



# Couples Managing Type 1 Diabetes Using Diabetes Technology

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**OBJECTIVE** | Diabetes technology has improved the lives of people with diabetes (PWD), but there is little research on how insulin pumps and continuous glucose monitoring (CGM) affect couples' relationships. The purpose of this study was to examine how the use of diabetes technology affects couple interactions.

**METHODS** | In a secondary data analysis, we used a multiple-method qualitative analysis, including a constant-comparison approach, to examine similarities and differences in couple interactions related to diabetes technology. PWD and their spouses were interviewed separately, using a semi-structured interview guide; the interviews primarily focused on how couples coped with type 1 diabetes.

**RESULTS** | Participants ( $n = 134$  couples) were using an insulin pump or CGM system. Average age was  $44 \pm 12.05$  years for PWD and  $44 \pm 12.62$  years for spouses. Couples' average length of relationship was  $18 \pm 12.50$  years. Among the PWD, 54 used a pump only, 12 used CGM only, and 68 used both. Four main themes emerged: 1) diabetes technology facilitates shared diabetes management for couples, 2) diabetes technology facilitates spousal involvement in diabetes care, 3) diabetes technology is a source of relationship tension, and 4) diabetes technology causes positive/negative responses to sleep and alarms.

**CONCLUSION** | Overall, couples perceived diabetes technology as having a positive effect on their relationship by increasing collaboration, promoting communication, and reducing diabetes burden and vigilance. Technology also was perceived to increase relationship tension, lifestyle inconveniences, and positive/negative responses regarding sleep and alarms. Involvement of spouses in diabetes technology education should be considered.

Diabetes technology such as insulin pumps and continuous glucose monitoring (CGM) systems are becoming more common in type 1 diabetes management. Approximately 30–40% of people with type 1 diabetes and an increasing number of insulin-requiring people with type 2 diabetes in the United States are using insulin pumps and CGM technology (1). Large randomized trials have demonstrated the efficacy of diabetes technology and its benefits (2–9), including reductions in A1C and glycemic variability, increased time in target glycemic range, decreased time in the hypoglycemic range, fewer hypoglycemic events, and improved quality of life. Despite these benefits, people with diabetes (PWD) using different types of technology can still experience moderately elevated diabetes distress, suggesting that technology does not mitigate or decrease distress (10). Similar to other chronic

diseases, diabetes affects not only PWD, but also the family members and partners who support PWD in managing the illness (11,12). Although there is research evidence regarding the impact of diabetes technology use among youths with type 1 diabetes and their parents (13), there is limited research focused on diabetes technology use with partners and how it is incorporated into their relationship.

In adults with type 1 diabetes, daily management behaviors are likely to occur in the context of romantic relationships (14). Couples may deal with daily diabetes stressors collaboratively (15,16). However, partners may experience stress and fear about hypoglycemia, sleep disturbances, and a variety of emotional responses such as worry, anxiety, and frustration in living with PWD (17,18).

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Diabetes technology may affect partners' experiences of living with PWD in both positive and negative ways. In a study of spouses of PWD ( $n = 74$ ), 86% reported that technology had made it easier for PWD to achieve glycemic targets, 54% reported a decrease in the number of hypoglycemic episodes, and 51% reported that hypoglycemic episodes were less severe (19). However, approximately half of the spouses did not perceive an improvement in hypoglycemia frequency with the use of technology (19). In two smaller focus group studies ( $n = 14$  each), spouses reported that technology improved their quality of life (20), decreased their anxiety about hypoglycemia, and improved their understanding of the experience of living with diabetes (21). Yet, spouses report negative experiences of diabetes technology, including malfunctioning equipment, high cost, limited or no insurance coverage, lack of formal education on CGM, and interrupted sleep due to alarms (19–21).

Taken collectively, there seem to be benefits and drawbacks to using technology for couples' management of diabetes (19–21). However, the current literature is limited in that there are only a few studies, each with small samples. There is a need to examine, in a larger sample, the ways in which diabetes technology is incorporated into couples' relationships that either positively or negatively affect diabetes management and how they cope with diabetes technology. Therefore, the purpose of this study was to understand couple-level interactions related to diabetes technology use. Specifically, we sought to understand how partners supported PWD in using insulin pumps and CGM and how technology affected the couples' coping and management of diabetes.

