Survey Reveals Patient and Health Care Provider Experiences and Challenges With the Use of High Doses of Basal Insulin

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CONCLUSIONS

01 This study highlights a disconnect between people with T2D and HCPs in the behaviors and emotions associated with the use of basal insulin

02 People are experiencing challenges associated with therapy, such as wasting and shorting basal insulin, of which HCPs are not aware

03 A smaller proportion of PCPs than endocrinologists prescribed high-capacity pens, indicating a need for education of PCPs on their use and suitability for people requiring >20 units of basal insulin per day

04 HCPs need to play a key role in helping people overcome these challenges, including connecting with their patients' emotional needs and understanding stressors associated with managing T2D

05 HCPs should consider how to encourage more effective communication with their patients to discuss their needs and provide education on long-acting insulin therapy, including available pen devices, to reach a shared decision on the most appropriate device for each individual

Survey Reveals Patient and Health Care Provider Experiences and Challenges With the Use of High Doses of Basal Insulin

Jennifer D. Goldman,[1,2] Eugenio Angueira-Serrano,[3,4] Jeffrey S. Gonzalez,[5] Christianne Pang,[6] Jacqueline Tait,[6] and Steven Edelman[7,8]

Type 2 diabetes is a chronic, progressive disease, and its management results in a high emotional burden on patients. Eventually many patients require and can benefit from the use of insulin. This article reports results of a survey of patients and health care providers regarding their experiences of and challenges with the use of basal insulin. Health care providers can play a key role in helping people with type 2 diabetes overcome the challenges associated with the use of basal insulin, including connecting with their emotional needs and understanding the stressors associated with managing diabetes.

In 2021, it was estimated that ~32.2 million people in the United States aged 20–79 years had diabetes, of whom 90% had type 2 diabetes (1). Timely and effective glycemic management is essential to reduce the risk of microvascular and macrovascular complications of diabetes (2). However, despite advances in available therapies, many people do not achieve their glycemic targets (3,4).

Type 2 diabetes is a progressive disease (5,6), and eventually, many patients require and benefit from insulin therapy. People who receive insulin therapy often need to increase their daily basal insulin dose, especially those with comorbidities such as obesity, which contribute to insulin resistance (7). In a meta-analysis of five phase 3a trials from the insulin degludec clinical trial program, approximately one-third of people with type 2

diabetes required >60 units/day of basal insulin (8). As the required dose of insulin increases, so does the number of insulin pens/vials required to fulfill the dosage requirements, and the likelihood that prefilled pen/vials will not contain the exact multiple of doses needed. This circumstance can result in the need to use more than one pen/vial to administer the correct dose. For example, if a pen has 20 units of insulin left, and a person requires 50 units of insulin, the person will need to inject the 20 units from the current pen plus 30 units from a new pen. This problem may lead to behaviors to avoid having to perform two injections, such as throwing away insulin pens that do not contain enough insulin to administer a full dose in one injection or, conversely, injecting only the insulin remaining in a pen but not making up the rest of the dose with a second injection (a practice termed "shorting insulin") (9).

Requirements for increased insulin doses and an increased number of injections have been linked to poor adherence, which in turn negatively affects long-term glycemic control and can cause considerable distress for people living with type 2 diabetes (10,11). The behavior of shorting insulin is poorly understood. Existing measures for assessing adherence to insulin are unlikely to capture information on this phenomenon. Additionally, the complexity of treatment regimens can be a considerable burden on patients (12). However, there is often a disconnect between patients and health care providers (HCPs) regarding the extent to which such barriers

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affect a patient's willingness to initiate and/or adhere to insulin therapy (13).

It is likely that some of the burden associated with higher insulin dose requirements may be relieved using high-capacity insulin pens such as Toujeo Max Solostar (insulin glargine 300 units/mL, 900-unit capacity) or Tresiba FlexTouch U-200 (insulin degludec 200 units/mL, 600-unit capacity). It is envisaged that the use of high-capacity pens could reduce the frequency of having to make decisions regarding wasting insulin or shorting doses and lead to the use of fewer pens and prescriptions. In addition, it could potentially eliminate the need to inject basal insulin more than once daily in those who need to inject more than the maximum dose of their pen. The maximum dose in most pens is 80 units, with the exception of the high-capacity pens, both of which have a maximum dose of 160 units. When requiring more than one injection, some users will take their injections at different times of the day, often following instructions from their HCP; however, it should be noted that this practice represents an off-label use of once-daily basal insulin. Data regarding the use of high-capacity pens and their effects on patient burden are rare.

We undertook a survey of patients and HCPs (endocrinologists and primary care practitioners [PCPs]) with the following objectives: *1)* to understand the patient experience and to quantify the challenges faced by people using high doses of basal insulin (≥50 units/day), with a particular focus on the injection experience and the potential needs of people requiring basal insulin; *2)* to assess the commonalities and disconnects between the perspectives of HCPs and people with type 2 diabetes regarding the basal insulin injection experience; and *3)* to measure the preferences regarding and importance placed on basal insulin pen features among people with type 2 diabetes and HCPs, both for higher-dose (>80 units/day) and lower-dose (50–80 units/day) usage.

Research Design and Methods

A preliminary qualitative research study was conducted to gather feedback from people with type 2 diabetes and HCPs with the goals of gaining a deeper understanding of the challenges associated with taking high doses of insulin and determining the most appropriate language for the survey questionnaire.

The HCP portion of this preliminary study involved 45-minute, one-on-one telephone/videoconference interviews with PCPs (*n* = 8) and endocrinologists

(*n* = 9). Interviews took place between 23 March and 26 March 2021.

For people with type 2 diabetes (*n* = 28), 45-minute, one-on-one telephone/videoconference interviews were conducted with high-capacity pen users (11 using the Toujeo Max Solostar and nine using the Tresiba U200 Flextouch) and standard-capacity pen users (nine using the Lantus Solostar pen). Of the 28 people who participated, 15 were taking >80 units/day of basal insulin, and 13 were taking 50–80 units/day. Interviews were timed to occur when respondents administered their basal insulin doses. The first part of the interview was observational. Participants assembled their pens and administered their injections at home. They were observed online via high-resolution cameras. After the injection observation, a discussion took place about the specifics of the experience. This observational aspect of the research allowed for the uncovering of challenges faced by people with type 2 diabetes that may not have been revealed via direct questioning and ensured that the injection experience was at the top of participants' minds for the interview. Interviews took place from 30 March to 19 April 2021.

Results from these surveys were used to format the final quantitative surveys that were sent to people with type 2 diabetes and HCPs (Supplementary Materials). The surveys contained questions on basal insulin usage, pen familiarity, and a blinded concept test in which respondents were shown "insulin pen X," which had the following profile (matching Toujeo Max Solostar characteristics): 900-unit capacity, maximum injection of 160 units, 5-second hold time, concentration/injection volume of 300 units, dial that extends, 8-week shelf life, and 2-unit dose increments.

