

Patients’ Preferences for Connected Insulin Pens: A Discrete Choice Experiment Among Diabetes Patients in the UK and US

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BACKGROUND

- People with diabetes (PWD) are found to face several challenges with insulin therapy, including managing complex regimens, dealing with forgetfulness, handling injection fears, and struggling with optimal dosing.¹⁻³
- Connected insulin pens may reduce treatment burden by automatically recording dosing and integrating this information with other relevant data (e.g., glucose levels).

OBJECTIVE

- This study set out to elicit preferences of PWD for connected insulin pens and associated mobile applications over 1-connected pens.

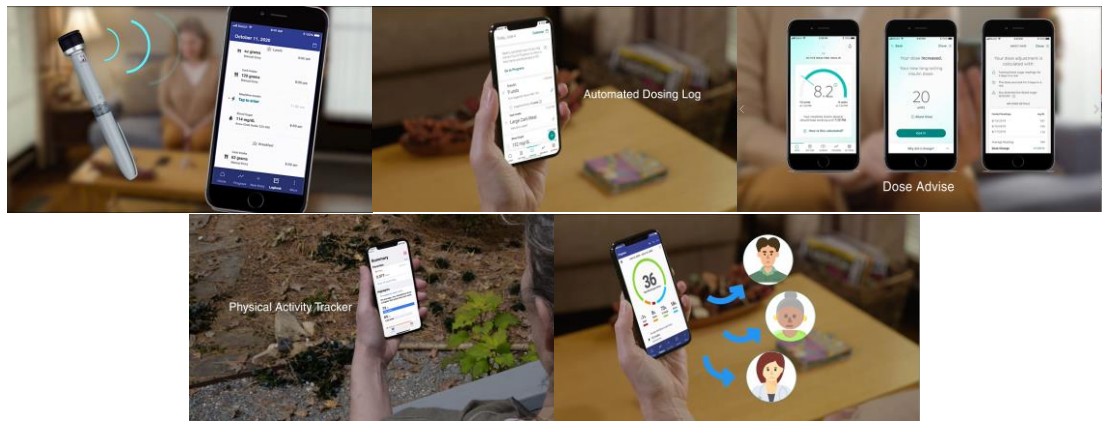
TARGET POPULATION

- Inclusion criteria
 - Adults (≥18 years) in the United States (US) and United Kingdom (UK)
 - Used insulin pen therapy for diabetes within the past 6 months
 - Type 1 diabetes (T1D): currently on multiple daily insulin regimen (basal + bolus or bolus only)
 - Type 2 diabetes (T2D): currently on a basal-only regimen or multiple daily insulin regimen (basal + bolus or bolus)
 - Currently using a smartphone
- Exclusion criteria
 - Using an insulin pump, a cartridge/reusable insulin pen, or premix insulin
 - Experience with connection-enabled pen systems

STUDY DESIGN

- An online discrete choice experiment (DCE) was conducted to explore preferences of PWD for connected insulin pens over non-connected pens.
- Connected insulin pens and their five considered attributes (Table 1) were introduced in a video (Figure 1).

