, and only covered 4 of the listed interventions.

- Published evidence from the UK is limited (2 studies) and derived from observational studies and service evaluations for 2 technologies while 3 additional studies (including 1 RCT) were conducted internationally.
- Most studies have short follow-up (≤12 months); no long term follow-up available in the published evidence.
- Lack of evidence to inform any subgroup analysis such as for individuals who are newly diagnosed or those with severe asthma (which is often poorly reported). Additionally, there is limited data for carers/family, especially for children under 6 years.
- Limited qualitative data on UK based user experience and integration.

Considerations for committee:

- To what extent is the evidence from studies conducted outside the UK generalisable to the UK healthcare context?
- What conclusions can be drawn from the clinical evidence on how use of the technologies may impact:
    - Self-management?
    - Asthma outcomes such as exacerbations, asthma control, adherence to medication?
    - Adults and children?
    - Different levels of asthma severity/control?
- Are there any clinical risks associated with introducing the technologies (compared with standard care) alongside evidence generation?
- Do the technologies have the potential to address an unmet need?

9.2 Health economic evidence

Key points:

- Conceptual modelling explored various value propositions with improving asthma control appearing most plausible based on clinical evidence.
- Incremental QALYs were very small, making ICERs highly sensitive to changes in the costs of technologies including costing structure (upfront

versus recurring costs). There is a broad range of prices across the technologies.

Limitations:

- There is a lack of clinical evidence to inform the economic model.
- The model time horizon is 5 years but there is very limited clinical data beyond 12 months.
- Uptake and dropout rates are likely to be important but there is no data to populate these parameters.
- The model results are sensitive to cost assumptions.

Considerations for committee:

- Are the economic model structure, assumptions and clinical and cost parameters suitable to answer the decision question (see final scope) for this assessment?
- What conclusions can be drawn on the plausibility of the technologies being cost-effective?
- Are there any economic risks associated with introducing the technologies alongside evidence generation? Do these vary by technology/pricing structure?

9.3 Overall evidence gaps

Key points:

- Key outcomes such as medication use/adherence, asthma control, and number and severity of exacerbations are underreported or inconsistently measured. EAG notes clear reporting of outcomes is needed using validated tools.
- Other outcomes like inhaler technique, symptom improvement, and patient-reported experiences are less commonly assessed.
- Limited comparative evidence from UK settings.
- Impact on quality of life, particularly in children under 16 years, are not well captured.

- Acceptability and patient perceptions of asthma control and digital technologies are underexplored.
- Barriers and facilitators to technology uptake and system-level implementation are poorly understood.
- Uptake and dropout rates may be important for modelling but there is currently a lack of data.

Considerations for committee:

- What are the key outcomes?
- What populations should the evidence be collected in?
- Any other considerations such as other information that should be collected or any equality considerations?

Appendix A Abbreviations

A&E	Accident & Emergency
ACT	Asthma Control Test
ACQ-5	Asthma Control Questionnaire
C-ACT	Childhood Asthma Control Test
CI	Confidence interval
DHP	Digital Health Passport
EAG	External assessment group
EAR	External assessment report
FEV-1	Forced expiratory volume in one second
FVC	Forced vital capacity
GP	General practitioner
HCP	Healthcare professional
ICER	Incremental cost-effectiveness ratio
ICST	The Institute of Clinical Science and Technology
MAQLQ	Mini-Asthma Quality of Life Questionnaire
MCID	Minimal clinically important difference
MD	Mean difference
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NPS	Net Promoter Score
NMB	Net monetary benefit
PAAP	Personalised asthma action plan
PEF	Peak expiratory flow
PROM	Patient-reported outcome measure
QALY	Quality-adjusted life year
RCT	Randomised controlled trial
RCP3Q	Royal College of Physicians Three Questions
RDMP	Respiratory Disease Management Platform
UK	United Kingdom
US	United States

HealthTech Programme

GID-HTE100063 Digital technologies for asthma self-management: Early Value Assessment

Professional organisation submission

Thank you for agreeing to give us your organisation's views on this technology or procedure and its possible use in the NHS.

You can provide a unique perspective on the technology or procedure in the context of current clinical practice that is not typically available from the published literature.

To help you give your views, please use this questionnaire. You do not have to answer every question – they are prompts to guide you. The text boxes will expand as you type.

Information on completing this submission

- Please do not embed documents (such as a PDF) in a submission because this may lead to the information being mislaid or make the submission unreadable
- We are committed to meeting the requirements of copyright legislation. If you intend to include **journal articles** in your submission you must have copyright clearance for these articles. We can accept journal articles in NICE Docs.
- Your response should not be longer than 10 pages.

About the organisation

Organisation name	British Thoracic Society
Are you (please highlight Yes or No):	An employee or representative of a healthcare professional organisation that represents clinicians? Yes or No **A specialist in the treatment of people with this condition: Yes** **A specialist in the clinical evidence base for this condition or technology: Yes** Other (please specify):
Please provide a brief description of the organisation (including where funding comes from)	BTS is the professional membership organisation representing health care professionals working in respiratory medicine and healthcare.
Has the organisation received any funding from any company with a technology related to the evaluation in the last 12 months? **If so, please state the name of company, amount, and purpose of funding**	No
Does the organisation have any direct or indirect links with, or funding from, the tobacco industry?	None

Current care pathway and unmet need

1. Please describe the current standard of care that is used in the NHS. Please note any clinical guidelines used in the NHS which are relevant to the care pathway. What setting would this technology be used in (primary care, general hospitals, specialist centres for example).	- There is overwhelming evidence for supported self-management in asthma which reduces acute healthcare utilisation and improves patient outcomes including disease control and asthma-related quality of life. Current national guidelines (NICE, NG245) recommend the provision of a personalised self-management programme to patients with asthma aged 5 and over, independently of healthcare setting. Despite these recommendations, national data suggests that there is failure to widely deliver this, and that this failure could be a contributor to asthma deaths. (NRAD, 2014) - Digital technologies for asthma self-management are not currently recommended for routine use in either national or international clinical guidelines, although emerging evidence suggests that there are likely to be subgroups, potentially in specific clinical settings, who would benefit from digital self-management support. For example, digital inhalers could be used to evaluate adherence pre-biologic therapy in asthma specialist centres. Guideline committees conclude that further research is needed. - Despite lack of an evidence-based UK approach, digital technologies that facilitate asthma self-management are increasingly accessible to patients, clinicians and clinical researchers, and evidence is accumulating that these can improve patient outcomes.
2. Does this procedure or technology have the potential to replace current standard care or would it be used as an addition to existing standard care? **Where would the technologies or procedure fit in the care pathway?**	- In the first instance, digital technologies in asthma self-management are likely to be used to optimise the delivery of (rather than replace) current standard of care interventions. For example, accessibility of a written personalised asthma action plan (PAAP) could be improved if delivered via a smartphone app; pulmonary rehabilitation programmes delivered by teleconsultation may improve participation amongst patients with work or caring responsibilities or those living in remote areas; feedback from smart inhalers could help patients to achieve and maintain optimal inhaler technique and adherence. - Exactly where these technologies fit into care pathways is currently unclear. Lower cost interventions could have a role in self-management across broad asthma populations e.g electronic PAAP for all patients with asthma. More resource-intensive interventions like digital medication adherence support could be targeted to specific groups who place a higher burden on healthcare services, such as uncontrolled severe asthma pre-biologic therapy which has already been shown to be a cost-effective intervention in this cohort (DOI: 10.1016/j.jaip.2023.03.008) - Remote peak flow/ spirometry or FeNO longitudinal measurements for diagnostic and monitoring of asthma

	- Early identification and management of asthma attacks in children using contactless home monitoring device (S87 Contactless and automated monitoring to study changes in nocturnal parameters before and after asthma attacks in children | Thorax) -
3. Is there an unmet need for patients with the condition or disease, or healthcare professionals managing the condition or disease?	- Asthma is the most common chronic respiratory disease in the UK, affecting >7 million people. In over 50% of cases, asthma is sub-optimally controlled, leading to reduced quality of life, hospital admissions and death. Uncontrolled asthma accounts for 89% of asthma treatment costs in the UK, projected at >£4 billion/year. Severe asthma is associated with higher costs per patient than type 2 diabetes, stroke or COPD. There is an increase in prevalence of asthma and severe asthma in disadvantaged socio-economic groups. Lower levels of health literacy can make self-management of asthma and accessing healthcare more challenging in these settings; 'at-home' digital technologies to aid patient education, assess adherence and easy-to-access PAAPs could provide a method by which health care inequalities in asthma can be reduced. (https://www.asthmaandlung.org.uk/sites/default/files/2023-03/auk-health-inequalities-final.pdf)

The technology

4. What are the potential benefits for patients and healthcare professionals from this technology (consider the potential clinical benefits, cost benefits, benefits to quality of life, and any wider benefits)?	- Improved access to supported self-management (including through increased flexibility and convenience) could improve the patient outcomes that optimal self-management is known to impact on, such as symptom control and asthma related quality of life, and acute healthcare utilisation. - Importantly this effect could be experienced across broader disease populations who are less able to self-manage their asthma or who may have previously faced barriers to accessing support for self-management. - Improvements in disease control will reduce the cost burden related to poorly controlled asthma. - Specifically, there is potential that digital adherence interventions optimising the use of standard therapies could reduce the number of patients that require high-cost biologic therapies in severe asthma. (DOI: 10.1016/j.jaip.2023.03.008) - Enhanced data collection through digital technologies could also represent a novel data resource, identifying new biomarkers and targets for intervention, that clinical researchers could utilise to improve patient care in future.
5. Are there any groups of patients who would particularly benefit from	- Patient groups experiencing barriers to accessing standard care as it is currently delivered, where digital technologies could help to overcome these barriers (e.g. some patients experiencing socioeconomic deprivation,

this procedure/technology? Are there any groups in which the technology would be less effective or would be less likely to benefit?	patients with caring responsibilities, patients in certain types of employment, patients in remote geographical areas, patients facing language barriers) could experience a particular benefit. - There may be certain subgroups who may experience specific benefits from these interventions, such as adherence interventions in severe asthma pre-biologic. Further evidence is required from clinical trials. - Whilst smartphone access is very high overall (94%) in the UK population, there is a risk that increased use of digital technologies could exclude specific groups within the population who may have reduced access to smartphones, stable internet or digital literacy (more deprived populations, rural populations, older populations). Survey data from 2024 suggests that over 80% of the 65+ age group now own a smartphone, however access was as low as 60% in the most deprived quintile in one study. - Young children where objective monitoring is difficult, contactless monitoring devices which provide objective parameters like respiratory rate, respiratory sounds like wheeze may support early identification of asthma attacks
6. How would healthcare resource use differ between the technology and current standard care?	- Whilst better asthma control related to optimised self-management could reduce acute healthcare utilisation in the longer term (e.g. reduced acute exacerbations and hospital admissions) there is evidence that implementation of digital technologies increase short-term healthcare contacts, for example, increased clinician alerts about poor adherence or frequent rescue medication use leading to more follow up appointments and medication adjustments. This may be appropriate but this burden would need to be considered when making formal recommendations.
7. Describe any system changes that would be needed if the NHS were to adopt the technology. Are there any potential barriers to the adoption of the technology or any changes that may be needed to enable implementation of the technology in the NHS?	- Clinical care pathways would need to be appropriately redesigned to accommodate digital technologies, which may include an increased short-term response to alerts about suboptimal self-management and increased risk, with implications for workforce. Interoperable systems that allow digital tools to communicate with primary and secondary healthcare systems and e.g. NHS app will be required for efficient long-term function. Digital tools will need to meet safety, data and regulatory standards. - Geographical heterogeneity in current NHS electronic data systems is likely to represent a significant barrier to achieving a national approach to implementation. -Personal privacy and GDPR guidelines can be a barrier for adoption of digital technologies where personalised data comies in to health care trusts, this would need consideration and a nationalised approach.
8. Are there any side effects or adverse effects associated with the technology?	- There are comparatively few side effects associated with the use of digital technologies. There is a risk that some patients may experience health anxiety as a result of increased tracking of clinical outcomes. Risks associated with loss or inappropriate sharing of data may also cause anxiety.

Equality considerations

9. Are there any equality issues that should be considered for this assessment?	- There are population subgroups who experience reduced asthma control as a result of suboptimal ability to self-manage (people with higher levels of socioeconomic deprivation, ethnic minority groups, children and adolescents, people with comorbid mental health issues). These groups (and others who experience barriers to the way self-management is currently delivered, such as those living in remote geographical areas, people with disabilities or caring responsibilities) should be considered in this assessment. - Implementation of digital technologies for patient care may be dependent on access to smartphones, stable internet and digital literacy. Variation in access in certain population subgroups should be considered.
10. Could the technologies reduce or increase health inequalities? How?	- Digital technologies could reduce health inequalities by improving access to self-management education and tools, with greater potential benefit in groups that either have (1) less ability to self-manage or (2) experience barriers to accessing support for self-management as it is currently delivered. - There is also a risk that increased reliance on digital technologies could widen health inequalities in certain groups with reduced access to smartphones and internet (those with the greatest socioeconomic deprivation, the elderly, rural populations).

Key messages

In up to 5 bullet points, please summarise the key messages of your submission	• Supporting self-management is a key component of providing high quality care to asthma patients. • Digital technologies could optimise the delivery of supported self-management, improve clinical outcomes (with associated cost savings) and reduce healthcare inequalities in asthma and healthcare costs. • The risks associated with these interventions, including increased short term healthcare utilisation and widening health inequalities in certain subgroups, should be carefully considered. • There are likely to be significant challenges to implementing a national approach to digital technologies for asthma self-management due to the variation in electronic systems currently used across the NHS. • Data collected through the increased use of digital technologies in routine asthma care could represent an important resource for improving care in future.

Thank you for completing the submission.

Please log in to your NICE Docs account to upload your completed submission.

Your privacy

The information that you provide on this form will be used to contact you about the topic above.

Please highlight **YES** if you would like to receive information about other NICE topics - YES or NO

For more information about how we process your personal data please see our privacy notice.

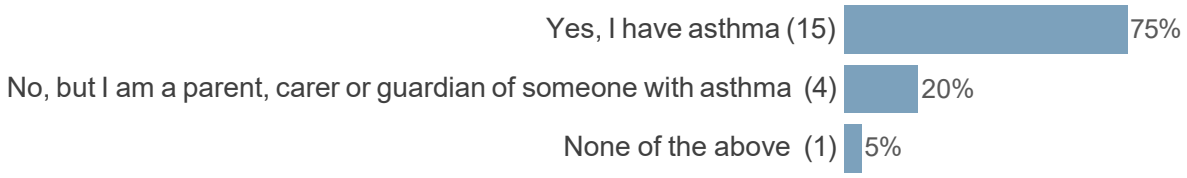
Digital technologies for asthma self-management EVA

This report was generated on 23/10/25. Overall 20 respondents completed this questionnaire. The report has been filtered to show the responses for 'All Respondents'. A total of 20 cases fall into this category.

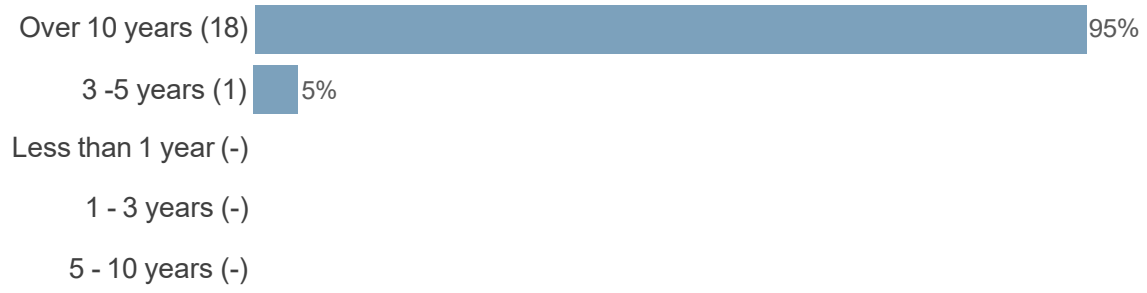
The following charts are restricted to the top 12 codes. Lists are restricted to the most recent 100 rows.

Are you (the person completing the survey) 16 years or over? (Name)

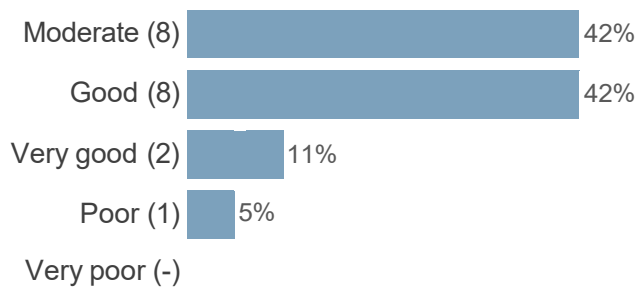
Are you (the person completing the survey) a person with asthma, or a carer for someone with asthma?



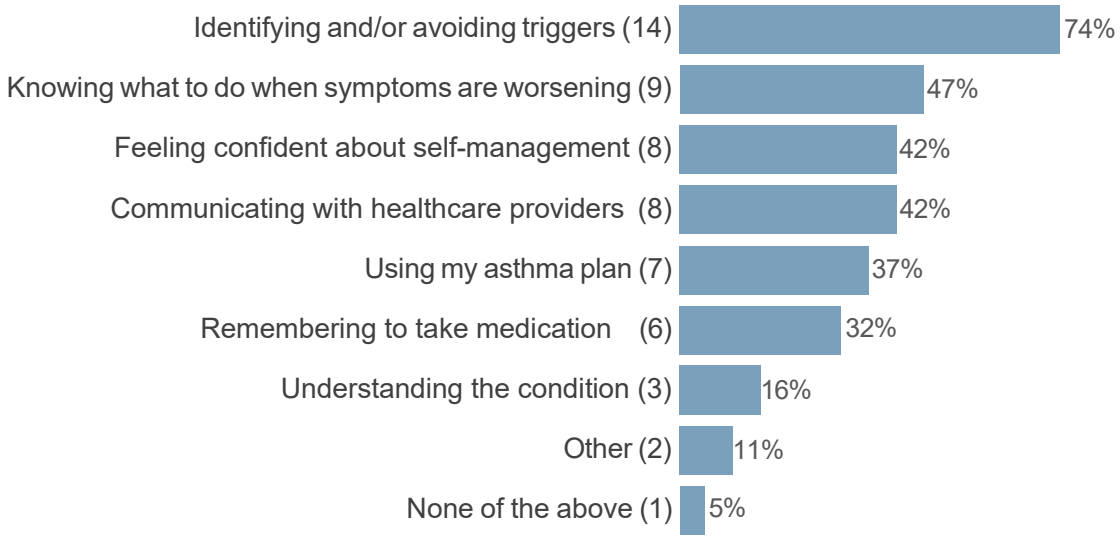
How long have you had asthma?



How would you describe your current asthma control?



Which of the following are challenges for you in managing your asthma? (Select all that apply)



If other, please specify

Environmental factors eg damp housing

Please describe how asthma affects or has affected your daily life. *(300 words max)*

More prone to chest infections in the winter. Become aware of breathlessness when climbing stairs. I don't feel I have asyfrom day to day so difficult to remember to take the steroid inhaler.

I have experienced long episodes (more than couple of weeks each time) of uncontrolled asthmatic symptoms quite frequently through the year - at least more than 6 times a year. These are more frequent during winter period (perhaps due to winter infections) but I have also experienced asthmatic symptoms in summer months and triggers can be dusts, allergies and physical stress.

Despite copious medications I am still symptomatic most days. This is usually breathlessness of moving too much, coughing when I talk too long, and a wheeze most evenings. I get tired out easily and avoid social situations in the winter as i'm scared of catching bugs and triggering my asthma. Cold weather also triggers my asthma so I cannot attend church during autumn/winter.

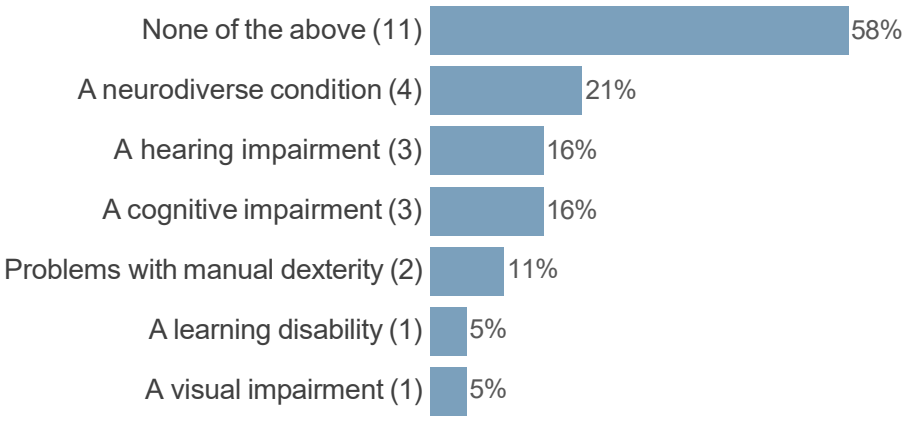
Impacts daily life when exacerbations happen; when it's controlled things feel more manageable, but the tiredness has an impact on daily life- ability to go out in the evenings for example if I've had a day when my asthma is worse. Identifying additional triggers can be hard sometimes. I dread winter because of the infections and dampness- I will but a chest infection that will then hangs around and affect me physically and mentally- and just as that clears, I might have another. I have to have courses or oral steroids sometimes too. Feeling breathless and triggered is horrible- and can make me feel anxious. I do t want to be ill and I dont want to be person who always cancels plans because of how I'm feeling. I don't feel as though people really understand how debilitating asthma can be.

Usually it has no effect in that, as long as I take my medication, it is well controlled. However, if I develop a cough it can linger for several weeks and can result in my not partaking in some activities, especially if it involves extensive use of my voice, e.g. social gatherings.

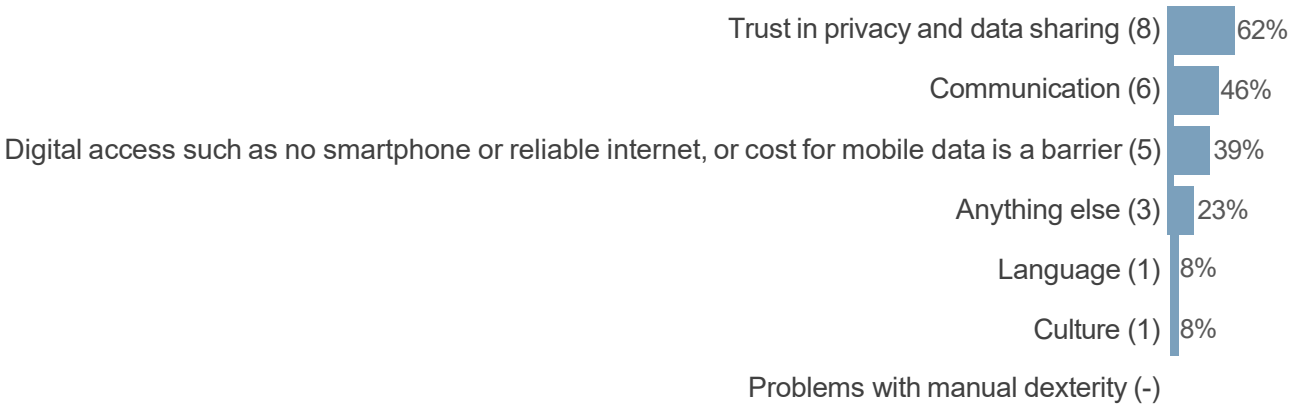
Please describe how asthma affects or has affected your daily life. *(300 words max)*

Every day, I have to take medication to help prevent my condition from worsening, since having long COVID, remembering to take my medication is a challenge. I get out of breath easily and find that going up and down stairs makes me out of breath. Often, I can hear the wheezing as I breathe. It will limit what activities I can do. I am unable to do high levels of cardio due to breathlessness, but I also have other long-term conditions that affect energy levels and mobility, etc. However, even without these, I am still unable to do cardio workouts due to breathlessness. Activities have to be carefully planned with lots of rest stops along the way.
When my asthma is aggravated and taking steroids makes me very tired and difficult to perform my day to day activities
I don’t struggle everyday but on the days that I do it has a large impact
I did consider my asthma quite well controlled up until recently. I was struggling with the hot weather as changes in temperature seem to be a major trigger along with fluctuating hormones and some sulphates in alcohol. I struggled walking to work in the really hot weather without using my reliever inhaler. I also struggled with exercise due to the changes in body temperature.
Breathlessness and it limits my mobility especially in winter.
exercise tolerance - unable to fully participate in sports etc - restricts emploment options
Experience of asthma requires daily medication, to avoid any further complications. Not sure of the long-term effects of medication for asthma.
I have severe brittle asthma which can be triggered by a multitude of things with little or no warning. Everyday life can be interestingly varied and unpredictable
It affects exercise in the winter months until the inhalers are taking full effect
My asthma symptoms have varied over time. If I have a cold or flu then my asthma can quickly spiral out of control as most infections go straight to my chest. I have to stay in bed for a couple of days when this happens and carefully monitor my peak flow and up my inhalers accordingly. Outdoor exercise can make my asthma worse, especially if it’s very warm outside or if there is a cold wind. I have currently stopped running because I was struggling to catch my breath.
It has effected my sons whole life from early school attendence due to hospital visits and admissions, to being stopped from going to school by the teacher in covid (before schools had closed and I'm a key worker). It continues to effect him occasionally when doing sport (usually feels it about 1-2 times per week, depending on how active he is. Despite antihistamines he often gets triggered by his grandmas cat, although this is his favourite animal in the world!
I can get an attack when eating certain foods that trigger the condition.
My attacks can come on quite suddenly. There can be long periods when I have no symptoms and do not need to use my Ventolin at all. Something ten might trigger an attack could be a cold, cold weather or pollen in the spring. Sometimes for no apparent reason and then need a course of prednisolone. I also have Barrett's Oesophagus and still don't know if that can affect my asthma. I have an emergency alarm and lanyard should attacks come on suddenly and I need help.

Do you experience any of the following that may affect how you use digital tools? *(select all that apply)*



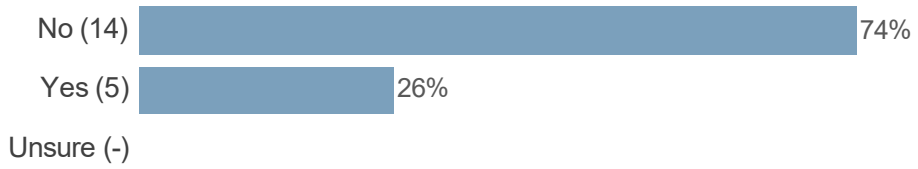
What else could affect your ability to use digital tools? *(select all that apply)*



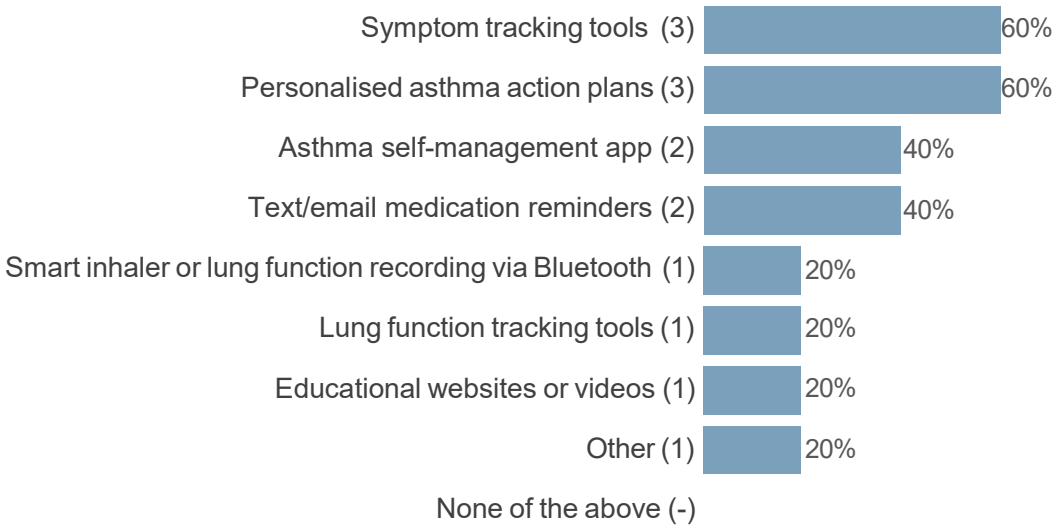
Please tell us why *(100 words max)*

None
I have very little trusts in any digital tools unless I can receive good accessible in-person guidance and support when required. I will also struggle to use digital tools due to not having access to equipment and infrastructure to support the digital tool and I am always worried on how my information may be used or could be lost through any security breaches on the platform. My personal security is very important to me than my health condition management
Maybe internet connection but this would t really be an issue.
Nome of these. Able to use digital tools well.
I don't like insurance companies knowing about my health conditions and using it for marketing etc.
I prefer speaking with a person about my asthma. I don't feel I would have the same benefit just using digital tools.
Due to cyber attacks and illegal access to my personal information
I live in a very rural area where stable internet connectivity is a huge problem.
[redacted] is dyslexic and likely autistic. He is very good on all tech but if words need entering that must be spelt correctly he can't reliably spell
Continual IT changes which get more difficult to keep up to date on as I get older.

Have you ever used digital tools to help manage your asthma?



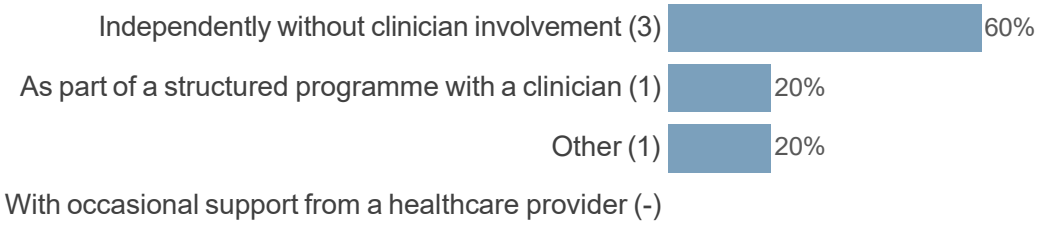
Which of the following digital tools have you used? *(Select all that apply)*



If other, please specify

My GP has sent me his notes from consultations which act as a reminder of medications. eg how many and how long to take steroids.

How did you use the digital tool(s)?



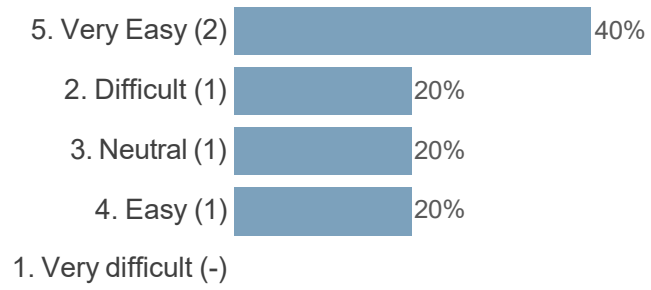
If other, please specify

Just looked at notes when needed to check what had been said.

What support would have been helpful when using the digital tool?

I complete an annual online assessment of my asthma and receiving text advice from my GP Nurse Specialist
An easier way to find the notes in the app or a print out at the time.. This may become easier as our GP surgery are now using AI to do their notes during my appointment so hope this will make it easier to check the notes myself.

On a scale of 1 to 5 (How easy was it to stick with using the digital tool?)



Please explain your answer.

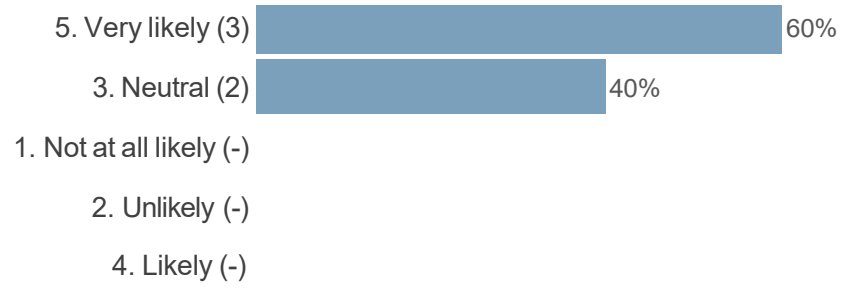
Online assessment easy.
I actively use my app each week when I monitor my peak flow, and also when I have symptoms to track them. I also receive daily notifications from the app regarding air pollution, pollen, and medication reminders
When you have few.or no symptoms you don't want to be bothered with thinking about your asthma. On the flip side it's not healthy to focus or dwell too much on asthma

Did you regularly use the digital tool for more than 1 month?

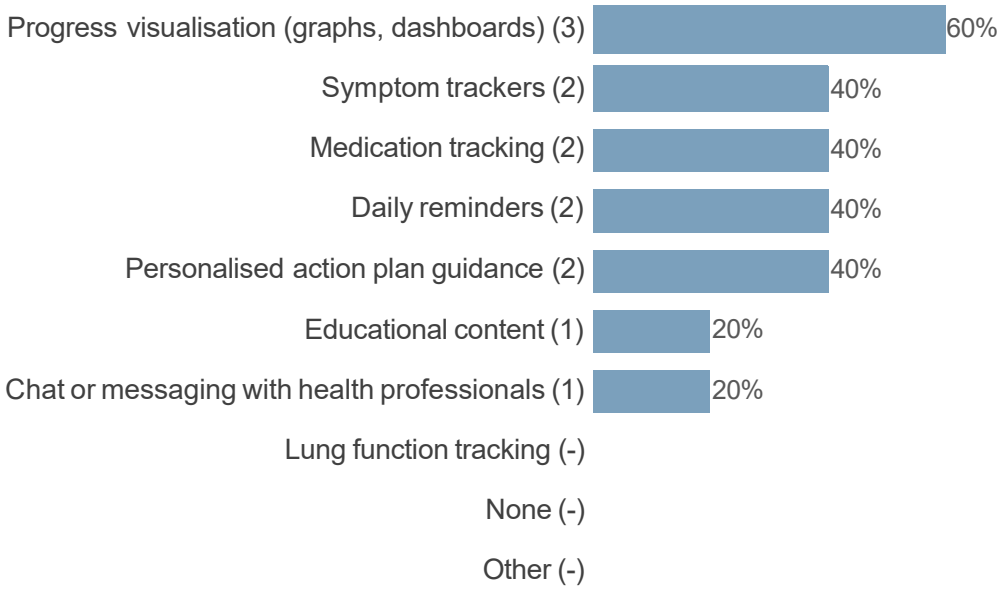
What impact did the digital tool(s) have on your asthma self-management? (include specific technologies if possible)

Nil
It helps me manage my symptoms and follow my PAAP. It also means I have symptoms and peakflows to hand when j have a review
I got too focussed on the numbers being generated in terms of symptoms getting better or worse. I also got fed up with being reminded I had asthma when i wasnt experiencing symptoms
To be able to keep reviewing the notes as I had various regular appointments over a number of weeks meant I could check any progress I was making. However I could only use this as am reasonably good with IT systems and using the apps.

On a scale of 1 -5 (How likely are you to recommend digital asthma tools to others?)



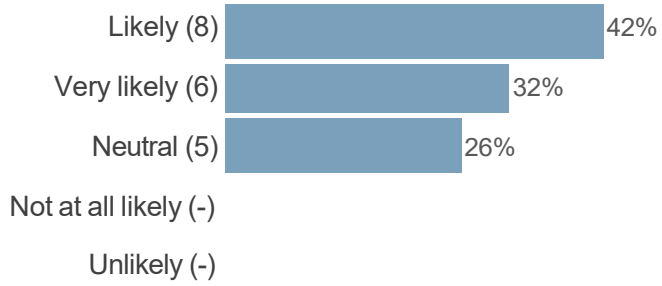
Which digital features have helped you the most? *(Select all that apply)*



Please explain your answer.

Nothing to add
I talk about the app to anyone I come across with asthma. My son also uses it and it helps me monitor his asta and SABA use
The main good point was being able to see some improvement of PF after an exacerbation.
I could refer to the notes when at follow up appointments Particularly important if at hospital appointments or seeing different GPS

How likely are you to use digital tools to manage your asthma in the future?



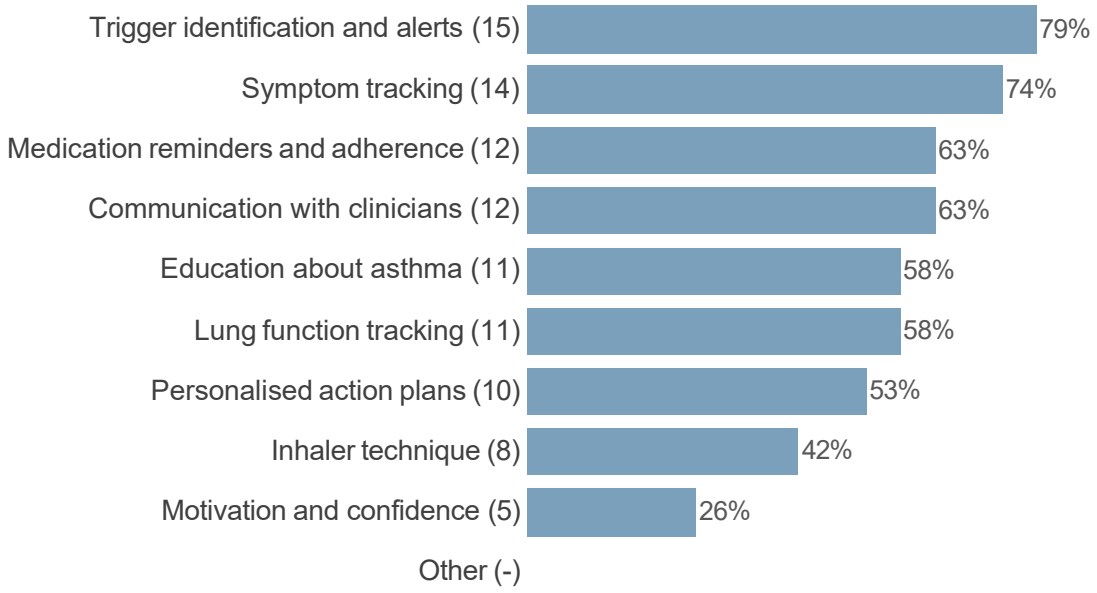
What would encourage or discourage you from using digital tools for asthma self-management in the future? (please consider usability, trust, time, clinician support, cost, etc.)

I would love to use any digital tools offered.
I have no confidence in safety, security and guidance of information offered on any digital platform. Unless someone can explain to me in simple and lay language (face-to-face) on what to do and how, and how the guidance will help me to manage my Asthma, I will not trust any information received. I will also want to have access to experienced, competent and trusted health care team quickly in order to encourage me to use any self management digital tool.
It saves me time looking for different things to track it on and then check my PAAP. The app i use colour codes symptoms similar to a PAAP so slight wheeze, follow green part of PAAP, amber symptoms like increased breathlessness increase SABA and start pred, red symptoms get emergency help. Is also let's me monitor my peak flow easily
Being offered them! [redacted] has discussed this with me- I've only been offered a symptoms diary which is a price of paper which feels like a child's way of recording my asthma. I would want to have full tracing and reassurance that this works- and whether a cost is involved. As a students I have a tight budget.
Complexity of what they do.
Not sure.
If the digital tool was complicated to use and took a long time to set up. If it were an app that was easy to download and easy to follow, that would encourage me to use it.
Trust ensuring my data is safe and none is tracking my helath for their advantage. Clinician input if it's just generic information I could just google it and also it should be free.
I don't feel like you would get the same benefits from using online tools. It is helpful to have a session in person so I can ask questions. Depending on if there was online assistance available such as live chat, this would probably discourage me from using online tools if this function was not available.
Encourage: adequate support until I was proficient.
regular clinician reviews would be nuch better
I prefer to have a clinician that specialises in asthma for confidence.
Enthusiasm from the healthcare team and evidence that it could help improve management
Using the data to predict my asthma chnages
My asthma nurse is amazing and really helpful. If I could go and see her for a run through of how the tool works, maybe at my regular check up, that would be great.
Encourage-Having the regualr feedback on a phone/device, ability to be in charge of monitoring and tweaking treatment as per wheeze plan if needed

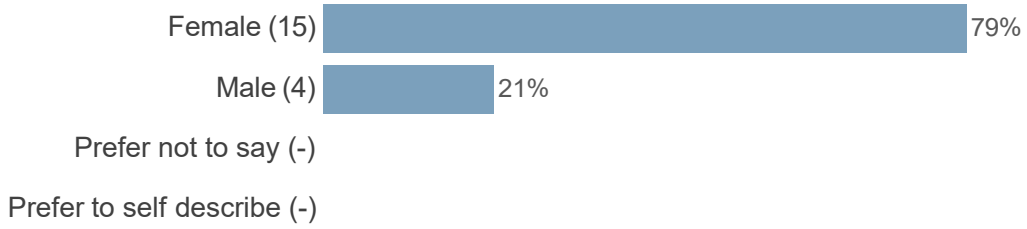
What would encourage or discourage you from using digital tools for asthma self-management in the future? (please consider usability, trust, time, clinician support, cost, etc.)

There are still numbers of people , not necessarily older people, are able to navigate smart phones etc. During an attack sometimes you want to talk to a real person for reassurance. These days it can be difficult to know where the information about you is safe Will the cost of implementing a digital system and time it will take to set up be beneficial to sufficient numbers of asthmatics to be worth it? How will this be measured? Is the money better spent in other areas. For example trainng GP receptionists to recognise when someone with a history of asthma calls or attends the surgery and is obviously 'wheezy' and appointment requests are seen as urgent. Is there a place for pharmacists to contact GPs when some one who is asthmatic goes to them for help and also able to discuss their asthma management with the individuals agreement.

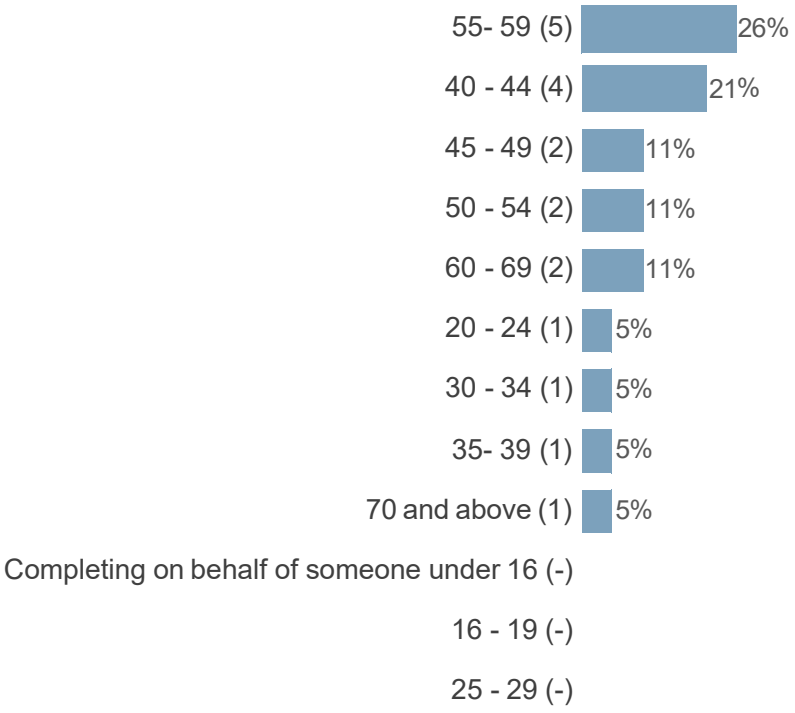
What areas of asthma self-management do you think could be improved on with digital tools? *Select all that apply*



What is your gender identity?



What is your age range?



What is your ethnicity?

GID-HTE10063 Digital technologies for asthma self-management

External assessment report

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Date completed: 11/10/2025

Contains confidential information: Yes

Number of attached appendices: 4

Purpose of the early value assessment report

The purpose of this external assessment report (EAR) by an external assessment group (EAG) for early value assessment is to review the evidence currently available for technologies within the decision problem and advise what further evidence should be collected to help inform future decisions on whether the technologies should be widely adopted in the NHS. NICE has commissioned this work and provided the template for the report. The report forms part of the papers considered by the Committee when it is making decisions about the early value assessment.

Declared interests of the authors

Description of any declared interests with related companies, and the matter under consideration. See NICE's Policy on managing interests for board members and employees.

None

Acknowledgements

This report was commissioned by the NIHR Evidence Synthesis Programme as project number NIHR175576.

Thanks to the co-authors and experts who gave insight and supported the development of the "GID-HTE10065 Algorithms applied to spirometry to support diagnosis of lung conditions in primary care and community diagnostic centres"; which was developed at the same time at this early value assessment. Their insight was also incorporated into this early value assessment.

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Responsibility for report

The views expressed in this report are those of the authors and not those of NICE or the NIHR Evidence Synthesis Programme. Any errors are the responsibility of the authors.

Table 1. Summary of all confidential information and its source in report

Brief description	AIC/CIC	Page numbers	Source
Depersonalised data	Depersonalised	131-2, 134, 137, 144, 268-76	Correspondence with experts
Features of AsthmaTuner	CiC	27, 251-52	Company RFI
Characteristics of unpublished data for Asthmahub	AiC	35-6	Company RFE
Characteristics of unpublished data for Asthmahub for Parents	AiC	36-7	Company RFE
Characteristics of unpublished data for Digital Health Passport	AiC	39-41, 58-60	Company RFE
Characteristics of unpublished data for myAsthma	AiC	42-4, 56-7	Company RFE
Characteristics of unpublished data for BreatheSmart/Respi.me (RDMP)	AiC	46-8	Company RFE
Quantitative and qualitative results from unpublished data for Digital Health Passport	AiC	62, 76, 79-80, 81, 85-6, 90, 92, 96, 98, 102, 103-4, 105, 107, 109, 177	Company RFE
Quantitative and qualitative results from unpublished data for myAsthma	AiC	65, 72-3, 75-5, 81, 92-3, 97-98, 102, 103, 106-7, 108-9, 113, 149, 176, 178	Company RFE
Quantitative and qualitative results from unpublished data for BreatheSmart/Respi.me (RDMP)	AiC	72, 76, 78, 80, 85, 89-90, 101, 102-103, 111	Company RFE

Quantitative and qualitative results from unpublished data for Asthmahub	AiC	95-96, 99, 106, 169	Company RFE
Quantitative and qualitative results from unpublished data for Asthmahub for Parents	AiC	94-5, 106-7, 163	Company RFE
Costs for AsthmaTuner	CiC	139, 257	Company RFI
Economic model results for ICST	CiC	115	Company RFE
Economic model design for ICST	CiC	118	Company RFI

Table of contents (page numbers) to be updated by NICE team after deleting the cover page and before including in the committee pack and publishing on the website.

Contents

Plain language summary 11
Executive summary 13
1. Decision problem 19
2. Technologies 19
3. Clinical context 23
3.1 National guidelines 23
3.2 Routinely collected data in the NHS 23
3.3 Equality issues 24
4. Clinical evidence 25
4.1 Search strategies and study selection 25
4.2 Included and excluded studies 26
5. Clinical evidence review 45
5.1 Quality appraisal of studies 45
5.2 Results from the evidence base 47
5.3 Adverse events and clinical risk 79
5.4 Clinical evidence summary and interpretation 79
6. Economic evidence 84
6.1 Existing economic evidence 84
6.2 Conceptual model 91
6.3 Results from the economic modelling 120
6.4 Summary and interpretation of the economic evidence 135
7. Integration into the NHS 136
8. Evidence gap analysis 139
8.1 Ongoing studies 139
8.2 Evidence gap analysis 146
8.3 Key areas for evidence generation 153
9. References 155
10. Appendices 163
Appendix A – Literature searching 163
Appendix A1: Search strategies 163
Appendix A2: PRISMA diagram: clinical 174
Appendix A3: PRISMA diagram: economics 175
Appendix A4: Excluded studies 176
Appendix B – Economic modelling 198
Appendix B1: Excluded studies 198
Appendix B2: Studies used to support model development 202
Appendix B3: Model validation 206
Appendix B4: Output from base case 212
Appendix B5: Results from sensitivity analysis 214
Appendix C – Additional detail on technologies 229
Appendix C1: Additional technical information 229
Appendix C2: Additional cost breakdown 236
Appendix D – Correspondence log 238

Abbreviations

Term	Definition
A&E	Accident & Emergency
AdViSHE	Assessment of the Validation Status of Health-Economic decision models
ACT	Asthma Control Test
ACQ-5	Asthma Control Questionnaire
AIR/MART	Anti-inflammatory Reliever/Maintenance and Reliever Therapy
API	Application Programming Interface
AQLQ	Asthma Quality of Life Questionnaire
BCT	Behaviour Change Theory
BNF	British National Formulary
BTS	British Thoracic Society
CEA	Cost-effectiveness analysis
CENTRAL	Cochrane Controlled Register of Trials
CDSR	Cochrane Database of Systematic Reviews
CI	Confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COPD	Chronic obstructive pulmonary disease
CSUQ	Computer System Usability Questionnaire
DHP	Digital Health Passport
DID	Difference in difference
DTAC	Digital technology assessment criteria
EAG	External assessment group
EU	European Union
EVA	Early value assessment
FeNO	Fractional Exhaled Nitric Oxide
FEV-1	Forced expiratory volume in one second
FVC	Forced vital capacity
GHG	Greenhouse gas
GINA	Global Initiative for Asthma
HCP	Healthcare professional

Term	Definition
HR	Hazard ratio
ICER	Incremental cost-effectiveness ratio
ICS	Inhaled corticosteroids
IG	Information Governance
INAHTA	The International Network of Agencies for Health Technology Assessment
LABA	Long-acting beta-2 agonist
MAQLQ	Mini-Asthma Quality of Life Questionnaire
MART	Maintenance and Reliever Therapy
MCID	Minimal clinically important difference
MD	Mean difference
MHRA	Medicines & Healthcare products Regulatory Agency
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NPS	Net Promoter Score
NR	Not reported
OR	Odds ratio
PAAP	Personalised asthma action plan
PEDE	Paediatric Economic Database Evaluation
PEF	Peak expiratory flow
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROM	Patient-reported outcome measure
PSS	Personal Social Services
PSSRU	Personal Social Services Research Unit
QALY	Quality-adjusted life year
RCP	Royal College of Physicians
RCP3Q	Royal College of Physicians Three Questions
RCT	Randomised controlled trial
RDMP	Respiratory Disease Management Platform
RePEc/IDEAS	Research Papers in Economics/IDEAS
RFE	Request for evidence

Term	Definition
RFI	Request for information
SABA	Short-acting beta-2 agonist
SD	Standard deviation
SGC	Synthetic glucocorticosteroid
SIGN	Scottish Intercollegiate Guidelines Network
SpO_2	Peripheral oxygen saturation
UK	United Kingdom
US	United States
VAS	Visual analogue scale
WHO ICTRP	World Health Organization International Clinical Trials Registry Platform

Plain language summary

Why this work is being done

Using digital technologies, such as apps on phones and tablets, could be used alongside the care people with asthma already receive to help them manage their conditions themselves. In this early value assessment (EVA), the External Assessment Group (EAG) were asked by the National Institute of Health and Care Excellence (NICE) to find and summarise evidence for nine technologies that support people to manage their asthma. The nine digital technologies the EAG were asked to include were: Asthmahub; Asthmahub for Parents; AsthmaTuner; BreatheSmart or Respi.me (part of the Respiratory Disease Management Platform, or RDMP); Digital Health Passport; Luscii; myAsthma; NuvoAir; and Smart Asthma. The EAG were asked to find out whether the current evidence about these technologies suggests that they might work in supporting people to manage their own asthma and if they might be good value for money for the National Health Service (NHS).

What the EAG found

After searching through databases and information that the technology companies had provided, the EAG found 211 pieces of information about how well the different technologies might work. This included: five pieces of information about BreatheSmart (RDMP); three about Asthmahub; three about Smart Asthma; one about Asthmahub for Parents; four about the Digital Health Passport; two about myAsthma; one about AsthmaTuner; one about Luscii; and one about NuvoAir. The EAG also found some pieces of information that reported on healthcare professionals', patients' and carers' experiences of using four of the technologies (AsthmaTuner, Digital Health Passport, and Smart Asthma). In general, there might be some evidence to suggest that the technologies might help improve peoples' asthma. However, the EAG did not find enough evidence to say for certain whether or not any of the technologies work well to support people to manage their own asthma or help manage their child's asthma.

The EAG also built an economic model, a tool used to find out whether these technologies might be value for money for the NHS. The EAG did many different types of analyses in the economic model to find out what might be the key costs and what uncertainties there are about how the technologies are used to help self-manage asthma. In general, the EAG found it might be possible that the technologies could be cost-effective in some circumstances. However, the EAG also found that more information is needed about the amount of people deciding to use the technologies (uptake), how many people stop using the technologies (dropouts), and how much the apps help to reduce asthma exacerbations.

What future research should focus on

Currently, more comparative evidence is needed for all of the technologies to say with certainty how well they work or if they are good value for money for the NHS. The EAG found 12 studies that are currently in progress: two for AsthmaTuner, three for BreatheSmart (RDMP); three for myAsthma; two for Asthmahub; one for Asthmahub for Parents; and one for NuvoAir. It is possible that these studies might help to fill some of the gaps in the current evidence for some outcomes, including quality of life, medication use and adherence, and asthma control.

Executive summary

Background and aims: The NHS 10-Year Plan has recognised respiratory medicine as a priority and is focused on using innovative and digital technologies to improve the quality of healthcare. The use of digital technologies could be used as an adjunct to standard care in supporting self-management of asthma. The purpose of this early value assessment (EVA) is to identify and summarise the available evidence for nine technologies that support self-management of asthma compared with standard care alone, where possible. Two technologies (Asthmahub and Asthmahub for Parents) are from the same company (ICST) but are considered as separate apps. A conceptual economic model has been developed to determine the potential value proposition for these technologies in the NHS. Areas for evidence generation to inform the key drivers of the model and address uncertainties will be identified to direct further research and data collection to inform a full future technology evaluation.

Clinical evidence: The EAG conducted literature searches and reviewed evidence submitted by the companies and Clinical Experts, identifying 20 relevant sources of quantitative evidence for inclusion. We included evidence for BreatheSmart/Respi.me from Respiratory Disease Management Platform (RDMP; n = 5), Digital Health Passport (n = 4), Smart Asthma (n = 3), myAsthma (n = 22), NuvoAir (n = 1), Asthmahub (n = 3), Asthmahub for Parents (n = 1), AsthmaTuner (n = 1) and Luscii (n = 1). Evidence was mainly reported in abstract or short report format (provided by companies), with 122 of 211 quantitative studies being in this format. Qualitative evidence was only available for four of the apps: AsthmaTuner, the Digital Health Passport, myAsthma and Smart Asthma.

For intermediate outcomes, evidence was available for BreatheSmart/Respi.me (RDMP; n = 5), myAsthma (n = 22), AsthmaTuner (n = 1), Asthmahub (n = 1) and Smart Asthma (n = 3). No quantitative information was reported for changes in inhaler technique. Qualitative evidence suggested potentially beneficial effects of using the Digital Health Passport and myAsthma apps. Quantitative evidence suggested mixed results

for changes to medication use, with some evidence suggesting improvement in adherence (BreatheSmart (RDMP), Asthmahub, and myAsthma), while some evidence for AsthmaTuner was mixed, with primary care (adults) potentially benefiting more than paediatrics. Qualitative evidence suggested using the apps could improve medication adherence. However, in some instances, the information may have conflicted with advice that patients had previously received, (as was reported regarding the Digital Health Passport). Data for adherence, but not attrition, was only available for BreatheSmart (RDMP) and Smart Asthma. Again, study evidence for BreatheSmart (RDMP) was mixed in terms of whether adherence to medication increased or decreased, while for Smart Asthma adherence to recording peak flow and symptoms may reduce over time. Qualitatively, it was mentioned that patients using AsthmaTuner may forget about the app or lose interest in using it regularly, while there was some suggestion that people using the Digital Health Passport only used the platform when their symptoms were worse. However, there was no quantitative evidence to support these suggestions. There were no data assessing number of referrals to specialists.

For the clinical outcomes, evidence was available for BreatheSmart/Respi.me (RDMP; n = 5), myAsthma (n = 4), Digital Health Passport (n = 3), Luscii (n = 1), AsthmaTuner (n = 1), Asthmahub (n = 1), and Asthmahub for Parents (n = 1). Only one study, using BreatheSmart (RDMP), reported on changes in symptoms, suggesting a reduction in patient reported symptoms. Qualitative evidence suggests patients gained more knowledge and insight into their condition and therefore noticed symptoms/impairment (reported for Asthmahub, Digital Health Passport and myAsthma). However, no evidence was available surrounding symptom-free days. For lung function, evidence was available for BreatheSmart (RDMP) and Luscii apps, with both generally suggesting maintenance of key measures such as predicted percentage of forced expiratory volume in one second (FEV1 % predicted) and forced vital capacity (FVC values), remaining in the normative lung function ranges. Similarly, asthma control was seen to either be maintained or improve (occasionally being statistically significant), as measured by tools such as the Asthma Control Test (ACT). Importantly, none of the apps appeared to have

evidence of a negative impact on asthma control (evidence available for BreatheSmart/Respi.me (RDMP), Digital Health Passport, myAsthma, Luscii, and AsthmaTuner). Evidence for the number of exacerbations or attacks were mixed (evidence available for myAsthma, BreatheSmart (RDMP), Digital Health Passport, Asthmahub, and Asthmahub for Parents), with some evidence suggesting a numerical or statistically significant improvement but with no differences observed between app users and non-users in other instances. Furthermore, eight studies are based on short term evidence (e.g., less than 6 months follow-up). There was limited evidence for mortality, with one RCT from BreatheSmart (RDMP) showing no deaths in either the intervention or control arms over the six-month study period.

For patient reported outcomes, evidence was available for BreatheSmart (RDMP; n = 3), Digital Health Passport (n = 3), myAsthma (n = 3), Smart Asthma (n = 3), NuvoAir (n = 1), and Asthmahub (n = 2). Generally, there was an observed decrease in school or work time being missed when using the app, although this varied and some evidence was derived from non-comparative studies. Additionally, the one included RCT assessing BreatheSmart (RDMP) was set in the US. There was also evidence of an improvement in quality of life but, again, this result was not consistently reported across the available evidence base. The evidence suggested that BreatheSmart (RDMP), NuvoAir, Digital Health Passport, Smart Asthma and myAsthma were well received by patients, with generally high acceptability, usability and perception of technology. From the qualitative evidence, patients and carers also noted the potential benefits of such apps and highlighted that, generally, they were easy to use.

Economic evidence: The EAG reviewedsix economic evaluations specific to the technologies (Asthmahub, AsthmaTuner, Digital Health Passport, NuvoAir, Smart Respiratory Products). The EAG also reviewed 5 additional economic evaluations, and the economic model that was developed for NICE guidance (NG245), which were not directly relevant to the decision problem. This evidence contributed to the development of a conceptual economic model, which was built to facilitate modelling of multiple value propositions (achieving better symptom control, less severe and less frequent exacerbations and

identification of misdiagnoses) associated with the technologies in scope. Results from this modelling work should not be interpreted as evidence or lack of evidence of cost-effectiveness. Instead, this modelling work aimed to determine key evidence gaps and key drivers of differences in costs and utilities compared with standard care, which should be addressed before a definitive evaluation is conducted.

