UCSF Benioff Children's Hospitals

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University of California San Francisco

CGM Use In Children With Type 2 Diabetes

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Disclosures

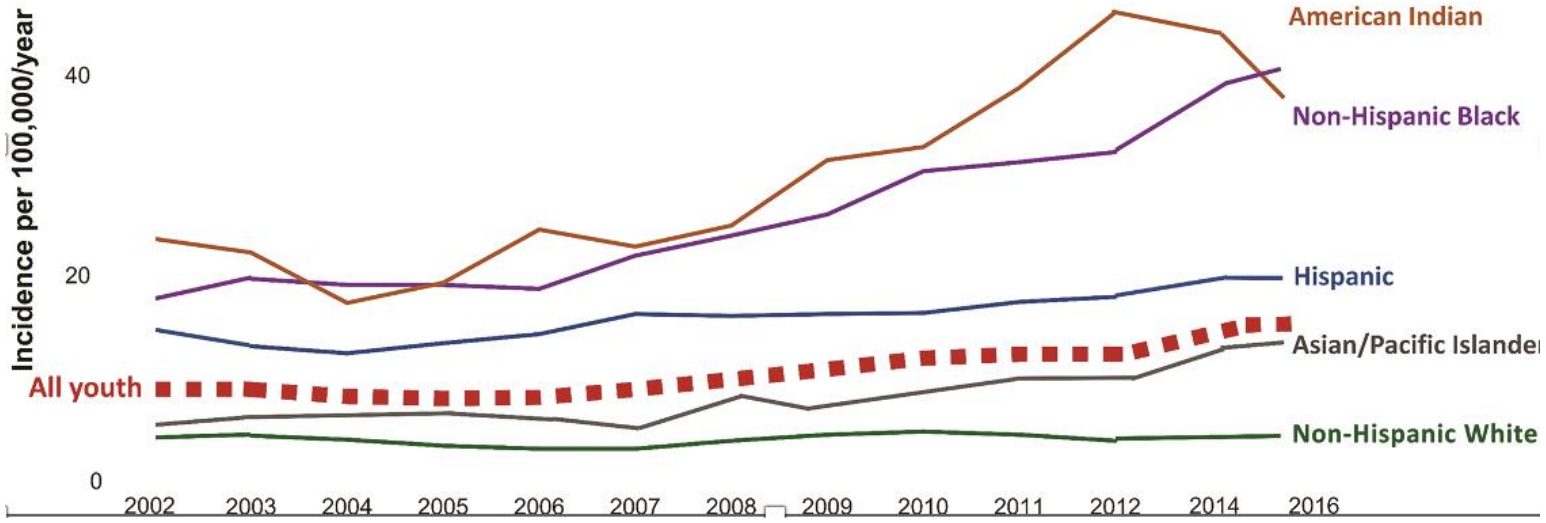
COMPANY / NAME	HONORARIA / EXPENSE	CONSULTING / ADVISORY BOARD	FUNDED RESEARCH
MEDTRONIC		✓	✓
MANNKIND			✓
Abbot			✓
NIH			✓
JDRF			✓
TANDEM DIABETES CARE		✓	
YPSOMED		✓	
INSULET	✓		
SEQUEL		✓	
JAEB		✓	
DIABETES CENTER BERNE		✓	

Outlines

- What do we know about CGM use in adults with Type 2 Diabetes?
- What do we know about CGM use in youth with Type 2 Diabetes?
- UCSF clinical trials in children with Type 2 Diabetes
- Future directions?

Epidemiology of Type 2 Diabetes (T2D) in Children

- Incidence of Type 2 Diabetes in Children: awakening epidemic
- Across all racial and ethnic groups, the prevalence of type 2 diabetes increased with age
- Aggressive disease course with increased risk of complications compared to adults with T2D and youth with type 1 diabetes (T1D)



