

Portal Instruments

CONNECTED, NEEDLE-FREE DRUG DELIVERY: IMPROVE OUTCOMES WITH A NEXT GENERATION DEVICE

The healthcare industry is seeing an ever growing trend towards patients self-administering their therapies at home. Barbara Taylor, Senior Director, Marketing, Portal Instruments, discusses this trend and how Portal is making a bold step towards this goal with its novel needle-free injection device.

INTRODUCTION

When examining today's healthcare market, some clear trends become apparent:

- People are living longer, as such more people are living with chronic diseases (149 million Americans in 2015).¹
- There have been tremendous advancements in treatments available for chronic diseases, especially with monoclonal antibodies (mAbs). However, despite their therapeutic value, compliance is as low as 50% (Figure 1).²
- This has put a toll on healthcare systems worldwide and requires rethinking how patients are treated and the overall population approach to healthcare.

One result of these trends is a push to move treatment to the home setting by

empowering patients to take control of their health and treatments, with less direct supervision. With this in mind, the challenge for the pharmaceutical and drug delivery industry is to think beyond just the pill (or the injection) itself and to design the therapy to fit into patients' lives with minimum possible disruption. Treatment decisions should take into consideration a patient's lifestyle, anxieties, obstacles to taking the medication and necessary support, as well as what happens before and after the treatment administration. Patients should be provided with the tools and support needed to be better empowered to take control of their health.

With an understanding of the needs for home treatments, Portal is developing a needle-free drug delivery platform technology to transform the administration of medicines and improve the patient experience for chronic diseases (Figure 2).

Portal's needle-free injector enables the administration of biologic drugs without the anxiety induced by needles. The Portal platform is also cloud-connected and provides reminders and real-time tracking of injections to



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"According to a survey conducted in 2012, 20% of RA sufferers report that they would not consider using a medication that required self-injection."

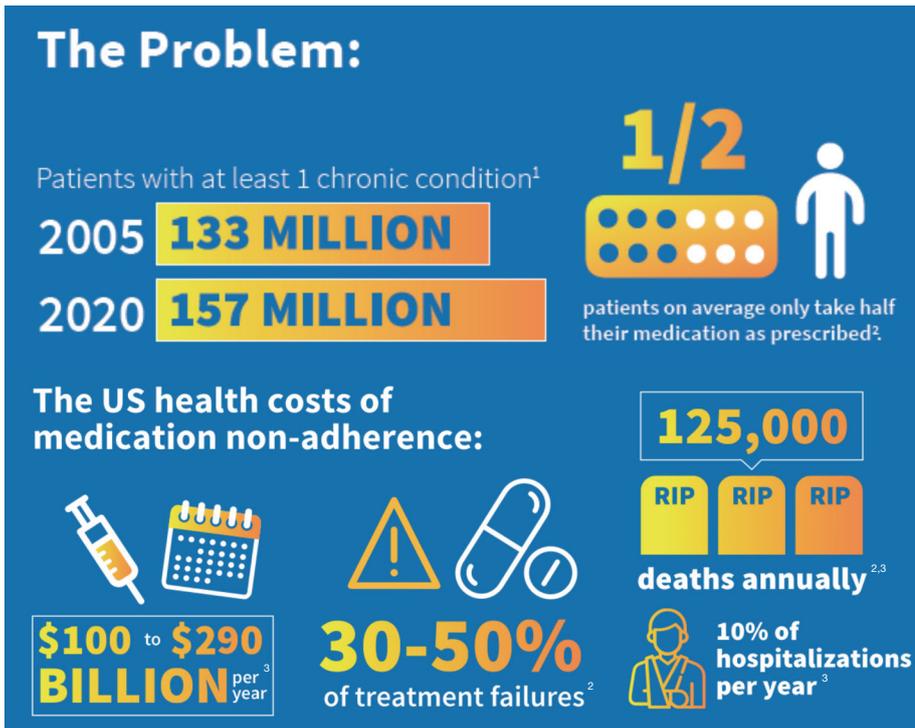


Figure 1: Despite the therapeutic value of modern medicine, adherence is low (50%), which puts a heavy burden on healthcare systems.¹⁻³

The Portal Solution



Figure 2: Portal Instruments' needle-free, digitally controlled injector, represents the next generation of needle-free drug delivery platforms.