Participants

People with type 2 diabetes were recruited from the dQ&A Patient Panel (dQ&A, San Francisco, CA), an opt-in panel of 12,000 people with diabetes, and from a large national consumer research panel. The data for this study were collected using Qualtrics (14), which is certified by the Health Information Trust Alliance Common Security Framework, ensuring that the data collection platform was compliant with the Health Insurance Portability and Accountability Act.

Eligible participants were ≥18 years of age, were diagnosed with type 2 diabetes and using ≥50 units/day of basal insulin (delivered in single or multiple injections and administered by either insulin pen or insulin

vial/syringe), had used their current brand of basal insulin for ≥1 year, and could be using any basal insulin regimen (e.g., with or without oral antidiabetic agents or a glucagon-like peptide 1 receptor agonist). People using second-generation basal insulins and high-capacity pens (Toujeo Max U300, Toujeo U300, and Tresiba U200) were excluded from the study. Therefore, all pen devices used by study participants had a maximum of 300 units of insulin per pen and a maximum delivery of 80 units per dose, so participants requiring >80 units/day would need to deliver their daily dose with more than one injection.

Eligible HCPs had been in post-residency practice for 2–35 years, were board certified, treated ≥150 total patients per month (including those with and without type 2 diabetes), spent ≥50% of their time in office-based practice/clinic in a private group or private solo practice, and were not based at a hospital or Kaiser Permanente practice per market research restrictions with pharmaceutical companies. PCPs treated ≥50 patients with type 2 diabetes per month, and endocrinologists treated ≥80 patients with type 2 diabetes per month. All HCPs were prescribing insulin therapy for ≥25% of their type 2 diabetes patients. HCPs were excluded if they were employed and/or paid by a pharmaceutical company as a clinical investigator or practiced in Vermont per state laws restricting physician honoraria for market research.

Samples were sourced independently (i.e., participants with type 2 diabetes were not necessarily assigned to participating HCPs). Respondents received nominal compensation for completing the survey ($10–15 for people with type 2 diabetes, $20 for endocrinologists, and $17 for PCPs).

The survey was blinded; participants were not given any information about the study sponsor or any product or company names. The study sponsor was not given information on the identity of participants.

Respondents answered standard questions on adverse event reporting, data integrity, confidentiality, nonpublic information, and employer participation approval. Respondents provided consent at the start of the survey and had the option to exit at that point. Institutional review board approval was not required because this was a market research study.

Data Collection and Analyses

Online quantitative surveys were conducted with people with type 2 diabetes between 9 July and 18 August 2021; HCPs completed surveys between 29 July and 13 August 2021. Questions included binary yes/no answers, multiple-choice answers, four-point response scales (choice of responses: strongly disagree, somewhat disagree, somewhat agree, strongly agree), and short free-text answers. Responses were analyzed descriptively using the MarketSight data analytics tool (MarketSight, Newton, MA), and the percentages of participants and HCPs providing each response were recorded. Descriptive comparisons were made between responses of people with type 2 diabetes and HCPs to the same question to enable a measure of potential discord.

Results

Demographics

In total, 387 people with type 2 diabetes completed the survey (296 pens users and 91 who used vials/syringes), of whom 230 required 50–80 units/day of basal insulin, and 157 required >80 units/day. The median survey completion time was 22.7 minutes. Of those receiving 50–80 units/day, 47% were male. Of those receiving >80 units/day, 42% were male (Table 1).

A total of 303 HCPs completed the survey. The median survey completion time was 19.5 minutes. Of the participating HCPs, 156 were PCPs and 147 were endocrinologists (Table 1).

Challenges

The challenges described in the sections below were either indicated as experienced by ≥25% of people with type 2 diabetes when responding to binary yes/no questions or noted by ≥40% of people with type 2 diabetes as "strongly agree" when responding to attitudinal queries using a four-point response scale.

Wasting Insulin

Only people who were using pen devices (n = 189 of those taking 50–80 units/day; n = 107 of those taking >80 units/day) were asked questions about wasting insulin. Wasting insulin was reported by 57% of people with type 2 diabetes (Figure 1A); of the 97 pen users (33%) who reported wasting insulin more than once per month, 76% reported wasting insulin two to four times a month. Fifty-two percent of HCPs indicated that they were not sure whether patients were wasting insulin; the 48% who were aware of insulin wasting estimated that a mean of 43% of their patients were doing so. HCPs estimated that a mean of 25% of patients wasted insulin more than once per month, whereas 33% of people with type 2 diabetes reported doing so.

TABLE 1 Demographic Characteristics of Participating People With Type 2 Diabetes and HCPs

Characteristic	People With Type 2 Diabetes (N = 387)	
	50–80 units/day (n = 230)	>80 units/day (n = 157)
Age range, years		
25–44	12 (5)	39 (25)
45–64	94 (41)	57 (36)
≥65	124 (54)	61 (39)
Male sex	108 (47)	66 (42)
Race/ethnicity		
White	193 (84)	134 (85)
Hispanic/Latino/Spanish	9 (4)	7 (4)
Black/African American	19 (8)	11 (7)
Asian	1 (0)	0 (0)
Native American	4 (2)	2 (1)
Other	2 (1)	1 (1)
Prefer not to say	2 (1)	2 (1)
A1C, %*		
≤7	75/217 (35)	48/149 (32)
7.1–8	81/217 (37)	53/149 (36)
≥8.1	61/217 (28)	48/149 (32)
U.S. geographical region		
Northwest	49 (21)	15 (10)
Midwest	60 (26)	36 (23)
South	77 (33)	46 (29)
West	31 (13)	19 (12)
Unknown	13 (6)	41 (26)
Insurance		
PPO plan	68 (30)	51 (32)
HMO plan	19 (8)	24 (15)
Medicare only	37 (16)	18 (11)
Medicare plus private	68 (30)	34 (22)
Medicaid	21 (9)	14 (9)
VA, military, armed forces	14 (6)	10 (6)
Self-pay	2 (1)	3 (2)
EPO plan	1 (0)	3 (2)
Oral drugs†	155/230 (67)	97/157 (62)
Metformin	113/155 (73)	64/97 (66)
Sulfonylureas	25/155 (16)	17/97 (18)
Oral GLP-1 receptor agonist	0 (0)	3/97 (3)
SGLT2 inhibitor	37/155 (24)	20/97 (21)
DPP-4 inhibitor	14/155 (9)	11/97 (11)
Other	27/155 (17)	6/97 (6)
None of above	2/155 (1)	1/97 (1)
	HCPs (N = 303)	
	Endocrinologists (n = 147)	PCPs (n = 156)
Years of post-residency practice		
2–10	32 (22)	39 (25)
11–20	64 (44)	50 (32)
21–35	51 (35)	67 (43)
Practice setting		
Office-based clinic	58 (39)	58 (37)
Private group practice	76 (52)	78 (50)
Private solo practice	13 (9)	20 (13)