## Research Design and Methods

This is a secondary data analysis of a larger study that included 199 romantic-couple dyads in which one individual was living with type 1 diabetes. In the larger study, we examined how illness appraisals of PWD and their partners (both overall and daily) were linked to partners' collaborative and supportive strategies and whether collaborative and supportive strategies were most beneficial for daily diabetes outcomes when they occurred in the context of viewing diabetes as a shared condition (11,22). Participants were recruited from two academic endocrinology clinics (in the mid-Atlantic and southwestern regions of the United States) for a study assessing dyadic coping. PWD in the larger study were eligible if they 1) were  $\geq 25$  years of age, 2) had been diagnosed with type 1 diabetes for at least 1 year, 3) spoke English as their primary language, 4) were free of any major impairments that might impede study completion (e.g., dementia), 5) were married or in a

cohabiting relationship for at least 1 year, and 6) had a partner who did not have diabetes who was also willing to participate in the study. Partners are hereafter referred to as spouses, as 94% of couples were married.

## Qualitative Data Collection and Analysis

The PWD and their spouses were interviewed separately. Interviews were conducted by two trained baccalaureate project coordinators and a graduate student with a master's degree. The interviewers were unknown to the participants. All interviewers completed training with a set protocol. Because this is a secondary data analysis, interviewers were not biased toward the themes identified in this study. Individual interviews focused on how couples coped with diabetes. A semi-structured interview guide was developed by the research team and rehearsed with other research team members before use (Table 1).

In this study, the analyses were restricted to only those PWD using an insulin pump, a CGM, or both and their spouses. The interviews were audio-recorded and transcribed verbatim. Transcripts were verified for accuracy (by authors E.G., M.L.L., and N.A.A.). Using qualitative description (23,24), data were analyzed using a constant-comparison approach (25) to examine similarities and differences in couple-level interactions related to diabetes technology. A constant-comparison approach involves coding data and comparing it to new data. While reflecting on previous data, old and new material are then compared cyclically. Interview data were qualitatively coded for analysis (23,24) using Microsoft Excel and NVivo, v. 12 (26). First, three authors (N.A.A., M.L.L., and E.G.) developed a coding system with a codebook to identify whether and how spouses

**TABLE 1** Interview Guide

1. How did (you tell your partner/your partner tell you) about (your/their) diabetes?
2. Tell me about the ways you cope or deal with diabetes.
3. When problems arise with diabetes, how do you cope or handle them?
4. What things do you or your partner do specifically in relation to diabetes, like things you do on a daily basis in relation to diabetes?
5. What things do you or your partner avoid doing in relation to diabetes?
6. What else can you tell me? Are there any other ways you or your partner are coping or dealing with diabetes?
7. Which of the following phrases best describes how you think about diabetes?
  - A. It is (my issue/my partner's issue) to deal with.
  - B. It is (my issue/my partner's issue), but I know that it affects (my partner/me).
  - C. It is a shared issue.
  - D. It is (my partner's/my) issue to deal with.

TABLE 2 Demographic Information (N = 134 Couples)

	PWD	Spouses
Age, years	44.05 ± 12.05 (25.85–64.78)	43.65 ± 12.62 (23.92–68.02)
Female sex*	60.4	40.3
White race	94	94.8
Hispanic ethnicity	5.2	1.5
Education less than “some college”	11.9	11.9
Length of diagnosis, years	27.02 ± 13.11 (3.10–57.87)	NA
Pump use	91	NA
CGM use	60	NA
A1C, %	7.58 ± 1.14 (4.9–1.2)	NA
Couples		
Relationship length, years	17.54 ± 12.50 (1–45)	
Household income ≥\$100,000 annually	55.9	

Data are mean ± SD (range) or %. \*One couple was a female same-sex couple. NA, not applicable.

supported PWD to use insulin pumps and CGM and how technology affected couples’ management of diabetes. Second, another round of coding was conducted to create a new codebook to specifically explore couple-level interactions with diabetes technology, including insulin pumps and CGM (author S.N.). Next, one of the authors (M.L.L.) reviewed the first and second rounds of codes for consensus. Codes on the PWD level, spouse level, and couple level were compared, contrasted, and collapsed to develop corresponding themes. Discussion among members of the research team facilitated consensus on themes that were derived from the data (27). Finally, sub-themes were developed within each theme after identifying patterns in couples’ experiences from responses around diabetes technology. Themes are reported in aggregate form with highlighted data that link to categories and maintain the anonymity of participants (28,29).

