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Self-Monitoring Technologies for Type 2 Diabetes and the Prevention of Cardiovascular Complications: Perspectives from End Users

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Abstract

Background:

The objective of this study was to explore facilitators and barriers to the adoption of self-monitoring devices in individuals with type 2 diabetes mellitus (T2DM).

Methods:

Individuals with T2DM who were currently using one or more devices to monitor their disease participated in focus groups. Transcripts of focus group meetings were coded into themes by two reviewers using NVivo qualitative software.

Results:

Twenty-eight adults with T2DM reported using a blood glucose meter, and almost half reported monitoring their blood pressure. Few individuals consistently monitored other aspects of their cardiovascular health. Four major themes impacting device use/disuse were identified: knowledge gaps, relationships with health care providers, environment, and personal experience. Knowledge barriers included lack of information regarding diabetes and the associated risk of complications. Perceptions of inconvenience, pain, and financial restrictions were important factors influencing the adoption, use, and abandonment of self-monitoring devices. Community-run programs, as well as dieticians and pharmacists, were identified as important resources for accessing information related to T2DM.

Conclusions:

We identified the need for development of accessible and relevant education material; improved communication of disease-specific information between patients and providers, as well as providers and community resources; and strategies to improve the convenience and cost of monitoring devices.

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Abbreviations: (BG) blood glucose, (BP) blood pressure, (CV) cardiovascular, (CVC) cardiovascular complications, (CVD) cardiovascular disease, (GP) general practitioner, (HC) health care, (HR) heart rate, (T2DM) type 2 diabetes mellitus

Keywords: type 2 diabetes, self-monitoring technologies, focus groups

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Introduction

Diabetes is one of the most common chronic conditions affecting the United States population. In 2007, it was estimated that 23.6 million Americans, 7.8% of the United States population, were suffering from diabetes.[1] Of the individuals diagnosed with diabetes, approximately 90–95% are classified as having type 2 diabetes mellitus (T2DM).[1] In 2006, diabetes was the seventh leading cause of mortality listed on American death certificates, with the risk of death among people with diabetes being estimated as approximately double that of non-diabetic individuals of similar age.[1] Although the majority of individuals with diabetes die from cardiovascular (CV) events, much of the population remains unaware of the risk of cardiovascular complications (CVCs).[2] In addition to being an independent risk factor for cardiovascular disease (CVD), diabetes is often associated with other risk factors for CVD, including high blood pressure (BP), elevated blood glucose (BG) levels, and lipid abnormalities.

Individuals with T2DM currently use health monitoring tools to manage their BG levels and monitor their BP. Devices used to monitor BG, BP, and physical activity levels may prove to be important assistive tools for the prevention and treatment of CVCs of T2DM. Research has shown that self-monitoring devices may effectively improve glycemic control and long-term CV outcomes of diabetes, but the factors that affect device acceptance and adherence to protocols need further study.[3–5] Information on the effectiveness and usability of these devices would be important for clinical research teams for the refinement of the technology and for the creation of new devices to help monitor CVCs of T2DM. Therefore, the goal of this research was to determine the issues surrounding the accessibility, delivery, and impact of monitoring devices on self-monitoring of T2DM and associated CVCs from the point-of-view of key stakeholders—individuals with T2DM. To our knowledge, no other qualitative studies have been performed to obtain user perspectives on the utility of self-monitoring devices in the management of T2DM and CVCs.

Research Design and Methods

Three focus groups were conducted in London, Ontario, Canada, in order to explore the feasibility and need for new technologies to assist in the prevention and treatment of the CVCs of T2DM. Individuals with T2DM (n = 28) were interviewed in open-ended, semi-structured thematic groups sessions to explore issues of accessibility, delivery, and the impact of monitoring devices on patient health. The probes asked during the focus groups were adopted using previous experience with the Assistive Technology Outcomes Project[6] and piloted among a representative group of patients prior to the study. The discussion topics concentrated on the following key concepts: (a) types of monitoring technology used; (b) effectiveness of interventions with different types of monitoring devices; (c) factors associated with acceptance and adherence to monitoring technologies and lifestyle modifications; (d) impact of T2DM, its management, and the use of monitoring technologies on daily living; and (e) indicators and factors associated with long-term use and integration of monitoring technologies.

