

# Barriers to Technology Adoption by Patients and Providers in Diabetes and Hypertension Care Management

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## Abstract

Remote monitoring has been demonstrated to be an effective tool for decreasing costs and improving outcomes, however, both patients and providers have shown a reluctance to embrace technology. This survey-based, cross-sectional designed study assessed the barriers faced by patients and providers in the District of Columbia for technology adoption in remote monitoring. The patients had a diagnosis of either diabetes, hypertension, or both conditions, and utilized the technology of a home blood glucose monitor, continuous glucose monitor or ambulatory blood pressure monitor. The surveyed providers included staff engaged in chronic disease management of patients with diabetes and hypertension. An adapted version of the Barriers to Health Promoting Activities for Disabled Persons Scale (BHADP) was administered to study participants and statistically analyzed. Data analysis compared and contrasted demographics and survey responses and revealed that there is a discordance in the ways that patients perceive the barriers to technology as compared to the ways that providers perceive them. Data analysis also revealed significant system barriers that limited providers use of remote monitoring technologies. A model is proposed that identifies inputs and barriers experienced by the patient in their journey to initiate or continue a technology (adapted from Moore *et al.*'s 2021 Conceptual Model).

**Keywords:** diabetes, hypertension, remote monitoring, barriers to care, chronic disease management

## 1. Background

Recent studies suggest that traditional outpatient management of chronic illness is insufficient at addressing the day-to-day challenges of chronic disease management [1]. The use of remote monitoring programs has been demonstrated to improve outcomes in chronic disease management including an increase in the

### Citation

Sidney Smith, Vivian Ayuk and Patty Scalzo (2023), Barriers to Technology Adoption by Patients and Providers in Diabetes and Hypertension Care Management. *Digital Medicine and Healthcare Technology* 2023(2), 1–15.

### DOI

<https://doi.org/10.5772/dmht.18>

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### Published

7 June 2023

timeliness of care and reduced hospitalizations and associated healthcare costs [2]. Benefits of remote monitoring to the patient include positive behavior changes and increased patient satisfaction [1]. Benefits to the patient/healthcare provider relationship include more time for engagement, continuity of experience, and dynamic data sharing for shared decision-making [3]. Care transforms from manual transfer of data at a healthcare appointment to availability of data 24 hours a day, seven days a week [3].

The foundation for a successful remote monitoring program, however, is a patient's willingness to engage actively in remote monitoring. Ferguson *et al.* [4] set out to explore the perceptions and experiences of older adults and healthcare professionals (HCPs) with regard to using wearable cardiac monitoring technologies and to identify barriers and facilitators of uptake and acceptance of these devices into clinical practice. Their findings found that the most significant factors had to do with the device design aspects, receiving appropriate and timely feedback, the user-friendliness of the technology and issues about cost and affordability [4]. Furthermore, discontinuation is an issue, with a recent study finding that greater than 90% of wearable users suspended use due to identified barriers such as loss of interest and forgetting to apply the device [5]. The use of multidisciplinary team-based strategies that provide feedback, either automated or provider-initiated, along with other approaches such as shared decision-making, coaching and motivational interviewing, have a greater likelihood of improving adherence [2]. Despite existing programs and technology, engaging patients in remote monitoring programs still proves challenging.

The adoption of technology into the primary care setting faces many barriers, including cost, necessity for culture change, disruptions in workflow and processes, training needs, and competing priorities for practice improvement [6]. Barriers such as device reliability, connectivity and reimbursement all need to be addressed by developers in order for technology adoption to continue to move forward [6].

Equity may be an issue in the deployment of digital technologies due to the availability and costs for mobile devices that may not be covered by all healthcare insurers and plans. Furthermore, complex skills demanded by digital care may vary among the patient population, such as low literacy, and this may further emphasize existing inequities [7]. The digital divide persists with only 5–16% of Medicare beneficiaries currently utilizing digital health technologies and the more affluent and educated continue to have greater access to technology [6]. The Digital Health Measurement Collaborative Community has developed a digital readiness tool for healthcare teams to utilize for patient assessment and readiness for technology [8].