Results

The sample included 268 individuals (134 couples) who identified as using an insulin pump or CGM system. The average age was 44 ± 12.05 years for PWD and 44 ± 12.62 years for spouses. The majority of participants were married, and their average length of relationship was 18 ± 12.50 years. Among PWD, 54 used a pump only, 12 used

CGM only, and 68 used both. The remaining demographic information can be found in Table 2.

The analysis provided insight into couples’ relationships and how diabetes technology benefits and challenges these relationships. In general, the overall sentiment regarding diabetes technology was positive. Furthermore, diabetes technology seemed to have a positive effect on the relationship. Four themes emerged from the analysis: 1) diabetes technology facilitates shared diabetes management by couples; 2) diabetes technology facilitates spousal involvement in diabetes care; 3) diabetes technology is a source of relationship tension; and 4) diabetes technology causes positive/negative responses to sleep and alarms.

Diabetes Technology Facilitates Shared Diabetes Management by Couples

Using technology affected many of the ways PWD and their spouses interacted with each other. Specifically, couples had conversations and increased collaboration around technology information and diabetes management.

Diabetes Technology Facilitates Communication

Technology facilitated direct and indirect communication about diabetes management via the information derived

from diabetes technology. Text and in-person communication were described as being initiated by both PWD and spouses. Spouses would sometimes ask general questions such as, “How was your day?” and see what type of response they got to indirectly gauge how their spouse with diabetes perceived that his or her diabetes management was going based on information from the technology. On other occasions, spouses were more direct. One spouse (female, age 25 years) stated, “We both just communicate to each other, like, ‘Hey, [the CGM] says you’re kind of high, or you’re kind of low. Take care of it.’”

Communicating needs was important for spouses to know if they should step up and help more or take a step back and let PWD manage on their own. One male spouse (age 26 years) said, “If the [CGM] is saying [my spouse’s blood sugar is] high or low, then, if she’s too busy or if she’s too low or something like that, well, then I step in.”

Diabetes technology, specifically CGM sharing, communicated PWDs’ glucose status without explicit interaction. CGM data were beneficial to both PWD and spouses, as they reduced spouses’ worries and the tendency for spouses to nag and question. For example, a spouse (male, age 34 years) discussed his bedtime routine: “Now that [CGM] is wireless, I can just grab it and look. If she’s okay, I can just put it back and leave it alone. It’s nice so that I can have peace of mind.” Another spouse (male, age 26 years) stated, “I always check [the CGM share application] on my phone when I’m at work to make sure she’s okay throughout the day.”

### Diabetes Technology Stimulates Collaboration

PWD and their spouses mentioned multiple ways diabetes technology potentiated collaboration. Couples talked about spousal support as crucial in several practical ways. Examples included encouraging PWD to initiate pump therapy or CGM by talking with the endocrinologist, maintaining a job with health insurance benefits, and demonstrating a willingness to pay out of pocket for the expensive technology. Collaboration appeared in the form of making day-to-day decisions together: “We’ll talk, making sure I get the bolusing right” (male PWD, age 43 years). Spouses provided instrumental support by joining PWD at appointments to learn how to use diabetes technology, being willing to learn together as technology advanced, and being present during transitional periods (i.e., starting or changing devices). One individual with diabetes (female, age 43 years) noted that her spouse watched their child so she could have scheduled time to analyze the patterns of insulin delivery from her pump

readings. “We came up with a plan that we put on the calendar days that I do that, so it’s his job to watch the little guy,” she said.

Technical collaboration was characterized by spouses helping PWD rotate pump sites or insert a CGM sensor, which was especially valuable for PWD who found the process scary or needed to use sites that were hard to reach or not easily accessible. One spouse (male, age 37 years) said, “I help her. I’m pretty much the one who helps her put [the sensor at an infusion site] in the middle of her back or around her waist to get away from scar tissue.”

### Diabetes Technology Reduces Couple-Level Diabetes Burden

For many couples, CGM use reduced the burden of diabetes. One PWD (female, age 44 years) noted, “Having [CGM] has made a huge difference in not having to focus on the diabetes.” Another PWD (male, age 46 years) said, “I feel like we have reasonably good control over it with [CGM], so I think we can actually incorporate it in our life the way we intend to live it.” Many couples described insulin pump therapy as a great tool that had made management simpler because it facilitated tighter blood glucose levels.