Figure 1. Screenshots from the Video



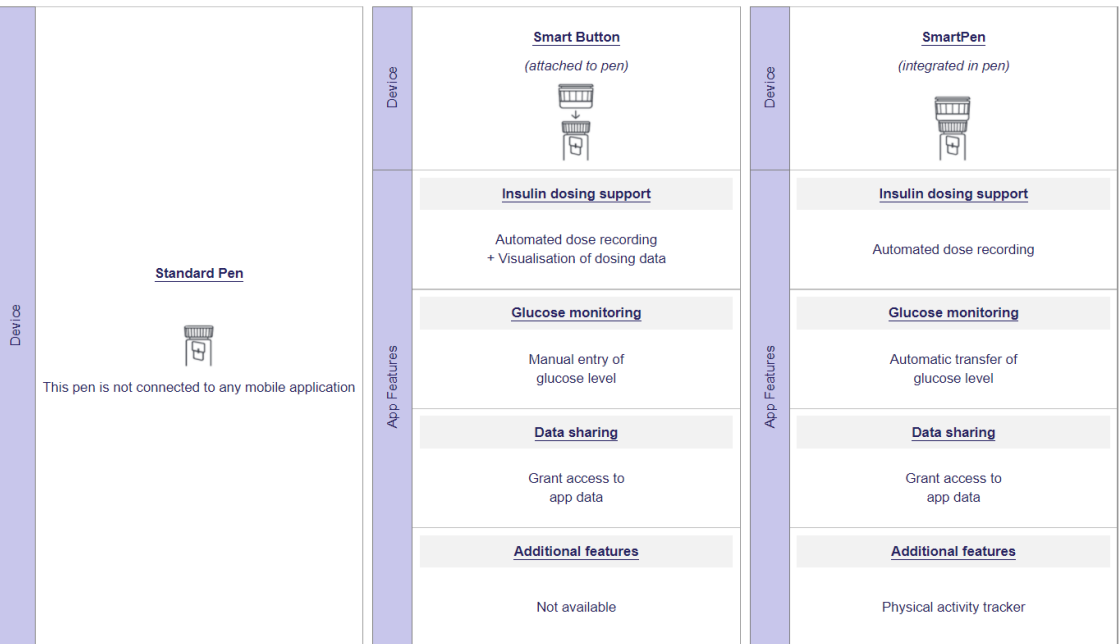
- Attribute selection and definition was informed by a literature review and qualitative interviews (n=20).

Table 1. Attributes and Levels

Attributes	Levels
Device	■ Smart Button (Bluetooth® transmitter attached to pen) ■ SmartPen (Bluetooth® transmitter integrated in pen)
Glucose monitoring	■ Not available ■ Manual entry of glucose level ■ Automatic transfer of glucose level
Insulin dosing support	■ Automated dose recording ■ Visualization of dosing data ■ Automated dose recording + Visualization of dosing data + Make dosing suggestion
Additional features	■ Not available ■ Dietary tracker ■ Physical activity tracker ■ Dietary tracker + Physical activity tracker
Data sharing	■ Not available ■ Send summary report by e-mail ■ Grant access to app data

- The DCE included 15 choices between a non-connected pen and two connected insulin pens (Figure 2).
- An innovative random constant logit (RCL) model was used for data analysis.
- Relative attribute importance (RAI) scores that sum to 100% were calculated. Opt-in utility of connected pens was combined with dosing support utility.
- Choice probabilities were estimated for 9 hypothetical pen scenarios.
- Differences in preferences between US and UK participants were explored.

Figure 2. Sample DCE Choice Question



Attribute levels were varied based on a D-efficient design with directional priors.