The EAG used extensive univariate sensitivity analyses to determine the key drivers and uncertainties associated with technologies being used to support self-management of asthma when compared with standard care in the NHS. In general, the incremental QALYs gained in the intervention arm were small when compared with the comparator arm. The model was therefore sensitive to small changes in the cost. In particular, the EAG identified that the model was extremely sensitive to the cost of monitoring per patient (both with app, and without app), and the costing approach of the technology, where there may be upfront costs (typically associated with hardware, training and integration), and recurring costs on an annual or monthly basis. The impact of dropout varied based on the pricing approach applied. Key drivers were therefore the per patient technology costs, per patient monitoring costs, and also the proportion of misdiagnoses identified (false positives) where treatment could be stopped.

Key areas where further evidence is needed include initial uptake of the technologies, dropout rates, the relative reduction in exacerbations when using the technologies, and the proportion of misdiagnoses that could be identified by the technologies when compared to standard care. However, the EAG did consider it plausible that the technologies could be cost-effective and dominant in some modelled scenarios. Because the costing approach differs between technologies (and has a large impact on the ICER), and because functionality may differ between the technologies, comparative data and a better understanding of how these technologies would be adopted in an NHS setting should reduce uncertainties in future economic evaluations.

Evidence gap analysis: Evidence is limited for all technologies and outcomes. Evidence was especially limited for Asthmahub for Parents, Luscii and NuvoAir. Asthma control was the most common outcome where the EAG

was able to identify evidence; the only technologies where there were no data for this outcome were NuvoAir and Smart Asthma. RCT evidence was available for AsthmaTuner and BreatheSmart (RDMP), although these RCTs were based in North America. This means there is a lack of comparative evidence about the technologies based in an EnglishNHS setting. Furthermore, follow up across the apps was generally quite short, with tenten of the included studies assessing less than a year follow up and ninenine of the studies reporting at six months or less. Six studies had an unclear follow up time. Adherence and attrition rates for using technologies was not reported.

The EAG identified 12 ongoing studies (AsthmaTuner = 2; BreatheSmart/Respi.me (RDMP) = 3; myAsthma = 3; Asthmahub = 2; Asthmahub for Parents = 1; NuvoAir = 1). These studies could add further details for some key outcomes, including quality of life, medication use and adherence, and asthma control.

Key points for decision makers:

- There is an overall lack of peer reviewed evidence for all technologies.
- Asthma control was the most commonly reported outcome. However, there was variation in how this was reported. In some instances, baseline and follow up data was not presented but mean change data was available.
- Longitudinal data for adherence and attrition when using the technologies is required. This will allow for a better understanding regarding app engagement and usage, which would reduce uncertainties in future economic modelling.
- In many cases, the baseline data lacks granularity. This means it is difficult to assess the populations studied and the severity of their asthma. Further work is required to identify the impact of these technologies across varying degrees of asthma states (such as uncontrolled, partially controlled and controlled symptom states, or disease severity states – where the rates of exacerbation may vary).

- There is a lack of evidence allowing for appropriate consideration of different subgroups which may be impacted differently by using the technologies. This includes those with newly diagnosed asthma, children under the age of five (and their families and carers), and those with severe asthma.
- Evidence generation should focus on the collection of comparative evidence. Due to the different functionality of each of the technologies, and the small incremental QALY gain expected, better understanding the use case, the costs associated with implementing the technologies, and the impact of the technologies on reducing asthma healthcare related resource use in a real world NHS setting would support future economic evaluation.

1. Decision problem

The decision problem is described in the scope and EAG comments are included in the protocol.[1] The EAG made no further changes or comments.

2. Technologies

A summary of the nine technologies from eight manufacturers that support the self-management of asthma using digital tools is included in Table 2. This has been derived from information found in the scope and company supplied requests for information. Additional detailed information relating to each device can be found in Appendix C. There are functional differences in the across the technologies. For example, four technologies are software only (Asthmahub, Asthmahub for Parents, Luscii, myAsthma, Digital Health Passport), 4 technologies include hardware and software (Respiratory Disease Management Platform (RDMP), AsthmaTuner, Smart Asthma, NuvoAir). For RDMP, it must be used with either the BreatheSmart or Respi.me (UK name) self-management app.

As of September 2025, as indicated in the final scope, all of the technologies had regulatory approval (three as class IIa, one as class IIb and five as class I medical devices under either the EU Council Directive 93/42/EEC or EU Regulation 2017/745). Three technologies were registered on the MHRA Public Access Registration Database. All eight companies stated they meet the Digital Technology Assessment Criteria (DTAC).

Seven companies have stated, in their request for information, that their technologies are currently in use within the NHS and one (MediTuner) reported a planned release in 2026.

The EAG reviewed the MHRA Field Safety Notices from Jan 2020 for company and technology names and did not find any safety notices.

From information provided by companies and from company websites, the EAG notes that technologies included in this assessment:

- Require internet access.
- Require a device to display and or receive results.
- Are to aid the clinician in reporting, that is, they will not be used autonomously without human interpretation.
- Each technology reports findings in a different manner as summarised in Table 2.

Additional detailed information relating to each device can be found in Appendix C.

Table 2: Description of technologies

Device (Company) [Previous Name]	Indications	Type of platform	Additional hardware	PAAP features	Types of Tracking
Respiratory Disease Management Platform (RDMP) (Aptar Digital Health) Previous names: Cohero Health mHealth asthma management platform which included the BreatheSmart mobile application which is now known as Respi.me Launched: 2017 Class I	Indicated for use by HCPs and their patients aged 16 and above with chronic respiratory conditions, including comorbidities.	Respi.me application (Patient mobile app and the healthcare professional web app)	Herotracker Sense (used by Metered Dose Inhalers to record and monitor actuation and technique of inhaler) Requires mobile device that can access and install the patient app. The app has limited offline features	Created by HCP before patient is onboarded based on sites typical clinical practice and designed in collaboration with the patient that can be updated at any time. PAAPs are based on symptoms, controller and rescue medications intake. It can integrate lung function if it is part of the sites PAAP	Patient can view PAAP and lung function scores.Patient can manually record symptoms, triggers, asthma control and QoL
Asthmahub & Asthmahub for Parents (The Institute of Clinical Science and Technology - ICST) Launched: 2020 Class I	Support asthma self-management for adults over the age of 18	Mobile app downloaded from App Store (iOS) or Google play store (Android) Asthmahub for Parents is functionally similar but is parent focused with child specific education tailored towards parents	Patient requires mobile device that can access and install the app	Can be downloaded for sharing. Generated through the app based on the best peak flow they enter into the app, and their medication regime e.g. MART, AIR, Fixed Dose. These can be updated at any time.	Manual input tools for tracking daily symptoms, reliever use, preventer adherence, RCP 3 questions and peak flow readings
Luscii (Luscii healthtech B.V) Launched: 2014 Class IIa	Digital platform designed to support asthma self-management for people of all ages	Mobile app for patients and a web-based dashboard for clinicians. The mobile app is available on Android and iOS. It does not work offline	Patient requires mobile device that can access and install the app. Can integrate with the MIR Spirobank Smart.	PAAP advice based on Ardens Action plan.	Symptoms, the Asthma Control Test and peak flow are tracked. Usage of medication can also be tracked if required. Data is manually entered
AsthmaTuner (MediTuner) Launched: Planned launch Q3 2026 Class IIb	Asthma and COPD for individuals aged 6 years and over. All use by children and adolescents under the age of 18 must be under the supervision of their guardian	A patient-facing mobile application (iOS/Android) and clinician web portal	A patient-facing mobile application (iOS/Android) A Bluetooth-connected spirometer A clinician-facing CarePortal for real-time data review and decision support for clinicians	[redacted]	[redacted]
myAsthma (my mHealth) [myAsthma Plus (previously myAsthma Biologic) is part of myAsthma] Launched: 14 April 2016. Class I	Available to patients aged 13 years and over with COPD and/or Asthma	Web-based interactive digital self-management app that can be downloaded via the App Store or Google Play or accessed via any web-browser	Requires mobile device that can access and install the app and/or device that can access a web browser, it cannot be accessed offline Can connect to wearable devices and smart inhalers (Optional)	Individualised PAAP tailored to each patient's unique needs and preferences. PAAP is based on the patient's symptom score, clinical teams can also add PEF parameters PAAP is customisable by clinicians via the clinician dashboard and can be updated/changed at any time	Patient is prompted to record symptoms each time they access, Medication diary with reminders, PEF can be entered manually by patient morning and evening lung function entered manually (FEV1 (Litres), FEV1 (%) and FVC (Liters)
NuvoAir Home [Previous names: Air Next] (NuvoAir Medical) Launched: 2018 Class IIa	Used by competent adults that have been trained by a HCP to perform spirometry and monitor diseases affecting the respiratory system. A competent adult can assist a child who is ≥ 5 years old to perform a spirometry test	Air Next spirometer (including firmware) is intended to perform basic lung function and spirometry testing. NuvoAir enables users to share data remotely with their caregivers	NuvoAir proprietary spirometer Requires mobile device that can access and install the patient app	None (not available in UK version)	Spirometry/PEF data is auto populated in the app from the NuvoAir proprietary spirometer when a test is performed. Tracking of symptoms using questionnaires such as GINA, breathlessness core, mood tracking or these can be customised by the individual asthma teams (manual input). A digital PAAP is not available in the UK version of the technology app. Rather, physiologists support patients to understand and follow their asthma action plan in whichever form this is issued by their responsible clinical service.
Digital Health Passport (Tiny Medical Apps) Launched: 2019 Class I	Ages 13-25 living with Asthma and Allergies and parents of children living with Asthma and Allergies (ages 5-12). Can also be used can by those 26+ (tertiary audience)	Self-management of long term asthma and allergy	Patient requires mobile device that can access and install the app. No other compatible hardware	Users can upload or store their PAAP in the app. PAAP is generated by the clinician using their existing process and is uploaded to the app by either uploading a PDF or taking a photo. Plan is accessible at any time and can be updated. Previous versions are retained within the app PEF values can be entered manually, but are not core to the action plan logic	Includes features for tracking asthma symptoms, medication use (including reliever and preventer inhalers) in addition to PEF. Data is manually entered by user and does not require an external device
Smart Asthma (Smart Respiratory Products Ltd) Launched: 2018 Class IIA	Intended for users aged 5 and over and their carers manage asthma	Portable spirometer connect to smartphone or device via 3.5mm jack or included Bluetooth adapter to patient app with limited offline functionality	Smart Peak Flow Peak Expiratory Flow Meter. Patient requires smart mobile device that can access and install the app.	Users can upload existing plans. HCP provides the plan not the app	Symptoms or medication use can be added to each measurement or as a note manually

Device (Company) [Previous Name]	Indications	Type of platform	Additional hardware	PAAP features	Types of Tracking
Abbreviations: AIR/MART = anti-inflammatory reliever/maintenance and reliever therapy; API = application programming interface; COPD = chronic obstructive pulmonary disease; FEV1 = forced expiratory volume in one second; FVC = forced vital capacity; HCP = healthcare professional; ICST = Institute of Clinical Science and Technology; N/A= not applicable; NR = not reported; PAAP = personalised asthma action plan; PEF = peak expiratory flow; PROM = patient reported outcome; RCP = Royal College of Physicians; RDMP = Respiratory Disease Management Platform					

3. Clinical context

3.1 National guidelines

NICE provides asthma self-management guidance for adults, young people, children (aged five years and older) with a diagnosis of asthma, and their families or carers (where appropriate).[2] This includes offering asthma self-management programmes, which include written personalised asthma action plans (PAAPs) and education. Generally, these are based on symptoms for children and adults, although in adults peak expiratory flow (PEF) may also be used. Additionally, patients should be made aware of triggers for asthma symptoms and exacerbations, which should be included in the PAAP. The PAAP should be tailored to the individual with asthma, via discussion and agreement with people aged five years and older. For adults (aged 17 years and older) using inhaled corticosteroids, the PAAP should include information on increasing dosage when asthma control deteriorates (clearly outlining what to do when symptoms do not improve).[2, 3]

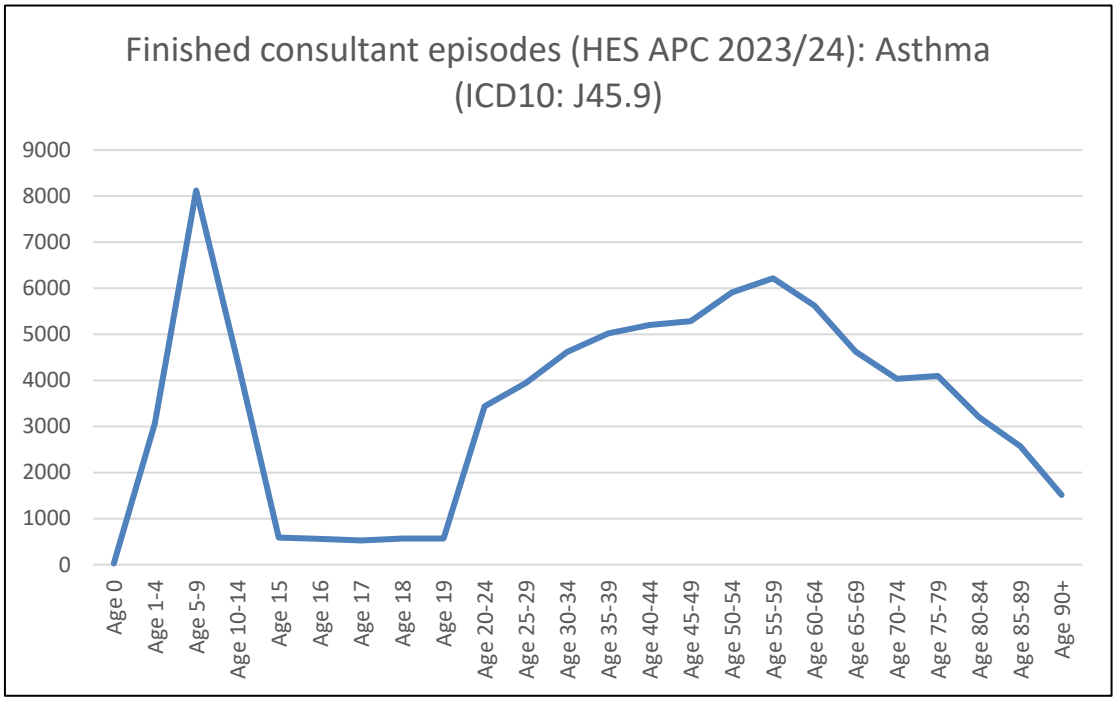
3.2 Routinely collected data in the NHS

For patients with severe asthma (accounting for between 5% to 10% of UK asthma patients), a UK Severe Asthma Registry is available.

Hospital Admitted Patient Care Activity reports released by NHS Digital for England contain data relating to diagnoses relevant to this EVA. Within the 2023/24 financial year, a primary diagnosis (ICD10 code) of “Asthma, unspecified” (J45.9) occurred in 57,132 inpatient admissions (89.4% of which were emergency admissions), with a median length of stay of one day (mean 2.6) and mean age of 44 years (with clear separation between number of admissions in children and adults; see Figure). A limitation of these aggregated national data summaries is that they count the total number of admissions, rather than the number of patients with an admission (that is, a patient who has frequent admissions and may have worse symptom control

may bias the results). However, Figure shows how healthcare resource usage changes with patient age.

Figure 1: Finished consultant episodes (from Hospital Episode Statistics Admitted Patient Care database) from 2023/24 for asthma



Abbreviations: HES APC = Hospital Episode Statistics Admitted Patient Care

Hospital Accident and Emergency Activity dataset recorded 130,674 attendances with a primary code of Asthma (SNOMED CT code: 195967001). This highlights the high hospital activity (and cost associated) with managing severe exacerbations on the NHS. However, the clinical coding team within the Newcastle upon Tyne Hospitals NHS Foundation Trust advised that they do not code patient notes in Accident & Emergency (A&E) and outpatient settings. Therefore, the quality and detail captured within this routine dataset is limited.

3.3 Equality issues

Equalities issues and considerations for this early value assessment are described in the equalities impact assessment alongside the scope. No

additional equality issues have been identified by the EAG during the assessment.

4. Clinical evidence

4.1 Search strategies and study selection

A pragmatic search strategy was developed and identified published literature reviews in the topic area (for example, Belisario et al 2013 and Hodkinson et al 2020).[4, 5] The strategy was optimised for the decision problem, for example including company and technology names listed in the Final Scope, and older device names as advised by the companies in their completed request for information (note that because of time constraints, Cohero and AirNext were not included as terms within the search strategy, which may be a limitation for retrieving older studies). The EAG note that sources of evidence relating to Cohero were identified and searches were also supplemented with information provided by the companies. The search strategy was applied to the following electronic databases:

- MEDLINE, EMBASE, CINAHL, Cochrane Database of Systematic Reviews (CDSR) and Cochrane Controlled Register of Trials (CENTRAL) for clinical evidence;
- The International Network of Agencies for Health Technology Assessment (INAHTA), Research Papers in Economics/IDEAS (RePEc/IDEAS), and the Paediatric Economic Database Evaluation (PEDE) for economic evidence;
- World Health Organization International Clinical Trials Registry Platform (WHO ICTRP) for ongoing studies; and
- MHRA Field Safety Notices for adverse events.

Published and unpublished studies provided by companies and other stakeholders were also considered and included if relevant to the decision problem.

While systematic reviews were excluded from the main report, we assessed their reference lists for potentially relevant includes. To accomplish this, we used the online platform CitationChaser, which automated the collection of potentially relevant records.[6]

Titles and abstracts were screened using online software (Rayyan).[7] Two reviewers (RPWK, JW) initially screened 20% of the studies, blinded. Any disagreements were discussed between reviewers. Once agreement was met between the two reviewers, the remaining studies were assessed individually by the reviewers. For those deemed relevant to the scope, full papers were retrieved and reviewed in the same manner as the title and abstracts (such as, 20% initially double screened). Any exclusions of full papers had the reason for exclusion tabulated.

4.2 Included and excluded studies

4.2.1 Results of the search

See Appendix A2 for the PRISMA diagram for clinical evidence.

4.2.2 Characteristics of included studies

Table 3 outlines the characteristics of the studies included in this EVA. Of the 211 included studies, three studies reported on Asthmahub (three of which were unpublished reports provided by the company),[8-10] one reported on Asthmahub for Parents,[11] one reported on AsthmaTuner,[12] four studies on the Digital Health Passport (three of which were unpublished reports provided by the company),[13-16] one study assessed the Luscii app,[17] two reported on myAsthma,[18, 19] one on NuvoAir,[20] five on BreatheSmart/Respi.me (RDMP; including one study published as a full report and an abstract),,[21-26] andand three on Smart Asthma.[27-29] In general, the interventions, comparators and study designs used across the studies met the scope of the EVA. Details surrounding whether the evidence was conducted in a primary, secondary or tertiary setting were less well reported. Demographic information such as age, sex, ethnicity, socioeconomic status (e.g. measured by Index of Multiple Deprivation or income), asthma control at baseline, concomitant medications and comorbidities were poorly reported across almost all included studies,

making it challenging to ascertain potential differences in populations or whether specific population groups were more represented in the evidence base than others. Where reported, adults with asthma were included inseven studies,[8, 11, 13, 21, 22, 24, 29] while five studies included children.[12, 13, 17, 26, 27, 30] One study included and reported on parent/carer outcomes.[20] In the remaining nine studies, the age of the study population was either not reported or unclear.[9, 10, 14-16, 18, 19, 23, 28] The reported outcomes across included studies tended to assess clinical and patient-reported outcome measures, with fewer studies reporting on intermediate outcomes.

Table 3: Description of key studies in the evidence base

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
Asthmahub (ICST)	Barry (2025) Retrospective cohort (pre versus post) (Full match to scope) UK (Wales) Full publication	11,062 (assumed adults due to the age ranges reported in the study starting at 18) Setting: Primary and secondary care (Full match to scope)	Intervention (n=11,062): Asthmahub, available in Welsh and English, including self-management algorithm, instructional videos on inhaler use and educational videos on multiple aspects of asthma care (Full match to scope) Comparator: N/A – pre versus post (Full match to scope)	RCP3Q (Royal College of Physicians Three Questions) Reliever inhaler use (Partial match to scope) Follow up: 4 or more months	Population: Practice deprivation group and age group reported; most participants were from the lower half of the deprivation distribution (n=5982). Asthma type and other demographic information NR. Intervention: No comments, fits decision problem. Outcomes: No clinical outcomes reported. Setting: Set in Wales (UK), so may be broadly generalisable

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Asthmahub for Parents (ICST)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
AsthmaTuner (Medituner)	Ljungberg (2019) Pilot cross-over RCT (Full match to scope) Sweden Full publication	90 children aged ≥ 6 years and adults with at least a doctor's diagnosis of asthma, and ACT/C-ACT scores <2 0 points from May 2016 to September 2018 were randomised; 77 assessed Setting: Primary care and specialised paediatric healthcare	Intervention first (primary care n = 16; paediatric n = 23): AsthmaTuner app, allows patients to register symptoms and measure FEV1 with a Bluetooth spirometer (MIR SmartOne). (Full match to scope) Comparator: Conventional treatment, defined as non-digital self-management using individual printed treatment plans (Full match to scope)	Inhaler technique (baseline only) ACT (12+yrs), C-ACT (6-11yrs) MARS medication adherence Lung function (FVC, FEV1; baseline only) (Partial match to scope) Follow-up: 8 weeks, with a 2-4 week washout, then another 8 weeks	Population: Age range, sex, concomitant treatments, comorbidities and current treatment plan reported. Population represents uncontrolled, partly controlled and controlled asthma. Intervention: No comments, fits decision problem. Outcomes: Intermediate and clinical outcomes

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
		(Full match to scope)			reported; PROMs not reported. Setting: Set in Sweden, unclear generalisability to UK context.
Digital Health Passport (Tiny Medical Apps)	Digital Health Passport Service Evaluation (2024) Prospective cohort (pre versus post) (Full match to scope) UK Report	1,106 users who downloaded and registered with the Digital Health Passport Setting: Unclear (Unclear match to scope)	Intervention (n=1,106): Digital Health Passport, a self-management app designed for teenagers, young adults and the parents/carers of pre-teens (Full match to scope) Comparator: N/A (Full match to scope)	Patient activation ACT Quality of life (EQ-5D-5L or 3L) Asthma attacks Days off Steroids Emergency care (Partial match to scope) Follow-up: 3 months	Population: Most participants were over 13 years old (78.8%), female (65.3%) and of White ethnicity (76.4%), with 54.3% of participants from IMD quintiles 1 and 2. ACT assessment at baseline suggested uncontrolled asthma. Intervention: No comments, fits decision problem.

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
					Outcomes: Clinical outcome and patient-reported outcome measures assessed. Intermediate outcomes not assessed. Setting: Set in the UK but unclear whether primary, secondary or tertiary care.
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Luscii app (Luscii)	Gijsen (2024) Prospective cohort (Full match to scope) Netherlands Abstract	40 children and young people aged 6 to 18 Setting: Unclear (Unclear match to scope)	Intervention (n=40): Luscii app, smartwatch (Fitbit Charge 5) and home spirometer (MIR Spirobank) (Full match to scope) Comparator: N/A	Heart rate (night-time) Deterioration in C-ACT score Lung function (Partial match to scope)	Population: No demographic information presented in abstract.

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
			(Full match to scope)	Follow-up: 12 weeks Note: all reported in abstract results, not methods.	Intervention: No comments, fits decision problem. Outcomes: Only clinical outcomes reported. Setting: Based in the Netherlands and unclear setting; unclear generalisability to UK context.
myAsthma (my mHealth Limited)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NuvoAir (NuvoAir)	Coughlin (2021) Survey (Full match to scope) UK (assumed due to study author affiliations) Abstract	18 patients or parents/carers using the NuvoAir home platform (includes all patients receiving a biologic and those who would benefit from home	Intervention (n=18): NuvoAir home platform, including mobile application, Bluetooth spirometer and physician portal (Full match to scope)	Acceptability of the NuvoAir platform (Partial match to scope) Follow-up: NR	Population: Mean age is the only demographic information of interest reported.

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
		monitoring due to unstable disease) Setting: Unclear (Unclear match to scope)	Comparator: N/A (Full match to scope)		Intervention: No comments, fits decision problem. Outcomes: Only patient-reported outcome measures are assessed. Setting: Geographical location unclear; cannot assess generalisability to the UK context.
Respiratory Disease Management Platform (Aptar Digital Health)	Biljani (2024) Prospective cohort (pre versus post) (Full match to scope) USA Abstract Linked abstracts provided by Aptar Digital Health: Biljani (2023)a	104 adults Setting: Unclear (Unclear match to scope)	Intervention (n=104): Aptar Digital Health Respiratory Platform (BreatheSmart app and Herotracker inhaler sensor) (Full match to scope) Comparator: N/A – pre versus post	ACT Change in controller medication adherence Rescue medication use between baseline and 3 months Acceptability (Partial match to scope)	Population: No demographic information reported. Intervention: The EAG note that the BreatheSmart app was acquired by Aptar Digital Health but is assumed to

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
	and Biljani (2023)b – treated by the EAG as a single unit as same study		(Full match to scope)	Follow-up: 3 months	still be of relevance to the scope. Outcomes: Only intermediate outcomes assessed. Setting: Based in an unclear setting in the US; unclear generalisability to the UK context.
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Ramsey (2022) Prospective cohort (pre versus post) (Full match to scope) USA Full publication	26 in Step 1 and 17 in Step 2; physician-diagnosed moderate or severe persistent asthma Setting: Unclear	Intervention (n varies by step): In Step 1, Cohero mobile tracking sleeves, smartphone with prepaid data plan and BreatheSmart mobile app; spirometry completed in-office; MedaCheck habit app for push notifications on weekly spirometry readings. In Step 2,	Feasibility and acceptability Adherence Disease severity and control Lung function (Full match to scope) Follow-up: 7-11 weeks for Step 1 and	Population: Mean age was 14.7 (SD 1.57); 50% female; 14 White, 11 Black or African-American, 1 patient of 'other' ethnicity; 50% had private insurance status; mean ACT at baseline was 20.33 (SD 4.15), suggesting a mix of

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
			telehealth behavioural intervention. (Full match to scope) Comparator: N/A – pre versus post (Full match to scope)	12-16 weeks for Step 2	uncontrolled, partly controlled and potentially controlled asthma. Concomitant corticosteroid use also reported. Intervention: The EAG note that the BreatheSmart app was acquired by Aptar Digital Health but is assumed to still be of relevance to the scope. Outcomes: Intermediate, clinical and patient-reported outcomes are all assessed. Setting: Based in an unclear setting in the US; unclear

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
					generalisability to the UK context.
	Simoneau (2019) RCT (Full match to scope) US Abstract This RCT also has a linked ClinicalTrials.gov record with quantitative data reported[30]	75 children aged 8 to 17 with physician-confirmed asthma Setting: Paediatric pulmonary clinic (Full match to scope)	Intervention (n=50): BreatheSmart app, Herotracker sensor, Cohero connect provider platform (Full match to scope) Comparator (n=25): Standard care (Full match to scope)	Adherence to medication Feasibility and acceptability ACT FEV1% predicted Lung function ER visits Number of missed days of school (Full match to scope) Follow-up: 3 and 6 months	Population: Mean age of children was 12 (SD 2.9), 40 were female and 35 male, 45.3% were Hispanic or Latino, 44% had moderate persistent asthma and 51% had severe persistent asthma. No other demographic information reported. Intervention: The EAG note that the BreatheSmart app was acquired by Aptar Digital Health but is assumed to still be of relevance to the scope. Outcomes: Intermediate, clinical

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
					and patient-reported outcomes all assessed. Setting: Set in the US; unclear generalisability to the UK context.
Smart Asthma (Smart Respiratory Products Ltd)	Thamjamratsri (2024)Thamjamratsri (2024) Prospective cohort (Full match to scope) Thailand Full publication	77 children aged 7 to 17 years old with physician-diagnosed asthma according to GINA, regularly use ICS and had asthma control within the previous month; 71 of the 77 children were assessed. Setting: secondary and tertiary care (Full match to scope)	Intervention (n=71): Smart Peak Flow (SPF) application used twice daily in the morning and in evening (Full match to scope) Comparator: N/A (Full match to scope)	Quality of life Medication use Asthma control Ease of use (satisfaction) Adherence to PEF measurements (Full match to scope) Follow-up: 3 months	Population: Children had a median age of 11.4 and 62% were male. 59.2% had moderate asthma, 69% had no exacerbations in the previous year and 100% has concomitant allergic rhinitis. Median ICS use was 4.6 years. 52.27% of caregivers had a Bachelor's degree. Intervention: No comments; fits decision problem.

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
					Outcomes: Intermediate, clinical and patient-reported outcomes all assessed. Setting: Set in secondary and tertiary care in Thailand; unclear generalisability to the UK context.
	Ananth (2023)Ananth (2023) UK (based on author affiliationsaffiliations) Abstract	App users who were sent two surveys in August 2022 (n=343) and December 2022 (n=42) Setting: unclear (Unclear match to scope)	Intervention: Digital peak flow and application (Full match to scope based on information being provided by the company) Comparator: N/A (Full match to scope)	Adherence Usability/satisfaction (Partial match to scope) Follow-up: August 2022 and December 2022	Population: No demographic information about the population was reported. Intervention: No comments; matches decision problem Outcomes: Only intermediate and

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
					patient-reported outcomes assessed. Setting: Set in the UK but unclear whether primary, secondary or tertiary care.
	Antalffy (2025)Antalffy (2025) Service evaluation (Partial match to scope) UK and Ireland Abstract	Adults and children using Smart Asthma app across 26 NHS and HSE Ireland centres Setting: Unclear (Unclear match to scope)	Intervention (n = 182 families): Smart Asthma Virtual Monitoring Service (Full match to scope) Comparator: N/A (Full match to scope)	Adherence Ease of use and acceptability (Partial match to scope) Follow-up: Unclear; appears to be 12 weeks	Population: No demographic information about the population was reported. Intervention: No comments, intervention matches decision problem. Outcomes: Only intermediate and patient-reported outcomes reported. Setting: States set in NHS and HSE

Technology (manufacturer)	Study name, design and location	Participants and setting	Intervention(s) and comparator	Outcomes measures and follow up	EAG comments
					Ireland centres but unclear whether primary, secondary or tertiary care.

Abbreviations: ACT = Asthma Control Test; ATS/ERS = American Thoracic Society (ATS) and the European Respiratory Society (ERS); C-ACT = Childhood Asthma Control Test; COPD = chronic pulmonary obstructive disorder; EAG = External Assessment Group; GINA = Global Initiative for Asthma; FEV = forced expiratory volume; FVC = forced vital capacity; HCP = healthcare professional; HSE = Health Service Executive; IMD = Index of Multiple Deprivation; MD = Doctor of Medicine; N/A = not applicable; NR = not reported; PEF = peak expository flow; SpO_2 = oxygen saturation; UK = United Kingdom; US = United States

Seven qualitative studies were included in this EVA;two of these studies provided open-ended comments from questionnaires. One of the studies was a conference abstract with an unclear study design but provided some information on the perspectives of clinicians.[29] The EAG included this abstract to add to the evidence despite the limited details reported. Table 4 outlines the characteristics of the qualitative studies. Two studies reported on myAsthma,[18, 31] three on the Digital Health Passport,[13, 16, 32]one on AsthmaTuner,,[33] and one on Smart Asthma.[29] No qualitative studies were identified for any of the remaining technologies of interest. Three studies were set in the UK,[13, 18, 31] with another two studies assumed to be set in the UK due to contextual details.[16, 32] One study was based in both the UK and Ireland.[29] One study on AsthmaTuner was set in Sweden.[33] Across all included studies, there were few demographic details reported about the participants or the methods used to sample participants and analyse data.

Table 4: Characteristics of included qualitative studies

Technology	Study ID	Country and setting	Participants	Age Sex Ethnicity	Other demographic information	Data collection and sampling method, theoretical perspective and data analysis method
myAsthma	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
AsthmaTuner	Schoultz 2022 [33]	Sweden; south, west and east regions (primary healthcare and hospital care)	5 nurses with experience of using eHealth in the healthcare of people with asthma	Age: NR Sex: male 1; female 4 Ethnicity: NR	Both primary and hospital care represented Length of experience using AsthmaTuner ranged from 4 months to 4 years	Data collection: Semi-structured interviews (four telephone interviews and 1 video call interview) Sampling method: NR Theoretical perspective: NR Data analysis method: Content analysis
Digital Health Passport	UCL Partners Health Innovation 2024 [13]	UK; setting NR	38 Parents/carers on behalf of the	Age: NR Sex: NR Ethnicity: NR	NR	Data collection: Structured telephone-based interviews Sampling method: Sampled from participants who had

Technology	Study ID	Country and setting	Participants	Age Sex Ethnicity	Other demographic information	Data collection and sampling method, theoretical perspective and data analysis method
			child or young person using DHP: 15 Child or young person using DHP themselves: 5 Adults (25+) using DHP for themselves: 15 Asthma nurses using DHP for demonstration or educational purposes: 3			taken part in a survey about Digital Health Passport Theoretical model: Continuous use model, adapted from Song et al 2021[34] Data analysis method: Thematically coded according to the continuous use model
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Technology	Study ID	Country and setting	Participants	Age Sex Ethnicity	Other demographic information	Data collection and sampling method, theoretical perspective and data analysis method
Smart Asthma	Antalffy (2023)[29]	UK and Ireland; 26 NHS and HSE Ireland centres	Clinicians; no further information reported	Age: NR Sex: NR Ethnicity: NR	NR	Data collection: NR Sampling method: NR Theoretical perspective: NR Data analysis method: NR
Abbreviations: HSE = Health Service Executive; NHS = National Health Service; NR = not reported; UCL = University College London; UK = United Kingdom						

5. Clinical evidence review

5.1 Quality appraisal of studies

Formal critical appraisal was not undertaken. However, here we present considerations for risk of bias and other potential issues associated with the current evidence base.

There are several observational studies included in the identified evidence, mainly retrospective and prospective cohorts with a pre-post design. None of the four retrospective analyses included used statistical analyses that attempted to include confounding factors.[8, 14, 15, 23] For the prospective cohorts (n = 78), there was only one study that performed logistic regression (analysis: association of nighttime heart rate and childhood Asthma Control Test (C-ACT); confounder: salbutamol use).[17] In general, the evidence is therefore at risk of bias for not considering confounders within their analyses.

One of the RCTs included, which assessed BreatheSmart (RDMP), utilised 2:1 randomisation,[26, 30] which can lead to statistical power issues. Using 2:1 randomisation leads to an increase of 12.5% in sample size to obtain the same precision estimate treatment comparison as 1:1 randomisation.[35]

In terms of population, most of the studies include people with uncontrolled asthma, although in some cases this is assumed due to baseline characteristics (for example, ACT scores of less than 20). The protocol highlighted the population of interest was those diagnosed with asthma (for example, controlled, partially controlled and uncontrolled). The lack of evidence across other asthma statuses means the results may not be generalisable to some of these subgroups.

The generalisability of some of the evidence is further questionable, as some studies were conducted in countries with very different healthcare systems. Five of the studies were conducted in the US, including an RCT assessing BreatheSmart (RDMP)..[26, 30]As all evidence conducted in the UK is drawn from observational studies and service evaluations, this demonstrates a lack of controlled evidence for UK based data.

It can be challenging to develop high-quality real world evidence for digital health technologies.[36] One reason for this in the current EVA is the need for self-reported measures, which can lead to recall bias and could significantly impact results. This is especially the case for more clinically based outcomes, such as asthma control, with questionnaires such as the ACT requiring patients to recall a previous period of time. This time period was not always clear from the study reports; since inaccuracies in recall are more likely with longer time lapses, this means there is uncertainty about the reliability of these outcome measures.

It is also worth noting that 122 of the 211 included studies were reported in abstract format or were provided by the company with limited details (unpublished research). Due to this, it was often difficult to distinguish specifics about the studies, for example outcomes were often not defined in a clear manner. This means that most of the evidence was not derived from peer reviewed publications and the limited data (for example, baseline characteristics, study settings) weakens the overall quality and robustness of the data.

The EAG made deviations from the protocol to include two studies presenting survey data, which was applicable to PROMs (for example, usability).[16, 20] As this data is directly measuring patient interaction with the apps, and a control arm not using an app would not be asked such questions, the EAG felt it was acceptable to include non-comparative evidence for these outcomes.

Although no formal critical appraisal was undertaken, the EAG also note limitations in the included qualitative studies. Most notably, only seven studies were of relevance to the decision problem; four of these used qualitative methodologies, while [redacted][16] One conference abstract presented data that appeared qualitative in nature but no details surrounding how this information was collected were reported.[29] This was a deviation from protocol for the EAG as these studies are not strictly qualitative in nature, but this decision was made to increase the amount of evidence considered in the qualitative review. However, the overall small amount of data and how it was collected and

presented means the qualitative evidence is less “rich” and certainty in the findings may be reduced.

Furthermore, very little information about the participants was presented across the included qualitative studies, meaning it is challenging to be able to note whether the digital technologies work for different groups of people. For example, as of March 2024, approximately 7% of households in the UK do not have home internet access and around 10 million adults are estimated to lack foundational-level digital skills. Groups such as older people (especially those over 75 years old) and people in more socioeconomically disadvantaged groups may also be at risk of digital exclusion. As such, without understanding who is providing perspectives on app use, it is uncertain whether barriers and facilitators have been explored for those who may be most likely to be impacted.[37] Finally, the studies only focus on four of the interventions within the decision problem: myAsthma, AsthmaTuner, Digital Health Passport and Smart Asthma. As such, it is unclear whether there would be similar findings for the other digital technologies of relevance to the decision problem. As a result of these limitations, it is difficult to draw any definitive conclusions from the current qualitative evidence base surrounding digital tools for self-managing asthma.

5.2 Results from the evidence base

5.2.1 Intermediate outcomes

Inhaler technique

Quantitative evidence

No included studies provided quantitative data assessing inhaler technique.

Qualitative evidence

UCL Health Partners Innovation 2024 reflected on how the Digital Health Passport helped enhance inhaler technique. Participants in their interviews highlighted the utility of videos about inhaler technique included in the Digital Health Passport. Furthermore, parents who used the Digital Health Passport

for their child reported that these videos also helped normalise asthma, meaning that their children were more likely to engage with using devices such as spacers.[13]

[redacted].[18]

Medication use

Quantitative evidence

One study reported data on medication use for Asthmahub,[8] one study for AsthmaTuner,[12] two for myAsthma,[18, 19] and two for BreatheSmart (RDMP)..[21, 23] No quantitative data for this outcome were identified for the Digital Health Passport, Luscii, NuvoAir or SmartAsthma. Outcome data are presented in Table 5.

Table 5: Quantitative outcome data for medication use

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
Asthmahub	Barry (2025) Retrospective cohort (UK (Wales))	Adults; subgroup of people who scored 0 on RCP3Q (sample size NR)	Intervention (n = NR): Asthmahub Comparator: N/A	Zero reliever inhaler uses per week (%)	Baseline 4 or more months	Baseline (n = NR): 29.1% 4 or more months (n = NR): 39.2% Difference 10.1% (95% CI 7.2 to 13%, P < 0.0001)	N/A	N/A
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Children Aged 6 and above and adults	Intervention (n = 77): AsthmaTuner Comparator (n = 77): Conventional	MARS adherence: medication use overall	Baseline 2 months, then 2-4 week washout Followed by	Difference: 0.06 (-0.11 to 0.24; P = 0.47)	Difference: -0.06 (-0.23 to 0.1; P = 0.43)	AsthmaTuner vs conventional difference: 0.13 (-0.11 to 0.38) Difference in crossover

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
			paper-based management		another 2 months (4.5 to 5 month follow-up)			effect: P = 0.64
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Adults in primary care	Intervention (n = 37): AsthmaTuner Comparator (n = 37): Conventional paper-based management	MARS adherence: medication use in primary care	Baseline 2 months, then 2-4 week washout Followed by another 2 months (4.5 to 5 month follow-up)	Difference: 0.11 (-0.14 to 0.35; P = 0.38)	Difference: -0.14 (-0.35 to 0.08; P = 0.2)	AsthmaTuner versus conventional difference: 0.23 (-0.11 to 0.57; P = 0.17) Difference in crossover effect: P = 0.39

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Children aged 6 and over	Intervention (n = 40): AsthmaTuner Comparator (n=40): Conventional paper-based treatment	MARS adherence: medication use for paediatrics	Baseline 2 months, then 2-4 week washout Followed by another 2 months (4.5 to 5 month follow-up)	Difference: 0.03 (-0.24 to 0.29; P = 0.85)	Difference: 0.00 (-0.25 to 0.25; P = 1)	AsthmaTuner versus conventional difference: 0.08 (-0.29 to 0.45; P = 0.67)
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Children aged 6 and above and adults	Intervention (n = 62): AsthmaTuner Comparator (n = 62): Conventional	MARS adherence: AsthmaTuner used on average once weekly or more overall	Baseline 2 months, then 2-4 week washout	Difference: 0.19 (0.01 to 0.38; P = 0.04)	Difference: -0.08 (-0.27 to 0.11; P = 0.4)	AsthmaTuner versus conventional difference: 0.27 (0 to 0.55; P = 0.5)

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
			paper-based management		Followed by another 2 months (4.5 to 5 month follow-up)			Difference in crossover effect: P = 0.37
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Adults in primary care	Intervention (n = 27): AsthmaTuner Comparator (n = 27): Conventional paper-based management	MARS adherence: AsthmaTuner used on average once weekly or more in primary care	Baseline 2 months, then 2-4 week washout Followed by another 2 months (4.5 to 5 month follow-up)	Difference: 0.26 (0.02 to 0.49; P = 0.03)	Difference: -0.19 (-0.43 to 0.06; P = 0.13)	AsthmaTuner versus conventional difference: 0.45 (0.13 to 0.77; P 0.01) Difference in crossover effect: P = 0.4

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Children aged 6 and over	Intervention (n = 35): AsthmaTuner Comparator (n = 35): Conventional paper-based treatment	MARS adherence: AsthmaTuner used on average once weekly or more for paediatrics	Baseline 2 months, then 2-4 week washout Followed by another 2 months (4.5 to 5 month follow-up)	Difference: 0.14 (-0.14 to 0.42; P = 0.3)	Difference: 0 (-0.29 to 0.29; P = 1)	AsthmaTuner versus conventional difference: 0.16 (-0.26 to 0.57; P = 0.45)
BreatheSmart (RDMP)	Bijlani (2024) Prospective cohort (pre versus post; US)	Adults	Intervention (n = 104): BreatheSmart (RDMP) Comparator: N/A	Medication use: rescue inhaler	Baseline 3 months	Narrative notes that usage decreased by 44% (95% CI 14.1 to 63.5)	N/A	N/A

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
BreatheSmart (RDMP)	Bijlani (2024) Prospective cohort (pre versus post; US)	Adults	Intervention (n = 104): BreatheSmart (RDMP) Comparator: N/A	Medication use: controller inhaler	Baseline 3 months	At 3 months adherence to controller medication was 45% higher than US asthma medication adherence (NB: unclear what this is comparing to) Adherence to controller medication decreased 10.7% (95% CI 6.4 to 15.1) Mediation adherence at	N/A	N/A

Technology	Author (year) Study design (country)	Population	Intervention/ Comparator	Outcome measurement	Follow-up	Intervention results	Control results	Differences between groups
						follow up was 17% higher than global medication adherence (NB: unclear what this is comparing to)		
BreatheSmart (RDMP)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
myAsthma	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Abbreviations: CI = confidence interval; MARS = Medication Adherence Report Scale; N/A = not applicable; NR = not reported; RDMP = Respiratory Disease Management Platform; SABA = short-acting beta-2 agonist; SD = standard deviation

Data from a retrospective cohort assumed to focus on adult patients surrounding Asthmahub noted a change in the number of people not using a reliever inhaler per week.[8] However, this was based on a subgroup of people who had scored 0 on the Royal College of Physicians Three Questions (RCP3Q), indicating controlled asthma; the number of participants contributing to this outcome was also not reported.

One pilot crossover RCT in children aged six or more and adults with at least a doctor's diagnosis of asthma (not specified) reported several outcomes relating to Medical Adherence Report Scale (MARS) adherence when using AsthmaTuner.[12] Adherence through MARS is based on a Likert scale of forgetting to take asthma medications (1 = always, 5 = never). Those using AsthmaTuner first had non-statistically significant mean difference in overall medication usage of 0.06 points and those in the conventional paper-based management first group also had a non-statistically significant change of -0.06 points. The difference between using the AsthmaTuner first and conventional treatment first was not statistically significant. This study also reported outcomes stratified by primary care and paediatrics (median age 12.5, IQR 9 to 14; range 6 to 17). In the primary care population, there was a non-statistically significant difference in mean overall medication usage when using the AsthmaTuner first and for those using conventional paper-based management first. The difference between using the AsthmaTuner and conventional treatment was also not statistically significant. In the paediatric population, the difference in mean overall medication usage using the AsthmaTuner was not statistically significant or when using conventional paper-based management. The difference between using the AsthmaTuner and conventional treatment was also not statistically significant.

This study also reported data relating to MARS adherence for those using the AsthmaTuner on average once weekly or more.[12] There was a statistically significant difference in mean overall medication usage for those using the AsthmaTuner once weekly or more, though the CIs were wide and close to the line of no effect. There was not a statistically significant effect for conventional paper-based management. The difference between using the

AsthmaTuner once weekly or more and conventional treatment was 0.27 (95% CI 0 to 0.55). Additionally, the study reported this outcome stratified by primary care and paediatrics. In the primary care population, there was a statistically significant difference in mean overall medication usage for those using the AsthmaTuner once weekly or more, but not for conventional paper-based management. The difference between using the AsthmaTuner once weekly or more and conventional treatment was statistically significant. In the paediatric population, there was not a statistically significant difference in mean overall medication usage for those using the AsthmaTuner once weekly or more or for conventional paper-based management. There was a non-statistically significant difference between using the AsthmaTuner once weekly or more and conventional treatment.

[redacted] reported on medication use when using myAsthma.[18, 19] [redacted]

One published prospective cohort (pre versus post) [redacted] reported on medication usage for BreatheSmart (RDMP).[21, 23] In the published prospective cohort study in adults, rescue medication usage decreased from baseline to 3 months.[21] [redacted][23]

Qualitative evidence

Schoultz 2022 highlighted that nurses who had used AsthmaTuner in their practice suggested that there may be a positive aspect of the app in terms of medication use. The nurses in this study noted that, because their patients were able to gain further insight into their condition, it was possible for them to notice signs of impaired asthma before clearer symptoms occurred, meaning that medication could be adjusted appropriately.[33]

There were some similarities in the report from UCL Partners Health Innovation, where interviewees noted that the timed medication reminders in the Digital Health Passport helped support them to take the right medications at the right times and encouraged better inhaler usage. One adult user commented that the reminders helped them to form the habit of taking their medications. The report noted that most of the participants felt like the medication alerts from the Digital Health Passport reduced their cognitive

load, particularly if they were managing lots of medications or had a busier family life.[13]

However, people interviewed about the Digital Health Passport also had some criticisms of the platform. Some participants noted that the information they received from the Digital Health Passport conflicted with information they had been given in the past, such as how often they should use their inhalers in an emergency, while others were unable to identify a link between using the app and improving their asthma. They suggested that this was too subjective a concept to be able to determine definitively.[13]

[redacted][16] [redacted][32]

One conference abstract stated that clinicians who had used Smart Asthma strongly agreed that the Smart MDI Sensor helped avoid unnecessary step ups in medication by identifying poor adherence.[29] However, details in this abstract were limited and it is unclear how many clinicians were included and how this information was collected.

Adherence/attrition rates

Quantitative evidence

Four studies reported data on adherence rates to medication for BreatheSmart (RDMP) but not on attrition rates.[23-26] Data on adherence rates to the app were not reported. Three studies reported on adherence data for Smart Asthma.[27-29] No quantitative evidence surrounding adherence or attrition was identified for any other technologies of interest.

An abstract of an RCT comparing BreatheSmart (RDMP) with standard care assessed 22 participants at 3 months, reporting that baseline adherence to medication based on pharmacy records was 56% in the intervention group and 86% in the control group. At 3 months, adherence to medication was stated to be higher in the intervention group than the control group (56% compared with 31%; P = 0.05). The trial registration for this RCT also reported medication adherence based on the proportion of days covered in terms of the ratio of the sum of unique days supplied, based on pharmacy

refills over the total number of days in assessment period, reporting 0.39 (SD 0.34) mean days for BreatheSmart (RDMP) (n = 50) and 0.33 (SD 0.30) mean days for the conventional treatment arm (n = 25) at 6 months.[26] A prospective cohort study reported a statistically significant improvement in medication adherence for the full sample of participants from baseline to study end (MD 0.19, SD 0.37; t = −2.14, P = 0.048, d = 0.52). For the subsample of participants that participated in Step 1 only (digital medication reminders), adherence in the study declined from baseline (69%) to the end of the study (46%; t = −2.14, P = .0.013, d = 1.90). However, for those who participated in both steps of the study (digital medication reminders and a telehealth behavioural intervention), adherence increased from baseline (30%) to the end of the study (65%; t = −5.63, P <0.001, d = 1.70).[25] Another prospective cohort (pre versus post) reported on adherence to medication and controller inhalers. This study also reported that adherence to controller mediation was 45% higher at 3 months compared with US asthma medication adherence, though it was unclear what data the result was being compared with.[21] An abstract linked to this prospective cohort study reported that adherence to controller medication decreased 10.7% at 3 months when using BreatheSmart (RDMP) (95% CI 6.4 to 15.1) but that medication adherence at follow-up was 17% higher than global medication adherence, though, again, it was unclear what data the result was being compared with.[22] [redacted][24]

One prospective cohort study assessing Smart Asthma in 71 children aged between 7 to 17 years old reported on adherence to peak flow measurements at 1, 2 and 3 months. When once daily measurements were assessed, there was a statistically significant decrease in adherence from 86.7% at 1 month to 76.7% at 2 months and 70% at 3 months (P < 0.001). For twice daily peak flow measurements, there was also a statistically significant decrease in adherence from 50% at 1 month to 40.8% at 2 months and 39.9% at 3 months (P < 0.001).[27] Another prospective cohort of Smart Asthma and peak flow users stated that 22/41 of patients surveyed (53.7%) stated that their usage of the digital peak flow meter after 6 months was similar to when they first used it.[28] Finally, a service evaluation of 276 families noted that 182 (66%) continued to use the Smart Asthma Virtual Monitoring Service. This abstract

also suggested that the proportion of families recording peak flow, symptoms and inhaler use declines over time. However, it was not possible to determine exact figures from the graphs provided in the abstract.[29]

Qualitative evidence

Four qualitative studies commented on adherence. Schoultz 2022 noted that the nurses they interviewed had suggested that their patients do not use the app as much as the nurses would like and that some patients either forgot about it or lost interest in using it regularly.[33] Although it was suggested that it could be difficult for patients to form a routine, the nurses interviewed also suggested that those who used AsthmaTuner regularly gained stronger self-care abilities.[33]

Similarly, the report from UCL Partners Health Innovation suggested that while some people used the Digital Health Passport for notifications and alerts if they did not require regular input, others only actively used the app when their symptoms were worse. This was also the same for parents and carers who used the Digital Health Passport on behalf of children. Furthermore, 97% of those interviewed about the Digital Health Passport said they intended to continue using the app.[13] [redacted][15]

As previously noted, one conference abstract stated that clinicians who had used Smart Asthma strongly agreed that the Smart MDI Sensor helped identify poor adherence, thereby helping to avoid unnecessary step ups in medication.[29] However, details in this abstract were limited and it is unclear how many clinicians were included and how this information was collected.

Number of referrals to specialists

Quantitative evidence

No included studies provided quantitative data assessing number of referrals to specialists.

Qualitative evidence

No studies presented qualitative data relevant to this outcome.

5.2.2 Clinical outcomes

Changes in symptoms/symptomatic improvement

Quantitative evidence

One study reported changes in symptoms or triggers for the BreatheSmart (RDMP) app.[23] No further quantitative evidence was identified for any of the other apps.

[redacted]

Qualitative evidence

As previously noted, Schoultz 2022 highlighted that nurses who had used AsthmaTuner in their practice suggested that their patients were able to gain further insight into their condition from using the app, making it possible for them to notice signs of impaired asthma before clearer symptoms occurred.[33]

This was the same for participants interviewed about the Digital Health Passport, who noted that it was useful in being able to indicate when their health may be deteriorating and to identify and monitor potential triggers. The report stated that “most” interview participants also reported that their asthma knowledge and management had improved.[13] [redacted][16, 32]

[redacted][31][redacted][18]

Lung function

Quantitative evidence

Two studies reported data for BreatheSmart (RDMP),[25, 26, 30] and one for Luscii.[17] No quantitative evidence for the other apps was found for this outcome.

An RCT compared BreatheSmart (RDMP; n = 50) to standard care (n = 25) in children with mild to severe persistent asthma.[26, 30] Results were reported for FEV1 percentage predicted; as a note, 23 of 25 patients in the control arm were included in this data. At baseline (mean 89.7, SD 18.2) versus 92.4 (SD

15), respectively, three months (mean 86.5 (SD 12.9) versus 99.7 (SD 17.8), respectively), and six months (mean 90.5 (SD 16.3) versus 103.6 (SD 14.8), respectively). Data suggest that both arms had normal lung function at baseline (such as, FEV1 % predicted greater than 80%),[38] which was maintained across the duration of the study. Numerically, the intervention group (BreatheSmart users) initially saw a decrease in values before an increase at six months. The standard care group were observed to increase their values gradually over each time period. However, despite variations, the values appear relatively stable for both groups over time and no statistical analysis information is provided. Spearman's correlations also showed a weak correlation with changes in medication adherence (correlation coefficient: BreatheSmart: 0.221; standard care: 0.283). Similarly, Spearman's correlation was used to correlate changes in medication adherence to FEV1/FVC ratio. However, FEV1/FVC ratios were not directly reported and the coefficients were small (correlation coefficient: BreatheSmart: -0.081; standard care: 0.174). Overall, the results of this study show maintenance of lung function but with no statistical analysis, inferences are difficult to make. Additionally, the weak observed correlations make interpretation of the impact of using BreatheSmart (RDMP) on lung function difficult to make.

A prospective cohort of children with moderate to severe persistent asthma (n = 26) was undertaken as a two-step study.[25] The initial step of the study included daily digital medication reminders through the MedaCheck Habit app, while step 2 was a telehealth behavioural intervention, which included adherence feedback via the BreatheSmart (RDMP) app and sessions for self-monitoring strategies (for example, discussions around barriers, adherence to medication responsibility and individually tailored training). Changes in FEV1% predicted were presented from baseline (mean 94.83, SD 24.76) to 7 to 11 weeks (step 1 mean 94.06, SD 42.30) and 16 weeks (step 2 mean 85.72, SD 26.14). Changes were not statistically significant (baseline to end of study MD 6.70, 95% CI -3.04 to 16.44, P = 0.163). Initially, at least numerically, there appears to be maintenance of FEV1% predicted, before a drop. However, this remains within the range for normal lung function (greater than 80%). FVC was also reported, changes from baseline (mean (SD):

110.69 (39.96)) to 7 to 11 weeks (mean (SD): 104.08 (28.53)) and 16 weeks (mean (SD): 103.40 (36.57)) are reported. Similar to FEV1% predicted, there was a numerical change but not a statistically significant decline (baseline to end of study mean difference 2.12, 95% CI 10.53 to 14.78, P = 0.730). Again, results suggest normal lung function was maintained. It is worth noting that the extra support provided (i.e. telehealth intervention which included sessions of self-monitoring strategies, discussions of barriers to adherence and allocation of treatment responsibility, organisational strategies, and guided problem solving training) makes it difficult to discern if any effect on outcomes is due solely to the BreatheSmart (RDMP) app. Additionally, this study included an app that is not included in the scope (MedaCheck Habit app).

For the Luscii app, a prospective cohort assessing children between 6 to 18 years old (n = 40) reported a non-statistically significant improvement in lung function at three-month follow-up when compared to baseline.[17] No further details were reported.

Qualitative evidence

In Schoultz 2022, the nurses interviewed suggested that the measurement values taken by AsthmaTuner were considered more reliable and accurate compared with when PEF was used; no further details were reported.[33]

People interviewed about the Digital Health Passport noted that the app gave them the flexibility to review data such as their peak flow (not specified), but that they often already had access to this information and support elsewhere.[13]

Asthma control

Quantitative evidence

Four studies reported data for BreatheSmart and Respi.me (RDMP),[21, 22, 24-26, 30] three for Digital Health Passport,[14, 15, 39]one for Luscii[17] and one for AsthmaTuner.[12] Table 6Table provides an overview of the results.

Table 6: Overview of quantitative evidence for asthma control

Technology	Author (year) Study design (country)	Population	Intervention Comparator	Outcome measure	Follow up	Baseline	Follow up Analysis results
BreatheSmart (RDMP)	Simoneau (2019) RCT (US)	Children; 8-17 years old	Intervention (n = 50): BreatheSmart (RDMP) Comparator (n = 25): standard care	ACT	Baseline 3 months 6 months	Mean (SD) Intervention: 18.9 (5.5) Control: 17.9 (5.5)	All mean (SD) 3 months Intervention: 21.2 (3.7) Control: 20 (3.4) 6 months Intervention: 19.7 (3.1) Control: 17.9 (5.6)
BreatheSmart (RDMP)	Bijlani (2024) Prospective cohort (US)	Adults	Intervention (n = varies): BreatheSmart (RDMP) Baseline n = 104 3 months n = 96 Comparator: N/A	ACT	Baseline 3 months	Mean (SD): 16.5 (4.7)	Increased by 2.8 (95% CI 2.0 to 2.6; P < 0.001)
BreatheSmart (RDMP)	Ramsey (2022) Prospective cohort (US)	Children; 12-17 years old	Intervention (n = 26): Two step study with telehealth behavioural intervention	ACT	Baseline 7-11 weeks 16 weeks	Mean (SD): 20.33 (4.15)	Mean (SD) 7-11 weeks: 21.75 (3.44) 16 weeks: 21.54 (3.02)

Technology	Author (year) Study design (country)	Population	Intervention Comparator	Outcome measure	Follow up	Baseline	Follow up Analysis results
			including BreatheSmart (RDMP) Comparator: N/A				Mean difference (absolute value): 1.46 (95% CI -3.24 to 0.32; P = 0.104)
Respi.me (RDMP)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Digital Health Passport	Digital Health Passport Service Evaluation (2024) Prospective cohort (UK)	Adults; 12 years or more Children; less than 12 years	Intervention (n = 200): Digital Health Passport Adults: 177 Children: 23 Comparator: N/A	ACT	Baseline 3 months	Mean (SD) Adults: 15.9 (5.32) Children: 18.5 (3.26)	Mean (SD) Adults: 17.4 (4.63) Children: 18.4 (2.23) Statistical analysis; t-statistic Adults: -5.03, P < 0.01 Children: -0.2, P = 0.84
Digital Health Passport	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Digital Health Passport	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Luscii	Gijsen (2024)	Children; 6-18 years	Intervention (n = 40): Luscii	C-ACT	Baseline	Median (IQR): 22.5 (NR)	Median (IQR)

Technology	Author (year) Study design (country)	Population	Intervention Comparator	Outcome measure	Follow up	Baseline	Follow up Analysis results
	Prospective cohort (Netherlands)		Comparator: N/A		3 months		24 (NR)
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Adults and children	Intervention (n = 77): AsthmaTuner Comparator (n = 77): conventional (paper based)	ACT and C-ACT	Baseline Follow up: 2 months 4.5 to 5 months	Mean (SD): 15.6 (3.1)	Mean (95% CI) 2 months: 19.45 (18.7 to 20.21) 4.5 to 5 months: 18.75 (17.97 to 19.53) Difference: 0.7 (0.06 to 1.34; P = 0.03)
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Adults	Intervention (n = 37): AsthmaTuner Comparator (n = 37): conventional (paper based)	ACT	Baseline Follow up: 2 months 4.5 to 5 months	Mean (SD): 15.1 (2.9)	Mean (95% CI) 2 months: 19.14 (18.08 to 20.19) 4.5 to 5 months: 18.78 (17.63 to 19.94) Difference: 0.33 (-0.68 to 1.35; P = 0.51)

Technology	Author (year) Study design (country)	Population	Intervention Comparator	Outcome measure	Follow up	Baseline	Follow up Analysis results
AsthmaTuner	Ljungberg (2019) Pilot crossover RCT (Sweden)	Children	Intervention (n = 40): AsthmaTuner Comparator (n = 40): conventional (paper based)	C-ACT	Baseline Follow up: 2 months 4.5 to 5 months	Mean (SD): 15.9 (3.2)	Mean (95% CI) 2 months: 19.75 (18.65 to 20.85) 4.5 to 5 months: 18.73 (17.61 to 19.84) Difference: 0.97 (0.13 to 1.81; P = 0.02)
Abbreviations: ACQ-5 = Asthma Control Questionnaire; ACT = Asthma Control Test; C-ACT = Children's Asthma Control Test; CI = confidence intervention; IQR = interquartile range; NR = not reported; RCT = randomised controlled trial; SD = Standard deviation							

An RCT compared BreatheSmart (RDMP; n = 50) to standard care (n = 25) in children with mild to severe persistent asthma.[26, 30] No statistical testing was reported as the data are taken from the clinical trial record. However, the numerical trend shows an increase in ACT scores between baseline and 3 months for both groups (see Table 6). This is followed by a decline in ACT scores, with the standard care arm returning to baseline values. The decline in the BreatheSmart (RDMP) arm was not as pronounced but still dropped below 20 points on the ACT, which is indicative of uncontrolled asthma. However, the mean is close to showing a minimally clinically important difference (MCID), which for the childhood ACT is 2.0 points.[40]

A prospective cohort of children with moderate to severe persistent asthma (n = 26) was conducted as a two-step study.[25] The initial step of the study included daily digital medication reminders through the MedaCheck Habit app, while step 2 was a telehealth behavioural intervention, which included adherence feedback via the BreatheSmart (RDMP) app and sessions for self-monitoring strategies (e.g. discussions around barriers, adherence to medication responsibility and individually tailored training). Changes in ACT values were not statistically significant from baseline to follow up (see Table 6). It is worth noting that there is an issue with the confidence interval reporting for these results, as they do not contain the point estimate. Additionally, the extra support provided makes it difficult to discern if any effect on outcomes is due solely to the BreatheSmart (RDMP) app.