Medical technology has been increasingly cited as a way to improve chronic disease management, however, there are many factors that must be considered when

determining whether or not medical technology is appropriate for a certain patient. Remote monitoring has been demonstrated as an effective tool for decreasing healthcare costs and increasing health outcomes for individuals living with chronic illnesses. Despite known benefits of remote monitoring, many patients are reluctant to embrace and utilize remote monitoring technology. In addition to the barriers faced by individual patients, barriers faced by providers and clinics may also impede the use of remote monitoring technology in chronic disease management. This study seeks to assess the unique barriers to adoption of remote monitoring technology faced by residents in the District of Columbia living with diabetes and hypertension. A knowledge of the barriers faced by providers and patients when incorporating remote monitoring technology can be instrumental when planning the incorporation of medical technology for chronic disease management into clinical practice.

Additionally, individuals with chronic illnesses are at increased risk for morbidity, mortality, and decreased quality of life compared to those without a chronic illness [9]. Helping individuals manage the day to day challenges of their condition can help minimize such adverse health outcomes. In addition to providing healthcare providers with data to drive treatment options, remote patient monitoring also helps participants develop skills and health behaviors to help them better manage their own chronic illness [2]. Furthermore, as patients learn to interpret their own monitoring data, it empowers them to be a more active member of their care which further improves outcomes [9]. While many studies have suggested the benefits of remote patient monitoring, monitoring is only effective if participants are engaged and willing to participate in the monitoring program [10]. Several barriers exist to the adoption of remote monitoring programs including cost, mistrust in technology, or lack of understanding of the benefits of remote monitoring [9].

## 2. Objectives

This survey-based study utilized qualitative research methods to examine the user experience (UE) of patients and providers regarding barriers to technology adoption. The objectives are as follows:

- Identify the barriers faced by patients and providers in adopting medical technology for chronic disease management.
- Identify differences in patient perceived barriers and provider perceived barriers to technology adoption

## 3. Methods/Intervention

This survey-based qualitative study utilized a cross sectional study design to examine the barriers faced by patients and providers in the technology adoption

process. The study underwent an expedited IRB review by the District of Columbia Department of Health and was found to be exempt. An adapted version of the Barriers to Health Promoting Activities for Disabled Persons Scale (Appendix ) was administered electronically via email, along with consent form, and responses were collected anonymously via email with use of Microsoft Forms. While most items on the scale were kept the same, some items related to physical accessibility were removed and additional items related to the use of technology were added to make sure technology specific barriers were addressed. The technology specific questions were created based on the common concerns voiced by patients in the clinical setting as well as common barriers to technology adoption cited in the literature. The scale is free to the public and permission is not required to use this scale, however the modifications made may alter its reliability and validity. All patient participants in the study were provided a complimentary blood glucose monitor, BP monitor and/or continuous glucose monitor. Patient participants were recruited from Sorogi Health's remote monitoring programs and La Clinica De Pueblo. Provider participants were recruited from the DC area.

Surveys were completely anonymous and all data were de-identified. Demographic data collected were age, gender and diagnosis. Inclusion criteria were: age 18 or greater with a diagnosis of diabetes and/or hypertension, ability to speak and understand written English or Spanish, and ability to read at a 3rd grade level. Exclusion criteria were: patient does not provide consent, unable to speak or understand written English or Spanish, and not diagnosed with diabetes or hypertension. No costs were incurred by survey participants and no incentives were provided. The survey was able to be completed within 20 min and participants needed to complete it in one sitting. The healthcare member group needed to be involved in chronic disease management of patients with diabetes and hypertension.

The final study groups were composed of:

- Twenty three healthcare professionals in the Washington DC area
- Twenty eight patients in the Washington DC area that were either currently enrolled in a remote monitoring program for twelve months or less, or had the option to enroll in a remote monitoring program. Patients were assisted to onboard their technology via an individual telehealth session. Two participants were Spanish speaking only.

Barriers to technology were assessed using an adapted version of the Barriers to Health Promoting Activities for Disabled Persons Scale. The scale utilized a 4-point Likert scale: 1 = Never, 2 = Sometimes, 3 = Often, 4 = Routinely. The Self-Ranked Likert Scale was administered electronically via email. The technology assessed in this study included Bluetooth compatible blood pressure monitors, Bluetooth compatible blood glucose meters, and continuous glucose monitors.

#### 4. Data analysis, confidentiality and privacy

Survey data was analyzed using descriptive statistics and non-parametric tests with SPSS. Demographic data was analyzed using frequency testing in SPSS. Data was coded and stored in the Sorogi Health Drive and will not be transmitted outside of the Sorogi Drive. A coded master list will be kept as a hard copy and maintained on a secure network with a firewall. The hard copy of the master list will be kept in a locked file cabinet in a locked office. The data will be kept for three years until the closure of the IRB protocol. All data has been coded by assigning participants a numerical code and no names appear on the questionnaire, tools or data. The numerical code assigned to each participant corresponds to the order in which the survey responses are received. All demographic data collected at the beginning has been de-identified. Collection of identifiable information was limited to minimum necessary. Access to study information was limited to the minimum number of persons necessary.