Furthermore, using an insulin pump supported couples’ spontaneity or freedom to engage in several activities. Being on a pump also provided couples with the freedom to leave home without as many supplies. One spouse (female, age 47 years) said the couple’s schedule was “more manageable, where you don’t have to be on a set schedule if you’re out traveling or at kids’ activities . . . . It’s a lot easier to manage with a pump than it used to be.” A PWD (male, age 57 years) noted the ease with which he could adjust his insulin dose based on whatever he and his spouse were doing.

### Diabetes Technology Facilitates Spousal Involvement in Diabetes Care

Diabetes technology changed the way spouses were involved in helping PWD manage their disease. In particular, couples experienced changes in their responses and roles related to hypoglycemia.

### Technology Serves as a Safety Net

Diabetes-related technology aided PWD and spouses with diabetes management by acting as a safeguard. Device use empowered many PWD to manage their diabetes independently, so they no longer needed to rely on their



spouse as much as they had in the past. Instead, PWD depended on the technology to provide CGM alerts. One PWD (female, age 64 years) described having multiple previous hypoglycemia episodes and noted, “Now that I have my CGM, it’s a lot easier to detect when those are going to come on and cause them to not happen, which is really nice.”

Additionally, technology alarms alerted spouses to respond as a backup to the technology when PWD had hypoglycemia, the insulin pump malfunctioned, or PWD were unable to respond for themselves. Several spouses discussed their ability to intervene when alarms occurred (e.g., turning off the insulin pump if needed during a hypoglycemia episode).

### Decreasing Spousal Vigilance and Involvement

A byproduct of technology as a safety net was the peace of mind spouses felt, allowing them to let down their guard. For many couples, CGM reduced spousal vigilance by replacing the spouse as the primary backup to monitor glucose levels in PWD. To this end, CGM allowed spouses to become a second level of defense. One PWD (female, age 61 years) said the couple had “made sure that I got the continuous glucose monitor . . . because he was so concerned about his inability to be home and with me all the time when there might be a [hypoglycemic] crisis again.”

Multiple spouses discussed how their role in diabetes management had changed since their spouse with PWD had adopted a device. This aspect not only highlighted the shared responsibility the spouses felt in diabetes management, but also underscored how their past experiences shaped their appreciation for diabetes technology. One spouse (male, age 60 years) said, “Before [my spouse] had the [CGM], I can remember waking up early, and I’d always feel her back to see if it was wet, cold—to see if she was sweating.” Another spouse (male, age 41 years) shared that he used to be very involved in the PWD’s care because he helped her with every injection, but “since she’s made the transition to the pump, my involvement is very minimal at this point.” Conversely, one PWD (female, age 61 years) described her expectation that she, not her spouse, manage her diabetes technology: “I deal with making sure that I’ve got enough insulin in my pump. . . . Separately, I take care of it. Together, I don’t expect him to take care of that.”

### *Diabetes Technology Is a Source of Relationship Tension*

Although the majority of couples indicated that diabetes technology had a positive impact on their ability to

cope with diabetes in their relationship, some disputes occurred, with relationship tension primarily around diabetes management. PWD also identified spouse noninvolvement with using the technology.

### Triggering Disagreements About Diabetes Management

Disagreements involving diabetes-related technology differed among couples. Multiple couples discussed how they disagreed with each other on how tightly to control blood glucose levels. One spouse (male, age 63 years) said, “Sometimes she just won’t, doesn’t test or doesn’t take her insulin before or after meals.” Another spouse expressed aggravation that the PWD was not using the pump appropriately, noting that he would eat several slices of pizza but would not take extra insulin even though he had the pump. Some spouses disagreed about when to treat hypoglycemia. One PWD (female, age 55 years) said, “[My spouse] says, ‘You’re beeping; why don’t you go get something?’ and I’m like, ‘No, I want to wait it out.’ So, I mean, that’s the only thing we sometimes disagree with.”

### Noninvolvement With Learning How to Operate the Pump

In two cases, PWD experienced frustration at their spouse’s lack of knowledge of how to operate the insulin pump despite multiple attempts to educate the spouse. This lack of knowledge of how to manipulate the pump sometimes coincided with a lack of spousal involvement. One PWD (female, age 55 years) said, “After all this time, he’s very disinvolved, and despite my trying to teach him about it sometimes, he, if I’m having a low blood sugar reaction, he’ll just scream at me like I’m being weird or something or whatever, and he doesn’t get it. So, for my management, I’m pretty much on my own . . . I do think that he avoids learning about it so that he doesn’t have to be responsible for my care.”