A prospective cohort utilising BreatheSmart (RDMP) provided data comparative to baseline (i.e. 104 at baseline for no app usage and 96 at 3 month follow up) for adult patients.[21, 22] Baseline ACT scores showed the cohort likely had uncontrolled asthma (mean 16.5, SD 4.7). After three months of usage, ACT scores were reported to statistically significantly increase by 2.8 points (see Table 6).

[redacted][24][redacted][41]

A service evaluation was conducted for the Digital Health Passport for children (8-12 years; n = 23) and adults (≥ 12 years; n = 177), with mainly

uncontrolled asthma (130 of 177 adults had < 20 ACT score).[39] Change was assessed from baseline (adult mean (SD): 15.9 (5.32); children mean (SD): 18.5 (3.26)) to three months (adult mean (SD): 17.4 (4.63); children mean (SD): 18.4 (2.23)), with statistically significant improvements observed in the adults but not the children (see Table 6). Adults were also considered in a stratified analysis where they considered adults self-reporting (n=162) and carers (n=15) separately, while the statistical significance was maintained for the self-reporting adults (p<0.01), this was not the case for carers (p=0.23). This is likely due to the reduced sample size..

[redacted][14, 15]

For the Luscii app, a prospective cohort assessing children aged 6 to 18 years old (n = 40) reported a non-statistically significant change in the children's ACT score from baseline to three months (see Table 6).[17] No measures of dispersion were reported. It is worth noting that, in the abstract the data are taken from, the timepoints are assumed to be incorrectly reported, as it shows a decline but the statement says it increased from baseline to three months. The EAG has therefore reported what we believe to be the correct data. The study did report a statistically significant association between nighttime heart rate and the childhood ACT (the association point estimate was not reported, 95% CI -1.258 to -0.181, P = 0.009, analysis corrected for salbutamol use). Results therefore suggest that a higher nighttime heartrate is associated with poorer asthma control. The authors suggest this finding brings non-invasive home monitoring a step closer, especially when coinciding with a numerical change in childhood ACT scores. No association was observed between childhood ACT and lung function (data not reported).[17]

For the AsthmaTuner app, a single crossover RCT included adult primary care (n = 37) and paediatrics (n = 40) compared against a conventional, paper-based action plan. The paper states that the focus is on those with uncontrolled asthma and the inclusion criteria mention including those with < 20 points on the ACT. ToTo note, information about treatment plans at baseline was also reported, which includes plans for patients with uncontrolled, partially controlled and controlled asthmaasthma[12] Therefore,

the included population is unclear. The results are reported for the end of the study, with sensitivity analyses showing no significant differences when considering the crossover (i.e. washout) period for ACT scores in both adults and children. Linear regression results showed a statistically significant improvement from baseline to 4.5 to 5 months when considering all patients and paediatrics, but not for adults in primary care (see Table 6). Results for the overall patient analysis remained statistically significant in separate models adjusting for number of AsthmaTuner assessment (on the log scale), care facility (adults or paediatrics), and for both previously mentioned factors. This study also noted that the proportion of participants with uncontrolled asthma decreased from 37% to 8% between weeks 1 and 9.*Qualitative evidence*

As previously noted, the nurses interviewed in Schoultz 2022 suggested that gaining insight into their condition through the AsthmaTuner app meant it was possible for them to notice the signs of impaired asthma earlier. In turn, the nurses suggested that this led to the patients having better asthma control.[33]

This was echoed by some of the participants interviewed about the Digital Health Passport, who commented that they had reported fewer asthma attacks since using the app. Some participants suggested this may be because they had better inhaler usage and minimised their risk but others were not able to identify a link between using the app and improved asthma control.[13] [redacted][32]

A conference abstract stated that clinicians who had used Smart Asthma strongly agreed that it empowered their patients to manage their asthma and to have better asthma control.[29] However, details in this abstract were limited and it is unclear how many clinicians were included and how this information was collected.

Symptom-free days

Quantitative evidence

No studies presented quantitative data relevant to this outcome.

Qualitative evidence

No studies presented qualitative data relevant to this outcome.

Exacerbations or attacks

Quantitative evidence

[redacted] reported evidence for myAsthma,[18, 19] one for BreatheSmart (RDMP), one for Digital Health Passport,[39] one for Asthmahub,[9] and one for Asthmahub for Parents.[11] No other technologies provided evidence for this outcome. For evidence presenting exacerbations, attacks or flare ups, we have considered this terminology to be interchangeable and these are therefore reported together here.

[redacted]

An RCT compared the BreatheSmart (RDMP; n = 50) application to standard care (n = 25) in children with mild to severe persistent asthma.[26, 30] It reported the number of emergency department visits at three months (BreatheSmart: 0; standard care: 1), and six months (BreatheSmart: 3; standard care: 3). No further data were available.

For the Digital Health Passport, a service evaluation was conducted in children (8-12 years; n = 23) and adults (≥ 12 years; n = 177), with mainly uncontrolled asthma (130 of 177 adults had < 20 ACT score).[39] The evaluation reported the cohort as a whole (n = 203) and considered: change from baseline to three months for: number of asthma attacks (mean at baseline: 1.02, SD 1.61) versus three months (mean 0.93, SD 1.51; no statistically significant difference); number of steroids received (mean at baseline 0.76, SD 1.39) versus three months (mean 0.92, SD 1.83; no statistically significant difference); and number of urgent and emergency department visits (mean at baseline: 0.47, SD 1.05) versus three months (mean 0.45, SD 0.94; no statistically significant difference). The results suggest that using the Digital Health Passport app did not lead to any statistically significant reductions in outcomes linked to exacerbations.

[redacted] [9].

[redacted] [11]

[redacted]

[redacted] [11]

Qualitative evidence

[redacted] [16] [redacted] [32]

Mortality

Quantitative evidence

One study (reported in two publications) reported mortality for the BreatheSmart (RDMP) app.[26, 30] No further evidence was identified for any of the other apps.

The RCT reported no deaths in either the intervention (0/50) or control (0/25) arms.[26, 30]

Qualitative evidence

No studies presented qualitative data relevant to this outcome.

5.2.3 Patient-reported outcomes

Time off work or school

Quantitative evidence

Overall, two studies assessing Digital Health Passport,[13, 14] and one for BreatheSmart (RDMP),[26, 30]reported data on the number of days missed from school or work.

[redacted] [14] [redacted] a prospective cohort study of 203 Digital Health Passport users (18.2% under the age of 13 years) indicated no differences (t = 1.06; P = 0.29) in the number of days off school or work at baseline (mean 2.23, SD 5.79) compared to follow up at 3 months (mean 1.77, SD 4.02).[13]

For BreatheSmart (RDMP), an RCT including children aged 8 to 17 years managed in a US paediatric pulmonary clinic randomised participants 2:1 to either BreatheSmart (RDMP) or a standard of care group. Those in the intervention group (n = 50) reported missing a mean of 1.12 (SD 1.9) and 2.1 (SD 1.5) number of days off school in the last 30 days from baseline and last 30 days from the 6 month follow-up visit, respectively.[26, 30] Those in the control group (n = 25) had a mean of 1.04 (SD 1.8) days off school in the last 30 days at baseline and 3.3 (SD 3.1) days in the last 30 days at follow up.[26, 30]

Qualitative evidence

No studies presented qualitative data relevant to this outcome.

Quality of life

Quantitative evidence

Quality of life was reported by eighteight included studies investigating the impact on patients using myAsthma in [redacted],[18, 19] BreatheSmart (RDMP) in one study,[24] Digital Health Passport in two studies,[13, 16]Asthmahub in two studies,,[8, 10] and Smart Asthma in one study.[27]

[redacted]18[redacted]19 [redacted]

[redacted] 24 [redacted]42 [redacted]43 [redacted]41

In a prospective cohort study assessing the Digital Health Passport,[13] the impact on quality of life in adults and children was measured using the EQ-5D-5L and EQ-5D-3L,[44] respectively, across the following 5 dimensions: mobility; self-care; usual activities; pain/discomfort; and anxiety/depression. Whilst it is not clear from the study the rationale for using the EQ-5D-5L for adults and EQ-5D-3L for children, compared to baseline after three months of use, no statistically significant improvement was observed in those that completed the EQ-5D-3L (n = 10, t = -0.98, P = 0.35) or EQ-5D-5L (n = 157, t = -0.15, P = 0.88).[13] [redacted][16]

A Welsh retrospective cohort study assessed self-reported symptoms and asthma control in adults using Asthmahub with the RCP3Q.[8] RCP3Q scores

of 0 are indicative of good asthma control while a score of 2 or 3 is indicative of poor control.[45] The RCP3Q scores were collected as part of a monthly 10-question asthma checker, with reminders sent to prompt users. In all app users with one or more app use, four or more months after their first app use (n = 1,581), 26.5% of patients had a RCP3Q score of 0 at their first app use, while 40.7% had a score of 0 four or more months later (difference 14.2%, 95% CI 11.3 to 17.0, P < 0.0001).[8] In the same study, a separate paired analysis was carried out for app users who had recorded a RCP3Q score both at baseline and exactly 12 months later (n = 133), which indicated a statistically significant improvement in RCP3Q scores at the 12 month follow-up (MD −0.31, 95% CI −0.52 to −0.09, paired t-test P = 0.0052).[8]

[redacted] 10.

Smart Asthma was used with a digital peak flow meter in a prospective cohort of 71 children from Thailand.[27] Quality of life was assessed via the The Paediatric Asthma Quality of Life Questionnaire (PAQLQ); results were subgrouped by those with good (minimum of 45 readings over 3 months; n = 27) or poor (n = 44) adherence to taking digital peak flow measurements. For those with good adherence, there was statistically significant improvements in PAQLQ measures form baseline to 3 month follow up for overall score and the subsets of symptoms, activities and emotions. No statistically significant differences were reported for any PAQLQ score for those with poor adherence to digital peak flow meter measures (see Table 7). Number of patients meeting the MCID for PAQLQ was also presented, showing overall 23 patients (32.29%) obtained at least a change of 0.5 points. Of these, 8 patients were in the good adherence subgroup and 15 patients were in the poor adherence subgroup (p <0.001). Therefore, while good adherence to using the peak flow meter and thereby the Smart Asthma app did lead to improvements in quality of life, the number of people who gained an MCID in the PAQLQ was higher in those did not adhere well.

Table 7. PAQLQ results for using digital peak flow meter with Smart Asthma app.

PAQLQ	Group	Baseline	3 months	p-value

		Median (IQR)	Median (IQR)	
Overall QoL	Good adherence	6.3 (5.7 to 6.7)	6.9 (6.4 to 7.0)	<0.001
	Poor adherence	6.5 (6 to 6.9)	6.7 (6.4 to 7.0)	0.101
Symptoms	Good adherence	6.2 (5.6 to 6.8)	6.8 (6.2 to 7.0)	0.001
	Poor adherence	6.3 (5.8 to 6.9)	6.7 (6.1 to 7.0)	0.098
Activities	Good adherence	6.0 (4.6 to 6.8)	6.8 (6.2 to 7.0)	<0.001
	Poor adherence	6.6 (5.5 to 7.0)	6.8 (6.4 to 7.0)	0.066
Emotions	Good adherence	6.5 (5.5 to 7.0)	7.0 (6.8 to 7.0)	<0.001
	Poor adherence	6.9 (6.3 to 7.0)	7.0 (6.5 to 7.0)	0.303

Qualitative evidence

No studies presented qualitative data relevant to this outcome.

Ease of use and acceptability

Quantitative evidence

Patient reported outcomes on ease of use and acceptability of the technologies was reported by ninenine studies, two evaluating BreatheSmart (RDMP),[21, 24] one assessing NuvoAir,[20] one assessing the Digital Health Passport,[16] two evaluating myAsthma,, [18, 19] and three assessing Smart Asthma.[27-29]

[redacted][24] [redacted] 46

An abstract of a prospective, single cohort observation study including 104 adults with 90 days of access to BreatheSmart (RDMP) collected patient feedback as a secondary outcome.[21] The study reported a platform rating mean score of 7.825 out of 10 (where 1 = low and 10 = high), with 82.5% participants reporting that the platform was very/somewhat easy to use,

92.5% reporting that alerts were very/somewhat helpful, and 97.5% rating the spirometer as very/somewhat easy to use.[21]

In a UK study (assumed due to author affiliations) aiming to evaluate the acceptability of the NuvoAir home platform for children, surveys were emailed to patients (or parents/carers) containing statements requiring responses on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree).[20] From 18 surveys completed out of 71 circulated by patients (44.4% of responses) or parents/carers (55.6% of responses), participants reported using the app for a mean number of 212.1 days (SD 42.1).[20] The majority of responses to the survey were positive, with 82.4% of the overall participants strongly agreeing, while 81.3% of the overall participants agreed that the NuvoAir Home spirometer and app were easy to set up (median:4; range: 3 to 5) and that it was easy to perform a spirometry test (median:4; range: 2 to 5).[20] Participants also agreed that NuvoAir helped them provide results to the clinical team (median: 4; range: 1 to 5).[20] Furthermore, it was reported that participants agreed they were likely to continue using the app (median: 4; range: 1 to 5) and were likely to recommend the app (median: 4; range: 1 to 5).[20]

[redacted] 16

[redacted] 18 [redacted] 19

For Smart Asthma two prospective cohorts[27, 28] and a service evaluation[29] were identified. One of the prospective cohorts, conducted in children from Thailand (n = 71), reported those who had good (minimum of 45 readings over 3 months; n = 27) or poor (n = 44) adherence to taking digital peak flow measurements.[27] With evidence suggesting for both groups they were generally satisfied with the digital peak flow meter (85.2 and 88.6%, respectively), found it simple to use (81.5 and 81.8%), it was easy to carry (100 and 90.9%), would recommend use (92.6 and 86.4%), allowed them to confidently manage their asthma (74.1 and 90.9%), would continue to use after project completion (66.7 and 81.8%), and found the application easy to use (85.2 and 88.6%). Overall, these results suggest the digital peak flow and Smart Asthma app were generally easy to use and accepted by the majority of

patients, whether they had good or poor adherence. It is worth noting that this study also reported the number of times a peak flow device was required to replaced with 22 of 71 children requiring replacements for varying reasons, mainly related to issues with the device: display defects (44.4%), propeller defects (22.2%), bluetooth defects (11.1%), broken devices (7.4%), power defects (7.4%), charging defects (3.7%), and lost devices (3.7%). The other prospective cohort assessed, via survey at two timepoints (August 2022, n = 343; December 2022, n = 41) UK based patients.[28] The August data from 343 patients suggested it was easy to see asthma deteriorating based on peak flow data within the app (84.5%), are comfortable using their digital peak flow meter in public (60.1%), and open to using other digital devices to monitor their health (88.6%). The December data from 41 patients suggested patients found using a digital peak flow meter was more useful than an analogue assessment (85.4%). They also reported they showed their data to a healthcare professional (65.9%), which led to changes in treatment (44.4%).

Finally, the service evaluation conducted in 26 NHS and HSE Ireland centres (including children and adults) found that patients reported the digital system more convenient than paper records and valued the ability to share data with clinicians and receive notifications.[29] Overall, the evidence for Smart Asthma is relatively positive, however, the majority of the evidence is linked to the use of the digital peak flow meter and not specifically the Smart Asthma application, although both are likely to be used together.

Qualitative evidence

The nurses interviewed in Schoultz 2022 suggested that AsthmaTuner was easy to use both for themselves and patients, with patients feeling confident about using the system.[33]

[redacted][31] [redacted][18]

When reporting about the Digital Health Passport, 100% of those interviewed said that the app was easy to use and 95% of the participants were very satisfied with the app. It was noted that some of the participants found some

of the wording and instructions unclear, giving the example of the word "hacks."[13] [redacted][32] [redacted].[16]

Patient perception of technology

Quantitative evidence

Patient perception of technology was reported by four studies, one evaluating NuvoAir,[20] one assessing BreatheSmart (RDMP),[25] one assessing the Digital Health Passport,[16] and one evaluating myAsthma.[18]

In a UK study (assumed due to author affiliations) investigating the acceptability of the NuvoAir home platform in children, surveys requiring responses to statements on a 5-point Likert scale (1 = strongly disagree; 3 = neutral; 5 = strongly agree) were emailed to patients (or parents/carers).[20] Out of 71 surveys circulated, 18 were completed by patients (44.4%) or parents/carers (55.6%), who reported using the app for a mean number of 212.1 days (SD 42.1). Results from the survey presented median scores of 4 (range: 1 to 5) for statements where participants felt it was useful and reassuring to be able monitor lung function at home.[20] Additionally, participants agreed the app helped them to monitor changes (median: 4; range: 3 to 5) and spot deterioration of their child's condition (median: 4; range: 2 to 5).[20] However, participants provided more neutral responses regarding whether the app helped them to improve their child's spirometry technique (median: 3; range: 3 to 5) or if it reduced anxiety about the child's spirometry performance (median: 3; range: 3 to 5).[20]

In a pilot study of adolescents aged 12 to 17 years with moderate to severe persistent asthma, participants received a technology-assisted stepped-care behavioural intervention.[25] After a baseline period of adherence monitoring, 18 patients, who were identified as having adherence below a set threshold, received four weekly, telehealth behavioural intervention sessions over a mean average of 5.25 weeks (SD: 1.76), and access to adherence feedback via BreatheSmart (RDMP).[25] From the 26 patients who completed the study, 64% indicated satisfaction with the apps used in the study.[25]

[redacted][18]

Qualitative evidence

[redacted][32] though no other studies reported qualitative data on this outcome.

5.3 Adverse events and clinical risk

Evidence was available from one study assessing BreatheSmart (RDMP).[26, 30] No further evidence was identified for any of the other apps.

The RCT for BreatheSmart (RDMP) observed no serious adverse events for the intervention (0/50) or control (0/25) arms. The only observed adverse events (classified as other) were caregiver-reported emergency department visit for asthma exacerbation (events were collected by non-systematic assessment) for the intervention (3/50) and control (4/25) groups.[26, 30]

5.4 Clinical evidence summary and interpretation

In all, 211 studies were included in the review of clinical effectiveness and seven studies included in the qualitative analysis. There was no quantitative evidence found surrounding inhaler use, adherence to the app or symptom-free days across the included studies.

Collectively three studies assessed Asthmahub,[8 9, 10] and one on Asthmahub for Parents,[11] reporting quantitative data surrounding one intermediate outcome (medication use), four clinical outcomes (GP visits, prednisolone courses, A&E attendances, and hospitalisations), and one patient-reported outcome (quality of life). The evidence suggested Asthmahub increased the number of people not using a reliever inhaler per week from 29.1% to 39.2%, albeit based on a subgroup of people who scored zero on the RCP3Q with an unknown amount of people included. The study also suggested there was a statistically significant improvement in quality of life for those who had used the app at least once after four or more months. [redacted][9] No qualitative evidence was identified for Asthmahub.

[redacted].[11] No qualitative evidence was identified for Asthmahub for Parents.

One study reported on AsthmaTuner,[12] reporting data for one intermediate outcome (medication use) and one clinical outcome (asthma control). No studies reported patient-reported outcomes for AsthmaTuner. Most of the results suggested no statistically significant changes in adherence to medication. However, those using AsthmaTuner once per week or more did increase their overall medication use (overall and for adults, but not for the paediatric population). For asthma control, overall a statistically significant increase was observed, which extended to the paediatric analysis but not the adult analysis. This suggests mixed results in the effectiveness of the app at impacting both medication use and asthma control. Nurses interviewed in Sweden for a qualitative study about AsthmaTuner suggested that there were positive aspects to the app in terms of how easy it was to use and that it could be a complement to physical healthcare, but that patient adherence would fall over time.[33]

Four included studies assessed the Digital Health Passport,[13-16] reporting data on two clinical outcomes (asthma control, exacerbations or attacks) and four patient-reported outcomes (time off work or school, quality of life, patient perception of technology, ease of use and acceptability). The evidence suggests there may be statistically significant observations in asthma control for adults when using the platform. A service evaluation suggested there was no statistically significant difference in number of asthma attacks, number of steroids received and number of urgent and emergency department visits. The evidence was conflicting on whether the Digital Health Passport reduced the number of days off school or work, with published data suggesting there was no change in time of school or work when using the EQ-5D, [redacted] Published data suggested there was no statistically significant difference in children's quality of life when using the Digital Health Passport, [redacted]. In general, most parents suggested that the Digital Health Passport made it easier to care for their child's asthma. [redacted] No intermediate outcomes were reported for the Digital Health Passport. The one published [redacted] included in the qualitative analysis suggested that the Digital Health Passport was generally easy to use and understand, despite some issues with wording and instructions not being clear, and helped people with their inhaler technique, adhere to their

medications, and with identifying when their condition might be worsening. ItIt was also noted that people tended to use the app when their condition was worse and that people would be less inclined to engage with the app when their asthma was controlled.[13, 16, 32]

Luscii was assessed by one included study,[17] which reported data for two clinical outcomes (lung function, asthma control). No intermediate or patient-reported outcomes were assessed for Luscii. The evidence suggested that using the Luscii app might provide a non-statistically significant improvement in lung function in children with asthma. The study also suggested a non-statistically significant increase in ACT in children from baseline to three months. No qualitative evidence was identified for Luscii.

[redacted][18, 19]. [redacted][18, 31]

NuvoAir was assessed by one UK study (assumed due to author affiliations),[20] reporting data on two patient-reported outcomes (patient perception of technology, and ease of use and acceptability). Generally, parents of children with asthma suggested that NuvoAir was easy to use and that it helped them be able to monitor changes in their child's condition and to improve their spirometry technique. No qualitative evidence was identified for NuvoAir.

Five studies reported on the BreatheSmart and Respi.me apps, which are from the Respiratory Disease Management Platform (RDMP).[21-26] Data was presented for two intermediate outcomes (medication use, adherence/attrition rates), five clinical outcomes (changes in symptoms/symptomatic improvement, lung function, asthma control, exacerbations or attacks, mortality) and five patient-reported outcomes (time off work or school, quality of life, patient perception of technology, ease of use and acceptability and safety). The use of rescue medication was reported to decrease while using the platform, as well as an increase in overall adherence to medications. A non-statistically significant percentage reduction in patient-reported monthly symptoms was found for those using the platform but there may be no difference in FEV1% predicted compared with standard care. Results from the

evidence surrounding lung function was mixed, with some evidence suggesting the platform leads to improvement and another suggesting a non-statistically significant decline, however, evidence is limited for this outcome. An RCT suggested there may be little difference in exacerbations or attacks leading to emergency department visits. No deaths were reported in an RCT for either the BreatheSmart (RDMP) or usual care arms. There may be a slight decrease in number of days off school at 6 months when using the BreatheSmart (RDMP) compared with usual care but not at 3 months. [redacted] In general, the BreatheSmart and Respi.me (RDMP) apps were suggested to be easy to use and helpful, with people generally expressing satisfaction with the app. No serious adverse events were observed in an RCT assessing the platform and emergency department visits for asthma exacerbations appeared balanced between arms. No qualitative evidence was identified for BreatheSmart or Respi.me (RDMP) apps.

Finally, three studies assessed Smart Asthma, reporting data on one intermediate outcome (adherence) and two patient-reported outcomes (quality of life, ease of use and acceptability). No data on clinical outcomes was identified. In general, two of the studies suggested that adherence to measuring outcomes such as peak flow reduced over time, though the third abstract stated that 53.7% of 41 patients said their digital peak flow meter use was the same at 6 months as when they first used it. People who used Smart Asthma generally stated that it made it easier to see if their asthma was deteriorating and was more convenient than paper records. However, one prospective cohort noted that 22 of 71 children needed to replace their peak flow device during the study. One conference abstract stated that clinicians agreed that Smart Asthma helped to improve asthma control and identify poor adherence, which could lead to reducing stepping up medications for patients. However, the data collection methods within this abstract were unclear.

In general, the EAG notes that there are several observational cohorts included in the evidence base (mainly prospective and retrospective cohort studies with a pre-post design), only one of which used a logistic regression to adjust for a single potential confounder. Furthermore, five of the studies

(includingan RCTs) were conducted in the US; all the evidence originating from the UK is derived from observational studies and service evaluations. It should also be noted that self-reported outcomes are also open to recall bias that may impact the overall reliability of the results. In addition, 10 of the studies were published as an abstract only or provided as unpublished data by the companies with few details reported, making it challenging to understand the specific methods used within these studies and who was included. The qualitative evidence was characterised by similar limitations surrounding generalisability and limited reporting of methods and demographic details. Additionally, the qualitative evidence only centred on three of the interventions listed within the decision problem.

6. Economic evidence

6.1 Existing economic evidence

6.1.1 Qualitative data relating to economic outcomes

From the clinical searches, several studies included in the qualitative framework analysis contributed some insights into the economic outcomes.

Cost of technology

Schoultz 2022 highlighted that several of the nurses they interviewed discussed the "economy". This included how AsthmaTuner involved a cost for the caregiver that, although small, they advised caution when offering it to patients "since the effect must correspond to the cost".[33] However, these points were not elaborated on further within the study.

Unscheduled hospital presentations

A conference abstract stated that clinicians who had used Smart Asthma strongly agreed Smart Asthma Virtual Care has the potential to prevent Emergency Department re-attendance.[29] However, details in this abstract were limited and it is unclear how many clinicians were included and how this information was collected.

Healthcare appointments/visits in all settings

One of the nurses interviewed in Schoultz 2022 noted that there was a potential impact of patients using AsthmaTuner on healthcare appointments. They suggested that patients do not have to come into the health centre for an appointment because "I see how they blow in any case."[33] Furthermore, it was also suggested that the ability to practice remote care meant that the impact of patients' geographical distance to the health centre was reduced. Despite this, in Schoultz 2022 the nurses suggested that, although it was possible to carry out work remotely, meetings with patients at the health centre were still needed. They suggested that conversations with patients were still important. In this sense, AsthmaTuner was a complement to face-to-face practice.[33]

One conference abstract stated that clinicians who had used Smart Asthma strongly agreed that the clinical dashboard could allow patients to be seen less often, thus reducing unnecessary visits. It was also stated that Smart Asthma Virtual Care may prevent unnecessary referrals and allows for stepping patients down to GP care sooner.[29] However, details in this abstract were limited and it is unclear how many clinicians were included and how this information was collected.

Number of treatments/extent of treatments

No studies presented qualitative data relevant to this outcome.

Staff time

In Schoultz 2022, it was suggested that AsthmaTuner had an impact on staff workload and time; this included some instances of patient visits becoming shorter, especially when combined with the use of virtual meetings. The reduced length of the meetings was attributed to the patients filling out forms and undertaking spirometry in preparation for virtual meetings. One of the nurses suggested that AsthmaTuner had been a “complement” and resulted in less workload. However, the nurses interviewed also perceived their time with the technology as short and they noted that they had received no formal training, gradually learning how to use the system “by doing”.[33]

In contrast, the report into the Digital Health Passport stated that some of the interview participants had indicated that they would go to their GP, asthma nurse or call 111 if they needed support using the app, highlighting this may impact on clinical resources.[13]

[redacted][31] [redacted].[18]

6.1.2 Economic literature searches

A pragmatic search strategy was developed in Medline (Ovid) by an experienced information specialist (HOK) and translated to Embase (Ovid) and INAHTA as appropriate (Appendix A1). The strategy included population and intervention terms, with an economic search filter and date limitation of December 2023 (date of the literature search conducted in NG245).

A total of 68 unique records were screened based on their titles and abstracts by a single reviewer (KK). A random sample of 20% of records was checked by a second reviewer (RP). From this, 17 records were selected for full-text retrieval and reviewed by a single reviewer (KK). None were deemed directly relevant to the scope as they did not include the interventions in scope. However, four studies described patient and implementation considerations of digital technologies in self-management in asthma (see summary in Section 7).[47-50] Furthermore, four systematic reviews summarising clinical evidence were identified and were used in citation chaining of the clinical effectiveness evidence.[51-54]

Because of a lack of direct economic evidence relevant to the scope, the sift was widened (not restricted to interventions listed in the scope) to include studies that would aid the development of a de novo model and to inform the model structure and parameterisation. Five studies from the economic and clinical literature searches conducted by the EAG were identified and summarised (see Appendix B2). A summary of full papers that were excluded are summarised in Appendix B1. Please see the PRISMA flow diagram of the search and screen process in Appendix A3.

Six companies also provided economic evidence as follows.

- MediTuner reported four studies. The EAG was unable to find one of these; one was available only in the Swedish language; one was already included by the EAG;[33] and an unpublished cost calculator was shared which compared the AsthmaTuner technology withwith standard care. During consultation, MediTuner shared three translated reports, one of which did not include any economic evidence, one included an undiagnosed population, and one has been summarised in Table 8.Table 7.

- myHealth acknowledged an ongoing cost-effectiveness evaluation that used myAsthma and shared a link to the evaluation of myCOPD, which was conducted by the York Health Economics Consortium in a prior

Medical Technology Guidance (see Section 8.1). The EAG considered this out of scope for the current decision problem (see Appendix B1).

- NuvoAir submitted one executable economic model developed in Microsoft Excel with accompanying report not in the public domain describing the costs associated with NuvoAir being implemented in three different places in the care pathway (primary care, secondary care and severe asthma clinics).
- Tiny Medical Apps submitted one service evaluation.
- Smart Respiratory Products submitted an unpublished business case for the NHS.
- The Institute of Clinical Science and Technology (ICST) submitted a report commercial-in-confidence [redacted]

Thesix pieces of economic evidence submitted by the companies are summarised in Table 8. No economic evidence was submitted by Aptar Digital Health or Luscii.

Table 8: Key economic evidence provided by companies (N=66)

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
Digital Health Passport: service evaluation (2024) UK	Intervention: **Digital Health Passport** (Tiny Medical Apps) Comparator: standard care	Predictions based on results of 177 patients using DHP for 3 months, with annual costs applied of managing asthma for a range of adult ACT score from 7 European countries (under 12 years excluded). Change in ACT score between registration and 3 months was then extrapolated to 3 years. Uptake of DHP assumed to increase year on year to a maximum of 40%. Attrition rate of 8% per year based on patients 'aging out' of the target cohort (12 to 24 year olds).	No change in EQ-5D-3L (n = 10) or EQ-5D-5L (n = 157) was found between registration and after 3 months of use. No change in self-reported emergency care usage or change in steroid prescriptions. A return on investment (ROI) of £9.28 per £1 spent was predicted over 3 years.	Authors state that "*improvement in asthma exacerbations, reliever medication use and general quality of life is not evidence in the DHP users included in the analysis at this time*". Costs included annual maintenance, annual licensing costs and one-off implementation costs (clinical time, project management, administration time, technical input – reported per ICB) including 3% stable inflation. The report explicitly states that IG support was not included (the EAG assumes this means Information Governance support at the organisation as part of set up). At stakeholder consultation the manufacturer advised that the ROI was updated in 2025 to £8.21 per £1 spent.
Bespoke cost calculator output (unpublished) in Microsoft Excel UK and Sweden	Intervention: **AsthmaTuner** Comparator: Standard care	NR	Three scenarios from UK perspective, each including 100 patients: •Base case assumed 30-minute GP appointment of which 10 with GP, 20 with nurse: overall saving of £2,095 • Low case assumed 30-minute GP appointment all with nurse: overall saving of £303. • High case assumed 45-minute appointment, 20 minutes with GP and 25 with nurse (using same timings as "Sweden case"): overall saving of £4,549.	Excel spreadsheet provided with no instructions or context. Each scenario assumed 1.3 hours of physical visits replaced, each assuming reduction in primary care visits 0.5 (unit unclear), source referenced is only available in Swedish language; EAG is unable to verify results.
Dental and Pharmaceutical Benefits Agency TLV Report (unpublished, translated from Swedish and provided by company) Sweden	Intervention: **AsthmaTuner** Comparator: standard care	NR	Time horizon of 1 year applied. PatientsPatients using AsthmaTuner are assumed to a)) avoid one healthcare visit every other year to patients using Personal Best peak expiratory flow meter, and b) to shorten working time for healthcare staff by 79 minutes per year compared to use of Personal Best peak expiratory flow meter. Cost-comparison shows that AsthmaTuner is cost-saving by 689 Swedish Krona (SEK) per patient, per year compared to Personal Best peak expiratory flow meter	Appendices not supplied by the Company, therefore summary has been based on evidence available in the main report. Limited detail provided, unable to verify results. Unclear whether efficiencies would also be realised in NHS practice.
Executable economic model, Microsoft Excel (unpublished, June 2023) UK	Intervention: **NuvoAir** Comparator: standard care	Variants of model included due to different places in pathway where the technology can be deployed (primary, secondary and tertiary care).	In a primary care population, the model assumes: • fewer GP appointments with practice nurse (2.34 annually with standard care, 1.43 with NuvoAir) • 56.4% have peak flow, 30.50% spirometry and 3.89% bronchial reversibility testing in primary care	Independent health economics assessment of its asthma service by Mind over Matter Medtech via the European Regional Development Fund's Cheshire and Warrington Health Matters programme.

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
		Primary care: 43,000 adult patients with uncontrolled asthma. Secondary care: 3,833 adult patients with asthma having first appointments. Severe asthma care centre: 1,151 adult patients with asthma who should be receiving biologics. Model includes costs of ambulance transport, treatment (including biologics) and other investigations conducted, as well as a unit cost for NuvoAir (£300) which is assumed to be a per-patient cost. Assumed that patients with controlled asthma do not have exacerbations, controlled asthma patients consume 2 canisters of SABA a year, uncontrolled average 6 canisters per year.	standard care, however that these are replaced (set to 0%) in the NuvoAir arm. • The EAG noted differences in the percentage of patients receiving oral steroids (Prednisone) in primary care, proportion of poor adherence is identified and successful attempts made to address it, proportion of poor technique is identified, and successful attempts are made to address it • Treatment benefits applied were the same in both arms. • Difference in percentage of patients who receive support and gain asthma control in primary care between arms (34.79% in standard care, 39.28% with NuvoAir). • Duration spent under primary care was different between arms (30 months standard care, 3 in NuvoAir). • Proportion of patients referred to secondary care when required in one year was different between arms (26% in standard care, 53% in NuvoAir) The report stated cost-savings when NuvoAir was implemented in primary care: £72 saving per patient where NuvoAir is provided in primary care (EAG unable to verify this figure using the executable model). Stated that 5,032 extra patients gain asthma control due to NuvoAir in year 1, with 7,179 in year 2, and 5,502 in year 3, although the EAG was unable to verify these numbers. Large cost savings of £123 and £393 per patient if implemented in secondary care or severe asthma clinic respectively were reported. For brevity, assumptions around applying the model in secondary care, where it is less likely to be used, have been omitted.	
Business case (Smart Respiratory Products) Also reported in Antalffy and Negandhi abstract UK	Intervention: **Smart Respiratory Products** Comparator: standard care	Multi-centre service evaluation (n = 667 patients) across 21 NHS, 5 HSE Ireland sites over 3-month period.	Total savings of £183.30 per patient reported in the business case (£213.80 in the abstract), this comprises the following assumptions: • Assuming (based on service with COPD where 32% reduction in GP visits was observed over six months) 30% probability of a patient avoiding one GP appointment and one outpatient appointment per year; direct cost saving of £46.80 per-patient. • Assuming 10% probability of avoiding a specialist referral; direct cost saving of £12 per-patient reported in the business case (£36 in the abstract). • Assuming 5% probability of preventing one A&E	Cost savings based on assumptions, unclear if these benefits can be realised in an NHS setting. Other costs (training, integration, maintenance) not considered. Different savings were provided in the two reports, could not be verified by the EAG, and the individual components did not sum to the total provided.

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
			attendance; direct cost saving of £12.50 per-patient in the business case (£12 in the abstract). • Assuming 20% probability of stepping down to GP care six months earlier; direct cost saving of £12 per patient in the business case (£18 in the abstract). • Assuming 50% of patients avoid step-up of medication; direct cost saving of £100 per device.	
ICST summary report [CiC] UK	[redacted]	[redacted]	[redacted]	[redacted]

Abbreviations: BNF = British National Formulary; CEA = cost-effectiveness analysis; ICB = Integrated Care Board; ICER = incremental cost-effectiveness ratio; N/A = not applicable; NR = not reported; QALY = quality-adjusted life year; RCT = randomised controlled trial; ROI = return on investment

6.1.3 Relevant economic models from NICE guidelines

The EAG reviewed NICE clinical guidelines for relevant economic models. This included the economic analysis that was used to support the update of British Thoracic Society (BTS)/NICE/Scottish Intercollegiate Guidelines Network (SIGN) collaborative guideline NG245 on diagnosis, monitoring and chronic asthma management (NG245, 2024).[2] This included a diagnostic accuracy model which compared testing strategies for diagnosing asthma, where populations then enter Markov models to simulate treatment and management. Three Markov models were described: a non-asthma management model for patients receiving a true negative or false positive diagnosis (that is, they do not have asthma); and separate short- and long-term models for management of patients with true positive or false negative results (that is, they do have asthma). The model for patients without asthma uses three health states: one for true negative cases, who receive the appropriate therapy for their non-asthma condition; one for false positive cases, who are treated as if they have asthma; and a death state that people move to in line with general population mortality. The short-term management Markov model includes two treatment states: one for people being treated for asthma; and one for false negative cases not being treated for asthma. This model also includes a remission state that people may only move to if their asthma was diagnosed in childhood, an exacerbation state that patients move into when their asthma flares up, and a death state. It is assumed that any patients with undiagnosed asthma will be correctly diagnosed during their time in the short-term model and move into the "treated" state. Therefore, the long-term model assumes all patients are correctly diagnosed and includes only a treated state, remission state, exacerbation state and death state.

6.2 Conceptual model

Because of a lack of directly relevant economic evidence to address the decision problem, the EAG developed a conceptual model to determine key drivers and areas of uncertainty to support future evidence generation. The aim of the conceptual economic model was to inform future data collection efforts. The EAG note that the simple cost comparison model suggested as an

option within the EAG Protocol, would not have the flexibility needed to explore the range of value propositionssi or determine key areas for evidence generation to support decision-making for the technologies in scope. Therefore, the conceptual Markov model developed was the most suitable approach. The model lacked full parameterisation and as such the results should not be interpreted as evidence, or lack of evidence, of cost-effectiveness. Instead, the economic model provided a framework that could be used to highlight evidence gaps and key drivers associated with digital technologies used to support asthma self-management when compared with standard care which should be addressed before an economic evaluation in future.

The model was coded in R Programming Language, using the *'rdecision'* package. The model reads in an input table (Microsoft Excel); where each column represents a parameter and each row represents a new scenario modelled. The model was developed from a UK NHS and Personal Social Services (PSS) perspective, over a five-year time horizon with monthly cycles (with alternative time horizons and cycle length considered in sensitivity analysis). Although a 1-year time horizon was proposed within the EAG Protocol, the difference in QALYs was so small between intervention and comparator, that a longer time horizon of 5 years was needed to allow the benefits to accrue and offset the upfront costs applied, to allow the EAG to better understand the key drivers of the model to guide further research. The longer time horizon also enabled the EAG to model the impact of patients stopping using the technologies over time (referred to as "dropout"). The EAG explored time horizons between 1 and 10 years in sensitivity analysis. The EAG highlight that in NG245, a time horizon of 5 years was also used, and that its committee agreed that a shorter time horizon would avoid the uncertainty of extrapolating, that there was limited data around referrals after severe exacerbations and that treatment switching would limit any longer-term models. BecauseBecause of this and the likely high drop out rate, the EAG did not model longer time horizons.

For the same reason, to increase the visibility of a potential difference between arms, the starting population is 100,000 patients with a diagnosis of asthma, who need ongoing management of their condition. The model is run twice for each modelled scenario, once for the intervention arm (starting population distributed across the “with app” and “without app” states to enable modelling initial uptake of the technologies) and once for the comparator arm (starting population distributed only across the “without app” states). A discount rate of 3.5% for costs and utilities was applied in line with the NICE reference case (NICE PMG9, 2013)[55].

6.2.1 Model structure

The EAG developed a Markov model (see Figure 2) combining aspects of the long-term Markov model used in NG245, and that used in the study by Zafari et al 2014[56] to enable modelling of multiple value propositions, for example: 1) increasing time spent with controlled symptoms, 2) reduction in the number of exacerbations, 3) reduction in the severity of exacerbations, 4) detection of misdiagnoses. The EAG also note that one technology (myAsthma) provides smoking advice and cessation support. The updated BTS/NICE/SIGN guidance (2024) recommends a review of smoking or vaping status at each review appointment and referral to smoking cessation services where appropriate. The EAG note that it may be plausible for some technologies to provide this support and reduce costs of onward referral. This may be considered as a value proposition in future economic modelling but is beyond the scope of the conceptual model developed for this EVA.

There are 12 health states in the model, accounting for those self-managing their asthma using a digital technology (referred to as “with app”) and those self-managing their asthma without using a digital technology (referred to as “without app”). The EAG acknowledges that the technologies included in the scope vary, in that some include hardware and some are remote services. However, the EAG has used “with app” and “without app” terminology for ease in reporting.

Patients with asthma (based on prevalence) in the cohort start in one of three asthma control states (fully controlled, partially controlled, uncontrolled), with

the proportions being the same across intervention (“with app”) and comparator (“without app”) arms at the beginning of the model. When the comparator arm of the model is run, the “with app” states (shaded grey in the diagram; Figure 2) are effectively switched off, leaving a 7-state model.

The modelled health states included in the Markov model are:

1. **Controlled, with app:** patients occupy this state when they have a correct diagnosis of asthma, it is under control, and they are actively using an app for self-management. Patients may transition to any other state where a correct diagnosis of asthma is being managed “with app”, “Dead”, or stop using the app, where they would transition to the “Controlled, without app” state.

2. **Partially controlled, with app:** patients occupy this state when they have a correct diagnosis of asthma, it is partially under control, and they are using an app for self-management. They may transition to other states where a correct diagnosis of asthma is being managed “with app”, “Dead”, or stop using the app, where they would transition to the “Partially controlled, without app” state.

3. **Uncontrolled, with app:** patients occupying this state use the app for self-management of their correctly diagnosed asthma and it is currently uncontrolled. Patients may transition from this state to other states where a correct diagnosis of asthma is being managed “with app”, “Dead”, or stop using the app, where they would transition to the “Uncontrolled, without app” state.

4. **Exacerbation, with app:** patients entering this state have been self-managing their asthma using an app and have had an exacerbation. Following an exacerbation, patients may transition back to one of the control states (fully controlled, partially controlled, uncontrolled) which include self-management “with app” or “Dead”. Patients cannot stop using the app whilst in the “Exacerbation, with app” state. This is a simplification and limitation of the model. However, because most

patients leave the Exacerbation state after one month, the EAG consider the impact of this to be small.

5. **Controlled, without app:** patients occupying this state have correctly diagnosed asthma that is under control using the standard care approach (that is, they are not self-managing with one of the technologies in scope). Patients also enter this state from “Controlled, with app” if they previously used the app to manage their condition but subsequently stopped using it. Patients may transition from this state to other states where a correct diagnosis of asthma is being managed “without app” or “Dead”.

6. **Partially controlled, without app:** patients occupying this state have correctly diagnosed asthma that is partially under control and are not using an app for self-management. Patients also enter this state from “Partially controlled, with app” if they were using the app to manage their condition but stop using it. Patients may transition from this state to other states where a correct diagnosis of asthma is being managed “without app”, or “Dead”.

7. **Uncontrolled, without app:** patients occupying this state have correctly diagnosed asthma that is uncontrolled and are not using an app for self-management. Patients also enter this state from “Uncontrolled, with app” if they were using the app to manage their condition but stop using it. Patients may transition from this state to other states where a correct diagnosis of asthma is being managed “without app” or “Dead”.

8. **Exacerbation, without app:** patients entering this state have been self-managing their correctly diagnosed asthma without using an app and have had an exacerbation. Following an exacerbation, patients may transition back to one of the control states (fully controlled, partially controlled, uncontrolled) which include self-management “without app” or “Dead”.

9. **Misdiagnosed, with app:** patients occupying this state have been misdiagnosed with asthma (false positive) and have been prescribed asthma medications and a technology for self-management. This allows the model to account for patients with an incorrect diagnosis of asthma that may be detected by the technologies. Some technologies have this as a value proposition, and it has been confirmed by clinical experts who noted that misdiagnoses may be more common in children. From this state patients may transition to the “Misdiagnosed, without app” state if they stop using the app, or “Dead” (using the standardised mortality rate based on age and sex). Patients can also transition to the “No disease” state if they receive a true negative diagnosis confirming they do not have asthma. This transition rate is set to 0 in the base case but explored in sensitivity analysis.

10. **Misdiagnosed, without app:** patients occupying this state have an incorrect (false positive) diagnosis of asthma and they are not using an app for self-management. Patients also enter this state from the “No disease, with app” state if they were using the app to manage their condition but stop using it. They may transition to the “No disease” state if they receive a true negative diagnosis confirming they do not have asthma, or “Dead” (using the standardised mortality rate based on age and sex).

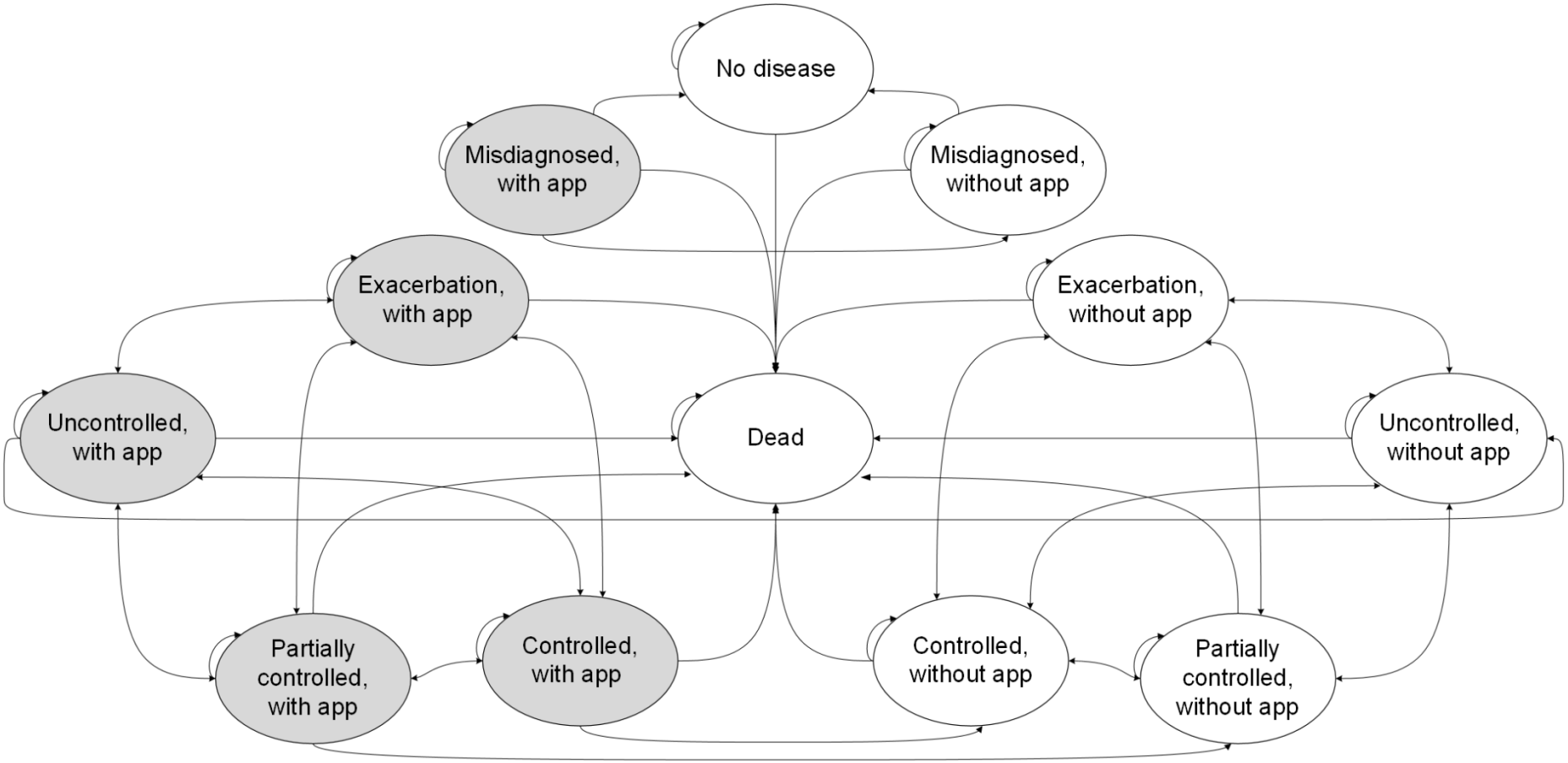
11. **No disease:** this state is populated when people who were given an incorrect (false positive) diagnosis of asthma but during management are then identified correctly as not having asthma. These patients no longer receive treatment and no longer need to use the technology; therefore, they are not assigned any costs. Patients can only transition from this state to “Dead” (using the standardised mortality rate for age and sex).

12. **Dead:** this is an absorbing state that patients transition to on death.

The health states defined in the model are named to reflect the 3 levels of symptom control which are used in asthma (fully controlled, partially

controlled, uncontrolled) as outlined previously by the Global Initiative for Asthma (GINA). However, if fewer or different levels of control need to be included in the model, transitions between these states can be ‘switched off (for example, to model two levels such as “controlled” and “uncontrolled”). The states could also be renamed to model, for example, different levels of disease severity where different exacerbation rates are available. Therefore, the model developed is flexible and adaptable to enable economic modelling of various scenarios if data become available in future.

Figure 2: Markov model



6.2.2 Model assumptions

Several assumptions have been made in developing the model.

- The starting population is assumed to have an existing diagnosis of asthma. This includes a) people who received true positive results on objective testing and are being treated appropriately; b) people who received false positive results on objective testing, who do not have asthma but are being treated inappropriately as if they do; and c) patients diagnosed with asthma without objective testing. The starting population will all be managed with either the comparator (standard of care) or intervention (self-management using one of the technologies listed in the scope).
- The starting population with a true positive diagnosis of asthma (prevalence) is split in the and intervention arm into “with app” and “without app” states based on the expected uptake of the app. For both arms, the group is then distributed across “Controlled”, “Partially controlled”, and “Uncontrolled” states. It is assumed that the split between levels of control is the same for those starting with and without the app. That is, the level of control of the disease is assumed not to influence whether a patient begins using the app or not. The EAG has considered alternative starting distributions of patients in sensitivity analysis.
- Patients can only start in a “Misdiagnosed” state when the prevalence is less than 100%, with a proportion starting in the “with app” state based on the initial uptake of the app, and the remainder going into the “without app” state. It is assumed that patients moving from the “Misdiagnosed” states to “No disease” do not incur any further costs associated with testing and simply stop incurring management and treatment costs.
- Patients can only stop using the app at the end of the cycle. If patients stop using the app, they cannot begin using the app again. This refers only to patients stopping using the app completely, and

not to those who may continue using the app, perhaps sporadically, or with different levels of adherence as their symptom control changes.

- For simplicity, it is assumed that a patient cannot transition between levels of control of asthma at the same time as they stop using the app for self-management. Therefore, patients can transition from the “Controlled, with app” state to the “Controlled, without app” state. Similarly, patients can transition between the “Partially controlled, with app” state to the “Partially controlled, without app” state, and so on. These dropout rates are considered the same across different levels of asthma control in the base case but are varied independently in sensitivity analysis.
- The EAG acknowledges that asthma is a disease that can go into remission, whereby the patient no longer experiences symptoms or needs treatment. Increased remission rates were not highlighted as a potential value proposition by the experts at the scoping workshop, so it is assumed that transitions into this state would be the same for intervention and comparator arms. As such, this was not modelled, so the economic model can be used to model increased levels of asthma control, but not explicitly the remission rate.
- In the base case, the EAG assumes that treatment costs are the same in both arms, and the same across all levels of control. This will be explored further in sensitivity analysis. The model does not explicitly consider the use of biologics in a population with severe difficult-to-treat asthma. However, this is considered indirectly within sensitivity analysis by increasing the treatment costs and adjusting utilities within states that include treatment.
- In the base case, the model has applied the costs for the SmartAsthma technology, which includes an upfront cost applied to all patients using the app at the start of the model. The EAG conducted sensitivity analysis to explore the impact of different

pricing models used by the companies, including recurring annual fee (accrued in full at the start of each year) and recurring monthly fees (accrued per cycle) in order to determine univariately, the impact for various levels of patient dropout.

- The costs associated with different severities of exacerbation are modelled as a weighted average (see Table 11) and applied to transitions into the **Exacerbation** state. In the base case it is assumed that 95% of those within the exacerbation state leave that state within 1 month before transitioning into other management (fully controlled, partially controlled, uncontrolled) states, either with app, or without app. Therefore, occupancy costs are not applied. On the other hand, quality of life is applied on the occupancy of the state.
- Utilities of the general population are read into the model (as an input table) which enables a baseline utility to be applied based on the age and ratio of males to females in the starting cohort. However, the input utility table only includes data for those aged 16 years and older. Therefore, for children under 16 years, the baseline utility of a 16-year-old has been assumed. The EAG note that only utility and standardised mortality rates vary by age in the conceptual model. Therefore, applying utility values derived from populations under 16 years old, if available, would have limited impact on results because they are applied in both comparator and intervention arms.
- Cohorts of adults and children are modelled separately to enable illustration of uncertainties. For the child population, which uses a minimum starting age of 6 years old, a maximum time horizon of 10 years is allowed, at which point they would need to be modelled as an adult cohort, for which the uncertainties would be like those modelled as an adult cohort from the outset.
- Utilities applied in the “Exacerbation, without app”, and “Exacerbation, with app” states are those used in NG245[2], adjusted

using a utility multiplier which is derived from the ratio between exacerbation and controlled utilities from Zafari et al. (2014), and weighted by the severity of disease in the starting population. NG245 used an individual patient simulation which gave more flexibility than the conceptual Markov model developed here, which does not retain history of where patients have transitioned from. The application of a utility decrement based on the utility in the previous state would be a preferred approach to using a single multiplier for the “Exacerbation” state but can only be applied where the utility in the previous state is known. Although a limitation, the simpler cohort approach taken for this early value assessment is appropriate, given that the aim of the conceptual modelling is not to reach a definitive conclusion on the cost-effectiveness of the interventions, but to explore the plausibility of the interventions being cost-effective and to identify gaps for future evidence generation. Individual patient simulations could be used in future to better model this, and other factors such as the impact of previous exacerbations on risk of future exacerbations.

- It is assumed that those with the disease have an increased mortality risk (applied using a hazard ratio) compared to those without the disease. The EAG has assumed that this may differ across levels of disease control, and exacerbation.
- For those with no disease who have been given treatment (inappropriately) after a false positive diagnosis, the model assumes no rate of exacerbation and uses the standardised mortality, based on their age and sex.

6.2.3 Clinical parameters

The clinical parameters of the conceptual model in an asthma population (separated by adults and children) are described in Table 9.