#### 5. Results

##### 5.1. Demographics

As shown in Table 1, the majority of patient participants were black, female, and between 51–60 years of age. The majority of healthcare professional participants were black, female, 30–39 years of age and were physicians or registered nurses. The majority of the healthcare professionals had been in practice from 0–5 years.

Table 1. Demographic information.

Race	Patient participants (%)	Healthcare professionals (%)
Black	81.5	39.1
White	7.4	30.4
Hispanic		21.7
Asian		8.7
Other	11.1	
Gender		
Male	18.5	17.6
Female	77.8	82.4
Age of patient participants		
Under 40	7.4	
Ages 41–50	25.9	
Ages 51–60	40.8	

Table 1. (Continued)

Race	Patient participants (%)	Healthcare professionals (%)
Ages 61–70	11.1	
Ages 71–80	11.1	
Over 80	3.7	
Age of Provider participants		
Ages 20–29	17.4	
Ages 30–39	43.5	
Ages 40–49	17.4	
Ages 50–59	13	
Over 60	8.7	
Provider years in practice		
0–5	36.4	
6–10	18.1	
11–15	18.2	
16–20	9.1	
21–25	9.1	
26–30	4.6	
30+	4.5	
Professions Represented by healthcare professionals		
Care Coordinator	4.3	
Health Information Specialist	4.3	
Medical Assistant	8.7	
Physician	17.4	
Pharmacist	8.7	
Population Health Manager	4.3	
Public Health Analyst	8.7	
Quality Improvement Manager	8.7	
Registered Dietitian	8.7	
Registered Nurse	17.4	
Social Worker	4.3	
Other	4.3	

## 6. Identification of barriers

In Table 2, the three most important barriers identified by the patient participants were “interferes with other responsibilities”, “lack of time” and “difficulty with depression/anxiety/other mental health concerns”. In Table 3, the three most important barriers identified by the healthcare professional participants for their patients were “I don’t understand how to use technology tools to improve my health”,

Table 2. Patient identified barriers.

Patient responses	Mean score
Overwhelming	1.73
Feeling what they do doesn't help	1.65
Not covered by my insurance plan	1.62
Difficulty with vision/hearing/ physical movement	1.69
No one to help me	1.81
Not interested	1.35
Lack of information and support	1.62
Lack of support from family and friends	1.85
Interferes with other responsibilities	1.89
Lack of time	1.89
Feeling I can't do things correctly	1.48
Difficulty communicating with provider	1.63
Lack of help from health care professionals	1.58
Lack of trust in my provider	1.19
Difficulty with depression/anxiety/other mental health concerns	1.92
I don't trust technology tools	1.42
I don't understand how to use technology tools to improve my health	1.65
Too tired to at the end of the day to learn new skills	1.69
Feel that there is too much information being given to me	1.31
Fear of being judged by healthcare providers	1.38
Shares too much information about me and my health	1.54
Information can be used to disqualify me from social services they need	1.31
Not able to read or write	1.35
Being a part of a monitoring program is too much work	1.42
Doctors don't understand what's important to me	1.31
Feeling that their illness is not that serious	1.12
Less time with their healthcare provider	1.46

“overwhelming”, and “lack of information and support”. In Table 4, the three most important system barriers identified by providers were “limited staff”, “data from remote patient monitoring does not integrate seamlessly to electronic health record” and “current electronic health record system not designed to integrate seamlessly with new technology tools”.

The three least important barriers identified by the patient participants were “feeling that my illness is not that serious”, “lack of trust in my provider” and “feel that there is too much information being given to me”. The three least important barriers identified by the healthcare professional participants for their patients were “lack of trust in my provider”, “less time with their healthcare provider” and “lack of help from healthcare professionals”. The three least important system barriers identified by providers were “don't trust the technology to provide accurate data”, “language barrier” and “cybersecurity concerns”.

Table 3. Provider identified barriers.

