



PREFERRED BY PATIENTS... WITH IMPROVED THERAPIES

Wearable injectors, which allow patients to self-administer therapy in their own homes, are now becoming a reality. As well as minimising the need for hospital or doctor appointments, it can provide very high bioavailability. Sandra de Haan, Head of Business Development (outside America) at Sensile Medical, describes how the company's micro pump technology advances have enabled it to develop wearable injector patch pumps to deliver better care for patients.

The first wearable injectors are now starting to hit the market. Such devices, in development at many biotech and pharmaceutical companies around the globe, will now enable patients to self-administer medications at home. They will give patients the chance to live a more normal life without the need for a visit to a clinic or given themselves multiple injections instead.

"Using a wearable device lowers the necessity for treatment in hospital or doctor's surgery. Patients regain independence and self-control as this is an easy-to-use device, with improved compliance a likely result."

The subcutaneous (SC) delivery from a wearable injector is less invasive from a patient's perspective than intravenous (IV) administration. This route of administration doesn't require special skills. It often provides very high bioavailability and in some cases offers a preferred pharmacokinetic profile over standard IV bolus.

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an easy-to-use device, with improved compliance a likely result.

In situations where drugs are reformulated, this technology enables the delivery of highly viscous drugs with injection volumes ranging well above what can be administered in a straight SC shot. Depending on the drug and the volume to be delivered, the duration of use for such devices can range from several minutes to hours or up to several days.

Needless to say, this kind of new delivery device must be compatible with a wide range of drugs and biologics in development. These drugs have a variety of specifications, delivery volumes, viscosities, durations of administration and dosage increments. In most cases, all this cannot be integrated in one single wearable injector design.

In addition to offering improved therapies, pharma companies have the potential for new branding opportunities and improved lifecycle management. A large number of pharma and biotech companies are currently seeking out wearable delivery systems and platform partners.

MICRO PUMP TECHNOLOGY SOLUTIONS

Sensile Medical has put enormous efforts into developing solutions and modular concepts in different technology areas around our core micro pump technology. This gives the flexibility to develop devices that support such drug-specific requirements and therapies.



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Sensile Medical's experience in multiple wearable injector projects has led to several modular concepts that we will focus on in this article. Sensile technology can offer some key advantages for the pharma company:

- Accurate dosing
- A high degree of independence from the primary packaging (can work with a standard vial)
- Cost-effective reusable/disposable concept.

SENSECORE – THE “HEART” OF SENSILE DEVICES

The SenseCore technology offers a wide range of advantages and is superior in many aspects over narrowly defined drug delivery systems or even syringe pumps, which may be used in clinical trials (Figure 1). SenseCore is a reciprocating-type positive displacement pump. Specifically, it is a piston pump (as is well known in pharmaceutical filling technology) with a ring-shaped piston area. The rotating piston together with an injection-moulded valve structure mechanically drives intake and outlet valves and additionally generates the correct pumping stroke derived from the primary rotation (Figure 2).

The design is flexible and can operate bi-directionally. As is typical of piston pumps, each pumping cycle:

- Generates a good suction pressure
- Takes in a well-defined volume of drug
- Accurately delivers a nominal pump volume at a defined delivery pressure and time.

The nominal delivery volume can easily be designed to the required optimum delivery volume per stroke, typically ranging (but not limited to) from <1 mL to 25 mL per cycle.

Regarding the viscosity of the liquids, SenseCore handles highly viscous liquids as well as gases and liquid/gas mixtures. It can also be used to reconstitute lyophilised products with diluents, mixing both products in a defined reconstitution process, transferring the reconstituted liquid into a primary container or administering it directly.

The delivery is highly accurate from the first until the last partial dose. As the drug leaves the cartridge, break-loose and/or glide forces of a rubber stopper or elastomeric relaxation do not affect dose accuracy (in contrast to delivery systems that push the stopper of a cartridge).