Perng, Diabetes Care, 2023

Lawrence, JM, JAMA, 2021

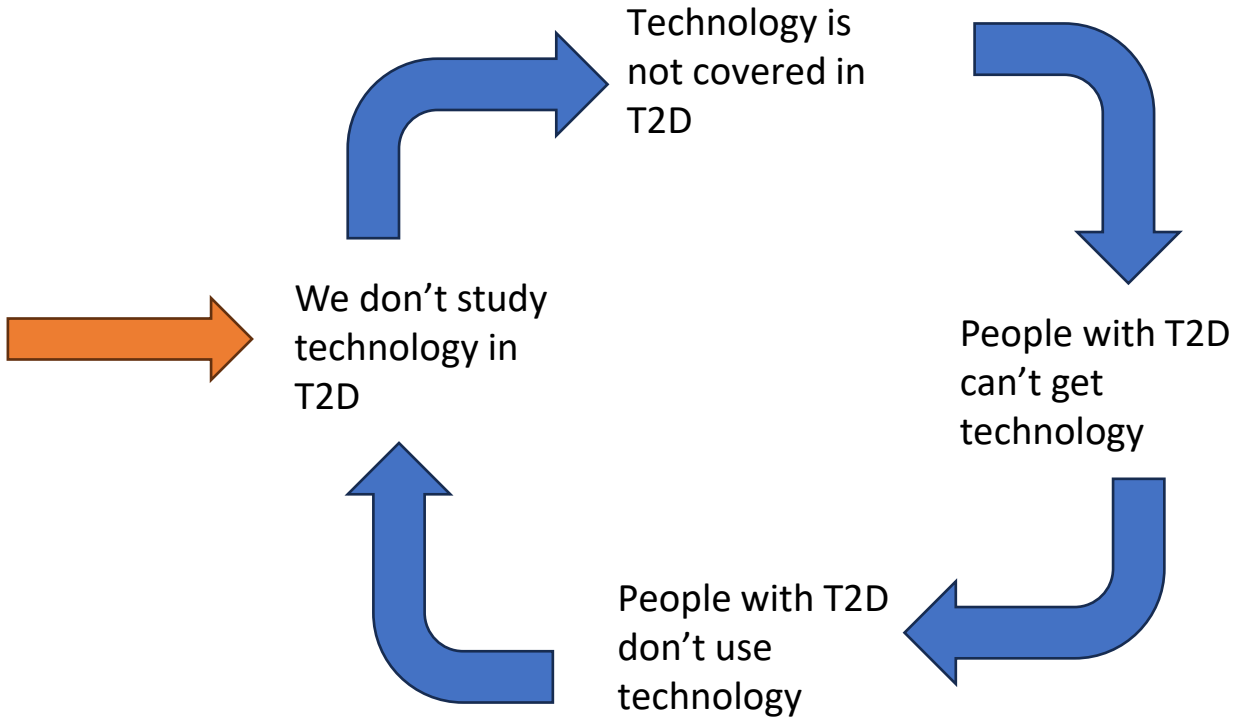
Today Study, NEJM, 2021

Professional Society Guidelines

Organization	Clinical guideline	Recommendation for people with T2D
CGM		
Endocrine Society 2018 [64]	Advances in Glucose Monitoring and Automated Insulin Delivery Systems: Supplement to Guidelines in 2016	Short-term intermittent CGM in people with T2D who have HbA1c > 7%
AACE 2021 [65]	Use of Advanced Technology in the Management of Persons with Diabetes Mellitus	CGM strongly recommended for all persons with diabetes treated with MDI (3 or more injections per day) or insulin pump CGM is recommended for individuals with problematic hypoglycemia Pregnant women treated with MDI CGM may be recommended for individuals with T2D who are treated with less intensive insulin therapy
AACE 2022 [66]	Diabetes Mellitus Comprehensive Care Plan	All persons using insulin should use CGM CGM is recommended for persons with T2D who are treated with insulin therapy or have high risk for hypoglycemia
ADA 2023 [67••]	Standards of Care	Adults using multiple daily injections (MDI) or continuous subcutaneous insulin infusion (CSII) Adults with diabetes on basal insulin Periodic use of CGM
AACE 2023 [68••]	T2D Algorithm	In people with T2D on basal insulin, CGM is associated with increased time-in-range, improved HbA1c, and decreased hypoglycemia Diagnostic or professional CGM can be used for new T2D diagnosis and for those with hypoglycemia
Connected pens		
AACE 2021 [65]	Use of Advanced Technology in the Management of Persons with Diabetes Mellitus	Connected pens may be recommended for all persons with diabetes treated with MDI or on insulin pump therapy
ADA 2023 [67••]	Standards of Care	Connected insulin pens can be helpful Insulin dose calculator or decision support systems may be helpful for titrating doses
Insulin pump or AIDs		
Endocrine Society 2018 [64]	Advances in Glucose Monitoring and Automated Insulin Delivery Systems: Supplement to Guidelines in 2016	Suggest CSII in people with T2D who have poor glycemic control despite intensive insulin therapy, oral agents, other injectable therapy and lifestyle modifications
AACE 2021 [65]	Use of Advanced Technology in the Management of Persons with Diabetes Mellitus	Insulin pump with CGM or SAP is recommended for persons with diabetes treated with MDI who prefer not to use AIDs
ADA 2023 [67••]	Standards of Care	Insulin pump therapy should be offered to youth and adults capable of using the device safely

Agarwal, Current Diabetes Reports, 2024

History of Technology (CSII, CGM, AID) for T2D



Courtesy of Gregory Forlenza, MD.

Glucose Dysregulation

- The dawn phenomenon
- Postprandial Glucose excursion
- Risk of hypoglycemia
- Glycemic variability

CGM use

- Can retrospectively review data to make lifestyle changes or medication adjustments.
- Could be a personal tool for behavior modification in T2D.
- Teenagers enjoy using technology

