Diabetes Technology Use for Management of Type 1 Diabetes Is Associated With Fewer Adverse COVID-19 Outcomes: Findings From the T1D Exchange COVID-19 Surveillance Registry

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People with coronavirus disease 2019 (COVID-19) and preexisting type 1 diabetes (T1D) are at high risk of diabetes-related outcomes such as diabetic ketoacidosis (DKA) and hospitalization (1). For people with elevated glucose levels, infections could further exacerbate the risk of acute complications. As part of the management of T1D, the use of diabetes technology including continuous glucose monitors (CGM) and insulin pumps is recommended to improve glycemic control (2). However, despite increasing evidence of the benefits of diabetes technology, its uptake remains low, in part owing to systemic racism and social inequities, including in diabetes and device education, patient motivation, and peer support (3,4). The aim of this article is to examine the association of technology use and clinical outcomes during the COVID-19 pandemic.

We analyzed data from the T1DX COVID-19 Surveillance Registry, a U.S.-based multicenter study for people with T1D, to examine the frequency of adverse outcomes across categories of technology use. The registry details have previously been described; briefly, all participating sites completed a chart review and via an online questionnaire submitted information on all patients with T1D at their sites who tested positive for COVID-19 (1,2).

This analysis included 447 people with T1D and laboratory-confirmed COVID-19 infection during March 2020–December 2020. Patients were grouped into four categories of diabetes technology use: "no device use," including patients who did not report using a CGM or insulin pump device; "CGM use," including all patients currently using a CGM device, regardless of insulin pump use; "insulin pump use," including all patients currently using an insulin pump, regardless of CGM device; and "CGM and insulin pump use," including patients who reported using a CGM in combination with an insulin pump. Adverse outcomes including hospitalization, DKA, severe hypoglycemia, or death were reported through medical chart review. Patients who were hospitalized or admitted to an intensive care unit were classified as hospitalized patients, whereas patients who received home care, or were seen at the clinic or emergency department, were grouped under the category of home care. DKA was defined as the presence of *1*) hyperglycemia (blood glucose >11 mmol/L), *2*) venous pH <7.3 or serum bicarbonate <15 mmol/L, and *3*) ketonomenia or ketonuria.

Diabetes technology use differed across race/ethnicity; non-Hispanic (NH) White individuals used CGM devices significantly more than NH Black and Hispanic individuals (67% vs. 10% and 16%, respectively; $P < 0.01$) (Fig. 1*A*). The rates of hospitalization and DKA were lower among all device users, including the subgroup that used CGM only ($N = 85$) (18% and 13%) and insulin pump only ($N = 25$) (12% and 12%), compared with rates among nonusers (61% and 36%, $P < 0.01$) (Fig. 1*B*). Further, the odds of hospitalization among nonusers of technology were higher compared with the odds for those using any device after adjustment for age, insurance status, and race/ethnicity (odds ratio 6.1 [95% CI 3.7–10.1]). Additionally, the odds of DKA among nonusers of technology were also higher

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	No Device Use N=181	CGM Use N=241	Insulin Pump Use N=183	CGM + Insulin Pump Use N=158
Age–group—N(%)				
<19 years	93 (51)	97 (40)	81 (44)	67 (42)
≥19 years	88 (49)	144 (60)	102 (56)	91 (58)
Gender—N(%)				
-Female	90 (50)	130 (54)	104 (57)	92 (58)
Insurance Status—N(%)				
-Private	55 (30)	162 (67)	135 (74)	117 (74)
-Public	126 (70)	79 (33)	48 (26)	41 (26)
Race/ethnicity—N(%) [a,b,c]				
-NH White	59 (33)	162 (67)	136 (74)	119 (75)
-NH Black	59 (33)	24 (10)	14 (8)	9 (6)
-Hispanic	54 (30)	39 (16)	27 (15)	24 (15)
-Other	9 (4)	16 (7)	6 (3)	6 (4)
Mean A1C (%), SD	10.2 (2.8)	8.4 (2.8)	8.1 (2.8)	8.0 (2.7)
Outcomes—N(%)				
-Hospitalization [a,b,c]	110 (59)	34 (18)	22 (12)	19 (10)
-DKA [a,b,c]	65 (35)	18 (18)	10 (10)	7 (7)
-SH	7 (54)	3 (21)	2 (14)	2 (14)
-Death	4 (57)	1 (14)	1 (14)	1 (14)