Provider responses	Mean score
Overwhelming	3.09
Feeling what they do doesn't help	2.30
Not covered by my insurance plan	2.39
Difficulty with vision/hearing/ physical movement	2.26
No one to help me	2.57
Not interested	2.48
Lack of information and support	2.74
Lack of support from family and friends	2.23
Interferes with other responsibilities	2.04
Lack of time	2.35
Feeling I can't do things correctly	2.32
Difficulty communicating with provider	2.13
Lack of help from health care professionals	2.00
Lack of trust in my provider	1.57
Difficulty with depression/anxiety/other mental health concerns	2.26
I don't trust technology tools	2.26
I don't understand how to use technology tools to improve my health	3.13
Too tired to at the end of the day to learn new skills	2.48
Feel that there is too much information being given to me	2.35
Fear of being judged by healthcare providers	2.09
Shares too much information about me and my health	2.22
Information can be used to disqualify me from social services they need	2.04
Not able to read or write	2.48
Being a part of a monitoring program is too much work	2.39
Doctors don't understand what's important to me	2.22
Feeling that their illness is not that serious	2.61
Less time with their healthcare provider	1.91

Table 4. Provider identified system barriers.

Provider responses	Mean score
Not enough time in an appointment	2.22
Lack of understanding of technology available for RPM	2.13
Too many tools to keep up with	2.22
Language barrier	1.78
Don't trust the technology to provide accurate data	1.70
Lack of training/support on how to use data to inform patient visits	1.91
Not well reimbursed for time spent teaching patient how to use technology	2.30



Table 4. (Continued)

Provider responses	Mean score
No standardized process for data analysis	2.17
No time to handle troubleshooting	2.70
Limited Staff	2.87
Inadequate coverage/reimbursement for incorporating technology	2.57
Financial outlook of the organization	2.57
Organizational culture and structure make it difficult to implement new ideas/initiatives such as incorporating technology in care management	2.30
Lack of coverage for RPM devices	2.30
Conflicting priorities	2.43
Current Electronic Health Record system not designed to integrate seamlessly with new technology tools	2.78
Cybersecurity Concerns	1.78
Lack of standardization of eligibility for RPM services	2.22
Prior authorization process to obtain technology devices for patients	2.26
Too expensive to adopt CGM use or implementing an RPM program for diabetes or blood pressure management	2.26
Lack of standardized guidelines for RPM in blood pressure and diabetes monitoring	2.04
Data from RPM does not integrate seamlessly to electronic health record	2.78
Lack of incentive to invest in adopting technology tools in blood pressure and diabetes management	2.61

## 7. Discussion

There was a dichotomy between the view that the providers held about the barriers experienced by patients and the barriers identified by the patient participants. Providers see technology as something that should be easily incorporated into the patient's daily routine while patients perceive the technology to be disruptive to their routine. Judging from the three most important barriers listed by the providers, one would infer that a little bit of training and education about the technology would eliminate the barriers for the patient. The patient participants did not list educational needs or lack of understanding in their top three identified barriers. The patient barriers were focused on lack of time to fit into their day and mental health challenges. Research has demonstrated that people with chronic disease have higher rates of mental health disorders [11], and this study suggests that mental health concerns may be impacting chronic disease management more than providers understand. This has led the authors to incorporate the Diabetes Distress Scale into patient/provider visits.

A major system barrier is that data from remote patient monitoring does not integrate seamlessly to the electronic health record. Fragmented data collection and analysis is a hurdle for providers who have limited time allocated to data interpretation. Data is not stored in the patient's health record which makes it easy for data to be lost and makes it difficult to track trends for individual patients. Another system barrier identified was "lack of incentive to invest in adopting technology tools in blood pressure and diabetes management". Creating incentives for providers to adopt technology and train staff in effective use of technology will encourage providers to adopt technology.

Many participants were unable to complete the Spanish language version of the survey due to being unable to read the questions. Illiteracy is a barrier in itself. Many health education materials are provided in written form so a thorough assessment of literacy should be done before providing written materials. Use of visual materials with no text is encouraged whenever possible.

Moore *et al.* [12], have proposed a Conceptual Model developed from the Line-of-Argument synthesis which identifies external stakeholders, factors and stages of device integration. The external stakeholders include device designers, family members, clinicians and researchers. Factors are identified as "ease of use", "intrinsic motivation", "extrinsic motivation" and "purpose of device". The stages of device integration involve the initial device adoption, the added value to life and the integration into daily life.

