

Smart Inhalers: The Value and the Challenge

With asthma cases rising globally, it is essential to explore new ways to help patients use their inhalers as prescribed to seek to reduce costs for health services and ensure patients get the optimal benefit from their inhaled medication

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Adding connectivity to inhalation devices offers promising potential for supporting medication adherence, proper inhaler usage, and improved outcomes, but scalability and business model issues must be resolved to accelerate development and adoption.

Medication nonadherence presents a serious issue across many chronic conditions, including asthma and chronic obstructive pulmonary disease. As well as adversely impacting patients, it has significant economic ramifications for both healthcare systems and pharmaceutical companies. Estimates of avoidable healthcare costs range up to \$290 billion in the US and €1.25 billion in Europe (1). Pharma companies lose an estimated 36% in potential sales per drug on average (2). This adds up to approximately \$188 billion in annual losses for the US pharma industry alone (3).

Focusing on asthma, more than 400 million people globally are expected to have the disease by 2025, up from 300 million today (4). Two-thirds of asthma deaths are preventable, yet approximately 50% of people with asthma do not take their medication as prescribed. In the UK, the disease is estimated to cost the healthcare system £1.1 billion for a patient base of around six million. However, the total economic

cost, considering broader factors such as loss of working time, is much higher.

Patients don't take their medication for a variety of reasons. These include the intermittence of asthma symptoms, questions about the efficacy of the drug, concerns about real and perceived side effects, mixed messages or lack of regular guidance about therapies from different clinicians, high out-of-pocket costs, or simply forgetting to take the medication.

Many treatment regimens include both preventive/controller medication and relief/rescue medication. Some patients have a tendency to forego the preventive medication, relying solely on the relief medication as needed. As the relievers provide immediate relief from symptoms, the patient feels it is justifiable to continue this approach. However, in reality, this behaviour is often a red flag that the disease is being poorly managed overall. If patients don't consistently take their preventer, relievers often aren't enough to stop the disease cascade that ends with hospitalisation. That being said, it is important to recognise that certain conditions such as high pollen count or pollution may trigger attacks that require relievers, even for patients who regularly take preventive medication.

Also, using an inhaler properly requires clear, careful patient education.

Insufficient instruction can result in poor inhaler technique, leading to patients who believe they're diligently taking their medication as prescribed but actually use the inhaler incorrectly.

Recognising that low adherence to therapy and poor inhaler technique are widespread problems, the interest in smart inhalers that can monitor and even encourage patient use has been rising. Asthma UK, a London-based patient support and advocacy nonprofit organisation, is among the stakeholders who see exciting potential in smart inhalers and other connected digital solutions for revolutionising asthma care, in part by boosting adherence. In its report 'Smart asthma: Real-world implementation of connected devices in the UK to reduce asthma attacks', Asthma UK notes that despite the widespread availability of effective treatments, care for the 5.4 million people with asthma in the UK has seen no significant improvement in recent years (4).

However, the development and adoption of connected solutions has been slow. In part, this is due to the lack of a standardised, evidence-based treatment protocol for asthma. Management of the chronic condition can entail ongoing self-management and support, yet treatment can be confusing, complex, highly variable by patient, and inconsistent between clinicians. Patients are often on

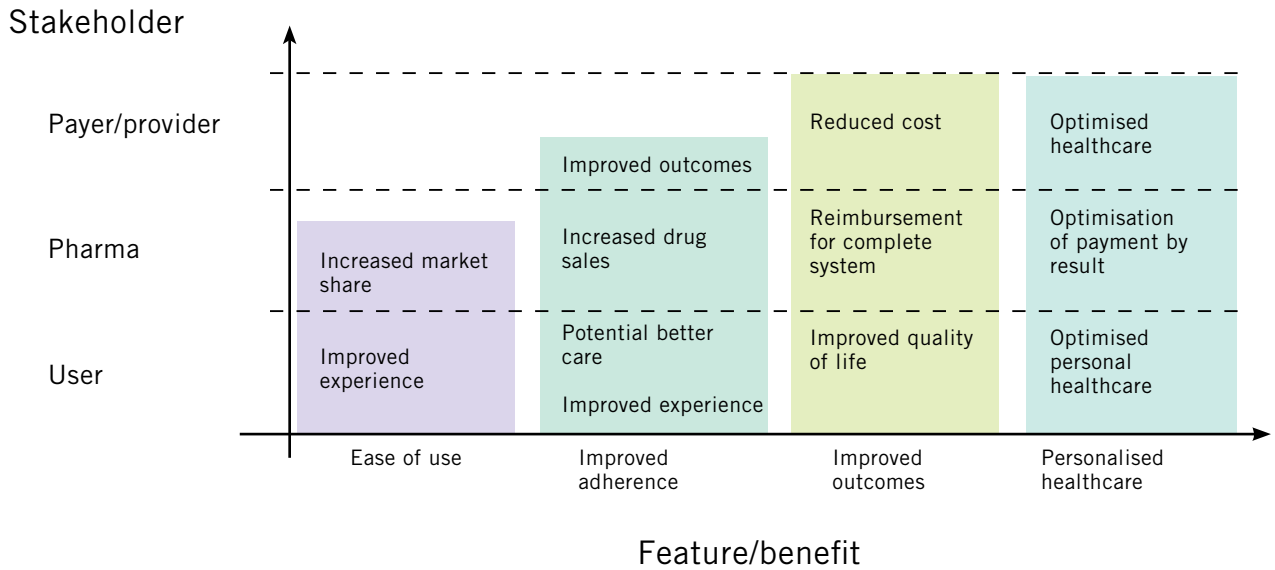


Figure 1: Benefits of electronic and connected devices (5)

multiple therapies from multiple pharma companies, which further complicates disease management.