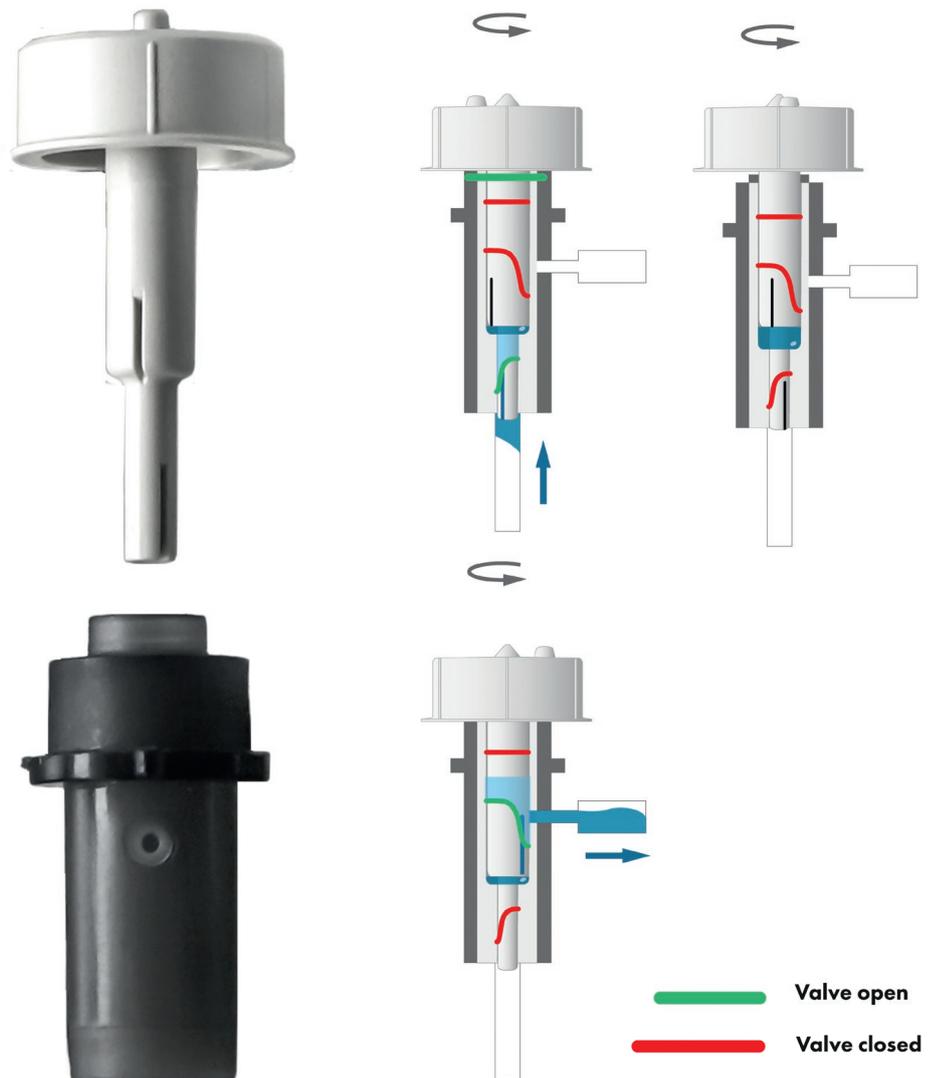


Figure 1: The SenseCore technology.

Figure 2: The pumping cycle of the SenseCore technology.

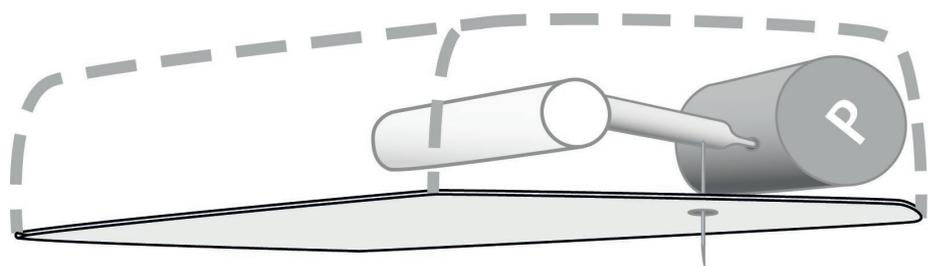


Figure 3: Needle insertion technology.

As drugs may react to plastic materials – even during the very short delivery process, we have experience with a range of materials for both the pump shaft and pump housing. Both parts are available with steel tools and can be tested at a very early stage to check drug compatibility.

Needle Insertion Technology

To allow a safe handling of the device, a fully mechanical design for needle insertion has been incorporated into Sensile's body-worn

patch injectors. The needle is not visible to the user before or after injection. At the start of injection, the needle is mechanically inserted into the tissue. Once the injection is finalised, the needle automatically retracts. This integrated safety feature prevents any needle-stick injury (Figure 3).

