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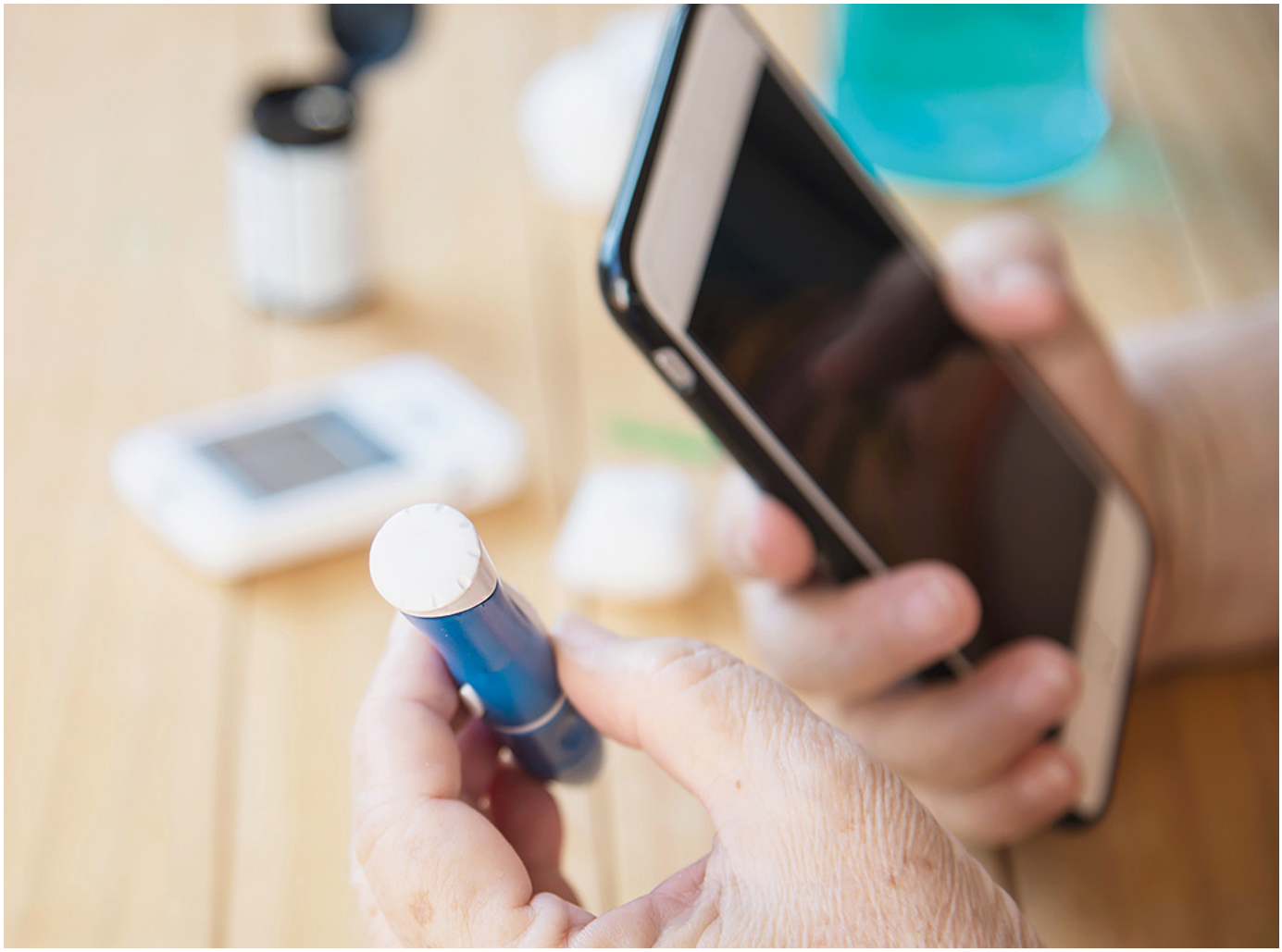

# The Benefits of Using Connected Pens and Caps

In 1921, the discovery of insulin revolutionized the treatment of people with type 1 diabetes mellitus. Since then, its administration has remained largely unchanged, relying on subcutaneous injection via syringe, pen, or insulin pump. Over the past century, there has been continuous evolution in the devices used to store and administer insulin. Initially, reusable syringes and needles were used, which required sterilization by boiling. Insulin was stored and sold in glass vials. The needles were thick and large, and after several uses, they had to be sharpened with a pumice stone. Injections were intramuscular, administered twice a day, with volumes ranging from 5 to 18 mL (1).