The additional costs of digital technology creates another potential hurdle. It is important not only to keep development and product manufacturing costs as low as safely possible, but to build a strong business case that connected inhalers deliver a return on investment for pharma companies and outcomes aligned with payer value-based reimbursement paradigms.

Taking a closer look from the technological, commercial, and user perspective at the challenges as well as the factors required to scale up connectivity in the respiratory disease management arena can provide helpful insights and guidance.

What is the Value of Smart Inhalers and Associated Digital Services?

Figure 1 shows the impact of improved medication management provided by an electronic or connected device. Some patients may well be engaged and motivated by the collection of data related to their medication. This feature might then increase market share of a drug where the patient has a choice of

medication. This, in turn, can lead to improved medication adherence and, hence, reduce the revenue loss to the pharma company. If this can be shown to improve clinical outcomes, then the healthcare payer starts to gain a benefit if this reduces higher costs associated with disease complications.

Finally, in the longer term, the ability to combine measurement of medication adherence with clinical outcomes may create the opportunity to provide more personalised healthcare. Medication dosing could potentially be modulated by patient-specific factors such as genomic factors and the presence of environmental considerations that may increase the risk of asthma at a particular time.

Figure 2 shows that there is a ‘hierarchy of opportunity’ for digital health. At the lowest level, a connected inhaler can measure adherence by providing an accurate timestamp for when medication was taken and comparing this to the medication guide. This, in itself, is useful as it allows a better understanding of nonadherence based on quantitative rather than qualitative data. However, the situation for a particular patient can be improved only when this information is part of a feedback loop. One route to achieving this is to share the information

with a healthcare professional who can identify which patients are having difficulty with adherence, prioritise those most in need for timely follow up, and provide support. Patient support programmes (PSPs) that seek to improve patient engagement and adherence through interventions such as training or education are already common in the pharma industry, and digital technologies are being used to improve the efficacy of these programmes.

Usually, a PSP aims to increase adherence and, as a result, medication sales. However, this business case limits the application of digital technologies to situations where a pharma company can earn a return on its investment through increased drug sales – typically, where there is a high-value drug involved. Wider use in healthcare is limited to the ability of a healthcare provider, who is already under tight time pressure to monitor patient data.

Moving up the hierarchy, another possibility is to create a feedback loop in which digital services are used to change patients’ behaviour to support adherence. This could be achieved via a smartphone app that could provide reminders, or a medication diary that would allow them to monitor and improve adherence. All these

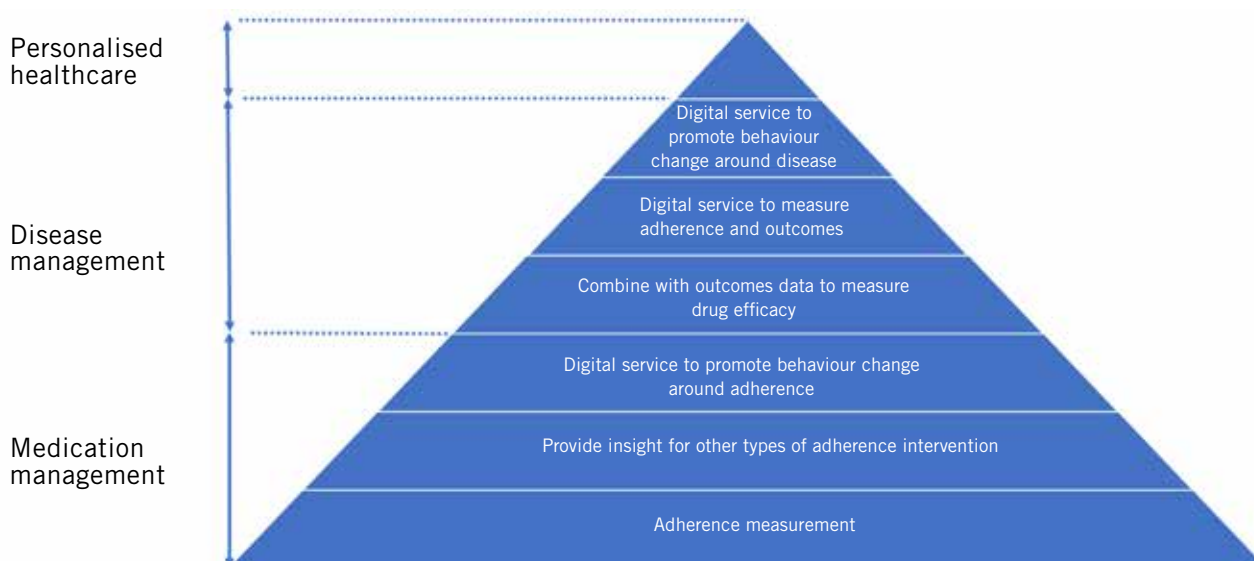


Figure 2: A hierarchy of opportunity for digital services

activities focus essentially on medication management.

