Key Features of Insulin Delivery Devices for Type 2 Diabetes: Type 2.0 Booth Survey

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This article reports on a survey conducted at four diabetes-related annual conferences in 2017 and 2018 to obtain input from the medical community regarding the most important features of insulin delivery devices to address the unmet needs of people with type 2 diabetes who require basal/bolus insulin therapy. The overall patterns of responses compiled from 742 participating health care providers, each voting for three of eight proposed features of insulin delivery devices, were mostly similar numerically at each conference. The features garnering the top three percentages of votes ($n = 2,226$) averaged for all four conferences were tube-free patch (14.7%), reduced number of insulin injections (14.7%), and dose capture report (14.2%). Four other features received almost as many votes: flexible dosing (14.0%), patient lifestyle app (13.3%), wireless controller (12.7%), and interconnected glucose monitoring (12.6%). This survey provided valuable information that can aid the development of future insulin delivery devices.

Many people with type 2 diabetes may ultimately require insulin to improve glycemic control and then progress to intensive insulin therapy, necessitating a multiple daily injection (MDI) insulin regimen (1,2). However, these patients may have difficulty remaining adherent and persistent with insulin therapy, especially as their regimen becomes more complex with the need for more frequent injections to deliver basal and bolus (prandial) insulin (3–7). Patients who are nonadherent or non-persistent with diabetes therapy often fail to meet glycemic targets (8), thereby increasing their risk of diabetes-related complications (2,9).

The potential for insulin pumps and other insulin delivery systems to improve glycemic control is increasingly recognized for people with type 2 diabetes (10). The results of the large OpT2mise study indicate that continuous subcutaneous insulin infusion with a durable insulin pump improves glycemic control compared with an MDI regimen for patients with advanced, poorly controlled type 2 diabetes (11,12). Other insulin delivery devices such as tubeless patch pumps also show potential to improve glycemic control and reduce barriers to insulin therapy when compared with MDI regimens for type 2 diabetes therapy (13–17). However, although some of these devices are already commercially available, their development is relatively recent, and research on their effectiveness is ongoing (10).

The aim of this survey was to obtain input from the medical community regarding the most important features—either currently available or needed in the future—of insulin delivery devices to address the unmet needs of people with type 2 diabetes who require intensive insulin therapy. Our objectives were to gather responses from the range of health care providers (HCPs) represented at three types of diabetes-related annual conferences that draw diverse attendees, including an educator-focused conference, an international technology-focused conference, and the American Diabetes Association (ADA) Scientific Sessions.

Methods

Type 2.0 is an unbranded medical education initiative that engages HCPs around the unmet needs of people living with type 2 diabetes on insulin therapy (18). Type 2.0 was highlighted in the exhibit halls of four annual diabetes conferences (three in the United States and one international). These included the 2017 and 2018 ADA Scientific Sessions (19,20), the 2017 American

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TABLE 1 Insulin Delivery Device Features Included in the Surveys

Feature		Rationale for Inclusion/Consideration
1.	Wireless controller	To allow for more discreet insulin dose delivery
2.	Patient lifestyle app	For lifestyle coaching, an adjunctive patient educational/emotional support tool
3.	Dose capture report	To track insulin doses, so the care team could determine when and how much insulin was delivered on a given day
4.	Flexible dosing	To enable HCPs to partner with patients and individualize therapy
5.	Reduced injections	To minimize the number of injections
6.	Large reservoir	To accommodate high insulin requirements
7.	Tube-free patch*	To enable a more convenient method of delivery
8.	High-contrast display†	To aid display reading by older patients and those with retinopathy
9.	Interconnected glucose monitoring‡	To incorporate data from glucose monitoring devices (e.g., Bluetooth-connected blood glucose meters, continuous glucose monitoring systems, and flash continuous glucose monitoring systems)

*Tube-free patch is defined as a wearable tubeless insulin delivery device. †High-contrast display was not included in the survey at the 2018 ADA Scientific Sessions. ‡Interconnected glucose monitoring was included only in the survey given at the 2018 ADA Scientific Sessions.

Association of Diabetes Educators (AADE) annual meeting (21), and the 2018 international conference on Advanced Technologies & Treatments for Diabetes (ATTD) (22).