TABLE 1 Demographic Characteristics of Participating People With Type 2 Diabetes and HCPs (Continued)

	HCPs (N = 303)	
	Endocrinologists (n = 147)	PCPs (n = 156)
Community type		
Rural	9 (6)	24 (15)
Urban	56 (38)	45 (29)
Suburban	82 (56)	87 (56)

Data are n (%). *A1C data were not available for all participants. †A total of 155 patients taking 50–80 units and 97 patients taking >80 units of insulin indicated that they were taking oral medications. Thus, percentages shown for individual drugs in this row are based on the total numbers of respondents taking any oral medication. DPP-4, dipeptidyl peptidase 4; EPO, exclusive provider organization; GLP-1, glucagon-like peptide 1; HMO, health maintenance organization; PPO, preferred provider organization; SGLT2, sodium–glucose cotransporter 2; VA, Veterans Affairs.
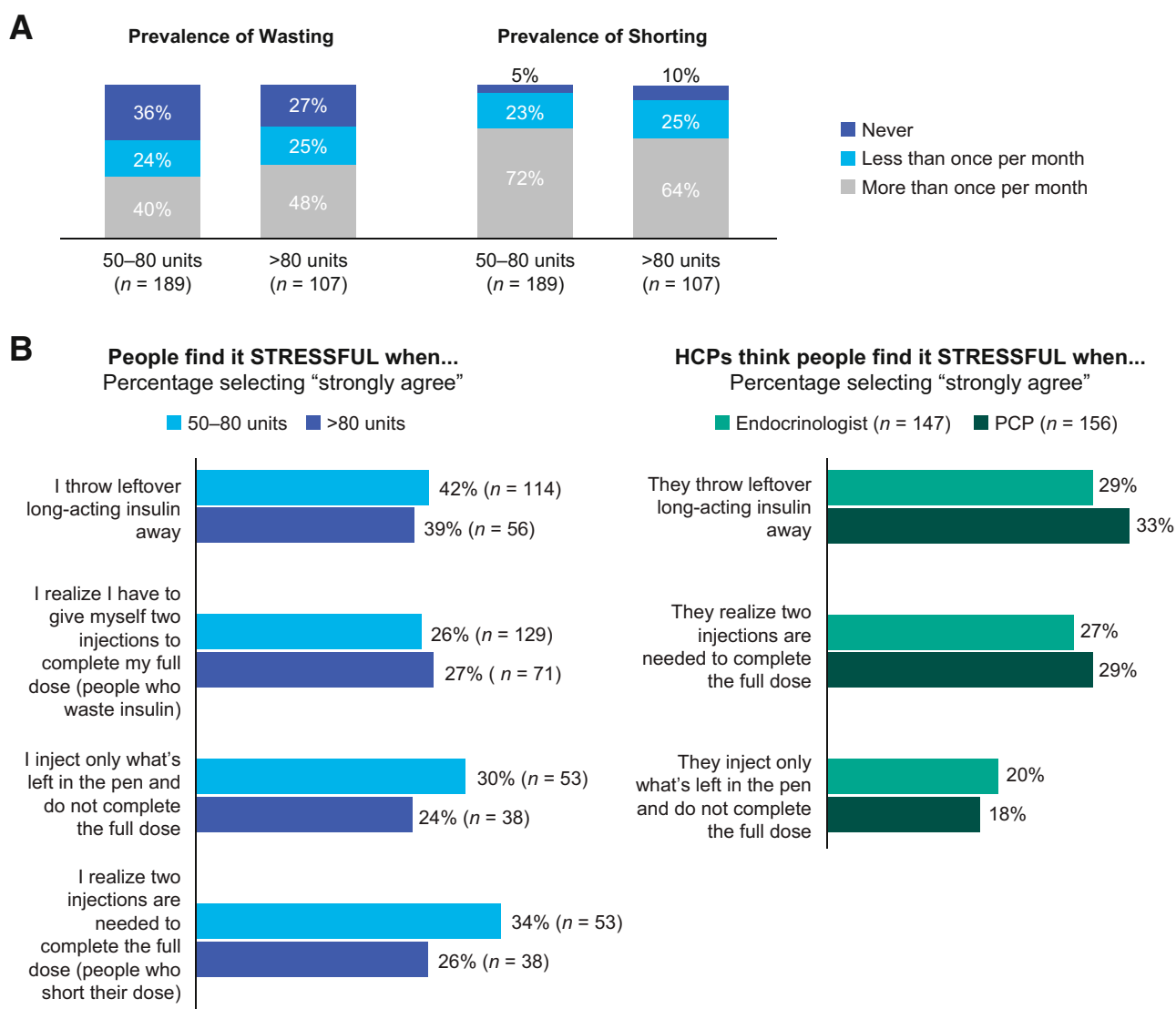
FIGURE 1 Prevalence of insulin wasting and shorting insulin (A) and the stresses associated with these behaviors (B). Questions about wasting and shorting insulin were only asked of pen users (excluding those who used syringes).

On average, those who reported wasting insulin more than once per month wasted 16.6 (SD 14.3) units each time (14.9 [SD 13.2] units for those requiring 50–80 units/day and 20.7 [SD 16.2] units for those requiring >80 units/day). Seventy-six percent of those who reported wasting insulin more than once per month did so two to four times per month, which was equivalent to wasting an estimated 813 units/year. Overall, 64% of people with type 2 diabetes (70% of those requiring 50–80 units/day and 55% of those requiring >80 units/day) and 57% of HCPs strongly agreed that throwing away unused long-acting insulin is a waste of money; agreement was greater among pen users than among syringe users (67 vs. 55%). Among people who wasted insulin, 41% strongly agreed that it is stressful to throw away insulin (Figure 1B), whereas fewer HCPs (31%) strongly agreed with this statement.

Shorting Insulin

Shorting insulin refers to the practice of underdosing by injecting only the insulin remaining in a pen but not making up the rest of the required dose with a second injection from another pen. Only people using pen devices (n = 189 of those taking 50–80 units/day; n = 107 of those taking >80 units/day) were asked questions about shorting insulin. Shorting insulin was reported by 31% of people with type 2 diabetes, with 7% reporting doing so more than once per month (Figure 1A). For those who reported shorting insulin more than once per month (n = 21), 62% did so two to three times per month. Overall, 51% of HCPs were not sure whether their patients were shorting insulin; the 49% of HCPs who believed patients were shorting insulin estimated that 33% of patients were doing so and that 19% were doing so more than once per month. Similar proportions of people with type 2 diabetes and HCPs (26 and 28%, respectively) strongly agreed that it is stressful for people with type 2 diabetes when they realize they need two injections to complete their full dose (Figure 1B). Twenty-seven percent of people with type 2 diabetes and 19% of HCPs strongly agreed that shorting insulin is stressful.