Thirty years later, in 1955, the first plastic syringes appeared (called Monoject®), and by the mid-1960s, U100 Insulin syringes marked in IU, of 0.3 mL, 0.5 mL, and 1 mL (30, 50, and 100 U) were already available (1).

In 1963, Dr. Arnold Kadisch from Los Angeles, California (USA), designed the first insulin and glucagon pump, which, due to its size, was never commercialized. It was not until the late 1970s that the first attempts were made to create practical devices for continuously infusing subcutaneous insulin (2). Later, it was also connected to a continuous glucose monitor (CGM).

Finally, in 1983, a pharmaceutical laboratory introduced insulin pens to the market. In 2017, the U.S. Food and Drug Administration (FDA) approved the first "smart" pen (smartpen), which was marketed in Spain in 2020 (3).

- It is a reusable device or pen into which an insulin cartridge is inserted, allowing for the monitoring of administered doses.
- It can also come in the form of a cap or smartcap that attaches to the insulin pen, offering the same features.
- Currently, smartpens and smartcaps can integrate information from continuous glucose monitoring systems.

New technologies applied to insulin pens incorporate advanced functions: automated data logging and insulin monitoring, all contributing to improved glycemic control and quality of life. However, all these advancements in connected pens and caps should not make us forget the basics—both for people with diabetes and for professionals dedicated to therapeutic education (4). These fundamentals include the correct insulin administration technique with key points such as appropriate needle size, proper site selection and rotation, administration technique, needle replacement, and proper storage.

Below, we will review several publications on insulin administration using pens or caps connected to CGM systems. This includes one study and two literature reviews.

## METHODOLOGY

The first publication is a study with 10 people who started using connected smartpens alongside FreeStyle Libre 2® sensors (6). Data measurements were taken before and after the intervention. However, only 5 of these patients transmitted their data to the sensor application. Conclusions: The sample size was small, and results were not statistically significant.

The second publication is an updated re- »

**THE IDEAL CANDIDATES FOR SMARTPEN/ SMARTCAP USE INCLUDE ALL PATIENTS UNDERGOING MULTIPLE DAILY INSULIN INJECTIONS. HOWEVER, IF PRIORITIZATION IS NECESSARY, WE SHOULD BEGIN WITH PATIENTS WHO REQUIRE IMPROVED GLYCEMIC CONTROL**