A brief verbal introduction was provided to conference attendees who visited the Type 2.0 exhibit hall booth, either individually or as a group during session breaks. The verbal introduction was designed to minimize the need for reading materials and to explain the goals of the survey. The goals were to identify the most important attributes and features of an insulin delivery device. We briefly summarized the unmet needs of patients with type 2 diabetes requiring basal/bolus insulin therapy, listed the eight device features included in each survey, and explained the rationale for their inclusion. In addition, we noted that the listed features were all available on marketed devices or under development on different types of insulin delivery devices (such as dose capture reports from smart pens and interconnected insulin pump systems featuring continuous glucose monitoring), although not all were available on a single insulin delivery device at the time the survey was conducted. Overall, nine device features were ultimately included in surveys, as listed in Table 1. For the final survey, interconnected glucose monitoring replaced high-contrast display as a feature.

An interactive wall display was used to capture the responses to this forced-ranking survey. The survey invitation was to "Create the insulin delivery device of the future, today." Respondents were asked to tap each of the eight icons corresponding to an insulin delivery device attribute or feature and then to choose the three icons that most resonated with them. Survey participants could also tap on the icons to bring up text descriptions for each feature, in case they forgot what the icon represented, and they were encouraged to ask additional questions for further clarification if needed. The booth display included a scoreboard summarizing results that refreshed with each completed survey.

We used summary statistics to describe the survey results for each conference, together with overall means for the survey responses. Statistical comparisons were not conducted.

Results

Responses were compiled from a total of 742 individuals at the four annual conferences, including 188 (25%) at the 2017 ADA Scientific Sessions, 389 (52%) at the AADE 2017 annual meeting, 75 (10%) at the 2018 ATTD conference, and 90 (12%) at the 2018 ADA Scientific Sessions.

Overall, seven of nine device features each garnered from 10 to 18% of the votes at all four conferences (when included), with one minor exception (wireless controller received 8% at the 2018 ATTD conference; Figure 1).

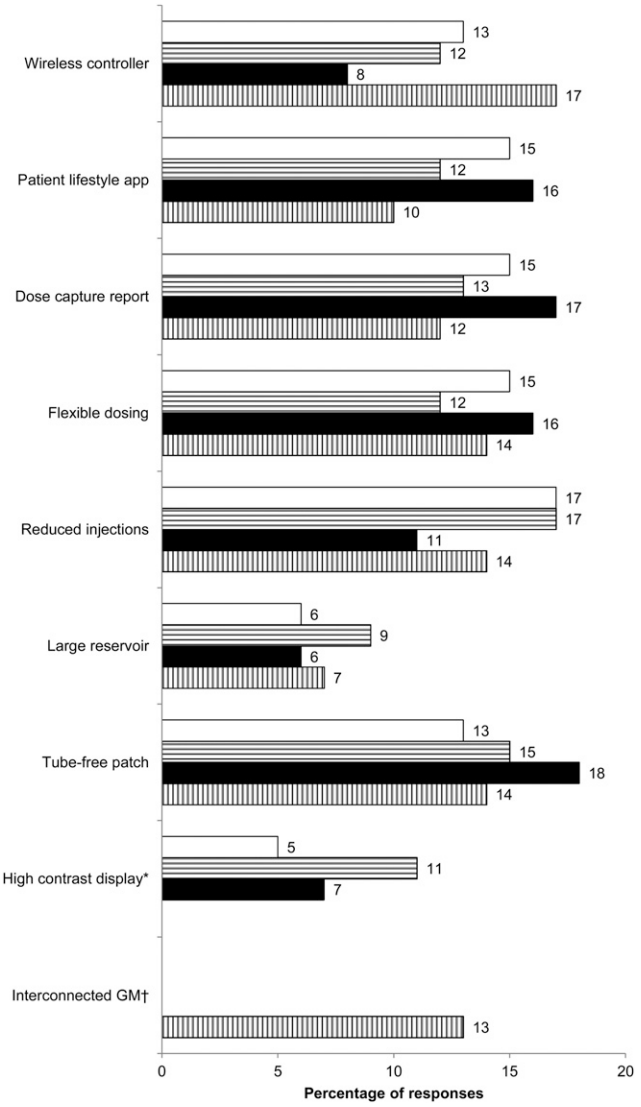

FIGURE 1 Percentage of votes (three votes each from 742 respondents) for proposed features of an insulin delivery product of the future, as gathered at four diabetes conferences. White bars = 2017 ADA Scientific Sessions (votes $n = 564$); horizontally striped bars = AADE 2017 annual meeting ($n = 1,167$); black bars = ATTD 2018 conference ($n = 225$); and vertically striped bars = 2018 ADA Scientific Sessions ($n = 270$). *High contrast display was not included in the survey at the 2018 ADA Scientific Sessions. †Interconnected glucose monitoring (GM) was included only at the 2018 ADA Scientific Sessions.

