



The Use of Diabetes Technology to Address Inequity in Health Outcomes: Limitations and Opportunities

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Abstract

Purpose of Review The management of diabetes has been revolutionized by the introduction of novel technological treatments and modalities of care, such as continuous glucose monitoring, insulin pump therapy, and telehealth. While these technologies have demonstrated improvement in health outcomes, it remains unclear whether they have reduced inequities from racial/ethnic minority or socioeconomic status. We review the current literature to discuss evidence of benefit, current limitations, and future opportunities of diabetes technologies.

Findings While there is ample evidence of the health and psychological benefit of diabetes technologies in large populations of people with type 1 and type 2 diabetes, there remain wide disparities in the use of diabetes technologies, which may be perpetuating or widening inequities. Multilevel barriers include inequitable prescribing practices, lack of support for social determinants of health, mismatch of patient preferences and care models, and cost.

Summary We provide a review of disparities in diabetes technology use, possible root causes of continued inequity in outcomes, and insight into ways to overcome remaining gaps.

Keywords Diabetes technology · Continuous glucose monitors (CGM) · Insulin pump · Telehealth · Disparities

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Introduction

As of 2020, 34 million or 1 in 10 Americans were living with diabetes [1]. Nationwide, one in every 4 persons with diabetes (PWD) were unable to achieve a glycated hemoglobin (HbA1C) level less than 7.5% [2]. Data from the Type 1 Diabetes Exchange revealed that less than 21% of adults were able to achieve HbA1c targets of less than 7% [3], increasing the risk for development of short- and long-term complications including premature mortality. Diabetes disproportionately affects racial/ethnic minorities, those with fewer economic resources, and lower educational attainment (i.e., underserved populations) [4]. Moreover, the estimated total cost of diabetes care approximates \$327 billion, 73% of which is due to direct medical costs and 17% due to reduced productivity in the workplace [5].

Diabetes self-management is essential for achieving and sustaining glycemic targets and delaying the onset of diabetes-related complications [6, 7]. However, underserved populations have to manage an array of challenges that are unique and unaccounted for in traditional healthcare paradigms. Low health literacy, limited proficiency with English, difficulty accessing appointments with primary

care providers/endocrinologists, racism, and the burdens of economic hardship are highly prevalent and pose as serious barriers to self-management of diabetes [8–15].

Diabetes technologies, such as insulin pump therapy and continuous glucose monitors (CGM), have emerged as new standards of care in diabetes, in which quality clinical trials show glycemic benefit and improvement in quality of life. Coupled with telemedicine care delivery, these recent technological solutions greatly reduce barriers to diabetes self-management and may have the largest benefit in underserved populations. Nevertheless, recent studies demonstrate wide disparities in diabetes technology use across the lifespan for CGM, insulin pump therapy, data management platforms, and telehealth, which reduces their true potential. [9, 10, 15–18].

In this narrative review, we summarize disparities in diabetes technology use and impact, present possible root causes of continued inequity, and offer insight into ways to overcome remaining gaps. This review is limited to English language papers focused on CGM, insulin pumps, and telehealth published in the last 5 years.

Continuous Glucose Monitoring (CGM)

The American Diabetes Association Standards of Care states “CGM can be helpful in improving HbA1c levels in people with diabetes on noninsulin as well as insulin regimens.” [19] The American Association of Clinical Endocrinologists recommends that “CGM be considered for all insulin-using patients, regardless of diabetes type.” [20] CGM has been shown to be effective in reducing HbA1c levels when used alone or in combination with an insulin pump. Patients also report higher treatment satisfaction and less diabetes distress with rtCGM use. [16, 21, 22] Although CGM utilization has been increasing since 2010, less than 38% of patients with T1D reported using CGM in the T1D Exchange as of 2018 [3]. Furthermore, utilization of CGM has been shown to vary by race, age, insurance, and type of diabetes, creating windows for disparities in benefits of CGM use. [8–10].