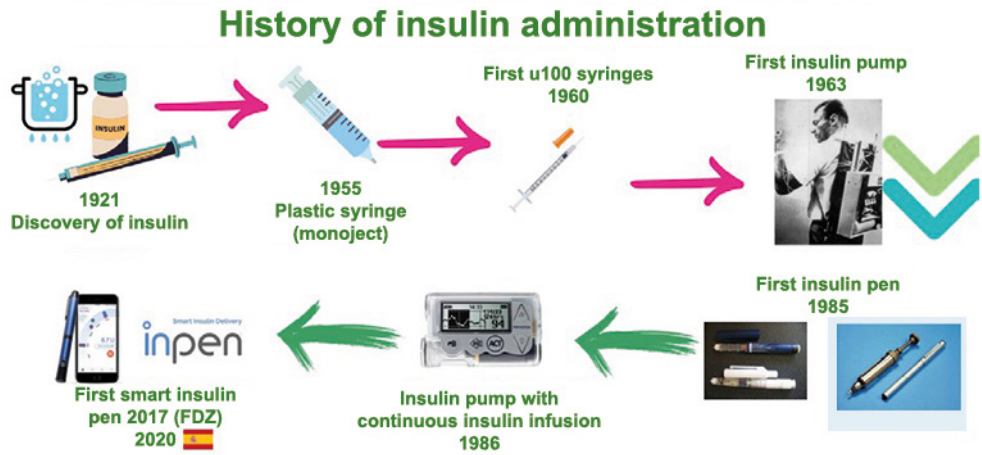


**IMAGE 1:** History of insulin


**IMAGE 2:** Insulin administration technique brochure. Source: educator team of tHospital de Llíria (Arnau-Llíria Health Department), Valencia, Spain(5).

» view of all existing materials on insulin administration through smartpens and connected caps (7). This review was conducted by a group of experts from SEEN (Spanish Society of Endocrinology and Nutrition). They describe advantages and disadvantages and conclude that integrating insulin administration with glucose monitoring helps both users and health care teams analyze glucose control and implement appropriate therapeutic changes, reducing therapeutic inertia.

The third publication is a systematic review evaluating all available literature on the clinical and economic benefits, as well as user contributions, regarding insulin pen platforms (8). Results showed that user satisfaction with these technologies was high, and economic benefits were also observed.

- These articles provide descriptions of all commercially available or-

soon-to-be-commercialized products, as well as their features and benefits, making them highly recommended for reading.

## RESULTS

By analyzing the main findings of the previous studies (7,8) we can observe that the use of smartpens and smartcaps among people with diabetes undergoing multiple daily insulin injections (basal-bolus therapy) offers several benefits: reduced missed insulin doses; improved insulin administration accuracy; and enhanced quality of life and user satisfaction. These devices introduce innovations in insulin administration and may offer advantages for self-management of diabetes treatment. As seen in different studies, these devices provide multiple features and connectivity with sensors. However, it is crucial that users understand these functionalities through guidance from their healthcare team, including endocrinologists and diabetes educators.

The ideal candidates for using smartpens and smartcaps include all patients receiving multiple daily insulin injections. Priority, nonetheless, should be given to those requiring better glycemic control, including suboptimal control (HbA1c/time in range); frequent hypoglycemia or high glucose variability; those with difficulty adhering to treatment, such as frequent missed doses (basal/bolus) or delayed bolus administration. Finally, also patients requiring care in dose adjustment, aiming for more precise insulin-to-carb ratio calculations and correction boluses.

Healthcare professional profile for Smartpen/Smartcap training: must be open and motivated for continuous education; should enhance knowledge in the »

» following areas: communication with people with diabetes; diabetes-related technology education; and comprehensive diabetes treatment training to prevent therapeutic inertia.

Patient benefits: accurate record of the last administered dose, increasing safety and adherence to treatment; improved glycemic control; and structured data with connectivity to mobile applications, glucose monitors, and health care provider platforms.

Health care professional benefits: reliable recorded data; access to the last administered dose; structured information that facilitates patient discussions and remote monitoring; and more effective and efficient follow-up consultations.

Areas for improvement in diabetes technology:

- All devices should include a bolus calculator and provide information on active insulin (currently, only one smartpen has this feature).
- Enhanced data analysis with personalized recommedations to aid patients in making informed decisions.

Health system funding and improved compatibility between different monitoring systems are necessary so that more patients using multiple daily insulin injections can benefit from these technologies. D

## CONCLUSIONS

Many patients miss basal and bolus insulin doses, administer them at incorrect times, or make administration errors. Lack of reliable insulin administration information is associated with poorer glycemic control, which is why using smartpens and smartcaps improves adherence, increases time in range, and reduces both high and low glucose levels. The integration of smartpens and smartcaps provides a comprehensive view of diabetes management.

However, health care professionals and patients must be properly educated about these devices to fully utilize their capabilities. Technology without proper therapeutic education is a failed investment.

Future perspectives: the development of devices with maximum possible features to improve the quality of life for people with diabetes.

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