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LEVERAGE TECHNOLOGY TO OVERCOME PULMONARY DRUG DELIVERY CHALLENGES

Here, Jean Vuillecard, Innovation & Product Manager, and Eric Dessertenne, Head of Business Development, both of Biocorp, define the limitations of traditional strategies to train, educate and track patient adherence with inhaled therapeutics and show how connectivity and other add-on digital technology can provide the support with these strategies that healthcare providers require.

THE LIMITS OF TRADITIONAL INHALED THERAPIES

Over the years, inhalation has been recognised as the main route of administration for asthma and chronic obstructive pulmonary disease (COPD) treatments, being preferred to oral medication. Indeed, inhaled medication allows high concentration and localised drug delivery leading to direct pharmacological effects while having lower risk for systemic side effects.

However, despite proven results in terms of clinical efficacy, delivery of inhalation drugs appears to be more complex than oral drugs. Where swallowing tablets is sufficient to achieve the desired therapeutic outcome, the effectiveness of an inhaled therapeutic is heavily dependent on the

drug formulation, user-friendliness of device design, and patient ability to inhale the right amount of active substance. Pulmonary drug delivery devices have to master all these aspects before achieving the desired therapeutic goals.

Medical device companies have developed a wide range of inhalers with brilliant designs and innovative mechanisms over the past few decades. For drug dissolved in a propellant, suspended into droplets or in dry powder, the number of inhaler designs has greatly increased over the last decades. Today, dry-powder inhalers (DPIs) and metered-dose inhalers (MDIs) are the main devices prescribed for asthma and COPD. Due to a relative low cost per dose, MDIs are still widely used and far ahead DPIs in terms of volume. However, evidence from published scientific literature demonstrates that the clinical effectiveness of an inhaler is closely dependent on the patient's inhalation technique.¹

Regardless of inhaler devices used, symptom control observed among European patients is suboptimal in 56.5% of the patients with asthma. This low proportion achieving symptom control is associated with a decline in quality of life, higher risk of exacerbations, and greater consumption of healthcare resources.² According to LIAISON (the largest observational studies on characteristics and management of asthmatics in Europe), low adherence to therapy and insufficient training of patients in the appropriate inhalation techniques



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"When connected with a pMDI, Inspair is capable of tracking every inhalation directly from the patient's inhaler. Specific sensors capture unique data related to breath-hand co-ordination, inhalation speed/depth and inhaled dose."

are amongst the most important factors contributing to uncontrolled asthma.

For most long-term treatments, keeping patients compliant with the initial prescription is a key challenge. Indeed, poor adherence to treatment leads to uncontrolled symptoms and, as a consequence to a degradation of patients' quality of life. However, understanding the causes of non-adherence is tricky since a number of medication-related and non-related factors are associated with patients' ability and willingness to stick to their inhaled therapy.

Poor adherence is associated with a higher risk of symptom exacerbation and it is therefore critical to identify treatment-related issues at early stages. Too often, the over-consumption of rescue medication reveals suboptimal asthma control arising from poor adherence to long-term controller medications. Meanwhile traditional self-reporting methods are not reliable and "white coat" compliance could be misleading for healthcare professionals (HCPs). Despite dose-counters being integrated into inhalers, identifying patients who are slowly drifting away from inhaled

therapy is a complex mission. For instance, an often confusing situation appears when patients believe they are taking medications as prescribed but, in reality, unintentionally use inhalers the wrong way. Inhalation errors have been well documented in the medical literature and seem to have a direct impact on intended therapeutic goals.

As pointed out by the Guide for Asthma Management and Prevention 2015, more than 80% of patients living with asthma do not use their inhaler adequately. Even more disturbing, a recent audit among HCPs³ confirmed previously published studies stating less than 10% of HCPs were competent for advising patients on the best use practices of MDIs.⁴ Data (see Figure 1) indicate that the most frequent errors when using an MDI are:

- the lack of breath-hand co-ordination (45%)
- speed and/or depth of inspiration (44%)
- no-post inhalation breath-hold (46%).⁵

Inadequate education of patients in inhalation techniques is too frequent and systematic reviews question this situation,

which has not changed significantly over the last 40 years, though considerable effort has been invested in education, training and device development.⁵

LEVERAGE TECHNOLOGY TO OPTIMISE TREATMENT OUTCOMES

Given these observations, we should rethink the way inhaled therapies are provided to patients. Despite medical guidelines aiming to reduce non-adherence and inhaler misuses, patients and their caregivers should be provided with user-friendly and high-quality educational material to improve the way they use their inhalation devices. As described by Gillette *et al*, inhalation techniques are significantly improved after educational interventions, especially in paediatric patients.⁶

HCPs are the most appropriate people to provide such instructions and to correct mistakes when made in order to ensure effective drug therapy and delivery; but this process is long and time-consuming. This is where technology can really support HCPs, identifying patients requiring specific (re)training and providing precious help to improve adherence to therapy and inhalation techniques over time.