Table 9: Economic modelling: clinical parameters

Variable **[variable name in economic model]**	**Value (adults: asthma)**	**Value (children: asthma)**	**Source**	**EAG commentary on availability, quality, reliability and relevance of the source/s**
Number of patients (starting population) [cohort_n]	100,000	Assumed the same as adults	Assumption. This number represents the number of patients who have a diagnosis of asthma and are receiving treatment. This includes patients who have been incorrectly diagnosed with asthma, based on the prevalence.	Size of the starting population does not influence findings, but because of the low rate of exacerbations, the EAG used a large sample size to better illustrate the small differences between arms.
Starting age, years [start_age]	47	6	Adults: van de Hei et al (2023),[57] which cited the INCA Sun trial (RCT aimed to determine the clinical value of digital tools to assess adherence to lunge function in adults with uncontrolled asthma; conducted in ten severe asthma clinics across Northern Ireland, Ireland and England). Children: Assumption	This variable will be adjusted in sensitivity analysis. Two Clinical Experts advised that diagnosis and management will vary across different age bands in children and highlighted that BTS/SIGN/NICE guidelines have different recommendations in children under 5, children aged 5 to 11 and people aged 12 and over. The EAG note that there was a lack of clinical evidence specific to these age categories therefore most clinical parameters were unaffected by age (exception being standardised mortality which was available for all ages, and baseline utilities which were only available for 16 years and older). However, the EAG also note that the model could be adapted for different age groups in future economic modelling when data become available.
Proportion male [male_prop]	36%	Assumed the same as adults	Adults: van de Hei et al (2023),[57] which cited the INCA Sun trial (RCT aimed to determine the clinical value of digital tools to assess adherence to lung function in adults with uncontrolled asthma; conducted in ten severe asthma clinics across Northern Ireland, Ireland and England). Children: Assumption	One Clinical Expert [redacted] advised that in pre-puberty more males would be expected than females; therefore, in sensitivity analysis the EAG inverted the proportion and modelled 64% as male.
Uptake of app in starting population	75%	Assumed the same as adults	Expert opinion	One Clinical Expert [redacted] advised the proportion may be lower in the children

Variable [variable name in economic model]	Value (adults: asthma)	Value (children: asthma)	Source	EAG commentary on availability, quality, reliability and relevance of the source/s
[p_app]				population. This was explored in sensitivity analysis.
Levels of control in starting population [p_start_contr] [p_start_partcontr] [p_start_uncontr]	Controlled: 20.7% Partially controlled: 39.2% Uncontrolled: 40.1%	Assumed the same as adults	Asthma survey 2020 report[58]	Due to uncertainty associated with this parameter the EAG have assumed other starting proportions of symptom control in sensitivity analysis.
Starting prevalence of asthma [prev]	90%	Assumed the same as adults	Assumption	The EAG assumed that 10% of the starting modelled population had an incorrect diagnosis of asthma. This enabled the EAG to model the value proposition of some technologies being able to identify misdiagnoses earlier. This also enabled the EAG to model the consequences (costs and utilities) associated with inappropriately being treated and managed for a condition that a patient does not have. Two Clinical Experts [redacted] have advised that misdiagnoses will be more common in children, therefore lower prevalence is included in sensitivity analysis for this population.
Annualised drop out rates (per year) – applicable to intervention arm only [p_app_no_app_contr] [p_app_no_app_partcontr] [p_app_no_app_uncontr]	50%	Assumed the same as adults	Expert opinion. Applied to controlled, partially controlled, uncontrolled and misdiagnosed states where the technology is used.	Assumed all dropouts happen from and to the same level of control (that is, controlled with app to controlled without app, and so on), and that all take the same value in the base case. One Clinical Expert [redacted] advised that drop out may be higher in the children population. Therefore, the EAG explored alternative dropout rates (variable across different levels of control) in sensitivity analysis.
Annualised exacerbation rates (in "controlled" states) [p_contr_exac]	0.195	0.175	NG245 (2024)[2]	-
Annualised exacerbation rates (in "partially controlled" states) [p_partcontr_exac]	0.199875	0.179375	Assumed 2.5% increase compared to controlled state (midway between controlled and uncontrolled)	This is an area of uncertainty, therefore the EAG varied the proportion increase in exacerbations from the partially controlled asthma state to 5% in sensitivity analysis.
Annualised exacerbation rates (in "uncontrolled" states) [p_uncontr_exac]	0.20475	0.18375	Assumed 5% increase compared to controlled state	The Clinical Experts highlighted to the EAG a UK primary care study which found that exacerbations increased the risk of future exacerbations [59]. However, the EAG took a pragmatic decision for this Early Value Assessment and chose to model a single exacerbation health state. In sensitivity analysis the EAG explored changes in the

Variable [variable name in economic model]	Value (adults: asthma)	Value (children: asthma)	Source	EAG commentary on availability, quality, reliability and relevance of the source/s
				exacerbation rate for the controlled arm states. This will affect results and from this infer if a plausible increased risk of subsequent exacerbations is a priority for evidence generation. Similarly, sensitivity analysis will explore if the increased risk of exacerbations in the uncontrolled state is a priority for evidence generation.
Relative reduction in exacerbations, per technology [RR_exac]	1	Assumed the same as adults	Assumption.	EAG assumes that the relative reduction in exacerbations will be the same for controlled, partially controlled, and uncontrolled states. There is a lot of uncertainty regarding the magnitude of reduction (not well reported in the clinical evidence); this parameter is explored further in sensitivity analysis.
Proportions transitioning from exacerbation state back to other states [p_exac_contr] [p_exac_partcontr] [p_exac_uncontr]	Controlled: 20.7% Partially controlled: 39.2% Uncontrolled: 40.1%	Assumed the same as adults	Asthma survey 2020 report[58]	The EAG has reflected this small number requiring hospitalisation for asthma exacerbation in the costs but used the proportions with each level of control in the base case. The proportions will be altered in sensitivity analysis.
Transition rates from controlled asthma state, without app [p_contr_partcontr_noapp] [p_contr_uncontr_noapp]	To Partially controlled: 0.50 To Uncontrolled: 0.006	Assumed the same as adults	Van de Hei et al 2023[57]	Assume that the rate of transitions between states is impacted by the use of an app.
Transition rates from controlled asthma state, with app [p_contr_partcontr_app] [p_contr_uncontr_app]	Initial base case used to explore value proposition 1: To Partially controlled: 0.45 To Uncontrolled: 0.0054 Reported base case results after exploring value propositions, and subsequent sensitivity and scenario analysis: To Partially controlled: 0.333 To Uncontrolled: 0.004	Assumed the same as adults	Assumed 10% reduction in rate of transition to partially controlled or uncontrolled with the use of the app as a starting base case to explore the first value proposition. A 33% reduction was then found by the EAG to provide a sensible baseline from which other parameters could be adjusted, so after other value propositions had been explored, this was adopted for the base case results reported, and subsequent sensitivity and scenario analysis.	Assume that the rate of transitions between states is impacted by the use of an app.

Variable [variable name in economic model]	Value (adults: asthma)	Value (children: asthma)	Source	EAG commentary on availability, quality, reliability and relevance of the source/s
Transition rates from partially controlled asthma state, without app [p_partcontr_contr_noapp] [p_partcontr_uncontr_noapp]	To Controlled: 0.50 To Uncontrolled: 0.006	Assumed the same as adults	Van de Hei et al 2023[57].	Assume that the rate of transitions between states is impacted by the use of an app. Set to be equivalent to non-app transition rate in the base case.
Transition rates from partially controlled asthma state, with app [p_partcontr_contr_app] [p_partcontr_uncontr_app]	To Controlled: 0.50 To Uncontrolled: 0.0054	Assumed the same as adults	Rate of transition to control is assumed the same across app and no app groups. Assumed 10% reduction in rate of transition to uncontrolled with use of the app.	Assume that the rate of transitions between states is impacted by the use of an app. Set to be equivalent to non-app transition rate in the base case.
Transition rates from uncontrolled asthma state, without app [p_uncontr_contr_noapp] [p_uncontr_partcontr_noapp]	To Controlled: 0.025 To Partially controlled: 0.025	Assumed the same as adults	Van de Hei et al 2023[57]	Assume that the rate of transitions between states is impacted by the use of an app.
Transition rates from uncontrolled asthma state, with app [p_uncontr_contr_app] [p_uncontr_partcontr_app]	To Controlled: 0.025 To Partially controlled: 0.025	Assumed the same as adults	Rate of transitions are assumed to be the same across app and no app groups.	Assume that the rate of transitions between states is impacted by the use of an app. Set to be equivalent to non-app transition rate in the base case.
Transition rate from exacerbation state [p_rec_in_window] [rec_window] recorded in days	95% in 1 month	Assumed the same as adults	NG245 [2]	Simplification of 28 day duration of exacerbation applied in NG245 for utilities (time to recover from exacerbation).[2] It is assumed most exacerbations will be resolved in 1 month. Longer stays can be modelled in sensitivity analysis.
Mortality, general population [read in as life tables]	Age and sex specific	Assumed the same as adults	ONS Life tables 2021 to 2023 (Office for National Statistics 2025)[60]	This is adjusted by the HR for mortality for those with asthma or exacerbation in applicable states, and applied to all patients in the no disease states.
Mortality, people in Controlled, Partially Controlled, and Uncontrolled states (HR applied to standardised mortality of general population) [HR_mort_contr] [HR_mort_partcontr] [HR_mort_uncontr]	HR = 1.25	HR = 1.77	NG245 [2]	This applies to controlled, partially controlled and uncontrolled states and reflects the increased mortality risk from having disease with each level of control. Although they are set to the same value (across all three levels of symptoms control) in the base case, these can be parameterised separately.
Mortality, people having an exacerbation (HR applied to standardised mortality of general population) [HR_mort_exac]	HR = 1.3125	HR = 1.8585	Assumption.	Assumed 5% increase to HR for mortality from Uncontrolled state.
Transition rate from "Misdiagnosed, with app" and "Misdiagnosed, without app" to "No disease" [p_nodisease_in_window_app] [p_nodisease_in_window_noapp]	0% in 1 year	Same as adults	Assumption.	This enables modelling of "incorrect diagnoses". Set to 0% in base case but increased in sensitivity analysis. Asthma+Lung state that 30% of asthma diagnoses are estimated as being incorrect.

Variable [variable name in economic model]	Value (adults: asthma)	Value (children: asthma)	Source	EAG commentary on availability, quality, reliability and relevance of the source/s
[nodisease_window expressed in days]				One Clinical Expert [redacted] stated that the proportion may be higher in children where objective tests may not be used, and where there is overlap with viral induced wheeze.

Abbreviations: BTS, British Thoracic Society; contr, controlled; EAG, External Assessment Group; exac, exacerbation; HR, hazard ratio; mort, mortality; NICE, National Institute for Health and Care Excellence; NG, NICE Guidelines; ONS, Office of National Statistics; partcontr, partially controlled; RCT, Randomised Controlled Trial; SIGN, Scottish Intercollegiate Guidelines Network; uncontr, uncontrolled

6.2.4 Resource use and cost parameters

Technology costs for eight technologies in scope (see Table 10, with a detailed cost breakdown summarised in Appendix C2). The EAG note that only a single cost was provided for Asthmahub therefore the EAG has assumed that this also applies to Asthmahub for Parents. For simplicity, the EAG modelled a generic base case using costs from one technology (SmartAsthma) and considered technology pricing within sensitivity analysis.

All costs associated with the technology were applied in the model on a per-patient basis. The costs attributed to monitoring “with app” varies across the technologies included in the scope (see Table 10). For example:

> All technologies include an upfront cost attributable to hardware, platform, integration, training of staff or training of the patient, which would be applied at the start of modelling (regardless of time horizon and dropout rate). Some of these costs were provided per patient, but where they were provided as a one-off cost to the organisation regardless of how many patients would use the technology; the EAG calculated a per patient cost. The EAG note thatthe ICS respiratory review of spirometry conducted by Asthma+Lung UK (2025) reported that the number of adult spirometry tests conducted in the last financial year across 13 Integrated Care Systems which ranged between 2,500 and 28,742. Not all of these patients would receive a diagnosis of asthma and not all of them would go on to use the digital technologies in scope. Therefore, the EAG assumed a minimum of 1,000 patients using the technology for a minimum of a year and therefore distributed the upfront costs across 1,000 patients. The EAG notes that having more patients using the technology or using the technology for longer than 1 year would reduce this upfront per patient cost. The EAG considered 1,000 patients to be a realistic minimum over which to distribute the upfront costs of technologies, and therefore did not model this cost distributed across fewer users. The EAG notes that this is a simplification but that as long as the organisation (for example, ICS)

continues to offer the technology to patients, the costs could be distributed across new users in future years, if the minimum is not achieved in the first year. Regardless of the costing model, it is assumed that these upfront costs cannot be recouped or offset after they have been paid. For example, for NuvoAir, it is assumed that the spirometry device sent to the patient for ongoing monitoring of their condition is not returned and reused for another patient. This could have significant implications for cost-effectiveness of specific technologies. One technology (NuvoAir) does not include staff time associated with training the patient to use the technology because it is a remote service where these costs are included within the technology cost.

- Two technologies have a recurring cost element which is applied on a per-year basis at the start of the year, such that when a patient stops using the app (dropout) the costs only stop being applied from the start of the following year. The EAG assumes that all patients who need access to the app would have access to it, and that licenses would not be restricted, such that a new user would not need to wait for an existing user to drop out. It is also assumed that a mechanism would be in place to make sure dropouts were recorded promptly and accurately, or that a subscription would not be renewed and charged automatically. That is, it is assumed that when a person drops out of using the app in the model, no further costs are incurred at the start of the next year.

- The EAG has also incorporated recurring costs which would be applied on a per-cycle basis. This includes costs from two technologies which were supplied on a “per-month” basis, which is the same as the cycle length in the base case. It also includes the time of a practice nurse to review the results of the app. This is included because these technologies are considered as an adjunct to standard care (as stated in the Final Scope) and cannot fully replace standard care.

- The EAG also assumed that patients would be introduced to the intervention (technologies in scope) at their annual review, with the cost of this appointment applicable to all arms and therefore omitted for simplicity.

- Whilst training cost supplied by the companies has been included, the EAG did not include staff time to attend training on the technologies within cost estimates because of the variability in reporting between manufacturers, the different staff that may be involved, and the number of practices that may share the technology. This makes it difficult to attribute a training cost per patient. For example, across three clinical experts who responded to EAG queries regarding training: one [redacted] stated that across a practice of 15,000 patients they have three practice nurses; one [redacted] stated a minimum of two staff which may include a health care assistant, nurse and may include a pharmacist as part of chronic disease management in patients; and one [redacted] was unsure. However, assuming that the training costs were distributed across 1,000 patients per ICB the EAG does not anticipate that the training cost per patient would be large. For example, if three practice nurses (Band 5) with qualifications attended a 2-hour training session, this would be the equivalent of a total of £318; or £0.31 per patient.

- All of the technologies included use a mobile device. The assumption from the manufacturers is that all patients will be able to use their own device or that of a family member or friend. Within sensitivity analysis, the EAG took a similar approach as applied in a previous EVA (Digital technologies for weight management, HTE14),[61] assuming that 5% of users would need to be provided with a tablet or mobile (assume £100), and a mobile internet connection (£21), with the remaining 95% of users being able to use their own device. This approach would incur an additional £17.60 per patient per year, which was included in the model as a recurring cost per cycle. The assumption being that the patient would return the device to the healthcare setting when they no longer use the technology to support self-management of their asthma,

and no further costs would be incurred. The EAG included these costs to address the barriers to access these technologies and equity concerns around digital exclusion.

Costs for standard care monitoring in the comparator arm were derived from NG245 (2024), which assumed 80% need one practice nurse visit per year, 15% need two practice nurse visits and 5% need one outpatient visit per year.[2] The costs attributed to monitoring "with app" varies across the technologies included in the scope (see Table 10). However, the EAG assumed that staff costs would be reduced during self-management with the apps to only 5 minutes of practice nurse staff time because patients have better control of their asthma, or because the information needed for their review is more easily accessible using the technology.

Additional costs used in the economic modelling (inflated to the latest available year using the CCEMG – EPPI Centre Cost Converter) are described in Table 11.

Table 10: Economic modelling: monitoring costs (per patient); all costs excluding VAT

Price category	Standard care	BreatheSmart/ Respi.me (Respiratory Disease Management Platform (RDMP) Aptar Digital Health)	Asthmahub (The Institute of Clinical Science and Technology - ICST)	Luscii (Luscii healthtech B.V)	AsthmaTuner (MediTuner)	myAsthma (my mHealth)	NuvoAir Home (NuvoAir Medical)	Smart Asthma (Smart Respiratory Products Ltd)	Digital Health Passport (Tiny Medical Apps)
Hardware	-	£112	No RFE	NR	[redacted]	NR	£360	£66.65	NR
Platform/license	-	-	£29	-	-	£35*	-	-	£7777
Integration	-	-	No RFE	£8.50	-	NR	N/A (online portal)	N/A	NR
Training (for staff)	-	-	No RFE	NR	[redacted]	NR	N/A (included in price)	N/A	NR
Practice nurse time to train patient on using technology (5 minutes)	-	£4.42	£4.42	£4.42	£4.42	£4.42	N/A	£4.42	£4.42
Upfront costs, per patient (one-off)	**£0**	**£116.42**	**£33.42**	**£12.92**	[redacted]	**£39.42**	**£360**	**£71.07**	**£8181.42**
Software	-	-	£0.00 (Assumed free app to patient)	-	[redacted]	**£30**	NR	NR	£0.00 (Assumed free app to patient)
Maintenance	-	-	No RFE	-	N/A (support included in pricing)	NR	N/A	NR	NR
Cost of technology, applied per patient per year (fixed annual cost)	**£0**	**£0**	**£0**	**£0**	[redacted]	**£30**	**£0**	**£0**	**£0**
Cost of technology	-	£180	-	£180	-	-	-	-	-
Standard care monitoring (primary care)	£29.85	-	-	-	-	-	-	-	-
Practice nurse time to review results of app	-	£7.46	£7.46	£7.46	£7.46	£7.46	£7.46	£7.46	£7.46
Costs per patient, per year (no fixed timeframe; can be applied monthly)	**£29.85**	**£187.46†**	**£7.46†**	**£187.46†**	**£7.46†**	**£7.46†**	**£7.46†**	**£7.46†**	**£7.46†**

Table 11: Economic modelling: other cost parameters

Parameter	Value (adults: asthma)	Value (children: asthma)	Source	Comment
Monitoring cost (no app), per year [c_monitoring_noapp]	£29.85	Same as adults	Asthma: NG245[2] stated value without FeNO (£27.26 per year excluding FeNO - inflated to £29.85; weighted average, assuming 1 practice nurse appointment for 80% of patients, 2 appointments for 15%, and an outpatient visit for 5%). EAG applied inflation to 2024 price year. The EAG note £29.85 in the comparator arm is the equivalent to 34 minutes with a Band 5 practice nurse. This is broadly in line with the recommendation by the Asthma+Lung report (which recommended a 20 to 30 minutes face to face annual review appointment).	Uncertainty associated with this parameter (setting of attendance may be related to disease severity). The EAG note that newly diagnosed with asthma may have higher rates of primary care contact after diagnosis and initial treatment, for example, NG245 recommends 3-month medication reviews in some circumstances.[2] Therefore, monitoring costs in the comparator arm were varied in sensitivity analysis.
Upfront cost: technology [c_app_upfront]	£71.07	Same as adults	Assumption. Based on upfront cost of SmartAsthma plus 5 minutes Band 5 practice nurse teaching the patient what to do.	Upfront costs vary by technology; and are varied in sensitivity analysis.
Annual cost: technology [c_app_recurring]	£0	Same as adults	Annual cost of SmartAsthma. Assume applied annually upfront (therefore cost applied to all patients, regardless of dropout)	Recurring annual costs vary by technology; and are varied in sensitivity analysis.
Monitoring cost (app), per year [c_monitoring_app]	£7.46	Same as adults	Assumption. Assuming 75% reduction in the costs of standard care (which is the equivalent of dropping from 34 minutes of a Band 5 practice nurse, to 8.5 minutes – saving 25 minutes of Band 5 practice nurse time). These costs are accrued each cycle, therefore if the app is no longer used or the patient dies then these costs no longer apply.	Note that the EAG applies additional £17.60 to account for 5% of the cohort needing a mobile device and monthly internet plan. The EAG also explored applying costs as upfront [c_app_upfront], fixed costs, as recurring fixed payment [c_app_recurring], or recurring payment per cycle which stops if app is no longer used [c_app_monitoring_app] in sensitivity analysis to determine the impact of the pricing model.
Treatment cost, per year (Misdiagnosed, and Controlled; Partially controlled; Uncontrolled states) [c_treatment_contr] [c_treatment_partcontr] [c_treatment_uncontr]	£45.14	£60.50	NG245	For adults: assuming 0.53 actuations per day, and that adults go straight onto ICS/LABA combined. For children assuming 1.11 ICS actuations and 1.01 SABA actuations per day; and that children were treated with ICS and separate SABA until adulthood.[2] Assume 2024 price year, no inflation applied. In the base case have assumed parameter values are the same across controlled, partially controlled and uncontrolled. However, these can be set individually.

Parameter	Value (adults: asthma)	Value (children: asthma)	Source	Comment
Cost of mild or moderate exacerbation [c_exac_mild] [c_exac_mod]	£46	Assumed same as adults	NG245 stated £42 to cover a GP visit and treatment.[2] The EAG inflated to 2024 price year.	In the base case have assumed parameter values are the same across mild and moderate exacerbation. However, these can be set individually.
Cost of severe exacerbation [c_exac_severe]	£183.11	Assumed same as adults	Calculated field using information from NG245. [2]	For severe exacerbations, average cost is £102. Assume that all exacerbations include an initial GP visit and a follow up with GP/nurse practitioner (50:50 split). GP visit cost £38, nurse practitioner visit £16.39 (NG245 table 19). Total cost of severe exacerbation calculated as £102 + £38 + (0.5*£38) + (0.5*£16.39) = £167.20, EAG inflated to 2024 prices.[2]
Weighted average cost of exacerbation (controlled) [c_contr_exac]	Calculated in R: (p_contr_exac_mild * c_exac_mild) + (p_contr_exac_mod * c_exac_mod) + (p_contr_exac_severe * c_exac_severe) Where p_contr_exac_mild = p_contr_exac_mod = 0.5 * (1 - p_contr_exac_severe)	Assumed same as adults	Calculated variable. Assuming 24% severe [p_contr_exac_severe] as stated in NG245 guideline for severity in people treated with asthma, and the rest split between 50% moderate and 50% mild.[2]	Uncertainty associated with this value (and proportion attending hospital). Therefore, cost is explored within sensitivity analysis.
Weighted average cost of exacerbation (uncontrolled) [c_uncontr_exac]	Calculated in R: (p_uncontr_exac_mild * c_exac_mild) + (p_uncontr_exac_mod * c_exac_mod) + (p_uncontr_exac_severe * c_exac_severe) Where p_uncontr_exac_mild andp_uncontr_exac_mod are calculated in R:0.5 * (1 - p_uncontr_exac_severe)	Assumed same as adults	Calculated variable. Assuming 31% severe [p_contr_exac_severe] as stated in NG245 guideline for severity in people untreated with asthma and the rest split between 50% moderate and 50% mild.[2]	As above
Abbreviations: contr, controlled; EAG, External Assessment Group; exac, exacerbation; FeNO, fractional exhaled nitric oxide; ICS, inhaled corticosteroids; LABA, long-acting beta agonist; mod, moderate; NICE, National Institute for Health and Care Excellence; NG, NICE Guidelines; partcontr, partially controlled; SABA, short-acting beta agonist; uncontr, uncontrolled				

6.2.5 Health state utilities

Utility parameters used in an asthma population are described in Table 12.

Table 12: Economic modelling: utility parameters in an asthma population

Parameter	Value (adults: asthma)	Value (children: asthma)	Source	Comment
Utilities, baseline [u_baseline]	Age and sex specific	Age and sex specific	NICE Decision Support Unit;[62] general population	This is the baseline utility used in the model [u_baseline] to which other multipliers, increments and decrements are applied. Downloaded spreadsheet of values read into the economic model which includes ages 16 to 101 years. The EAG note that for patients aged less than 16 years that the starting utilities for a 16-year-old were usedused. The EAG note that in NG245 (2024) that patients aged less than 20 were assumed to have a utility score of 1 (equal to "perfect health"). The EAG considered that it was not appropriate to assume perfect health in children with asthma.asthma. However, the general approach in setting the same utility value for all children (upup to 15 years) is similarsimilar to the approach adopted in NG245.
Utility multiplier (controlled) [um_contr]	0.880	0.96	NG245 states that this accounts for all patients with persistent asthma-like symptoms at baseline, entering a diagnostic pathway for suspected disease.[2]	EAG assumes this applies to all patients, accounting for all patients being symptomatic at baseline, entering a diagnostic pathway for suspected disease. With asthma-like symptoms having a similar negative impact on quality of life across all patients.
Utility multiplier (partially controlled) [um_partcontr]	0.8372	0.9133	NG245[2]; Zafari et al 2014[56]	Utility multiplier from NG245 [2] for controlled asthma, further adjusted using utility multiplier derived using ratio between partially controlled and controlled utilities from Zafari et al 2014 [56]. Asthma (adults): 0.880*(0.900/0.946) Asthma (children): 0.96*(0.900/0.946)
Utility multiplier (uncontrolled) [um_uncontr]	0.7833	0.8545	NG245[2]; Zafari et al 2014[56]	Utility multiplier from NG245 [2] for controlled asthma, further adjusted using utility multiplier derived using ratio between uncontrolled and controlled utilities from Zafari et al 2014 [56] (multiplier = 0.842/0.946). Asthma (adults): 0.880*(0.842/0.946) Asthma (children): 0.96*(0.842/0.946)
Utility multiplier (severe exacerbation) [um_exac_severe]	0.6781	0.7398	NG245[2]; Zafari et al 2014[56]	Utility multiplier from NG245 [2] for controlled asthma, further adjusted using utility multiplier derived using ratio between exacerbation and controlled utilities from Zafari et al 2014 [56]. Asthma (adults): 0.880*(0.729/0.946) Asthma (children): 0.96*(0.729/0.946)
Utility multiplier (moderate exacerbation) [um_exac_mod]	0.7251	0.7868	NG245[2]	Utility multiplier from severe exacerbations (state in row above) with adjustment for moderate exacerbations using the values from NG245 [2] Asthma (adults): 0.6781+(0.134-0.087) Asthma (children): 0.7398+(0.134-0.087)

Utility multiplier (exacerbation) [um_exac]	Calculated in R: p_exac_severe * um_exac_severe) + ((1 - p_exac_severe) * um_exac_mod)	Assumed the same as adults	Weighted average between the utility multipliers for moderate and severe exacerbations using [p_exac_severe] (the estimated proportion of exacerbations that are severe)	-
QALYs lost from false positive diagnosis (Misdiagnosed states) [ud_falsepos]	0	0	Assumption	Large uncertainty associated with this value; however, will only be applied in the "Misdiagnosed, without app", and "Misdiagnosed, with app" states. Two Clinical Experts [redacted] highlighted that most side-effects would only affect patient on high dose inhaled steroids for a prolonged period. One Clinical Expert [redacted] advised that short term side-effects include oral pharyngeal effects. The EAG identified a study (Kavanagh et al. 2019), which stated that misdiagnosis of asthma may delay alternative diagnosis, and long-term use of inhaled steroids may impact bone, muscle, psychiatric, cardiovascular, ocular and metabolic disease may also impact quality of life.[63] Two Clinical Experts [redacted] advised that the impact of an alternative missed diagnosis could be significant and may include restriction of activity unnecessarily which may impact health. One Clinical Expert [redacted] advised that there may be mental health repercussions and may impact future careers (for example military).

Abbreviations: contr, controlled; EAG, External Assessment Group; exac, exacerbation; mod, moderate; NICE, National Institute for Health and Care Excellence; NG, NICE Guidelines; partcontr, partially controlled; QALY, Quality Adjusted Life Year; um, utility multiplier; uncontr, uncontrolled

6.2.6 Model validation

The EAG built a conceptual economic model for this early value assessment, rather than a fully parameterised economic model needed to support routine use guidance. The focus of the conceptual modelling was to identify key drivers and key uncertainties, rather than estimating cost-effectiveness within a target population.. Therefore, validation was mainly internal rather than external.

The EAG applied extreme value testing and documented model validation using the Assessment of the Validation Status of Health-Economic decision models (AdViSHE) tool (see Appendix B3).[64] Two authors (RO, SG) reviewed the Markov traces to ensure that appropriate numbers of patients transitioned to each health state. Extreme value testing of probabilities, costs and utilities was also performed checking that results were plausible based on the inputs (SG, KK). The model was peer reviewed by an experienced health economist (GSS).

6.2.7 Presentation of results

Results of the economic modelling were reported separately for adults and children. Model outputs included end state occupancies of states, total costs, total quality-adjusted life years (QALYs), from which incremental costs, incremental QALYs, incremental cost-effectiveness ratios (ICERs) and incremental net monetary benefit (NMB) using a willingness to pay threshold of £20,000/QALY could be calculated.

Due to paucity of clinical data directly relevant to the technologies in scope, the EAG considered 4 different value propositions independently (starting with the values reported in Table 9 to explore value proposition 1) to select an appropriate base case for further modelling:

1) Increased symptom control (intervention arm only) which was modelled by reducing the transition rates to worse levels of control.
2) Reduced number of exacerbations which was modelled in the intervention arm by applying a relative reduction to the exacerbation rate observed in the comparator arm.
3) Reduced severity of exacerbations which was modelled by reducing costs associated with exacerbation and adjusting utilities for the health state (weighted average between mild, moderate and severe exacerbation).
4) Increased detection of patients who have been incorrectly diagnosed with asthma (“misdiagnosis”) which was modelled by reducing treatment costs (that is, by assuming treatment is stopped when identified as a misdiagnosis) and by applying an arbitrary utility decrement (0.01) associated with being on treatment unnecessarily. The EAG note that although treatment costs are not incurred after a misdiagnosis is corrected, technologies which apply an upfront cost or recurring annual cost will have already incurred a cost for the year, which cannot be recouped.

A most plausible scenario (the base case) was selected from these different value propositions to create a baseline to understand the variation in results across the sensitivity and scenario analyses. The base case results are not intended as accurate estimates of cost-effectiveness.

To determine the key drivers from the economic modelling and to inform future data collection efforts, the EAG then focused on univariate deterministic sensitivity analysis. This included the following:

- Age at baseline: adults 37 and 57 years; children 9 years.

- Sex: 64% male (children only).
- Time horizon:1, 2, 3, 10 years.[65] Note that the children cohort (starting age of 6) are modelled for 10 years at which point they would move to the adult cohort (starting age of 16), where treatments and costs differ.
- Prevalence: 98%, 90% and 80%. Lower prevalences of 70% and 50% were considered in children, where there may be lack of objective testing in the initial diagnosis.
- Uptake of the app: 100% and 50% start using the app.
- Dropout per year: 25%, 75% from all asthma control states where an app is used. Additionally, the EAG modelled a specific scenario where the dropout was higher (75%) in the fully controlled state only, with 50% in partially controlled and uncontrolled states.
- Levels of control in starting population:
    - 33% controlled, 33% partially controlled, 33% uncontrolled (both intervention and comparator).
    - 10% controlled, 20% partially controlled, 67% uncontrolled (intervention and comparator).
    - 10% controlled, 20% partially controlled, 67% uncontrolled (intervention only).
- Different treatment costs across levels of control: partially controlled 25% more than controlled, uncontrolled 50% more than controlled.
- Increased annualised exacerbation rates: 5% increase for partially controlled, 10% increase for uncontrolled.
- Relative reduction in exacerbations in intervention arm: 0.25, 0.75.
- The proportion of exacerbations being severe in the technology arm being 5% less (24% in base case, 19% in sensitivity analysis).
- Proportions transitioning from exacerbation to fully controlled (33%), partially controlled (33%) and uncontrolled (33%).
- Incorrect diagnoses being identified within one year (intervention arm only): 5%, 10%, 25%, 50%, 100% (reflecting an absolute best-case scenario; clinically implausible).
- Technology costs: costs associated with each of the technologies were included. To investigate the impact of the different pricing models across the manufacturers, the EAG used the costcost ofSmartAsthma andand applied it as an upfront, recurring annual and recurring monthly cost. TheThe EAG note that at stakeholder consultation, SmartAsthma confirmed that they are available withwith an upfront cost only. . Therefore, this sensitivity analysis was explorative only to demonstrate the impact of different cost options on economic modelling results, using a fixed cost). The EAG also modelled a scenario where the cost of £17.60 to cover 5% of the cohort requiring a mobile device and internet plan was applied to consider digital inclusion. The EAG also explored distributing costs of hardware and platforms across a larger number of patients per Integrated Care System (increased to 2,500 from 1,000 in the base case). The EAG note that this latter sensitivity analysis was only applicable to two systems (Asthmahub, Digital Health Passport, Luscii).

- Increased monitoring costs (standard care) per arm: 100%. This will enable modelling of change of setting of monitoring (outpatients, secondary or tertiary care setting).

The EAG highlight that an early economic model was built, which was not fully parameterised for each technology, and did not include probabilistic sensitivity analysis (because (because of a lack of data). There was significant uncertainty in the parameter estimates related to risk of bias and generalisability. Therefore. Therefore, the base case estimates are not considered to be accurate estimates of cost-effectiveness. The term 'dominance' is used as shorthand to refer to results where a technology has greater benefits and smaller cost than the comparator. Dominance may also not be accurate, but if benefits are likely to continue to accrue beyond the time horizon in the base case then a greater positive QALY difference is more likely and so too is dominance using a longer time horizon.

6.3 Results from the economic modelling

6.3.1 Asthma (adults)

The EAG noted differences in results across the 4 value propositions, Table 13:

6.3.1.1 Increasing time spent with controlled symptoms

The most plausible base case for this value proposition assumed a 33% reduction in transitions from controlled to partially controlled (intervention: 33%; comparator: 50%) and 33% reduction in transitions from controlled or partially controlled to uncontrolled asthma (intervention: 0.4%; comparator: 0.6%). The intervention was associated with an incremental cost of £23.96, and incremental QALYs of 0.0019. This resulted in an ICER of £12,536/QALY and incremental NMB of £14. It was identified that if the relative reduction of transitions to worse levels of symptom control were less than 23% that the ICER would exceed £20,000/QALY. There was identified published clinical evidence (section 5.2.2) that demonstrated better asthma control (for example through change in Asthma Control Test scores) for some of the interventions in scope. Whilst there is some uncertainty associated with the magnitude and duration of increased level of control across the technologies, the EAG considered this value proposition plausible.

6.3.1.2 Reduction in number of exacerbations

Assuming a 10%, 20%, and 30% reduction in exacerbations all resulted in an ICER greater than £20,000/QALY. The EAG identified that a reduction of 50% or greater would be needed to reduce the ICER to below £20,000/QALY. One Clinical Expert advised that a reduction of 50% would be clinically meaningful. One study[18] [redacted]. The EAG note that evidence of a reduction in exacerbations is generally lacking across the technologies, therefore there is uncertainty regarding clinical plausibility of this scenario. The EAG note that the results of theearly economic modelling show that the incremental NMB was negative and small when varying relative risk of exacerbation in the intervention arm, therefore any future research should be proportionate to its value.

6.3.1.3 Reduction in exacerbation severity

Assuming a 75% reduction in the proportion of exacerbations which were severe (remainder being mild or moderate) gave an incremental cost of £16.82 per patient and incremental QALY gain of 0.0001848. This resulted in an ICER greater than £20,000/QALY and a negative incremental NMB of -£13. The EAG considered that the difference in utilities between moderate and severe was small, and that the proportion experiencing exacerbation alone was unlikely to result in an ICER below the £20,000/QALY threshold.

6.3.1.4 Detection of misdiagnoses

The assumptionassumption that the technologies were able to detect 50% of false positive results (intervention: 50%, comparator: 0%) resulted in an incremental cost of £12.87, and incremental QALYs of 0.0016, with an ICER of £7,819/QALY and incremental NMB of £20. The EAG note that this result is driven by removal of treatment costs which accrue on a per cycle basis overover the time horizon, and monitoring costs, where these are applied per cycle or per year. The EAG also note that there is limited data across the technologies for this value proposition, and limited data for how often a misdiagnosis would be corrected in the comparator arm.

TevidenceTable 13: Economic results when modelling asthma management of 100,000 adults (4 value propositions)

		End state occupancy												
Scenario	**Description**	**Controlled**	**Partially Controlled**	**Uncontrolled**	**Exacerbation**	**Misdiagnosed**	**No Disease**	**Deaths**	**Total costs, £**	**Total QALYs**	**Incremental costs, £**	**Incremental QALYs**	**ICER, £/QALY**	**Incremental NMB (£)**
Standard care	**Comparator**	**27,296**	**29,922**	**30,802**	**489.9**	**9,867**	**0**	**1,622**	**361.5**	**3.354**	**NA**	**NA**	**NA**	**NA**
Value proposition 1: increasing length of time with controlled symptoms	[VP1] Intervention with 10% fewer transitions to lower control (initial base case for exploring value proposition)	27,435	29,805	30,780	489.8	9,867	0	1,622	385.4	3.355	23.91	0.0005406	44,223	-13.1
	[VP1] Intervention with 25% fewer transitions to lower control	27,664	29,610	30,747	489.8	9,867	0	1,622	385.5	3.355	23.94	0.001403	17,064	4.1
	[VP1] Intervention with 33% fewer transitions to lower control (most plausible base case after exploring value propositions)	**27,803**	**29,490**	**30,728**	**489.8**	**9,867**	**0**	**1,622**	**385.5**	**3.356**	**23.96**	**0.001911**	**12,536**	**14.3**
	[VP1] Intervention with 50% fewer transitions to lower control	28,110	29,220	30,690	489.7	9,867	0	1622	385.5	3.357	24	0.002997	8,008	35.9
Value proposition 2: reduction in number of exacerbations	[VP2] Intervention + 0.90 RR exac	27,323	29,926	30,775	486.5	9,867	0	1,622	384.9	3.354	23.33	0.0001472	158,471	-20.4
	[VP2] Intervention + 0.80 RR exac	27,351	29,930	30,747	483.2	9,867	0	1,622	384.3	3.354	22.78	0.0002964	76,849	-16.9
	[VP2] Intervention + 0.70 RR_exac	27,380	29,934	30,717	480	9,867	0	1,622	383.8	3.355	22.22	0.0004476	49,655	-13.3
Value proposition 3: reduction in exacerbation severity	[VP3] Intervention with 25% reduction in proportion of severe exacerbations	27,296	29,922	30,802	489.9	9,867	0	1,622	383.1	3.354	21.53	6.158e-05	349,621	-20.3
	[VP3] Intervention with 50% reduction in proportion of severe exacerbations	27,296	29,922	30,802	489.9	9,867	0	1,622	380.7	3.354	19.17	0.0001232	155,676	-16.7
	[VP3] Intervention with 75% reduction in proportion of severe exacerbations	27,296	29,922	30,802	489.9	9,867	0	1,622	378.3	3.354	16.82	0.0001848	91,027	-13.1
	[VP4] Comparator + utility decrement FP	27,296	29,922	30,802	489.9	9,867	0	1,622	361.5	3.349	NA	NA	NA	NA

		End state occupancy												
Scenario	**Description**	**Controlled**	**Partially Controlled**	**Uncontrolled**	**Exacerbation**	**Misdiagnosed**	**No Disease**	**Deaths**	**Total costs, £**	**Total QALYs**	**Incremental costs, £**	**Incremental QALYs**	**ICER, £/QALY**	**Incremental NMB (£)**
Value proposition 4: detection of misdiagnoses	[VP4] Intervention + 5% detected (with utility decrement)	27,296	29,922	30,802	489.9	9,219	648.4	1,622	384.1	3.35	22.53	0.0002083	108,164	-18.4
	[VP4] Intervention + 10% detected (with utility decrement)	27,296	29,922	30,802	489.9	8,634	1,233	1,622	382.8	3.35	21.24	0.0004051	52,438	-13.1
	[VP4] Intervention + utility decrement FP (with 50% detected as misdiagnoses)	27,296	29,922	30,802	489.9	5,527	4,341	1,622	374.5	3.351	12.97	0.001658	7,819	20.2

[Key: bold=base case] Abbreviations: FP, false positives; ICER, incremental cost-effectiveness ratio; NA, not applicable; NMB, net monetary benefit; QALY, quality-adjusted life year; SoC, standard of care; VP, value proposition;

6.3.1.55 Sensitivity analysis

The aim of the conceptual model is to determine key drivers and areas of uncertainty. The EAG considered the value proposition of maintaining higher levels of symptom control as the most plausible to demonstrate this. This is because asthma control was the most commonly reported outcome in the clinical evidence. Therefore, all remaining sensitivity analysis assumed the same 33% reduction in transition to worse levels of control in the intervention arm as the most plausible base case (incremental cost of £23.96, incremental QALYs of 0.001911, ICER £12,536/QALY); with other univariate changes applied on top of this to determine the direction and magnitude of their impact on the results.

The model was most sensitive to univariate changes in the technology costs, costs of monitoring in standard care and identification of misdiagnoses (see Appendix B5).

- **Technology cost per patient**: Increasing the cost of the intervention by £17.60 per year (the approximate cost of a mobile device and monthly internet plan applied to 5% of the cohort), increased the ICER to £24,617/QALY. At stakeholder consultation a company suggested an alternative cost for monthly internet plan, therefore using this cost ofof £8.00 per year, resulted in an ICER of £18,034/QALY.

  The EAG note that one technology was potentially considered dominant (Asthmahub), and two technologiesies (base case: DHP, SmartAsthma) had an ICER less than £20,000/QALY. The remaining technologies had an ICER which exceeded £20,000/QALY with a corresponding negative incremental NMB: AsthmaTuner ([redacted]), Luscii (-£178), myAsthma (-£14), NuvoAir (-£202), RDMP (-£255).

  If the upfront costs of software-only technologies were distributed across 2,500 patients (instead of 1,000 patients in the base case), both AsthmaHub and DHP were considered potentially dominant, and Luscii still had an ICER which was greater than £20,000/QALY.

It should be noted that both the QALY gain and cost saving were very small and becausebecause this is a conceptual modelmodel, based on a lot of assumptions, 'dominant' findingsfindings should be interpreted with cautioncaution.

Due to the potential for patients to stop using the app ("dropout") at any time, the economic model was sensitive to the pricing approach applied across technologies. Using the costs for SmartAsthma as an example:

- If these were attributed as an upfront cost of £71.10 and a separate ongoing cost of £7.46 per year for practice nurse review, incremental costs were £23.96 and the ICER was £12,536 (incremental NMB of £14).
- Treating the £71.10 cost as an annual recurring cost resulted in an incremental cost of £95.79 per patient, ICER of £50,126 (incremental NMB of -£58). Reducing the dropout rate to 25% (50% in base case), reduced the ICER to £45,149/QALY; still greater than the willingness to pay threshold of £20,000/QALY.
- Alternatively, treating the £71.10 cost as a monthly recurring cost (which is not incurred from the point of dropout onwards) resulted in an incremental cost of £63.83 per patient and an ICER of £33,400/QALY (negative incremental NMB, -£26). Reducing the annual dropout rate to 25% had little impact on the ICER (£34,429/QALY; slight increase due to a greater number of patients continue using the intervention, which is more expensive than monitoring in the comparator arm).

These results show the impact of varying the costing approach for the technologies. The single upfront cost being applied once across the five-year time horizon is favourable because it allows time for the benefits to accrue and offset the initial cost. If the time horizon was reduced to one year all three pricing models described above when applied to SmartAsthma resulted in an ICER greater than

£20,000/QALY. The EAG note that five technologies apply an upfront cost associated with hardware, software or platform costs.

- **Cost of monitoring in standard care**: When doubling the cost of monitoring in the comparator arm (to £59.70 per year), the intervention arm was potentially considered dominant, with an incremental cost saving of £5.38 per patient and incremental NMB of £44. This scenario may reflect monitoring different populations with asthma, or in different healthcare settings, for example with a higher proportion attending hospital-based asthma clinics, or using FeNO, and so on. This may vary across the NHS based on availability of services and staff.

  The EAG note that in the base case that the intervention (SmartAsthma) was assumed to be an adjunct to standard care, but with a 75% reduction in standard monitoring costs associated with practice nurse and outpatient appointments, as in NG245. The cost of this reduction is the equivalent of reducing practice nurse time by 25 minutes per patient per year. However, in sensitivity analysis the intervention maintained an ICER less than £20,000/QALY until this reduction dropped below 32%. Greater reductions in ongoing monitoring costs would be needed to offset the cost of more expensive technologies.

- **Identification of misdiagnoses**: When assuming a prevalence of 90% (that is, 10% of people using the intervention do not actually have asthma) the ICER remained below £20,000/QALY (incremental NMB of £20) when 5% of the false positives were detected and taken off treatment. A larger effect would be seen if the prevalence was lower than 90%. The EAG note that this analysis assumed a 0% detection of misdiagnoses in the comparator arm, which may not reflect current NHS practice.

The base case (which already assumed patients stayed within better levels of control for longer) was relatively insensitive to additional univariate changes in starting patient age, dropout rate, and proportions starting in each level of

symptom control. Across these scenarios, the change in ICER and variance in the incremental net monetary benefit were considered small (see Appendix B5). Increasing the dropout rate to 75% per year or reducing to two levels of symptom control (controlled and uncontrolled) resulted in an ICER above £20,000/QALY; correspondingly, the incremental NMBs were small and negative (-£4.8 and -£4.5, respectively). The EAG also note that increasing the treatment costs of partially controlled by 25% and uncontrolled by 50% did not change the direction of results for any technology.

Decreasing the time horizon to 1 year resulted in a smaller incremental gain in QALYs (0.00032), however when increasing to 10 years the incremental QALYs remained small (0.0023). Assuming that a higher proportion of patients had uncontrolled asthma, 100% of patients used the app and 0% dropped out over the 5-year time horizon, the intervention arm was considered dominant (incremental cost saving of £30.52; incremental NMB of £113). However, the EAG considered this scenario implausible. Reducing the prevalence to 70%, still resulted in an ICER below £20,000/QALY. Combining parameter changes, such as assuming patients remain in higher levels of symptom control and experience fewer exacerbations reduced the ICER even further. However, because there is a lack of clinical evidence, it is not clear to the EAG which combination of scenarios are clinically plausible. The EAG note that when using the parameters used in the base case a time horizon longer than 3 years was needed to bring the ICER below £20,000/QALY.

All of the incremental QALYs calculated were positive, suggesting that across all scenarios modelled by the EAG, using a digital technology for asthma management was favourable compared with standard care. This is likely to be because of the increased time spent in states of better asthma control, with a higher utility multiplier, and fewer exacerbations, where utilities accrued are lower. There are also no adverse events associated with the technology to cause utility to be lower than in the comparator arm. Therefore, where incremental NMB is negative, this is driven by the incremental costs being high enough for the ICER to cross the willingness to pay threshold of £20,000

per QALY. Incremental costs are particularly affected by the costs of the technologies, the costing model applied, and the dropout rate.

Table 14: Economic sensitivity analysis (adults)

Scenario	Total costs (£)	Total QALYs	Incremental costs (£)	Incremental QALYs	ICER (£/QALY)	Incremental NMB (£)
Comparator - base case	361.5	3.354	NA	NA	NA	NA
Intervention – most plausible base case after exploring value propositions (33% less move to lower control)*	385.5	3.356	23.96	0.001911	12,536	14.3
Intervention + 25% drop out per year	369.9	3.357	8.405	0.002836	2,963	48.3
Intervention + 75% drop out per year	393.9	3.355	32.37	0.00138	23,452	-4.8
Intervention + £17.60 device/internet	408.6	3.356	47.04	0.001911	24,617	-8.8
Intervention + £8.00 device/ internet	396	3.356	34.46	0.001911	18,034	3.8
Intervention + costs of RDMP	655.4	3.356	293.8	0.001911	153,766	-255.6
Intervention + costs of Asthmahub	357.2	3.356	-4.28	0.001911	Dominant*	42.5
Intervention + costs of Luscii	577.8	3.356	216.2	0.001911	113,146	-178
Intervention + costs of AsthmaTuner	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Intervention + costs myAsthma	414.5	3.356	53.02	0.001911	27,745	-14.8
Intervention + costs NuvoAir	602.2	3.356	240.7	0.001911	125,930	-202.4
Intervention + costs DHP	393.22	3.356	31.7272	0.001911	16,598598	6.5
Intervention + costs AsthmaHub (distributed across 2500 patients per ICB)	344.2	3.356	-17.33	0.001911	Dominant	55.6
Intervention + costs of Luscii (distributed across 2500 patients per ICB)	573.9	3.356	212.4	0.001911	111,145	-174.2
Intervention + costs DHP (distributed across 2500 patients per ICB)	358.6	3.356	-2.93	0.001911	Dominant	41.2
Intervention + costs of SmartAsthma (treated as upfront cost)	385.5	3.356	23.96	0.001911	12,536	14.3
- with 25% drop out	369.9	3.357	8.405	0.002836	2,963	48.3
Intervention + costs of SmartAsthma (treated as ongoing annual costs)	457.3	3.356	95.79	0.001911	50,126	-57.6
- with 25% drop out	489.6	3.357	128.1	0.002836	45,149	-71.3
Intervention + costs of SmartAsthma (treated as ongoing costs paid monthly)	425.4	3.356	63.83	0.001911	33,400	-25.6
- with 25% drop out	459.2	3.357	97.66	0.002836	34,429	-40.9
Comparator at 1 year	77.87	0.7243	NA	NA	NA	NA
Intervention + costs of SmartAsthma (upfront) at 1 year	118.2	0.7246	40.35	0.0003203	125,976	-33.9
Intervention + costs of SmartAsthma (treated as ongoing annual costs) at 1 year	118.2	0.7246	40.35	0.0003203	125,976	-33.9
Intervention + costs of SmartAsthma (treated as ongoing monthly costs) at 1 year	106.1	0.7246	28.23	0.0003203	88,145	-21.8
Comparator + QALY loss FP 0.01	361.5	3.349	NA	NA	NA	NA
Intervention + QALY loss FP 0.01	385.5	3.351	23.96	0.001911	12,536	14.3
Intervention + 5% FP detected	384.1	3.352	22.6	0.002119	10,664	19.8
Comparator + 200% monitoring costs in SoC arm	497	3.354	NA	NA	NA	NA
Intervention + 200% monitoring costs in SoC arm	491.6	3.356	-5.38	0.001911	Dominant*	43.6
Comparator ++ 2 levels of control (controlled, uncontrolled)	362	3.344	NA	NA	NA	NA
Intervention ++ 2 levels of control (controlled, uncontrolled)	386.4	3.345	24.4	0.0009972	24,469	-4.5

Abbreviations: FP, false positives; ICER, incremental cost-effectiveness ratio; NA, not applicable; NMB, net monetary benefit; QALY, quality-adjusted life year. * dominance should be interpreted cautiously due to the conceptual nature of the model and the small incremental gains estimated.

6.3.2 Asthma (children)

The same overall trends as reported in adults with asthma (section 6.3.1), were observed when modelling children with asthma.

6.3.2.1 Value propositions

The same direction of results was observed across the four value propositions. Incremental QALYs were higher, and therefore ICERs were reduced when compared to adults, Table 16.

Table 15: Economic results when modelling asthma management of 100,000 children (4 value propositions)

		End state occupancy												
Scenario	**Description**	**Controlled**	**Partially Controlled**	**Uncontrolled**	**Exacerbation**	**Misdiagnosed**	**No Disease**	**Deaths**	**Total costs, £**	**Total QALYs**	**Incremental costs, £**	**Incremental QALYs**	**ICER, £/QALY**	**Incremental NMB (£)**
Standard care	**Comparator**	**27,942**	**30,386**	**31,174**	**447**	**9,997**	**0**	**54.25**	**432.4**	**3.872**	**NA**	**NA**	**NA**	**NA**
Value proposition 1: increasing length of time with controlled symptoms	[VP1] Intervention with 10% fewer transitions to lower control (initial base case for exploring value proposition)	28,088	30,264	31,150	447	9,997	0	54.25	456.2	3.873	23.8	0.0006412	37,117	-11
	[VP1] Intervention with 25% fewer transitions to lower control	28,328	30,060	31,114	446.9	9,997	0	54.25	456.2	3.874	23.83	0.001665	14,317	9.5
	[VP1] Intervention with 33% fewer transitions to lower control (most plausible base case after exploring value propositions)	**28,474**	**29,934**	**31,094**	**446.9**	**9,997**	**0**	**54.25**	**456.2**	**3.874**	**23.85**	**0.002268**	**10,516**	**21.5**
	[VP1] Intervention with 50% fewer transitions to lower control	28,797	29,652	31,054	446.9	9,997	0	54.25	456.2	3.876	23.89	0.003559	6,714	47.3
Value proposition 2: reduction in number of exacerbations	[VP2] Intervention + 0.90 RR exac	27,968	30,390	31,147	444	9,997	0	54.25	455.6	3.872	23.29	0.0001582	147,224	-20.1
	[VP2] Intervention + 0.80 RR exac	27,994	30,394	31,120	441	9,997	0	54.25	455.2	3.872	22.8	0.0003183	71,630	-16.4
	[VP2] Intervention + 0.70 RR_exac	28,022	30,398	31,091	438	9,997	0	54.25	454.7	3.873	22.31	0.0004804	46,442	-12.7
Value proposition 3: reduction in exacerbation severity	[VP3] Intervention with 25% reduction in proportion of severe exacerbations	27,942	30,386	31,174	447	9,997	0	54.25	454	3.872	21.65	5.917e-05	365,855	-20.5
	[VP3] Intervention with 50% reduction in proportion of severe exacerbations	27,942	30,386	31,174	447	9,997	0	54.25	451.9	3.872	19.52	0.0001183	164,907	-17.1
	[VP3] Intervention with 75% reduction in proportion of severe exacerbations	27,942	30,386	31,174	447	9,997	0	54.25	449.7	3.872	17.38	0.0001775	97,925	-13.8
Value proposition 4: detection of misdiagnoses	[VP4] Comparator + utility decrement FP	27,942	30,386	31,174	447	9,997	0	54.25	432.4	3.868	NA	NA	NA	NA
	[VP4] Intervention + 5% detected (with utility decrement)	27,942	30,386	31,174	447	9,340	656.9	54.25	454.4	3.868	22.09	0.0002098	105,287	-17.9
	[VP4] Intervention + 10% detected (with utility decrement)	27,942	30,386	31,174	447	8,747	1,249	54.25	452.8	3.868	20.49	0.0004081	50,216	-12.3
	[VP4] Intervention + utility decrement FP (with 50% detected as misdiagnoses)	27,942	30,386	31,174	447	5,599	4,398	54.25	442.6	3.869	10.22	0.00167	6,121	23.2

[Key: bold=base case] Abbreviations: FP, false positives; ICER, incremental cost-effectiveness ratio; NMB, net monetary benefit; QALY, quality-adjusted life year; VP, value proposition

6.3.2.2 Sensitivity analysis

As with the adult cohort, the EAG considered the value proposition of maintaining higher levels of symptom control as the most plausible. Therefore, all other sensitivity analysis assumed the same 33% reduction in transition to lower levels of control in the intervention arm as this most plausible base case (incremental cost of £23.85, incremental QALY of 0.002268, ICER £10,516/QALY, incremental NMB of £22); with other univariate changes applied to this to determine the direction and magnitude of their impact on results.

As with the adult cohort, the model was most sensitive to univariate changes in the technology costs, costs of monitoring in standard care and identification of misdiagnoses (see Appendix B5).

- **Technology cost per patient:** If 5% of patients were to be provided with a mobile device and internet plan to use the technologies (considering digital equality), the ICER increased to £20,703/QALY.

  One technology (Asthmahub) was potentially considered dominant with incremental cost savings of £4.39 per patient. Two technologies (Two iesDHP, SmartAsthma) had an ICER less than £20,000/QALY. The remaining six technologies had an ICER greater than £20,000 and corresponding negative incremental NMB: AsthmaTuner ([redacted]), Luscii (-£172), myAsthma (-£7), NuvoAir (-£195), RDMP (-£249).

  If the upfront costs were distributed across 2,500 patients (instead of 1,000 patients in the base case), both AsthmaHub and DHP were considered dominant, and Luscii still had an ICER which was greater than £20,000/QALY.

  As with adults, the economic model was sensitive to the costing approach used. Using the costs of SmartAsthma as an example:

  - Using an upfront cost of £71.10 and a separate ongoing cost of £7.46 per year for practice nurse review, resulted in an

incremental cost of £23.85 and ICER of £10,516 (incremental NMB of £22).

- Treating the £71.10 cost as an annual recurring cost resulted in an incremental cost of £95.96 per patient, and ICER of £42,308 (incremental NMB of -£51). Reducing the dropout rate to 25% (from 50% in the base case), reduced the ICER, but not below £20,000/QALY.

- Alternatively, treating the £71.10 as a monthly recurring cost (and not incurred from the point of dropout onwards) resulted in an incremental cost of £64.06 per patient and an ICER of £28,241/QALY (incremental NMB: -£19). Reducing the annual dropout rate to 25% had little impact on the ICER (£29,100/QALY).

- **Cost of monitoring in standard care**: When doubling the cost of monitoring in the comparator arm (to £59.70 per year), the intervention arm was potentially dominant, with an incremental cost saving of £5.57 and incremental NMB of £51. This could reflect a higher of proportion of patients being monitored with additional appointments with a practice nurse, or in a hospital outpatient setting. The EAG note that this may be more likely in children than adults, where additional testing (such as FeNO) may be used, and where more input from specialist staff may be needed. A 2024/25 Asthma and Lung UK review of Integrated Care Systems reported that of 32 respondents (of 42 Integrated Care Systems), only 12 currently commission spirometry diagnostic services for children and may refer to secondary care for asthma diagnosis and potential management[66]. NG245 also recommends medication reviews following pharmacological intervention trials and recommends FeNO monitoring for adults at time of review or changes in asthma therapy,[2] therefore the EAG consider it plausible that the costs of standard care could be higher.

- **Identification of misdiagnoses**: When assuming a prevalence of 90% (that is, 10% of those being treated and monitored for asthma do not actually have it), the intervention maintained an ICER below £20,000 (incremental NMB of £20) when 5% of the false positives were detected and taken off treatment. The Experts advised that prevalence in the treated population may be lower in children where it can be difficult to do objective testing to confirm a diagnosis. Although greater detection of misdiagnoses may be possible in this population, there was a lack of published evidence to support this.

Because standardised utility values were only available for adults, utilities for those under 16 years were set to those of a 16-year-old. Therefore, baseline utility values were not linked to age, and adjusting the age parameter in the paediatric model had no impact on the results. If utility values were available for younger patients, these would be expected to be higher than the baseline values used and further reduce the ICER in favour of the intervention.

The EAG note that thet base case was considered cost effective with an ICER less than £20,000/QALY when using a 3-year time horizon. Modelling on two levels of symptom control in children resulted in an ICER of £20,235/QALY (with a small negative incremental NMB of -£0.3). Increasing the dropout rate above 75% per year or reducing the prevalence below 50% would result in an ICER above £20,000/QALY. The economic model was not sensitive to changes in other parameters (see Appendix B5).

Table 16: Economic sensitivity analysis (children)

Scenario	Total costs (£)	Total QALYs	Incremental costs (£)	Incremental QALYs	ICER (£/QALY)	Incremental NMB (£)
Comparator - base case	432.4	3.872	NA	NA	NA	NA
Intervention – most plausible base case after exploring value propositions (33% less move to lower control)*	456.2	3.874	23.85	0.002268	10,516	21.5
Intervention + 25% drop out per year	440.5	3.876	8.165	0.003374	2,420	59.3
Intervention + 75% drop out per year	464.7	3.874	32.32	0.001636	19,763	0.4
Intervention + £17.60 device/internet	479.4	3.874	47.02	0.002268	20,731	-1.7
Intervention + £8.00 device/internet	466.7	3.874	34.4	0.002268	15,164	11
Intervention + costs of RDMP	726.9	3.874	294.6	0.002268	129,878	-249.2
Intervention + costs of Asthmahub	428	3.874	-4.385	0.002268	Dominant*	49.7
Intervention + costs of Luscii	649.3	3.874	217	0.002268	95,655	-171.6
Intervention + costs of AsthmaTuner	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Intervention + costs myAsthma	485.4	3.874	53.03	0.002268	23,381	-7.7
Intervention + costs NuvoAir	672.9	3.874	240.6	0.002268	106,052	-195.2
Intervention + costs DHP	464464	3.874	31.6262	0.002268	13,938938	13.7
Intervention + costs AsthmaHub (distributed across 2500 patients per ICB)	414.9	3.874	-17.43	0.002268	Dominant*	62.8
Intervention + costs of Luscii (distributed across 2500 patients per ICB)	645.5	3.874	213.1	0.002268	93,968	-167.8
Intervention + costs DHP (distributed across 2500 patients per ICB)	429.3	3.874	-3.035	0.002268	Dominant*	48.4
Intervention + costs of SmartAsthma (treated as upfront cost)	456.2	3.874	23.85	0.002268	10,516	21.5
- with 25% drop out	440.5	3.876	8.165	0.003374	2,420	59.3
Intervention + costs of SmartAsthma (treated as ongoing annual costs)	528.3	3.874	95.96	0.002268	42,308	-50.6
- with 25% drop out	560.8	3.876	128.5	0.003374	38,079	-61
Intervention + costs of SmartAsthma (treated as ongoing costs paid monthly)	496.4	3.874	64.06	0.002268	28,241	-18.7
- with 25% drop out	530.5	3.876	98.18	0.003374	29,100	-30.7
Comparator + QALY loss FP 0.01	432.4	3.868	NA	NA	NA	NA
Intervention + QALY loss FP 0.01	456.2	3.87	23.85	0.002268	10,516	21.5
Intervention + 5% FP detected	454.5	3.87	22.16	0.002478	8,944	27.4
Comparator + 200% monitoring costs in SoC arm	568.8	3.872	NA	NA	NA	NA
Intervention + 200% monitoring costs in SoC arm	563.3	3.874	-5.568	0.002268	Dominant*	50.9
Comparator - 2 levels of control (controlled, uncontrolled)	432.8	3.86	NA	NA	NA	NA
Intervention - 2 levels of control (controlled, uncontrolled)	457.1	3.862	24.32	0.001202	20,235	-0.3

Abbreviations: FP, false positives; ICER, incremental cost-effectiveness ratio; NA, not applicable; NMB, net monetary benefit; QALY, quality-adjusted life year; * dominance should be interpreted cautiously due to the conceptual nature of the model and the small incremental gains estimated.