Several spouses confirmed they “don’t really do much” when it comes to helping PWD manage their diabetes technology. One spouse said the PWD (male, age not disclosed) “talks to the pump and tells it how much she plans on eating; I don’t really do very much.” Another spouse said that, although he had not learned to use the pump, he could probably turn it off or remove it if he had to and might be able to replace the infusion site in a pinch.

### Creating Inconveniences

Although devices can provide immense benefits to enhance diabetes management, they can also be less than

accommodating at times. Several couples mentioned that the pump caused PWD to be unable to participate in water activities such as swimming, scuba diving, or tubing, which was something they enjoyed doing together or as a family. One PWD (female, age 50 years) said, “We’ve talked about, like, kayaking and stuff like that, and it is hard for me to do. I can’t, I mean, I would have to find some kind of waterproof thing to do any kind of water activities.” One spouse expressed support for the PWD by saying she chose not to do things he could not do because of his pump. Interestingly, only pumps were mentioned with regard to activity inconveniences.

For a handful of couples, the pump was too intrusive. There were also concerns about sleeping and intimacy. A PWD (male, age 57 years) said, “I might sometimes choose to sleep in the nude, and I can’t because I’ve got to have something to clip the insulin pump to . . . Obviously, sexual functioning isn’t happening, so we’ll occasionally have aborted trysts that just don’t go anywhere.” In reference to CGM, one spouse (male, age not disclosed) said, “We call it the puppy because she has to carry it around with her all the time.” One PWD said that she and her spouse had felt increased awareness of the presence of diabetes since she began using the pump and CGM.

### *Diabetes Technology Causes Positive and Negative Responses to Sleep and Alarms*

#### **Effects on Sleep**

Diabetes technology provided many benefits for PWD, although spouses noted that they had both positive and negative experiences with technology interrupting their sleep. Interrupted sleep was seen as a positive outcome of CGM use for some spouses. When PWD were experiencing hypoglycemia, alarms would wake spouses to support them. Several spouses described their nights as safer because of the CGM; one spouse (male, age 60 years) said, “The sensor really helps me wake up when she gets a low or the sensor rates her as high, etc. And she sleeps a little deeper than I do, so that’s one key area [in which] I think that our nighttime is safe.” One spouse (female, age 38 years) reported, “Two nights ago, we were both up every 30–45 minutes because he was having a night with constant lows . . . The CGM alarms wake me up, too, which is good so that I can make sure that he’s treating it.” Alternatively, some spouses were annoyed and reported negative experiences with how diabetes technology affects their sleep. In some cases, PWD relied on their spouses to hear alarms, and spouses felt that it was their responsibility to wake the PWD. One spouse (female, age 46 years) said,

“The meter will go off in the night sometimes, so I’ll wake him up. If he’s sleeping through something—maybe that’s a coping mechanism for him—to know I can get him awake.”

In contrast, a few spouses described getting more sleep as a result of diabetes technology use. As one put it, “Before there were [continuous glucose] monitors, it was more challenging for me. We would set the alarm at midnight, so every night at midnight we were getting up to check her blood sugar” (male, age 42 years). This spouse went on to say he was getting more sleep because waking up in the middle of the night was no longer routine. Although CGM devices have high-alert alarms, only hypoglycemia alarms were mentioned with regard to interrupting sleep.

#### **Emotional Responses to Alarms**

Couples responded to alarms with both frustration and gratitude. One spouse (female, age 44 years) said, “[My spouse] has to change his infusion site about every 3 days. It gets frustrating when it hits in the middle of a movie, or in the middle of driving somewhere, [but] in the middle of the night doesn’t bother me so much.” One PWD shared that her spouse was able to cope better with her diabetes because he could hear the CGM and check in to see how she was treating it.

#### **Discussion**

Our findings suggest that diabetes technology is generally positive in the context of a couple’s relationship, contributing to collaboration, promoting communication, and reducing burden and vigilance. However, diabetes technology can also contribute to relationship tension and lifestyle inconveniences. Specifically, technology is perceived as helpful in alerting couples to hypoglycemia or assisting in managing diabetes. Yet, in some situations, such as sounding alarms, technology can cause disruptions to sleep and other life activities. Finally, we identified differences in spousal support and involvement with technology among couples, with some spouses supporting PWD with the use of technology and others remaining uninvolved.