Different needle sizes and diameters are often requested and can be carefully chosen in regards to viscosity of the drug product and required delivery speed.

A note on Freedom to Operate (FTO):

There are many patents on needle insertion technology. Sensile Medical's patented technology is integrally tied to our pump action and is completely different from all other injector solutions.

Sensor Technology

Safety is a high priority. With the use of a variety of sensors, issues like occlusion caused by crystals or increase in back-pressure from the patient's tissue can be detected and appropriate measures taken.

RFID detection is commonly used to avoid usage of the device with any other drug product. This protects from misuse or usage with a competitor product.

USER INTERFACE

Human factors considerations are playing an ever-increasing role, especially as novel drug delivery systems are coming to market. Health care professionals (HCPs), patients and caregivers need to be able to prepare, place, activate and remove the device safely with minimal difficulty.

The SenseCore technology allows for single-button operation with visual and audible signals that are easy to understand. The user interface can also incorporate a coloured touchscreen display, multiple language packages, etc. Options and alternatives are evaluated in human factors studies throughout the device development program. The devices can be pre-programmed for the desired drug delivery profile at the time of manufacturing. Alternatively, if the therapy requires a weight-based delivery adjustment, programming can be done by the doctor or even patients.

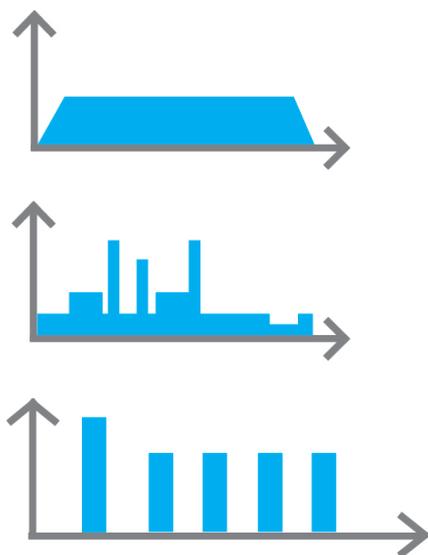


Figure 4: Possible delivery profiles over time.

Generally speaking, the system offers the possibility to adapt the delivery profile according to specific therapy needs, e.g. administration of drug over a defined period at a constant basal rate or using a specific profile with peaks. Integration of bolus deliveries is also possible (Figure 4).

COMMUNICATION & DATA MANAGEMENT

Sensile Medical's technology includes state-of-the-art electronics. Various types of communication or a data transfer protocol can be integrated if required. The devices can also offer an interface to download data from clinical trials to add to the documentation.

SENSILE MEDICAL'S WEARABLE INJECTOR PLATFORM

Disposable/Reusable Device Design

The SenseCore technology allows for the development of a small two-component device comprising a single-use disposable unit and a reusable unit:

- Disposable unit contains all parts in contact with the drug or the patient: the pump, fluidic channels, and patient interfacing elements like the needle and the adhesive or optional infusion set, sterile packaged.
- Reusable unit includes electronics, sensors, drive, rechargeable battery and the simple user interface.

This disposable/reusable concept offers several advantages:

- The design of the disposable unit enables a cost-efficient, high-volume production process. Using just two plastic parts for the SenseCore technology supports keeping the costs at a low level.
- Many therapies require frequent dosing or dosing for long periods. This can lead to high costs of goods if a delivery system is "fully disposable" and the device is discarded after each administration. With Sensile Medical's disposable/reusable concept, there is no need to discard the entire device after use, as the mechanism that provides the force and energy is part of the reusable unit that can be used over a defined period. This not only reduces costs significantly, it also leads to less waste, which can be important for environmentally conscious markets.

- The priming process is automatic and does not require separate handling steps. This integrated feature increases safety, saves time and helps prevent errors by HCPs, patients and caregivers.

Multiple Customisation Options

At Sensile Medical, we differentiate between:

- Body-worn patch injectors
- Off-body worn injectors
- Reconstitution devices
- Bolus injectors
- Usage of the SenseCore technology in various other combinations used in home care, hospital care, lab and diagnostics etc.

For all these devices, one option is to use a standard vial – often a pharma company's existing primary container. There is no need for a long and costly conversion to a cartridge.

We can either use vials of multiple sizes but also incorporate a cartridge into the device if this is our partner's choice of primary packaging. The benefits in terms of timelines and budgets are obvious.