Logistical Burden

Overall, 65% of people with type 2 diabetes reported that they pick up their insulin refills at the pharmacy (Figure 2A). Those requiring >80 units/day were more likely to refill every 30 days compared with those requiring 50–80 units/day (P = 0.012). Twenty-three percent of people with type 2 diabetes strongly agreed that frequent trips to the pharmacy for long-acting

insulin refills are burdensome; twice as many HCPs strongly agreed with this statement (Figure 2B). Overall, 47% of people with type 2 diabetes and HCPs strongly agreed that carrying fewer long-acting insulin pens when traveling would be less burdensome.

Burden of Two Basal Insulin Injections

About half of the people with type 2 diabetes (51%) reported that they split their daily basal insulin into two or more injections per day. Those who used two or more injections reported that they were splitting their dose per their HCP's instructions (44%) and/or for better control/coverage (29%). These data were coded from verbatim comments of 167 respondents.

Among pen users who required >80 units/day of basal insulin and split their dose into two or more injections a day, 88% said they injected the doses at different times of the day, whereas 12% reported that they take their basal insulin injections back to back. Of those taking 50–80 units/day, 33% reported that they inject two or more times per day (Figure 2A). Sixty-five percent of HCPs, compared with 41% of people with type 2 diabetes, strongly agreed that patients prefer to take only one basal insulin injection daily (Figure 2B). Fifty-two percent of HCPs, compared with 32% of people on more than one basal insulin injection per day, strongly agreed that one less injection per day would make a meaningful difference to injection burden (Figure 2B).

Adherence Issues Arising From the Need for Two Injections of Basal Insulin

Forty-seven percent (n = 60) of respondents needing to split their daily basal insulin dose into two or more injections per day reported missing basal insulin doses (Figure 3A); of these, 19% missed their dose once per month, 15% missed a dose twice per month, 6% missed doses once per week, and 7% missed doses more than once per week. Sixty-three percent of HCPs knew people were missing insulin doses, and they estimated that 28% of people taking two or more basal insulin injections per day were missing insulin doses (vs. 38% of patients who reported missing doses) (Figure 3A).

The most common reasons given by respondents (n = 139; from verbatim responses) for missing insulin doses were that they forgot (55%), they fell asleep (19%), and they were too busy (15%). When asked about prespecified reasons for missing insulin doses, "strongly agree" was selected for the following challenges by HCPs and people on two or more injections per day and receiving >80 units/day: missing their insulin dose to
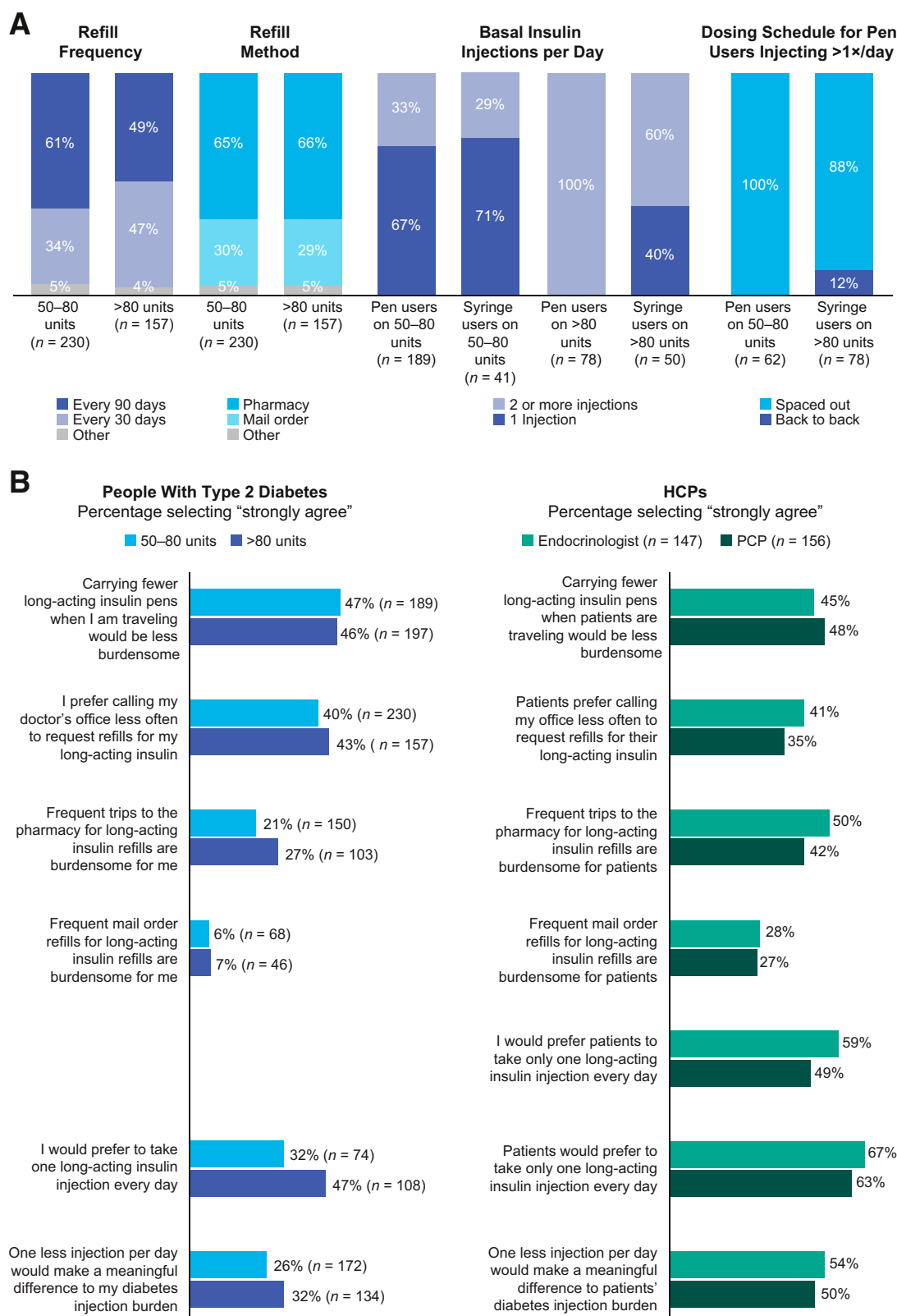
A

Refill Frequency

- 50–80 units (*n* = 230): Every 90 days 61%, Every 30 days 34%, Other 5%
- >80 units (*n* = 157): Every 90 days 49%, Every 30 days 47%, Other 4%

Refill Method

- 50–80 units (*n* = 230): Pharmacy 65%, Mail order 30%, Other 5%
- >80 units (*n* = 157): Pharmacy 66%, Mail order 29%, Other 5%