PWD and their spouses perceived technology as a facilitator of collaboration and instrumental support and generally a facilitator of coping as a couple. For some couples, diabetes technology enhanced communication and relieved some relationship difficulties, whereas, for other couples, diabetes technology became another source of relationship tension regarding diabetes management. In

one couple, the PWD lacked an expectation that her spouse should be involved with her diabetes technology.

The extent to which couples appraise diabetes as a shared or individual problem may distinguish between these perspectives among couples. Our research based on the larger sample showed that, when PWD perceive diabetes to be a shared problem, they report greater relationship quality and lower regimen distress. When spouses perceived daily stressors to be more shared, PWD reported greater daily self-care (11). Furthermore, shared illness appraisal, when paired with greater collaborative strategies, is associated with better physical health (11). For technology to be beneficial to couples, health care practitioners may consider assessing couples' perception of sharing diabetes and then encouraging a shared view of diabetes so that diabetes technology can be most effectively used by the couple to improve diabetes self-management.

Within couples, CGM has been shown to not only increase collaborative diabetes management, but also to increase spouses' understanding of diabetes (21). In a study of couples using CGM, Barnard et al. (19) also found that when couples collaborated, it facilitated the reduction of diabetes partner burden. In that study, the presence of spousal support when using technology allowed PWD to achieve improved glucose levels as a result of better management of hypoglycemia (19). In general, there is an association between better glycemic levels and self-care in PWD who have higher relationship satisfaction and more social support (30). Thus, our finding that diabetes technology can enhance couples' collaboration and shared responsibility for the work of managing this complicated condition suggests the need to involve spouses in diabetes technology education strategies.

The benefits of using CGM for the health of people with type 1 diabetes are well established (9,31,32). However, our results contribute to diabetes and family science by elucidating the benefits of CGM for couples' relationships. We found several positive effects on couples' relationships. CGM decreased spouses' need to be vigilant and gave them "peace of mind." In particular, CGM with data sharing was noted to reduce spousal worry and replace the need for nagging and questioning about glucose levels because the spouses could see the glucose levels. These findings are similar to those from a study of CGM use in parents and adolescents (33). In that study, participants found CGM to be an empowering tool because they could access glucose data effortlessly, and trend arrows enabled them to see whether glucose was rising or falling and at what speed (34). Because hypoglycemia is one of the top

concerns of PWD and their families, CGM is an important technology that assists PWD and their spouses with this daily concern (34).

Insulin pumps have been shown to be effective in helping PWD manage their glucose levels (35–37). In this study, we found that couples benefited from each other's support when adopting and using insulin pumps to manage diabetes. Spouses supported PWD in multiple ways, including initiating insulin pump therapy, helping to make day-to-day decisions, allowing for uninterrupted time for PWD to analyze their glucose trends, joining appointments, maintaining health insurance, and being willing to pay out of pocket to obtain the insulin pump. Consistent with other research, we found that spouses reported less stress and diabetes-related responsibility with the insulin pump, as it promoted independence in the PWD (8). In a critical interpretive synthesis, it was shown that a new insulin pump user could find this technology very stressful without additional support or resources and that PWD may have difficulty incorporating this insulin pump technology into their lives without support (37). This study addresses the limited research examining spousal support for insulin pump therapy and its impact on couples' relationships.

Diabetes technology revealed tension in some relationships. Spouses' refusal to learn to operate insulin pumps or CGMs, for example, may be a symptom of underlying relationship problems, a novel factor contributing to such difficulties, or both. Spousal noninvolvement may also represent the wishes of PWD to remain independent and, as a result, refusal to allow their spouses to learn to manage the equipment. Spousal noninvolvement in the diabetes care of PWD appears to have implications for diabetes outcomes. A quantitative analysis revealed that some PWD who did not benefit from CGM (i.e., had no decrease in A1C) reported that their spouse did not understand or become involved in CGM use (38). In contrast, many PWD who experienced a reduction in A1C reported that their spouses were interested in learning about CGM and engaged in supportive diabetes care. Thus, the use of technology may serve as an opportunity for spouses to become more knowledgeable about type 1 diabetes and more involved in diabetes care, ultimately benefitting glycemic stability. It is possible that spouses who do not become involved in technology use may tend to focus on the perceived negatives of such devices. For example, uninvolved spouses may be less aware of the benefits of CGM and more likely to complain about nighttime alarms or the presence of devices during sexual activity. Future work may identify the individual differences and

relationship factors that determine spousal involvement and determine whether noninvolvement and technology frustration are reciprocally related across time.

