



# MULTISENSORY TRAINING AND SMART DEVICES FOR IMPROVING PULMONARY DRUG DELIVERY

In this article, Craig Baker, Executive Vice-President, Noble, highlights the importance of device training in the effective treatment of diseases for which inhaler-delivered therapeutics are prescribed. He outlines recent advances in training techniques and the emergence of smart devices with training and error reporting functionality built in.

## INTRODUCTION

A number of advantages exist with pulmonary administration for the treatment of chronic and acute conditions, that offer promising future growth in these markets. According to the US National Institutes of Health (NIH), a nominal dose is defined as “the total prescribed dose” of an inhalable therapeutic. Commonly observed actual doses (medicament effectively reaching the lung) however, are in the range 6-60% of the nominal dose. Such incomplete doses pose safety risks to patients and reduce the effectiveness of their treatments.

**“THE RESULT IS AN EFFICIENT LEARNING EXPERIENCE FOR PATIENTS, WHICH BUILDS CONFIDENCE WITH A DEVICE WHILE IMPROVING ADHERENCE AND SAFETY”**

Successful use of respiratory delivery devices depends on a number of factors including the properties of the lung, disease state, breathing patterns and delivery techniques. Using a respiratory drug delivery device can create anxiety for patients and leave them questioning their ability to self-administer. In order to prevent such outcomes, the industry has turned to education to support and empower patients.

A recent example of this education is the creation of a smart training device with sensor technologies and auditory instructions that measure the flow rate and velocity of inhalations and provide feedback to patients in real-time. The result is an efficient learning experience for patients, which builds confidence with a device while improving adherence and safety.

Inhaled drugs have long been the preferred delivery route for respiratory-related indications, including asthma, COPD and cystic fibrosis. These conditions are characterised by inflammation, constriction or obstruction of airways and the lung. Such factors can adversely affect the

functions of the lung and are best treated with targeted therapies such as anticholinergics, beta-agonists or corticosteroids. The efficiencies of targeted therapies that treat these conditions lie in the localisation and rapid uptake in the lungs.

In recent years, the absorption of drugs for systemic delivery has become an attractive

option to treat a number of chronic conditions with the delivery of antibodies and therapeutic proteins. As these therapeutic categories continue to grow, more patients and healthcare professionals (HCPs) will find themselves interfacing with and learning how to use respiratory drug delivery devices. A strong foundation and learning experience from day one is the first step in promoting healthy outcomes and adherence



**Craig Baker**  
Executive Vice-President  
T: +1 888 933 5646  
E: [info@noblecorporate.com](mailto:info@noblecorporate.com)

**Noble**  
121 South Orange Avenue  
Suite 1070 North  
Orlando  
FL 32801  
United States

[www.GoNoble.com](http://www.GoNoble.com)

for patients. As a result, innovative educational products with smart technologies are changing the way brands educate patients throughout the product lifecycle, from product launches to the revitalisation of established brands.

## PULMONARY DRUG DELIVERY

The ventilatory or respiratory system consists of several major components that enable the breathing processes. As we inhale, the diaphragm and inspiratory muscles contract, drawing air through the nasal/oral cavity and through airways until it reaches the alveoli sacs of the inner lung. Within the alveoli, oxygen passively diffuses across the capillary endothelium and into the bloodstream, where red blood cells carry oxygen throughout the body until it is exhaled, mainly in the form of carbon dioxide.

By definition, autonomous patients are those able consistently and effectively to administer themselves a prescribed dose free of error. In order to reach this level, patients progress through a number of learning stages where motor and muscle skills are acquired and confidence is built. We call the early stages of this learning process “onboarding”, and it is characterised by highly variable outcomes. Errors experienced during the onboarding phase are gross and frequent in nature and are often avoidable through education and training programs. The use of smart and sensor technologies monitors patient behaviours and provides corrective feedback when a step is out of sequence or inhalation performance is insufficient. Such an approach provides patients the support needed to learn about their drug delivery device efficiently and autonomously manage their treatments.

Many of the variables effecting the nominal dose and disposition of drug molecules within the lung are dependent on a patient’s interaction with the device interface, specifically the force and timing of inspiratory efforts. These variables are determined by a drug’s physical properties such as mass/particle size and associated to optimal ranges of force and volume. Forces outside (+/-) this range adversely affect the disposition of the dose, reducing the absorption and therapeutic effect of the particles.

The table shown in Figure 1 serves as an evaluation of common steps associated with the delivery and effectiveness of an inhaled drug therapy. The severity and probability of harm are approximations based on observational studies of metered-dose inhalers (MDIs) and dry-powder inhalers (DPIs). A number of risk management strategies can mitigate these risks and preventable errors. Educating patients on techniques and behaviours associated with drug delivery devices is often a cornerstone of such strategies.

Step	Description	Risk of error
1	Prepare device	Low
2	Remove mouthpiece	Low
3	Inspect the mouth piece for obstructions	High
4	Prepare dose	Medium
6	Breath out, away from the device	High
7	Place device in mouth	Medium
8	Actuate dose	High
9	Inhale with the appropriate force and duration	High
10	Hold breath (as specified in IFU)	Medium
11	Repeat dose as prescribed	Medium
12	Clean and store device as prescribed	Medium

Figure 1: Table of Common Steps for Using Respiratory Delivery Devices.