Participant inclusion criteria were broad, only requiring an individual with T2DM to be currently using one or more devices to monitor BG, BP, heart rate (HR), and/or physical activity. Individuals who were not medically able to participate in a group, were unable to communicate in English, lived in institutional settings, and/or had cognitive or psychiatric disabilities that affect their ability to give informed consent were not eligible to participate in the study. Participants were recruited throughout the Spring of 2008 from the clinical therapy program at Parkwood Hospital and St. Joseph's Family Practice Unit of the University of Western Ontario. Ethics approval was obtained for the study by the Health Sciences Research Ethics Board at the University of Western Ontario. A $20 honorarium was given to all participants in the study.

All focus groups were conducted in the summer of 2008 by the same researchers in clinical research meeting rooms at Lawson Health Research Institute in Parkwood Hospital. One researcher experienced in focus group facilitation conducted the focus groups, while two graduate students co-led the groups. Captioners were hired to transcribe the focus groups, and each focus group session was also audio recorded. The facilitator followed an open-ended, semistructured question guide while remaining flexible to exploring themes further as they arose during a session.

Each focus group session lasted approximately 60–90 minutes. Prior to the start of each session, participants were asked to review and sign an informed consent form, after which demographic information was collected from each participant. At the end of each session, participants were thanked for their participation and encouraged to contact the facilitator if they had any questions or concerns, as well as if there was anything they wanted to address that they felt had not been adequately covered during the session. After each session, the researchers involved in the groups met for a debriefing in which the notes of the co-leaders were reviewed and the main messages from the group were identified, and it was determined whether there was a need to make changes to the questions asked based on the findings from that group. Upon completion of the sessions, the researchers compared the captioners' notes to the audio recordings to ensure that all data were entered correctly.

Analyses

Data were analyzed in depth after all three focus groups were completed. Analyses were conducted using NVivo qualitative analysis software (version 8.0; QSR International, Cambridge, MA) and followed a constant comparison method. Transcripts were read over by two researchers, and nodes were developed that represented identified themes and ideas pertaining to self-monitoring of diabetes. The study sought to obtain insight into patient experiences, hence the nodes were generated from the data rather than being predetermined. The transcripts were then reviewed again, with sections of text being grouped under applicable nodes, and new nodes being added as necessary. This process was repeated until no new nodes were identified. Once coding was completed, nodes that shared similar characteristics were grouped together to form themes.

Table 1.
Demographic Characteristics of Participants[a]

Mean age (years)	71 (8.32)
Gender	
Women	14
Men	14
Race	
Caucasian	27
Asian Indian	1
Education	
Less than high school	3
High school	5
College	7
University	13
Current employment	
Full-time paid	2
Part-time paid	1
Retired	25
Length of time with type 2 diabetes	
6 months to 1 year	2
1 to 5 years	8
6 to 10 years	9
More than 10 years	9

[a] Data are mean (standard deviation) or counts.

Results

Demographic characteristics of the participants are presented in **Table 1**. The mean age of participants was 71 years (± 8.3), and females comprised 46% of the study sample. Ten participants reported being diagnosed with T2DM for less than 6 years, 9 participants reported a disease duration of 6–10 years, and 8 reported a disease duration of over 10 years. All participants reported using a BG meter, and almost half reported monitoring their BP. Just over a third of participants (35.7%) reported that they monitored their BG on a daily basis, and 14.3% of participants monitored their BP 2–3 times per month. Few people consistently monitored other aspects of their CV health or used pedometers and/or HR monitors.

Knowledge Gaps

Type 2 Diabetes and Cardiovascular Complications

"I think the biggest problem is, as this lady said, lack of info—where to get the info, how to deal with it, how to use it."