It is well-established that racial-ethnic disparities exist in CGM use between non-Hispanic Blacks (NHB), Hispanics, and non-Hispanic Whites (NHW). Such disparities in use have also been shown to persist after controlling for a host of factors including SES, insurance, health literacy, self-reported diabetes distress, self-management practices, numeracy, level of education, and pediatric or adult care setting [3, 15]. It has also been demonstrated that provider prescribing biases play a significant role in disparities in use [15, 23]. Patients have endorsed that providers often failed to share in the decision-making around technology, inadvertently restricting access. In addition, providers have unilaterally made decisions to prescribe based on patient insurance type without having discussions with patients. In fact, one study of T1D providers across

the USA estimated provider implicit bias in prescribing against publicly insured patients to be as high as 85% [10]. In addition, a single-center study showed that NHW children were 2 times more likely to have been prescribed CGM than NHB children and NHB children who were prescribed CGM were also more likely than NHW children to discontinue CGM within 1 year, even with adequate insurance coverage. [8]

While provider bias is an important influencer, the lack of support for patients and their families to initiate and sustain CGM use may also be missing and may impact providers’ level of confidence in prescribing CGM. Social determinants of health require full support and extension of care into the home environment that is not currently part of standard of endocrinology care and especially not part of CGM prescription management. Underserved populations experience an array of challenges to taking on new treatment regimens and ensuring that the personal investment is worth the extra potential time and cost. Several qualitative studies have highlighted that providers endorse the lack of confidence in managing social determinants while also acknowledging that they are significant barriers to the delivery of standards of diabetes care.

To compound issues of provider biases and lack of system supports for underserved populations, the fact remains that CGM remains unaffordable. Without insurance coverage, costs of CGM can range from \$2,500 to \$6,000 per year out of pocket, with high costs even with insurance coverage in the hundreds to thousands of dollars annually [24]. Data from the DIAMOND trial estimates that CGM supplies cost \$15.20 per day, which may be unattainable for many, compared to a daily cost of \$0.73–3.00 for finger-stick test strips [25, 26]. For those that are covered under insurance, eligibility requirements are burdensome. Clinical documentation of patient blood glucose testing of greater than 4 times daily and the use of at least three injections of insulin daily have traditionally been prerequisites for CGM coverage by most Medicare and Medicaid plans [18]. While some of these restrictions have now been eliminated, cumbersome authorization and reauthorization procedures continue to keep CGM out of reach for many Medicare and Medicaid-insured populations. Furthermore, many state Medicaid plans and private insurers still do not cover CGM fully for type 1 diabetes and none fully cover type 2 diabetes [24]. Given the patchwork of coverage and high startup cost for CGM, its low utilization among underserved populations is unsurprising.

Insulin Pump Therapy

There are an estimated 350,000 insulin pump users in the USA, with 90% of users having T1D and 10% having T2D [23]. Modern insulin pumps that communicate with CGM devices to automatically adjust insulin in response (automated insulin delivery, AID) significantly reduce the incidence of

hypoglycemic events, increase time in glycemic target range, and lower HbA1c [27, 28]. In addition, insulin pumps are associated with higher patient satisfaction than traditional MDI therapy [29]. Smart insulin pens are also available as an alternative to insulin pump therapy [30]. Although there is potential for smart insulin pens to reduce disparities in technology use and outcomes, these devices are understudied to date.

Similar to CGM, utilization of insulin pump therapy is associated with substantial racial, age, gender, and socioeconomic disparities [31]. Sixty three percent of patients in the T1D Exchange reported using insulin pump in 2018, with NHB, non-native English speakers, older, and male PWD exhibiting lower use [3]. Reasons for lack of pump use vary and may include providers not offering pumps, providers stating blood sugars were too high to qualify, preference for MDI, and/or denial due to restrictive insurance eligibility requirements [3]. A study by Puckett et al. found that how providers screened for eligibility and educated children and parents with T1D for an insulin pump greatly influenced use: when pumps were discussed early within the first visit upon meeting patients compared to 6–12 months past the first visit, patients were more likely to agree to and adopt insulin pump [32]. It is important to note that the ADA does not recommend or require eligible patients to wait for any given period of time for pump allocation. However, CMS coverage for insulin pump therapy is more conservative and requires patients complete a comprehensive diabetes education program, engage in blood glucose monitoring at least 4 times a day, and administer insulin injections at least 3 times a day with frequent adjustments for at least 6 months prior to initiating an insulin pump [33]. Organizational, provider, and insurance policies that require evidence of frequent blood glucose monitoring, successful use of MDI, and achievement of glycemic targets have thus led to disadvantages for patients with fewer resources, lower education, and lesser English language and numeracy skills. Similar to CGM costs, the mean annual out-of-pocket cost difference of \$3,923 between insulin pump and MDI is likely also prohibitive for underserved populations without adequate insurance coverage. [12] Lastly, insulin pump therapy unlike CGM requires more intensive education to manage safely, which can be a barrier to both prescribing providers and patients who may not have an adequate level of support to take on a new way of managing insulin. Arguably, the newer generations of automated insulin pumps are able to offload the educational burdens of insulin management, so there is hope that some of these disparities in educational attainment may lessen, however this is unknown at the current time.