As depicted in Figure 1, we would like to propose a model in which that identification of barriers is an important part of the process at each stage of device integration. Barriers may change over time. This study focused on initial barriers in people new to device adoption but these barriers could easily change over time and are important to reassess during all stages of device integration. Shown in Figure 1 are the many inputs that affect the decision to adopt and/or to continue utilizing a technology. The main stakeholder is the patient, who is impacted by a list of external stakeholders.

External stakeholders include:

- Healthcare system (insurers, health plans, etc)
- Family members and friends
- Device designers
- Researchers
- Clinicians

Barriers faced by the patient when deciding to initiate or continue a technology include:

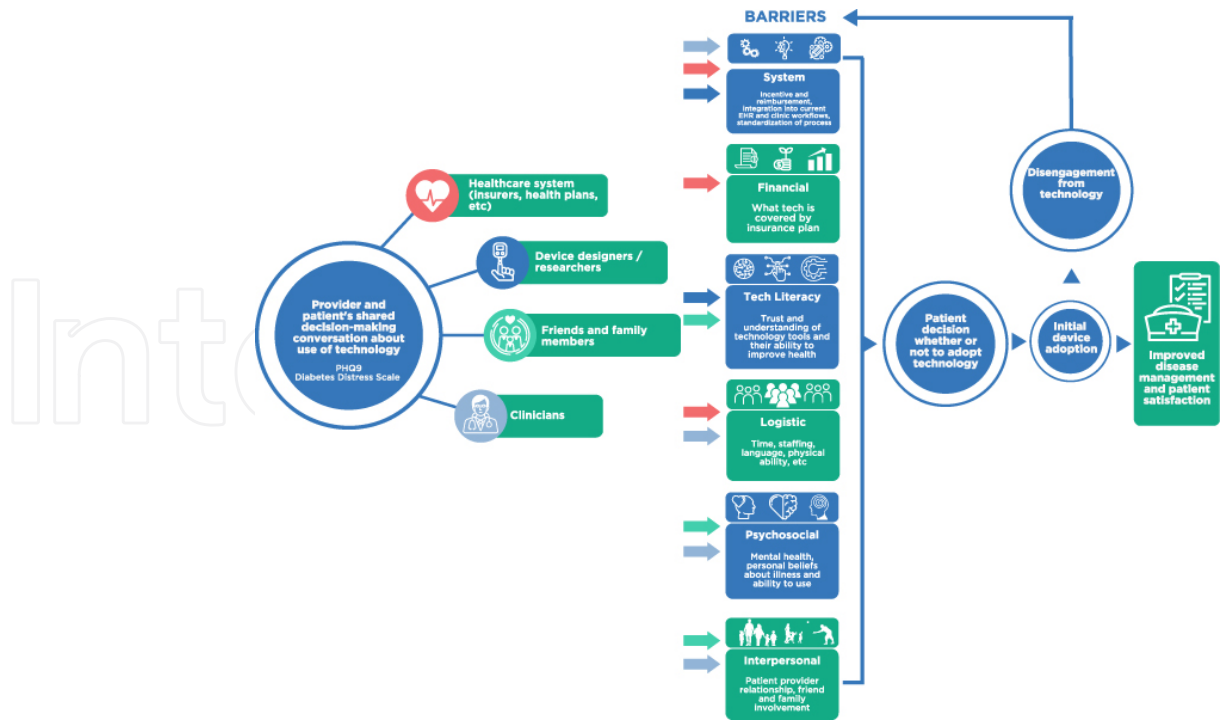


Figure 1. The Sorogi Model: inputs and barriers experienced by patients in their journey to initiate or continue a technology (adapted from Moore *et al.* 2021 Conceptual Model).

- System
  - Less time with healthcare provider
  - Not enough time in an appointment
  - Lack of understanding of available technology
  - Too many tools to keep up with
  - Lack of training/support
  - Not reimbursed for time spent teaching patient how to use tech
  - No standardized process for incorporating tech
  - Organizational culture makes it difficult to incorporate new ideas
  - EHR doesn't integrate with tech
  - Too expensive to adopt RDM program/lack of incentive to adapt
- Financial
  - Not covered by insurance
  - Information can be used to disqualify from social services
- Technology Literacy
  - Lack of information and support
  - Lack of trust in technology tools