"Algorithms in the device's software enable the injections to be specifically tuned, both in terms of injection depth within tissue and precisely controlling the release of medication during the injection process – fast at first and then slow."

improve adherence and communication between the patient and care teams – all with the aim to improve therapeutic outcomes.

UNDERSTANDING THE PATIENT EXPERIENCE

Many patients exhibit anxiety when it comes to the subject of needles. It is important to understand that this needle anxiety goes beyond physical pain; some patients dislike the stigma associated with needle usage, whilst others are afraid of not being able to properly self-administer injections. This fear of needles can interfere with administration and ultimately patient compliance. There are other circumstances that discourage patients from bringing needle-based devices into their homes, one example being parents with young children, who may fear that children will hurt themselves should they stumble across or decide to play with the device. According to a survey conducted in 2012, 20% of RA sufferers report that they would not consider using a medication that required self-injection.⁴

Alternative devices, utilising needle-free technology, could bypass such fear. Portal Instruments has developed one such device, a needle-free injector based in jet-injector technology. Uniquely, Portal's next-generation needle-free injector uses a computer-controlled linear actuator to pressurise the medication and inject it in a very fine liquid stream, roughly equivalent in diameter to a strand of hair. The entire injection takes place in less than half a second. The algorithms in the device's software enable the injections to be specifically tuned, both in terms of injection depth within tissue and precisely controlling the release of medication during the injection process – fast at first and then slow.

“A key problem with the historic approach is that the stored energy is the same fixed amount for every patient, despite differences in skin types and patient profiles, resulting in an injection depth that is difficult to regulate.”

THE HISTORIC NEEDLE-FREE PROBLEM

Needle-free drug delivery devices are nothing new, examples have been around since the 1960s, but their widespread adoption has been hampered because, to date, such devices have been unable to overcome key issues, including:

- Being able to deliver only a limited volume of medication.⁵
- A limited ability to control injection depth.^{5,6}
- Loud and painful during injection.⁶

The reason prior attempts at designing needle-free injectors have struggled is that they have been limited by relying largely on either mechanical or gas-based approaches to generate the high pressures required to expel the fluid at sufficient speed to pierce the skin and thus achieve a successful subcutaneous injection. Stored energy systems, such as a high-powered spring or compressed gas cartridges (e.g. air, CO₂, N₂), work by generating a sudden burst of energy (and often an accompanying loud bang) when that spring releases or the CO₂ cartridge explodes, driving the injection with the necessary force and pressure.

A key problem with this historic approach is that the stored energy is the same fixed amount for every patient, despite differences in skin types and patient profiles, resulting in an injection depth that is difficult to regulate. Stored energy systems lack the ability to control the injection (i.e. the fluid stream) in real time, meaning that once the mechanism of action is activated, there is no possibility of further modifications to the injection. Portal refers to this as an “open-loop system”. This issue becomes very significant when attempting to deliver larger volumes, 1 mL for example, often needed

Diameter Comparison Portal vs. Needle & Syringe

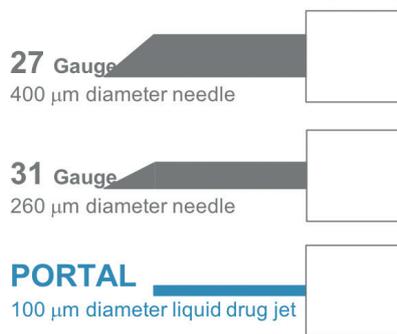


Figure 3: Comparison of standard needle gauges with the Portal device’s liquid jet.

for viscous biologics, to the subcutaneous space in a needle-free fashion.

An additional problem is that, just as this energy is released quickly, it dissipates quickly - meaning only a limited volume of medication can be delivered at a time. With the spring-based approach, the spring is used to generate the necessary energy to force the fluid out of an orifice at high speed (>150 m/s). Since the spring has an energy profile that decays over the course of the injection, the fluid velocity will also

decay over time. A similar decaying velocity profile is also characteristic for gas-based injectors. Thus, the highest velocity of fluid expulsion occurs at the onset of the injection, followed by a decrease to smaller and smaller velocities. When considering a 1 mL injection of a viscous biologic, this profile may be insufficient to achieve a successful subcutaneous injection. Furthermore, for every doubling of dosage volume, a fourfold increase in power is required, resulting in more force (and therefore theoretically more discomfort) on the patient.