Basal Insulin Injections per Day

- Pen users on 50–80 units (*n* = 189): 2 or more injections 33%, 1 Injection 67%
- Syringe users on 50–80 units (*n* = 41): 2 or more injections 29%, 1 Injection 71%
- Pen users on >80 units (*n* = 78): 2 or more injections 100%
- Syringe users on >80 units (*n* = 50): 2 or more injections 60%, 1 Injection 40%

Dosing Schedule for Pen Users Injecting >1×/day

- Pen users on 50–80 units (*n* = 62): Spaced out 100%
- Syringe users on >80 units (*n* = 78): Spaced out 88%, Back to back 12%

Legend:
- Every 90 days
- Every 30 days
- Other
- Pharmacy
- Mail order
- Other
- 2 or more injections
- 1 Injection
- Spaced out
- Back to back

B

People With Type 2 Diabetes
Percentage selecting "strongly agree"

- 50–80 units
- >80 units

Statement	50–80 units	>80 units
Carrying fewer long-acting insulin pens when I am traveling would be less burdensome	47% (*n* = 189)	46% (*n* = 197)
I prefer calling my doctor's office less often to request refills for my long-acting insulin	40% (*n* = 230)	43% (*n* = 157)
Frequent trips to the pharmacy for long-acting insulin refills are burdensome for me	21% (*n* = 150)	27% (*n* = 103)
Frequent mail order refills for long-acting insulin refills are burdensome for me	6% (*n* = 68)	7% (*n* = 46)
I would prefer to take one long-acting insulin injection every day	32% (*n* = 74)	47% (*n* = 108)
One less injection per day would make a meaningful difference to my diabetes injection burden	26% (*n* = 172)	32% (*n* = 134)

HCPs
Percentage selecting "strongly agree"

- Endocrinologist (*n* = 147)
- PCP (*n* = 156)

Statement	Endocrinologist	PCP
Carrying fewer long-acting insulin pens when patients are traveling would be less burdensome	45%	48%
Patients prefer calling my office less often to request refills for their long-acting insulin	41%	35%
Frequent trips to the pharmacy for long-acting insulin refills are burdensome for patients	50%	42%
Frequent mail order refills for long-acting insulin refills are burdensome for patients	28%	27%
I would prefer patients to take only one long-acting insulin injection every day	59%	49%
Patients would prefer to take only one long-acting insulin injection every day	67%	63%
One less injection per day would make a meaningful difference to patients' diabetes injection burden	54%	50%

FIGURE 2 Logistical burden of basal insulin injections (*A*) and the burden of having to use two or more injections (*B*).

A

People Missing Doses
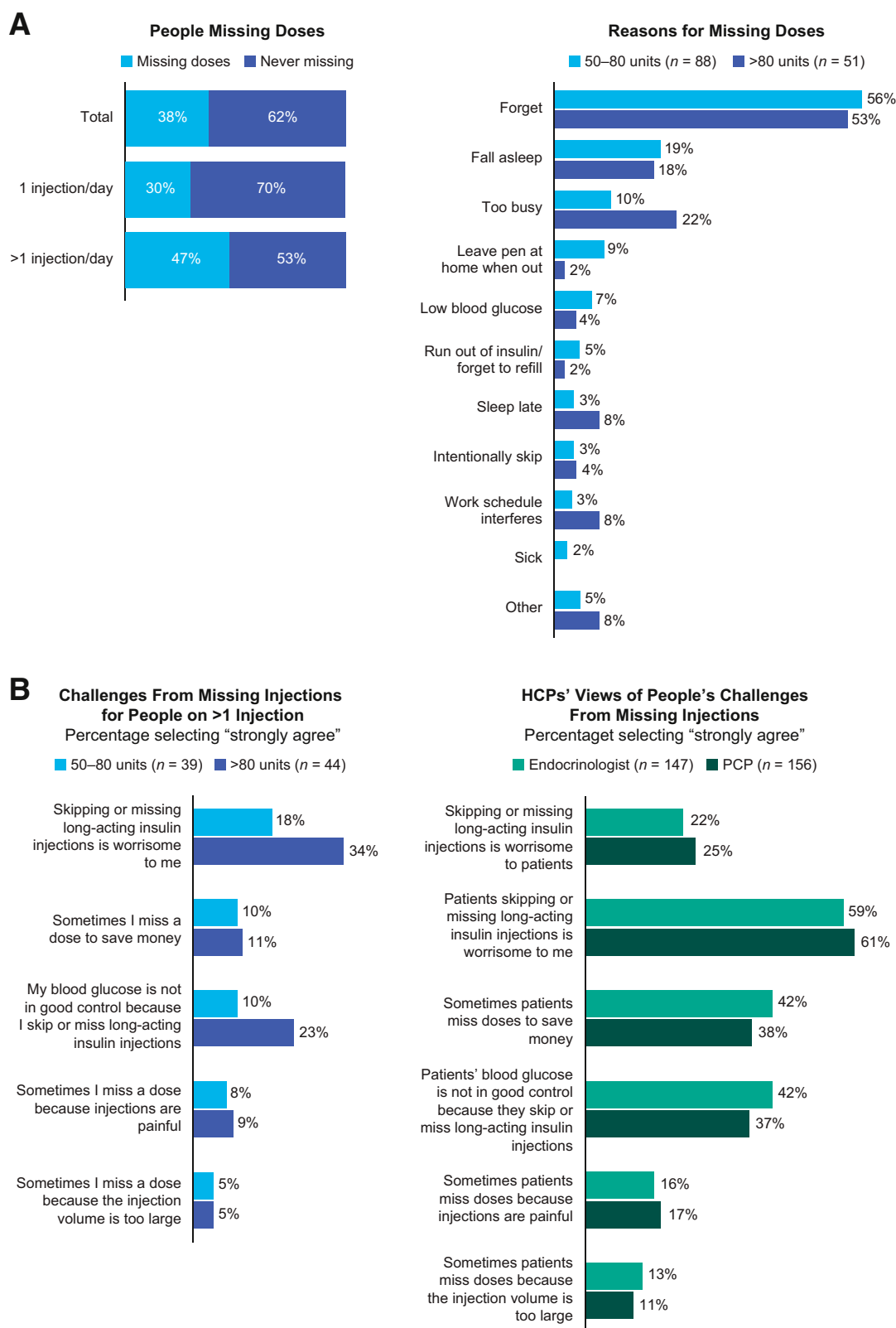
■ Missing doses ■ Never missing

	Missing doses	Never missing
Total	38%	62%
1 injection/day	30%	70%
>1 injection/day	47%	53%

Reasons for Missing Doses

■ 50–80 units (*n* = 88) ■ >80 units (*n* = 51)