## METERED-DOSE INHALERS

Pressurised metered dose inhalers (pMDI) were first introduced in the 1950s. Today’s devices use many of the same scientific and behavioural properties as their predicates. These devices generally consist of a drug-containing canister, actuation mechanism, (external housing), metering valve, actuation nozzle and mouthpiece. When pressure is applied to the inverted canister, the metering valve is depressed, releasing a high-velocity spray that passes through the actuator nozzle and is expelled through the mouthpiece. The design and engineering of the actuation nozzle and expansion chamber determines the initial velocity, volume and orientation of the metered dose. Pressurised canisters house the active pharmaceutical ingredients and HFA propellants. The internal lining of these containers is often coated to prevent the adhesion of drug particles and increase the stability of the formulation over time. A second class of MDI’s, breath-activated metered-dose inhalers, are actuated by a patient’s inspiratory effort rather than depressing the canister.

## DRY-POWDER INHALERS

An alternative to MDI’s are dry-powder inhalers (DPIs), which have experienced a steady rise in adoption in recent years. Often, a capsule containing a single dose in powder form is punctured and the powder is inhaled through the inhaler device. Active pharmaceutical ingredients are often contained in carrier particles that deliver the medicament to the appropriate region of the lung for absorption. Several environmental factors affect the performance of DPIs, including ambient humidity, which can adversely affect the flow and velocity needed to deliver the dose. Although there is no need to co-ordinate actuation with inhalation as is the case with MDIs, proper education and training is required to use and maintain DPI inhalers appropriately.

## THE PATIENT EXPERIENCE

Scientific and technological advances have enabled much of the growth and success of the pulmonary delivery market. Companies are now focusing their attention on improving the patient experience within this delivery market. This requires a patient-centric approach to drug delivery, which begins with understanding the stages patients pass through during their treatment. This begins from the initial diagnosis and extends throughout the course of a patient’s treatment. The emotions experienced during these processes are unique to each stage and often require specific educational approaches to fully address. In addition to emotional stressors, a number of human factors must also be considered when applying a patient-centric approach. Following is a brief summary of both:

1. Psychological and emotional impact of diagnosis
2. Physical impairments associated with age and conditions
3. Fear and anxiety associated with self-administration, often leading to avoidance behaviours
4. Social needs of the patient, including family and medical support systems
5. Lack of experience and education with drug delivery devices leading to onboarding challenges
6. Synchronisation and muscle memory needed to safely and effectively administer with a pulmonary drug delivery device.

According to Dr Sam Pejham, Assistant Clinical Professor at the University of California, San Francisco, and creator of the smartphone app, AsthmaMD, easy access to the educational information is the first step in promoting patient adherence with respiratory inhalers. This often includes the development of therapeutic action plans to help patients identify

**“DEVICE-TRAINING SOLUTIONS INCORPORATING  
MULTISENSORY TECHNOLOGIES, SUCH AS AUDIO,  
VISUAL, AND TACTILE FEEDBACK HAVE BEEN PROVEN TO  
STRENGTHEN NEUROLOGICAL CONNECTIVITY”**

changes in their conditions and modify their therapies as required.

A recent study conducted by the NIH indicated that the majority of asthmatics do not adhere to their prescribed control inhalers but rather rely on their emergency inhaler for acute onsets. Through education and action plans, these types of events can be mitigated and adherence improved. As mentioned by Dr Pejham, priming, cleaning and inhaling with respiratory devices are problematic tasks for patients and often vary across drug manufacturers and devices. As a result, many physicians are hesitant in changing a patient’s treatment after they have successfully on-boarded and established muscle memory to a specific device. Based on his experience, many patients do not have the ability to detect errors in their treatment, such as clogs in expansions chambers, which adversely affect the delivery of a full dose. Providing education and training

information to patients that help them adhere to their prescribed treatments and fulfil the functional requirements of devices is an effective strategy to improve patient outcomes and build brand loyalty with patients and health-care providers.

Understanding the needs of patient populations is the first step in effectively educating them. This often begins with condition and age-related impairments and ends with delivering a superior training experience. Modern neurological research suggests that information perception, encoding, decoding and retrieval is influenced by the strength and uniqueness of educational stimuli. Thus, device-training solutions incorporating multisensory technologies, such as audio, visual, and tactile feedback have been proven to strengthen neurological connectivity between semantic networks of the brain, a principle referred to as cross-modal processing. As a result, the effectiveness

of multisensory training devices is clinically superior to traditional means of education and complimentary to the objectives of brands, manufacturers and providers.

Due to the success of multisensory device training, smart technologies are now augmenting the training device market. Smart technologies provide the opportunity for brands to turn simulation devices into teaching devices that incorporate real-time error detection, notification and correction. This direct feedback process accelerates the learning process and becomes the most accurate, consistent and accelerated process when on-boarding patients to a drug delivery device.

At its core, the ultimate goal of device training is to create value for industry stakeholders by enhancing the patient experience, reducing the burden on HCPs and improving safety. As new brands continue to launch and augment markets, brands will continue looking for strategies to differentiate themselves from competitors. In the modern era of patient-centric care, those able to provide a superior product and educational experience to patients will be competitively positioned and benefit from the loyalty established by patients and HCPs.

# The leading topic-targeted sponsored drug delivery publication.

Subscribe  
**FREE**  
Online

**ONdrugDELIVERY**  
niche information & intelligence



[www.ondrugdelivery.com](http://www.ondrugdelivery.com)