During medical appointments, patients often have difficulty sharing and describing treatment-related issues and discomfort. Identifying handling inhalation errors made at home is not an easy task, since patients try to do their best and will try to minimise their mistakes when in front of HCPs. People living with asthma can be advised to keep a logbook with daily doses inhaled (preventer and reliever medication), symptom frequency as well as exposure to triggers. However, very few have the time and motivation needed to keep such a diary over the years. In many cases, daily habits make it difficult to remember medication over-consumption or forgotten doses.

So HCPs are still lacking information regarding patients' day-to-day adherence and inhalation techniques. Furthermore, a steep increase in the number of errors within patient groups using a device for more than two years has been clearly described (see Figure 2). Therefore, patient education should be provided over the whole period inhaled therapy is being used, and re-training patients using inhalers for long periods should also be considered.

To overcome these challenges, Biocorp designed Inspair – a smart solution collecting data related to treatment adherence and

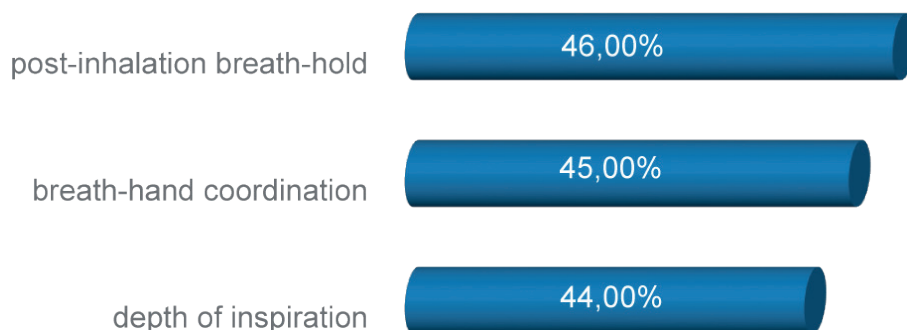


Figure 1: Most frequent errors among MDI users.⁵

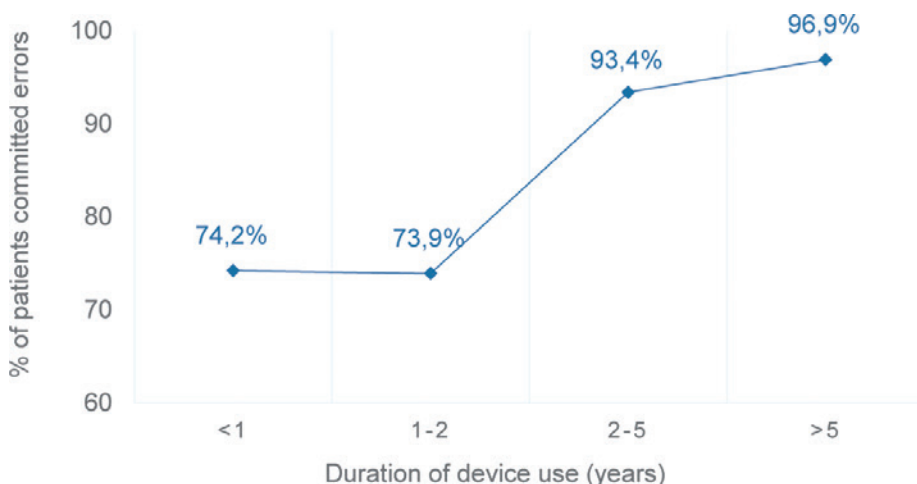


Figure 2: Duration of device use versus error, comparison. (Source: Arora, et al 2014)

inhalation techniques. In addition to reconnecting patients with doctors, Inspair functionalities foster better self-care therapy.

Inspair consists of a smart sensor that can be attached to any pMDI (see Figure 3). Connected with a dedicated mobile app via Bluetooth, the smart solution embeds an inhalation tracking system, an active feedback system as well as digital features to allow treatment monitoring.

“Inspair’s solution offers a range of digital tools to improve traditional treatment monitoring. From inhaled dose and symptom logbooks to seasonal triggers, Inspair’s electronic reports can be personalised and enriched with environmental exposure and symptom control insights.”