	50–80 units	>80 units
Forget	56%	53%
Fall asleep	19%	18%
Too busy	10%	22%
Leave pen at home when out	9%	2%
Low blood glucose	7%	4%
Run out of insulin/ forget to refill	5%	2%
Sleep late	3%	8%
Intentionally skip	3%	4%
Work schedule interferes	3%	8%
Sick	2%	
Other	5%	8%

B

Challenges From Missing Injections for People on >1 Injection
Percentage selecting "strongly agree"

■ 50–80 units (*n* = 39) ■ >80 units (*n* = 44)

	50–80 units	>80 units
Skipping or missing long-acting insulin injections is worrisome to me	18%	34%
Sometimes I miss a dose to save money	10%	11%
My blood glucose is not in good control because I skip or miss long-acting insulin injections	10%	23%
Sometimes I miss a dose because injections are painful	8%	9%
Sometimes I miss a dose because the injection volume is too large	5%	5%

HCPs' Views of People's Challenges From Missing Injections
Percentaget selecting "strongly agree"

■ Endocrinologist (*n* = 147) ■ PCP (*n* = 156)

	Endocrinologist	PCP
Skipping or missing long-acting insulin injections is worrisome to patients	22%	25%
Patients skipping or missing long-acting insulin injections is worrisome to me	59%	61%
Sometimes patients miss doses to save money	42%	38%
Patients' blood glucose is not in good control because they skip or miss long-acting insulin injections	42%	37%
Sometimes patients miss doses because injections are painful	16%	17%
Sometimes patients miss doses because the injection volume is too large	13%	11%

FIGURE 3 Percentages of people with type 2 diabetes who reported missing insulin doses and their reasons for missing doses (*A*) and the perceived challenges associated with missing insulin doses (*B*). Data reflect all participants with type 2 diabetes who reported missing doses and provided verbatim responses (*n* = 139).

save money (40 and 11%, respectively), missing insulin doses to avoid painful injections (17 and 9%, respectively), and missing insulin doses to avoid large injection volumes (12 and 5%, respectively) (Figure 3*B*). These data demonstrate that HCPs often overestimate the challenges that people with type 2 diabetes face that result in missing insulin doses.

Twenty-seven percent of people receiving >80 units/day and 24% of HCPs strongly agreed that missing basal insulin injections is worrisome to people with type 2 diabetes. A larger proportion of HCPs (60%) strongly agreed that people with type 2 diabetes missing doses is worrisome to the HCPs themselves (Figure 3*B*). Compared with only 17% of people receiving >80 units/day, approximately 40% of HCPs strongly agreed that missing injections negatively affected blood glucose control (Figure 3*B*).

Environmental Waste

Overall, 38% of people with type 2 diabetes strongly agreed that they would prefer to use and dispose of fewer pens/syringes, needles, and packaging. Echoing this, 29% of HCPs thought that people would prefer to be less environmentally wasteful. A larger proportion of HCPs (45%) stated that they themselves prefer their patients to use and dispose of fewer pens, needles, and packaging.

Injection Site Reactions

Injection site reactions, including pain, bruising, knots, and/or bumps, were reported by 68% of all respondents; of those receiving >80 units/day, 12% reported experiencing reactions all the time compared with 6% of those receiving 50–80 units/day ($P = 0.024$). Endocrinologists estimated that 17% of patients experience injection site reactions compared with an estimate of 23% by PCPs ($P = 0.002$). Both people with type 2 diabetes (21% [23% for those receiving >80 units/day and 20% for those receiving 50–80 units/day]) and HCPs (28% [30% of endocrinologists and 27% of PCPs]) strongly agreed that injection site reactions from basal insulin are bothersome.

Pen Familiarity and Blinded Concept Test

Most respondents (72% of those receiving 50–80 units/day and 59% of those receiving >80 units/day) had never heard of high-capacity pens (Figure 4*A*). Endocrinologists were more likely than PCPs to prescribe high-capacity pens (Figure 4*B*). For individuals receiving 50–80 units/day or >80 units/day who indicated that they would likely/definitely switch to the concept "insulin pen X,"

lower injection volume (24 and 16%, respectively), increased convenience (15 and 26%, respectively), increased time of use/pen capacity (20 and 15%, respectively), and reduction in the number of pens to store or travel with (16 and 19%, respectively) were cited as reasons (verbatim) (Figure 5*A*). HCPs who indicated they would "likely or definitely" prescribe "insulin pen X" expressed verbatim that high capacity and high concentration would be reasons for prescribing (Figure 5*B*).

Discussion

To our knowledge, this study is the first to report the perspectives of people with type 2 diabetes and HCPs on the basal insulin injection experience. The results highlight key differences between the beliefs and perceptions of people with type 2 diabetes versus HCPs regarding this topic and suggest there is a need for better communication between people with type 2 diabetes and HCPs to overcome these differences.

Wasting insulin to avoid having to take two injections was commonly reported in this study; however, fewer than half of HCPs indicated that they were aware of this practice, and those who were aware underestimated how often it occurred. It was also common for people to not inject their full insulin dose; approximately half of HCPs were not sure whether this was being done. Approximately half of people participating in this survey injected basal insulin more than once per day, and this practice was more common in those needing >80 units/day than those needing 50–80 units/day. A higher proportion of people reported missing doses when needing more than one versus one injection per day; therefore, needing more than one basal insulin injection per day was associated with an increased risk of poor adherence. This finding supports current knowledge that increased injection frequency is associated with an increased likelihood of missing injections and, similarly, that the risk of poor adherence increases as the number of injections increases (10,12).