6.4 Summary and interpretation of the economic evidence

Results from this economic modelling should not be interpreted as evidence or lack of evidence of cost-effectiveness. Instead, this conceptual modelling work has highlighted key evidence gaps and key drivers of differences in costs and utilities of digital technologies used to support self-management of asthma, when compared with standard care alone. These should be addressed before completing a full economic evaluation in the future.

Key findings:

- The EAG focused efforts on building a conceptual model to show the impact of using digital technologies for self-management of asthma, across different levels of symptom control. The conceptual economic model lacked full parameterisation, however alloweded exploration of multiple value propositions associated with the technologies in scope. For example, maintaining better control of symptoms for a longer period, reducing the frequency and severity of exacerbations, and increasing the detection of incorrect diagnoses of asthma. The model was used to explore different scenarios in which the technologies in scope might be cost effective when compared with standard care.

- Throughout the modelling, incremental QALYs were very small. The EAG note that this meant that even small changes in costs had a large impact on the ICER. The cost per patient of the technologies had the potential to increase the ICER above £20,000/QALY, and whether these were applied as upfront costs or recurring annual or monthly costs, had a particularly big impact. Where an upfront hardware or platform cost is applied, this is sensitive to the number of patients who will use the digital technologies, with greater uptake per organisation (that is, GP practice, Integrated Care System, and so on) bringing the cost per patient down. The impact of dropout rates over time horizons longer than a year affect technologies with recurring costs more than technologies with an upfront cost. Although a 50% dropout rate was

assumed by the EAG, a Clinical Expert advised that dropout may be higher in children. Because this scenario may be clinically plausible, the EAG notes that dropout rates are an important consideration for future research, and particularly how they relate to ease of use and patient or carer acceptability.

- Key areas where evidence is needed include: initial uptake of the technologies (which is more of an issue for technologies with large recurring costs, provided people do not dropout within the first year; if they do drop out in the first year, higher upfront costs are more of an issue), dropout rates in those who start using the technologies, and relative reduction in exacerbations when using the digital technologies for self management of asthma. There is some evidence of better symptom control when using the technologies, but the overall quality of reporting was poor and the outcome measures reported varied. Future economic evaluations could be supported by comparative evidence from a UK setting, that uses clear reporting of outcomes and baseline characteristics, using standardised tools.

7. Integration into the NHS

Implementation considerations

The EAG note that there are some key functional differences between the technologies that may impact how they integrate into the asthma management pathway. For example, four technologies are software only, three technologies include both hardware and software, and one technology is a remote service that includes independent clinical review of the results. Therefore, the clinical suitability, uptake and dropout rate may differ across technologies but also may vary across patient cohorts (such as between different severities of asthma or levels of control). Integration into the NHS also differs between technologies, as some patients may be able to download and use the technology, thus not requiring a clinical referral. Given the differences in

technology costs, the appropriateness of each technology may be decided on a local or regional level depending on budget constraints.

Six technologies (RDMP, Asthmahub, Luscii, myAsthma, NuvoAir, Digital Health Passport) reported that they are currently in use within the NHS. One is currently available as part of trials or evaluations (Smart Asthma), and atat consultation, confirmed that they are commercially suppliedsupplied to 11 NHS Trusts or Integrated Care Boards. One. O is not currently available to the NHS (AsthmaTuner). A 2024/25 Asthma and Lung UK review of Integrated Care Systems reported that of 32 respondents (of 42 Integrated Care Systems), 25 were currently using self-management apps for asthma or COPD. Commonly reported apps in scope of this EVA used were myAsthma (N=9), Digital Health Passport (N=4), Asthmahub (N=1), Asthmahub for Parents (N=2), with 5 Integrated Care Systems also implementing multiple apps.[66]

The EAG identified four published studies which were not directly relevant to the decision problem but that considered helpful implementation considerations, which have been highlighted for committee to inform decision making.

- A systematic review of qualitative studies by Duan et al (2025) summarises the stresses and expectations associated with electronic inhaler monitoring devices in patients with COPD or asthma.[48] Findings noted patient concerns relating to data security and access and skepticism about the accuracy of information provided by the devices with a preference for human contact to address queries or concerns. The portability and appearance of the devices was also a key consideration for use.
- A narrative review by Chan et al (2023) summarises the evidence surrounding acceptability and feasibility of digital adherence interventions in asthma.[47] Similarly, concerns related to the transparency of data handling and integration and clinical oversight were commonly reported themes. The authors also highlighted that

to ensure successful implementation of digital interventions, that careful selection of the digital intervention should be considered to meet the patient's needs, lifestyle, abilities and preferences.

- A narrative review by Pinnock et al (2023) summarises a taxonomy of 14 potential components of support for self-management of asthma.[50] The review noted that the digital technologies can support behaviour change to enable improved self-management of asthma. Authors also highlighted that monitoring features, such as self-recorded symptom logs or peak flow reading are rarely adhered to beyond a few weeks because of a lack of interactive action plan and noted the importance of a personalised plan. Once again, concerns relating to ensuring appropriate clinical, regulatory and information governance oversight is in place when implementing the technologies were key themes.
- A narrative review by Effing (2023) describes the developments in respiratory self-management interventions and their implementation.[49] Barriers to implementation raised included workforce upskilling, overcoming negative views of the usefulness of the technologies (clinician and user perspectives), ensuring continuity of care and flexible access to professional advice. This also mentions tailoring self-management interventions to meet the patients needs, beliefs and capacity to improve motivation, adherence and outcomes. Furthermore, funding was noted as a potential barrier to large scale technology adoption.

The studies reported that generally digital technologies that support asthma management were user friendly and improved patient confidence in managing their condition. The EAG consider that some patients may have preferences for specific technologies, which may need to be considered using shared decision making with patients and on an individual basis. As per the final scope, none of the technologies can replace regular review by healthcare professionals. How each technology handles and manages data (including data sharing or access) should be transparently reported and available to patients to support informed decision making.

Sustainability considerations

Medicines account for 25% of emissions within the NHS, of which inhalers (3% of emissions) occur at the 'point of use' with 20% of emissions primarily found in the manufacturing and freight inherent in the supply chain.[67] Tools that can help with better use, adherence and management of these devices could reduce direct and indirect emissions linked to inhalers and other associated medicines and reduce the carbon footprint associated with the management of asthma in line with delivering a net zero NHS. Some technologies require hardware with disposable or reusable consumables to perform spirometry.

- Aptar is ISO14064 (a framework for organisations to quantify, manage, and report on their greenhouse gas (GHG) emissions and removals) compliant and has provided climate transition plans and corporate sustainability reports.
- Luscii have reported they are in the process of developing a carbon footprint and carbon reduction plan.
- MyHealth claim their myAsthma app's videos and education content help patients correctly use their inhalers, reducing inhaler waste, and reduce exacerbations which further reduces the use of devices.
- NuvoAir and Smart Asthma have supplied a carbon reduction plan. NuvoAir reported that the spirometer that is sent to the patient can be recycled (presumably for the purpose of cleaning and reusing).
- One conference abstract stated that clinicians who used Smart Asthma strongly agreed that the app would contribute towards the NHS goal of achieving net zero, though provided no further information.[29]

8. Evidence gap analysis

8.1 Ongoing studies

A total of 12 ongoing studies were identified from six manufacturers (seven technologies) (see Table 17).

ForFor AsthmaTuner, one study is ongoing (NCT07145632) and another is completed (NCT06062433). The completed trial (NCT06062433) will provide information on patient reported satisfaction of asthma care, number of visits required for asthma care (including time for visits), and frequency of poorly controlled asthma (i.e. ACT < 20). To note, thisthis study is taking place in the US, which may limit the generalisability to the UK NHS usage. The ongoing trial (NCT07145632) aims to measure number of patients presenting successful inhalation techniques, which currently has no evidence from any app available (see section for intermediate outcome Inhaler technique).

ForFor BreatheSmart/Respi.me (RDMP), one study is completed (NCT03103880), while one is ongoing (NCT06364527). The completed trial (NCT03103880) would provide data on change in asthma control, rescue/controller medication usage, and patient reported acceptability of the BreatheSmart app. To note, the record has not been updated since July 2024. The ongoing study (NCT06364527) would provide further evidence for asthma control, rescue medication use, quality of life, and adherence to medication.

ThereThere is one ongoing study about the Digital Health Passport. The company provided a statement regarding an evidence generation plan. However, limited details for this plan were available;; see Table 17 for further details.

ThereThere are three ongoing studies assessing myAsthma, with one trial of currently unknown status (NCT02556073) and two studies provided by the companies. The clinical trial registration was last updated in 2015 and was being conducted in Taiwan. The two ongoing studies provided by the company are real world evidence evaluations, which could provide further evidence on quantitative and qualitative outcomes.

ThereThere are two ongoing studies for Asthmahub and one for Asthmahub for Parents. All three studies were provided by the company. The Asthmahub data would provide clinical evidence for impact on exacerbations (e.g. GP attendance, hospital admissions, and accident and emergency visits) and patient reported data of quality of life. The ongoing study for Asthmahub for

Parents would provide evidence that is currently lacking for this version of Asthmahub. [redacted]

One ongoing study was identified for NuvoAir, which is a single arm study (NCT05603494). The trial record was last updated in 2023 but results could help provide evidence of using the NuvoAir app for self-management of asthma by assessing symptoms and medication use.

Table 17: Ongoing studies and their relevance to the decision problem

Ongoing study	Alignment with scope	Indicated study end date	EAG comments
AsthmaTuner (2 studies)			
Clinical Trial Record (NCT06062433)	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	05/06/2025	Trial stated as completed, no results posted.
Clinical Trial Record (NCT07145632)	Intervention: Full match to scope Comparator: full match to scope Participants: partial match to scope Setting: full match to scope	01/06/2027	Trial provided by company, stated as recruiting. Includes patients with diagnosed asthma and COPD

Ongoing study	Alignment with scope	Indicated study end date	EAG comments
	Outcomes: full match to scope		
Respiratory Disease Management Platform (2 studies)			
Clinical Trial Record (NCT06364527)	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	Nov 2025	Trial stated as recruiting
Clinical Trial Record (NCT03103880)	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	29/08/2018	Trial stated as completed, no results posted
Digital Health Passport (1 Study)			
Evidence generation plan for the Digital Health Passport for asthma	Intervention: Full match to scope Comparator: full match to scope	Not reported (three year timeframe)	Provided by company. A comparative effectiveness study with implementation evaluation, including 500 participants. Aims to strengthen existing

Ongoing study	Alignment with scope	Indicated study end date	EAG comments
	Participants: full match to scope Setting: full match to scope Outcomes: full match to scope		clinical evidence with additional real world data, establish data linkage, enhance health economic analysis, and undertake comparative effectiveness study
myAsthma (3 studies)			
Clinical Trial Record (NCT02556073)	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	Dec 2016	Trial stated as unknown status
A real world evaluation of self-management using myAsthma. University of Southampton	Intervention: Full match to scope Comparator: none Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	Dec 2025	Provided by company. Mixed methods design, retrospective quantitative evaluation of 27,514 registered users on myAsthma (usage and engagement). Qualitative interview data from 20 users (acceptability).
The myAsthma app pilot evaluation and	Intervention: Full match to scope	2027	Provided by company.

Ongoing study	Alignment with scope	Indicated study end date	EAG comments
next steps. Cambridge and Peterborough Integrated Care Board.	Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope		Real world evaluation between practices using myAsthma and non-users.
Asthmahub (2 studies)			
Analysis of ICST Asthma dataset: Change in GP attendances after one year of app use	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	Currently unknown	Provided by company. The baseline is an average of the first six months of app usage, which would be a deviation from protocol.
	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope	Currently unknown	Provided by company. The baseline is an average of the first six months of app usage, which would be a deviation from protocol.

Ongoing study	Alignment with scope	Indicated study end date	EAG comments
	Outcomes: full match to scope		
Asthmahub for Parents (1 study)			
Asthmahub for Parents: Health Service Utilisation outcomes	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	Currently unknown	Provided by company.
NuvoAir (1 study)			
Clinical Trial Record (NCT05603494)	Intervention: Full match to scope Comparator: full match to scope Participants: full match to scope Setting: full match to scope Outcomes: full match to scope	March 2023	Trial stated as unknown status Comparator is assumed to baseline

8.2 Evidence gap analysis

In line with the published scope and protocol, the EAG have summarised the evidence gaps across the eight included technologies across the outcomes of interest. See Table 18 for an overview of the level of evidence available for each outcome. This does not consider qualitative evidence, only the available quantitative data. This is due to the lack of qualitative evidence available and that the availability of this information would not change the conclusionsconclusions of the evidence gap analysis. Additionally, qualitative data was lacking in terms of specific information to the technologies.

Evidence was assessed on the availability of data. We considered evidence to be available when there was sufficient comparative data, with a hierarchy of evidence applied (RCTs being the highest level of evidence). We also considered the generalisability of this evidence to the EnglishNHS setting. WhereW evidence was conducted in a similar setting, this would be rated higher than a setting which is dissimilar (such as the US). Finally, we considered the quality of the observational evidence, which did not (for the most part) consider confounding. Therefore, given the overall quality of evidence,an arbitrary cut off of a minimum of five studiesstudies reporting on an outcome was required to achieve GREEN status in Table 18.

Table 18: Evidence gap analysis

Outcomes	Asthmahub	Asthmahub for Parents	AsthmaTuner	Digital Health Passport	Luscii	myAsthma	NuvoAir	Smart Asthma	BreatheSmart and Respi.me (RDMP)	All technologies or pathway-related
Inhaler technique	RED	RED	RED	RED	RED	RED	RED	RED	RED	RED
Medication use	AMBER	RED	AMBER	RED	RED	AMBER	RED	RED	AMBER	RED
Adherence/attrition rates	RED	RED	RED	RED	RED	RED	RED	RED	AMBER	RED
Number of referrals to specialists	RED	RED	RED	RED	RED	AMBER	RED	RED	RED	RED
Changes in symptom/symptomatic improvement	RED	RED	RED	RED	RED	RED	RED	RED	AMBER	RED
Lung function	RED	RED	RED	RED	AMBER	RED	RED	RED	AMBER	RED
Asthma control	AMBER	AMBER	AMBER	AMBER	AMBER	AMBER	RED	REDRED	AMBER	AMBER
Symptom-free days	RED	RED	RED	RED	RED	RED	RED	RED	RED	RED
Exacerbations or attacks	RED	RED	RED	AMBER	RED	AMBER	RED	REDRED	AMBER	RED
Mortality	RED	RED	RED	RED	RED	RED	RED	RED	AMBER	RED
Time off work or school	RED	RED	RED	AMBER	RED	AMBER	RED	RED	AMBER	RED
Quality of life	AMBER	RED	RED	AMBER	RED	AMBER	AMBER	AMBER	AMBER	RED
Ease of use and acceptability	RED	RED	RED	AMBER	RED	AMBER	AMBER	AMBER	AMBER	RED
Patient perception of technology	RED	RED	RED	AMBER	RED	AMBER	AMBER	RED	AMBER	RED

Outcomes	Asthmahub	Asthmahub for Parents	AsthmaTuner	Digital Health Passport	Luscii	myAsthma	NuvoAir	Smart Asthma	BreatheSmart and Respi.me (RDMP)	All technologies or pathway-related
Adverse events and clinical risk	RED	RED	RED	RED	RED	RED	AMBER	RED	AMBER	RED
Key: AMBER, some evidence available; GREEN, evidence available; RED, no evidence available										

The EAG note some key evidence gaps for the technologies relating to this assessment as follows.

Population

- There is a lack of evidence that either exclusively or explicitly assesses patients with severe asthma or those with newly diagnosed asthma.
- The EAG assumes that the majority of included evidence assessesassesses a population with uncontrolled asthma, based on mean values for measures of asthma control (such as, ACT). Further work should look to provide greater detail in the baseline characteristics. Future studies should also consider stratifying by patient risk using criteria suggested by Couillard et al (2022), which includes: number of asthma attacks in the last 12 months; FeNO values; blood eosinophils; and Global Initiative for Asthma (GINA) risk factors (e.g. mean ACQ score ≥ 1.5, low FEV, obesity).[68]
- The population characteristics of the included participants were poorly reported across the included literature. Future evidence generation should provide details relating to key baseline characteristics (such as age, sex, level of asthma control, and time since initial asthma diagnosis) to consider the generalisability of evidence across populations and ensure that the technologies have been adequately assessed across different groups of people.
- Future evidence generation should provide more evidence from carers and family members perspectives who are using the app, especially for those under six years of age. This should also include intermediate and clinical outcomes, to assess the impact of using the apps across the range of relevant outcomes.

Interventions

- In general, there was limited evidence published in peer reviewed journals regarding the technologies of interest.

- There was limited evidence for Asthmahub for Parents, Luscii and NuvoAir.

- Some technologies provide different pieces of equipment (hardware), such as spirometry devices (NuvoAir, AsthmaTuner, Luscii), digital peak flow meter ((Smart Asthma), electronic inhaler monitoring device (Smart Asthma) and inhaler sleeves (BreatheSmart/Respi.me (RDMP)), while others require only a mobile phone. Furthermore, the functionality of the software is not always the same, with potential app differences which may be down to preference of the user. Additionally, in some cases are targeted at carers/families (Asthmahub for Parents). Therefore, the generalisability of evidence from one technology to another is unclear.

Comparators

- There is a lack of comparative evidence in a UK setting for nearly all included apps. [redacted]_Asthmahub, myAsthma, BreatheSmart (RDMP), the Digital Health Passport and Smart Asthma apps have some UK-based evidence available. The one included RCT was conducted in the US, which may limit the generalisability to a UK NHS setting.

Outcomes

- Two outcomes have no quantitative data associated for any technology: inhaler technique and symptom-free days.

- For adherence/attrition rates, there was limited evidence for how well people adhered to both medication and the technologies. Long-term data regarding technology engagement is required. Due to the different functionalities of the technologies, it is unclear how many patients would be clinically appropriate for each. The EAG note that dropout was a key driver in the conceptual economic model, and that this impacted some technologies more than others depending on their costing approach (upfront cost, recurring annual cost, recurring monthly cost). The EAG note that dropout rates may differ between different

levels of symptom control; however, there was a lack of data regarding this in the clinical evidence. Furthermore, the EAG note that reasons for no longer using the technology over time may include improvement in patient symptoms (such that less monitoring is required) or deterioration in patient symptoms (such that more monitoring, either face-to-face or in a hospital setting may be required) or difficulty using the technology (lack of internet, functionality not working). Therefore, the reasons for dropout should also be collated in future evidence generation.

Other considerations

- There is a lack of peer reviewed evidence for most technologies. Peer reviewed evidence was available for Asthmahub (n = 1), AsthmaTuner (n = 1), BreatheSmart and Respi.me (RDMP; n = 3),and Smart Asthma (n = 1). No peer reviewed evidence was available for Asthmahub for Parents, Digital Health Passport, Luscii, myAsthma, or NuvoAir.

- Follow-up for ten of the included studies assessing less than a year follow up and nine of the studies reporting at six months or less. Six studies had an unclear follow up time. Therefore, data with longer follow up periods is required to determine the effectiveness of the technologies to support long-term asthma management.

- Where information was reported that was either explicit or allowed for the assumption of uncontrolled asthma (ACT score less than 20), most of the evidence base was within uncontrolled asthma, which may overestimate the efficacy of such self-management apps across the population of people with asthma as a whole.

- Limited qualitative data were only available for four of the technologies of interest (AsthmaTuner, Digital Health Passport, and Smart Asthma). Further, UK-based qualitative studies exploring the perspectives of patients, parents/carers and healthcare professionals for all technologies of interest are required to better understand how people

use the technologies, how they fit in with current practice and wider barriers and facilitators to their use.

- Given some qualitative information suggested that information provided in the Digital Health Passport conflicted with advice and information patients had previously been given, there is a need for clinical governance and to ensure that technologies align with local clinical guidelines and action plans.

- Conceptual economic modelling has shown that because the incremental QALY gain is small, the model is most sensitive to univariate changes in the per patient costs of the technologies, and how they are applied (upfront, or recurring on an annual or monthly basis), the cost of monitoring in standard care in the NHS and how this is delivered (for example, understanding the proportion reviewed remotely, at an appointment with a practice nurse, or at an outpatient clinic), and the rate at which misdiagnoses can be identified by the technologies (when compared with standard care).

- Single univariate changes to parameters in the economic model are not enough to offset the high total costs associated with some technologies. Combinations of changes would therefore be needed, but because there is limited evidence available, there is significant uncertainty as to which combinations would be clinically plausible in the NHS. Therefore, comparative data should be collected to reduce this uncertainty for future economic modelling.

- The EAG highlight that the conceptual model was not fully parameterised and therefore all results, including findings of dominance, should be interpreted with caution. The model was helpful to highlight key evidence gaps and key drivers which can support future evidence generation.

8.3 Key areas for evidence generation

The EAG have considered priorities for future evidence generation based on clinical evidence gaps and the results (key drivers and areas of uncertainty) of the conceptual economic model. The EAG has suggested key research questions and study designs for the technologies in scope of this assessment (see Table 19Table). The EAG have focused on the creation of real world evidence: while RCTs have been suggested in some instances, further real world evidence could also answer these questions. ConductingConducting RCTs does allow for control of confounding, which would be helpful in this context with a potentially highly variable patient group. Additionally, such RCTs have currently only taken place in countries outside of a UK NHS setting, andand so there is a need for controlled evidence set in the UK to better understand the clinical effectiveness of the technologies in an NHS context. That said, there is also a need for further data regarding how the technologies work in real world settings, which observational studies (such as prospective cohorts) could help to answer. Where possible, these real-world evidence studies should be comparative (e.g. with registry data or a cohort of non-app users) to further strengthen the evidence base. In these instances, it would be important for the statistical analyses to take into account important confounding factors (such as age, level of deprivation, FeNOO values, and so on). The main focus should be on data that compares against users not using a self-management app.

Table 19: Evidence generation recommendations

#	Research question	Technologies	Recommended study design	Outcomes
1.	What are the adherence and attrition rates of users with diagnosed asthma at varying levels of control (controlled, partially controlled, and uncontrolled) when using the technologies?	All	Prospective or retrospective cohort	Adherence and attrition rates
2.	Does the use of the technology (compared to no technology), improve patient awareness of their condition and lead to improvements of asthma?	All	RCT Prospective cohort	Inhaler technique, medication use and adherence, symptoms and symptomatic improvement, asthma control, exacerbations and attacks
3.	What is the impact of using the technology (compared to no technology), on quality of life and other outcomes of importance to patients?	All	RCT Prospective or retrospective cohort	Quality of life, in particular in those users under the age of 16 years, ease of use and acceptability, patient perception of technology, patient perception of asthma control
4.	What are the main barriers and facilitators to using the technologies from the patient, carer and healthcare professional perspectives?	All	Qualitative (interviews, focus groups)	Ease of use and acceptability, patient perception of technology, barriers and facilitators to uptake and usage of technologies
5.	How do the technologies align and fit in with current clinical practice in the UK, including local guidelines and action plans?	All	Qualitative (interviews, focus groups, ethnography)	Barriers and facilitators to system-level alignment and implementation

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10.Appendices

Appendix A – Literature searching

Appendix A1: Search strategies

Clinical effectiveness searches

Database(s): Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions 1946 to August 21, 2025

https://ovidsp.ovid.com/ovidweb.cgi?T=JS&NEWS=N&PAGE=main&SHAREDSEARCHID=1nBM9VcsDHwufa5uENX6ZTbUsBNC1C3fl7itgGllo43H4hKZvgE8CoDB18suVDhop

#	Searches	Results
1	exp Asthma/	149603

2	(asthma or asthmatic or "chronic respiratory" or wheez*).ti,ab,kw.	210252
3	((reduc* or inflammation or narrow*) adj2 airway*).ti,ab,kw.	24549
4	or/1-3	241296
5	Self-Management/	7064
6	((self or personal) adj2 (manag* or regulat* or care or help or aid or govern* or organi*)).ti,ab,kw.	124904
7	or/5-6	125534
8	Digital Technology/ or Digital Health/	2488
9	((medical or digital or automated or personal* or cyber*) adj2 (technolog* or device*)).ti,ab,kw.	56278
10	(phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet).ti,ab,kw.	723866
11	((apple or google or mobile*) adj2 (play or store or based or application* or intervention* or device* or technolog*)).ti,ab,kw.	27196
12	(MedTech or app or apps).ti,ab,kw.	55505
13	or/8-12	815927
14	(mHealth or "Institute of Clinical Science & Technology" or "Tiny Medical apps" or "Smart respiratory products Ltd" or "Smart respiratory products limited" or "Imperial I-Hub" or Luscii or Nuvoair or MediTuner or "aptar digital health").ab,in,go,ci.	7194
15	4 and 7 and 13 and 14	61
16	(MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner* or "Asthma Tuner" or "NuvoAir home" or " aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart).ti,ab,kw.	22
17	or/15-16	81

Database(s): Embase 1974 to 2025 August 20

https://ovidsp.ovid.com/ovidweb.cgi?T=JS&NEWS=N&PAGE=main&SHAREDSEARCHID=1nBM9VcsDHwufa5uENX6ZStY0bdUPlhGSR8z9Vpjcf0cbRr0XhMwNnuessNI7FWNu

#	Searches	Results
1	exp asthma/	338389
2	(asthma or asthmatic or "chronic respiratory" or wheez*).ti,ab,kw.	320691
3	((reduc* or inflammation or narrow*) adj2 airway*).ti,ab,kw.	38094
4	or/1-3	420133
5	self care/ or self care agency/ or self help/	108615
6	((self or personal) adj2 (manag* or regulat* or care or help or aid or govern* or organi*)).ti,ab,kw.	163944
7	or/5-6	201748
8	digital health/ or digital health technology/ or digital technology/	14698
9	((medical or digital or automated or personal* or cyber*) adj2 (technolog* or device*)).ti,ab,kw.	79212
10	(phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet).ti,ab,kw.	964173
11	((apple or google or mobile*) adj2 (play or store or based or application* or intervention* or device* or technolog*)).ti,ab,kw.	36541
12	(MedTech or app or apps).ti,ab,kw.	80069
13	or/8-12	1099946
14	(mHealth or "Institute of Clinical Science & Technology" or "Tiny Medical apps" or "Smart respiratory products Ltd" or "Smart respiratory products limited" or "Imperial I-Hub" or Luscii or Nuvoair or MediTuner or "aptar digital health").ab,mf,my,mv,dm,dv,in,tn,so,dc,de,ct.	9760
15	4 and 7 and 13 and 14	96
16	(MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or	67

	AsthmaTuner* or "Asthma Tuner" or "NuvoAir home" or " aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart).ti,ab,kw.	
17	or/15-16	157

Cochrane DSR and CENTRAL

ID	Search	Hits
#1	MeSH descriptor: [Asthma] explode all trees	14707
#2	(asthma or asthmatic or "chronic respiratory" or wheez*):ti,ab,kw	41273
#3	((reduc* or inflammation or narrow*) NEAR/2 airway*):ti,ab,kw	2933
#4	#1 OR #2 OR #3	42404
#5	MeSH descriptor: [Self-Management] this term only	1437
#6	((self or personal) NEAR/2 (manag* or regulat* or care or help or aid or govern* or organi*)):ti,ab,kw	33365
#7	#5 OR #6	33365
#8	MeSH descriptor: [Digital Technology] this term only	28
#9	MeSH descriptor: [Digital Health] this term only	67
#10	((medical or digital or automated or personal* or cyber*) NEAR/2 (technolog* or device*)):ti,ab,kw	7771
#11	(phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet):ti,ab,kw	103818
#12	((apple or google or mobile*) NEAR/2 (play or store or based or application* or intervention* or device* or technolog*)):ti,ab,kw	10655
#13	(MedTech or app or apps):ti,ab,kw	13995
#14	#8 OR #9 OR #10 OR #11 OR #12 OR #13	117002
#15	(mHealth or "Institute of Clinical Science & Technology" or "Tiny Medical apps" or "Smart respiratory products Ltd" or "Smart respiratory products limited" or "Imperial I-Hub" or Luscii or Nuvoair or MediTuner or "aptar digital health")	3619
#16	#4 AND #7 AND #14 AND #15	37
#17	(MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner* or "Asthma Tuner" or "NuvoAir home" or " aptar	13

	digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart):ti,ab,kw	
#18	#16 OR #17	47
#19	#18 in Cochrane Reviews, Cochrane Protocols	4

CINAHL(Via EbscoHost)

(XB MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner or "NuvoAir home" or "aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart) OR ((mHealth or "Institute of Clinical Science & Technology" or "Tiny Medical apps" or "Smart respiratory products Ltd" or "Smart respiratory products limited" or "Imperial I-Hub" or Luscii or Nuvoair or MediTuner or "aptar digital health") AND (MJ (digital technology or digital health) OR XB ((medical or digital or automated or personal* or cyber*) N/2 (technolog* or device*)) OR XB (phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet) OR XB ((apple or google or mobile*) N/2 (play or store or based or application* or intervention* or device* or technolog*)) OR XB (MedTech or app)) AND (MJ (self-management or self-care or self-regulation or self-monitoring) OR XB ((self or personal) N/2 (manag* or regulat* or care or help or aid or govern* or organi*))) AND (MJ asthma OR XB (asthma or asthmatic or "chronic respiratory" or wheez*) OR XB ((reduc* or inflammation or narrow*) N/2 airway*))) 9

INAHTA

((MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner* or "Asthma Tuner" or "NuvoAir home" or " aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart).[Title] OR (MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner* or "Asthma Tuner" or "NuvoAir home" or " aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart)[abs]) OR (((mHealth or "Institute of Clinical Science & Technology" or "Tiny Medical apps" or "Smart respiratory products Ltd" or "Smart respiratory products limited" or "Imperial I-Hub" or Luscii or Nuvoair or MediTuner or "aptar digital health")) AND ((Digital technology)[mh] OR (Digital Health)[mh] OR ("medical technolog*"~2 or "digital technolog*"~2 or "automated technolog*"~2 or "personal* technolog*"~2 or "cyber* technolog*"~2)[Title] OR ("medical technolog*"~2 or "digital technolog*"~2 or "automated technolog*"~2 or "personal* technolog*"~2 or "cyber* technolog*"~2)[abs] OR ("medical device*"~2 or "digital device*"~2 or "automated device*"~2 or "personal*

device*"~2 or "cyber* device*"~2)[Title] OR ("medical device*"~2 or "digital device*"~2 or "automated device*"~2 or "personal* device*"~2 or "cyber* device*"~2)[abs] OR ("apple play"~2 or "apple store"~2 or "apple based"~2 or "apple application*"~2 or "apple intervention*"~2 or "apple device*"~2 or "apple technolog*"~2)[Title] OR ("apple play"~2 or "apple store"~2 or "apple app"~2)[abs] OR ("google play"~2 or "google store"~2 or "google app"~2)[Title] OR ("google play"~2 or "google store"~2 or "google based"~2 or "google application*"~2 or "google intervention*"~2 or "google device*"~2 or "google technolog*"~2)[abs] OR (MedTech or app or apps)[Title] OR (MedTech or app or apps)[abs] OR (phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet)[Title] OR (phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet)[abs]) AND ((self-management)[mh] OR ("self manag*"~2 or "self regulat*"~2 or "self care"~2 or "self help"~2 or "self aid"~2 or "self govern*"~2 or "self organi*"~2)[Title] OR ("self manag*"~2 or "self regulat*"~2 or "self care"~2 or "self help"~2 or "self aid"~2 or "self govern*"~2 or "self organi*"~2)[abs] OR ("personal manag*"~2 or "personal regulat*"~2 or "personal care"~2 or "personal help"~2 or "personal aid"~2 or "personal govern*"~2 or "personal organi*"~2)[Title] OR ("personal manag*"~2 or "personal regulat*"~2 or "personal care"~2 or "personal help"~2 or "personal aid"~2 or "personal govern*"~2 or "personal organi*"~2)[abs]) AND ((Asthma)[mh] OR (asthma or asthmatic or "chronic respiratory" or wheez*)[Title] OR (asthma or asthmatic or "chronic respiratory" or wheez*)[abs] OR ("reduc* airway*"~2 OR "inflammation airway*"~2 OR "narrow* airway*"~2)[Title] OR ("reduc* airway*"~2 OR "inflammation airway*"~2 OR "narrow* airway*"~2)[abs])) 0

World Health Organisation International Clinical Trials Registry Platform (WHO ICTRP)

MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner or "NuvoAir home" or "aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart OR (Asthma AND app AND self-management) 28

MHRA Field safety notices

Asthma 5

Economics searches

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions 1946 to August 19, 2025

https://ovidsp.ovid.com/ovidweb.cgi?T=JS&NEWS=N&PAGE=main&SHAREDSEARCHID=5qvpvPDAy2LQOcl8tf7oRkJsMpOJ640a1Foe2bWJoEnIwgZzTF4wy985RaADT0hzt

#	Searches	Results
1	exp Asthma/	149578
2	(asthma or asthmatic or "chronic respiratory" or wheez*).ti,ab,kw.	210246
3	((reduc* or inflammation or narrow*) adj2 airway*).ti,ab,kw.	24547
4	or/1-3	241290
5	Self-Management/	7062
6	((self or personal) adj2 (manag* or regulat* or care or help or aid or govern* or organi*)).ti,ab,kw.	124907
7	or/5-6	125537
8	Digital Technology/ or Digital Health/	2488
9	((medical or digital or automated or personal* or cyber*) adj2 (technolog* or device*)).ti,ab,kw.	56279
10	(phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet).ti,ab,kw.	723858
11	((apple or google or mobile*) adj2 (play or store or based or application* or intervention* or device* or technolog*)).ti,ab,kw.	27190
12	(MedTech or app or apps).ti,ab,kw.	55496
13	or/8-12	815909
14	4 and 7 and 13	538
15	limit 14 to dt=20231201-20250820	71
16	Economics/	27551

17	"Costs and Cost Analysis"/	52331
18	"Cost Allocation"/	2019
19	Cost-Benefit Analysis/	98522
20	"Cost Control"/	21717
21	"Cost Savings"/	13076
22	"Cost of Illness"/	35066
23	"Cost Sharing"/	2833
24	"Deductibles and Coinsurance"/	1902
25	Medical Savings Accounts/	552
26	Health Care Costs/	46617
27	Direct Service Costs/	1218
28	Drug Costs/	18107
29	Employer Health Costs/	1098
30	Hospital Costs/	12402
31	Health Expenditures/	25802
32	Capital Expenditures/	2005
33	"Value of Life"/	5846
34	exp Economics, Hospital/	26259
35	exp Economics, Medical/	14464
36	Economics, Nursing/	4013
37	Economics, Pharmaceutical/	3169
38	exp "Fees and Charges"/	31721
39	exp Budgets/	14390
40	(low adj cost).mp.	105854
41	(high adj cost).mp.	23900
42	(health?care adj cost$).mp.	21924
43	(fiscal or funding or financial or finance).tw.	241136

44	(cost adj estimate$).mp.	3062
45	(cost adj variable).mp.	56
46	(unit adj cost$).mp.	3443
47	(economic$ or pharmacoeconomic$ or price$ or pricing).tw.	485283
48	or/16-47	1075496
49	15 and 48	9

Embase 1974 to 2025 August 14

https://ovidsp.ovid.com/ovidweb.cgi?T=JS&NEWS=N&PAGE=main&SHAREDSEARCHID=5WAZPa0S8hvuyA8T6PMCTTL4epT9Ml4kuJOiyIyPrsRQjqR1jzWMN3OutlHjkX7OT

#	Searches	Results
1	exp asthma/	338267
2	(asthma or asthmatic or "chronic respiratory" or wheez*).ti,ab,kw.	320541
3	((reduc* or inflammation or narrow*) adj2 airway*).ti,ab,kw.	38070
4	or/1-3	419969
5	self care/ or self care agency/ or self help/	108542
6	((self or personal) adj2 (manag* or regulat* or care or help or aid or govern* or organi*)).ti,ab,kw.	163794
7	or/5-6	201593
8	digital health/ or digital health technology/ or digital technology/	14613
9	((medical or digital or automated or personal* or cyber*) adj2 (technolog* or device*)).ti,ab,kw.	79112
10	(phone* or telephone* or smartphone* or cellphone* or smartwatch* or "mobile health" or mhealth or m-health or ehealth or e-health or emental or e-mental or online or web or internet).ti,ab,kw.	962864

11	((apple or google or mobile*) adj2 (play or store or based or application* or intervention* or device* or technolog*)).ti,ab,kw.	36500
12	(MedTech or app or apps).ti,ab,kw.	79953
13	or/8-12	1098444
14	4 and 7 and 13	1157
15	limit 14 to dc=20231201-20250820	292
16	socioeconomics/	179987
17	"cost benefit analysis"/	101443
18	"cost effectiveness analysis"/	213128
19	"cost of illness"/	22634
20	"cost control"/	82076
21	economic aspect/	149155
22	financial management/	125184
23	"health care cost"/	253088
24	health care financing/	14344
25	health economics/	37572
26	"hospital cost"/	28213
27	(fiscal or financial or finance or funding).tw.	382121
28	"cost minimization analysis"/	4339
29	(cost adj estimate$).mp.	4683
30	(cost adj variable$).mp.	367
31	(unit adj cost$).mp.	6127
32	or/16-31	1302356
33	15 and 32	61

IDEAS/RePEc

MyAsthma | Asthmahub | "Digital Health Passp|t" | "Smart asthma system" | "Smart asthma app" | Luscii | AsthmaTuner | "NuvoAir home" | "aptar digital health respiratory disease management platform" | "ADH RDMP" | "respi.me" | "respi me" | breathesmart 0

Asthma + app 4

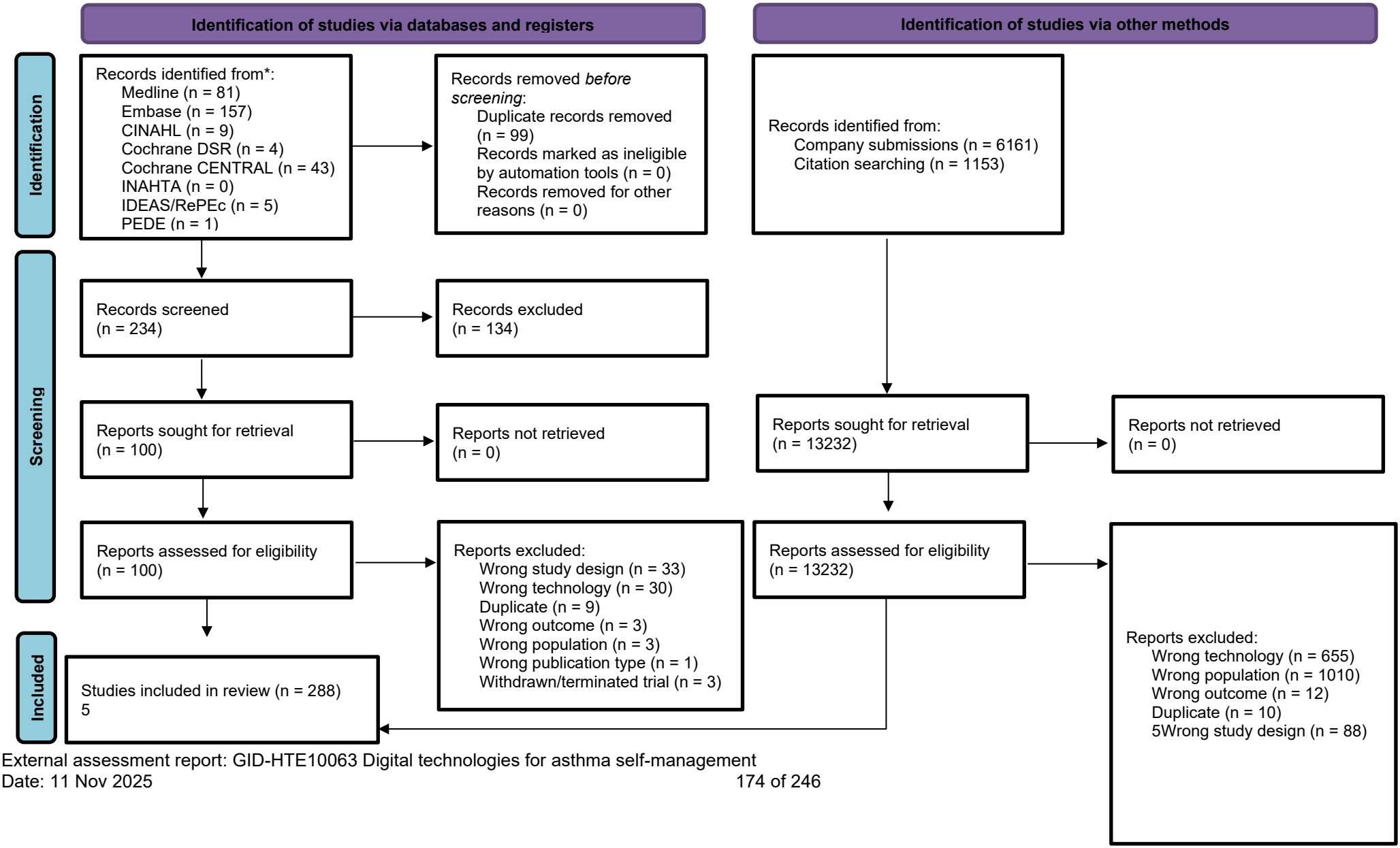
asthma + self-management + (digital|app) 3

Paediatric Economic Database Evaluation

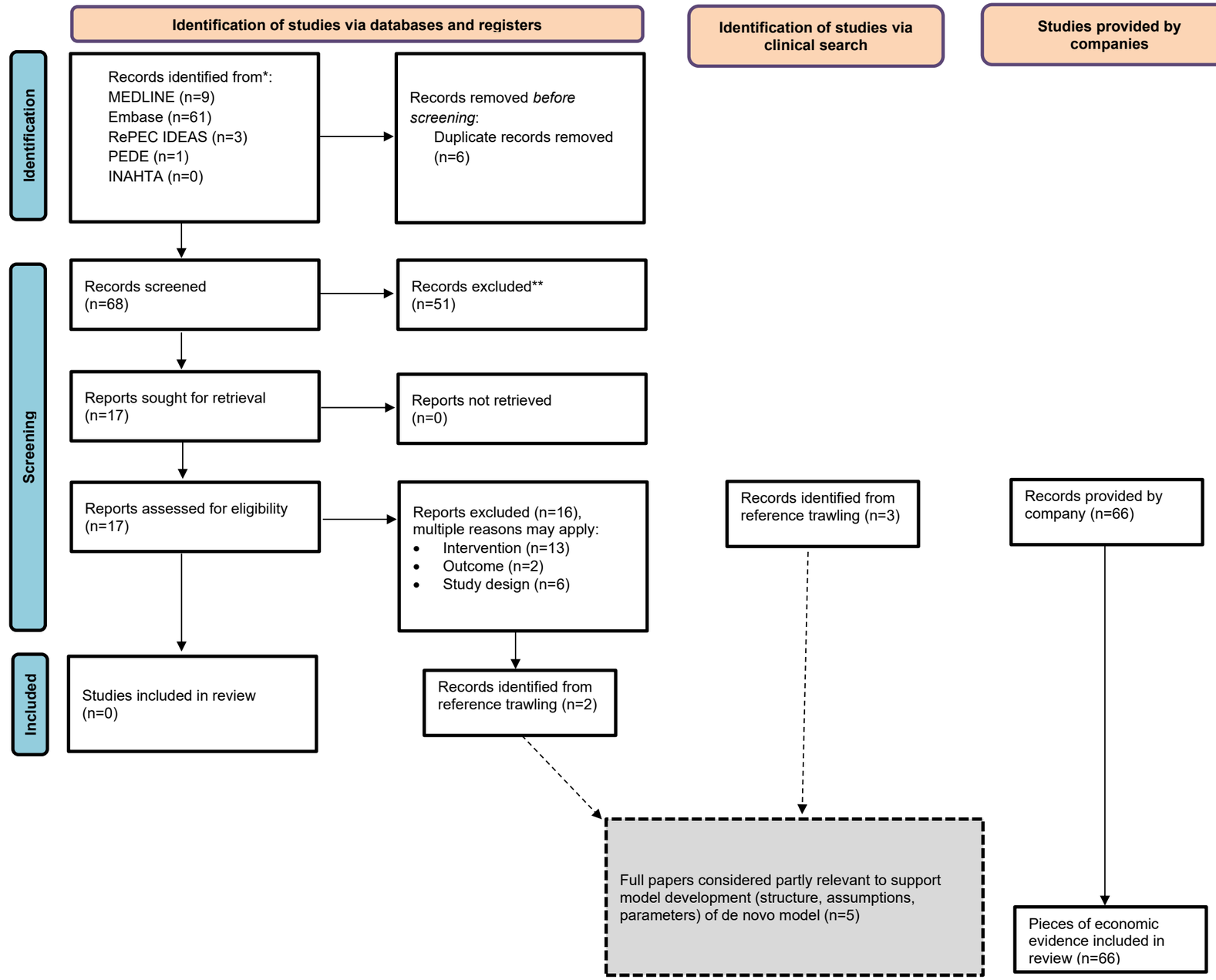
MyAsthma or Asthmahub or "Digital Health Passport" or "Smart asthma system" or "Smart asthma app" or Luscii or AsthmaTuner or "NuvoAir home" or "aptar digital health respiratory disease management platform" or "ADH RDMP" or "respi.me" or "respi me" or breathesmart 0

Asthma AND app AND self-management 1

Appendix A2: PRISMA diagram: clinical



Appendix A3: PRISMA diagram: economics



Appendix A4: Excluded studies

#	Technology	Source	Study	Publication type	Reasons for exclusion
1.	Asthma AI+	EAG clinical effectiveness literature search	ACTRN12624000360516p	Trial registration	Intervention: not technology listed in scope;
2.	Smartinhaler™	EAG clinical effectiveness literature search	Adejumo (NPJ primary care respiratory medicine, 2022)	Qualitative study (Journal article)	Intervention: not technology listed in scope
3.	NuvoAir	EAG clinical effectiveness literature search	Agerskov (Am J Respir Crit Care Med, 2021)	Abstract	Study design: single arm
4.	Mixed	EAG clinical effectiveness literature search	Alquran (IJERPH, 2018)	Systematic review (Journal article)	Study design: systematic review
5.	myAsthma	EAG clinical effectiveness literature search	Anonymous (Nurs Stand, 2017)	App review	Duplicate
6.	myAsthma	EAG clinical effectiveness literature search	Atherton (Disease Management and Health Outcomes, 2020)	Prospective observational study (Journal article)	Population: self-reported symptoms of asthma
7.	Mixed	EAG clinical effectiveness literature search	Bodini (Eur. Respir. J, 2019)	Abstract	Study design: review

#	Technology	Source	Study	Publication type	Reasons for exclusion
8.	Mixed	EAG clinical effectiveness literature search	Camacho-Rivera (JMIR mHealth and uHealth, 2020)	Review (Journal article)	Study design: review
9.	NuvoAir	EAG clinical effectiveness literature search	Chen (Thorax, 2022)	Abstract	Outcomes: home based spirometry accuracy
10.	-	EAG clinical effectiveness literature search	CTRI/2022/11/047068	Trial registration	Intervention: app not named
11.	-	EAG clinical effectiveness literature search	CTRI/2023/02/050030	Trial registration	Intervention: app not named
12.	Mixed	EAG clinical effectiveness literature search	Dauletbaev (Paediatr Respir Rev, 2022)	Scoping review (Journal article)	Study design: review
13.	Mixed	EAG clinical effectiveness literature search	Eaton (JMIR mHealth and uHealth, 2024)	Systematic review (Journal article)	Study design: review
14.	Mixed	EAG clinical effectiveness literature search	Farzandipour (Appl Clin Inform, 2017)	Systematic review (Journal article)	Study design: review
15.	myAsthma	EAG clinical effectiveness literature search	Fiks (Ambul Care Manag, 2014)	Qualitative study (Journal article)	Study design: interviews and focus groups on developing the app

#	Technology	Source	Study	Publication type	Reasons for exclusion
16.	Mixed	EAG clinical effectiveness literature search	Fradley (J Aerosol Med Pulm Drug Deliv, 2015)	Abstract	Study design: review
17.	Mixed	EAG clinical effectiveness literature search	Franzmair (JMIR mHealth and uHealth, 2021)	Systematic review (Journal article)	Study design: review
18.	-	EAG clinical effectiveness literature search	Geryk (JMIR Res Protoc, 2016)	Mixed methods study (Journal article)	Intervention: app not named
19.	ACT app	EAG clinical effectiveness literature search	Ghozali (Int J Syst Assur Eng Manag, 2022)	Cross-sectional survey (Journal article)	Intervention: not technology listed in scope
20.	Mixed	EAG clinical effectiveness literature search	Honarvar (Shiraz E Medical Journal, 2018)	Review (Journal article)	Study design: review
21.	-	EAG clinical effectiveness literature search	Hosseini (Sensors, 2017)	Feasibility study (Journal article)	Intervention: not technology listed in scope
22.	-	EAG clinical effectiveness literature search	Hosseini (IEEE Xplore, 2016)	Abstract	Intervention: not technology listed in scope
23.	Mixed	EAG clinical effectiveness literature search	Househ (Health Inform J, 2017)	Review (Journal article)	Study design: review

#	Technology	Source	Study	Publication type	Reasons for exclusion
24.	Mixed	EAG clinical effectiveness literature search	Hui (JMIR mHealth and uHealth, 2021)	Qualitative study (Journal article)	Intervention: not technology listed in scope
25.	-	EAG clinical effectiveness literature search	Lio (JMIR mHealth and uHealth, 2020)	Qualitative study (Journal article)	Intervention: not technology listed in scope
26.	RespRight app	EAG clinical effectiveness literature search	IRCT20210621051651N1; Farzandipour (Resp Med, 2024)	Trial registration; Journal article	Intervention: not technology listed in scope
27.	-	EAG clinical effectiveness literature search	R000043881	Trial registration	Intervention: not technology listed in scope
28.	-	EAG clinical effectiveness literature search	Vellopoulou (Appl Health Econ Health Policy, 2019)	Cross-sectional survery (Journal article)	Intervention: not technology listed in scope
29.	Mixed	EAG clinical effectiveness literature search	Khusial (JMIR formative research, 2022,	Qualitative study (Journal article)	Intervention: not technology listed in scope
30.	Mixed	EAG clinical effectiveness literature search	Kim (JMIR mHealth and uHealth, 2017)	Scoping review (journal article)	Study design: review
31.	Mixed	EAG clinical effectiveness literature search	Kobson (Eur J cardiovasc Nurs, 2024)	Systematic review and qualitative study (Journal article)	Study design: review

#	Technology	Source	Study	Publication type	Reasons for exclusion
32.	ADAPT app	EAG clinical effectiveness literature search	Kosse (Patient preference and adherence, 2017)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
33.	ADAPT app	EAG clinical effectiveness literature search	Koster (In J Clin Pharm, 2017)	Abstract	Intervention: not technology listed in scope
34.	NuvoAir	EAG clinical effectiveness literature search	Kostikas (Am J Respir Crit Care Med, 2021)	Abstract	Outcome: spirometry quality
35.	Mixed	EAG clinical effectiveness literature search	Koyuncu (Expert Rev Respir Med, 2024	Review (Journal article)	Study design: review
36.	Mixed	EAG clinical effectiveness literature search	Marcano Belisario (Cochrane Database Syst.Rev, 2013)	Systematic Review (Journal article)	Study design: review
37.	-	EAG clinical effectiveness literature search	McDonald (J Asthma, 2025)	Qualitative study (Journal article)	Intervention: not technology listed in scope
38.	Breathe app	EAG clinical effectiveness literature search	McGihon (Eur Resp J, 2019)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
39.	BreatheSmart	EAG clinical effectiveness literature search	Melvin (BMJ Open Respiratory Research, 2017)	Observational study (Journal article)	Duplicate

#	Technology	Source	Study	Publication type	Reasons for exclusion
40.	Breathe app	EAG clinical effectiveness literature search	Morita (JMIR mHealth and uHealth, 2019)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
41.	BreatheSmart app	EAG clinical effectiveness literature search	Mosleh (IEEE, 2022)	Journal article	Study design: testing app algorithm
42.	AsthmaTuner	EAG clinical effectiveness literature search	Myers (Eur Resp J, 2024)	Abstract	Outcome: diagnostic accuracy
43.	Asthma SMART	EAG clinical effectiveness literature search	NCT05572177	Trial registration	Intervention: not technology listed in scope
44.	AsthmaTuner	EAG clinical effectiveness literature search	NCT04132778	Trial registration	Terminated trial
45.	AsthmaTuner	EAG clinical effectiveness literature search	NCT04652141	Trial registration	Duplicate
46.	myAsthma	EAG clinical effectiveness literature search	NCT04744272	Trial registration	Trial withdrawn; delayed due to NHS pandemic pressures
47.	Medisafe android application	EAG clinical effectiveness literature search	NCT06233123	Trial registration	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
48.	AsthmaTuner	EAG clinical effectiveness literature search	NCT02571309	Trial registration	Duplicate
49.	BreatheSmart	EAG clinical effectiveness literature search	NCT03734861	Trial registration	Duplicate
50.	myAsthma	EAG clinical effectiveness literature search	NCT01966068	Trial registration	Duplicate
51.	myAsthma	EAG clinical effectiveness literature search	NCT03511482	Trial registration	Withdrawn clinical trial (lack of funding)
52.	-	EAG clinical effectiveness literature search	NCT03642418	Trial registration	Intervention: not technology listed in scope
53.	KmAsthma	EAG clinical effectiveness literature search	NCT05850806	Trial registration	Intervention: not technology listed in scope
54.	BreatheSmart	EAG clinical effectiveness literature search	NCT06364527	Trial registration	Duplicate
55.	Mixed	EAG clinical effectiveness literature search	Nguyen (JACI, 2021)	Systematic review (Journal article)	Study design: review

#	Technology	Source	Study	Publication type	Reasons for exclusion
56.	Astmakompas app	EAG clinical effectiveness literature search	NL-OMON53444	Trial registration	Intervention: not technology listed in scope
57.	Mixed	EAG clinical effectiveness literature search	O'Connor (Children, 2021)	Review (Journal article)	Study design: review
58.	Mixed	EAG clinical effectiveness literature search	Quach (NetMAHIB, 2023)	Systematic review (Journal article)	Study design: review
59.	Mixed	EAG clinical effectiveness literature search	Quach (Can. J. Respir. Crit. Care Sleep Med, 2023)	Systematic review (Abstract)	Study design: review
60.	Mixed	EAG clinical effectiveness literature search	Ramsey (J Allergy Clin Immunol, 2019)	Review (Journal article)	Study design: review
61.	Mixed	EAG clinical effectiveness literature search	Robinson (JMIR mHealth and uHealth, 2024)	Systematic review (Journal article)	Study design: review
62.	Mixed	EAG clinical effectiveness literature search	Robinson (Respirology, 2023)	Abstract	Study design: review
63.	NuvoAir	EAG clinical effectiveness literature search	Roy (Eur Resp J, 2024	Abstract	Study design: single arm

#	Technology	Source	Study	Publication type	Reasons for exclusion
64.	-	EAG clinical effectiveness literature search	Rudin (JAMA Network Open, 2025)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
65.	Internet based education program	EAG clinical effectiveness literature search	Runge (Chest, 2006)	Prospective cost-benefit analysis (Journal article)	Intervention: not technology listed in scope
66.	Smart Asthma	EAG clinical effectiveness literature search	Sakkatos (2020, Allergy Eur J Allergy Clin Immunol)	Abstract	Study design: single arm
67.	Mixed	EAG clinical effectiveness literature search	Sapouna (J Bras Pneumol, 2023)	Systematic review (Journal article)	Study design: review
68.	-	EAG clinical effectiveness literature search	Simpson (Eur Respir J, 2017)	Qualitative study (Journal article)	Study design: interviews and focus groups on perspectives of mHealth
69.	Mixed	EAG clinical effectiveness literature search	Slater (J Med Internet Res, 2017)	Systematic review (Journal article)	Study design: review
70.	Breathe app	EAG clinical effectiveness literature search	To (ERJ open research, 2020)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
71.	JASMIN app	EAG clinical effectiveness literature search	Wyatt (West J Nurs Res, 2024)	Feasibility study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
72.	Mixed	EAG clinical effectiveness literature search	Xiao (Stud Health Technol Inform, 2018)	Systematic review and meta-analysis (Abstract)	Study design: review
73.	Mixed	EAG clinical effectiveness literature search	Yi (Healthc Inform Res, 2018)	Systematic review (Journal article)	Study design: review
74.	AsthmaTuner	EAG clinical effectiveness literature search	NCT04132778	Trial registration	Duplicate
75.	AsthmaTuner	EAG clinical effectiveness literature search	NCT05162703	Trial registration	Population: exercise induced asthma
76.	myAsthma	EAG clinical effectiveness literature search	NCT04744272	Trial registration	Withdrawn clinical trial; delayed due to NHS pandemic pressures
77.	AsthmaTuner	EAG clinical effectiveness literature search	NCT04652141	Trial registration	Population: included undiagnosed asthma
78.	-	EAG clinical effectiveness literature search	NCT06900361	Trial registration	Intervention: not technology listed in scope
79.	Medisafe android application	EAG clinical effectiveness literature search	NCT06233123	Trial registration	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
80.	myAsthma	EAG clinical effectiveness literature search	Anonymous (Nurs Stand, 2017)	App review	Publication type
81.	-	Provided by company	Barry (Pri Care Respi Med, 2025b)	Respective cohort analysis) Journal article	Intervention: not technology listed in scope
82.	AsthmaTuner	Provided by company	Bjerg (ERJ Open Res, 2020)	Research letter	Population: diagnosis
83.	AsthmaTuner	Provided by company	Reier-Nilsen (BMJ Open Sport Exerc Med, 2023)	Observational diagnostic study	Population: sports induced asthma
84.	AsthmaTuner	Provided by company	Reier-Nilsen (Resp Med, 2024)	Observational study	Population: long COVID
85.	AsthmaTuner	Provided by company	NCT04652141	Trial registration	Population: undiagnosed asthma included
86.	myAsthma	Provided by company	NHS England (2020)	ICB-wide Case Study	Study design: no comparator
87.	myAsthma	Provided by company	Parkes (2020)	Conference poster	Study design: no comparator
88.	myAsthma	Provided by company	Lanario (2025)	Real world retrospective study (Abstract)	Study design: no comparator
89.	NuvoAir	Provided by company	Gogali (Euro Resp J, 2020)	Conference abstract	Outcome: assessing spirometry accuracy