During the focus groups, it became apparent that many participants, whose comments appear in quotes in this section, lacked an understanding of the condition and its physiological implications. "Somebody really needs to publish a little booklet to help the person with diabetes, because unless you know, you can't ask a question. You can ask a question, but you get a much better question and a much better transmission of knowledge if a person has some background [information]." Many participants were unaware of the increased risk of CVCs associated with T2DM. For example, a participant stated that he did not monitor his BP because he did "not have a BP problem." Participants also commonly expressed trouble relating the number of steps taken per day to physical changes, which could partially explain why the vast majority of participants who reported using a pedometer at some point in time also reported that they discontinued using it: "Well, who cares how far I walked? I walked as far as I did. If I needed exercise, I got on the treadmill." Moreover, there was some concern regarding the accuracy of pedometers related to differences in stride length between individuals. The purpose of HR monitors was also not widely known by our participants: "But then I sit and think about it, and I'm wondering what the value that [measuring HR] would have for me."

Monitoring Devices

Some participants also lacked awareness of the wide range of devices, other than BG meters, that are available to self-monitor the CVCs of T2DM. For example, some participants were unaware that they could purchase home-monitoring BP devices, while others were not aware of the existence of accelerometers and noninvasive BG meters. Skepticism regarding the accuracy of public BP devices found in pharmacies was widespread and was the major barrier to the regular use of this device by our participants. Knowledge regarding the necessary upkeep of self-monitoring devices was also lacking. Some participants were not aware that they needed to get their BG meter calibrated regularly nor that they needed to change the batteries in their meter.

Relationships with Health Care Providers

General Practitioners

Many participants expressed that they felt that their general practitioner (GP) was not a good source of information regarding T2DM and self-monitoring: "I think, more often than not, doctors are so pressed with [time] ... got the next guy who's coming in, you here, and the guy who just got out. They don't really have the time to find out what it is that a person needs to know." Others also stated that the duration of standard patient visits was too short to discuss all of their medical concerns: "A lot of GPs have a sign: 'one question only.' I have congestive heart failure and diabetes, high BP; what's my worst symptom today?" Some individuals expressed the feeling of being "passed around" between specialists and health care (HC) providers when looking for information. These feelings were not uniform. Individuals who were happy with their GP stated that they felt as though their GP set aside extra time for them, met with them frequently, went over their diet and exercise regimens as well as lab and self-monitoring results, and answered their questions or directed them to a specialist if needed.

Regardless of whether an individual liked their GP or not, he/she found it comforting to know that someone else was helping them to monitor their condition: "I complain because I go to the GP too often, but I find it very good because I do not stay strictly to my diet, and I don't exercise. So I do want to know from someone else if I'm still okay. I feel better." Moreover, some participants reported that they rely on the blood tests ordered by their GP to check the accuracy of their BG meters and stated that glycated hemoglobin results gave them an overall idea of how their BG monitoring was going over the relevant months; one participant relied on monthly or bimonthly blood work to monitor her sugar levels instead of routinely self-monitoring: "It is important to see your doctors all the time. Especially when you do the blood sugar, such as the fasting one, and they can tell you what your average has been over a certain period of time. It gives you more hope, because sometimes, you are up and down and all over the place, and then you see the average and it's not quite so stressful knowing you are doing okay." Several participants also stated that they rely on visits with their GP to check their BP, which may be due to the fact that self-monitoring of BP is not as common as self-monitoring of BG.

Other Health Care Professionals

Participants agreed that pharmacists were a good source of information regarding BG monitoring, prescriptions, as well as advice pertaining to self-monitoring devices; device companies were also identified as helpful for troubleshooting device problems. Medical specialists were not frequently mentioned by participants during the sessions, but when discussed, participants complained that visits were too short and that they felt "passed around" between specialists and GPs. Participants who have had contact with a dietician reported that this professional was a great resource for help in structuring meals, as well as obtaining recipes and pamphlets; however, some complained that the direct advice given by the dieticians was difficult to adopt: "I live alone. I'm a grazer ... but no one talks about that. They say, 'no, you are supposed to do it this way.' That's unrealistic for me." A few participants made references to nurses as being good resources for answering questions pertaining to T2DM.