KEY RESULTS

Table 2. Sociodemographic and Clinical Characteristics

Characteristics	Overall (N=540)	UK [^] (n=204, 37.8%)	US [^] (n=336, 62.2%)
Age (years), mean (SD)	58.3 (13.6)	55.4 (13.7)	60.1 (13.2)
Sex, n (%)			
Female	220 (40.7%)	77 (37.7%)	143 (42.6%)
Type of diabetes [†] , n (%)			
Type 1 diabetes	165 (30.6%)	82 (40.2%)	83 (24.7%)
Type 2 diabetes	375 (69.4%)	122 (59.8%)	253 (75.3%)
Most recent HbA1c level, n (%)			
7% or below (154 mg/dl or below)	165 (30.6%)	32 (15.7%)	133 (39.6%)
Between 7.1% and 8.0% (155 mg/dl – 183 mg/dl)	174 (32.2%)	67 (32.8%)	107 (31.8%)
8.1% or above (184 mg/dl or above)	139 (25.8%)	54 (26.5%)	85 (25.3%)
Current insulin type [‡] , n (%)			
Basal-bolus insulin	288 (53.3%)	95 (46.6%)	193 (57.4%)
Long-acting (basal) insulin only	185 (34.3%)	57 (27.9%)	128 (38.1%)
Mealtime (bolus) insulin only	50 (9.3%)	39 (19.1%)	11 (3.3%)
Current method of blood glucose monitoring, n (%)			
Blood glucose meter	398 (73.7%)	150 (73.5%)	248 (73.8%)
Flash glucose monitor	95 (17.6%)	47 (23.0%)	48 (14.3%)
Continuous glucose monitor	47 (8.7%)	7 (3.4%)	40 (11.9%)
Current method of recording insulin dosing [*] , n (%)			
Not at all	257 (47.6%)	79 (38.7%)	178 (53.0%)
Printout log sheet downloaded from web or paper logbook	119 (22.0%)	53 (26.0%)	66 (19.6%)
Smartphone App	67 (12.4%)	38 (18.6%)	29 (8.6%)
Spreadsheet on computer	46 (8.5%)	18 (8.8%)	28 (8.3%)

*Not mutually exclusive.

[^]Recruitment targeted a 60% of US and 40% of UK.

[†] Recruitment targeted a 30% to 70% ratio between Type 1 and Type 2 diabetes.

[‡] Recruitment targeted a 50% of basal use only and a 50% of basal + bolus or bolus use. In addition to basal, bolus, and basal-bolus insulin, insulin-GLP-1 only: overall, n=10 (UK, n=8; US, n=2), bolus + insulin-GLP-1: overall, n=2 (US, n=2), basal + insulin-GLP-1: overall, n=4 (UK, n=4), basal + bolus + insulin-GLP-1: overall, n=4 (UK, n=2; US, n=2), basal + inhaled insulin: overall, n=1 (UK, n=1), basal + bolus + insulin-GLP-1: overall, n=1 (US, n=1)

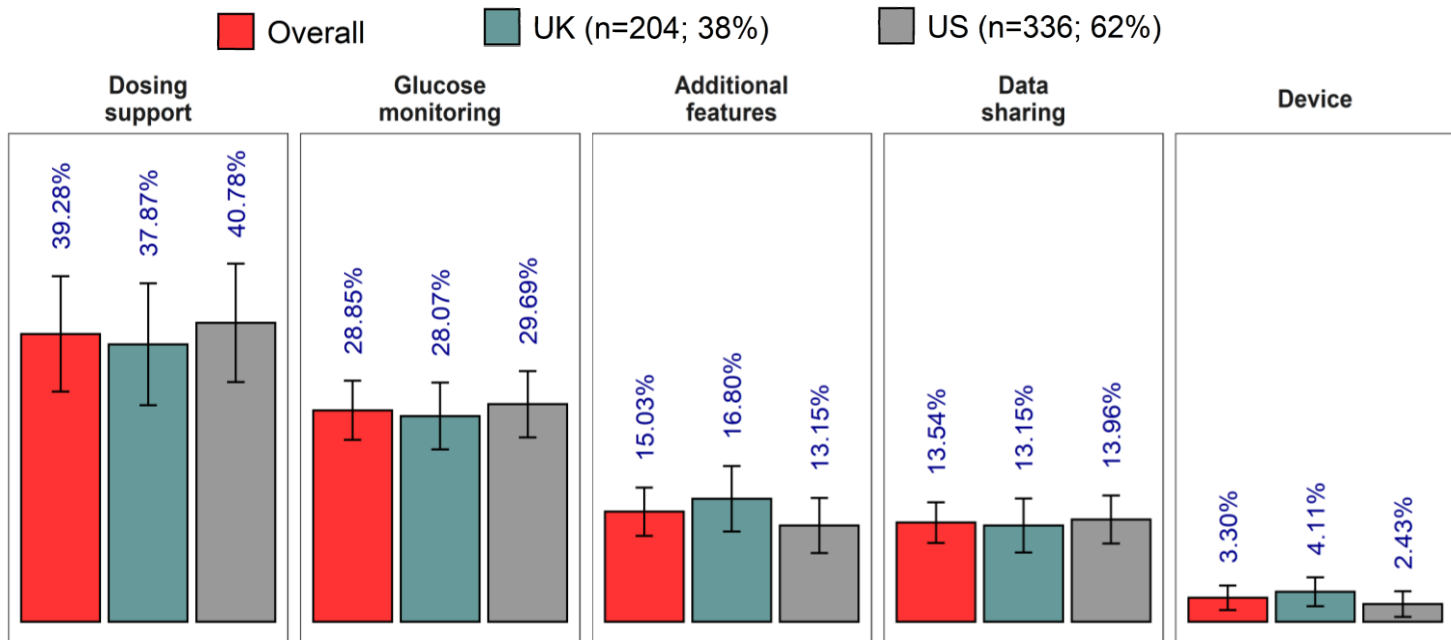
Abbreviations: HbA1c = hemoglobin A1; SD = standard deviation; T1D = type 1 diabetes; T2D = type 2 diabetes; US = United States; UK = United Kingdom