#	Technology	Source	Study	Publication type	Reasons for exclusion
90.	NuvoAir	Provided by company	Hawkes (JCF, 2021)	Conference abstract	Population: Patients with Cystic Fibrosis
91.	NuvoAir	Provided by company	Kocks (2023)	Journal article preprint	Outcome: assessing spirometry accuracy
92.	NuvoAir	Provided by company	Lewis (Euro Resp J, 2024)	Conference abstract	Population: Patients with COPD
93.	NuvoAir	Provided by company	Parrott (Euro Resp J, 2023)	Conference abstract	Population: not all participants had confirmed asthma
94.	NuvoAir	Provided by company	Pradhan (ERJ Open Research, 2025)	Prospective study (Journal article)	Outcome: assessing spirometry accuracy
95.	NuvoAir	Provided by company	Robshaw (Inspire, 2023)	Conference abstract	Outcome: assessing spirometry accuracy
96.	NuvoAir	Provided by company	Robshaw (ARNS, 2023)	Conference poster abstract (unpublished)	Outcome: assessing spirometry accuracy
97.	NuvoAir	Provided by company	Robshaw (Euro Resp J, 2023)	Conference abstract	Population: not all participants had confirmed asthma
98.	NuvoAir	Provided by company	Wang (Thorax, 2022)	Conference abstract	Outcome: assessing spirometry accuracy

#	Technology	Source	Study	Publication type	Reasons for exclusion
99.	Smart respiratory products	Provided by company	NA (2024)	Prospective evaluation (abstract)	Population: unified airway disease (asthma with rhinosinusitis)
100.	Smart respiratory products	Provided by company	Kupa (PCRS, 2024)	Conference abstract	Outcomes: assessing peak flow meters
101.	Smart respiratory products	Provided by company	VanZeller (BMC Pulmonary Medicine, 2019)	Journal article	Outcomes: assessing peak flow meters
102.	NuvoAir	EAG clinical effectiveness literature search	Matthes (Euro Resp J, 2024)	Conference abstract	Study design: no comparator
103.	Smart Asthma	EAG clinical effectiveness literature search	Swaminathan (Am J Respir Crit Care Med, 2017)	Conference abstract	Study design: diagnostic concordance study
104.	MemahamiAsma®	Citation Chaser	Al Raimi (Journal of Pediatr Nurs, 2022)	Quasi-experimental study	Intervention: not technology listed in scope
105.	MemahamiAsma®	Citation Chaser	Al Raimi (CIN, 2022)	Quasi-experimental study (Journal article)	Intervention: not technology listed in scope
106.	-	Citation Chaser	Anderson (PloS one, 2016)	Qualitative Study (Journal article)	Intervention: not technology listed in scope
107.	U-TRAK mobile app	Citation Chaser	Bindler (J Asthma, 2023)	Single-arm observational	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
				study (Journal article)	
108.	-	Citation Chaser	Bond (Stu Health Technol Inform, 2014)	Qualitative study (Journal article)	Population: not population listed in scope
109.	-	Citation Chaser	Brown (JACI: In practice, 2014)	Review	Publication type
110.	-	Citation Chaser	Burbank (J Asthma, 2015	Pilot intervention study (Journal article)	Intervention: not technology listed in scope
111.	-	Citation Chaser	Carpenter (TMB, 2015)	Qualitative study (Journal article)	Intervention: not technology listed in scope
112.	Smart tech	Citation Chaser	Chan (Lancet Respir Med, 2015)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
113.	Asthma Health Application (AHA)	Citation Chaser	Chan (Nat Biotechnol, 2017)	Observational study (Journal article)	Intervention: not technology listed in scope
114.	-	Citation Chaser	NCT03277664; Chen (AACI, 2020)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
115.	Scripps Asthma Coach smartphone app	Citation Chaser	Cook (JACI: In Practice, 2016)	Single arm interventional study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
116.	Asthma hero	Citation Chaser	Cushing (Patient prefer, 2016)	Mixed methods study (Journal article)	Intervention: not technology listed in scope
117.	-	Citation Chaser	Dennison (J Med Internet Res, 2013)	Qualitative study (Journal article)	Population: not population listed in scope
118.	Air Next spirometer	Citation Chaser	Exarchos (Respir Res, 2020)	Cross-sectional prospective study (Journal article)	Intervention: not technology listed in scope
119.	Telegram app	Citation Chaser	Faraji (Nurs Open, 2020)	Pilot randomised controlled trial (	Intervention: not technology listed in scope
120.	-	Citation Chaser	Farzandipour (Appl Clin Inform, 2019)	Mixed methods (Journal article)	Intervention: not technology listed in scope
121.	-	Citation Chaser	Guarnieri (J Clin Med, 2022)	Cross-sectional survey study (Journal article)	Intervention: not technology listed in scope
122.	Propeller Sensor Platform	Citation Chaser	NCT02994238; Gupta (Pediatrics, 2021)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
123.	Air application	Citation Chaser	Hernández (PloS one, 2018)	Cross-sectional prospective study (Journal article)	Intervention: not technology listed in scope
124.	-	Citation Chaser	Howard (Appl Ergon, 2016)	Qualitative study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
125.	Albuterol Digihaler app	Citation Chaser	NCT03890666; Hoyte (JACI: In Practice, 2022)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
126.	-	Citation Chaser	Hui (Health Inform J, 2019)	Mixed methods study (journal article)	Intervention: not technology listed in scope
127.	-	Citation Chaser	Lio (JMIR mHealth and uHealth, 2020)	Qualitative Study (Journal article)	Intervention: not technology listed in scope
128.	-	Citation Chaser	Jácome (J Investig Allergol Clin Immunol, 2020)	Observational study (journal article)	Intervention: not technology listed in scope
129.	snuCare application	Citation Chaser	Kim (Asia Pac Allergy, 2016)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
130.	mHealth	Citation Chaser	Koster (J Asthma, 2015)	Qualitative study (Journal article)	Intervention: not technology listed in scope
131.	AioCare app	Citation Chaser	Kupczyk (J Asthma, 2020)	Single arm feasibility study (Journal article)	Intervention: not technology listed in scope
132.	Healthy.me Web-based PCHMS	Citation Chaser	Lau (JIMR, 2015)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
133.	Mixed	Citation Chaser	Licari (JACI: In Practice 2019)	Review (Journal article)	Study design; review

#	Technology	Source	Study	Publication type	Reasons for exclusion
134.	WeChat	Citation Chaser	NCT02917174; Lin (Allergy Asthma Immunol Res, 2022)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
135.	-	Citation Chaser	Liu (Eur Respir J, 2010)	Prospective controlled study (Journal article)	Intervention: not technology listed in scope
136.	Puff City	Citation Chaser	Lu (Contemp Clin Trials, 2019)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
137.	Clip-Tone buddy smartphone app	Citation Chaser	Mahmoud (J Asthma, 2022)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
138.	Mixed	Citation Chaser	Makhecha (BMJ Open Respir Res, 2020)	Mixed methods study (Journal article)	Intervention: not technology listed in scope
139.	Mychart; Epic Systems Corporation, Wisconsin USA)	Citation Chaser	Mammen (J Telemed Telecare, 2019)	Mixed methods study (Journal article)	Intervention: not technology listed in scope
140.	ARCA app	Citation Chaser	NCT04480242; Mayoral (Qual Life Res, 2021)	Qualitative study (Journal article)	Intervention: not technology listed in scope
141.	-	Citation Chaser	McClure (J Pediatr Nurs 2018)	Pre-post intervention study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
142.	Propeller, Health, Madison, WI	Citation Chaser	Merchant World Allergy Organ, 2018)	Letter	Intervention: not technology listed in scope
143.	Smartinhalers and Smarttturbos	Citation Chaser	NCT02451709; Morton (Thorax, 2016)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
144.	M-ADEPT	Citation Chaser	Mosnaim (JACI: In Practice, 2015)	Proof-of-concept single arm study (Journal article)	Intervention: not technology listed in scope
145.	Propeller app	Citation Chaser	Mosnaim (JACI. In Practice, 2020)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
146.	AirDuo Digihaler and ProAir Digihaler app	Citation Chaser	Mosnaim (JACI. In practice, 2023)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
147.	-	Citation Chaser	Moudgil (Thorax, 2000)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
148.	-	Citation Chaser	Mukherjee (BMC Medicine, 2016)	Observational study (Journal article)	Intervention: not technology listed in scope Study design
149.	Smartphone Asthma Management System (SAMS) app	Citation Chaser	Nichols (JMIR formative research, 2020)	Qualitative study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
150.	-	Citation Chaser	Odom (J Am Assoc Nurse Pract, 2016)	Brief report	Intervention: not technology listed in scope
151.	-	Citation Chaser	NCT03012061 and NCT02924688; Oppenheimer (Chest, 2023)	Post hoc analysis (randomised trials)	Intervention: not technology listed in scope
152.	Smartinhaler Tracker electronic monitors	Citation Chaser	Patel (JACI: In practice, 2012)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
153.	Kiss My Asthma Prototype app	Citation Chaser	Peters (JMIR, 2017)	Participatory study (Journal article)	Intervention: not technology listed in scope
154.	-	Citation Chaser	Pinnock (Clin Exp Allergy, 2007)	Qualitative study (Journal article)	Intervention: not technology listed in scope
155.	-	Citation Chaser	Roberts (J Asthma, 2016)	Qualitative study (Journal article)	Intervention: not technology listed in scope
156.	iAsthma, AsthmaMD	Citation Chaser	Roberts (Health Educ J, 2019)	Qualitative study (Journal article)	Intervention: not technology listed in scope
157.	iAsthma, AsthmaMD	Citation Chaser	Roberts (JMIR Formative Research, 2018)	Mixed methods study (Journal article)	Intervention: not technology listed in scope
158.	BWH Asthma app	Citation Chaser	Rudin (ACI, 2017)	Qualitative study (Journal article)	Intervention: not technology listed in scope
159.	BWH Asthma app	Citation Chaser	Rudin (ACI, 2019)	Mixed methods study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
160.	e-San Ltd	Citation Chaser	Ryan (J Telemed Telecare, 2005)	Observational study (Journal article)	Intervention: not technology listed in scope
161.	t+ Asthma application	Citation Chaser	Ryan (BMJ, 2012)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
162.	-	Citation Chaser	NCT01281215; Schermer (J Respir Crit Care Med, 2002)	Randomised controlled economic evaluation (Journal article)	Intervention: not technology listed in scope
163.	-	Citation Chaser	Schneider (Health Inform J, 2015)	Qualitative study (Journal article)	Intervention: not technology listed in scope
164.	asthmaMD and asthmaPulse	Citation Chaser	Schneider (Telemed J E Health, 2015)	Qualitative study (journal article)	Intervention: not technology listed in scope
165.	-	Citation Chaser	Schneider (JCHC, 2014)	Qualitative study (journal article)	Intervention: not technology listed in scope
166.	AirWatch®	Citation Chaser	Sherman (Clinical pediatrics, 2014)	Retrospective observational study (Journal article)	Intervention: not technology listed in scope
167.	Lung Health for Kids APP	Citation Chaser	Versteegh (Front Pediatr, 2022)	Qualitative study (Journal article)	Intervention: not technology listed in scope

#	Technology	Source	Study	Publication type	Reasons for exclusion
168.	KidsHealth smart phone application	Citation Chaser	Wu (2016, ASONAM)	Conference abstract	Intervention: not technology listed in scope
169.	-	Citation Chaser	Zimmer (Disease Management, 2000)	Randomised controlled trial (Journal article)	Intervention: not technology listed in scope
170.	-	Provided by company	Edwards (Pharmaceutical Journal, 2022)	News article	Publication type: news article
171.	Mixed	Provided by company	The Institute of Clinical Science and Technology	Audit report	Intervention/outcomes; discusses use of self management apps
172.	Smart Asthma	Provided by company	Folliard (Irish Thoracic Society conference, 2024)	Conference abstract	Study design: cross-sectional study
173.	Smart Asthma	Provided by company	Antalffy (Primary care respiratory society conference, 2025)	Conference abstract	Publication type: Overview document
174.	Smart Asthma	Provided by company	Ananth (Primary care respiratory society conference, 2025)	Conference abstract	Population: mixed asthma and COPD
175.	Smart Asthma	Provided by company	Clayton (KJP paediatric respiratory conference, 2024)	Conference abstract	Intervention: Smart Rescue app
176.	Smart Asthma	Provided by company	Levy (PubMed Journal at National Library of Medicine, 2024)	Journal article	Publication type: narrative review
177.	Smart Asthma	Provided by company	Wolfe (Ongoing pilot: https://www.kcl.ac.uk/research/technology-enhanced-	Website article	Intervention: includes other applications (Wheezo) and

#	Technology	Source	Study	Publication type	Reasons for exclusion
			integrated-asthma-care-teamcare)		appears to focus on inhaler sensor which is the Smart Rescue app
178.	Smart Asthma	Provided by company	Loke (Ongoing pilot https://www.researchgate.net/publication/377644967_ABRUPT_-_Asthma_Better_outcomes_and_Reduced_Unscheduled_care_using_Patient-directed_digital_Technologies)	Researchgate abstract	Publication type: abstract with limited details regarding digital technology perspective (i.e. not app specific)
179.	Smart Asthma	Provided by company	Negandhi (Primary care respiratory society conference, 2025)	Conference abstract	Intervention: smart sensors, Smart Rescue app
180.	Smart Asthma	Provided by company	Roberts (Primary care respiratory society conference, 2025)	Conference abstract	Intervention: Smart Rescue app
181.	Smart Asthma	Provided by company	Hird (Primary care respiratory society conference, 2025)	Conference abstract	Study design: cross-sectional study
182.	Smart Asthma	Provided by company	Sakkatos (ERS publications, 2020)	Conference abstract	Study design: predictive accuracy study
183.	AsthmaTuner	Provided by company	Ljunberg (ERS 2018)	Conference abstract.	Study design: cross-sectional study

Appendix B – Economic modelling

Appendix B1: Excluded studies

#	Technology	Source	Study	Publication type	Reasons for exclusion
184.	AeviceMD	EAG economic literature search	NCT06377345	Trial registration	Intervention: not technology listed in scope; Study design: ongoing study (estimated completion December 2025)
185.	AsthmaTuner	EAG economic literature search	NCT04132778	Trial registration	Study design: terminated trial due to insufficient funding, no publication identified.
186.	AsthmaTuner	EAG economic literature search	NCT02571309	Trial registration	Study design: completed trial (publications listed included Fuhrman et al. 2011, and Zafari et al. 2014 which has been summarised in section 6.1)
187.	AsthmaTuner	Provided by Company	Bjerg (ERS Open Res, 2020)	Prospective non-randomised (reported in research letter)	Population: work-related asthma Intervention: AsthmaTuner used in diagnosis (not

#	Technology	Source	Study	Publication type	Reasons for exclusion
					management of diagnosed asthma).
188.	Astmaskompas and Spirobank	EAG economic literature search	NCT05643183; Zijp (Digit Health, 2024; 2055207624)	Before-after trial (12 weeks)	Intervention: Astmakompas, not technology listed in scope
189.	CANATEXTS	EAG economic literature search	NCT05484037	Trial registration	Intervention: not technology listed in scope; Study design: ongoing study (due to complete May 2026)
190.	Mixed	EAG economic literature search	Chan (ERS Monograph, 2023; 185-198)	Narrative review	Intervention: not specified Study design: narrative review
191.	Mixed	EAG economic literature search	Duan (JMIR mHealth and uHealth, 2025; e57645)	Systematic review of qualitative studies	Intervention: not specified Study design: systematic review
192.	Mixed	EAG economic literature search	Effing (Chronic Resp Dis, 2023; 1-15)	Narrative review	Intervention: not specified Study design: narrative review
193.	Mixed	EAG economic literature search	Pinnock (ERS Monograph, 2023; 199-215	Narrative review	Intervention: not specified Study design: narrative review

#	Technology	Source	Study	Publication type	Reasons for exclusion
194.	Mixed	EAG economic literature search	Health Information and Quality Authority 2015	Systematic review	Intervention: mixed Study design: systematic review
195.	Mixed	EAG economic literature search	Santino (Am J Respir Crit Care, 2025; 211) [Abstract]	Abstract	Intervention: mixed Study design: Cross-sectional survey of adults (UK evidence identified which was priortised).
196.	Mixed	EAG economic literature search	Smith (HTA, 2005)	Systematic review	Intervention: mixed Study design: systematic review
197.	Mixed	EAG economic literature search	O'Sullivan (Allergy, 2023; 861-883)	Systematic review	Intervention: mixed Study design: systematic review
198.	Mixed	EAG economic literature search	Wellmann (J Personal Med, 2024)	Systematic review	Intervention: mixed Study design: systematic review
199.	myCOPD	Provided by myHealth	Davies (Appl Health Eco Health Policy, 2023; 689-700)	Summary of MTG68 (2022); the EAG note that this was subsequently replaced by HTE19 (2024)	Intervention: not listed in scope Population: COPD (not asthma)
200.	Peer-training via telephone	EAG economic literature search	NCT00860834	Trial registration	Intervention: not technology listed in scope;

#	Technology	Source	Study	Publication type	Reasons for exclusion
					Outcome: no economic outcomes captured
201.	Self-regulation intervention	EAG economic literature search	NCT01979055	Trial registration	Intervention: not technology listed in scope; Outcome: no economic outcomes captured
202.	Systematic Intervention Agent (SiA)	EAG economic literature search	NCT06908421	Trial registration	Intervention: not technology listed in scope; Study design: ongoing study (estimated completion May 2027)

Appendix B2: Studies used to support model development

The following 5 studies were reviewed by the EAG and elements used to support economic model development (structure and parameterisation).

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
Zafari (J Allergy Clin Immunol, 2014; 908-915) [56] Markov model (simulation study) with 5 states: uncontrolled, controlled, partially controlled, exacerbation, death. Developed in R programming language. US [Setting unreported]	Scenario: full adherence to regular controller treatment Scenario 2: standard care	Population: adults (aged 19 years and older) with uncontrolled asthma. Time horizon: 10 years (weekly cycles). Costs adjusted to 2011 price year, US dollars. Discounting 3% applied to costs and QALYs.	At end of 10-years: higher proportion of patients were alive in the full adherence scenario than standard care scenario (74% compared with 62%), the number of weeks with uncontrolled asthma reduced by 31% and the number of exacerbations reduced by 40%. Full adherence associated with $3,187 more costs ($5,973 compared with $2,786), 2.26 fewer exacerbations (2.94 compared with 5.20) and 0.13 more QALYs (7.68 compared with 7.55), resulting in ICER of $24,515/QALY. Probability of being cost-effective at $50,000/QALY was 0.90. Hypothetical program aimed at improving adherence, each $29 increase in annual costs will need to increase adherence level by 10% to	Stratified population into 3 age groups (18-35, 36-64 and >64 years). Uncontrolled asthma stratified into 3 groups according to treatment: i) no controller medication, ii) low-dose controller therapy (beclomethasone-equivalent daily dose up to 500 micrograms), iii) medium or high doses controller therapy (beclomethasone-equivalent daily dose of 500-1000 micrograms). PSA conducted using Monte Carlo simulation with 5000 iterations. Authors acknowledge limitation that full-adherence was based on 1-year randomised trial data, extrapolated to 10 years

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
			remain cost-effective at $50,000/QALY.	
Van de Hei (J Allergy Clin Immunol Pract, 2023; 3064-3073) Markov model Netherlands (incorporated data from an RCT conducted in UK and Ireland setting)	Intervention: personalised adherence-enhancing intervention (digital inhaler, assessed medication adherence, inhalation technique, peak expiratory flow) Comparator: usual care (adherence coaching, inhaler training, action plan)	Population: adult patients (aged 18 years or older) with difficult-to-treat asthma (defined as uncontrolled asthma despite medium or high-dose inhaled corticosteroids in combination with a second controller e.g. long-acting beta-agonist). Costs adjusted to 2022 price year, Euros. Dutch societal perspective and health care payer's perspective. Time horizon varied between 1 year and lifetime, applying cycle length of 2 weeks.	The intervention was associated with a cost saving of 3,207 Euros at 1 year, with biologics accounting for 69% of the total costs in the usual care arm, 49% in the intervention arm. Cost savings of 14,548 Euros and 26,309 Euros were found at 5- and 10-years respectively. No difference in QALYs was found, due to no difference in exacerbations between arms. Model was sensitive to the proportion of patients transitioning between controlled and uncontrolled (and vice-versa), cost of biologics and proportion of patients using biologics in standard care arm. 10-year time horizon and 1-year intervention use indicated that the intervention would be cost-saving across 6 scenarios.	Need to consider generalisability of results from this subgroup of patients (difficult-to-treat only). Incorporated results from RCT. Internal and external validation conducted; using AdViSHE tool. Exacerbations included those managed in community, those requiring attendance at A&E, and those requiring hospital admission.
Mukherjee (BMC Medicine, 2016; 113) National service evaluation (secondary	N/A	Population: diagnosed with asthma (via read code or ICD10 codes) attending various health care settings,	Asthma resulted in 6.3M primary care consultations, 93,000 hospital in-patient episodes, 1,800 intensive care unit episodes, and 36,800	Costs included: GP consultations, practice nurse consultations, out of hour calls, community prescribing, ambulance trips, A&E visits, inpatient episodes, ICU episodes,

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
analysis of primary and secondary NHS datasets) UK		prescribed asthma medications (using BNF codes). Data from 2011-2012 price year.	disability living allowance claims. Costs were estimated to be at least £1.1 bn: 74% of which were associated with the provision of primary care services (60% prescribing, 14% consultation), 13% for disability claims, 12% for hospital care. There were 1,160 asthma deaths.	disability living allowance. Authors acknowledge lack of robust reporting of biologics, therefore costs reported would be an underestimate. Reliance on routinely collected information (coding).
Ryan (BMJ, 2012; e1756) RCT with CEA [NCT00512837] UK	Intervention: submission of symptoms via mobile (twice daily) Comparator: paper-based monitoring techniques (twice daily)	Population: patients aged 12 years and older, with poorly controlled asthma (asthma control questionnaire score 1.5 or higher)	At 6 months there was no significant difference in asthma control questionnaire, self-efficacy (knowledge, attitude, self-efficacy asthma) questionnaire, number of acute exacerbations, steroid courses, unscheduled consultations between arms. Study concluded that mobile supported self-monitoring was not cost effective. A fifth achieved well controlled threshold.	RCT had 139 patients in each arm; low number due to eligibility criteria (poor control of asthma and compatible mobile phone and network). Results may be influence by short time-horizon (6 months), and significant difference in age between arms (older in comparator arm).
Fuhrman (J Asthma, 2011; 565-571) Prospective cohort France [14 paediatric hospital wards]	N/A	Population: children aged between 3 and 17 years who were hospitalised for an asthma exacerbation.	Across 498 children admitted for an asthma exacerbation with previous diagnosis of asthma, the mean length of stay was 3.3. days. Upper respiratory infection was identified as the most common trigger (75%), followed by	Information regarding usual asthma care, frequency of symptoms, previous exacerbations and comorbidities were collected via parental interview. Information regarding potential triggers for current exacerbation reported by physician.

Study name, design and location	Intervention(s) and comparator	Participants and setting, length of follow-up	Relevant outcomes and key findings	EAG comments
		Study duration: November 2006 to November 2007	allergen (19%) and decrease or interruption of controller therapy (11%). A total of 26% had been hospitalised with an asthma exacerbation in the previous year, continuous inhaled corticosteroids used by 42%, and regular follow-up for asthma in 57%. Control of asthma during the previous month was considered optimal in 23%, partial in 30% and poor 48%. A total of 69% had at least one preventable risk factor for hospitalisation: no regular controller therapy, no asthma action plan, no follow-up for asthma.	

Appendix B3: Model validation

AdViSHE tool

Part A: Validation of the conceptual model (2 questions)

Part A discusses techniques for validating the conceptual model. A conceptual model describes the underlying system (e.g., progression of disease) using a mathematical, logical, verbal, or graphical representation. Please indicate where the conceptual model and its underlying assumptions are described and justified.
Response: Section 6.2

A1/ Face validity testing (conceptual model):

Have experts been asked to judge the appropriateness of the conceptual model? If yes, please provide information on the following aspects: - Who are these experts? - What is your justification for considering them experts? - To what extent do they agree that the conceptual model is appropriate? If no, please indicate why not.
Response: Expert opinion sought on value propositions and key outcomes (NICE Scoping workshop); which were integrated in the decision problem outlined in the scope. Experts sought and ratified by NICE (range of expertise and geographical location across the UK). Model structure and parameters developed based on economic model used in NG245 and other published models looking at different self-management technologies. Opinion sought from experts (documented in Appendix D). Draft report shared with NICE and SCMs; comments received and actioned.

A2/ Cross validity testing (conceptual model):

Has this model been compared to other conceptual models found in the literature or clinical textbooks? If yes, please indicate where this comparison is reported. If no, please indicate why not.
Response: For conceptual model the EAG focused efforts on internal validation. Cross checks with other published models are outlined in the following table

	Cohort	Result from EAG conceptual model	Result from published model [source]	Comment
Total cost per patient	Asthma (adult)	£659.9 comparator @ 10 year time horizon	Between £1355 and £1462 @ life time horizon across strategies [NG245]	Longer time horizon in NG245, also NG245 includes remission
Total QALY per patient	Asthma (adult)	6.083 @ 10 year time horizon	Between 18.97 and 19.02 @ life time horizon [NG245]	(higher utility)

Total cost per patient	Asthma (adult)	£659.9 comparator @ 10 year time horizon	$2,786 @ 10 years [Zafari et al. 2014]	Zafari et al. 2014 applied weighted average of 3 age groups, and uncontrolled stratified into 3 groups according to treatment (US dollars, 2011 price year)
Total QALY per patient	Asthma (adult)	6.083 @ 10 year time horizon	7.55 @ 10 years [Zafari et al. 2014]	

Part B: Input data validation (2 questions)

Part B discusses techniques to validate the data serving as input in the model. These techniques are applicable to all types of models commonly used in HE modelling. Please indicate where the description and justification of the following aspects are given:

- search strategy;
- data sources, including descriptive statistics;
- reasons for inclusion of these data sources;
- reasons for exclusion of other available data sources;
- assumptions that have been made to assign values to parameters for which no data was available;
- distributions and parameters to represent uncertainty;
- data adjustments: mathematical transformations (e.g., logarithms, squares); treatment of outliers; treatment of missing data; data synthesis (indirect treatment comparison, network meta-analysis); calibration; etc.

B1/ Face validity testing (input data):

Have experts been asked to judge the appropriateness of the input data? If yes, please provide information on the following aspects: - Who are these experts? - What is your justification for considering them experts? - To what extent do they agree that the conceptual model is appropriate? If no, please indicate why not.
Response: Opinion sought from experts on key parameters where data were not available from the clinical evidence (documented in Appendix D).

B2/ Model fit testing:

When input parameters are based on regression models, have statistical tests been performed? If yes, please indicate where the description, the justification and the outcomes of these tests are reported. If no, please indicate why not.
Response: No regression models were directly applied by the EAG during development. Due to lack of clinical evidence, parameterisation based on values used in NG245 and other published economic models (see section 6.2.3, 6.2.4, 6.2.5)

Part C: Validation of the computerized model (4 questions)

C1/ External Review:

Has the computerized model been examined by modelling experts? If yes, please provide information on the following aspects: - Who are these experts? - What is your justification for considering them experts? - To what extent do they agree that the conceptual model is appropriate? If no, please indicate why not.
Response: No external review conducted outside of the team within time constraints. Model was reviewed by Gurdeep Sagoo, Senior Lecturer in Health Economics Newcastle University, and an expert in economic evaluation and health technology assessment. The model structure was reviewed during development and revisions were made to structure and possible transitions wherever needed. Model parameter inputs for both costs and outcomes were checked for appropriateness. Markov model traces were checked for errors and model output was validated and sense-checked. Sensitivity analyses conducted were appropriate with output checked for consistency and validity.
Aspects to judge include: appropriateness to represent the underlying clinical process/disease (disease stages, physiological processes, etc.); and appropriateness for economic evaluation (comparators, perspective, costs covered, etc.).

C2/ Extreme value testing:

Has the model been run for specific, extreme sets of parameter values in order to detect any coding errors? If yes, please indicate where these tests and their outcomes are reported. If no, please indicate why not.
Response: Extreme value testing was performed across parameters used in the Markov model. The following tests have been performed: • Longer time horizon (1 and 20 years; base case 5) • Starting age (16 years; base case 47) • Increased proportion of male patients in starting population (100%; base case 36%) • Starting population uncontrolled (100%; base case 40.9%) • No internal transitions between Controlled, Partially Controlled, and Uncontrolled states (stay in starting states unless exacerbation or death) • No use of the app (0%; base case 75%) and no cost of app (£0) in intervention arm • 100% use app and 0% drop out • Double or no monitoring costs • Double or no treatment costs • Double or no cost of exacerbation • £1000, £0 or upfront app costs • No utility multiplier (decreasing utility) associated with different levels of control of asthma • No utility multiplier (decreasing utility) associated with exacerbation

- Mortality HR set to 1 (standardised mortality only)
- Extremely high mortality (HR=1000) associated with disease (exacerbation and non-exacerbation)
- High utility decrement (0.5) for false positives
- All transitions from exacerbation are back to the Uncontrolled state
- Partially controlled state switched off
- 0% of patients recovering from exacerbations within one month (effectively an absorbing state)
- 1 day recovery window (base case 95% of patients recover within one month)
- No transitions to exacerbation states
- Low prevalence (1%; base case 90%)
- All patients with false positive diagnoses of asthma detected (in intervention arm) (base case 0%)
- Smaller cohort (100, base case=100,000)

For brevity, results of these checks are not reported but have been documented by the EAG.

C3/ Testing of traces:

Have patients been tracked through the model to determine whether its logic is correct? If yes, please indicate where these tests and their outcomes are reported. If no, please indicate why not.
Response: State occupancy through all states for each cycle across the time horizon reviewed by 3 modellers (RO/SG/KK), QA'd by lead health economist (GSS) to ensure cohort moving as expected. Extreme testing reviewed (0%, 100%) to ensure cohort movement as expected also. Tabular output and figure illustrating state occupancy over time included in report Appendix B4.

C4/ Unit testing:

Have individual sub-modules of the computerized model been tested? If yes, please provide information on the following aspects: - Was a protocol that describes the tests, criteria, and acceptance norms defined beforehand? - Please indicate where these tests and their outcomes are reported. If no, please indicate why not.
Response: Not applicable (no sub-modules), but some functions that have been developed during previous economic modelling were reused, and were thoroughly validated during development. Additionally, note that rdecision includes over 1300 internal validation checks. Output reviewed for "warnings" (RO/SG).

Part D: Operational validation (4 questions)

Part D discusses techniques used to validate the model outcomes.

D1/ Face validity testing (model outcomes):

Have experts been asked to judge the appropriateness of the model outcomes? If yes, please provide information on the following aspects: - Who are these experts? - What is your justification for considering them experts? - To what extent did they conclude that the model outcomes are reasonable? If no, please indicate why not.
Response: Draft report with initial results (including end state occupancy, QALY, costs) shared with NICE and SCMs (09/10/2025). Ongoing consideration of validity of outcomes throughout development and results generation.

D2/ Cross validation testing (model outcomes):

Have the model outcomes been compared to the outcomes of other models that address similar problems? If yes, please provide information on the following aspects: - Are these comparisons based on published outcomes only, or did you have access to the alternative model? - Can the differences in outcomes between your model and other models be explained? - Please indicate where this comparison is reported, including a discussion of the comparability with your model. If no, please indicate why not.
Response: Development of conceptual model focused on internal validation. Due to lack of published clinical evidence full parameterisation was not possible, therefore multiple assumed values used. The model was designed and run to demonstrate key uncertainties and highlight missing data. Therefore, comparing results with other published economic models not considered appropriate. Results of this modelling should not be used to reach conclusions on definitive cost-effectiveness of the technologies in scope.

D3/ Validation against outcomes using alternative input data:

Have the model outcomes been compared to the outcomes obtained when using alternative input data? If yes, please indicate where these tests and their outcomes are reported. If no, please indicate why not.
Response: Included in sensitivity analysis (see section 6.2.7).

D4/ Validation against empirical data:

Have the model outcomes been compared to empirical data? If yes, please provide information on the following aspects: - Are these comparisons based on summary statistics, or patient-level datasets? - Have you been able to explain any difference between the model outcomes and empirical data? - Please indicate where this comparison is reported. If no, please indicate why not. **D4.A/** Comparison against the data sources on which the model is based (dependent validation).
Response: Not conducted.

D4.B/ Comparison against a data source that was not used to build the model (independent validation).
Response: Not conducted.

Part E: Other validation techniques (1 question)

E1/ Other validation techniques:

Have any other validation techniques been performed? If yes, indicate where the application and outcomes are reported, or else provide a short summary here.
Response: Naive benchmarking: • Changes in state occupancies associated with changes in parameters • Changes in per-patient costs when implementing upfront and annually incurred costs • Count of patients still using the app with different drop-out rates • Code reviews [RO]. • Walk throughs for sense-checking where needed.
Examples of other validation techniques: structured “walk-throughs” (guiding others through the conceptual model or computerized program step-by-step); naïve benchmarking (“back-of-the-envelope” calculations); heterogeneity tests; double programming (two model developers program components independently and/or the model is programmed in two different software packages to determine if the same results are obtained).

Appendix B4: Output from base case

Comparator (SoC) base case

Transition probabilities, age = 47

	ControlledApp	PartiallyControlledApp	UncontrolledApp	ExacerbationApp	MisdiagnosedApp	ControlledNoApp	PartiallyControlledNoApp	UncontrolledNoApp	ExacerbationNoApp	MisdiagnosedNoApp	NoDisease	Dead
ControlledApp	0.94616274	0.043574929	0.0048908221	0.0051333116	0	0	0	0	0	0	0	0.00023819895
PartiallyControlledApp	0.041663839	0.94784893	0.0049963938	0.0052526372	0	0	0	0	0	0	0	0.00023820001
UncontrolledApp	0.0044687219	0.0065315991	0.98337915	0.0053823317	0	0	0	0	0	0	0	0.00023820111
ExacerbationApp	0.20128217	0.36597845	0.37805924	0.054438186	0	0	0	0	0	0	0	0.00024195823
MisdiagnosedApp	0	0	0	0	0.99980947	0	0	0	0	0	0	0.00019052851
ControlledNoApp	0	0	0	0	0	0.94616274	0.043574929	0.0048908221	0.0051333116	0	0	0.00023819895
PartiallyControlledNoApp	0	0	0	0	0	0.041663839	0.94784893	0.0049963938	0.0052526372	0	0	0.00023820001
UncontrolledNoApp	0	0	0	0	0	0.0044687219	0.0065315991	0.98337915	0.0053823317	0	0	0.00023820111
ExacerbationNoApp	0	0	0	0	0	0.20128217	0.36597845	0.37805924	0.054438186	0	0	0.00024195823
MisdiagnosedNoApp	0	0	0	0	0	0	0	0	0	0.9998095	0	0.00019052851
NoDisease	0	0	0	0	0	0	0	0	0	0	0.9998095	0.00019052851
Dead	0	0	0	0	0	0	0	0	0	0	0	1

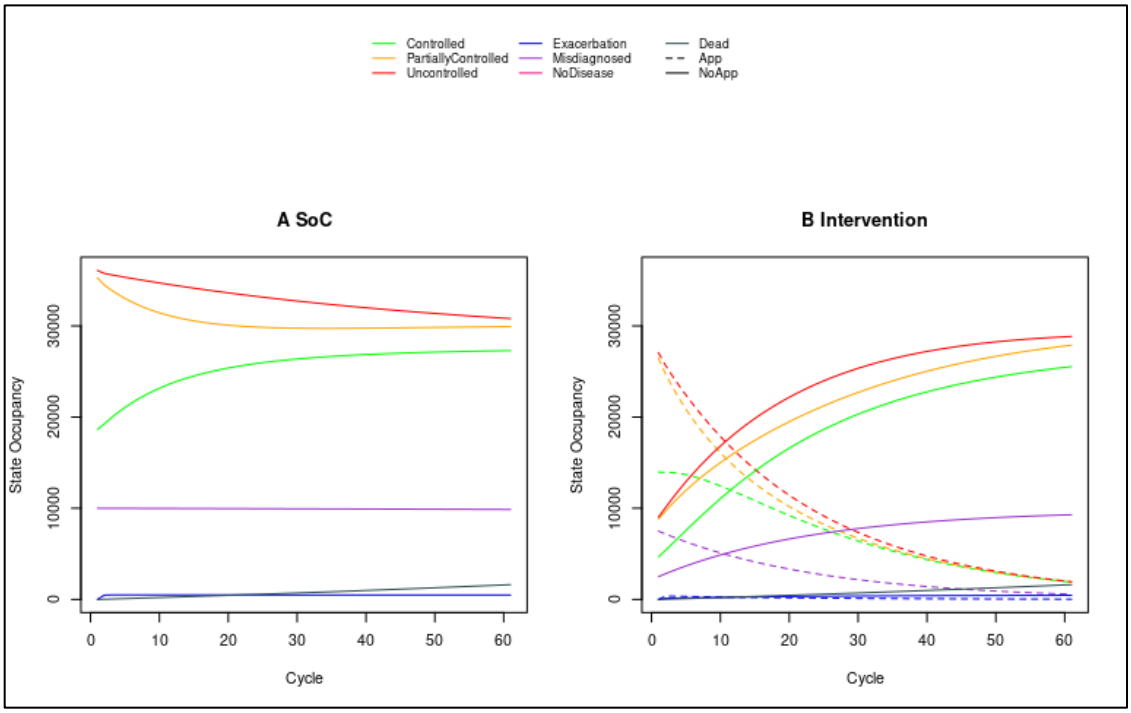
Intervention - base case

Transition probabilities, age = 47

	ControlledApp	PartiallyControlledApp	UncontrolledApp	ExacerbationApp	MisdiagnosedApp	ControlledNoApp	PartiallyControlledNoApp	UncontrolledNoApp	ExacerbationNoApp	MisdiagnosedNoApp	NoDisease	Dead
ControlledApp	0.91613334	0.033896746	0.004767449	0.0051323822	0	0.039831884	0	0	0	0	0	0.00023819895
PartiallyControlledApp	0.041880865	0.90826506	0.0048734761	0.0052526097	0	0	0.039489785	0	0	0	0	0.00023820001
UncontrolledApp	0.0044891671	0.0065117542	0.94240444	0.0053823302	0	0	0	0.040974106	0	0	0	0.00023820111
ExacerbationApp	0.20273916	0.36457219	0.37800863	0.054438062	0	0	0	0	0	0	0	0.00024195823
MisdiagnosedApp	0	0	0	0	0.95815074	0	0	0	0	0.0416587279785915	0	0.00019052851
ControlledNoApp	0	0	0	0	0	0.94616274	0.043574929	0.0048908221	0.0051333116	0	0	0.00023819895
PartiallyControlledNoApp	0	0	0	0	0	0.041663839	0.94784893	0.0049963938	0.0052526372	0	0	0.00023820001
UncontrolledNoApp	0	0	0	0	0	0.0044687219	0.0065315991	0.98337915	0.0053823317	0	0	0.00023820111
ExacerbationNoApp	0	0	0	0	0	0.20128217	0.36597845	0.37805924	0.054438186	0	0	0.00024195823
MisdiagnosedNoApp	0	0	0	0	0	0	0	0	0	0.9998095	0	0.00019052851
NoDisease	0	0	0	0	0	0	0	0	0	0	0.9998095	0.00019052851
Dead	0	0	0	0	0	0	0	0	0	0	0	1

State occupancy (per cycle)

Plot A displays the state occupancies for the comparator (SoC), and plot B displays the state occupancies for the intervention. Note that The No Disease and Dead states are not split into App/No App. States with zero occupancy across all cycles are not plotted.



Appendix B5: Results from sensitivity analysis

Asthma (adults)

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
Comparator - base case	**0**	**0**	**0**	**0**	**0**	**27296**	**29922**	**30802**	**489.9**	**9867**	**0**	**1622**	**361.5**	**3.354**	**NA**	**NA**	**NA**	**NA**
[VP1] Intervention - base case (10% less move to lower control)	1899	1919	1938	33.42	575.8	25536	27886	28842	456.4	9292	0	1622	385.4	3.355	23.91	0.0005406	44,223	-13.1
[VP1] Intervention - base case (25% less move to lower control)	2019	1785	1924	33.24	575.8	25645	27825	28822	456.6	9292	0	1622	385.5	3.355	23.94	0.001403	17,064	4.1
[VP1] Intervention - base case (33% less move to lower control)	**2093**	**1703**	**1917**	**33.13**	**575.8**	**25710**	**27787**	**28811**	**456.7**	**9292**	**0**	**1622**	**385.5**	**3.356**	**23.96**	**0.001911**	**12,536**	**14.3**
[VP1] Intervention - base case (50% less move to lower control)	2256	1518	1901	32.9	575.8	25854	27702	28790	456.8	9292	0	1622	385.5	3.357	24	0.002997	8,008	35.9
[VP2] Intervention + 0.90 RR exac	1833	1991	1927	30.06	575.8	25490	27934	28849	456.5	9292	0	1622	384.9	3.354	23.33	0.0001472	158,471	-20.4
[VP2] Intervention + 0.80 RR exac	1840	1983	1906	26.61	575.8	25511	27947	28841	456.6	9292	0	1622	384.3	3.354	22.78	0.0002964	76,849	-16.9
[VP2] Intervention + 0.70 RR_exac	1847	1975	1884	23.19	575.8	25532	27959	28833	456.8	9292	0	1622	383.8	3.355	22.22	0.0004476	49,655	-13.3
[VP3] Intervention - 25% reduction in propotion of severe exacerbations	1827	2000	1947	33.53	575.8	25469	27922	28855	456.3	9292	0	1622	383.1	3.354	21.53	6.158e-05	349,621	-20.3
[VP3] Intervention - 50% reduction in propotion of severe exacerbations	1827	2000	1947	33.53	575.8	25469	27922	28855	456.3	9292	0	1622	380.7	3.354	19.17	0.0001232	155,676	-16.7
[VP3] Intervention - 75% reduction in propotion of severe exacerbations	1827	2000	1947	33.53	575.8	25469	27922	28855	456.3	9292	0	1622	378.3	3.354	16.82	0.0001848	91,027	-13.1
[VP4] Comparator + 0% detected + QALY loss FP 0.01	0	0	0	0	0	27296	29922	30802	489.9	9867	0	1622	361.5	3.349	NA	NA	NA	NA
[VP4] Intervention + 5% detected (with utility decrement)	1827	2000	1947	33.53	445.5	25469	27922	28855	456.3	8774	648.4	1622	384.1	3.35	22.53	0.0002083	108,164	-18.4
[VP4] Intervention + 10% detected (with utility decrement)	1827	2000	1947	33.53	340	25469	27922	28855	456.3	8294	1233	1622	382.8	3.35	21.24	0.0004051	52,438	-13.1

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
[VP4] Intervention + 50% detected (with utility decrement)	1827	2000	1947	33.53	17.99	25469	27922	28855	456.3	5509	4341	1622	374.5	3.351	12.97	0.001658	7,819	20.2
Intervention + 0.90 RR exac	2105	1688	1896	29.7	575.8	25735	27796	28804	456.8	9292	0	1622	384.9	3.356	23.4	0.002082	11,242	18.2
Intervention + 0.80 RR exac	2118	1673	1875	26.29	575.8	25760	27804	28796	456.9	9292	0	1622	384.4	3.356	22.85	0.002255	10,133	22.3
Intervention + 0.70 RR_exac	2132	1659	1853	22.91	575.8	25786	27813	28788	457.1	9292	0	1622	383.8	3.356	22.3	0.002431	9,172	26.3
Intervention + 100% use app	2790	2270	2555	44.18	767.7	25182	27075	28148	445.6	9100	0	1622	393.5	3.357	31.94	0.002548	12,536	19
Intervention + 50% use app	1395	1135	1278	22.09	383.9	26239	28499	29475	467.7	9484	0	1622	377.5	3.355	15.97	0.001274	12,536	9.5
Intervention + 25% drop out per year	7151	5806	6700	111.6	2092	21427	22964	23973	378.1	7775	0	1622	369.9	3.357	8.405	0.002836	2,963	48.3
Intervention + 75% drop out per year	597	486.8	534.4	9.596	154	26914	29269	30220	480.2	9713	0	1622	393.9	3.355	32.37	0.00138	23,452	-4.8
Intervention - 25% reduction in monitoring costs (25 mins)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	405	3.356	43.52	0.001911	22,771	-5.3
Intervention - 33% reduction in monitoring costs (8.5 mins)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	401.5	3.356	40	0.001911	20,929	-1.8
Intervention - 50% reduction in monitoring costs (17 mins)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	395.3	3.356	33.74	0.001911	17,654	4.5
Intervention + £17.60 internet	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	408.6	3.356	47.04	0.001911	24,617	-8.8
Intervention + £8.00 internet/device	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	396	3.356	34.46	0.001911	18,034	3.8
Intervention + costs of RDMP	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	655.4	3.356	293.8	0.001911	153,766	-255.6
Intervention + costs Asthmahub	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	357.2	3.356	-4.28	0.001911	Dominant	42.5
Intervention +costs of Luscii	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	577.8	3.356	216.2	0.001911	113,146	-178
Intervention +costs of AsthmaTuner	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Intervention + costs myAsthma	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	414.5	3.356	53.02	0.001911	27,745	-14.8
Intervention + costs of NuvoAir	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	602.2	3.356	240.7	0.001911	125,930	-202.4
Intervention + costs DHP	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	393.22	3.356	31.7272	0.001911	16,598598	6.5

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
Intervention + costs SmartAsthma+ 25% drop out	7151	5806	6700	111.6	2092	21427	22964	23973	378.1	7775	0	1622	369.9	3.357	8.405	0.002836	2,963	48.3
Intervention + costs of SmartAsthma (treated as ongoing fixed costs)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	457.3	3.356	95.79	0.001911	50,126	-57.6
Intervention + costs of SmartAsthma (treated as ongoing fixed costs) + 25% drop out	7151	5806	6700	111.6	2092	21427	22964	23973	378.1	7775	0	1622	489.6	3.357	128.1	0.002836	45,149	-71.3
Intervention + costs of SmartAsthma (treated as ongoing not fixed costs)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	425.4	3.356	63.83	0.001911	33,400	-25.6
Intervention + costs of SmartAsthma(treated as ongoing not fixed costs) + 25% drop out	7151	5806	6700	111.6	2092	21427	22964	23973	378.1	7775	0	1622	459.2	3.357	97.66	0.002836	34,429	-40.9
Intervention + costs AsthmaHub (distributed across 2500 patients per ICB)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	344.2	3.356	-17.33	0.001911	DominantDominant	55.6
Intervention +costs of Luscii (distributed across 2500 patients per ICB)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	573.9	3.356	212.4	0.001911	111,145	-174.2
Intervention + costs DHP (distributed across 2500 patients per ICB)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	358.6	3.356	-2.93	0.001911	DominantDominant	41.2
Intervention 75% drop out in controlled arm	1158	1211	1676	23.7	154	26464	28447	29064	466.1	9713	0	1622	440.6	3.356	79.08	0.001567	50,479	-47.7
Intervention - reduced proportion of severe exac by half (0.12 in control/partcontr, 0.155 in uncontr)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	441.9	3.356	80.34	0.002034	39,498	-39.7
Comparator + younger (37)	0	0	0	0	0	27553	30204	31093	494.5	9942	0	714.5	363.1	3.465	NA	NA	NA	NA
Intervention + younger (37)	2112	1719	1935	33.45	580.1	25953	28049	29083	461	9362	0	714.5	386.9	3.467	23.88	0.001974	12,099	15.6
Comparator + older (57)	0	0	0	0	0	26761	29336	30199	480.3	9712	0	3511	358.4	3.203	NA	NA	NA	NA

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
Intervention + older (57)	2052	1669	1879	32.48	566.7	25207	27243	28247	447.7	9146	0	3511	382.5	3.205	24.11	0.001826	13,206	12.4
Comparator + time horizon (1)	0	0	0	0	0	24039	30843	34364	497.6	9977	0	279.8	77.87	0.7243	NA	NA	NA	NA
Intervention + costs SmartAsthma at 1 year	12259	13166	15581	238.5	4490	13131	16384	18724	258.9	5487	0	279.8	118.2	0.7246	40.35	0.0003203	125,976	-33.9
Intervention + costs of SmartAsthma (treated as ongoing fixed annual costs) at 1 year	12259	13166	15581	238.5	4490	13131	16384	18724	258.9	5487	0	279.8	118.2	0.7246	40.35	0.0003203	125,976	-33.9
Intervention + costs of SmartAsthma (treated as ongoing not fixed annual costs) at 1 year	12259	13166	15581	238.5	4490	13131	16384	18724	258.9	5487	0	279.8	106.1	0.7246	28.23	0.0003203	88,145	-21.8
Comparator + time horizon (2)	0	0	0	0	0	25970	29845	33157	495.7	9953	0	578.7	152.9	1.422	NA	NA	NA	NA
Intervention + time horizon (2)	8411	7526	9120	145.6	2688	18979	20984	23953	349.9	7265	0	578.7	185.5	1.423	32.68	0.0008655	37,761	-15.4
Comparator + time horizon (3)	0	0	0	0	0	26746	29736	32198	493.8	9927	0	898.9	225.1	2.092	NA	NA	NA	NA
Intervention + time horizon (3)	5393	4530	5386	88.88	1609	22455	24193	26723	404.8	8318	0	898.9	253.2	2.093	28.18	0.001338	21,063	-1.4
Comparator + time horizon (10)	0	0	0	0	0	27262	29788	28848	477.8	9677	0	3948	659.9	6.083	NA	NA	NA	NA
Intervention + time horizon (10)	182.3	147	154.2	2.803	43.93	27137	29611	28666	475	9633	0	3948	681.7	6.085	21.88	0.0023	9,512	24.1
Comparator + 33% controlled, pcontrol,uncontrol	0	0	0	0	0	31169	31044	25809	488.7	9867	0	1622	361.3	3.375	NA	NA	NA	NA
Intervention + 33% controlled, pcontrol,uncontrol	2389	1736	1605	33.15	575.8	29364	28805	24122	455.4	9292	0	1622	385.2	3.377	23.93	0.002397	9,984	24
Comparator + 10.6% controlled, 29.2% pcontrol, 60.1% uncontrol	0	0	0	0	0	19862	22535	45620	492.9	9867	0	1622	362.1	3.305	NA	NA	NA	NA
Intervention + 10.6% controlled, 29.2% pcontrol, 60.1% uncontrol	1515	1285	2825	32.84	575.8	18708	20944	42741	460	9292	0	1622	386.2	3.307	24.09	0.001251	19,253	0.9
Intervention + 10.6% controlled, 29.2% pcontrol, 60.1% uncontrol + 100% app + 0% drop out	23094	19551	45372	492.4	9867	0	0	0	0	0	0	1622	331.6	3.31	-30.52	0.004117	Dominant	112.9
Comparator + 25% controlled, 25%	0	0	0	0	0	25006	24906	38107	491.2	9867	0	1622	361.8	3.335	NA	NA	NA	NA

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
pcontrol, 50% uncontrol																		
Intervention + 25% controlled, 25% pcontrol, 50% uncontrol	1909	1390	2365	32.95	575.8	23560	23119	35676	458.1	9292	0	1622	385.8	3.336	24.03	0.001851	12,985	13
Comparator + QALY loss FP 0.01	0	0	0	0	0	27296	29922	30802	489.9	9867	0	1622	361.5	3.349	NA	NA	NA	NA
Intervention + QALY loss FP 0.01	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	385.5	3.351	23.96	0.001911	12,536	14.3
Intervention + all FP detected	2093	1703	1917	33.13	5.758e-08	25710	27787	28811	456.7	3072	6795	1622	365.5	3.354	3.933	0.00492	799.5	94.5
Intervention + 33% FP detected	2093	1703	1917	33.13	75.82	25710	27787	28811	456.7	6481	3311	1622	377.6	3.353	16.12	0.003106	5,189	46
Intervention + 25% FP detected	2093	1703	1917	33.13	136.6	25710	27787	28811	456.7	7058	2673	1622	379.4	3.352	17.84	0.002846	6,268	39.1
Intervention + 10% FP detected	2093	1703	1917	33.13	340	25710	27787	28811	456.7	8294	1233	1622	382.8	3.352	21.31	0.002316	9,202	25
Intervention + 5% FP detected	2093	1703	1917	33.13	445.5	25710	27787	28811	456.7	8774	648.4	1622	384.1	3.352	22.6	0.002119	10,664	19.8
Comparator + double monitoring costs in SoC arm	0	0	0	0	0	27296	29922	30802	489.9	9867	0	1622	497	3.354	NA	NA	NA	NA
Intervention + double monitoring costs in SoC arm	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	491.6	3.356	-5.38	0.001911	Dominant	43.6
Comparator + 98% prevalence	0	0	0	0	0	29722	32582	33540	533.4	1973	0	1648	363.2	3.299	NA	NA	NA	NA
Intervention + 98% prevalence	2279	1854	2087	36.08	115.2	27996	30257	31372	497.2	1858	0	1648	387.1	3.301	23.9	0.002081	11,485	17.7
Comparator + 95% prevalence	0	0	0	0	0	28812	31584	32514	517.1	4934	0	1639	362.6	3.32	NA	NA	NA	NA
Intervention + 95% prevalence	2209	1797	2023	34.97	287.9	27139	29331	30412	482	4646	0	1639	386.5	3.322	23.92	0.002017	11,858	16.4
Comparator + 80% prevalence	0	0	0	0	0	24263	26597	27380	435.4	19735	0	1589	359.4	3.423	NA	NA	NA	NA
Intervention + 80% prevalence	1860	1513	1704	29.45	1152	22854	24700	25610	405.9	18583	0	1589	383.4	3.424	24.03	0.001699	14,147	9.9
Comparator + 70% prevalence	0	0	0	0	0	21230	23273	23957	381	29602	0	1556	357.3	3.491	NA	NA	NA	NA
Intervention + 70% prevalence	1628	1324	1491	25.77	1727	19997	21612	22409	355.2	27875	0	1556	381.4	3.493	24.1	0.001486	16,217	5.6
Comparator - increased annualised exac rate (5% increase	0	0	0	0	0	27498	30070	30440	502.1	9867	0	1622	362	3.355	NA	NA	NA	NA

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
partial, 10% increase uncontrolled)																		
Intervention - increased annualised exac rate (5% increase partial, 10% increase uncontrolled)	2110	1713	1896	33.95	575.8	25900	27925	28466	468	9292	0	1622	386	3.357	23.95	0.001925	12,442	14.5
Comparator - controlled/uncontrolled only	0	0	0	0	0	42198	0	45822	489.9	9867	0	1622	362	3.344	NA	NA	NA	NA
Intervention - controlled/uncontrolled only	2617	0	2778	31.37	575.8	40034	0	42592	458.4	9292	0	1622	386.4	3.345	24.4	0.0009972	24,469	-4.5
Comparator (better controlled starting population)	0	0	0	0	0	35878	35601	16545	486.8	9867	0	1622	361	3.406	NA	NA	NA	NA
Intervention (better controlled starting population)	2756	1992	1024	33.26	575.8	33798	33025	15429	453.4	9292	0	1622	384.8	3.408	23.87	0.00282	8,462	32.5
Comparator (poorer controlled starting population)	0	0	0	0	0	20289	25292	42437	492.4	9867	0	1622	362	3.312	NA	NA	NA	NA
Intervention (poorer controlled starting population)	1551	1465	2633	32.95	575.8	19106	23518	39746	459.4	9292	0	1622	386	3.313	24.05	0.001167	20,608	-0.7
Comparator + increased treatment costs in uncontrolled arm (double)	0	0	0	0	0	27296	29922	30802	489.9	9867	0	1622	429.9	3.354	NA	NA	NA	NA
Intervention + increased treatment costs in uncontrolled arm (double)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	453.7	3.356	23.81	0.001911	12,459	14.4
Comparator + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	0	0	0	0	0	27296	29922	30802	489.9	9867	0	1622	411.5	3.354	NA	NA	NA	NA
Intervention (SmartAsthma) + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	434.9	3.356	23.39	0.001911	12,238	14.8
Intervention + costs of RDMP + increased	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	704.8	3.356	293.3	0.001911	153,468	-255.1

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER, £/QALY	Incremental NMB
treatment costs in partially controlled (25%) and uncontrolled (50%)																		
Intervention + costs AsthmaHub + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	406.6	3.356	-4.85	0.001911	DominantDominant	43.1
Intervention +costs of Luscii + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	627.1	3.356	215.7	0.001911	112,848	-177.4
Intervention +costs of AsthmaTuner + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Intervention + costs myAsthma + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	463.9	3.356	52.45	0.001911	27,447	-14.2
Intervention + costs of NuvoAir + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	651.6	3.356	240.1	0.001911	125,632	-201.9
Intervention + costs DHP + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2093	1703	1917	33.13	575.8	25710	27787	28811	456.7	9292	0	1622	442.6	3.356	31.15	0.001911	16,300	7.1

Abbreviations: exac, exacerbation; FP, False Positive; ICER, Incremental Cost-Effectiveness Ratio; NA, Not Applicable; NMB, Net Monetary Benefit; pcontrol, partially controlled; QALY, Quality Adjusted Life Year; RR, Relative Reduction; SoC, Standard of Care; uncontrol, uncontrolled; VP, Value Proposition

Asthma (children)

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
Comparator - base case	**0**	**0**	**0**	**0**	**0**	**27942**	**30386**	**31174**	**447**	**9997**	**0**	**54.25**	**432.4**	**3.872**	**NA**	**NA**	**NA**	**NA**
[VP1] Intervention - base case (10% less move to lower control)	1938	1940	1948	30.36	583.3	26149	28324	29201	416.6	9413	0	54.25	456.2	3.873	23.8	0.0006412	37,117	-11
[VP1] Intervention - base case (25% less move to lower control)	2063	1801	1934	30.19	583.3	26265	28259	29179	416.7	9413	0	54.25	456.2	3.874	23.83	0.001665	14,317	9.5
[VP1] Intervention - base case (33% less move to lower control)	**2139**	**1715**	**1926**	**30.09**	**583.3**	**26334**	**28219**	**29167**	**416.8**	**9413**	**0**	**54.25**	**456.2**	**3.874**	**23.85**	**0.002268**	**10,516**	**21.5**
[VP1] Intervention - base case (50% less move to lower control)	2309	1523	1910	29.87	583.3	26487	28129	29144	417	9413	0	54.25	456.2	3.876	23.89	0.003559	6,714	47.3
[VP2] Intervention + 0.90 RR exac	1869	2016	1938	27.31	583.3	26098	28374	29209	416.6	9413	0	54.25	455.6	3.872	23.29	0.0001582	147,224	-20.1
[VP2] Intervention + 0.80 RR exac	1876	2008	1919	24.19	583.3	26118	28386	29201	416.8	9413	0	54.25	455.2	3.872	22.8	0.0003183	71,630	-16.4
[VP2] Intervention + 0.70 RR_exac	1883	2001	1899	21.09	583.3	26138	28397	29193	416.9	9413	0	54.25	454.7	3.873	22.31	0.0004804	46,442	-12.7
[VP3] Intervention - 25% reduction in propotion of severe exacerbations	1863	2023	1958	30.45	583.3	26079	28363	29216	416.5	9413	0	54.25	454	3.872	21.65	5.917e-05	365,855	-20.5
[VP3] Intervention - 50% reduction in propotion of severe exacerbations	1863	2023	1958	30.45	583.3	26079	28363	29216	416.5	9413	0	54.25	451.9	3.872	19.52	0.0001183	164,907	-17.1
[VP3] Intervention - 75% reduction in propotion of severe exacerbations	1863	2023	1958	30.45	583.3	26079	28363	29216	416.5	9413	0	54.25	449.7	3.872	17.38	0.0001775	97,925	-13.8
[VP4] Comparator + 0% detected + QALY loss FP 0.01	0	0	0	0	0	27942	30386	31174	447	9997	0	54.25	432.4	3.868	NA	NA	NA	NA
[VP4] Intervention + 5% detected (with utility decrement)	1863	2023	1958	30.45	451.4	26079	28363	29216	416.5	8889	656.9	54.25	454.4	3.868	22.09	0.0002098	105,287	-17.9
[VP4] Intervention + 10% detected (with utility decrement)	1863	2023	1958	30.45	344.5	26079	28363	29216	416.5	8403	1249	54.25	452.8	3.868	20.49	0.0004081	50,216	-12.3