Environment

Convenience

Perceived inconvenience appeared to be a major barrier to the use HR monitors and pedometers. Participants spoke of being taught to monitor their HR during their exercise classes but complained of the difficulty of finding their pulse manually. One woman stated that she would consider using a HR monitor if she did not have to wear it around her neck: "I'm a nurse, but I have a heck of a time trying to find my pulse, [but] I don't really want to wear something around my chest." Participants reported that it was a hassle to remember to put on a pedometer every day as well as to convert number of steps walked to distance covered and that they frequently forgot to put on their pedometer even when they intended to use the device.

Participants found BG monitoring to be time-consuming, and most stated that monitoring their sugar levels was always in the back of their heads. There were some complaints regarding testing in public places because of the preparation work involved and the problem in disposing of used testing products in public. Moreover, the "messiness of pricking yourself" was also a deterrent, even when staying at home: "I do a lot of quilting and sewing, and I hate getting blood on my things." Participants expressed a desire for a BG meter that would automatically take readings for them, as well as an all-in-one meter that would take BP, HR, and BG readings for them. Participants also stated that a continuous BG monitor would be more convenient: "Well, it would obviously be easier to use. Quicker too. You wouldn't have to get the little strip out of here and put it in there, that sort of thing." Similarly, participants stated that they would be very interested in an all-in-one monitoring device, because it would be a lot easier than relying on several different devices.

Participants who used computer log books to chart their BG or BP readings appreciated the various ways in which their readings were displayed, and found that it helped them more efficiently interpret how their condition was progressing: "[The computer program] tells you if you screwed up, and it does various graphs ... and then it gives you down to the minute, something like that ... and the reason I started using the computer was they give you a little book with this; I can write down whatever I like, but when you put your meter into the machine, it records exactly what it was." However, individuals who were not as comfortable with computers reported difficulty with using the computer program and saw using their computer as another step that they needed to add to their already busy monitoring routine: "I hate [computer logs] ... to me, that would be an extra step. I want to do it and see it and that's it." Some participants also discussed how paper-based log books were too small to record their readings and were not conducive to obtaining a sense of their average values. Despite this inconvenience, the vast majority of individuals still relied on the books to record their BG and/or BP readings; one participant actually made his own log book in which he recorded his BG readings.

Financial Restrictions

Financial restrictions not only impacted the use of devices to monitor CVCs, but also impeded participants from making necessary lifestyles changes in response to their condition: "I wish the government would pay for those [exercise classes]. ... [And] your diabetic foods, it's more expensive. You have to get the fresh fruits all year, not just when they are in season, and it seems that everything just costs more."

Although the majority of participants reported receiving their BG meters free from health professionals, the pharmacy, or through a magazine advertisement, the cost of lancets was frequently reported as a barrier to frequent BG self-monitoring: "A testing session a day is an awful lot for a senior to pay. That's my main reason. They are not covered by a drug plan." The cost of a BP device was also mentioned as a barrier to home BP monitoring, and the cost of upgrading computer requirements was mentioned as a barrier to the use of computer log books. While there was widespread agreement that the use of non-invasive BG meters would make monitoring easier and less painful than traditional methods, this increased convenience was overshadowed by concerns regarding the cost of this new device: "People who can afford it will grab it to the best technology, but people who can't, they will prick their fingers."

Social Influence

Some participants expressed that social support helped them to manage their diabetes more effectively, and others reported benefiting from the experience of family members who were diagnosed with the condition: "I could contribute the lack of difficulty with diabetes is that my wife attended these [diabetes education] seminars with me at the hospital. And we adjusted our lifestyle tremendously on the basis of the advice that we were given." In contrast, one individual found it harder to eat properly when living with someone else because of the temptation of food lying around the house that was purchased for the non-diabetic family member.

The need for self-discipline was identified as being especially great at social functions or when eating out at restaurants, and it was evident that the participants were most aware of their condition and its effects on their day-to-day life and in social situations involving food: "I'm particularly aware of it when we went out to friends last night for a barbeque and when they served ice cream with chocolate sauce for dessert, and the nice wine. ... I had to say, 'no, I'm sorry' ... everybody is drinking and I'm not drinking, and those are the kinds of occasions where I feel deprived." Traveling and shift-work were also listed as barriers to the development of a routine in eating patterns and regular monitoring. Stress was mentioned as a major trigger for increases in sugar levels.