The two features with the consistently lowest percentage of votes at each conference were large reservoir (6–9%) and high-contrast display (5–11%). The top three percentages averaged for all four conferences were 14.7% for both tube-free patch and reduced injections and 14.2% for dose capture report (Figure 2).

Results at the two ADA Scientific Sessions, with mostly clinician and researchers in attendance, showed some numeric differences, although reduced injections and flexible dosing were included in both years among features with the highest percentages of votes (Figure 1). At the 2017 ADA meeting, 17% of votes were for reduced injections and 15% each were for flexible dosing, patient lifestyle app, and dose capture report, whereas at the 2018 ADA meeting, 17% of votes were for wireless controller and 14% each were for flexible dosing, reduced injections, and tube-free patch. At the AADE meeting, an educator-focused conference, the highest percentages of votes were for reduced injections (17%) and tube-free patch (15%), with wireless controller, patient lifestyle app, dose capture report, flexible dosing, and high-contrast display all garnering 11–13% of votes. In contrast, at the 2018 ATTD conference, an international diabetes technology-focused conference, the highest percentages of votes were for tube-free patch (18%), dose capture report (17%), patient lifestyle app (16%), and flexible dosing (16%); the other features each garnered ≤11% of votes (Figure 1).

Discussion

This survey enabled us to obtain input from HCPs regarding what they considered to be the most important features of insulin delivery devices to address the unmet needs of people with type 2 diabetes who require intensive insulin therapy. All of the proposed features garnered at least 5% of votes, up to a maximum of 18% of votes, at each conference. The survey response patterns were mostly similar (although not compared statistically) across the three conference types, with some minor differences that could perhaps be attributed to the typical attendees at specific conferences.

At the AADE meeting, attended mostly by diabetes educators, a reduced number of injections and a tube-free patch were most commonly selected, suggesting the greatest value was placed on improving patient quality of life. At the ATTD conference, the focus was on four items: patient lifestyle app, dose capture report, flexible dosing, and tube-free patch, all with 16–18% of votes, suggesting that the technology-focused attendees particularly valued the hard data available to make treatment decisions and the innovations that are closer to fruition. The survey responses at the two ADA meetings, which included probably the most diverse attendees, showed relatively consistent patterns, although the wireless controller gained votes and the patient lifestyle app lost votes between 2017 and 2018.

No single feature or attribute was selected by >18% of respondents. Indeed, at the two conferences with the most robust numbers of responders (the 2017 ADA and AADE meetings), six of eight device features each