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
[VP4] Intervention + 50% detected (with utility decrement)	1863	2023	1958	30.45	18.23	26079	28363	29216	416.5	5581	4398	54.25	442.6	3.869	10.22	0.00167	6,121	23.2
Intervention + 0.9 RR exac	2151	1702	1907	26.98	583.3	26358	28227	29160	416.9	9413	0	54.25	455.7	3.875	23.36	0.002452	9,529	25.7
Intervention + 0.80 RR exac	2164	1688	1887	23.9	583.3	26382	28235	29152	417.1	9413	0	54.25	455.2	3.875	22.87	0.002638	8,671	29.9
Intervention + 0.70 RR exac	2177	1675	1867	20.83	583.3	26406	28243	29143	417.2	9413	0	54.25	454.7	3.875	22.39	0.002827	7,919	34.2
Intervention + 100% use app	2853	2287	2569	40.12	777.8	25799	27497	28499	406.8	9219	0	54.25	464.2	3.875	31.8	0.003024	10,516	28.7
Intervention + 50% use app	1426	1143	1284	20.06	388.9	26870	28942	29836	426.9	9608	0	54.25	448.3	3.874	15.9	0.001512	10,516	14.3
Intervention + 25% drop out per year	7326	5860	6756	101.6	2120	21956	23324	24279	345.2	7877	0	54.25	440.5	3.876	8.165	0.003374	2,420	59.3
Intervention + 75% drop out per year	609	489.3	535.2	8.694	156	27559	29722	30587	438.3	9841	0	54.25	464.7	3.874	32.32	0.001636	19,763	0.4
Intervention - 25% reduction in monitoring costs (25 mins)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	475.8	3.874	43.48	0.002268	19,170	1.9
Intervention - 33% reduction in monitoring costs (8.5 mins)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	472.3	3.874	39.95	0.002268	17,612	5.4
Intervention - 50% reduction in monitoring costs (17 mins)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	466	3.874	33.67	0.002268	14,843	11.7
Intervention - + £17.60 internet	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	479.4	3.874	47.02	0.002268	20,731	-1.7
Intervention - + £8.00 internet/device	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	466.7	3.874	34.4	0.002268	15164	11
Intervention + costs of RDMP	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	726.9	3.874	294.6	0.002268	129,878	-249.2
Intervention + costs Asthmahub	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	428	3.874	-4.385	0.002268	Dominant	49.7
Intervention +costs of Luscii	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	649.3	3.874	217	0.002268	95,655	-171.6
Intervention +costs of AsthmaTuner	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Intervention + costs myAsthma	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	485.4	3.874	53.03	0.002268	23,381	-7.7
Intervention + costs of NuvoAir	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	672.9	3.874	240.6	0.002268	106,052	-195.2

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
Intervention + costs DHP	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	464 464	3.874	31.6262	0.002268	13,938 938	13.7
Intervention + costs SmartAsthma + 25% drop out	7326	5860	6756	101.6	2120	21956	23324	24279	345.2	7877	0	54.25	440.5	3.876	8.165	0.003374	2,420	59.3
Intervention + costs of SmartAsthma(treated as annual fixed ongoing costs)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	528.3	3.874	95.96	0.002268	42,308	-50.6
Intervention + costs of SmartAsthma (treated as annual fixed ongoing costs) + 25% dropout	7326	5860	6756	101.6	2120	21956	23324	24279	345.2	7877	0	54.25	560.8	3.876	128.5	0.003374	38,079	-61
Intervention + costs of SmartAsthma (treated as annual not fixed ongoing costs)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	496.4	3.874	64.06	0.002268	28,241	-18.7
Intervention + costs of SmartAsthma (treated as annual not fixed ongoing costs) + 25% dropout	7326	5860	6756	101.6	2120	21956	23324	24279	345.2	7877	0	54.25	530.5	3.876	98.18	0.003374	29,100	-30.7
Intervention + costs AsthmaHub (distributed across 2500 patients per ICB)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	414.9	3.874	-17.43	0.002268	DominantDominant	62.8
Intervention +costs of Luscii (distributed across 2500 patients per ICB)	21392139	17151715	19261926	30.0909	583.33	26334262334	28219282219	2916729167	416.88	94139413	0	54.25	645.5	3.874	213.11	0.002268002268	93,968968	-167.88
Intervention + costs DHP (distributed across 2500 patients per ICB)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	429.33	3.874874	-3.035035	0.002268002268	DominantDominant	48.44
Comparator + older (9)	0	0	0	0	0	27938	30382	31170	446.9	9996	0	66.34	432.3	3.872	NA	NA	NA	NA
Intervention + older (9)	2139	1715	1926	30.09	583.3	26331	28216	29164	416.8	9413	0	66.34	456.2	3.874	23.85	0.002268	10,516	21.5
Comparator + time horizon (1)	0	0	0	0	0	24157	30908	34477	448.1	9999	0	11.53	92.57	0.8261	NA	NA	NA	NA
Intervention + time horizon (1)	12318	13171	15616	214.6	4500	13206	16428	18801	233.3	5499	0	11.53	132.9	0.8264	40.31	0.0003714	108,527	-32.9

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
Intervention + costs SmartAsthma at 1 year	12318	13171	15616	214.6	4500	13206	16428	18801	233.3	5499	0	11.53	132.9	0.8264	40.33	0.0003714	108,588	-32.9
Intervention + costs of SmartAsthma (treated as ongoing fixed annual cost) at 1 year	12318	13171	15616	214.6	4500	13206	16428	18801	233.3	5499	0	11.53	132.9	0.8264	40.33	0.0003714	108,588	-32.9
Intervention + costs of SmartAsthma (treated as ongoing not fixed costs) at 1 year	12318	13171	15616	214.6	4500	13206	16428	18801	233.3	5499	0	11.53	120.8	0.8264	28.27	0.0003714	76,116	-20.8
Comparator + time horizon (2)	0	0	0	0	0	26224	29966	33341	447.6	9999	0	22.09	182	1.626	NA	NA	NA	NA
Intervention + time horizon (2)	8493	7526	9149	131.2	2700	19184	21074	24106	316.2	7298	0	22.09	214.6	1.627	32.64	0.001012	32,260	-12.4
Comparator + time horizon (3)	0	0	0	0	0	27130	29948	32443	447.3	9998	0	33.12	268.3	2.4	NA	NA	NA	NA
Intervention + time horizon (3)	5469	4536	5406	80.29	1620	22799	24367	26944	366.9	8378	0	33.12	296.4	2.402	28.11	0.001574	17,861	3.4
Comparator + time horizon (10)	0	0	0	0	0	28660	31059	29701	446.3	9992	0	142.2	796	7.141	NA	NA	NA	NA
Intervention + time horizon (10)	190.7	151.4	156.6	2.594	45.36	28532	30877	29513	443.7	9946	0	142.2	817.8	7.143	21.74	0.002759	7,877	33.5
Comparator + 33% controlled, pcontrol,uncontrol	0	0	0	0	0	31742	31626	26135	445.9	9997	0	54.25	432.2	3.896	NA	NA	NA	NA
Intervention + 33% controlled, pcontrol,uncontrol	2430	1756	1614	30.11	583.3	29923	29346	24434	415.7	9413	0	54.25	456	3.899	23.83	0.002838	8,396	32.9
Comparator + 10.6% controlled, 29.2% pcontrol, 60.1% uncontrol	0	0	0	0	0	20444	22932	46123	449.7	9997	0	54.25	432.9	3.816	NA	NA	NA	NA
Intervention + 10.6% controlled, 29.2% pcontrol, 60.1% uncontrol	1557	1297	2839	29.84	583.3	19267	21313	43226	419.8	9413	0	54.25	456.9	3.817	23.99	0.001488	16,115	5.8
Comparator + QALY loss FP 0.01	0	0	0	0	0	27942	30386	31174	447	9997	0	54.25	432.4	3.868	NA	NA	NA	NA
Intervention + QALY loss FP 0.01	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	456.2	3.87	23.85	0.002268	10,516	21.5
Intervention + all FP detected	2139	1715	1926	30.09	5.833e-08	26334	28219	29167	416.8	3112	6884	54.25	431.4	3.873	-0.9507	0.005295	Dominant	106.9

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
Intervention + 50% FP detected	2139	1715	1926	30.09	18.23	26334	28219	29167	416.8	5581	4398	54.25	442.6	3.872	10.29	0.003938	2,613	68.5
Intervention + 25% FP detected	2139	1715	1926	30.09	138.4	26334	28219	29167	416.8	7150	2708	54.25	448.6	3.871	16.24	0.00321	5,060	48
Intervention + 10% FP detected	2139	1715	1926	30.09	344.5	26334	28219	29167	416.8	8403	1249	54.25	452.9	3.87	20.56	0.002676	7,683	33
Intervention + 5% FP detected	2139	1715	1926	30.09	451.4	26334	28219	29167	416.8	8889	656.9	54.25	454.5	3.87	22.16	0.002478	8,944	27.4
Comparator + double monitoring costs	0	0	0	0	0	27942	30386	31174	447	9997	0	54.25	568.8	3.872	NA	NA	NA	NA
Intervention + double monitoring costs	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	563.3	3.874	-5.568	0.002268	Dominant	50.9
Comparator + 98% prevalence	0	0	0	0	0	30426	33087	33945	486.7	1999	0	56.23	433.9	3.84	NA	NA	NA	NA
Intervention + 98% prevalence	2330	1868	2098	32.77	116.7	28675	30728	31760	453.9	1883	0	56.23	457.7	3.842	23.82	0.00247	9,643	25.6
Comparator + 95% prevalence	0	0	0	0	0	29494	32074	32906	471.8	4998	0	55.49	433.3	3.852	NA	NA	NA	NA
Intervention + 95% prevalence	2258	1810	2033	31.76	291.7	27798	29787	30788	440	4707	0	55.49	457.2	3.854	23.84	0.002394	9,956	24
Comparator + 80% prevalence	0	0	0	0	0	24837	27010	27710	397.3	19994	0	51.79	430.4	3.913	NA	NA	NA	NA
Intervention + 80% prevalence	1902	1525	1712	26.75	1167	23408	25084	25927	370.5	18827	0	51.79	454.4	3.915	23.95	0.002016	11,878	16.4
Comparator + 70% prevalence	0	0	0	0	0	21733	23634	24246	347.7	29990	0	49.32	428.5	3.953	NA	NA	NA	NA
Intervention + 70% prevalence	1664	1334	1498	23.41	1750	20482	21948	22686	324.2	28240	0	49.32	452.5	3.955	24.02	0.001764	13,617	11.3
Comparator + 50% prevalence	0	0	0	0	0	15523	16881	17319	248.3	49984	0	44.38	424.6	4.035	NA	NA	NA	NA
Intervention + 50% prevalence	1189	952.8	1070	16.72	2917	14630	15677	16204	231.6	47067	0	44.38	448.8	4.036	24.17	0.00126	19,181	1
Comparator - 64% males	0	0	0	0	0	27941	30386	31173	447	9997	0	56.29	432.3	3.912	NA	NA	NA	NA
Intervention - 64% males	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	56.29	456.2	3.915	23.88	0.002292	10,418	22
Comparator - increased annualised exac rate (5% increase partial, 10% increase uncontrolled)	0	0	0	0	0	28133	30528	30829	458.1	9997	0	54.26	432.8	3.873	NA	NA	NA	NA

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
Intervention - increased annualised exac rate (5% increase partial, 10% increase uncontrolled)	2155	1725	1907	30.82	583.3	26514	28351	28839	427.1	9413	0	54.26	456.7	3.875	23.86	0.002283	10,453	21.8
Comparator - controlled/uncontrolled only	0	0	0	0	0	43129	0	46373	447	9997	0	54.25	432.8	3.86	NA	NA	NA	NA
Intervention - controlled/uncontrolled only	2665	0	2797	28.5	583.3	40944	0	43096	418.4	9413	0	54.25	457.1	3.862	24.32	0.001202	20,235	-0.3
Comparator used in better controlled population	0	0	0	0	0	36489	36232	16783	444.2	9997	0	54.25	431.8	3.932	NA	NA	NA	NA
Intervention + app used in better controlled population	2800	2013	1030	30.21	583.3	34397	33612	15653	413.9	9413	0	54.25	455.6	3.935	23.78	0.003339	7,123	43
Comparator used in poorer controlled population	0	0	0	0	0	20967	25622	42911	449.3	9997	0	54.25	432.8	3.824	NA	NA	NA	NA
Intervention + app used in poorer controlled population	1601	1471	2646	29.93	583.3	19754	23825	40203	419.3	9413	0	54.25	456.7	3.825	23.97	0.001393	17,202	3.9
Comparator + increased treatment costs in uncontrolled arm (double)	0	0	0	0	0	27942	30386	31174	447	9997	0	54.25	524.5	3.872	NA	NA	NA	NA
Intervention + increased treatment costs in uncontrolled arm (double)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	548.1	3.874	23.65	0.002268	10,425	21.7
Comparator + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	0	0	0	0	0	27942	30386	31174	447	9997	0	54.25	499.7	3.872	NA	NA	NA	NA
Intervention (SmartAsthma) + increased treatment costs in	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	522.8	3.874	23.07	0.002268	10,171	22.3

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
partially controlled (25%) and uncontrolled (50%)																		
Intervention + costs of RDMP + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	793.5	3.874	293.8	0.002268	129,532	-248.4
Intervention + costs AsthmaHub + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	494.6	3.874	-5.168	0.002268	DominantDominant	50.5
Intervention +costs of Luscii + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	715.9	3.874	216.2	0.002268	95,310	-170.8
Intervention +costs of AsthmaTuner + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Intervention + costs myAsthma + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	552	3.874	52.25	0.002268	23,036	-6.9
Intervention + costs of NuvoAir + increased treatment costs in partially controlled	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	739.5	3.874	239.8	0.002268	105,707	-194.4

Scenario	Controlled App	Partially Controlled App	Uncontrolled App	Exacerbation App	NoDisease Treated App	Controlled (NoApp)	Partially Controlled (NoApp)	Uncontrolled (NoApp)	Exacerbation (NoApp)	NoDisease Treated (NoApp)	No Disease	Deaths	Total costs, £	Total QALYs	Incremental costs, £	Incremental QALYs	ICER	Incremental NMB (£)
(25%) and uncontrolled (50%)																		
Intervention + costs DHP + increased treatment costs in partially controlled (25%) and uncontrolled (50%)	2139	1715	1926	30.09	583.3	26334	28219	29167	416.8	9413	0	54.25	530.6	3.874	30.83	0.002268	13,593	14.5

[Key: bold=base case] Abbreviations: exac, exacerbation; FP, False Positive; ICER, Incremental Cost-Effectiveness Ratio; NA, Not Applicable; NMB, Net Monetary Benefit; pcontrol, partially controlled; QALY, Quality Adjusted Life Year; RR, Relative Reduction; SoC, Standard of Care; uncontrol, uncontrolled; VP, Value Proposition

Appendix C – Additional detail on technologies

Appendix C1: Additional technical information

Device (Company) [Previous Name]	Contraindications	Planned changes or updates	Training Requirements	Installation methods	Patient Data	How this technology fits into the clinical care pathway	Provides education	Communication features	Outputs (for patients)	Outputs (for HCPS)	Safety features	Additional features (as claimed by company)
Respiratory Disease Management Platform (RDMP) (Aptar Digital Health)	NR	None	Training for HCPs focuses on clinical integration and platform configuration including device set-up and use, web portal navigation and personalised care planning Training for patients is designed to be self-managed with in app education and customised onboarding with the HCP or with APTAR digital health team	App installed on patient device. Nothing additional needed for HCP	Data is stored and hosted online on cloud servers (France) that are GDPR compliant	Can be deployed in primary, secondary, emergency and remote care settings	Module that provides view educational materials (articles and videos) that are tailored to their individualised and personalised asthma action plan	Two-way synchronisation between the patient app and HCP web portal	-	Respi.me Connect healthcare provider portal provides healthcare providers with analysed data on controller and MART (if needed) medication adherence, rescue medication intake, inhalation technique, symptoms, triggers, and electronic patient reported outcomes including the Asthma Control Questionnaire 5-question and the mini-Asthma Quality of Life Questionnaire	Scheduled medication alerts and reminders configured by patient and HCP	NR

Device (Company) [Previous Name]	Contraindications	Planned changes or updates	Training Requirements	Installation methods	Patient Data	How this technology fits into the clinical care pathway	Provides education	Communication features	Outputs (for patients)	Outputs (for HCPS)	Safety features	Additional features (as claimed by company)
Asthmahub (The Institute of Clinical Science and Technology - ICST)	N/A	None	NR	App installed on patient device. Nothing needed for HCP	Securely stored in a centralised system to support continuity, user access across devices, and optional sharing with healthcare professionals. All data are stored securely on UK-based servers. The technology complies with the UK GDPR, and ICST also holds ISO27001 and Cyber Essentials Plus Accreditation. No data is shared automatically with the NHS or third parties without explicit consent and is anonymised	Supports annual reviews, diagnosis and medication checks in primary care enable symptom tracking, self-management, and early intervention using action plans in community/home settings supports discharge planning and structured follow-up in secondary care	Library of short videos and written resources including asthma basics, inhaler techniques, triggers, treatments, and managing flare-ups which are regularly reviewed by clinical experts and ICST. Updates are made centrally and pushed via updates to the app via the app stores	No in-app messaging	Visualises trends over time and prompts patients when their readings suggest deterioration to help patients take action and provide additional information for clinical reviews	12 month summary of a patients condition is downloadable via the app, where a healthcare professional can see how their condition has been since the last annual review.	The action plan, peak flow feature and symptom wellness dial includes clear red-zone instructions for when urgent or emergency care is needed which are prominently displayed when symptoms or PEF suggest worsening control.	Welsh and English language. Wellness prompts, PROM tracking, appointment reminders, and structured educational pathways like the Expert Patient Programme. Regular engagement campaigns (e.g. Staying Well in Winter, new guidance updates), where patients receive emails and in-app notifications. Users can also access live virtual events and Q&A sessions with clinical leads from their local area. Optional integration with virtual wards. AsthmaHub and AsthmaHub for Parents provide video education delivered by smoking cessation experts within the NHS and smoking status monitoring within the app.

Device (Company) [Previous Name]	Contraindications	Planned changes or updates	Training Requirements	Installation methods	Patient Data	How this technology fits into the clinical care pathway	Provides education	Communication features	Outputs (for patients)	Outputs (for HCPS)	Safety features	Additional features (as claimed by company)
Luscii (Luscii healthtech B.V)	N/A	None	Provided by company	App installed on patient device.	The data is always under the control of the healthcare provider (the data controller), whilst Luscii is the data processor. Data processed is stored on Amazon Web Services (Frankfurt, Germany) which is ISO9001, ISO27001, ISO27017 and ISO27018 certified Data is retained for 2 years after end of the contract	It will be used for patients with asthma across the ICS.	Yes, delivered via text and embedded videos with a wide range of topics	Yes, Video calling 2 way messaging and 1 way messaging Automatic messages depending on patient response Option for patient to request contact via a button	NR	Healthcare professionals can access all information via a web-based dashboard	Asthma control test scores - different advice provided based on different scores Advice provided on what action to take and how urgently Alerts to healthcare professionals also an option	Embedded videos from external sources
AsthmaTuner (MediTuner)	N/A	NR	• Short online training for healthcare providers and patients. • Onboarding materials and ongoing support provided by MediTuner team.	-	• Patient data stored within the EU (Sweden) • GDPR-compliant with encrypted storage • Patients control data sharing with HCPs	Functions as a digital extension of routine asthma care. Used at home by patients and in clinics via CarePortal. Complements or replaces traditional in-clinic reviews with asynchronous follow-up and structured treatment adjustments.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

myAsthma (my mHealth)	None identified	None	HCP training provided through online resources and the Ops & Customer success teams Patient training provided by app set up and activations, FAQ section and support from customer support team	App installed on patient device. Nothing additional needed for HCP	App data is stored within AWS (3x data centres in London) NHS and ICO compliant storage duration and deletion of patient records	Integrates into the existing care pathway for asthma health management at any stage	11 short videos accessible by patients at any time that are aligned to BTS/NICE/SIGN guidelines Clinical team works with specialists to ensure content is relevant and up to date	one-way notification feature whereby clinicians can message patients either individually or enmasse	NR	Clinical teams can request anonymised raw data or analysis depending on type of request. Data can be provided for research purposes where ethical approval has been sought	PAAP contains information to guide the patient based on the symptom scores they have reported.	Activity Diary: >100 types of wearable devices can be linked to myAsthma Environmental Features including Air Quality, Pollen Forecast and Weather: Linked to patient location Medical Appointment Diary for patients to record upcoming appointments Inhaler instruction videos: Interactive based on the patients prescribed inhaler and device. Aims to support good inhaler technique Mind Toolkit: 10 short videos supporting anxiety management, mind exercises, and meditation Smoking advice and cessation support Weight reporting Walking videos RCP 3 questionnaire Supports the use of biologic therapy

NuvoAir Home (NuvoAir Medical)	Heart attack within 1 week, Low blood pressure or severe high blood pressure, Abnormal heart rhythm, Unstable heart failure, Eye surgery within 1 week, Sinus surgery or middle ear surgery or infection within 1 week, Thoracic, Abdominal or Brain surgery within 4 week, High, uncontrolled, blood pressure in the blood vessels that supply the lungs, Collapsed lung, Clinically unstable blood clot in the lung, Recent concussion with continuing symptoms, History of fainting or passing out that is related to forced expiration and/or cough, Brain aneurysm, Active or suspected transmissible respiratory or systemic infection, including tuberculosis, Physical conditions predisposing to transmission of	Potential improvements to algorithm and UX design in next 6-12 months	Training for clinicians on use of the web portal	App installed on patient device. Nothing additional needed for HCP	Data is automatically transferred for storage and online viewing to a secure cloud storage system that uses industry standard protocols, encryption and data centre security	Home monitoring in tandem with NHS asthma care services dependent on monitoring objectives	Technology does not provide education but patients can access digital coaches (physiologists) who work with patients to provide education	Patient can send their spirometry reports via email to a health professional or person of their choice Patient has access to digital coach, but communication is handled outside the app	Trend graph created when test is completed. Individuals can also view and share PDF reports of their spirometry.	digital coaches and the asthma clinical team have secure access to all home collected data in a web-based portal data can be viewed as raw data or in trend graphs	NuvoAir physiologists that work alongside individuals to support self-monitoring will communicate with patients if there is data that looks concerning and guide them to follow their asthma action plan.	Set reminders for medication/spirometry/exercise Option to connect with Hailie inhaler sensors Option to connect with Apple Health to track steps data Option to connect with Fitbit to track steps data Option to do a full loop (include the inspiratory portion) or exhale only spirometry test Option to set goals

Device (Company) [Previous Name]	Contraindications	Planned changes or updates	Training Requirements	Installation methods	Patient Data	How this technology fits into the clinical care pathway	Provides education	Communication features	Outputs (for patients)	Outputs (for HCPS)	Safety features	Additional features (as claimed by company)
	infections, such as coughing up blood, significant secretions, or oral lesions or oral bleeding, Late-term pregnancy											
Digital Health Passport (Tiny Medical Apps)	No contraindications	Support for additional conditions (epilepsy, enhanced care plan features, and mental health/wellbeing tools) Improved accessibility to support patients with learning difficulties and neurodivergence	Self-onboarding for patients, with clear in-app guidance, video tutorials and printable quick-start materials requiring minimal training CPD accredited training package, complemented by webinars and tailored communications for HCPs (Free 1 hour online course, full day advanced session for specialist practitioners and asthma educators, downloadable resources, webinars and email based help desk)	App installed on patient device. Nothing needed for HCP	Stores patient data in secure UK-based data centres. ISO27001 compliant	In primary care, GPs and practice nurses can use the app during annual reviews to reinforce asthma education, track symptoms and create or review digital asthma action plans. In secondary care, it supports discharge planning by ensuring patients leave with a digital care plan and access to ongoing self-management support. In community settings, the app is promoted by school nurses and health visitors to families and young people, supporting asthma education between appointments.	Range of educational content to support self-management. Includes trusted resources from the NHS Syndication Service, Asthma + Lung UK, Beat Asthma and the "Move on Asthma" programme. Content is delivered through a dedicated in-app learning hub and includes articles, videos and animations tailored to young users. Content is reviewed periodically as part of clinical risk process	Yes to NHS services via the Convenet platform. Patients can reorder medication through the app with GP practices using compatible systems via NHS login and IM1 interface	App visualises symptom trends and medication use over time, helping users identify patterns, spot early signs of deterioration and reflect on their asthma control	Digital Health Passport (DHP) does not currently generate patient-level data outputs for direct use for HCPs, it includes a deploy dashboard that provides anonymised usage data at population level.	Allows users to track triggers, symptoms and response to medications, all of which can be referenced during appointments.	AIR/MART and anaphylaxis plans, and emergency instructions are supported Free access with no referral codes or clinician onboarding needed. Offline functionality. NHS Login integration.

Device (Company) [Previous Name]	Contraindications	Planned changes or updates	Training Requirements	Installation methods	Patient Data	How this technology fits into the clinical care pathway	Provides education	Communication features	Outputs (for patients)	Outputs (for HCPS)	Safety features	Additional features (as claimed by company)
Smart Asthma (Smart Respiratory Products Ltd)	None currently known	Continuous improvement and maintenance. Addition of further educational materials (links to external websites, videos).	No training needed	App installed on patient device. Nothing needed for HCP	All data stored in the UK on a London-based server with appropriate data governance processes in place	Replacement for mechanical peak flow meters. Smart Asthma can be used in primary care, secondary care, tertiary care as well as in the neighbourhood in community pharmacy.	Links are incorporated to useful websites, i.e. Asthma UK. External links are included on proper inhaler technique, the importance of tracking PEF data, how to measure your PEF correctly, and a useful podcast by Mark Levì discussing many interesting and practical aspects of asthma management.	The app features one-way communication. Users can share their charts displaying PEF, symptoms, inhaler use, and ACT data via email after providing consent. Upon agreeing to the sharing policy, they can also share their data in real time with their clinician through the Smart Asthma Dashboard, a web-based application. The app also supports custom user notifications, which can appear within the app or as cloud messages in the Android system.	The app presents PEF results in comparison to the user's personal best, along with symptom severity and inhaler medication use, displayed in a bar chart over time. This helps users identify patterns, detect early signs of deterioration, and reflect on their asthma control. It also displays ACT scores as an additional indicator of their condition. Based on historical data, the app predicts the user's likely peak flow zone for the following day and provides a standard asthma action plan (there is an option to upload custom plans) for each zone, as well as alerts for potential overuse of SABA inhalers.	Optional access for HCP for continuous monitoring of PEF, symptoms, inhaler use for each type, ACT or ACQ scores, patient notes	Alerts when patient is in the red zone for a long time or overuse of the rescue inhaler in the form of a notification	Works offline, only the notifications triggered by a certain event are not received and reports cannot be shared. All data stored on the mobile in the app cache until the next re-connection to the internet

Abbreviations: ACQ, Asthma Control Questionnaire, ACT; Asthma Control Test, AIR/MART; Anti-inflammatory Reliever/Maintenance and Reliever Therapy, API; Application Programming Interface, COPD; Chronic Obstructive Pulmonary Disease, FEV1; Forced Expiratory Volume in one second, FVC; Forced Vital Capacity, GINA; Global Initiative for Asthma, HCP; Healthcare Professional, NR; Not reported, PAAP; Personalised asthma action plans, PEF; Peak Expiratory Flow, PROM; Patient Reported Outcome Measures, RCP; Royal College of Physicians, SABA; short-acting beta-2 agonist

Appendix C2: Additional cost breakdown

Device (Company) [Previous Name]	Cost	What is included	Integration	Training Cost
Standard care	Recurring: £29.85 per patient per year	Monitoring costs associated without FeNO (NG245); assuming 1 practice nurse appointment for 80% of patients, 2 appointments for 15%, and an outpatient visit for 5%		
Respiratory Disease Management Platform (RDMP) (Aptar Digital Health)	Upfront (tech): £112+£4.42 Recurring: £180+£7.46 per patient per year	Hardware £112, Software £180 (£15 per month), VAT (£58). EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).	-	-
Asthmahub (The Institute of Clinical Science and Technology - ICST)	Upfront: £29+£4.42 per patient Recurring: £7.46 per patient per year	£29,000 per Welsh Healthboard provided by the company (EAG assumed 1,000 patients per ICB per year; £29.00 per patient cost). EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).	NR	NR
Luscii (Luscii healthtech B.V)	Upfront: £8.50+£4.42 per patient Recurring: £180+£7.46 per patient per year	Minimum monthly fixed fee = £1,500 based on 100 patients per month, a per patient fee applies to all patients over 100 patients. Monthly for a minimum 12 month contract. EAG has assumed that this is equivalent to £180 per patient per year. EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).	£8,500.00 one-off [EAG considered that this cost would be spread across 1,000 patients per year, which would be the equivalent of £8.50 per patient]	
AsthmaTuner (MediTuner)	[redacted]	Software: [redacted] Hardware: [redacted] including Support (e-mail and live chat support for patients and HCPs), 2-year warranty EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).	Single site, using company 2FA, takes approx. 1 hour with no charge. For IT integrations, i.e. integrating with an existing IT system, time needed correlates with size and complexity. This would be a one-time cost if the one system is used by multiple sites	[redacted] HCPs can meet with customer success manager who can provide demonstrations and support for the platforms features and assistance with technical queries & onboarding
myAsthma (my mHealth)	Upfront: £35 per patient Recurrent (annual, fixed): £30 per patient Recurrent: £7.46 per patient per year	Blended average of £65 per patient per year (£30 per patient per year thereafter). All software, e-learning platform for training clinical teams, and associated first and second line support activities (for example helpdesk, maintenance, hosting.). It does not include hardware as this is a software only solution EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).	Included in cost	Included in cost
NuvoAir Home (NuvoAir Medical)	Upfront: £360 per patient Recurrent: £7.46 per patient per year	Cost per patient licence. 12 week asthma assessment 10x pre-calibrated turbines for Spirometer Access to patient app for duration of license Access to web portal for clinicians Triage and onboarding training 12 week and Annual fully interpreted Respiratory Data Insights reports sent to clinicians Regular clinical huddles with site and NuvoAir Team Technical support (Mon-Fri 9am-5pm) EAG assumed 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results) – no training costs were applied.	There are no ongoing maintenance costs and no software installation is required on Hospital or GP practice PCs as the Clinician Portal is a web app (https://care.nuvoair.eu/).	Training on the Clinician Portal is provided remotely by the Physiologists and NuvoAir Team and is included in the price.
Smart Asthma (Smart Respiratory Products Ltd)	Upfront: £66.65+£4.42 per patient	SPF peak flow meter hardware: £49.99 Smart MDI Sensor: £33.33 (discount applied for bundle; £66.65 (peak flow and smart MDI sensor bundle)	Integration with NHS platforms such as EMIS or SystemOne is not included and would be costed separately if required	Included in cost

Device (Company) [Previous Name]	Cost	What is included	Integration	Training Cost
	Recurring: £7.46 per patient per year	Maintenance Delivery to patients (via Amazon fulfilment) if required EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).		
Digital Health Passport (Tiny Medical Apps)	Upfront: £7777+£4.42 per patient Recurrent: £7.46 per patient per year	DHP Platform ICS £49,500 per ICS (EAG assumed 1,000 per ICB) DHP Condition Implementation & Deployment ICS £27, 500 per condition (EAG assumed applied for asthma only) EAG calculation: (£49,500+£27,500)/1000=£77 per patient for platform. EAG assumed 5 minutes practice nurse time for training patient (£4.42), 75% reduction in standard care costs (£7.46; which is the equivalent of 8.5 minutes of a practice nurse who would review results).	Service integration with electronic health records and clinical systems where available: EHR Integration - £25,000-£100,000. At stakeholder consultation the company confirmed that these integration costs were optional and would only be relevant in a secondary care setting. The EAG have therefore not included these costs.	Included in cost

Appendix D – Correspondence log

The EAG sent questions to experts on the 25/09/2025. Experts were asked to reply by the 03/10/2025. Four experts replied with responses, which can be seen below.

Question	Response(s)
On average how many patients per GP practice will have an asthma diagnosis? Can we assume each practice will have on average 1000 asthma patients who would require monitoring?	[redacted] Depends on the size of the practice. 10% would be a reasonable guestimate, BUT the data are that over- and under-diagnosis are very common and an asthma diagnosis does not mean the patient has asthma [redacted] I believe 10,000 is an 'average' GP surgery list size and 1,000 would be 10% of this which is approx. asthma prevalence – so if you have to put one number on it then yes. However, surgery list size varies greatly (eg. Very small practices may have 3000, large multi-branch organisations may have tens or hundreds of thousands!). [redacted] I am in secondary care so not best placed to answer this but I can say that within Dorset we currently have 106,476 patients registered on all surgery systems as having astma.
We are modelling two broad cohorts (adults and paeds) who would have a diagnosis of asthma and would be requiring ongoing monitoring. a. For adults: have assumed average age of 47 years and 36% male sex (using data	[redacted] A. Cannot comment B. No. Firstly, prepuberty males commoner than females. Secondly, it makes no sense to lump preschoolers and school

from INCA Sun, Hale et al. 2023 which was used in a prior economic model). Does this seem reasonable? b. For children: we have assumed average age of 6 years and same 36% male sex. Does this seem reasonable?	age children. I would follow the age brackets of the BTS SIGN NICE guidelines [redacted] B. Clinically under 5s/5-12/over 12s have different management as per most treatment guidelines so I think that would make more sense [redacted] a. Yes unless there is any other more up to date epidemiological data. b. As above
We have assumed that 75% of those diagnosed with asthma requiring monitoring will use one of the technologies listed in the scope. Does that proportion seem reasonable in both adults and children?	[redacted] For children, include parents if they are young. I would have thought most would, but those who don't will likely have the most needs and need to be included somehow [redacted] Yes [redacted] Yes I would think so, or at least have the potential to use the tools.
In the economic model we have considered that 10% of patients would require a mobile phone/tablet in order to use one of the technologies (NuvoAir which relies on the	[redacted] I would have thought far too low. When we started using NuovoAir in CoVID times, virtually everyone had a device

patient having a device). Does that proportion seem reasonable in both adults and children?	[redacted] It seems very low I would imagine most people would need a device to access? [redacted] I would have thought that this number would be higher?
We have assumed that the starting levels of control (in standard care before using the technologies listed are: 23% controlled, 30% partially controlled and 47% uncontrolled [using data from Furhan et al. 2011]. Do these proportions seem a reasonable starting point for both adults and children?	[redacted] There must be better and more recent data than these, have you asked Asthma+Lung UK? – they would be an excellent source of information [redacted] Is there not any more up to date figures available? [redacted] I think that you should look at either controlled or uncontrolled as “partially controlled” could be misconstrued.
We have also assumed that 50% of users will stop using the app per year. a. Does that proportion seem reasonable in both adults and children? b. Is it appropriate to assume that this drop out rate will apply equally to patients regardless of their level of control (i.e. 50% drop out applied to “controlled”, “partially controlled” and “uncontrolled” asthma states equally)?	[redacted] A. I think it would depend on the App and its utility **B.** I don’t know but there must be data out there [redacted] b. Seems like a reasonable estimate, but likely to vary per app

	based on usability/utility etc. Have any studies measured drop out rates? [redacted] a. Is this based on other disease areas where digital platforms are used, as if there is prior evidence in other specialities aside from asthma then it should be looked at. b. I think the drop out rate will be higher in those with controlled asthma. [redacted] The drop out rate could be higher than 50% in the paediatric population. In a small local trail of a digital peak flow meter and app (Smart Respiratory) the majority of the 25 families stop using the app within 6 months. Only 68% of the families used the peak flow meter and app given to them. The children were aged between 5-16 years.
We have also included additional health states to account for a proportion of patients who have a diagnosis of asthma, however on monitoring over time may have this diagnosis removed (that is the original diagnosis was incorrect). a. Some literature suggests that this proportion may be 30%. Is that proportion plausible and reflective of your experience in adults? And children? b. Can you please help describe the health impact of an incorrect asthma diagnosis (providing inhaled steroids) on an adult or child?	[redacted] a. Adults cannot comment. Children may b as high as 50% b. Child – may be a restriction of activities unnecessarily; cost of meds and risk of side-effects; trivialising the diagnosis of asthma, if everyone has an inhaler then n ot taken seriously c. We have assumed misdiagnosis of asthma may delay alternative diagnosis ***Yes***, and long-term use of inhaled steroids may impact bone, muscle, psychiatric,

c. We have assumed misdiagnosis of asthma may delay alternative diagnosis, and long-term use of inhaled steroids may impact bone, muscle, psychiatric, cardiovascular, ocular and metabolic disease (Kavanagh et al. 2019) may also impact quality of life. Therefore, are we correct to assume that a utility decrement for those misdiagnosed? d. Is it plausible that use of the technologies listed in the scope may identify these misdiagnoses earlier than standard care?	cardiovascular, ocular and metabolic disease (Kavanagh et al. 2019) may also impact quality of life ***likely a problem only with prolonged, high dose***. Therefore, are we correct to assume that a utility decrement ***what does that mean?*** for those misdiagnosed? d. Yes [redacted] a. I think yes for adults. Recent guidelines stress the importance of objective tests and spirometry is now more accessible again for adults after being unavailable during the pandemic, so I imagine this figure will decrease in the future. I think it would be higher in children, as objective tests are often not used and there is overlap with viral induced wheeze b. Impact of an alternative missed diagnosis which could be significant, side effects as below and possible avoidance of activities which could negatively impact health eg. Avoiding exercise because you think you can't exercise with asthma would have negative effect on health c. Yes but I think it would be difficult to quantify as highly variable between patients, eg most side effects only affecting people on high dose inhaled steroids d. Yes

	[redacted] a. Yes b. There are mental repercussions for some. For some people it can affect their career choices (particularly for the military). If prescribed high doses of ICS then there cold be longer term S/E akin to those of OCS. Shorter term S/E such as oral pharyngeal effects. c. Yes d. Possibly [redacted] I cannot quantify the number of children with an incorrect diagnosis, however, can confirm this is a factor in the paediatric population. As a physio I'm clinically demonstrating the physiological response to exercise to families by observing exercise on a treadmill and highlighting normal breathlessness following exercise. This is predominantly in sedentary children and young people, inclusive of those with a high BMI. This phenomenon can also be seen in athletic children who need to develop greater stamina (and sometimes management of breathing pattern disorder) rather than asthma treatment alone. Any additional monitoring that can guide diagnosis, or management, will reduce the side effects of ICS and reduce anxiety; anxiety is a barrier to

	physical activity essential to wellbeing of the whole population, including those living with asthma. As access to asthma diagnostics (spirometry) is more challenging for children and young people, compared to adults, the use of digital monitoring adds to the clinical picture available for identifying asthma in the paediatric population.
Thinking of implementation costs, how many staff (including banding and job title) in a single practice would require training to implement one of the technologies in the scope?	[redacted] No idea [redacted] Again I think this would vary depending on the technology – eg if it is more an educational tool that would require less staff input than ones with medical devices to train patients to use. GP practice nurses do most of the chronic asthma management so I imagine they would be doing most of this work. Number of staff varies by practice – eg. I work in a practice with 15,000 patients and we have 3 practice nurses. [redacted] It will be dependant on the size of the practice/population covered but the minimum of 2 (for A/L cover/sickness etc). This could be done by various bands of staff such as an HCA but also ideally by a nurse/equivalent (paramedic/pharmacist) who will undertake the chronic disease management of patients.
We are assuming that for a patient group diagnosed and <u>treated</u> for asthma that any exacerbations they have will be 76% mild or moderate (50:50 split for mild and moderate), and 24% will be severe; using data from the	[redacted] **a.** As with many of the questions here, it would be better to tap into data that exists rather than ask for off the cuff opinions?

NG245 2024. With the same proportions applied for adults and children. **A.** Does this seem reasonable? **B.** Do we need to explore the possibility of self management apps changing the severity of exacerbations, for example, by prompting the user to seek care before it becomes severe?	**b.** Definitely [redacted] a. yes b. yes [redacted] a. yes b. yes
We are assuming that for a patient group diagnosed and not treated for asthma (used as a proxy for uncontrolled asthma) that any exacerbations they have will be 69% mild or moderate (50:50 split for mild and moderate), and 31% will be severe; using data from the NG245 2024. With the same proportions applied for adults and children. Does this seem reasonable?	[redacted] Yes if that's what the data say, not familiar with this set [redacted] Yes [redacted] Yes
Do you expect that self management using an app will lead to fewer exacerbations regardless of level of control, or will it be of more value in controlled, partially controlled or uncontrolled asthma? Do we need to account for a different improvement for each, or can we assume the same proportion fewer exacerbations across all levels for each technology?	[redacted] There must be data on this. I would expect improvement in all, but more scope for improvement in the really severe [redacted] I would imagine more scope for improvement in uncontrolled asthma – must be some data on this?

	[redacted] The app if used correctly should lead to fewer exacerbations. I would expect the proportion to be higher in uncontrolled asthmatics and therefore account for differences.
We are aiming to use data regarding exacerbations which require unplanned care, such as emergency department visits, hospitalisations and other unplanned primary care services, within the model. We need to consider the potential impact the applications may have on this outcome (e.g. percentage change). In your opinion, what is the potential for asthma applications to impact the need for this unplanned care?	[redacted] If they are to be of value, by at least 50% [redacted] I believe this is one of the outcomes with best potential, I would estimate 50% [redacted] Again, if they are used correctly then we should see a decrease in the need to attend some of these services.

NICE National Institute for Health and Care Excellence

Health Tech Programme

HTE10063 Digital technologies to support asthma self-management

External Assessment Report (EAR) and economic model – Collated Comments table

Any confidential information provided should be underlined and highlighted. Please underline all confidential information, and separately highlight information that is 'commercial in confidence' in blue and all that is 'academic in confidence' in yellow.

Comment no.	Stakeholder	Page no.	Section no.	Comment	EAG response
1	My mhealth Limited			There have been no randomised controlled trials or studies conducted for myAsthma outside of the UK. We provided evidence in the Request for Evidence document which included: 1. The myAsthma App Pilot Evaluation and Next Steps. Cambridge and Peterborough Integrated Care Board (2023). Published on the my mhealth website: https://knowledgehub.mymhealth.com/successful-pilot-study-paves-the-way-for-widespread-deployment-of-myasthma-across-nhs-cambridgeshire-peterborough 2. The myAsthma App Pilot Evaluation and Next Steps. Mid-Project Evaluation (May 2024). Cambridge and Peterborough Integrated Care Board (2024). 3. Use of a digital tool to support and optimise high-risk asthma patients (2022) NHS England.	We apologise that the company has been unable to see the information that has been marked as academic in confidence within the Report. The two evaluations by the Cambridge and Peterborough ICB (2023 and 2024) as well as Hudson et al (2025) were included in the report as academic in confidence information as they are not publicly available. We excluded the following articles from the report: - Parkes et al: excluded as it does not have a comparator and therefore does not meet the eligibility criteria for the assessment. - J Lanario et al (ERS Abstract 54755): excluded as it does not have a comparator and therefore does not meet the eligibility criteria for the assessment. We are unable to locate the article from NHS England highlighted by the company in bullet 3. The article from the Health Innovation Network is not eligible for the clinical effectiveness report as it is a news article.

				https://transform.england.nhs.uk/key-tools-and-info/digital-playbooks/respiratory-digital-playbook/use-of-a-digital-tool-to-support-and-optimise-high-risk-asthma-patients/ 4. Parkes, E., Lewis, V., Zalewska, K. (2020) Introduction of the 'myAsthma' application to aid managing complex asthma patients in the outpatient setting. https://heiw.nhs.wales/files/informing-the-future-virtual-conference-poster-submissions/introduction-of-the-myasthma-application-to-aid-managing-complex-asthma-patients-in-the-outpatient-setting/ 5. ERS Abstract 54755: Asthma control and quality of life burden associated with missed work days J. Lanario, M. Hyland, A. Blythin, T. Wilkinson, M. Masoli. Pending publication 6. L. Hudson, G. Checketts, H. Rupani, A. Nanzerkelly, D. Pettigrew, T. Wilkinson, J. Rose. Real-World Evaluation of a Digital application for Severe Asthma Management in the NHS. Pending publication 7. Health Innovation Network. New app launches to support patients with severe asthma on biologic therapies. https://thehealthinnovationnetwork.co.uk/archive/new-app-launches-to-support-patients-with-severe-asthma-on-biologic-therapies/	Furthermore, we have now excluded Ahmed (2016) and Fiks (2015) from the report; we thank the company for clarifying that these articles were not relevant to the assessment.

				Out of these pieces of evidence, it appears that the EAR have focused the review on 2 studies that are not associated with my mhealth's myAsthma product: Ahmed (2016) and Fiks (2015). We request that you review the studies we originally provided and exclude the two studies that are not related to my mhealth's myAsthma product. It is essential that the evidence we submitted is fully considered, to ensure a fair comparison between the different technologies.	
2	My mhealth Limited	37	4.2 Included and excluded studies	Table 3: Description of key studies in the evidence base Ahmed (2016) is not a study conducted for my mhealth's myAsthma. The tool used in this research was My Asthma Portal (MAP). Please refer to the request for evidence document my mhealth provided. **This is referred to throughout the document.**	Thank you to the company for highlighting this; we have removed the Ahmed (2016) study from this table and information regarding the study throughout the report.
3	My mhealth Limited	39	4.2 Included and excluded studies	Table 3: Description of key studies in the evidence base Fiks (2015) is not a study conducted for my mhealth's myAsthma. This study evaluated the feasibility, acceptability, and impact of MyAsthma, an EHR-linked patient portal supporting shared decision-making for paediatric asthma. Please refer to the request for evidence document my mhealth provided. **This is referred to throughout the document.**	Thank you to the company for highlighting this; we have removed the Fiks (2015) study from this table and information regarding the study throughout the report.

4	The Institute of Clinical Science and Technology	14	Executive Summary	• Regarding statement: "Qualitative evidence was only available for three of the apps: AsthmaTuner, the Digital Health Passport, and myAsthma" – we have a comprehensive external evaluation that provides extensive qualitative data for both patients and healthcare professionals. Please consider: o For example: Patients reported increased opportunities to change their health behaviours and enhance their understanding and management of their conditions. Most participants expressed satisfaction with the app and would recommend it to others. [redacted]	Thank you for this comment. We are able to see from the report submitted that it contains information for Asthmahub and Asthmahub for Parents relating to: patient perception of technology (in the form of data surrounding satisfaction); inhaler usage; number of visits to clinical services. For Asthmahub, there are also data available for asthma control (consisting of questions on inhaler usage, GP visits, A&E admissions, steroid prescriptions and the RCP3Q). There is also a small amount of qualitative data, though this was not stratified by technology and also includes responses from people using COPDhub. However, due to time constraints, the EAG are unable to incorporate the newly-submitted information not already in the public domain provided by the company into the EAR.
5	The Institute of Clinical Science and Technology	12	Plain Language Summary	• Regarding statement: "We also found some pieces of information that reported on healthcare professionals', patients' and carers' experiences of using three of the technologies (AsthmaTuner, Digital Health Passport and myAsthma)." – we have comprehensive external evaluation of the asthmahub app, the findings of which are detailed in the attached confidential document. For example: o the evaluation found that "There was a strong desire	The EAG are unable to incorporate the newly-submitted information not already in the public domain provided by the company into the EAR.

				among interviewed HCPs for the platform's continuation. Participants consistently recognised the value of the toolkit in providing high-quality, centralised resources and expressed concern about the potential consequences of its absence. The platform's guidelines and tools were seen as crucial in reducing variability in clinical practice across different settings and roles, ensuring consistent and high-quality care across Wales. Maintaining the platform's availability is considered essential for sustaining progress in respiratory care." ○ Please note, the app Asthma for Parents, whilst designed to support the health of children is indeed an app for the child's parents or carers. Therefore, any evidence pertaining to Asthma for Parents should be acknowledged here. [redacted]	
6	The Institute of Clinical Science and Technology	15	Executive Summary	• Regarding statement: "myAsthma suggested, at least numerically, a reduction in specialist attendance for those using the app compared to usual care. This RCT was based in	Thank you for this comment. The article by Edwards (2022) was excluded from the EAR as its study design does not meet the eligibility criteria.

					the US and lacks generalisability to the UK NHS population." – please refer to: ○ The case study by Edwards (2022), Class action: how we are improving the treatment of asthma by going into schools provided in the original submission, showed improved asthma control, reduced emergency visits, and better school attendance, leading to expansion across 52 schools in Pembrokeshire. ○ The unpublished evidence Asthmahub for Parents: Health Service Utilisation outcomes by Dr Gareth R Davies provided in the original submission demonstrating Use of Asthmahub for Parents was associated with significant reductions in GP visits, prednisolone courses, and A&E attendances among children who used the app for at least four months. These findings suggest that regular engagement with the app supports better asthma control and reduces reliance on urgent and emergency care. ○ Further, in 2023 ICST carried out a survey via the Healthhub apps, with the aim of determining if the	We apologise that the company were unable to see the academic in confidence data within the EAR due to redaction. We can confirm that the unpublished article 'Asthmahub for Parents: Health Service Utilisation outcomes' was included within the EAR. The EAG are unable to incorporate the newly-submitted information not already in the public domain provided by the company referred to in bullet point 3 into the EAR.

					apps are helping individuals to manage their condition (see Appendix 4 for details of the survey). The survey was sent to users of all three apps for completion (n ~ 10,000) with a response rate of just under 4% (n=371). When asked how long they had been using the app, the majority of responders noted they had used the app for more than 6 months (51%, n = 371, response rate ~ 3.71%), with 26% of responders using the app for more than 12 months (see Figure 4). When asked how often they are using the app, the most common response was that they use the app less than once a month (43% of respondents, n = 366, response rate ~ 3.66%) (see Figure 4). To determine the perceived impact of the app on the user's ability to manage their condition, users were asked how well their condition was managed prior to downloading the app, and how well their condition was managed since downloading the app (on a scale of 1 to 10). The response rate to the	

					question was around 3.57% (357 responses). Responses showed a significant improvement in the patients perceived ability to manage their condition since downloading the app ($p < 0.001$, Wilcoxon Signed Rank Test) (see Figure 5). As part of the survey, users were asked if their number of GP visits had increased or decreased since using the app. The response rate was around 3.68% (n = 368), with 82 (22%) indicating that their number of visits to the GP had decreased, 214 (58%) indicating their number of visits to the GP had not changed, 24 (7%) indicating that their number of visits to the GP had increased, and 48 (13%) stating 'other', the majority of which stated they haven't needed to see a GP (Figure 6). Users were also asked if their number of admissions to the ED had increased or decreased since using the app. The response rate was around 3.67% (n = 367), with 58 (16%) indicating that their number of admissions to the ED had decreased, 174 (47%)	

				indicating their number of admissions had not changed, 7 (2%) indicating that their number of admissions to the ED had increased, and 128 (35%) answering 'other', the majority of which stated they hadn't had any admissions to ED (Figure 6). [redacted]	
7	The Institute of Clinical Science and Technology	15	Executive Summary	• Regarding statement: "Only one study, using BreatheSmart (RDMP), reported on changes in symptoms, suggesting a reduction in patient reported symptoms. Qualitative evidence suggests patients gained more knowledge and insight into their condition and therefore noticed symptoms/impairment (reported for Asthmahub, Digital Health Passport and myAsthma). However, no evidence was available surrounding symptom-free days." – please consider: ○ The original submission publication Barry (2025) Creating expert patients: Outcomes from a national digital therapeutic approach for people with asthma in Wales found that use of the national asthma apps was associated with significant improvements in patient-reported asthma control, including higher proportions	Thank you for this comment. The Executive Summary is intended to provide a very high-level overview of the evidence identified in the EAR overall. The EAG therefore appreciate the suggestion but have not amended the current wording.

				achieving an RCP3 score of 0 and reduced reliance on reliever inhalers, with the greatest gains seen in patients from the most deprived areas.	
8	The Institute of Clinical Science and Technology	16	Executive Summary	• Regarding statement: "Similarly, asthma control was seen to either be maintained or improve (occasionally being statistically significant), as measured by tools such as the Asthma Control Test (ACT). Importantly, none of the apps appeared to have evidence of a negative impact on asthma control (evidence available for BreatheSmart/Respi.me (RDMP), Digital Health Passport, myAsthma, Luscii, and AsthmaTuner)." – please consider: o The original submission publication Barry (2025) Creating expert patients: Outcomes from a national digital therapeutic approach for people with asthma in Wales found that use of the national asthma apps was associated with significant improvements in patient-reported asthma control, including higher proportions achieving an RCP3 score of 0 and reduced reliance on reliever inhalers, with the **greatest gains seen in patients from the most deprived areas.**	Thank you for this comment. The Executive Summary is intended to provide a very high-level overview of the evidence identified in the EAR overall. The EAG therefore appreciate the suggestion but have not amended the current wording.

9	The Institute of Clinical Science and Technology	16	Executive Summary	• Regarding statement: "The evidence suggested that BreatheSmart (RDMP), NuvoAir, Digital Health Passport and myAsthma were well received by patients, with generally high acceptability, usability and perception of technology." – we have two external evaluations that provides extensive qualitative data for both patients with regards: o From the original submission report: Robinson (2024), Functionality and Quality of Asthma mHealth Apps and Their Consistency With International Guidelines: Structured Search and Evaluation This is supported by the independent study assessed 53 asthma apps for quality, functionality, and alignment with GINA guidelines, concluding Asthmahub was one of only three apps rated as high quality, scoring over 4 on the MARS scale and achieving a perfect 11/11 IMS functionality score, making it a standout tool for clinicians and patients alike. [redacted]	Thank you for this comment. The article by Robinson et al (2024) was identified in the searches for the EAR and was excluded as it is a review of multiple technologies and is therefore ineligible. The EAG are unable to incorporate the newly-submitted information not already in the public domain provided by the company referred to in bullet point 2 into the EAR.
10	The Institute of Clinical Science and Technology	18	Executive Summary	• Regarding statement: "Evidence is limited for all technologies and outcomes. Evidence was especially	Thank you for this comment. As previously noted, the paper by Edwards (2022) was excluded from the EAR due to its study design.

					limited for Asthmahub for Parents and NuvoAir, while no evidence was identified for Smart Asthma. Asthma control was the most common outcome where the EAG was able to identify evidence; the only technologies where there were no data for this outcome were NuvoAir and Smart Asthma." – please consider the 1) paper from original submission and 2) additional evaluation report provided: ○ Edwards (2022) Class action: how we are improving the treatment of asthma by going into schools [redacted]	The EAG are unable to incorporate the newly-submitted information not already in the public domain provided by the company referred to in bullet point 2 into the EAR.
11	The Institute of Clinical Science and Technology	116	6.2.1 Model structure		• Regarding statement: "The EAG also note that one technology (myAsthma) provides smoking advice and cessation support. The updated BTS/NICE/SIGN guidance (2024) recommends a review of smoking or vaping status at each review appointment and referral to smoking cessation services where appropriate. The EAG note that it may be plausible for some technologies to provide this support and reduce costs of onward referral. This may be considered as a value proposition in future economic modelling but is beyond the scope of the conceptual model developed for this EVA" – please consider the following statement:	Thank you for this comment. The EAG acknowledge that this may be plausible for some technologies but have not updated section 6.2.1 which is focused on the description of the economic model. However, the EAG have added this additional detail to Appendix C1 of the report.

				○ AsthmaHub and AsthmaHub for Parents provide extensive video education delivered by smoking cessation experts within the NHS and smoking status monitoring within the app.	
12	The Institute of Clinical Science and Technology	160	7. Integration into the NHS	"Sustainability considerations Medicines account for 25% of emissions within the NHS, of which inhalers (3% of emissions) occur at the 'point of use' with 20% of emissions primarily found in the manufacturing and freight inherent in the supply chain. 68 Tools that can help with better use, adherence and management of these devices could reduce direct and indirect emissions linked to inhalers and other associated medicines and reduce the carbon footprint associated with the management of asthma in line with delivering a net zero NHS. Some technologies require hardware with disposable or reusable consumables to perform spirometry. • Aptar is ISO14064 (a framework for organisations to quantify, manage, and report on their greenhouse gas (GHG) emissions and removals) compliant and has provided climate transition plans and corporate sustainability reports. • Luscii have reported they are in the process of developing a carbon footprint and carbon reduction plan. • MyHealth claim their myAsthma app's videos and education content help patients correctly use their	As previously noted, due to time constraints, the EAG are unable to incorporate the newly-submitted information not already in the public domain provided by the company into the EAR.

				inhalers, reducing inhaler waste, and reduce exacerbations which further reduces the use of devices.
				• NuvoAir and Smart Asthma have supplied a carbon reduction plan. NuvoAir reported that the spirometer that is sent to the patient can be recycled (presumably for the purpose of cleaning and reusing) – please consider the original published paper:
				  • Barry (2025). Trends in low global warming potential inhaler prescribing: A UK-wide cohort comparison from 2018–2024, which concluded that Wales was the only UK nation to show sustained improvements, with both an increase in low GWP inhaler prescribing and a reduction in high GWP use. This change was linked to the rollout of the national digital respiratory toolkit, which included updated guidelines, educational modules, and patient apps, supporting behaviour change in both healthcare professionals and patients.
				  • Further, the attached evaluation report concluded: Currently, Wales is outperforming the other home nations in reducing high global warming potential (GWP)	

				inhaler use. There has been no change in England, a deterioration in N Ireland and Scotland and only in Wales a significant switch to low GWP inhalers. This change towards dry powder inhalers (DPIs) and soft mist inhalers (SMIs) was found to correlate significantly with uptake of the Healthhub apps. Overall, the results suggest that the ICST toolkit has played a crucial role in supporting the switch to low GWP inhalers in Wales. The shift to DPI/SMI inhalers and changes in inhaler usage have positively impacted the environment. Practices with high adoption of the Healthhub apps have seen a significantly lower carbon footprint from prescribed inhalers. Wales is on course to meet the England 2030 target (50% of inhalers being low GWP) this year. • [redacted]	
13	The Institute of Clinical Science and Technology			[redacted]	Thank you for providing this new evidence. Due to time constraints, the EAG is unable to include further data from unpublished sources within the EAR.
14	Tiny Medical Apps Ltd	33	-	Setting 'unclear'. Multiple settings were covered with recruitment from community (online), primary and secondary care. This is referenced on page 11 of the UCLP	Thank you for this comment. We have reviewed the information provided in the UCLP Service Evaluation paper but note that the information refers to adoption strategies, not to the setting where the participants in the

				Service Evaluation under 'Adoption strategies'.	study were recruited from. As such, we have retained the 'Unclear' assessment regarding setting within the EAR.
15	Tiny Medical Apps Ltd	34-36	-	Can we see the DHP sections that have been redacted on these pages in order that we can check for any inaccuracies?	We apologise that the company has been unable to review redacted information regarding the DHP as part of the consultation. This issue has been flagged to NICE by the EAG.
16	Tiny Medical Apps Ltd	53	-	Age and sex available from UCLPartners if needed	Thank you for your comment. Due to time constraints, any additional information not in the public domain cannot be incorporated into the EAR.
17	Tiny Medical Apps Ltd	57	5.1	No reference to Partners in Health Measures and finding from UCL Service Evaluation (2024). This measure should be considered in narrative in 5.4 in relation to app usage and impact	Thank you for highlighting this. The EAG have reviewed the Partners in Health Measures from this report and, as it is a composite measure of questions relating to several different outcomes, it is not feasible to map the tool on to a single outcome within the EAR.
18	Tiny Medical Apps Ltd	86	5.2.2	This is a feature of the ACT rather than a research design decision. Adult Asthma Control Tests are used in the population aged 12 and over.	Thank you for this comment. The EAG has removed this statement from the EAR.
19	Tiny Medical Apps Ltd	93	5.2.3	This data from the service evaluation data was improved by the submitted [redacted] [redacted] This paper does not seem to have been considered; is it referenced in the redacted portion? Primary difference is statistically significant difference in days off school, slightly less impressive ROI	Thank you for this comment. We can confirm that we have included this paper within the EAR but the company were unfortunately not able to see the data due to academic in confidence information being redacted.
20	Tiny Medical Apps Ltd	104	5.4	States "no change in time off school/work." Action: Update to reflect observed improvements in updated data in [redacted]where applicable)	Thank you for this comment. As previously noted, this unpublished work was included within the EAR and its data were considered academic in confidence. The EAG can confirm that data from this unpublished study was considered for this outcome within the clinical effectiveness conclusions.