- A connected insulin pen was preferred over a non-connected pen in 80.3% of DCE choices. Estimation results are shown in Figure 3.

RAI

- The relative importance of attributes differed:
 - Dosing support: 39.9% (overall), 37.9% (UK), 40.8% (US)
 - Automatic transfer of glucose: 29.0% (overall), 28.1% (UK), 29.7% (US)
 - Additional features: 14.6% (overall), 16.8% (UK), 13.1% (US)
 - Data sharing: 13.6% (overall), 13.1% (UK), 14.0% (US)
 - Device: 2.9% (overall), 4.1% (UK), 2.4% (US)
- Country difference was not significant.

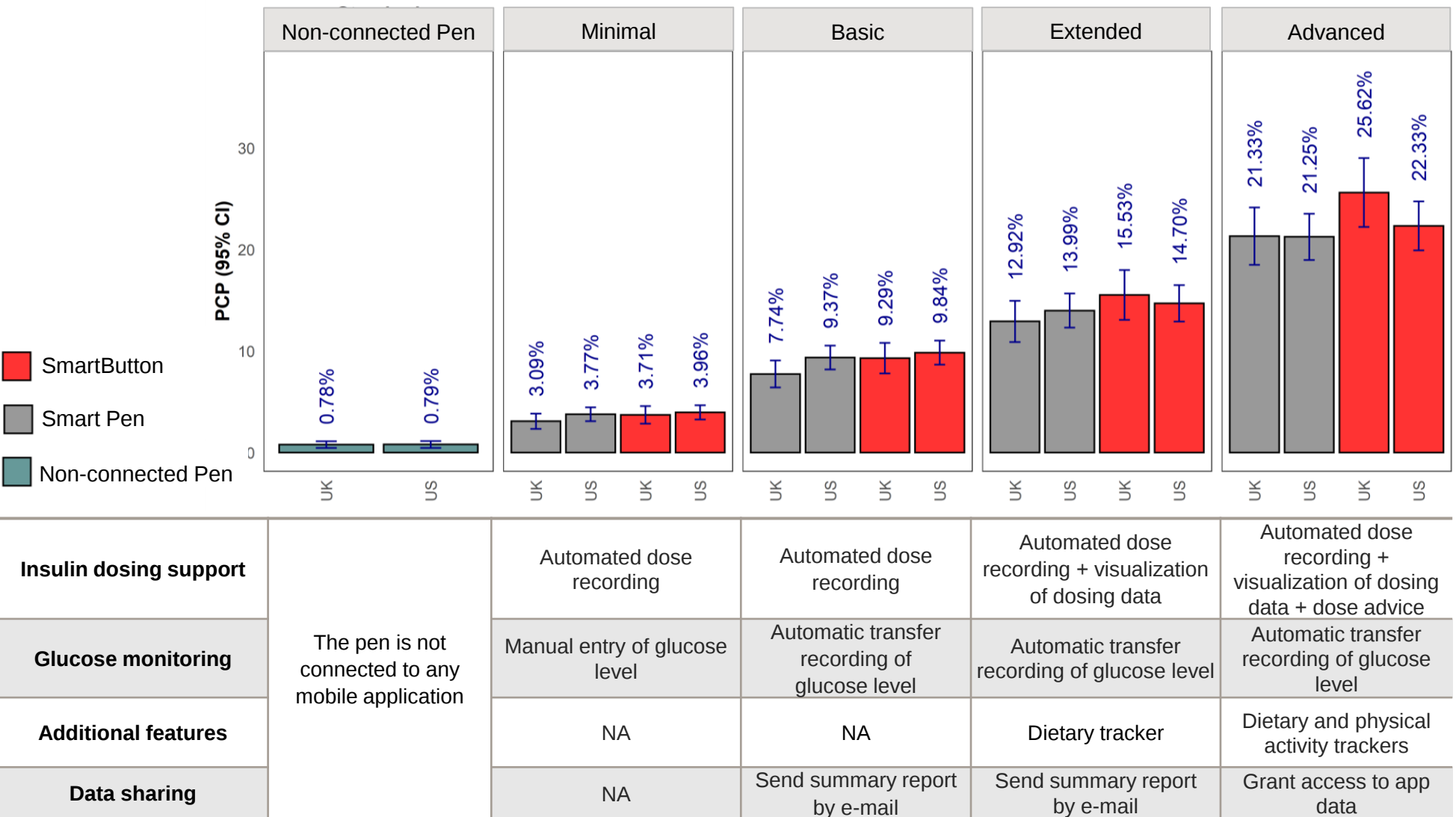
Figure 3. Estimated RAI Scored by Country (overall, N=540)