INHALATION TRACKING SYSTEM

When connected with a pMDI, Inspair is capable of tracking every inhalation directly from the patient’s inhaler. Specific sensors capture unique data related to breath-hand co-ordination, inhalation speed/depth and inhaled dose.

Dose counting is definitively a useful feature but all the doses counted are not necessarily doses that were inhaled by the patient. Knowing the difference is critical to identifying the root causes of suboptimal treatment outcomes when patients seem to comply with the prescribed therapy.

Physicians and patients need more information on the inhalation itself to make better decisions. Having access to accurate and objective metrics offers new possibilities as to how to manage long-term therapy and encourage patient self-improvement.

ACTIVE FEEDBACK & EDUCATIONAL SYSTEM

Pulmonary drug delivery using pMDIs requires patients to follow complex handling instructions with several operations to be performed in a specific sequence. The correct inhalation manoeuvre turns out

to be complicated for patients, particularly for children and the elderly.

To reduce the complexity of using pMDI, Inspair embeds visual and audio signals providing guidance throughout the inhalation process. From inhaler shaking to the breath-hold step, patients receive a clear and user-friendly guide through the inhalation.

Inhalation data are then automatically recorded and transmitted to a dedicated mobile app. A feedback system points out both correct use and misuse. Based on personal inhalation data, the app provides useful advice to the patient to improve inhalation technique and therefore optimise drug delivery and treatment outcomes.

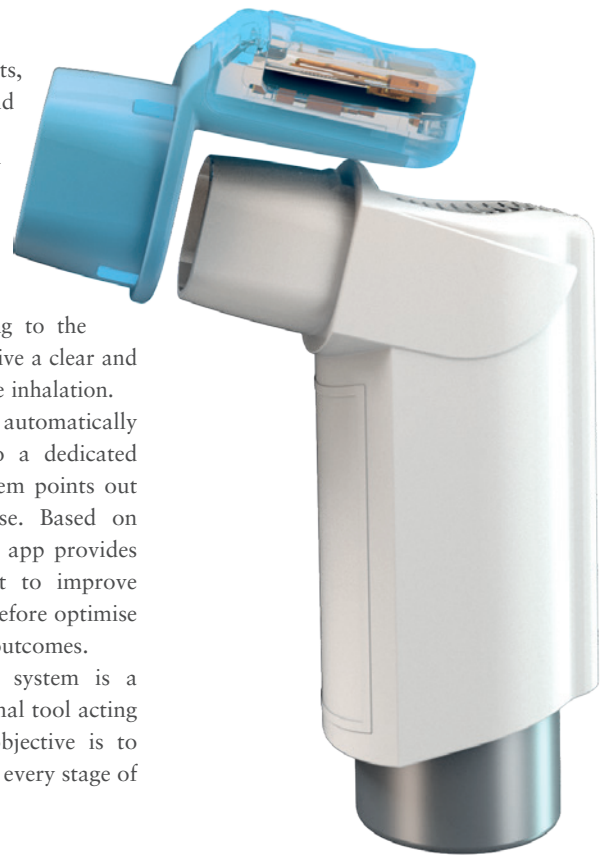
Inspair’s active feedback system is a digital, personalised educational tool acting like a coach. Its ultimate objective is to support patients and HCPs at every stage of inhaled therapies.

DIGITAL FEATURES TO MONITOR INHALED THERAPY

When it comes to long-term therapy, having access to comprehensive and accurate treatment data is critical for effective monitoring. Now with the support of technology, patients, caregivers and HCPs are able to monitor inhaled therapy as never possible before.

Inspair’s solution offers a range of digital tools to improve traditional treatment

Figure 3: Inspair smart sensor can be attached to a large range of inhalers.



monitoring. From inhaled dose and symptom logbooks to seasonal triggers, Inspair’s electronic reports can be personalised and enriched with environmental exposure and symptom control insights. These digital features provide patients and HCPs with a clear view of the treatment with real-life, day-to-day information.