Ajjan, NatureReviews, 2024

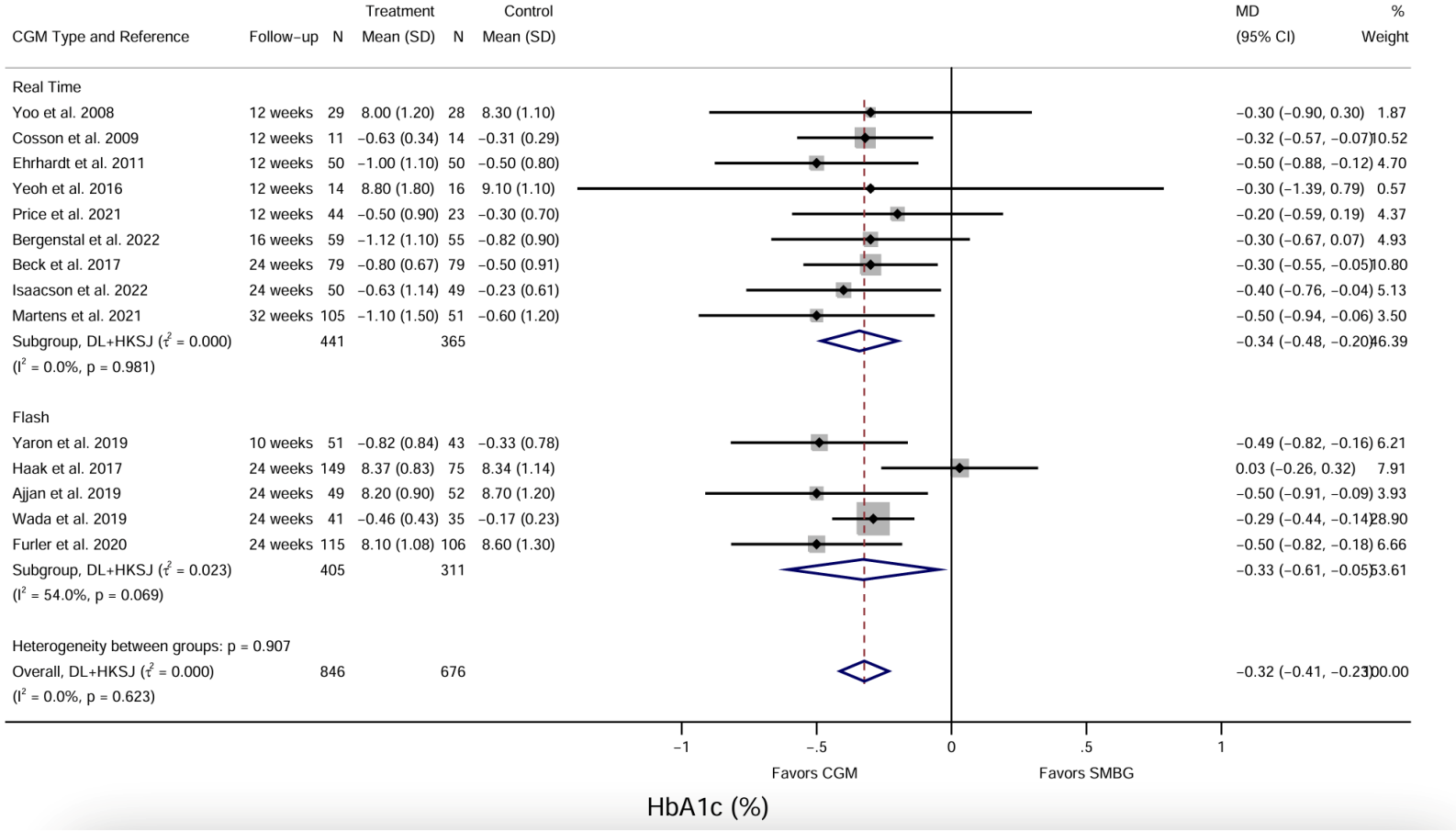
Effectiveness of CGM
in adults with Type 2 Diabetes

Key studies in CGM and T2 Diabetes

Author (year)	Type of study	Number of participants	Treatment	Participant age (years) at study start	Glycaemic status (HbA_{1c} (%)) at study start	CGM sensor	Study Period
Riveline et al. (2022)[135]	Retrospective	41,027	Any	18–99	–	FreeStyle Libre	2 years
Guerci et al. (2023)[65]	Retrospective	5,933	Basal insulin	18–99	–	FreeStyle Libre	2 years
Ajjan et al. (2023)[196]	RCT	141	Insulin or sulfonylurea	Adults with AMI		FreeStyle Libre	90 days
Chesser et al. (2022)[81]	Single-arm interventional	9	Any	13–21	Mean 11.9	Dexcom G6	12 weeks
Aronson et al. (2023)[110]	RCT	116	Non-insulin	≥18	Mean 8.6	FreeStyle Libre	16 weeks
Manfredo et al. (2023)[155]	Prospective interventional	41	Insulin	Median 16.2 (youth)	Mean 10.3	Dexcom G6	10 days
Chang et al. (2023)[156]	Crossover RCT	9	Insulin	15–19	Mean 11.5	Dexcom G6	3 months