PORTAL'S SOLUTION

To solve these problems, Portal Instruments, is developing a needle-free injector with a computer-controlled motor and with an internal feedback control system, similar to a car’s cruise control. This “closed-loop” control system senses pressure and adjusts the jet speed to appropriately deliver the drug.

The Portal needle-free jet-injector platform consists of an electromagnetic actuator controlled by a computer that generates a jet of liquid with a diameter

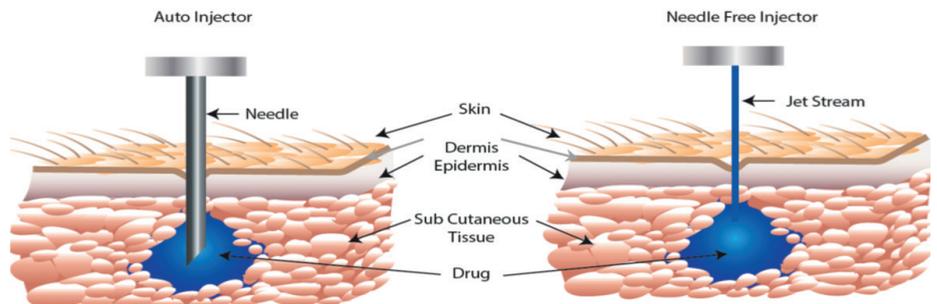


Figure 4: Comparison of injection by a standard autoinjector and Portal’s jet-injection device.

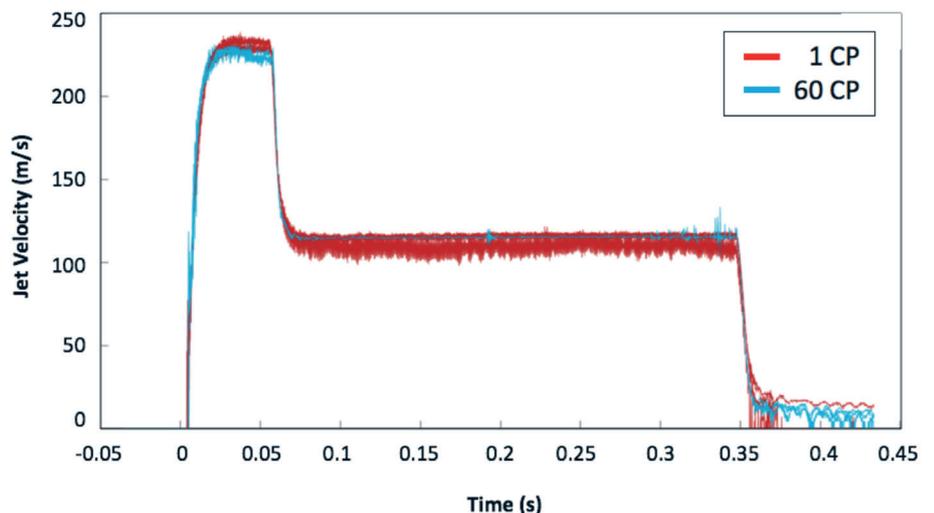


Figure 5: The velocity curve of the Portal injection over time: a fast penetration with a controlled, slower delivery phase, consistent across a range of viscosities.

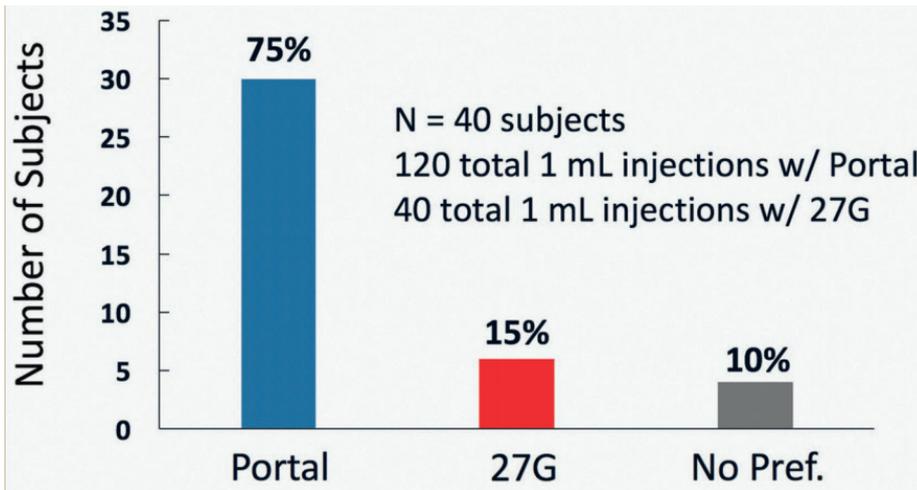


Figure 6: Subject preference for the Portal Handheld Device versus 27G needle and syringe.