- Shares too much information about me and my health
- Don't understand how to use technology to improve health
- Feel there is too much information being given to me
- Not able to read and write
- Logistics
  - Mobility issues
  - No one to help
  - Interferes with other responsibilities
  - Lack of time
  - Being part of a monitoring program is too much work
  - Language barrier
  - No time or staff for trouble shooting
- Psychosocial
  - Overwhelming
  - Feeling that what I do doesn't help
  - Feeling I can't do things correctly
  - Difficulty with depression/anxiety/other mental health concerns
  - Feeling that their illness is not that serious
- Interpersonal
  - Lack of support from family and friends
  - Difficulty communicating with my provider
  - Lack of help from healthcare professionals
  - Lack of trust in my provider
  - Fear of being judged by healthcare providers
  - Doctors don't understand what is important to me
  - Not interested
  - Too tired at the end of the day to learn new skills

Lastly, and importantly, the results of our study have pointed out that “difficulty with depression/anxiety/other mental health concerns” is an important barrier faced by patients in the technology adoption process. The American Diabetes Association notes that diabetes distress affects about one third of adults living with Type 2 diabetes and depression affects one in five adults living with Type 2 diabetes [13]. Anxiety and depression have been found to be associated with hypertension [14]. It is imperative that providers are screening patients for both depression and diabetes distress along with screening for other barriers during the entire journey of technology adoption and persistence.

## *8. Limitations of study*

Our study has several limitations. First, since the patient study recruits were only drawn from two centers and the sample size was relatively small, reproducibility may be limited. Secondly, due to the fact that the study involved a self-reported survey, recall bias may be a factor. Thirdly, survey results were not matched to a particular patient/provider relationship, which may have provided greater insights. Fourth, the survey was only available in written form and many potential patient participants were illiterate and therefore unable to participate.

## *9. Summary*

Our results demonstrate the need for the creation of a standardized screening tool that may be used by providers to assess a patient's readiness and willingness to initially engage with technology and to continue to persist with technology. Barriers may arise during the technology journey that were not present initially. Therefore, ongoing assessment of technology barriers is important.

Additionally, our results uncovered that "difficulty with depression/anxiety/other mental health concerns" is an important barrier faced by patients in the technology adoption process. Screening for depression, anxiety and diabetes distress needs to be protocolized and offered to patients at structured time periods.

Technology initiation is not a "one and done" implementation. A patient's successful use of technology requires ongoing assessment and input from the healthcare team. The adoption and continued use of technology is a journey; an ongoing process that requires ongoing shared decision-making conversations between the patient and the healthcare team.

## *Funding*

This work was supported by Sorogi.

## *Conflict of interest*

The authors have no relevant financial or non-financial interests to disclose.

## *Appendix*

Adapted Barriers to Health Promoting Activities for Disabled Persons Scale (BHADP).

**Patient survey**

Please circle the number that best indicates how much each of these keeps you from using technology tools such as Bluetooth blood pressure monitors, Telehealth platforms, nutrition and fitness apps, remote monitoring devices and apps in your blood pressure and or diabetes care.

1 = Never

2 = Sometimes

3 = Often

4 = Routinely

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Too tired to at the end of the day to learn new skills	1	2	3	4
Overwhelming	1	2	3	4
Feeling what I do doesn't help	1	2	3	4
Not covered by my insurance plan	1	2	3	4
Lack of money	1	2	3	4
Cost too much money	1	2	3	4
Difficulty with vision/hearing/ physical movement	1	2	3	4
No one to help me	1	2	3	4
Not interested	1	2	3	4
Lack of information and support	1	2	3	4
Lack of support from family and friends	1	2	3	4
Interferes with other responsibilities	1	2	3	4
Lack of time	1	2	3	4
Feeling I can't do things correctly	1	2	3	4
Difficulty communicating with provider	1	2	3	4
Lack of help from health care professionals	1	2	3	4
Lack of trust in my provider	1	2	3	4
Difficulty with depression/anxiety/other mental health concerns	1	2	3	4
I don't trust technology tools	1	2	3	4
I don't understand how to use technology tools to improve my health	1	2	3	4
Feel that there is too much information being given to me	1	2	3	4
Fear of being judged by healthcare providers	1	2	3	4
Shares too much information about me and my health	1	2	3	4
My information can be used to disqualify me from social services I need	1	2	3	4
Not able to read or write	1	2	3	4
Being a part of a monitoring program is too much work	1	2	3	4
My doctors don't understand what's important to me	1	2	3	4
Feel that my illness is not a serious illness	1	2	3	4
Less time with my healthcare provider	1	2	3	4

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Diabetes Distress Scale: <https://diabetesdistress.org/dd-assess-score-3>.

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