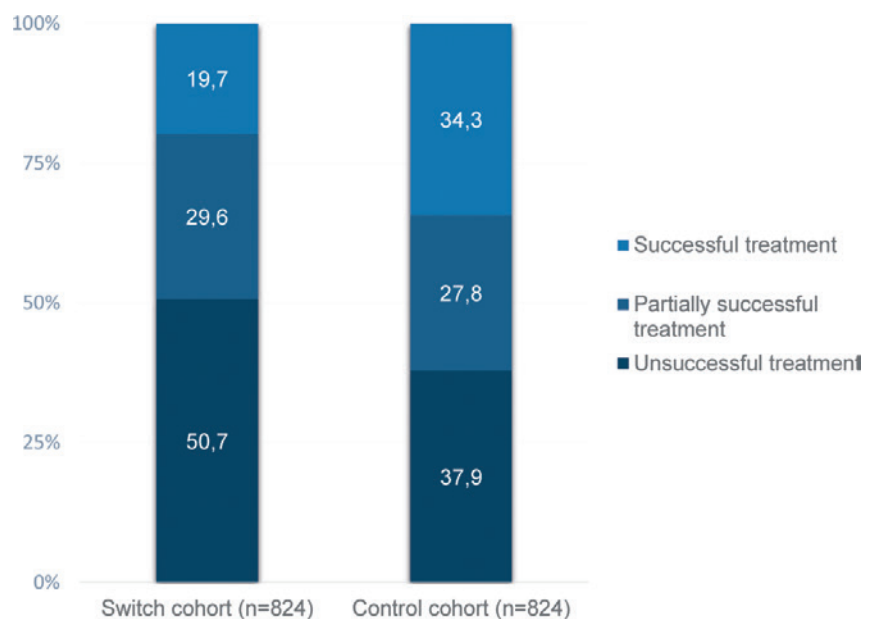


Figure 4: Handling error rates among patients who switch inhalers.⁷

An alert feature allows relatives, caregivers or HCPs to be informed about lack of adherence, overexposure, and potential triggers and symptom exacerbations.

ADD-ON APPROACH: SEAMLESS INTEGRATION OF TECHNOLOGY

The wide adoption of information technology into healthcare is transforming drug delivery and monitoring. Patients are demanding modern and more effective health services. Consequently, medical devices are taking advantage of digital features and wireless connectivity to optimise traditional treatment outcomes. The medical device sector cannot stop innovating and our objective is to continue bringing new technologies that will improve patient therapy and safety. However, we should be careful that innovations do not confuse patients and HCPs.

Jumping directly to a completely new inhaler device with high-tech features embedded could achieve the opposite of what innovation is aiming at – improving medication delivery and patient's experience safety. Leiner *et al* provide a well-documented body of evidence on the consequences of switching inhaler devices.⁷ Figure 4 points out the increasing error rates among patients switching from one inhaler to another.



Figure 5: Inspair fits pMDIs without interfering with spray diffusion.

It is therefore important that patients can keep using the same inhaler when appropriate. As medical device developers we focused on developing a way to integrate technology seamlessly into the current patient environment. The add-on approach appears to be the best solution to turn existing devices into smart inhalers without dramatically changing the patient's familiar routine.

"Inspair's add-on does not require the initiation of a new inhaler device development program. Fully customisable and cost-effective, Inspair's smart sensor can be adapted to suit every pMDI available on the market."

Inspair is a compact add-on module designed to fit MDIs without interfering with spray diffusion (see Figure 5). That way, patients can continue to use their inhaler as usual. This add-on approach enhances treatment management possibilities while avoiding the confusion that can arise from having to use an entirely new inhaler.

Another distinct advantage of the add-on approach is that, in terms of time-to-market, add-on is the fastest way to bring added-value products to patients and to HCPs. Indeed, Inspair's add-on does not require the initiation of a new inhaler device development program. Fully customisable and cost-effective, Inspair's smart sensor can be adapted to suit every pMDI available on the market.

In addition, the add-on approach is durable. When inhalers are empty, patients throw them away. As the Inspair smart sensor is removable and reusable, patients can continue to use it with new devices. It allows patients to keep track of inhalations over longer periods.

CONCLUSION

Pulmonary delivery is a highly effective administration route for respiratory disease treatments. However, suboptimal outcomes have been observed in an increasing part of patients living with asthma and COPD. Despite efficient medical devices, patients still struggle to use inhalers in line with recommendations. Low adherence and incorrect inhalation techniques have a significant impact on patient quality of life and symptom exacerbation. Numerous studies have pointed out the lack of proper training among patients and HCPs.

For these reasons, Biocorp has developed Inspair, a connected solution turning any traditional inhaler on the market into a smart device. Inspair is a compact, add-on module designed to fit pMDIs without interfering with spray diffusion. Smart sensors collect unique inhalation data and are connected to smartphones via Bluetooth low energy. This innovative solution offers new possibilities for improving the education of patients and HCPs in the most appropriated way to use inhalers and to enhance patient adherence.

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