Community-Based Programs

"If the government was smart, they would pour more money into the [community-based] programs, in light of the fact that more and more people are being diagnosed, to make it more available to more people, because it's the education that is going to help most, I think."

Participants generally agreed that community-based programs, especially diabetes clinics, were the best sources of information and help regarding diabetes, lifestyle changes, and the monitoring of diabetes complications. Participants reported attending diabetes programs run through hospitals and universities, as well as joining community-based exercise groups and research studies. Participants found these programs as their major source of diet information, mostly through the dietician-access these programs provided.

Several participants stated that there was a lack of connection between GPs and available community-based programs, and a few participants also found that disconnect existed between the various community-based resources as well. This disconnect resulted in participants not being uniformly informed of the diabetes-focused resources available to them in the community. While the majority of participants found community-based programs invaluable, a participant reported being directed to information pamphlets rather than getting personal consultation when attempting to access resources from a diabetes clinic, and another reported distress over the feeling that a referral form was required from their physician before questions would be answered at the clinic.

Personal Experience

Experience with the Condition

Generally speaking, self-testing of BG levels seemed to occur most frequently when an individual was diagnosed with T2DM, then tapered off over time, as participants felt that their BG levels had reached a desirable level: "When I started, [I was] taking my blood every day for the first two or three years ... then I slacked off, and last year and a half or so, it has been perhaps only once a week. And it was constant, so that gave me some confidence that I was healthy, so I haven't been doing it as frequently as I perhaps should." Moreover, as time since diagnosis of the condition increased, so did the subjects' abilities to rely on cues from their bodies to prompt them to self-test their BG. Some individuals also stated that they took one reading a day, usually in the morning, and would test again that day if their reading was outside of their "normal" zone or if they knew that they had eaten foods that would have a negative effect on their sugars.

Health Scares

Even though participants stated that the frequency with which they self-monitored their BG declined as the years since their diagnosis increased, diabetes-related health complications prompted some participants to begin monitoring again more frequently: "When I first learned I had diabetes, I used [a BG meter] faithfully four times a day, and my finger got kind of sore, so I just laid off and didn't bother, and I figured I was okay. And I guess about 6 months ago, I thought, I better test my blood again and start doing it, because I was having vision problems, different things." However, health scares were not enough to cause some participants to alter their behavior: "I'm a bad boy. I continue doing what I do in a sometimes very immoderate sequence. ... I guess I should modify. ... I have [had a health scare] about a half dozen times."

Pain

"It has been suggested I test myself three times a day, but my fingers object even to twice."

Soreness of the fingers and concerns regarding neuropathy were commonly voiced barriers to frequent BG monitoring. However, despite the pain in their fingers, participants preferred not to obtain blood samples from other sites on their bodies. The prospect of not having to prick their fingers was a very appealing factor to participants when discussing use of noninvasive BG meters: "I definitely would be interested in a [noninvasive] meter like that, because I know, after a while on this, when I start taking it four times a day, the fingers get very sore, and I tried other parts, my arms, and that does not work as well." Moreover, some participants also stated that they would be interested in testing BG with urine strips if the technology was as accurate as conventional BG meters.

Discussion and Conclusions

We used a qualitative approach to explore facilitators and barriers to the adoption of self-monitoring devices in individuals with T2DM. Four major themes that impact device use and disuse were identified: knowledge gaps, relationships with HC providers, environment, and personal experience. Within these themes, we uncovered various factors that aided, and impeded, device use.

Knowledge barriers to the adoption and/or regular use of self-monitoring devices included lack of information regarding T2DM and its association to increased risk of CVCs. Failure to understand the relationship between T2DM and CVCs led individuals to question the purpose of monitoring outcomes other than BG levels.