A higher level in the hierarchy are digital services that aim to link medication use or behaviour change to clinical outcomes. For example, the usage data collected may be combined with other data to indicate a patient's current risk level of asthma attack. Alerting the patient may nudge behaviour towards improving direct medication usage or seeking medical advice before an attack occurs. The digital services could also target behaviours such as exercise or diet change that support better outcomes. These types of interventions go beyond medication management to focus on disease management.

Finally, at the top of the hierarchy is the opportunity to provide more personalised healthcare in which medication use and disease management are tailored to a patient's specific needs.

Where Are We Now?

Reasonable as it is to assume that better adherence leads to improved health outcomes, the evidence remains elusive. For example, an analysis of several studies on adherence interventions such as patient education, reminders, simplified dosing, and counselling found that some interventions had a positive effect on adherence and outcomes, but no single strategy demonstrated improvement in all settings (6).

Additionally, patient attitudes and behaviours can affect adherence and treatment outcomes. A recent study categorised European REALISE (Recognize Asthma and Link to Symptoms and Experience) survey respondents into five distinct attitudinal clusters that reflected common beliefs and attitudes towards asthma and how to manage it. Researchers found that the different patient groups displayed clear

variability in terms of how confidently they managed their asthma, reliever and preventer medication adherence, and level of asthma control (7).

These findings, which support the value of identifying specific patient attitudinal subgroups and then appropriately targeting interventions, are consistent with Asthma UK's philosophy that tackling asthma medication adherence issues first requires understanding and grouping people's behaviours in order to target effective action – digital or otherwise.

The potential of connected solutions to improve medication adherence through numerous benefits such as better usability, reliable medication reminders, increased patient support, and other factors that positively influence behaviour has helped drive the development of connected drug delivery devices. To date, these devices have been most frequently used for high-value medications for chronic diseases in competitive markets such as multiple sclerosis, human growth hormone deficiency, and diabetes.

Scaling connected solutions and applying them to wider healthcare practice, including respiratory disease, continues to be challenging. However, studies have shown that digital health interventions offer numerous benefits,



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including improved asthma control, reduced use of reliever medications, and better adherence to controller/preventer medications (8). The growing evidence includes research that found that the number of asthma-related emergency department visits by patients decreased by more than half, from 11.6 to 5.4, when electronic medication monitors that tracked rescue and controller inhaler medication use were used, along with a digital health platform that shared data on medication use and asthma control status with patients and providers (8). These findings are consistent with studies that demonstrate improved adherence for injectable drug delivery when connected devices are used. The challenge that remains is the ability to demonstrate that the results from these studies can be scaled and extended to real-world settings.

Reaping the Benefits

To add connectivity to inhalers, pharma companies have been using add-on sensing devices that attach to commercially available inhalers. Next-generation devices include integrated sensors and companion mobile apps. The ability to capture and share reliable medication usage data in real time, with both patients and providers, enables better monitoring and earlier intervention that can contribute to more efficient disease management and help prevent symptom escalation.

Usability and interoperability are key functionalities that need to stay front and centre when developing connected inhalers. It's not unusual for one patient to use multiple medications from several different pharma companies. Therefore, a system that can integrate multiple data sources and share them easily with multiple providers – via a plethora of electronic health records – is a must.

Unique cost-control challenges continue to be the primary factor limiting the number of connected inhalers and other medication delivery devices on the market. Adding and integrating connectivity to inhalers and other drug

delivery devices typically requires a battery, Bluetooth, one or more sensors, and associated electronics which can add a significant expense to products that have traditionally been low cost to bring to market.

Working with a development partner who can manufacture the electronics internally makes connectivity for drug delivery devices far more affordable. End-to-end development and manufacturing capabilities can accelerate time to market by streamlining design and production. Additionally, knowledge and experience regarding global rules and regulations can reduce project costs and support regulatory approval.

Growing evidence that smart inhalers can improve patient medication adherence and minimise largely preventable adverse outcomes has piqued the interest of patients, providers, and pharma companies. However, this interest now needs to be converted into tangible action. Organisations such as Asthma UK are working on building the evidence, agnostic to specific devices or therapies. The ability to scale up successfully requires cost-efficient manufacturing processes and a strategic patient-centric approach that demonstrates the value of the connected devices to outcomes-focused payers.

More work is required before smart inhalers and associated digital services can be better implemented and demonstrate the ability to move up the hierarchy shown in **Figure 2**. However, the ability to accurately determine when patients are taking their medication, and provide a digital marker that can then be acted upon with confidence, is a valuable step forward in that journey, and a reality today.

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