Respondents= 540; LL= -4326.5; BIC= 8784.7; Adj. McFadden R²= 0.39
Abbreviations: MLE = maximum likelihood estimate; CI = confidence interval
Significance: *** p-value <0.1%; ** p-value <1%; * p-value <5%
The RCL included a finite mixture of the alternative specific constant (non-connected pen): Group 1 (n=88, 16.3%) = 5.429 (0.640)***; Group 2 (n=405, 74.9%) = -2.749 (0.440)***; Group 3 (n=47, 8.8%) = 1.528 (0.181)***; Averaged constant = -1.043 (0.402)**

- Three distinct tendencies to opt into a connected insulin pen were found:
 - Technology supporters (74.9%; n=405) always chose a connected pen
 - Technology sceptics (8.8%; n=47) only chose a connected insulin pen with many features
 - Technology opponents (16.3%; n=88) never chose a connected pen

Figure 4. Choice Probabilities on Pen Scenarios (overall, N=540)



Abbreviations: CI = confidence interval; PCP = predicted choice probability; UK = United Kingdom; US = United States; NA = not applicable

Pen Scenarios

- A connected insulin pen was preferred (p<0.001) over a non-connected pen in all considered scenarios (Figure 4).
- More pen functions were always preferred (p<0.001) over fewer functions.
- Country difference was not significant.

CONCLUSIONS

- In general, PWD viewed connected insulin pens to be valuable tools when compared to non-connected pens.
- Pen preferences were most affected by the automatic transfer of insulin dosing and glucose data.
- Findings from this study suggest that connected insulin pens may improve PWDs’ experience with insulin therapy.

DISCLOSURES/ACKNOWLEDGEMENTS

- Presenting author Sebastian Heidenreich is employed by Evidera, a business unit of PPD. Evidera was contracted by Eli Lilly and Company to conduct the research study. Dr. Heidenreich is a minority stockholder of PPD, as part of his employment with Evidera.
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