Ajjan, nature Reviews, 2024

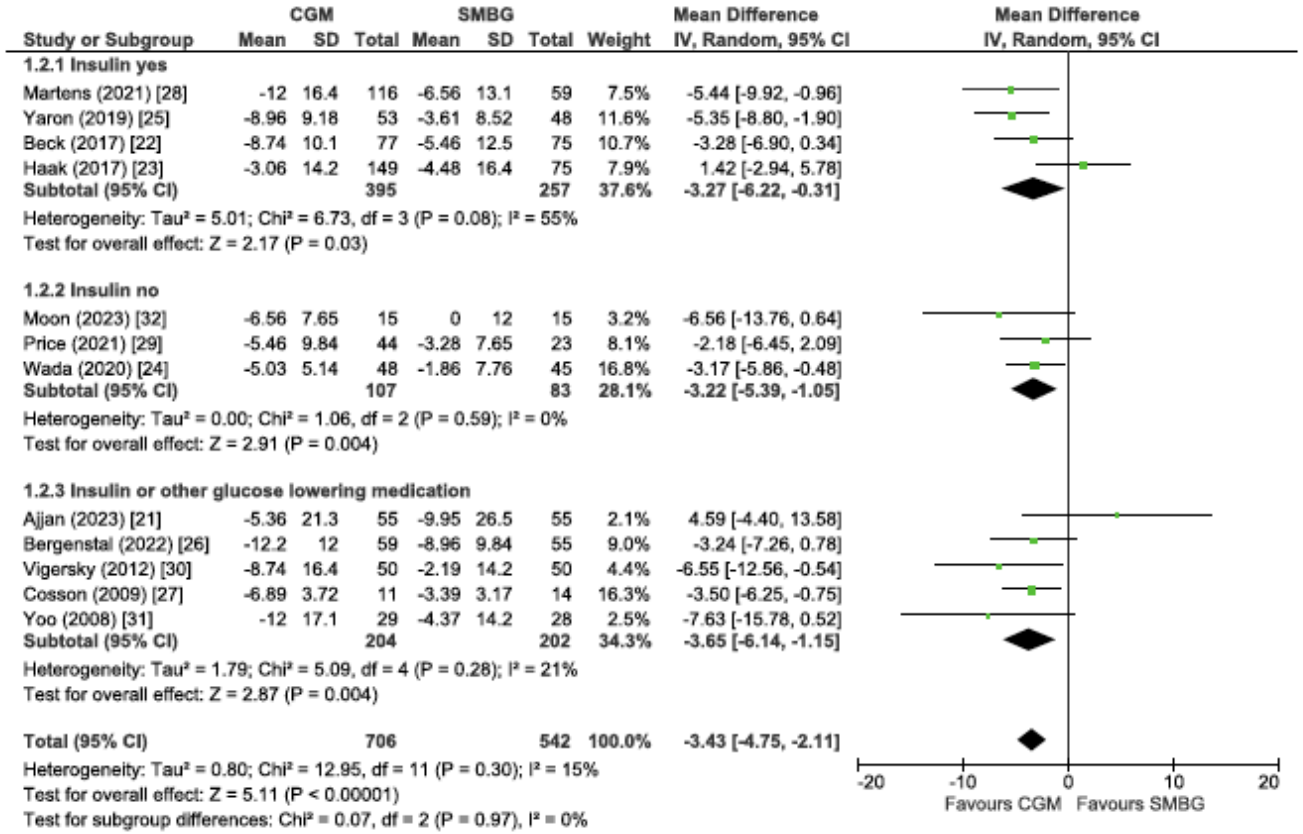
CGM led to modest but statistically significant declines in HbA1c, with little heterogeneity in the results.



Fourteen RCTs assessing CGM were included
with 825 patients in 9 RCTs using rt-CGM and 822 in 5 RCTs using FGM

Ehl, JCEM, 2024

CGM led to a mean difference (MD) in HbA1c of −3.43 mmol/mol (−0.31%)p<0.00001



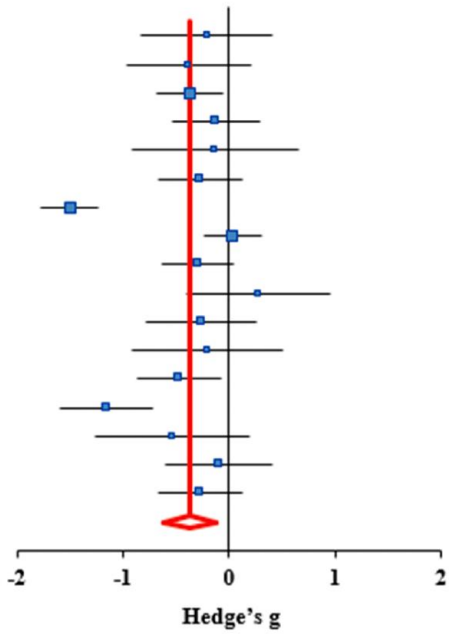
12 RCTs comprising 1248 participants.

eight investigating rtCGM and four isCGM. Compared with SMBG, CGM use (rtCGM or isCGM)

Jancev, Diabetelogia, 2024

CGM decreases HbA_{1c} (*−0.37, p < 0.001)*

Study ID	N	ES (hg)	95% CI Lower Limit	95% CI Upper Limit	Weight
1	43	−0.21	−0.84	0.42	5.2%
2	46	−0.38	−0.97	0.20	5.4%
3	158	−0.37	−0.69	−0.06	6.8%
4	88	−0.12	−0.54	0.30	6.3%
5	25	−0.13	−0.92	0.66	4.4%
6	100	−0.27	−0.67	0.12	6.4%
7	267	−1.50	−1.77	−1.23	7.0%
8	224	0.03	−0.25	0.31	6.9%
9	156	−0.29	−0.63	0.04	6.7%
10	34	0.28	−0.40	0.95	4.9%
11	57	−0.26	−0.78	0.26	5.8%
12	30	−0.20	−0.92	0.51	4.7%
13	101	−0.47	−0.87	−0.07	6.4%
14	93	−1.15	−1.59	−0.71	6.2%
15	30	−0.54	−1.27	0.19	4.7%
16	67	−0.09	−0.60	0.41	5.8%
17	100	−0.27	−0.67	0.12	6.4%
Total	1619	−0.37	−0.63	−0.11	100%