An important outcome of this study is that it highlights a disconnect between the perceptions of HCPs and actual injection practices of people with type 2 diabetes. HCPs in this study underestimated the practices of wasting and shorting insulin, the proportion of people with type 2 diabetes who experience injection site reactions, the willingness of people with type 2 diabetes to take back-to-back injections, and the proportion of people with type 2 diabetes who miss insulin doses. HCPs also underestimated the stress associated with adherence issues such as wasting insulin and shorting doses. This
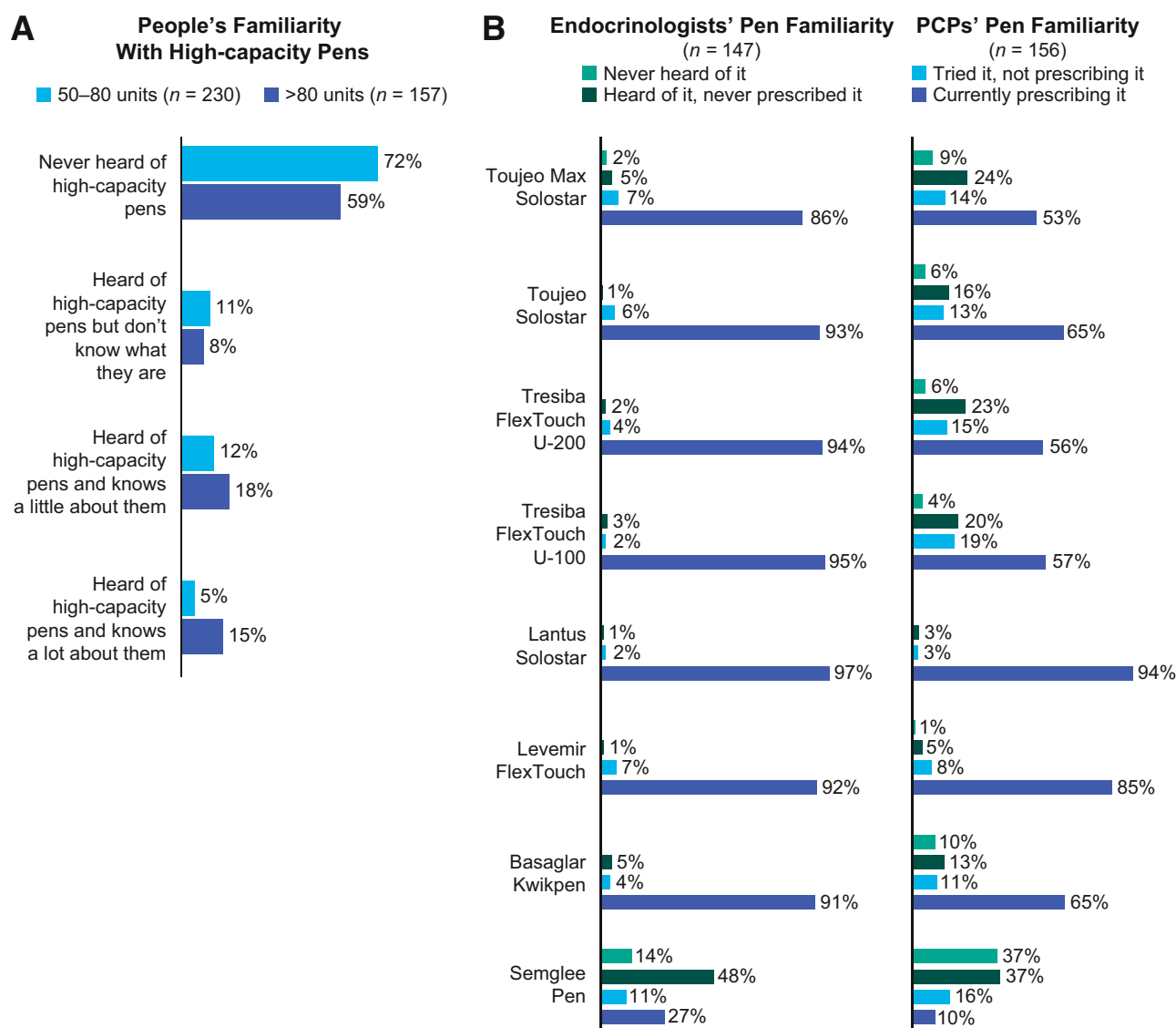
A — People's Familiarity With High-capacity Pens

■ 50–80 units (*n* = 230) ■ >80 units (*n* = 157)

- Never heard of high-capacity pens: 72% / 59%
- Heard of high-capacity pens but don't know what they are: 11% / 8%
- Heard of high-capacity pens and knows a little about them: 12% / 18%
- Heard of high-capacity pens and knows a lot about them: 5% / 15%

B — Endocrinologists' Pen Familiarity (*n* = 147)

■ Never heard of it
■ Heard of it, never prescribed it

PCPs' Pen Familiarity (*n* = 156)

■ Tried it, not prescribing it
■ Currently prescribing it

Pen	Endocrinologists	PCPs
Toujeo Max Solostar	2%, 5%, 7%, 86%	9%, 24%, 14%, 53%
Toujeo Solostar	1%, 6%, 93%	6%, 16%, 13%, 65%
Tresiba FlexTouch U-200	2%, 4%, 94%	6%, 23%, 15%, 56%
Tresiba FlexTouch U-100	3%, 2%, 95%	4%, 20%, 19%, 57%
Lantus Solostar	1%, 2%, 97%	3%, 3%, 94%
Levemir FlexTouch	1%, 7%, 92%	1%, 5%, 8%, 85%
Basaglar Kwikpen	5%, 4%, 91%	10%, 13%, 11%, 65%
Semglee Pen	14%, 48%, 11%, 27%	37%, 37%, 16%, 10%

FIGURE 4 Familiarity with high-capacity insulin pens of people with type 2 diabetes (*A*) and HCPs (*B*).

finding may be a reflection of the fact that people are often unrealistically optimistic about their own health when talking to their HCP (15).

In a self-reported survey of people living with type 1 or type 2 diabetes who used mealtime insulin, only 63.5% reported splitting a dose between two pens when their required dose was more than what was left in their pen, with 15% using only the insulin left in the pen and 36.3% throwing away any remaining insulin (9). People who wasted insulin in that study indicated that injecting twice for one dose was frustrating, time-consuming, and painful (9). Similarly, in the current study, people with type 2 diabetes reported that these behaviors were a source of stress. These behaviors may have implications for glucose control, as poor adherence is linked to

reduced long-term metabolic control (10,16). Additionally, there are likely cost implications.

Reasons for missing injections commonly given by people with type 2 diabetes were that they forgot, fell asleep, and were too busy, with only a small proportion reporting that they intentionally skipped injections. Reasons for missing injections for which HCPs indicated strong agreement were to save money (40%), because injections are painful (17%), and because of the large injection volume (12%). This finding suggests that HCPs do not regularly discuss the reasons people with type 2 diabetes give for missing injections or that people with type 2 diabetes do not communicate their reasons for missing injections with their HCPs. Thus, there is a real need for HCPs to connect with their patients and

A Reasons People Are Likely to Switch to Insulin Pen X

■ 50–80 units (*n* = 173) ■ >80 units (*n* = 121)

Reason	50–80 units	>80 units
Lower injection volume	24%	16%
More convenient	15%	26%
Lasts longer/pen capacity	20%	15%
Fewer pens to store or travel with	16%	19%
Fewer trips to pharmacy	16%	7%
Shelf life	13%	9%
Seems like a good fit, better than current	9%	15%
Depends on insurance coverage and/or HCP	11%	8%
Larger maximum dose/fewer injections	5%	12%
Less waste	3%	5%
Shorter hold time	4%	
Better than syringes	2%	2%
Other	5%	9%

B Reasons HCPs Are Likely to Prescribe Insulin Pen X

■ People 50–80 units (*n* = 289) ■ People >80 units (*n* = 292)

Reason	People 50–80 units	People >80 units
High-capacity pen, lasts longer	31%	30%
Low volume/high concentration	29%	26%
Shelf life	22%	17%
High dose/one dose	20%	37%
Ease of use, convenience	18%	15%
Hold time	12%	9%
Fewer pens needed, fewer refills	8%	5%
Good features overall	8%	7%
More effective, better absorption	6%	5%
Room to titrate up to higher doses	6%	2%
Better compliance	6%	6%
Less waste	1%	1%
Other	7%	8%

FIGURE 5 Reasons to switch to a high-capacity insulin pen given by people with type 2 diabetes (*A*) and HCPs (*B*).

ask questions such as, "How often are you not able to take your insulin?", "Are there times when you miss an insulin dose?", and "Are there times when you take less than your normal dose of insulin?" However, a study has shown that people often withhold information from their HCPs because they do not want to be judged, to hear how harmful this behavior is, or to be embarrassed (17).