of 100 µm, about a quarter of a 27 gauge hypodermic needle, approximately the diameter of a human hair (Figure 3). It is this jet of liquid, which contains the drug of interest, that pierces the skin to reach the desired subcutaneous space, without the intervention of any physical component to puncture the skin (Figure 4).

The actuator enables precise control of the speed of the pressurised jet of liquid, thus resulting in accurate targeting of the desired subcutaneous space with the exact amount of drug needed. In contrast to historic devices, the velocity profile of Portal’s

device is much more controlled, with an initial fast penetration phase followed by a consistent, slower delivery phase (Figure 5). The high adaptability of the system further allows the jet-injection device to accommodate the delivery of low to very high viscosities and drug concentrations without any changes to the device. The design of the device currently supports the subcutaneous administration of up to 1 mL of drug preparation in less than a second.

“Portal’s unique technology allows full control of the jet via a computer-controlled feedback mechanism, thus decreasing

sensation when compared with needle and syringe,” said Patrick Anquetil, CEO of Portal Instruments.

Furthermore, the jet-injection device is relatively quiet, fast and the software automatically adapts injection parameters to suit not only the viscosity, but also the temperature of the medication. The pain of traditional needle-free injectors has also been addressed; studies have shown that patients perceive less pain using, and demonstrate an overall preference for, Portal’s needle-free injector compared with needle-based injections (Figure 6).⁸

The other advantage with Portal’s innovative injector is that Portal has developed a primary container that is compatible with standard pharmaceutical fill/finish lines. This reduces any additional capital expenditure for manufacturing on the pharmaceutical line. And the patient receives their medication dose pre-packaged in the cartridge, ready to be used; there is no need for the patient to have to transfer medication from a syringe to the injector.

Portal’s development process is based on a design, build, test and iterate model throughout which Portal places a heavy emphasis on patient input and expertise of healthcare providers. Portal has run rigorous human factors studies including contextual inquiries, formative and other