Summary

In all, current health policy and practice do not support equitable access to CGM and insulin pumps. The research

demonstrates that patients are not introduced to diabetes technology in a meaningful way for them to be able to make educated decisions; providers have implicit biases and forced biases in prescribing due to the lack of necessary supports in their practices; patients and their families are not given adequate wraparound support for integrating technology into other competing priorities and restrictions; and insurance policies and costs provide even longer paths of resistance.

Telehealth

Telehealth is an umbrella term for electronic, telephonic audio, video, or text communication between a patient and their provider(s) for education (tele-education), consultation (teleconsultation), and monitoring (telemonitoring) [34]. Tele-education refers to any intervention that teaches, trains, or coaches patients remotely. Tele-education encompasses an array of programs that includes video conferences with certified diabetes care and education specialists or pre-recorded videos or slides that can be viewed on demand. Teleconsultation allows for either a patient or a provider to communicate with another provider in a non-face-to-face manner (i.e., email or telephone). Telemonitoring allows for the transmission of data to a clinician. Telehealth can further be broken down as asynchronous – electronic communications without face-to-face contact (i.e., email, patient portal or telephone) – or synchronous in which the visit involves both image and voice contact (i.e., videoconferencing) [35].

Telehealth has recently become more widely available to inpatient and outpatient providers due to the COVID-19 pandemic, whereas previously Centers for Medicare & Medicaid Services only allowed for telehealth coverage for outpatient providers in rural communities [36]. Most endocrinologists are geographically concentrated in urban centers, with as much as 36% of children and 16% of adults having no access to an endocrinologist within a 20-mile radius [37]. As a result, there is an urgent need for telehealth to bridge disparities in care across race-ethnicity, rural/urban, and socioeconomic strata. Telehealth can potentially make attending medical visits easier for patients who have to work and are not allowed time off and/or who have limited mobility or access to transportation.

There have been several meta-analyses done exploring the impact of telehealth on diabetes health outcomes. A meta-analysis of 55 studies from around the world of persons with T1D or T2D showed that 22 studies demonstrated greater improvement in HbA1c in those who received telemedicine as opposed to care as usual; and another 33 studies showed no difference between the 2 groups. Studies with favorable outcomes tended to involve participants with T2D over the age of 40 in an intervention for six months or less [38]. Another meta-analysis found that despite significant

heterogeneity in telehealth care approach, there was a statistically significant reduction in HbA1c among those with T2D who used telehealth compared to usual in-person care: (-0.43% (95% CI: -0.64% to -0.21% ; $p < 0.001$). [34].

Disparities in telehealth are understudied, as the majority of telehealth studies fail to recruit racially and ethnically diverse samples. A meta-analysis of telehealth interventions by Issacs et al. showed that tele-monitoring trials had median minority participation rates of only 23% [39]. Moreover, current studies with acceptable proportions of underserved individuals may not be applicable to real-world scenarios given that they often used financial incentives or offered free tablets, test strips, and other devices to bolster participation [18]. An example of this type of study randomized NHB and Hispanic participants with T2D to a monthly phone call versus a biweekly telemonitoring visit and remote monitoring of weight, blood sugar, and blood pressure for 3 months noting greater improvements in HbA1c in the telephone arm (-2.57% vs -2.07%) [40]. Another study used a laptop for remote monitoring of non-Hispanic black patients with T2D by a nurse, demonstrating a higher likelihood of achieving HbA1c $\leq 7\%$ when compared to those who received the standard of care from their provider. [41].

Telehealth can also be used to provide diabetes education. In a small study by Gal et al., 35 patients were assigned to a certified diabetes care education specialist (CDCES), who provided them with 3 sessions of CGM education via telehealth, resulting in mean HbA1c reduction from $8.3\% \pm 1.6$ at baseline to 7.2 ± 1.3 at 12 weeks ($P < 0.001$). IDEATel, a telehealth study of racially/ethnically diverse Medicare beneficiaries with T2D, randomized to tele-education intervention versus usual care narrowed disparities in HbA1c between NHB and NHW participants after 5 years. [42].