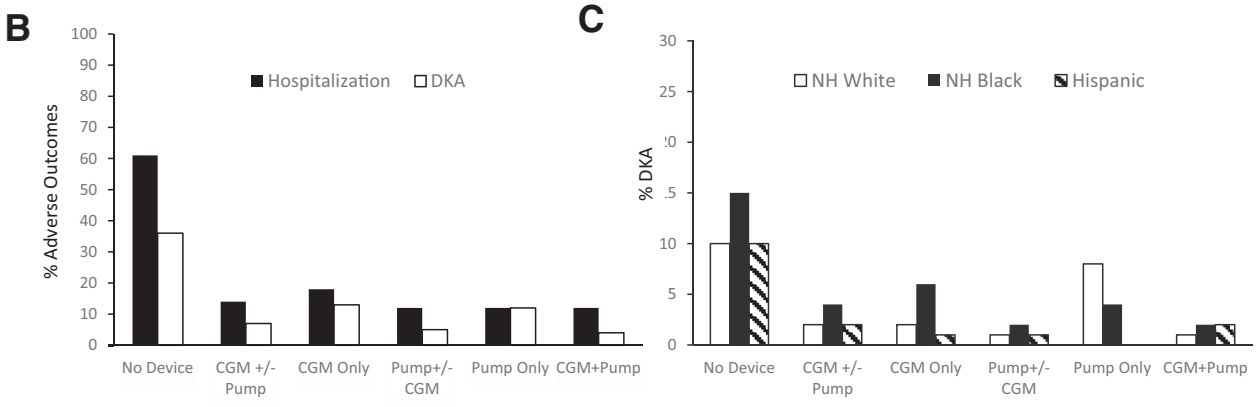

Figure 1–*A*: Distribution of patient factors and adverse outcomes, *N* (%), among T1D patients who tested positive for COVID-19 across diabetes device users and nonusers (CGM users, CGM ± insulin pump; insulin pump users, pump ± CGM). *B*: Distribution of adverse outcomes among categories of diabetes technology use. *C*: Distribution of DKA by race/ethnicity across categories of diabetes technology use. [a]χ^2 test ($P < 0.05$), CGM use vs. no device use. [b]χ^2 test ($P < 0.05$), insulin pump use vs. no device use. [c]χ^2 test ($P < 0.05$), CGM+pump use vs. no device use. SH, severe hypoglycemia.

compared with the odds for those using a device (4.3 [2.4–7.8]).

On stratifying adverse outcomes by race/ethnicity across each device use group, we found that DKA rates were higher across all race/ethnicity groups among device nonusers than among those using any device (Fig. 1*C*). Similarly, the frequency of hospitalization was also found to be higher across all race/ethnicity groups among technology nonusers (NH White 16%, NH Black 24%, Hispanic 18%) in comparison with those using any device (CGM, NH White 5%, NH Black 3%, Hispanic 3%; insulin pump, NH White 7%, NH Black 2%, Hispanic 2%; $P < 0.01$). Lastly, in this population, underlying comorbidities, such as hypertension, obesity, cardiovascular disease, and asthma, were not seen to be disproportionately distributed across race/ethnicity groups (data not shown).

This study provides additional evidence supporting the benefits of diabetes technology in optimizing glycemic control. Recent studies have shown that diabetes-related morbidity tends to be exacerbated amid the current pandemic (1,2), and our findings demonstrate that glycemic management with technology is associated with a lower risk of adverse outcomes during COVID-19 infection. This study further confirms the known existence of racial disparities in the use of diabetes technology. It underscores the importance of considering social inequities, such as socioeconomic status and education level, when advocating for measures to improve technology uptake. Lastly, in addition to device access, diabetes- and device-specific education, as well as peer support mechanisms, should be recognized as imperative for alleviation of adverse outcomes.

It remains critical to advocate for equitable access to diabetes technology. In support of this effort, the T1D Exchange Quality Improvement (T1DXQI) Collaborative has proposed a framework to address inequities exacerbated by COVID-19 (5). With this framework, by underscoring structural racism as one of the key drivers of disproportionate technology access, the aim is to identify opportunity gaps where providers can address health inequities with the help of quality improvement principles.

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