21	Tiny Medical Apps Ltd	104	5.4	States: “No statistically significant difference in children’s quality of life” Ensure findings for UCLP(2024) are incorporated from Page 40 “It is possible that the measurement instrument was not sensitive enough for this particular cohort. An asthma-focused quality of life measurement may be more suitable for this purpose but it is possible such an instrument may have significant overlap with other measures in the survey such as ACT and PIH” Also note part of principal activities within the submitted DHP Evidence Generation Plan to address this finding.	Thank you for this comment. To help clarify this point we have added some additional context to the statement within Section 5.4: “The evidence was conflicting on whether the Digital Health Passport reduced the number of days off school or work, with published data suggesting there was no change in time of school or work when using the EQ-5D […]”
22	Tiny Medical Apps Ltd	104	5.4	Qualitative finding framed negatively (“however”) that people use the app more when their condition is worse. This would be better reframed as neutral/positive and theory-consistent: active use increases when needed; passive use continues when well. Remove “however”/negative framing; add distinction between active vs. passive use to avoid implying burden or health anxiety from unnecessary tracking. App use can be differentiated into active and passive. Passive use is where a person keeps the app on their phone and receives medication reminders and air quality alerts, but does not need to actively interact (users do not consider this as ‘using the technology’). Active use includes symptom tracking, accessing action plans and educational resources which is only expected when	Thank you for this comment. We agree with the company’s comment surrounding the wording and have removed the word “however” from this statement to avoid potential negative framing. Regarding the statement around active and passive users, the EAG agree that there may be differences in how patients interact with the app. This may be a consideration for future work. However, it is currently out of scope of the current report. Additionally, with no formal data on how patients are using or “not using” the app, the EAG would not like to speculate on this.

				symptoms are uncontrolled. The assumption that patients would actively use features when well does not consider the burden or side effects (for example increased health anxiety) against reduced benefits (when asthma already is controlled).	
23	Tiny Medical Apps Ltd	111	6.1.2	Notes above regarding reference to un-published paper [redacted]	As previously noted, the EAG included this unpublished report within the EAR.
24	Tiny Medical Apps Ltd	112	6.1.2	Referencing ROI from previous report; updated in 2025 to a lower figure of £8.21	Thank you for this update. The EAG cannot find this value in the public domain; therefore we have stated this updated number was highlighted by the company at stakeholder consultation (in the 'EAG comment' column) – see Table 7.
25	Smart Respiratory Products Ltd	12	Plain language summary	Apologies for the confusion, the company Smart Respiratory Products Ltd developed two sensors, Smart Peak Flow (SPF) and Smart MDI Sensor (previously Smart Rescue). The Smart Asthma app performs self-monitoring, using both devices and connects remotely to a clinician dashboard. All these features are included in the pricing. Please broaden your searches to include "Smart Asthma", "Smart Peak Flow", "Smart Rescue", "Smart MDI Sensor", "SPF" and "Smart Respiratory".	Thank you for your comment. The EAG has considered the information provided by the company surrounding these two additional technologies and reviewing information provided on the company website, the EAG has assessed their eligibility as follows. **Smart Peak Flow (SPF)**: The EAG believes that SPF could be used in conjunction with the Smart Asthma app and therefore is eligible for inclusion within the EAR. **Smart MDI Sensor and Smart Rescue:** The EAG believes that the Smart MDI Sensor is a separate technology, which is used with the Smart Rescue application (as per the company website) is therefore not eligible for inclusion within the EAR. The EAG have therefore considered the evidence provided by the company in the following comments based on these judgements. Furthermore, the EAG applied a pragmatic approach to literature searching (as permitted in the NICE process and methods guide). Due to time constraints, the EAG

					have not updated the searches to include the terms suggested by the company but have considered the evidence provided as part of the consulation.
26	Smart Respiratory Products Ltd	14	Executive summary	Apologies for the confusion, the company Smart Respiratory Products Ltd developed two sensors, Smart Peak Flow (SPF) and Smart MDI Sensor (previously Smart Rescue). The Smart Asthma app performs self-monitoring, using both devices and connects remotely to a clinician dashboard. All these features are included in the pricing. Please broaden your searches to include "Smart Asthma", "Smart Peak Flow", "Smart Rescue", "Smart MDI Sensor", "SPF" and "Smart Respiratory".	See response to comment #25.
27	Smart Respiratory Products Ltd	18	Evidence gap analysis	We are submitting internal data on 58% of Smart MDI Sensor users, improving their ACT scores from 18.0 (poor asthma control) to 20.2 (good asthma control): [redacted]	Thank you for this comment and link. Due to time constraints, we are unable to include data not already in the public domain that has not previously been provided into the EAR.
28	Smart Respiratory Products Ltd	18	Evidence gap analysis	We are submitting a peer reviewed paper showing a minimum 0.5 point clinically significant improvement in PAQLQ scores of regular users of Smart Peak Flow, which was 27 out of 71 patients (38%). Published in Journal of Asthma. https://www.tandfonline.com/doi/abs/10.1080/02770903.2024.2414343.	As previously discussed in comment #29, the EAG consider this article to meet the eligiblity criteria and have now included it within the EAR.
29	Smart Respiratory Products Ltd	27	4.2	The current EAG report implies that there is no clinical effectiveness data available and no ongoing studies for Smart Respiratory. This is not the case. We think this may be due in part to lack of clarity as to what data we should submit (see earlier comments re the full app). We provide below information	Thank you for your comment. The EAG have reviewed the publications listed by the cimpany for relevance to the scope of this assessment. Accessibility, Usability and Utility of an app-based Digital Asthma Diary - *Aoife Folliard, Thomas Antalffy (Published at the Irish Thoracic Society conference)* – This article is

				on the available data which has not been considered in the EAG report to allow inclusion. Accessibility, Usability and Utility of an app-based Digital Asthma Diary - *Aoife Folliard, Thomas Antalffy (Published at the Irish Thoracic Society conference)* https://link.springer.com/article/10.1007/s11845-024-03831-1 Patient attitudes towards digital peak flow monitoring in asthma - *Sachin Ananth, Serena Alpi, Thomas Antalffy (Published at the European Respiratory Society conference.)* https://publications.ersnet.org/content/erj/62/suppl67/pa3675 Asthma attacks: using technology for early identification and monitoring resolution (ID 400). - *Antalffy T, Levy ML (Published at Primary Care Respiratory Society conference.)* https://www.pcrs-uk.org/conference-abstract-gallery/abstract/400 Digital monitoring of inhaler use is associated with reduced short-acting beta-agonist use in airways disease (ID 498). - *Ananth Sachin, Alpi S, Antalffy T (Published at Primary Care Respiratory Society conference.)* https://www.pcrs-uk.org/conference-abstract-gallery/abstract/498 Reducing pMDI Risks with an Electronic Monitor. See page 68, Abstract ID: 14804 - *Sadie Clayton, Antony Wilson, Thomas*	not eligible for inclusion in the clinical effectiveness section of the EAR as it only measures and reports data at a single time-point of 3 months (ineligible study design). Patient attitudes towards digital peak flow monitoring in asthma - *Sachin Ananth, Serena Alpi, Thomas Antalffy (Published at the European Respiratory Society conference.)* - the EAG consider this abstract to be eligible and have now included this within the clinical effectiveness section of the EAR. Asthma attacks: using technology for early identification and monitoring resolution (ID 400). - *Antalffy T, Levy ML (Published at Primary Care Respiratory Society conference.)* – This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is an overview piece (ineligible publication type). Digital monitoring of inhaler use is associated with reduced short-acting beta-agonist use in airways disease (ID 498). - *Ananth Sachin, Alpi S, Antalffy T (Published at Primary Care Respiratory Society conference.)* – This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is includes participants with both asthma and COPD and does not stratify by condition (ineligible population). Reducing pMDI Risks with an Electronic Monitor. See page 68, Abstract ID: 14804 - *Sadie Clayton, Antony Wilson, Thomas Antalffy, Will Carroll (Published at KJP Paediatric Respiratory conference.)* - This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is assesses Smart Rescue, an ineligible intervention (see comment #25 for further details). Asthma: effect of excess short-acting β2-agonist (SABA) inhaler prescriptions on healthcare resource utilisation. - *Mark L Levy, Toby Gd Capstick, Thomas Antalffy*

				Antalffy, Will Carroll (Published at KJP Paediatric Respiratory conference.) https://www.paediatricrespiratory.com/wp-content/uploads/2024/04/Abstracts_HTML-Book_KJP-2024.pdf Asthma: effect of excess short-acting β2-agonist (SABA) inhaler prescriptions on healthcare resource utilisation. - *Mark L Levy, Toby Gd Capstick, Thomas Antalffy (Published in PubMed journal at National Library of Medicine.)* https://pubmed.ncbi.nlm.nih.gov/39054088/ Technology Enhanced integrated AsthMa care (TEAMCare). - *Ingrid Wolfe (Ongoing NIHR endorsed pilot conducted by King's College London. IRAS No. 311701.)* https://www.kcl.ac.uk/research/technology-enhanced-integrated-asthma-care-teamcare ABRUPT - Asthma Better outcomes and Reduced Unscheduled care using Patient-directed digital Technologies. - *Tuck-Kay Loke (Ongoing NIHR endorsed pilot conducted by King's College London. IRAS No. 337763.)* https://www.researchgate.net/publication/377644967_ABRUPT_-_Asthma_Better_outcomes_and_Reduced_Unscheduled_care_using_Patient-directed_digital_Technologies Longitudinal study on peak expiratory flow monitoring and its impact on quality of life in childhood asthma. - *Keawalee Thamjamratsri, Yiwa Suksawat , Potjanee Kiewngam, Wanlapa Jotikasthira, Adithep Sawatchai, Natchanun Klangkalya,*	*(Published in PubMed journal at National Library of Medicine.)* - This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is an narrative analysis, not an empirical study (ineligible publication type). Technology Enhanced integrated AsthMa care (TEAMCare). - *Ingrid Wolfe (Ongoing NIHR endorsed pilot conducted by King's College London. IRAS No. 311701.)*- After assessing the associated ISRCTN record, this article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is assesses sensors, an ineligible intervention (see comment #25 for further details). ABRUPT - Asthma Better outcomes and Reduced Unscheduled care using Patient-directed digital Technologies. - *Tuck-Kay Loke (Ongoing NIHR endorsed pilot conducted by King's College London. IRAS No. 337763.)* - This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is a short statement of intent, not an empirical study (ineligible publication type). Longitudinal study on peak expiratory flow monitoring and its impact on quality of life in childhood asthma. - *Keawalee Thamjamratsri, Yiwa Suksawat , Potjanee Kiewngam, Wanlapa Jotikasthira, Adithep Sawatchai, Natchanun Klangkalya, Watcharoot Kanchongkittiphon, Wiparat Manuyakorn (Published in PubMed journal at National Library of Medicine.)* - Digital monitoring of inhaler use is associated with reduced short-acting beta-agonist use in airways disease. - *Sachin Ananth, S Alpi, T Antalffy (Published in BMJ Journal.)* – The EAG consider this article to be eligible and have now included it within the clinical effectiveness section of the EAR.

				Watcharoot Kanchongkittiphon, Wiparat Manuyakorn (Published in PubMed journal at National Library of Medicine.) https://pubmed.ncbi.nlm.nih.gov/39401135/ Digital monitoring of inhaler use is associated with reduced short-acting beta-agonist use in airways disease. - *Sachin Ananth, S Alpi, T Antalffy (Published in BMJ Journal.)* https://thorax.bmj.com/content/79/Suppl_2/A136.1 Improved Efficiency and Increased Adherence with Smart Asthma Virtual Monitoring Service. - *Darshan Negandhi, Thomas Antalffy (Published at Primary Care Respiratory Society conference.)* https://www.pcrs-uk.org/sites/default/files/2025-09/Abstract-666.pdf Identifying and Correcting pMDI Dosing Errors in the Community. - *Darshan Negandhi, Thomas Antalffy (Published at Primary Care Respiratory Society conference.)* https://www.pcrs-uk.org/sites/default/files/2025-09/Abstract-668.pdf Exploring patients' use of reliever inhalers for asthma monitored using Smart Rescue: a qualitative study. - *Roberts M, Fleming S, Ashdown HF, Wanat M (Published at Primary Care Respiratory Society conference.)* https://www.pcrs-uk.org/conference-abstract-gallery/abstract/674	Improved Efficiency and Increased Adherence with Smart Asthma Virtual Monitoring Service. - *Darshan Negandhi, Thomas Antalffy (Published at Primary Care Respiratory Society conference.)* – The EAG consider this article to be eligible and have now included it within the clinical effectiveness section of the EAR. The EAG note that the health economic outcomes were also considered within the economic evidence section 6.1.2 and Table 7, therefore no change to the report was made. Identifying and Correcting pMDI Dosing Errors in the Community. - *Darshan Negandhi, Thomas Antalffy (Published at Primary Care Respiratory Society conference.)* - This article is not eligible for inclusion in the EAR as it is assesses smart sensors, an ineligible intervention (see comment #25 for further details). Exploring patients' use of reliever inhalers for asthma monitored using Smart Rescue: a qualitative study. - *Roberts M, Fleming S, Ashdown HF, Wanat M (Published at Primary Care Respiratory Society conference.)* – This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is assesses Smart Rescue, an ineligible intervention (see comment #25 for further details). Digital Respiratory Transformation: Insights from DAACC (Digital Peak Flow Assisted Asthma Care Clinic). - *Hird MI, Hughes M, Hughes A, Rogers-Thomas E, Brown HG, Bharaj P, Gilroy-Cheetham J (Published at Primary Care Respiratory Society conference.)* This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is is a cross-sectional study (ineligible study design).

				Digital Respiratory Transformation: Insights from DAACC (Digital Peak Flow Assisted Asthma Care Clinic). - *Hird MI, Hughes M, Hughes A, Rogers-Thomas E, Brown HG, Bharaj P, Gilroy-Cheetham J (Published at Primary Care Respiratory Society conference.)* https://www.pcrs-uk.org/conference-abstract-gallery/abstract/704	
30	Smart Respiratory Products Ltd	60	5.2.1 Medication use, Quantitative evidence	We are submitting a publication containing quantitative evidence on medication (inhaler) use showing a significant reduction in SABA use of patients using the Smart MDI Sensor device. Published in BMJ Journal. https://thorax.bmj.com/content/79/Suppl_2/A136.1.abstract. Since the Smart MDI Sensor is one element of the Smart Asthma self-monitoring kit, it is reasonable to assume the same benefits will accrue to Smart Asthma users.	As previously discussed in comment #29, this article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is includes participants with both asthma and COPD and does not stratify by condition (ineligible population).
31	Smart Respiratory Products Ltd	75	5.2.2 Clinical Changes in symptoms, Quantitative evidence	We are submitting a peer reviewed paper showing a minimum 0.5 point clinically significant improvement in PAQLQ scores of regular users of Smart Peak Flow, which was 27 out of 71 patients (38%). Published in Journal of Asthma. https://www.tandfonline.com/doi/abs/10.1080/02770903.2024.2414343. The Utility Gain from an MCID increase in PAQLQ is between 0.03 and 0.07 utility units, achieved in 38% of pediatric patients.	As previously discussed in comment #29, the EAG consider this article to meet the eligiblity criteria and have now included it within the clinical effectiveness section of the EAR.
32	Smart Respiratory Products Ltd	78	5.2.2 Asthma control,	We are submitting internal data on 58% of Smart MDI Sensor users, improving their	Thank you for this comment and link. Due to time constraints, we are unable to include data not already in

			Quantitative evidence	ACT scores from 18.0 (poor asthma control) to 20.2 (good asthma control): [redacted] Based on systematic reviews and meta-analyses, the Representative Utility Score (EQ-5D-3L) for Poor asthma control is ≈0.72, and for Good asthma control, ≈0.87. The change in asthma control represents a Utility Gain of ≈0.15 in 58% of patients.	the public domain that has not previously been provided into the clinical effectiveness section of the EAR.
33	Smart Respiratory Products Ltd	97	5.2.3 Ease of use and acceptability	We are submitting internal survey data on ease of use and acceptability, showing 90% of respondents agreeing with “Taking my peak flow is quicker and easier” and 100% agreeing with “More convenient than taking notes on paper”: [redacted]	Thank you for this comment and link. Due to time constraints, we are unable to include data not already in the public domain that has not previously been provided into the clinical effectiveness section of the EAR.
34	Smart Respiratory Products Ltd	100	5.2.3 Patient perception of technology	We are submitting internal survey data on ease of use and acceptability, showing 97% of respondents agreeing with “I use it more than my mechanical peak flow meter”, 87% agreeing with “I record my symptoms and inhaler use more than before”, and 100% agreeing with “The automatic charts are convenient”: [redacted]	Thank you for this comment and link. Due to time constraints, we are unable to include data not already in the public domain that has not previously been provided into the clinical effectiveness section of the EAR.
35	Smart Respiratory Products Ltd	146	6.3.1.2 Technology cost per patient	The current presentation of the Smart Asthma price in the report as the reference cost for all technologies and scenario analysis testing this in different format i.e. upfront cost, monthly or annual implies that there is uncertainty around the price. This is not the case and we would appreciate that scenario testing is not done on this basis. The £71.10 upfront cost of the Smart Asthma solution is the total cost for the device and the app, no further annual or	Thank you for your comment. Just to clarify when applying the cost of £71.07 this has been applied as an upfront cost for Smart Asthma technology (see Table 9 and 10). Different pricing models of other technologies (which utilise different combinations of upfront, annual recurring, or monthly recurring) have been applied on a per technology basis as appropriate. The additional senstivity analysis conducted by the EAG aimed to exploring how the pricing model (upfront, recurrent costs annual, recurrent costs monthly which can stop if the user stops using the app) impacts the results. The EAG has

				monthly costs are incurred, regardless of how long the patient keeps using the platform.	added additional wording to section 6.2.7 to state that this was explorative analysis, and that Smart Asthma is only available with an upfront cost.
36	Smart Respiratory Products Ltd	158	7.	We currently supply the following Trusts/ICBs on a commercial basis. Royal Sussex County Hospital NHS Frimley Integrated Board Derbyshire Children's Hospital Barts Health NHS Trust Tameside and Glossop Integrated Care NHS FT Stockport NHS Foundation Trust Birmingham Women's & Children's NHS FT Hartlepool & Stockton Health University Hospital Southampton NHS Foundation Trust Bloomfield Medical Centre Medway NHS Foundation Trust	Thank you for your comment, the EAG have updated section 7 to reflect this.
37	Smart Respiratory Products Ltd	171	8.2 Interventions	The Smart Peak Flow device, working with the Smart Asthma app is NOT a spirometer but a digital peak flow meter (PEFM). The Smart MDI Sensor is an electronic inhaler monitoring device, called an "inhaler sleeve" in this section.	Thank you for your comment. We have updated section 8.2 with the information relevant to Smart Asthma.
38	Smart Respiratory Products Ltd	172	8.2 Other considerations	Please find the Peer Reviewed evidence for Smart Asthma at the following places: Evaluating an electronic device to monitor the type 2 high unified airway response to dupilumab. - *Stewart, Kirsten; Kuo, Chris RuiWen; Chan, Rory; Lipworth, Brian (Published by University of Dundee.)* https://discovery.dundee.ac.uk/files/134651	Thank you for your comment. The EAG have reviewed the publications listed by the cimpany for relevance to the scope of this assessment. Evaluating an electronic device to monitor the type 2 high unified airway response to dupilumab. - *Stewart, Kirsten; Kuo, Chris RuiWen; Chan, Rory; Lipworth, Brian (Published by University of Dundee.)* – The EAG excluded this article presented in the company RFE from the clinical effectiveness section of the EAR as it

				899/PIIS1081120624002333.pdf Comparison of digital vs. mechanical peak flow meters in a real-world setting (ID 567). - *Kupa E, Fleming S, Turner PJ, Hayward GN and Ashdown HF (Published by University of Oxford.)* https://www.pcrs-uk.org/conference-abstract-gallery/abstract/567 Comparison of bench test results measuring the accuracy of peak flow meters. - *Cristiano VanZeller, Andrew Williams & Ian Pollock (Published by BMC Pulmonary Medicine.)* https://bmcpulmmed.biomedcentral.com/articles/10.1186/s12890-019-0837-3 Testing the accuracy of a novel digital peak flow meter aligned with a smartphone app compared to a lab spirometer. - *Panagiotis Sakkatos, Andrew Williams (Published by PubMed Central, National Library of Medicine.)* https://pmc.ncbi.nlm.nih.gov/articles/PMC8142228/ Prediction of peak expiratory flow of the next day through a smartphone application designed for individuals with asthma. - *Panagiotis Sakkatos, Thomas Antalffy, Natalia Pavlovskaia (Published by ERS Publications.)* https://publications.ersnet.org/content/erj/56/suppl64/155	assesses a unified airway disease consisting of asthma with rhinositus (ineligible population) Comparison of digital vs. mechanical peak flow meters in a real-world setting (ID 567). - *Kupa E, Fleming S, Turner PJ, Hayward GN and Ashdown HF (Published by University of Oxford.)* – The EAG excluded this article presented in the company RFE from the clinical effectiveness section of the EAR as it assesses peak flow meters (ineligible outcome measure) Comparison of bench test results measuring the accuracy of peak flow meters. - *Cristiano VanZeller, Andrew Williams & Ian Pollock (Published by BMC Pulmonary Medicine.)* – The EAG excluded this article presented in the company RFE from the clinical effectiveness section of the EAR as it assesses peak flow meters (ineligible outcome measure) Testing the accuracy of a novel digital peak flow meter aligned with a smartphone app compared to a lab spirometer. - *Panagiotis Sakkatos, Andrew Williams (Published by PubMed Central, National Library of Medicine.)* - The EAG excluded this article presented in the company RFE from the clinical effectiveness section of the EAR as it assesses peak flow meters (ineligible outcome measure) Prediction of peak expiratory flow of the next day through a smartphone application designed for individuals with asthma. - *Panagiotis Sakkatos, Thomas Antalffy, Natalia Pavlovskaia (Published by ERS Publications.)* - This article is not eligible for inclusion in the clinical effectiveness section of the EAR as it is does not appear to be assessing the Smart Asthma self-management app but instead measures PEF via any smartphone (ineligible intervention)

39	Smart Respiratory Products Ltd	181, 182, 183, 184, 185, 190	Appendix 1 - Search strategies	Please broaden your searches to include “Smart Asthma”, “Smart Peak Flow”, “Smart Rescue”, “Smart MDI Sensor”, “SPF” and “Smart Respiratory”.	See response to **comment #25**.
40	Smart Respiratory Products Ltd	250	Appendix C1 - Additional technical information	Please find additional technical information for the table that we missed including previously. - Column **Planned changes and updates**: Continuous improvement and maintenance. Addition of further educational materials (links to external websites, videos). - Column **How this technology fits into the clinical care pathway**: Smart Asthma can be used in primary care, secondary care, tertiary care as well as in the neighbourhood in community pharmacy. NICE/BTS/SIGN NG245 stipulate that peak flow can be used to support diagnosis of asthma if FeNO and spirometry aren't available or are inconclusive. So Community Diagnostic Centres should provide patients with Smart Asthma peak flow meters to monitor their asthma over a period over 2 weeks. NG245 also encourages the use of Personal Asthma Action Plans and monitoring peak flow is a key measurable.If a patient is provided with Smart Asthma devices at an asthma review, their condition is monitored between reviews, providing valuable data to the clinician. Adherence to medication is an issue and can be monitored by the Smart MDI Sensor. The adherence data can be used by clinicians to make informed decisions as to	Thank you for your comment. We have added some of the additional proposed text to the following columns in Appendix C1 (trying to keep the content and level of detail conistent across manufacturers): • "planned changes or updates” • "How this technology fits into the clinical care pathway”. • "provides education” • "Communication features” • "Outputs (for patients)” • "Outputs (for HCPs)” Additional clarifications or detailed descriptions of the technology can be raised by committee directly to the company.

				whether to discharge a patient, step their medication up or down. Smart Asthma aligns well with the three shifts of the NHS 10 Year Plan. It digitally enables the patient, focuses on prevention instead of treatment and provides a solution for the patient to be monitored at neighbourhood level, reducing the need for the patient to be referred to secondary care. - Column **Provides Education:** External links are included on proper inhaler technique, the importance of tracking PEF data, how to measure your PEF correctly, and a useful podcast by Mark Levì discussing many interesting and practical aspects of asthma management. - Column **Communication features:** The app features one-way communication. Users can share their charts displaying PEF, symptoms, inhaler use, and ACT data via email after providing consent. Upon agreeing to the sharing policy, they can also share their data in real time with their clinician through the Smart Asthma Dashboard, a web-based application. The app also supports custom user notifications, which can appear within the app or as cloud messages in the Android system. - Column **Outputs (for patients):** The app presents PEF results in comparison to the user's personal best, along with symptom severity and inhaler medication use, displayed in a bar chart over time. This helps users identify patterns, detect early signs of deterioration, and reflect on their asthma control. It also displays ACT scores as an additional indicator of their condition. Based on historical data, the app predicts	

				the user's likely peak flow zone for the following day and provides a standard asthma action plan (there is an option to upload custom plans) for each zone, as well as alerts for potential overuse of SABA inhalers. - Column **Outputs (for HCPs): ..** ,inhaler use for each type, ACT or ACQ scores, patient notes	
41	MediTuner	12	What the EAG found	*After searching through databases and information that the technology companies had provided, the EAG found 20 pieces of information about how well the different technologies might work.* ***This included: … one about AsthmaTuner*** > We have multiple studies demonstrating the effectiveness of AsthmaTuner and at least three of these should be considered here. In addition to the previously mentioned RCT study, the most relevant document is a real-world implementation data report from 768 patients collected in an evaluation published on-line by Swedish healthcare: '*An independent real-world report published by the healthcare region of Jönköping'.* It shows improved ACT scores after a two-year intervention follow-up, an 18% improvement in lung function and fewer primary care visits. On average, patients had one fewer healthcare visit over two years as a result of better asthma control. These findings led to AsthmaTuner being included in the national reimbursement system, and it is now prescribable across Sweden.	Thank you for this comment. The real world implementation data available appears to be publicly available in Swedish. Given the time constraints of the project, the EAG would not have sought to translate non-English evidence. This is stated in the final protocol. The EAG see an English version has been submitted within these comments. However, given the time constraints, the EAG are unable to incorporate this previously unsubmitted evidence into the clinical effectiveness section of the EAR. The paper 'Shorter time to Clinical Decision' was excluded from the clinical effectiveness section of the EAR as it is a letter to the editor (ineligible publication type). The study by T. Reier-Nilsen et al., Heliyon 2024 (PMID:38628706) is not within scope for the clinical effectiveness section of the EAR as it focuses on long COVID patients, not people with asthma (ineligible population).

				We have also conducted the "Shorter Time to Clinical Decision" study, comparing traditional evaluation methods at occupational and environmental clinics with the use of AsthmaTuner. The results show that AsthmaTuner can reduce the time to clinical decision by up to six weeks per patient while also saving time for healthcare staff. Additionally results from the ADVERT study (NCT04652141), presented at European Respiratory Society Congress 2024 (1) and currently under review, demonstrated that variability testing using home spirometry, collecting serial FEV_1 and PEF measurements, showed the highest diagnostic accuracy for asthma among patients with asthma-like symptoms in primary care. Notably, the presence of at least two days with positive diurnal variability (>10%) during the evaluation period provided the optimal balance of sensitivity and specificity, respectively, (FEV_1: 61% (95% CI, 48-72), 58% (42-71); PEF: 76 (64-85), 69 (55-81) for asthma diagnosis. A study by T. Reier-Nilsen et al., Heliyon 2024 (PMID:38628706) evaluated patients suffering from long-covid symptoms. Duirnal variability in FEV_1 with AsthmaTuner was assessed before and after three weeks asthma treatment, which reduced significantly together with symptoms of fatigue and shortness of breath.	
42	MediTuner	14	Executive summary,	*The EAG conducted literature searches and reviewed evidence submitted by the companies and Clinical Experts, identifying*	Please see the EAG's response to comment #41.

			Clinical evidence	*20 relevant sources of quantitative evidence for inclusion.* ***We included evidence for … AsthmaTuner (n = 1)*** > See comment no 1	
43	MediTuner	15	Executive summary, Clinical evidence	*Quantitative evidence suggested mixed results for changes to medication use,…,* ***while some evidence for AsthmaTuner was mixed, with primary care (adults) potentially benefiting more than paediatrics.*** > The RCT showed that adherence was improved in groups using AsthamTuner on average once a week or more, as mentioned in the details of section "Medication use, Quantitative evidence"	Thank you for this comment. In the 'Medication use' section of the EAR, the EAG note the following: "This study also reported data relating to MARS adherence for those using the AsthmaTuner on average once weekly or more.[12] […] Additionally, the study reported this outcome stratified by primary care and paediatrics. In the primary care population, there was a statistically significant difference in mean overall medication usage for those using the AsthmaTuner once weekly or more, but not for conventional paper-based management. The difference between using the AsthmaTuner once weekly or more and conventional treatment was statistically significant. In the paediatric population, there was not a statistically significant difference in mean overall medication usage for those using the AsthmaTuner once weekly or more or for conventional paper-based management. There was a non-statistically significant difference between using the AsthmaTuner once weekly or more and conventional treatment." As there was suggested to be a statistically significant difference in MARS adherence in the primary care population for those using the app once a week or more but not in the paediatric population, the EAG believe that the current wording used in the Executive Summary is accurate and have made no amendments.
44	MediTuner	15	Executive summary, Clinical evidence	***For the clinical outcomes, evidence was available for … AsthmaTuner (n = 1)*** >AsthmaTuner has two pieces of evidence tied to clinical outcomes, the RCT listed as no 1 in Table 1: Key clinical effectiveness studies as well as the evaluation in Region	Please see response to comment #41 with regards to the translated study from Sweden.

				Jönköpings Län in Sweden listed in Table 3: Key cost effectiveness studies. The RCT listed in Table 1 demonstrates improvement in ACT, and the Region Jönköping demonstrates effect on ACT as well as on lung function while also saving time for healthcare staff and fewer primary care visits (see '*An independent real-world report published by the healthcare region of Jönköping*').	
45	MediTuner	15	Executive summary, Clinical evidence	***For lung function, evidence was available for BreatheSmart (RDMP) and Luscii apps*** > In the real-world data (see '*An independent real-world report published by the healthcare region of Jönköping')*, 768 patients using AsthmaTuner showed an 18% improvement in lung function (FEV_1). After 25 unique measurement days, the average improvement was 12.5%, and after 150 days, it was 18%.	Please see response to comment #41 with regards to the translated study from Sweden.
46	MediTuner	16	Executive summary, Clinical evidence	***The evidence suggested that BreatheSmart (RDMP), NuvoAir, Digital Health Passport and myAsthma were well received by patients…*** > The study "Nurses' experiences of using AsthmaTuner – an eHealth self-management system for healthcare of patients with asthma" showed that both nurses and patients found the tool useful and easy to handle. AsthmaTuner has been awarded "Best Digital Technology for Asthma Care" by The European Federation of Allergies and Airways Diseases (EFA)	Thank you for this comment. The Executive Summary is intended to provide a very high-level overview of the evidence identified in the EAR overall. The EAG therefore appreciate the suggestion but have not amended the current wording.

				representing 45 patients' organisations in 26 countries. https://www.efanet.org/news/117-dig-it/4243-press-release-european-patients-award-12023-best-digital-health-technologies-for-asthma-and-copd	
47	MediTuner	59	5.2 Results from the evidence base 5.2.1 Intermediate outcomes Inhaler technique	***Please see study nu 2 in table 1: Key clinical effectiveness studies in our RFE response***. > In our late-breaking abstract "Digital Objective Automated Feedback on Inhalation Technique", 27 patients (71%) reported that feedback helped improve their inhalation technique ($p < 0.05$). All six operators agreed the automated feedback was valuable (2).	Thank you for highlighting this information. However, due to the study design, appearing to be cross-sectional, this study is not eligible for inclusion in the current report.
48	MediTuner	75	5.2 Results from the evidence base 5.2.2 Clinical Outcomes Changes in symptoms	***RCT study: Supplementary figure S2.*** > In the AsthmaTuner RCT, uncontrolled asthma decreased from 37% to 8% between week 1 and week 9.	Thank you for this comment. The EAG has added this information from the Ljungberg (2019) study into 'Clinical outcomes – Asthma control' as this information refers to decreases in uncontrolled asthma as opposed to specific asthma symptoms: "This study also noted that the proportion of participants with uncontrolled asthma decreased from 37% to 8% between weeks 1 and 9."
49	MediTuner	76	5.2 Results from the evidence base 5.2.2 Clinical Outcomes Lung function	***Lung function*** ***Quantitative evidence*** ***No quantitative evidence for the other apps was found for this outcome*** > In the real-world implementation data (see '*An independent real-world report published by the healthcare region of Jönköping')*, we observed an 18% improvement in lung function (FEV_1). The data included 768 patients using AsthmaTuner. In this population, after 25 unique measurement days in AsthmaTuner, lung function had	Please see response to comment #41 with regards to the translated study from Sweden.

				improved by an average of 12.5%, and after 150 unique measurement days, an average improvement of 18% was achieved.	
50	MediTuner	87	5.2.2 Clinical evidence Asthma control Quantitative evidence	***For the AsthmaTuner app, a single crossover RCT included…*** > All patients had uncontrolled asthma at study start, defined by an ACT score < 20 points. AsthmaTuner's self-management module support patients in real-time by enabling self-evaluation of lung function and symptoms, which together defines asthma control, however, this was not used as an inclusion criterion. Only ACT score was used to define uncontrolled asthma at baseline.	Thank you for this comment. The EAG appreciate that the inclusion criteria for the Ljungerg (2019) study required participants to have an ACT < 20. However, the comment within the EAR relates specifically to reported treatment plans in the baseline characteristics (Table 1 in the study), which includes plans for uncontrolled, partially controlled and controlled asthma patients. It was unclear to the EAG why these were reported if all participants had uncontrolled asthma according to the ACT. To make this clearer within the EAR, we have made a minor adjustment to the wording: "The paper states that the focus is on those with uncontrolled asthma and the inclusion criteria mention including those with < 20 points on the ACT. To note, information about treatment plans at baseline was also reported, which includes plans for patients with uncontrolled, partially controlled and controlled asthma.[12] Therefore, the included population is unclear."
51	MediTuner	103	5.4 Clinical evidence summary and interpretation	***One study reported on AsthmaTuner, reporting data for one intermediate outcome (medication use) and one clinical outcome (asthma control).*** > Please see comment 1. Real-world data from 768 patients shows improved ACT scores after two years, 18% improvement in FEV_1, and fewer primary care visits (one less visit on average).	Please see the EAG's response to comment #41.
52	MediTuner	108	6.1.1 Qualitative data relating to economic outcomes	> Real-world implementation data from AsthmaTuner supported its inclusion in the national reimbursement system, making it prescribable across Sweden. The Swedish National Board of Health and Welfare (TLV)	Thank you for providing a translated version of this document. The EAG note that this presents detail relating to the decision to subsidise AsthmaTuner Digital Spirometer in Sweden. The EAG have added a summary of the economic analysis to Table 7 in the EAR. However,

				evaluated the data and concluded the following: - The cost of using AsthmaTuner is lower than that of a conventional Personal Best PEF meter. - TLV assessed that, for adults with uncontrolled asthma, the cost of AsthmaTuner is reasonable compared to the benefits — notably the reduction in healthcare visits. - In a health-economic analysis submitted by the company, using the assumptions of a two-year warranty for AsthmaTuner versus a one-year warranty for the PEF meter, plus one fewer healthcare visits every two years, their calculation found a saving of SEK 689 per patient per year (≈ £55 per patient per year). - TLV's own analysis, with the same assumptions about warranties and reduced visits but without assuming additional staff-time savings, found that AsthmaTuner is cost-saving by approximately SEK 438 per patient per year (≈ £35 per patient per year). See the attached file 'Basis for Decision: Subsidy for AsthmaTuner Digital Spirometer'.	as this is newly-submitted evidence not in the public domain, the EAG has not considered this within the clinical effectiveness section of the EAR.
53	MediTuner	110	6. Economic evidence 6.1 Existing economic evidence	***MediTuner reported four studies. The EAG was unable to find one of these; one was available only in the Swedish language; one was already included by***	Thank you for your comment. The EAG have reviewed the three submitted studies: 1. Thank you for providing a translated version of the real-world report. The EAG note that the appendices that hold

			6.1.2 Economic literature searches relating to economic outcomes	***the EAG;32 and an unpublished cost calculator was shared which compared the AsthmaTuner technology to standard care.*** > Please find attached to the submission: 1. An independent real-world report published by the healthcare region of Jönköping (AI translated from Swedish to English). 2. Basis for Decision: Subsidy for AsthmaTuner Digital Spirometer (AI translated from Swedish to English). 3. ERJ 2020 - Shorter time to clinical decision. AsthmaTuner has effect on ACT as well as on lung function while also saving time for health care staff and fewer primary care visits. The reduction in patients with very low ACT scores also supports fewer emergency visits	economic data have not been supplied, therefore the EAG have not summarised this in the economic section of the report. As previously noted, the EAG has also not included this newly-submitted evidence in the clinical effectiveness section of the EAR. 2. Thank you for providing a translated version of this document. Please see response to comment #52. 3. The EAG note that this study used AsthmaTuner to inform a clinical diagnosis of work-related asthma, therefore does not report outcomes relating to people diagnosed with asthma and is considered out of scope in line with Table 2 of the EAG Protocol.
54	MediTuner	134	Table 9 Economic Modelling: monitoring costs	***Economic Modelling: monitoring costs (per patient), all costs excluding VAT*** > As our pricing was confidential, our costs are blacked out in the table – as such impossible to comment or verify. Can these be provided to us in another format/channel for verification/comment?	The EAG apologise that the company has been unable to review redacted information surrounding AsthmaTuner as part of the consultation. We have flagged this issue with NICE.
55	MediTuner	149	Table 13 Economic	***Table 13 Economic sensitivity analysis (adults)***	Please see response to comment #54.

			sensitivity analysis	> As our pricing was confidential, our costs are blacked out in the table – as such impossible to comment or verify. Can these be provided to us in another format/channel for verification/comment?	
56	MediTuner	155	Table 15: Economic sensitivity analysis	***Table 15: Economic sensitivity analysis (children)*** > As our pricing was confidential, our costs are blacked out in the table – as such impossible to comment or verify. Can these be provided to us in another format/channel for verification/comment? 1. Myers L, Bellander M, Ljungberg H, Isachsen M, Eduards M, Lindman M, et al. Late Breaking Abstract - Assessing the diagnostic accuracy of home spirometry system for asthma diagnosis. European Respiratory Journal.64(suppl 68):PA5199. https://publications.ersnet.org/content/erj/64/suppl68/pa5199 2. Ljungberg H, Nordlund B, Carleborg A. Late Breaking Abstract - Digital objective automated feedback on inhalation technique. European Respiratory Journal.52(suppl 62):PA1337. https://publications.ersnet.org/content/erj/52/suppl62/pa1337	Please see previous comment #54 regarding redaction of information. Thank you for your comment and highlighting these abstracts. The EAG have reviewed the two abstracts: 1.Myers et al. (2024) was originally found in the EAG's clinical effectiveness literature searches and assessed to be out of scope for the EAR as it is a diagnostic accuracy study; it is listed within the 'Excluded studies' table in Appendix A4. 2. Ljungberg et al. (2018) reports inhaler technique using "In Check Dial" and the MIR Spirobank II Spirometer. – the EAG have assessed this abstract and note that the study appears to be of a cross sectional design, which is not eligible for inclusion. Additionally, it appears to assess diagnostic accuracy, which is beyond the scope of the EAR. The EAG note that the abstracts do not report outcomes that have been considered within sensitivity analysis in Table 15 therefore no changes have been made to the EAR.
57	MediTuner			Additional Documents	Thank you for this information. The EAG have reviewing this newly-submitted information and have made the following assessments regarding their eligiblity.

				 An independent real-world report pub  AsthmaTuner Decision by Dental an  ERJ 2020 - Shorter time to clinical decisic	**AsthmaTuner Final Report v2.0 (Bra Liv)** – Although this information is publicly available, the original publication is in Swedish and the EAR protocol states that publications not in the English language are ineligible. This unpublished translated version of the report was not provided at the time of the RFE; due to time constraints, the EAG have not incorported this evidence into the EAR. **Shorter time to clinical decision in work-related asthma using a digital tool** – This article was excluded from the EAR due to it being a letter to the editor (ineligible publication type). **AsthmaTuner decision** – This unpublished report was not previously provided in the RFE and so, due to time constraints, the EAG have not incorporated the clinical effectiveness data into the EAR.
58	Association of Respiratory Nurses	12	Exec summary	There is a lack of robust research both quantitative and qualitative to provide any definitive guidance as to whether an 'app' provides any benefit to patients.	Thank you for your comment. No changes required.
59	Association of Respiratory Nurses	12	Exec summary	There is a lack of cost benefit evidence to assess whether any of the 'apps' would be a cost effective tool.	Thank you for your comment. No changes required.

Section B: Comments on the economic model (please add further rows as required)

Issue	Stakeholder	Description of problem	Description of proposed amendment	Result of amended model or expected impact on the result (if applicable)	EAG response
1	Tiny Medical Apps Ltd	Markov model assumes that patients only stop at cycle end and cannot restart.	We note this is a pragmatic modeling simplification so this is not a hard objection. Suggest the model notes real-world patterns		Thank you for this comment. We note that the conceptual economic model is a framework which can be

			(e.g., periods of active vs. passive use) for future refinement.		utilised in future economic evaluations. It would be challenging to quantify transition rates back and forth between 'no app' and 'app' states, but such transitions could be added if data were available to support this in the future.
2	Tiny Medical Apps Ltd	Base case assumes treatment costs are identical in both arms and across all asthma control levels—this is unrealistic.	Revise the model to differentiate costs by asthma control level (e.g., uncontrolled patients have higher healthcare and economic activity costs; controlled patients lower). Expand beyond exacerbations-only framing to include well-evidenced cost impacts.	Interventions targeted at uncontrolled asthma are likely to offer significant benefits over those targeting populations where RCP3 score is low or ACT is high. Resource cost such as nurse time onboarding patients is better used on patients with poorer control and higher background risks (eg lower income, poor housing)..	Thank you for your comment. The EAG note that NG245 (2024) did not include different treatment costs for different levels of asthma symptom control. Feedback gained from experts was that there may be variation in levels of symptom control across asthma patients despite being on the same medication regime. To explore this further the EAG have added scenario analysis where the treatment costs of controlled remain the same as the base case, 25% increase assumed in the partially controlled group and 50% increase in the uncontrolled group. This has been added to sensitivity analysis; however has not changed the direction of results for any technology.
3	Tiny Medical Apps Ltd	Platform license cost of £102 per person for Digital	Remove £25 per person from the platform licence cost per person. Thist would only be relevant in a	This will reduce the upfront costs of the Digital Health Passport from £106.42 to the	Thank you for this comment. We have marked this £25 per patient as optional (and

		Health Passport in Table 7. (pg 134). The calculation used for this (page 252) is including an EPR integration cost. The Digital Health Passport works independently of EPR integration. This is an optional service offered by TMA via G-Cloud to secondary care as a one-off fee, independent of the asthma service being evaluated across community, primary and secondary care. The standard care referenced in the model uses primary care costs.	secondary care setting (and would need an alternative 'standard care' cost comparator.	true cost £81.42 (based upon 1000 users per ICB). This will positively impact the result for the DHP.	added the detail provided in this consultation comment to Appendix C2 for transparency). The costs have also been updated in Table 9 and the economic analysis updated appropriately for scenarios using the Digital Health Passport (DHP).
4	Tiny Medical Apps Ltd	Software only solutions(eg Asthma Hub and Digital Health Passport) have the potential to reach much greater numbers of users than 1000 per ICB.	Consider using higher numbers per ICB for software solutions compared to solutions incorporating hardware in future modelling.		Thank you for your comment. The EAG distributed one-off costs of Digital Health Passport (by Tiny Medical Apps) across 1000 patients, assuming 1000 patients across an Integrated Care Board. This is using data from the ICS respiratory review of spirometry conducted by Asthma+Lung UK (2025) with justification provided in the first bullet of section 6.2.4. The EAG has applied scenario analysis considering the impact if the

					technology was applied to 2,500 patients in an ICB. The EAG note that this approach would impact three technologies (Asthmahub, Luscii, Digital HealthPassport).
5	Smart Respiratory Products Ltd	The Smart Asthma solution includes Smart Peak Flow, a digital peak flow meter, and detailed instructions and training videos on the current peak flow manoeuvre, implying that patients on the Smart Asthma system will not need a (less efficient) mechanical peak flow meter and the associated peak flow technique education, as it is included in the app. Consequently one part of the Smart Asthma cost is not **incremental cost** but **a cost** that's **already included** in the calculations. This cost portion is what would have been spent on tracking peak flow with a traditional peak flow meter. NICE NG245 calculates the device cost and the practice nurse cost of tracking the peak flow of an adult using a traditional	The current upfront cost of Smart Asthma (c_app_upfront = £71.07) budgets both the Smart Peak Flow digital peak flow meter (as part of the Smart Asthma monitoring system) and a Band 5 practice nurse teaching the patient what to do. Consequently the £15.22 - £25.78 cost of traditional peak flow tracking has to be deducted as non-incremental cost. Taking the average of £15.22 and £25.78, which is £21.00, the incremental cost of Smart Asthma for ICER calculations should be £71.07 - £21.00 = £50.07. Similarly, the cost of other evaluated solutions that replace mechanical peak flow meters should be reduced by £21.00.	Thankfully, there is no need to rerun the model, just the cost parameter of the ICER calculation for Smart Asthma needs to be revised.	Thank you for your comment. NG245's Evidence review C presents costs applicable to diagnosis of asthma using peak flow testing. Costs of monitoring asthma in NG245 (available here) do not include a cost for peak flow testing, therefore the EAG has assumed that the Smart Asthma solution provides peak flow testing as an adjunct to the monitoring that takes place in the comparator arm. Potential time savings, that could come about through reduced peak flow testing at annual reviews, have been considered in the reduction in staff time costed into the intervention arm for all technologies. Of note, reducing the upfront cost would make the ICER more favourable, so no further modelling has been carried out.

		peak flow meter £15.22 - £25.78 in Evidence reviews for diagnostic test accuracy of peak expiratory flow variability for the diagnosis of asthma: Asthma: diagnosis, monitoring and chronic asthma management (update): Evidence review C, https://www.ncbi.nlm.nih.gov/books/NBK611966/table/niceng245er3.tab5/?report=objectonly.			
6	Smart Respiratory Products Ltd	The cost of a mobile internet connection is assumed at £21 per month. This figure is combined with an assumed device cost of £100 to yield an annual cost of £352. Since an assumed 5% of patients need to be provided a mobile device, this yields an annual cost of £17.60. Data only SIM cards, which is what patients need to use a mobile device, typically start from £5 per month https://smarty.co.uk/data-sim, https://www.lycamobile.co.uk/paymonthly/en/bundle/12-month-10gb-plan/, https://www.lebara.co.uk/en/lebara-ppc.html or £40 per	Assuming £5 as the "usual" data-only SIM card cost per month and keeping the £100 device cost assumption yields an annual cost of £160 for 5% of patients, which is £8.00 per patient per annum instead of the current £17.60. Please modify the £17.60 recurring annual cost to £8.00 for every technology reviewed.		Thank you for your comment. We have applied the £8 suggestion from the company as sensitivity analysis to show the impact of this reduced cost associated with a device and data plan. When this lower cost was applied, the ICER was below £20,000/QALY.

		annum https://www.three.co.uk/broadband/data-sim-payg, which is £3.33 per month			

NICE National Institute for Health and Care Excellence

Medical Technologies Advisory Committee Interests Register

Topic: Digital technologies to support asthma self-management

NICE's declaration of interest policy can be accessed here

Name	Role with NICE	Type of interest	Description of interest	Interest arose	Interest declared	Interest ceased	Comments
Dr Jacob Brown	Chair	N/A	Nothing to Declare	-	16/10/2025	-	No further action
Mr Abdullah Pandor	Committee Member	Financial interest	I have delivered online workshops on rapid reviews at international conferences (ISPOR) for which I received an honorarium.	November 2021 and August	24/09/2025	-	Declare and participate
Mr Abdullah Pandor	Committee Member	Financial interest	I am an expert evaluator for Horizon Europe (EU Research and Innovation programme grant). I received payment for this role.	May/June 2022 and May/June 2023	24/09/2025	-	Declare and participate
Mr Abdullah Pandor	Committee Member	Non financial professional and personal interests	I am a standing member of the NICE Medical Technologies Advisory Committee (MTAC).	2018 (ongoing)	24/09/2025	-	Declare and participate

Mr Abdullah Pandor	Committee Member	Non financial professional and personal interests	I am a standing member of the NIHR Health Technology Assessment General Funding Committee	2022 (ongoing)	24/09/2025	-	Declare and participate
Mr Abdullah Pandor	Committee Member	Non financial professional and personal interests	I am a standing member of the NIHR Decarbonising the Health and Social Care System Funding Committee	2025 (from April)	24/09/2025	-	Declare and participate
Mr Abdullah Pandor	Committee Member	Non financial professional and personal interests	I am currently employed by the University of Sheffield whose job description includes bringing in research grant income primarily from sources such as the NIHR, Industry, Charitable Institutions, and other agencies (NICE and the Ministry of Health in Singapore)	Ongoing	24/09/2025	-	Declare and participate
Mr Abdullah Pandor	Committee Member	Non financial professional and personal interests	I am also engaged in major academic research collaborations with various organisations (see https://www.fundingawards.nihr.ac.uk/ for detailed list of academic collaborators)	Ongoing	24/09/2025	-	Declare and participate

Mr Abdullah Pandor	Committee Member	Non financial professional and personal interests	My spouse is an academic at the University of Sheffield. She has a similar research profile to mine and is also tasked with generating research grant income from sources such as the NIHR, Industry, Charitable Institutions, and other government agencies.	Ongoing	24/09/2025	-	Declare and participate
Dr Avril McCarthy	Committee Member	N/A	Nothing to Declare	-	22/10/2025	-	No further action
Dr Devavrata Joshi	Committee Member	Financial Interest	Senior clinical lecturer, Brunel Medical School, Brunel University	01.11.2023	19/10/2025	ongoing	No further action
Dr Devavrata Joshi	Committee Member	Financial Interest	General practitioner, NHS (multiple practices)	07.12.2022	19/10/2025	ongoing	No further action
Dr Devavrata Joshi	Committee Member	Financial Interest	GP ENT Clinical Lead, East of England, NHS England	01.01.2025	19/10/2025	ongoing	No further action
Dr Devavrata Joshi	Committee Member	Financial Interest	MRCGP Examiner (SCA), Royal College of General Practitioners (Examiner for the Simulated Consultation Assessment part of the MRCGP qualification)	12.11.2024	19/10/2025	ongoing	No further action

Dr Devavrata Joshi	Committee Member	Financial Interest	Shield Therapeutics – shareholdings **(Pharmaceutical company – a commercial stage specialty pharmaceutical company with a focus on addressing iron deficiency with one compound, ferric maltol)**	06.01.2021	19/10/2025	ongoing	No further action
Dr Elizabeth-Ann Schroeder	Committee Member	N/A	Nothing to Declare	-	10/06/2025	-	No further action
Dr Jennie Walker	Committee Member	N/A	Nothing to Declare	-	18/06/2025	-	No further action
Dr Jihad Malasi	Committee Member	Non financial professional and personal interests	ICB Clinical lead for Mental Health	Sept 2023	19/08/2025	-	Declare and participate
Dr Jihad Malasi	Committee Member	Non financial professional and personal interests	Non executive director for Social Enterprise Kent (community interest company) - providing social kitchens, support to voluntary sector through small grants, teaching / training.	8/1/2024	19/08/2025	-	Declare and participate
Dr Jihad Malasi	Committee Member	Non financial professional	Member of British Medical Association	Nov 2023	19/08/2025	-	Declare and participate

		and personal interests					
Dr Katherine Boylan	Committee Member	N/A	Nothing to Declare	-	22/10/2025	-	No further action
Kiran Bali	Committee Member	N/A	Nothing to Declare	-	29/09/2025	-	No further action
Mr Michael Kolovetsios	Committee Member	Financial Interest	I am employed by Medtronic and work in the coronary and renal denervation operating unit. Medtronic manufactures medical technologies across a range of therapy areas, but to the best of my knowledge, the company does not have products directly related to the topic under discussion.	Nov 2019	27/10/2025	Ongoing	Declare and participate. Updated November 2025
Prof Neil Hawkins	Committee Member	Financial Interest	I am a director of a company providing on health technology assessment services to pharmaceutical companies. No services have been provided to any of the named stakeholders in in respect to any related technologies.	-	14/08/2025	Ongoing	Declare and participate

Dr Philip Crilly	Committee Member	N/A	Nothing to Declare	-	20/08/2025	-	No further action
Dr Richard Packer	Committee Member	N/A	Nothing to Declare	-	21/08/2025	-	
Ms Sharon Foxwell	Committee Member	Non financial professional and personal interests	I am working on a PPI basis with the developers of the Tiny Medical Apps app - not in relation to asthma but in relation to epilepsy.	2/11/2025	19/06/2025	-	Declare and participate. Updated November 2025
Dr Stacey Chang-Douglass	Committee Member	Financial Interest	I am a full-time employee of Clarivate, as head of Health Economics in the consulting department since August 2024. Clarivate is a publicly traded analytics company that provides bibliometrics, business intelligence, and competitive profiling for pharmacy and biotech, patents, and regulatory compliance. 27 August 2024 Not applicable My company provides research and consulting support to pharmaceutical companies at various stages of their product development, including	27 August 2024	18/06/2025	Not applicable	Declare and participate

			NICE submissions. However, I am not involved in any work associated with medical or diagnostic devices or medical technologies or digital health. This COI arose since my employment with Clarivate in August 2024				
Dr Stacey Chang-Douglass	Committee Member	Financial Interest	I am a part-time employee of Evidera, a health economic and outcome research consultancy, since January 2023. Evidera is part of PPD, which is a business entity of Thermo Fisher Scientific. However, research and consulting activities conducted by Evidera are independent of its parent organisations and other entities within the business. My company provides research and consulting support to pharmaceutical companies at various stages of their product development, including	August 2015	18/06/2025	Not applicable	Declare and participate

			NICE submissions. However, I am not involved in any work associated with medical or diagnostic devices or medical technologies. This COI arose since my employment with Evidera in January 2023. My employment with Evidera ends on 31 July 2024.				
Dr Stacey Chang-Douglass	Committee Member	Indirect Interest	I am the founding director of a charitable organisation, Pro Bono Health Economist Network, which provides research and training support to other health charities, which could be patient groups directly or indirectly involved in NICE recommendations. However, currently we are not involved in any work with any patient group. Additionally, we do not receive funding from any pharmaceutical or medical device manufacturers.	December 2021	18/06/2025	Not applicable	Declare and participate
Dr Stacey Chang-Douglass	Committee Member	Indirect Interest	I have been a professional reviewer (health	August 2015	18/06/2025	Not applicable	Declare and participate

			economist) for National Institute for Health August 2015 Not applicable Interests form (advisory committees) October 2022 4 of 5 Research (NIHR) since August 2015. I provide independent comments on NIHR funding proposals and Health Technology Assessment reports, which may include research associated with pharmaceutical products or medica devices. However, I am not involved directly in any of the funding decisions.				
Dr Teik Goh	Committee Member	N/A	Nothing to Declare	-	12/10/2025	-	No further action
Prof Andrew Bush	Specialist Committee Member	N/A	Nothing to Declare	-	9/07/2025	-	No further action
Miss Anne Marie Whiting	Specialist Committee Member	N/A	Nothing to Declare	-	29/07/2025	-	No further action

Prof Ian Sinha	Specialist Committee Member	Financial Interests	Paid employment in a role relevant or potentially relevant to the committee including in the health and social care sector or commercial sector": I am NHSE NW CYP transformation lead for CYP asthma	01/01/2023	22/07/2025	Ongoing	Declare and participate
Prof Ian Sinha	Specialist Committee Member	Financial Interests	"Paid employment in a role relevant or potentially relevant to the committee including in the health and social care sector or commercial sector": I am Clinical Lead for the CYP arm of the National Respiratory Audit Program	01/01/2019	22/07/2025	Ongoing	Declare and participate
Dr Kay Roy	Specialist Committee Member	N/A	Nothing to Declare	-	30/07/2025	-	No further action
Dr Natalie Harper	Specialist Committee Member	Financial Interests	Sponsorship to the ERS conference	07/09/2024	23/06/2025	11/09/2024	Declare and participate
Dr Natalie Harper	Specialist Committee Member	Financial Interests	Pending sponsorship to the ERS conference	07/09/2024	23/06/2025	01/10/2025	Declare and participate

Dr Olivia Barry	Specialist Committee Member	N/A	Nothing to Declare	-	07/07/2025	-	No further action
Mrs Emma Thompson	Specialist Committee Member	N/A	Nothing to Declare	-	19/06/2025	-	No further action
Mrs Mala Thapar	Specialist Committee Member	N/A	Nothing to Declare	-	10/07/2025	-	No further action