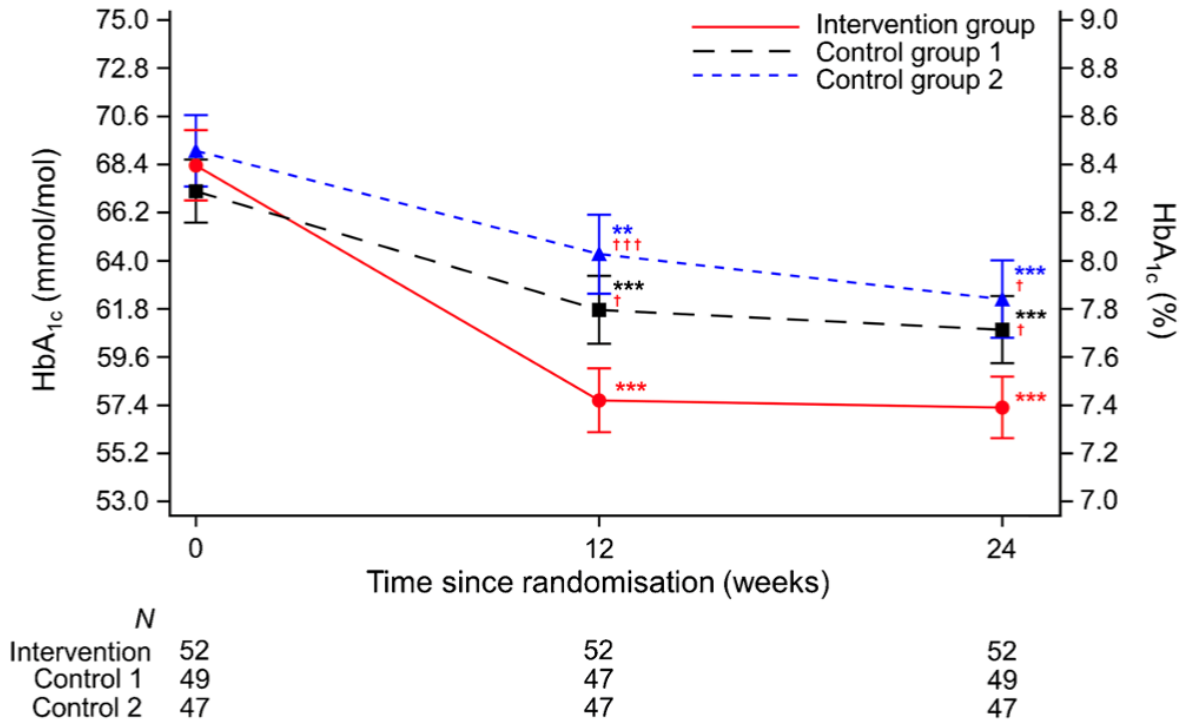


Heterogeneity: Q = 92.35, Q-df = 74.35,
I^2 = 82.7%, t^2 = 0.23, (p<0.001)

17 RCT, 1619 patients

King, Health Care, 2024

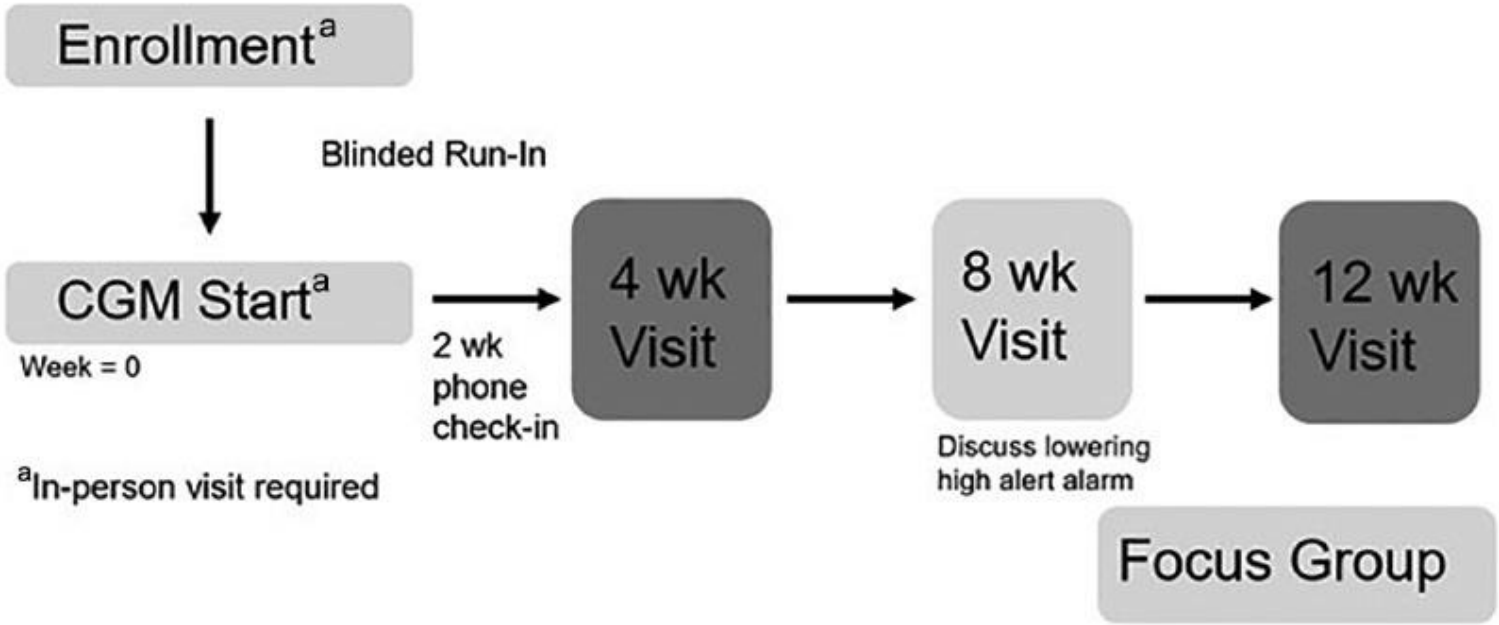
isCGM offers a greater reduction in HbA_{1c} when education on the interpretation of graphical patterns in CGM is provided