Diabetes technology seemed to have both positives and negatives for coping with type 1 diabetes with regard to sleep. Couples' quality of sleep may be reduced because of blood glucose levels, with highs and lows triggering alarms from CGMs or pumps, further compromising both spouses' sleep quality (39,40). Some spouses embraced this inconvenient aspect of technology, as it improved their spouse's health. In contrast, technology also played a role in improving sleep quality because it reduced spouses' burden by eliminating the middle-of-the-night routine. Combined findings from previous studies that emphasized the important role of sleep in managing diabetes (39,41) and this study suggest that it might be important to identify how to minimize sleep reduction and disruption (e.g., preventing hypoglycemic events). Furthermore, our findings also indicate that it might be necessary to encourage spouses to learn how to use devices to make the most of these technologies and minimize any potential negative outcomes at night (18).

### *Clinical Implications*

Providers and educators can translate our findings into clinical practice in several meaningful ways. First, patients may benefit from including spouses in diabetes technology education, when possible. Notably, the majority of diabetes self-management education and support provided to people with type 1 diabetes occurs without the presence or involvement of spouses (42). Couple-level support can improve overall diabetes management and prevent hypoglycemia. Second, couples can benefit from a discussion about strategies to collaborate and communicate when initiating diabetes technology and in subsequent follow-up appointments. For example, couples may benefit from discussions addressing when and how a spouse should respond to a predictive alert of impending hypoglycemia. Because diabetes technology can create inconveniences such as alarms, discussing these topics at the outset and providing strategies to address concerns may be beneficial. Next, when providing diabetes technology education, it is important to encourage discussions regarding the advantages of couple-level support in terms of safety and diabetes management. Finally, it is important to assess spousal noninvolvement and technology-related frustration when seeing patients clinically. Couples counseling may be indicated for distress, anxiety, and depression that may affect the ability of PWD to use diabetes technology optimally.

### *Limitations*

Our study provides a secondary analysis of couple-level interactions related to using diabetes technology. However, there are limitations to be considered. First, this was a secondary analysis, and the interview questions did not specifically ask about technology. Next, our sample included mostly non-Hispanic White, well-educated individuals in heterosexual relationships. Therefore, our results may not translate to ethnic minority couples, those with lower socioeconomic status, or those in same-sex relationships. Third, there are many access barriers to diabetes technology, and this study examined only couples currently using diabetes technology. This may have excluded couples who had previously used diabetes technology but lost access or voluntarily discontinued use.

Future studies are needed to investigate other aspects of how diabetes technology affects couples. First, there is a need to investigate how couple-level interactions and diabetes management are affected by the loss of access to technology (e.g., because of cost or insurance issues) and the impact this has on life as a couple. More study is needed to determine whether spousal noninvolvement and technology frustration are reciprocally related across time. Also, interventions are needed to help partners be positively engaged in supporting diabetes technology rather than exhibiting negative engagement such as nagging or avoidance. Finally, there is a need to study newer technology such as hybrid closed-loop insulin delivery systems and the impact they have on couples' collaboration compared with the kind of collaboration found in this study.

### *Conclusion*

In general, our results suggest that diabetes technology may aid in couple communication and involvement in diabetes management in ways that reduce the burden of diabetes for PWD and spouses. Thus, in addition to the positive effect that technology has had on diabetes outcomes, technology may also have a beneficial impact on spouses' disease burden and couples' relationships. Because spouses are an important source of support for PWD, reducing the burden for spouses may hold benefits for their continued support across the life span.

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## DUALITY OF INTEREST

N.A.A. and M.L.L. have received equipment grants from Dexcom to conduct unrelated studies. M.L.L. has received an investigator-initiated grant from Abbott Diabetes Care to conduct an unrelated study. No other potential conflicts of interest relevant to this article were reported.

## AUTHOR CONTRIBUTIONS

N.A.A., M.L.L., S.N., E.L.T., and E.G. conducted the data analysis. N.A.A., M.L.L., and S.N. wrote the manuscript. E.L.T., R.G.K.d.G., and E.G. contributed to the introduction and discussion. N.A.A. and E.G. wrote the abstract. V.S.H. and C.A.B. provided expert review, edited the manuscript, and contributed to the introduction and discussion. N.A.A. 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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