Correlation between A1c and Continuous Glucose Monitor Time in Range in a Cohort of Pediatric Patients with Type 1 Diabetes

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Background

Type 1 diabetes (T1D) affects 187,000 people under 20 years of age in the United States (1). Hemoglobin A1c (A1c) is the standard for evaluating glycemic control in children and adults with T1D (2), but recent advances in diabetes technology have provided additional methods of evaluating blood glucose levels. While A1c approximates the average blood glucose over the previous three months, continuous glucose monitoring (CGM) allows for monitoring of glycemic control over varied time frames using time in range (TIR, 70-180 mg/dL) and mean glucose (3). Studies in primarily adult populations have shown that TIR correlates with A1c (4), but few studies have evaluated this correlation in children. The purpose of this analysis is to examine the association between A1c and TIR, as well as the influence of age, duration since diagnosis, and DKA at diagnosis in a pediatric population.

Materials and methods

Patients in this study had type 1 diabetes, were seen at the Barbara Davis Center for Diabetes between Jan 2018 and Dec 2020, and at the time of last visit were < 22 years old, had a diabetes duration > 3 months and had available A1c and diabetes technology data at the same clinical encounter. Demographics, A1c, pump usage, and sensor usage at the most recent clinical encounter were extracted from the medical record. CGM and pump use data refer to the preceding 14 days. Patients not on CGM or using CGM less than or equal to 70% of the time were excluded.

Pearson's correlation coefficient and generalized linear models were used to examine the relationship between A1c and CGM TIR. A1c levels above 14% were recoded as 14%. A1c was defined as the independent variable and TIR was defined as the dependent variable (4).

Demographics

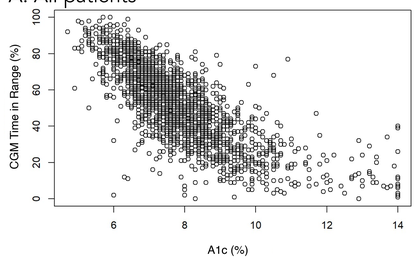
	Value
Number of patients	1952
Age, mean (SD)	13.24 (4.52)
Gender = male (%)	963 (49.3)
A1c, mean (SD)	7.87 (1.5)
Diabetes Duration years, mean (SD)	5.60 (4.07)
Race/Ethnicity, n (%)	
American Indian/Alaska Native	4 (0.2)
Asian	18 (0.9)
Hispanic	205 (10.5)
More than one Race	32 (1.6)
Native Hawaiian/Other Pacific Islander	1 (0.1)
Non-Hispanic Black	45 (2.3)
Non-Hispanic White	1382 (70.8)
Other	43 (2.2)
Unknown	222 (11.4)
English as primary language, n (%)	1904 (97.6)
CGM use, mean (SD)	91.13 (8.1)
CGM Mean Glucose, mean (SD)	184.78 (42.3)
CGM percent >180 mg/dL, mean (SD)	45.77 (21.6)
CGM percent <70 mg/dL, mean (SD)	2.45 (2.9)
CGM percent 70-180 mg/dL, mean (SD)	51.77 (20.7)
On insulin pump, n (%)	1483 (76.0)
Using hybrid closed loop, n (%)	546 (28.0)
Home address in a rural zip code, n (%)	296 (15.2)
Insurance, n (%)	
Medicaid	479 (24.6)
Military Plans	104 (5.3)
Private	1364 (70.1)
Had DKA at diagnosis of diabetes, n (%)	727 (37.2)

A. Scatterplot of TIR vs A1c using the unadjusted model. The unadjusted correlation is -0.77.

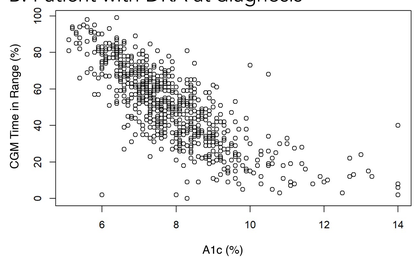
B & C. Scatterplots of TIR vs A1c in patients who had DKA at diagnosis (B) and those that did not have DKA at diagnosis (C). The unadjusted correlation in those with and without DKA at diagnosis is -0.78.

A1c vs CGM Time in Range

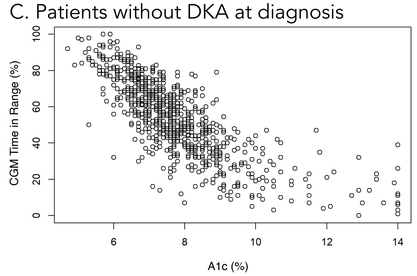
A. All patients



B. Patient with DKA at diagnosis



C. Patients without DKA at diagnosis



Conclusions

There is a linear correlation between A1c and TIR in pediatric patients. CGM TIR decreased by 10.6 percentage points for each 1 percentage point increase in A1c, which is equivalent to 152 fewer minutes per day within the ideal range. This is comparable to previous studies in adult patients (4).

We found no relationship between A1c and age or whether the patient had DKA at the time of initial diagnosis of diabetes (6).

Benefits of TIR:
- Calculated from CGM data (does not require blood).
- Often measured over 2 weeks, allowing for more frequent adjustment of diabetes care regimens, but could be measured over multiple different time periods.
- Can be assessed from home (with access to relevant software and/or the internet).

Drawbacks to TIR:
- Some patients do not use CGM or do so intermittently.
- A 14-day lookback period may not be representative of a patient's long-term glycemic control.

Limitations:
- Retrospective, single-center design.
- This cohort of patients has a high level of glycemic control (average A1c 7.9%), which may make these results less generalizable because CGM use is correlated with improved A1c (5).

This study demonstrates that A1c is correlated with CGM TIR in children and is not affected by age or the presence of DKA at diagnosis. **The consistent relationship between TIR and A1c suggests that it is appropriate to use TIR in conjunction with A1c to facilitate fine-tuning of glycemic control.**

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Conflict of Interest: *GPF conducts research sponsored by Medtronic, Dexcom, Abbott, Tandem, Insulet, Lilly, and Beta Bionics and has been a speaker/consultant/advisory board member for Medtronic, Dexcom, Abbott, Tandem, Insulet, Lilly, and Beta Bionics. RF, AS, and GTA have no conflicts of interest to report.*

Ethics Approval: This study was approved by the Colorado Multiple Institutional Review Board (20-2686).