24 week randomized open-label multicenter trial, adults with type 2 diabetes

Kim, Diabetologia, 2024

Real-Time CGM in Adolescents and Young Adults With Type 2 Diabetes Can Improve Quality of Life **(SOY-T2 Study)**



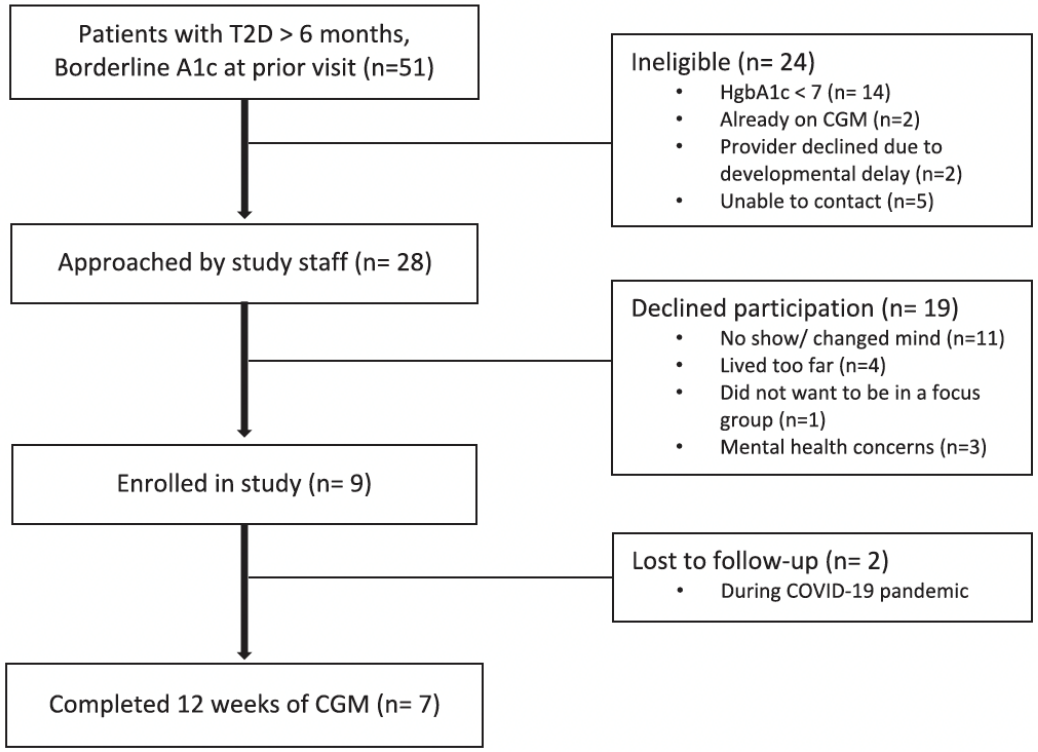
Chesser, JDST, 2022

Population

Participants recruited for UCSF Madison Clinic for Pediatric Diabetes

- **Inclusion Criteria:**
  - Ages: 13 - 21 yo
  - T2DM ≥ 6 months
  - No diabetes medications added or discontinued in prior 4 weeks
  - HgbA1c > 7.0%
  - All FDA approved medication regimens included (lifestyle alone, metformin, victoza, daily basal insulin, and/or short acting insulin)
- **Exclusion Criteria:**
  - No personal smart phone
  - Non-English or Spanish speaker