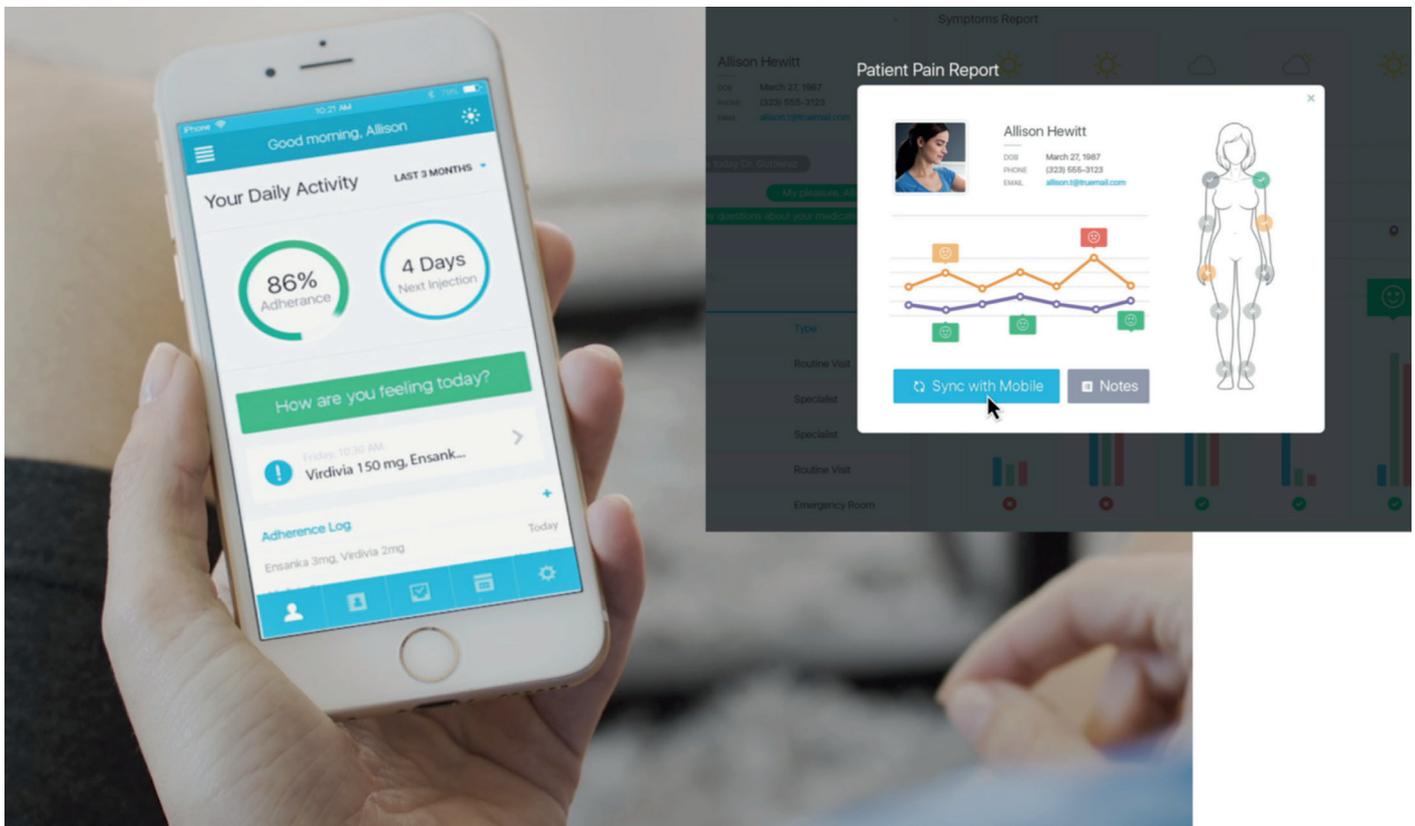


Figure 7: Portal’s digital ecosystem, designed around the patient with the goal to improve outcomes.

heuristic evaluations. In-depth interviews with patient groups revealed challenges and needs and provided valuable insight about how the design of the device could affect the experience of their prescribed therapy and overall adoption of their treatment as an integrated part of their lifestyles.

DIGITAL TOOLS FOR IMPROVED EXPERIENCES & OUTCOMES

Digital tools and accompanying services are another way to build a positive patient experience and enable the patient to take control of their health and medication. When properly designed around the patient, such tools can assist with educating a patient as to the proper usage of their device, reminding them to take their medication at the correct times and logging treatments and symptoms – all important aspects of managing a chronic disease.

In a similar vein, Portal is looking to ensure their digital tools can assist communication with physicians by providing injection and symptom data (Figure 7). With clear, accurate data recorded over time, physicians can review patients' therapeutic results and make more informed decisions about further treatment.

Additionally, when digital tools are integrated with the drug delivery device, information can be gathered in near real-time. At the aggregate level, this data can lead to identification of trends with regard to adherence obstacles, patient behaviours and possibly correlated lifestyle data. This data can, in turn, be used to enhance the patient experience with the goal of improving adherence and therapeutic outcomes.

If trends continue, nearly 50% of the population will have a chronic disease by 2030.¹ However, with novel therapeutics, patient-centred treatments which take the patient's lifestyle into account and digital tools to aid in treatment support and decision making, progress is being made towards a healthcare system in which patients are empowered to take control of their health and therapy.

PARTNERSHIPS

Portal is looking to develop strong partnerships with all major biologics players seeking to gain an edge by offering their therapeutics fully integrated with a digital, patient-centred delivery system.

ABOUT THE COMPANY

Portal Instruments is a clinical-stage medical device company, developing a next generation needle-free drug injection platform to transform the drug delivery experience for patients suffering from chronic diseases such as ulcerative colitis, multiple sclerosis, rheumatoid arthritis and psoriasis.

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ABOUT THE AUTHOR

Barbara Taylor is the Senior Director of Marketing at Portal Instruments. Ms Taylor has over 20 years' experience in healthcare strategy, marketing and sales in the medical device, biotech and technology industries. Ms Taylor holds an MBA from the Kellogg Graduate School in Evanston, IL, US, and a BS in biology from the University of Michigan in Ann Arbor, MI, US.



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** The Portal device can deliver 1ml of drug in 1/3 of a second per Portal internal studies