BODY-WORN VERSUS OFF-BODY

There are several aspects:

Adhesive

Body-worn patch injectors use an adhesive to connect the device directly with the patient's skin. Depending on the size of the device, this adhesive area can reach that of a face of a mobile phone. In several human factors studies it has become apparent that the adhesive has to be carefully chosen. Aspects to consider include: duration the device is body-worn; patient activity level; skin moisture, exposure to water, skin types and so on. We also rely on external partners and their expertise, when appropriate.

On the other hand, some patients have very sensitive skin and cannot tolerate a long-term worn device. Here, we advise switching to an off-body worn injector with use of a standard infusion set with a much smaller footprint.

Delivery Volume

The larger the total drug volume to be delivered, the heavier the device. A body-worn patch injector can be acceptable for volumes up to about 20 mL. For volumes above that, it is advisable to switch to an off-body worn injector with a standard infusion set.



Figure 5: Features of the large volume, body-worn patch injector – SenseTrial.



Figure 6: Small-volume body-worn patch injector – SensePatch.

LARGE-VOLUME BODY-WORN PATCH INJECTOR – SENSETRIAL

- SenseTrial (Figure 5, previous page) contains an integrated needle which is fully automatically injected and retracted
- SenseTrial delivers up to 20 mL from an integrated drug reservoir into the subcutaneous tissue
- SenseTrial offers variable and/or pre-programmed dosing regimens
- SenseTrial works with a standard vial as primary packaging
- SenseTrial offers an interface for data download to support clinical trials.

This device is now available for customisation to fit a drug product.

A SMALL-VOLUME BODY-WORN PATCH INJECTOR – SENSEPATCH

- SensePatch (Figure 6) contains an integrated needle which is fully automatically injected and retracted
- SensePatch is a drug delivery device to infuse up to 3 mL into the subcutaneous tissue. It is designed to be used with standard 3 mL cartridges (it can also be configured for larger cartridges)
- SensePatch offers variable and pre-programmed dosing regimens
- SensePatch delivers basal and bolus rates.

Both device concepts, large-volume and small-volume body-worn patch injectors can be customised to be used off-body with an infusion set.

OUR CONCEPT FOR RECONSTITUTION – SENSELYO

SenseLyo (Figure 7) is a reconstitution device which can infuse the drug directly via a standard luer infusion set or fill the drug into one or more primary packages.

The pump design allows a bi-directional operation. Using this function, a diluent and a lyophilised medium can be mixed



Figure 7: The SenseLyo system for reconstitution.

at a predefined cycle time and duration. The transfer of the final drug product can be in one of the primary containers or directly infused into the patient's tissue:

- It can be programmed regarding pumping volumes, speed, breaks and number of cycles
- The fluidic adapter can be customised allowing connection of various types of primary packages.

OUR CONCEPT FOR BOLUS INJECTION – SENSEPEN

SensePen (Figure 8) is a drug delivery device which can reconstitute two drugs and infuse into the subcutaneous tissue. It:

- Contains an integrated needle which is fully automatically injected and retracted
- Offers variable and pre-programmed dosing regimens
- Delivers treatment-relevant data (e.g. injection times/doses) that can be downloaded from device.

CONCLUSION

Sensile Medical can provide lab-scale equipment to test your drug with its SenseCore technology. You can then simulate dosing, assess delivery accuracy



Figure 8: The SensePen system for delivering a bolus injection.

and evaluate general device compatibility.

Sensile Medical offers proof-of-concept phases to de-risk a future development project by:

- Design & system brief protocol and kick-off workshop
- Scenario building & key design strategy
- Target group and market research
- Handling, usability, component arrangement and implementation of main functionalities, main key design elements, style directions
- Accompanied by presentations, mock-ups, first human factors study, if applicable, and report.

We are looking forward to building your bridge from drug to patient (Figure 9).

ABOUT SENSILE MEDICAL

Sensile Medical is a leading company in the area of advanced micro pump technology developing a broad range of customer-specific delivery and dosing solutions. Sensile Medical is a full-service provider of pump-based drug delivery solutions, with in-house specialists for engineering, electro mechanics, software development and more. Our partners include well-known pharmaceutical and biotech companies.



Figure 9: A patch pump in situ.

We are Swiss pioneers in Large Volume Injector Devices

Offering a clever platform for unique devices



BUILDING BRIDGES
FROM DRUGS TO PATIENTS.



HAVE A
GOOD DAY!
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