Consort Diagram

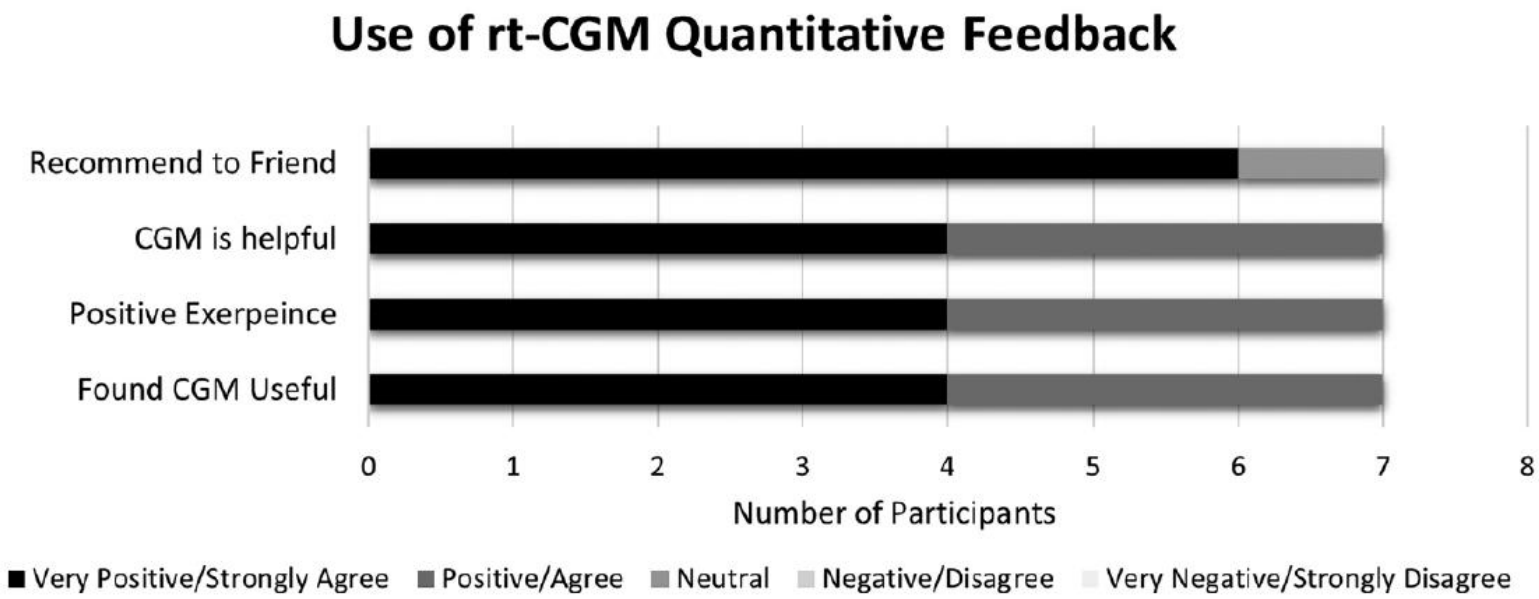


Recruitment challenges

n=9	
Median age (years)	19.1 [16.8, 20.5]
Female gender	78%
T2D characteristics	
Median duration of diabetes (y)	2.5 [1.4, 6.0]
Mean baseline A1c (%)	11.9 ± 2.8
Mean baseline TIR (%)	16 ± 14
Using insulin	67%
Public insurance	67%
Race and Ethnicity	
Hispanic/Latinx	44%
Non-Hispanic Black	44%
Asian/Pacific Islander	33%
Parent with some college education	33%

Chesser, JDST, 2022

Quantitative feedback



Focus Group/Feedback

"It was something different. I never thought there was something like that that I could get. I always thought I would have to prick my fingers."

"Seeing my numbers made me think about what I was putting in my body."

"It is life changing."

"I worried about everything [at first]. I was so scared to stick myself with the tiny plastic needle. I worked myself up [...] But, it got quicker every time I did it."

"I want to see my numbers change. I want to make them different."

Courtsey of Hanna Chesser

CGM is both feasible and acceptable

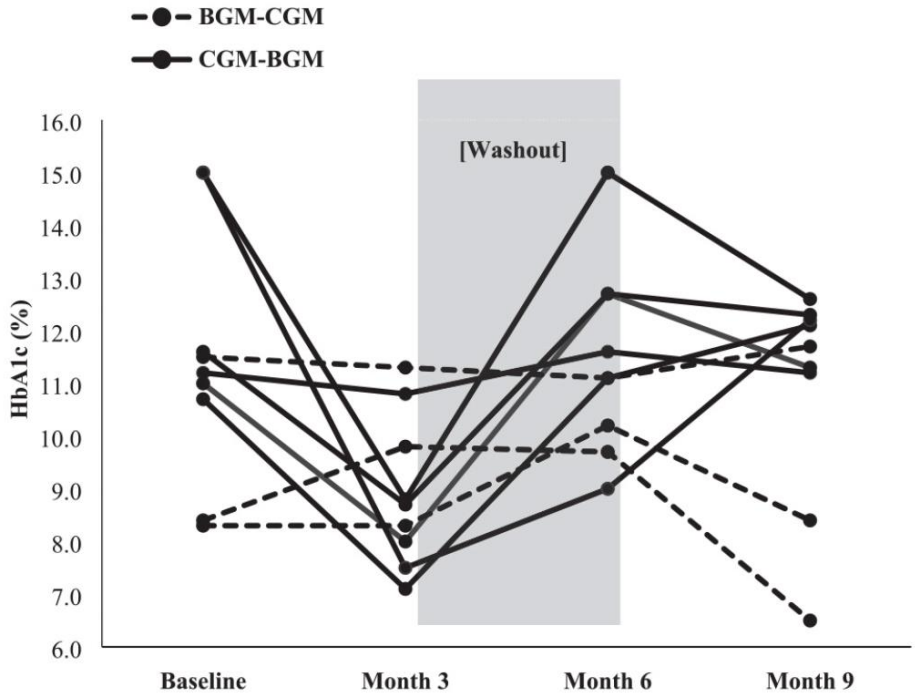
- All participants reported using the CGM
- There was a significant increase in the PedsQL diabetes score (70-75, *P*=0.0263)
- On a satisfaction survey (n=7), 100% had a positive experience with CGM, found it easy to use, useful, and desired to continue to use CGM in the future
- 67% self-reported eating fewer meals while using CGM

Courtsey of Hanna Chesser,
Chesser et al., Diabetes 1 June 2021; 70 (Supplement_1): 900–Poster