Moreover, many participants were not aware of devices that were available to self-monitor CVCs. Therefore, not only is there a need for primary HC providers to (a) stress the relationship between T2DM and CVCs and (b) explain what the output of the monitoring actually implies in terms of CV health, but there is also a need for greater promotion of available self-monitoring devices. These findings are in line with other qualitative studies on self-management behaviors of patients with T2DM.[7–9]

The majority of participants stated that they relied on community-run programs, such as diabetes clinics, to access resources pertaining to T2DM. Therefore, community-based programs may be key figures in the translation of knowledge to individuals with T2DM regarding the condition, CVCs, and self-monitoring. Through educational classes and sessions, these programs have the potential to reach a wide audience. Community organizations involved in T2DM prevention and care should consider holding more frequent classes explaining the relationship between T2DM and CVCs and the monitoring of these risk factors. Additionally, participants identified dieticians and pharmacists as key sources of information about T2DM; therefore, it may be essential to involve these allied HC professionals in the promotion of device use among individuals with diabetes.

Although participants frequently stated that they were dissatisfied with their GP as a source of information regarding their condition, they stated that they viewed their GP as a key figure in the monitoring of the progression of their diabetes and valued the physician–patient relationship. General practitioners should be trained to help patients become more independent in their monitoring; further, GPs can help ease patients' concerns regarding the accuracy of their self-monitoring devices by comparing readings they obtain on their meters to those of personal meters. Moreover, there is a need to create closer ties between GPs and community resources for individuals with diabetes so that patients are uniformly made aware of resources available to them. Not only will this benefit the patient, but it may help ease the reliance of patients on their GPs in an already overburdened HC system.

Perceptions of inconvenience, pain, and financial restrictions were also identified as important factors that influenced the adoption, frequency of use, and abandonment of self-monitoring devices and should therefore be considered when designing and promoting new devices to individuals with diabetes. It appears that the creation of all-in-one and noninvasive devices may serve to increase the frequency of self-monitoring of T2DM CVCs, provided that educational resources are in place to help patients understand the importance of this monitoring. Frequency of self-monitoring was also inversely related to years since diagnosis of T2DM, and did not necessarily increase following declines in health. Therefore, there is also a need for continuing education emphasizing the importance of self-monitoring among individuals who have had T2DM for years.

There are some limitations to our study. The qualitative nature of focus groups prevented us from quantifying our results and drawing conclusions regarding causation. Further, our sample predominantly consisted of Caucasian, retired, community-dwelling older adults. Therefore, our findings may not be generalizable to patients with T2DM who are not older adults as well as to institutionalized individuals. Moreover, because the majority of our participants had been diagnosed with the condition for many years prior to participation in the groups, their views may not be representative of individuals newly diagnosed with diabetes.

Results from these focus group sessions indicate a need for further research, with particular emphasis on: (a) accessible and relevant T2DM self-management education material; (b) improved communication of disease-specific information between patients and providers, as well as providers and community resources; and (c) strategies to improve the convenience and cost of monitoring devices.

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References:

1. Centers for Disease Control and Prevention. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2007. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2008.
2. Coccheri S. Approaches to prevention of cardiovascular complications and events in diabetes mellitus. Drugs. 2007;67(7):997–1026.
3. UK Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. BMJ. 1998;317(7160):703–13.
4. Diabetes Control and Complications Trial Research Group. Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. J Pediatr. 1994;125(2):177–88.
5. Harris MI, Cowie CC, Howie LJ. Self-monitoring of blood glucose by adults with diabetes in the United States population. Diabetes Care. 1993;16(8):1116–23.
6. Hammel J, Finlayson M. Focus group facilitation guide: Assistive Technology Outcomes Project. Unpublished manuscript.
7. Mulvaney SA, Mudasiru E, Schlundt DG, Baughman CL, Fleming M, VanderWoude A, Russell WE, Elasy TA, Rothman R. Self-management in type 2 diabetes: the adolescent perspective. Diabetes Educ. 2008;34(4):674–82
8. Gazmararian JA, Ziemer DC, Barnes C. Perception of barriers to self-care management among diabetic patients. Diabetes Educ. 2009;35(5):778–88.
9. Nagelkerk J, Reick K, Meengs L. Perceived barriers and effective strategies to diabetes self-management. J Adv Nurs. 2006;54(2):151–8.