For patients who do not have access to an endocrinologist or a CDCES, e-consults may be an optimal way of accessing specialists. An e-consult allows for a face-to-face interaction between a primary care physician (PCP) and endocrinologist/diabetologist to discuss diabetes management. One study comparing e-consult to usual care randomized providers into an e-consult arm versus a care-as-usual arm. They found no difference in change in HbA1c at 6 or 12 months between the 2 groups. At a 6-month follow-up, there were several reasons noted for the lack of improvement in the e-consult arm. Based on the review of the electronic medical record communications and qualitative interview, PCPs only followed the e-consult recommendations 38% of the time due to the lack of patient follow-up, unfamiliarity with newer diabetes medications, or patient refusal [43]. Another study of the Dallas Veterans Affairs hospital showed that e-consultation resulted in a greater HbA1c reduction of 1.21% versus a reduction of 0.79% in for those seen in person in the endocrinology clinic. [44].

While these studies show positive outcomes of various telehealth models in underserved populations, COVID-19

data demonstrated that only approximately half of all Federally Qualified Health Centers engaged in telehealth during the first year of the COVID-19 pandemic. This raises the question of how many providers offer these services to underserved patients and how to disseminate such practices in real-world care paradigms. A meta-analysis of telehealth interventions by Heitkeimper concluded that in order to be successful, as defined as improvement in HbA1c, telehealth needed to involve video contact between the educator and patient. [45] Interventions that utilized less labor-intensive interventions such as automated text messages or phone calls did not lead to improvement in glycemic control.

There are numerous barriers to using telehealth technology for underserved populations. The availability of broadband internet access is far from universal. Twenty-four million Americans, most of whom live in rural areas or on tribal lands, live in “digital deserts,” without access to high-speed Internet which limits the ability to participate in telehealth. [46] Broadband access and usage have been shown to be lower for Black and Hispanic patients with diabetes and/or hypertension when compared to White, especially younger people who were well educated, employed, and had health insurance. New broadband access programs, such as the Affordable Connectivity Program (ACP) [47], which is a U.S. government program run by the Federal Communications Commission (FCC) program to help lower costs for low-income households to pay for internet service may help. These programs also offer lower-cost or free connected devices, such as a laptop or tablet. [48] Another barrier for NHB and Hispanic persons is concerns about the confidentiality of telehealth [49]. One qualitative study of NHB and Hispanic people with T2D who declined to participate in a telehealth intervention identified barrier including disinterest, inconvenience, and lack of perceived benefit of engaging in telehealth. [17] Language can also be a barrier for non-English speakers. In a cross-sectional analysis of primary care patients in California from 2015 to 2016, those with limited English proficiency were 40% less likely to use telehealth, suggesting that interpreter services need to be integrated into telehealth care [50, 51].

Summary

Although telehealth can improve health outcomes in persons with diabetes, there are several limitations to such visits. Persons of lower socio-economic status, in rural areas, and those with limited English proficiency may be more likely to have access or communication issues. Again, supports are needed that help providers and patients utilize telehealth in a meaningful and less burdensome way to support underserved population needs.

Conclusions and Recommendations

Diabetes technologies function in a multitude of ways with the potential to greatly reduce disparities in outcomes by improving quality of care, reducing diabetes distress, improving quality of life, and optimizing diabetes self-management to improve health outcomes. Unfortunately, industry norms, insurance policies, provider practices, and certain patient factors limit access to underserved groups who could benefit the most.

Widespread transformation at multiple levels needs to happen to effect change. In addition, advocacy at the state level has already shown great effects in changing insurance coverage and should be replicated across more states. Screening and support for social determinants of health are urgently needed to alleviate prominent burdens for underserved populations to take on new care paradigms and harness intended benefits. Providers must remain vigilant of internal biases and external pressures that promote such biases to provide equitable levels of care tailored to the individual needs. Incentive systems, such as extra RVUs or compensation, are needed for practices that offer support for the underserved such as comparable billing for social determinants of health screening codes as traditional evaluation and management visit.

Most importantly, the inclusion of underserved populations is needed at every step of the process, including in the design, marketing, implementation, and dissemination plan of diabetes technologies. The use of user-centered design approaches and stakeholder advisory boards are optimal methods of effectively matching interventions to target populations and have increasingly been endorsed by multiple major research funding agencies such as the Robert Wood Johnson Foundation (RWJF), Patient-Centered Outcomes Research Institute (PCORI), and National Institutes of Diabetes Digestive and Kidney Diseases (NIDDK). True inclusion of underserved populations in diabetes technology products must now be embraced by industry, regulators, and payors.

Diabetes technologies harness great power in reducing and potentially eliminating multiple disparities in access to high-quality diabetes care and major health outcomes. Efforts to intervene upstream are needed urgently to improve outcomes at the population and generational levels.

Declarations

Conflict of Interest Shivani Agarwal works as a healthcare disparities advisor for Medtronic Inc. and Beta Bionics. Iman Simmonds and Alyson K. Myers have no disclosures.

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