CGM in adolescents with Type 2

Pilot RT cross over

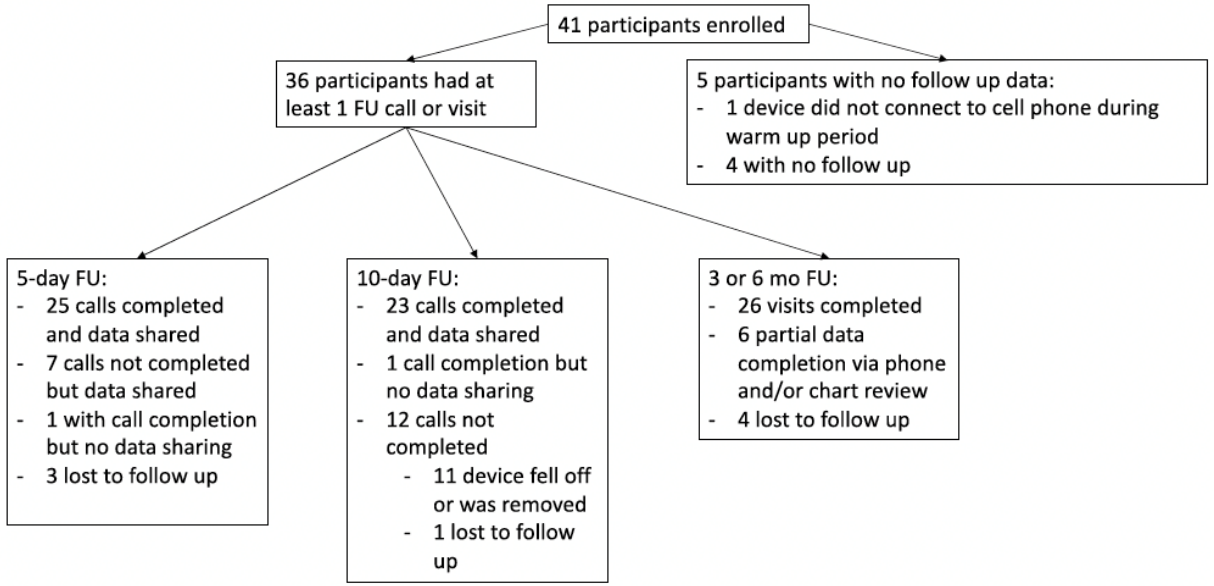
- 9 adolescents, majority Latinx
- Randomzied to Dexcom G6 or BGM followed by 3 months wash out period and then crossed over to the other arm



Chang, JDST, 2023

Short term use of CGM >> behavioral modifications

- Participants (n=41) had median age of 16.2 y



- 10-day CGM use did not impact short-term or long-term glycemic control in youth with T2D

- Most participants reported behavioral changes and wanted to continue using CGM

Manfredo, Front Endcocrinol, 2023

Barriers and Facilitators to CGM uptake

- 20 AYAs and 10 parents: 35% used CGM
- Average age 16.5 yo
- 65% female and 55% from minorities background

Semi structured interview

Lifestyle

CGM users

Getting started on CGM
Education
Diabetes management
Opinion
What care givers should know

Non CGM users

Prior knowledge
Decision making
Education
Potential lifestyle changes

Peyetty, *The Science of Diabetes Self-Management and Care*,2024

Benefits vs Barriers

BENEFIT

Convenience vs Fingersticks

POTENTIAL BARRIERS

Physical and Auditory

Youth Privacy, Autonomy

Education About Use

Ongoing study at UCSF:

Feasibility Of The Freestyle Libre Continuous Glucose Monitoring System In Youth With Type 2 Diabetes (FREE-CGM)

Objectives:

- To investigate the acceptability, appropriateness, and feasibility of CGM use in youth with T2D
- To determine the effect size of CGM on glycemic control-related measures in youth with T2D
- To evaluate the effect of CGM use on behavioral and psychosocial outcomes in youth with T2D

Study Design

6-month pilot randomized controlled feasibility study of CGM use compared to standard glucose monitoring

Inclusion criteria

- Age < 21 years
- Clinical diagnosis of T2D
- Duration of T2D ≥ 3 months
- HbA1C ≥ 6.5%
- Stable medication regimen (No medication changes and no change in basal insulin dose by more than 20% in the 2 weeks prior to enrollment)
- Naïve to CGM use
- Has a smart phone compatible with CGM system

Evidence for AID in Type 2 Diabetes

Table. AID RCTs in T2D					
Study	**System**	**Duration of AID**	**Control Group**	**Target Range**	**Time in target improvement**
Kumareswaran 2014	Hovorka	24h	Usual Care	70-144	+16% (40 v 24%)
Thabit 2017	Hovorka	72h	Conventional SQ	100-180	+21.8% (59.8 v 38.1%)
Bally 2018	Hovorka	up to 15d	Conventional SQ	100-180	+24.3% (65.8 v 41.5%)
Taleb 2019	Haidar	24h	MDI	72-180	+23% Overnight (100 v 78%)
Boughton 2021	Hovorka	20d	MDI	100-180	+15.1% (52.8 v 37.7%)
Peters 2022	OP5	8 wk	MDI	70-180	+15.1% (52.8 v 37.7%)

Courtesy of Greg Forlenza, MD.

Future Directions

- More and larger studies: randomized controlled trials, real-world studies, and studies with patient-reported outcome measures.
- The Cost Effectiveness of Use of CGM in youth with type 2 diabetes (MDI, CSII, basal insulin, no insulin, and prediabetes)
- The correlation between the use of CGM and treatment plan and change in plan
- Correlation with behavioral modifications
- CGM use in new-onset Type 2 Diabetes
- Inpatient use of CGM in Type 2 Diabetes

Ajjan, nature Reviews, 2024

Acknowledgment

- Study participants and their families
- Srinivasan, Shylaja, MD.
- Chesser, Hannah, MD.
- Wong, Jenise, MD., PhD.
- UCSF Diabetes Technology Research Group