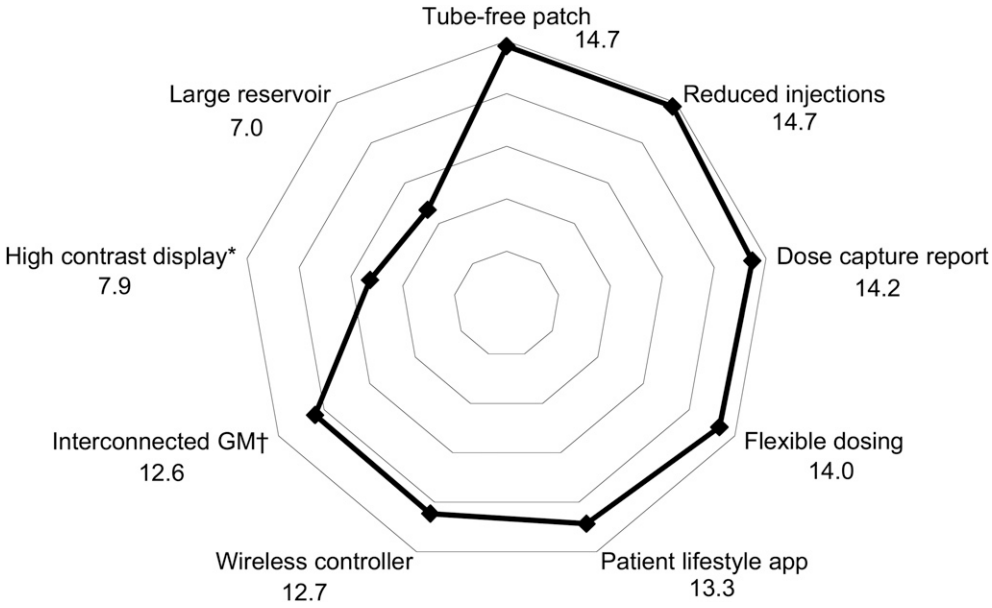

FIGURE 2 Mean percentage of votes (n = 2,226) for each proposed feature of an insulin delivery product of the future, averaged over four diabetes conferences with 742 respondents. *High contrast display was not included at the 2018 ADA Scientific Sessions. †Interconnected glucose monitoring (GM) was included only at the 2018 ADA Scientific Sessions.

resonated with similar numbers of respondents (12–17%). We can speculate that this finding implies that all six of these device attributes were considered to be necessary and equally important by diabetes-focused HCPs.

This was a forced-ranking survey in which participants could choose only their top three features. A high-contrast display and large reservoir were not often selected among these top features. Some survey participants reported that the availability of concentrated insulin formulations caused them to prioritize other device features over a large reservoir; however, the use of concentrated insulin formulations is not currently approved by the U.S. Food and Drug Administration for use in devices such as insulin pumps. A large insulin reservoir may thus be an important attribute, given that insulin-resistant patients with type 2 diabetes may have high insulin dose requirements (23), and survey participants generally emphasized the need for greater personalization of therapy and favorability toward a reduced number of injections. Aagren et al. (24) found that patients with type 2 diabetes may use up to a mean of 51 units/day of basal insulin plus a mean of 32 units/day of a prandial insulin. Given these higher insulin demands compared with average patients with type 1 diabetes, insulin pump use in patients with type 2 diabetes may require higher basal rates and larger prandial doses, leading to the rapid depletion of current insulin pump cartridges. A large insulin reservoir may help reduce the frequency of costly insulin cartridge changes in a next-generation device.

For the final survey at the 2018 ADA meeting, we elected to add interconnected glucose monitoring as a feature and eliminate high-contrast display because it had ranked low in previous surveys. (We retained large insulin reservoir because of its potential importance, as noted above.) Consistent participant feedback at previous conferences indicated an interest in including interconnected glucose monitoring as an option, and thus we considered it important to understand the desirability of this feature. In the 2018 ADA survey, interconnected glucose monitoring received the fifth highest percentage of votes (13%), slightly less than wireless controller, flexible dosing, reduced injections, and tube-free patch (14–17%).

Several limitations of our survey need consideration. Because interconnected blood glucose monitoring was included only on the 2018 ADA meeting survey, and high-contrast display was included in only three surveys, the data for those two items are less complete than for others. Moreover, the survey participants were not randomly selected, but instead were self-selected by their decision to visit the Type 2.0 booth; therefore, we cannot be certain that participants were representative of conference attendees. In addition, this was a loosely structured survey, and participants' demographic information was not collected, precluding us from validating our assumptions on the most common attendee professions at each conference. Nonetheless, the survey responses were gathered from a large number of individuals (n = 742) working in diabetes-related fields and, by virtue of their conference attendance, invested in optimizing therapy for people with type 2 diabetes.

Assessing the patient perspective was outside the scope of this survey; however, questionnaires have been developed to assess the impact on patients of diabetes treatment devices (25) and patient satisfaction with insulin delivery devices (26). Insulin device satisfaction has been associated with better glycemic control, greater insulin adherence, and fewer long-term complications in type 2 diabetes (26).

This survey provides valuable information for the development of future insulin delivery devices by identifying features that HCPs consider to be important, with the most commonly selected features, on average, being tube-free patch, reduced number of insulin injections, dose capture report, flexible dosing, patient lifestyle app, wireless controller, and interconnected glucose monitoring. In turn, future insulin delivery devices have the potential to improve diabetes management and address unmet needs of people with type 2 diabetes who require intensive insulin therapy.

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DUALITY OF INTEREST

Both authors are employees of Becton Dickinson and Company. D.S. owns stock in Dexcom, Inc., and T.O. owns stock in Becton Dickinson and Company. No other potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

D.S. and T.O. collected the data, reviewed and edited the manuscript, and contributed to the discussion. D.S. 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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