Before educating people about their insulin regimen, understanding the emotional factors associated with diabetes and diabetes distress is crucial (11,18,19). Thus, dialogue between HCPs and people with type 2 diabetes needs to include a recognition of and response to emotional reactions (e.g., fear, disappointment, shame, or sense of failure) that can accompany both the diagnosis of type 2 diabetes and the need for initiation or

intensification of insulin therapy. There is a need for HCPs to have educational discussions with their patients to make a shared decision on an appropriate pen device or on whether to switch from their current pen or syringe/vial based on patients' concerns and preferences. Making shared decisions involves HCPs and their patients discussing together how best to manage the disease based on patients' preferences as well as clinical factors (20,21).

Although the data presented in this study highlight a disconnect between people with type 2 diabetes and HCPs, it is important to acknowledge that there are disparities within health care systems that may lead to behaviors such as skipping insulin doses to reduce costs. Socioeconomic status has been associated with higher rates of diabetes-related mortality, with income and

education being important determinants of death (22). The strongest predictor of having access to diabetes care and screening is having health insurance, and those without insurance have 60% fewer office visits with a physician, are prescribed 25% fewer medications, and have 16% more emergency department visits (23,24). In a study of U.S. adults with diabetes assessing cost-related medication nonadherence (defined as taking medication less than prescribed because of its cost), respondents who had an annual income <$50,000 without health insurance were more likely to engage in cost-related medication nonadherence than those with an income ≥$50,000 and those with health insurance, respectively (25). Insulin use increased this risk by 1.24 times (25). Racial/ethnic disparities are likely to exacerbate this risk further, with a recent study in the United States showing that, at comparable income levels, minorities were less likely than Whites to have health insurance (26). Additionally, compared with White patients, individuals of all racial/ethnic minorities had lower rates of initiation of newer diabetes medications, with this difference being significant for Black and Native American/Alaskan Native people independent of socioeconomic status (27).

High-capacity insulin pens may be appropriate for people who need higher doses of basal insulin. In particular, these high-capacity pens may help to reduce behaviors such as wasting insulin and shorting doses. In a study of people with type 2 diabetes who use premixed insulin, when asked, "What do you do when you do not have a full dose left in your current pen?," only 27 of 110 indicated that they injected twice to avoid waste (28). However, in that study, insulin wastage was lower for those who used a 300-unit pen compared with those who used a 150-unit cartridge (3.6 vs. 13.6% of their insulin, respectively). This finding suggests that high-capacity basal insulin pens may help to reduce insulin wastage and insulin shorting, as people would be less likely to need to inject twice to complete their dose; in turn, this consequence could have a positive impact on the stress associated with needing to inject twice, as well as reduce the need for refills. Furthermore, fewer instances of shorting insulin may lead to improved glycemic control. Indeed, in the current questionnaire, when asked to provide reasons for switching to "insulin pen X," which shared the same profile as Toujeo Max Solostar (although respondents were blinded to this fact), people cited "lower injection volume," "more convenience," "pen capacity/lasts longer," and "fewer pens to store or travel with." HCPs echoed this view, noting the pen's high capacity and lower injection volume as reasons for prescribing.

However, in this study, many people with type 2 diabetes did not know these pens existed. Additionally, only just over half of PCPs were currently prescribing either the Toujeo Max Solostar or Tresiba FlexTouch U-200, compared with 86 and 94% of endocrinologists, respectively. This finding may indicate that PCPs have not been fully educated on the potential of high-capacity basal insulin pens and therefore believe these pens are reserved for special population types such as individuals with a high degree of insulin resistance. In reality, these pens would be suitable for anyone requiring basal insulin at doses of ≥20 units/day. (This dosage criterion is based on the ability to use all insulin within the pen, comfortably, within the 56-day prespecified storage period once opened and stored at room temperature.) Therefore, there is a need to educate PCPs regarding the use of high-capacity pens to enable them to fully discuss pen options with their patients and make shared decisions on the best pen choice for each patient.

In the process of making shared decisions, the cost of insulin is an important factor, and ~10% of respondents with type 2 diabetes in this study indicated that they had missed doses because of the cost. Insulin prices have risen in the past two decades, and the cost can cause significant burden to some people with type 2 diabetes; therefore, it may be appropriate to prescribe the lowest-priced insulin available to effectively and safely achieve treatment goals (29).

Limitations

Limitations of this study may include the potential for social desirability bias. Results of the survey may be limited by the use of closed questions/picklists or agree/disagree statements. Questionnaire responses available were limited by the statements that were selected to be included in the final questionnaire and thus may not have been comprehensive. Additionally, HCPs included in this study were not necessarily treating the people with type 2 diabetes who participated in the study.

Conclusion

This study highlights a disconnect between people with type 2 diabetes and HCPs with regard to the behaviors and emotions associated with a long-acting insulin regimen. It shows that many HCPs are unaware that people with type 2 diabetes are experiencing challenges associated with their therapy. HCPs underestimate the

frequency of behaviors such as shorting insulin and missing injections and the extent to which people with type 2 diabetes are aware that these actions may affect their glycemic control. In addition, a smaller proportion of PCPs prescribed high-capacity pens compared with endocrinologists, indicating a need for education of PCPs regarding the use and suitability of these pens for individuals requiring >20 units of basal insulin per day. HCPs need to play a key role in helping people with type 2 diabetes overcome challenges related to taking basal insulin, and this effort should include connecting with the emotional needs of people with type 2 diabetes and understanding the stress associated with managing the disease. Only then can HCPs effectively communicate with people with type 2 diabetes to discuss their needs and provide education on long-acting insulin therapy, including discussing available pen devices, to reach shared decisions on the most appropriate device for each person.

DUALITY OF INTEREST

J.D.G. is a speaker for Abbot Diabetes, Lilly, Novo Nordisk, Sanofi, and Xeris. E.A.-S. is a consultant for Sanofi and a speaker for Novo Nordisk and Sanofi. C.P. and J.T. are employees of dQ&A. No other potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

C.P. and J.T. contributed to the study design and acquisition and analyses of data. All authors were involved in the interpretation of the data and drafting and revising the manuscript for important intellectual content, approved the manuscript for submission, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. J.D.G. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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