Trend of Diabetes-Related Hospital Admissions During the Transition Period From Adolescence to Adulthood in the State of California

Angel Siu Ying Nip[1] and Maya Lodish[1,2]

Diabetes Care 2021;44:2723–2728 | https://doi.org/10.2337/dc21-0555

OBJECTIVE

This study examined the incidence of diabetes-related hospital admissions and described the characteristics among youth and emerging adults with type 1 (T1D) and type 2 diabetes (T2D) in California.

RESEARCH DESIGN AND METHODS

A retrospective study was conducted using the statewide inpatient database during the years 2014–2018. Individuals aged 13–24 years hospitalized with diabetic ketoacidosis (DKA) or severe hypoglycemia (SH) were recorded. Demographic characteristics and health measures among youth (ages 13–18) and young adults (ages 19–24) were compared.

RESULTS

A total of 34,749 admission encounters for T1D and 3,304 for T2D were analyzed. Hospitalization rates significantly increased with age during the transition to adulthood, from 70/100,000 California population at age 17 to 132/100,000 at age 19 in T1D. Higher hospitalization rates were demonstrated in young adults than in youth in T1D, and the rate was significantly higher in Black young adults (23.9%) than in youth (12.0%) among the age-adjusted population with diabetes ($P < 0.0001$). More young adults admitted were on public insurance, and approximately half were from the lowest income quartile. No difference was observed in hospital length of stay; however, hospital charges were higher among young adults. Young adults were three times more likely to be admitted for severe conditions.

CONCLUSIONS

We demonstrated a significant rise in hospital admission during the transition period in individuals with T1D. There were significantly more Black young adults who were on public insurance and had lower socioeconomic status. Our findings suggest that the health care system fails many emerging adults with diabetes, particularly for people of color, and that improving medical transition is crucial.

As adolescents with diabetes transition to adulthood, they may demonstrate poorer adherence to treatment regimens and may be vulnerable to complications such as

[1]Department of Pediatrics, University of California, San Francisco, San Francisco, CA
[2]Division of Pediatric Endocrinology, University of California, San Francisco, San Francisco, CA

Corresponding author: Angel Siu Ying Nip, siuying.nip@ucsf.edu

Received 11 March 2021 and accepted 25 September 2021

This article contains supplementary material online at https://doi.org/10.2337/figshare.16689349

This article is featured in a podcast available at https://www.diabetesjournals.org/content/diabetes-core-update-podcasts.

diabetic ketoacidosis (DKA) or severe hypoglycemia (SH). The Type 1 Diabetes (T1D) Exchange Clinic Registry revealed that only 17% of adolescents (ages 13–17) and 14% of emerging adults (ages 18–25) are currently reaching American Diabetes Association (ADA)-recommended HbA_{1c} targets (1). DKA is a diabetes emergency associated with high morbidity and mortality (2). It is a hallmark of T1D but is increasingly recognized in patients with type 2 diabetes (T2D). The U.S. Centers for Disease Control and Prevention (CDC) reported that age-adjusted hospitalizations for DKA among children and adults decreased 1.1% per year from 2000 to 2009 but increased 6.3% per year from 2009 onward in the U.S. (3). Several epidemiological studies have reported that hospitalization rates have increased worldwide, particularly in emerging adults (4,5). However, limited data are available in the state of California to study the rates of hospitalization and the characteristics among youth and young adults with both types of diabetes.

Transition to "Emerging Adulthood"

During childhood and adolescence, there is a gradual shift from diabetes care supervised by parents and other adults to self-care management. A transition period between pediatric and adult care often arises in later adolescence, and this developmental stage of life is termed "emerging adulthood" from the late teens through the 20s. There is a broad consensus that a lack of effective transition from pediatric to adult diabetes care may contribute to fragmentation in health care, decreased frequency of clinical follow-up, and adverse outcomes in young adults with diabetes. A number of important factors have been identified as risk factors for these poor outcomes during emerging adulthood, including loss of health insurance coverage, increased risk-taking behaviors, and difficulty coping with added responsibilities (6,7).

There are often gaps in health insurance during this period, and lack of access to adequate health care continues to be a significant barrier for the emerging adult population, particularly in the state of California. California Children's Services (CCS) is a supplemental state medical insurance for low-income children with chronic medical conditions, including diabetes. As part of the program, children with T1D are eligible for devices such as insulin pumps and continuous glucose monitors (CGM). However, this program only supports children up to 21 years old, and additional criteria are often required to get the devices approved beyond age 21. In addition, CGMs are currently not covered by Medi-Cal, California's Medicaid program. Thus it is not unexpected to find that children and young adults of lower socioeconomic status with lack of insurance coverage consistently demonstrated lower rates of CGM usage than those of higher socioeconomic status (8).

Given that individuals in the transition period to adulthood have had the highest rates of underinsurance or uninsurance and may lose CGM coverage after aging out of CCS, the reforms to expand CGM coverage to adults on Medi-Cal should be of particular benefit to emerging adults with diabetes in California. Thus, our study aims to provide local data on hospitalization rates in emerging adults with diabetes with the goal to inform efforts to improve health outcomes and prevent complications for vulnerable young adults during this challenging transition to independence.

RESEARCH DESIGN AND METHODS

Date Sources

This was a retrospective cohort study using the inpatient database from the California Office of Statewide Health Planning and Development (OSHPD) during the years 2014–2018. Data were abstracted from facility-level utilization data on health care services from hospitals and health care facilities across the state of California. We identified all hospitalizations among individuals aged 13–24 whose primary diagnosis was DKA, hypoglycemia, or a closely related condition, such as nonketotic hyperglycemia, diabetes with hyperosmolarity, or diabetes with coma, with either T1D or T2D, using *International Classification of Diseases* (ICD) codes (Supplementary Material). These hospitalizations were referred to as "diabetes-related hospitalizations." We excluded drug-induced hyperglycemia, monogenic diabetes, and gestational diabetes.

Outcomes

Our primary outcome was the age-specific annualized diabetes-related hospitalization rates in individuals with either type of diabetes and whether there was any difference during the transition period. We averaged data for all study years. To calculate the DKA hospitalization rates, we used the estimated age-specific population in state of California as the denominator. We also estimated the age-specific population by race to calculate the race-specific hospitalization rates. Population data were collected from the U.S. Census Bureau, Population and Housing Unit Estimates in 2018 (9). In addition, we extrapolated the estimated age-specific numbers of patients with T1D in California from the ADA and the CDC to calculate the rates of hospitalization among the population with T1D (10,11). However, T2D data in youth were not available from existing national databases.

We defined two subgroups, youth (ages 13–18) and young adult (ages 19–24) in this cohort study. We calculated the diabetes-related hospitalization rates and evaluated the differences in demographic characteristics between the two groups. As a proxy for socioeconomic status, we used the median income of the patient's ZIP code of residence (categorized into quartiles) and insurance type (public vs. private). ZIP code–estimated incomes were based on the American Community Survey (ACS) in 2016 (9). Patients were categorized based on the ICD codes into three disease severities: mild, moderate, and severe. Uncomplicated DKA or hypoglycemia was categorized as mild disease, and DKA with uncontrolled diabetes or with complications was categorized as moderate disease. Severe disease was defined as the presence of coma or need for intensive care.

No patients were involved in setting the research questions, in developing plans for design, interpretation, or implementation of the study. There were no plans to disseminate the results of the research to patient communities. Data were deidentified, and the study was deemed exempt from review by the University of California, San Francisco Institutional Review Board.

Statistical Analysis

Demographic characteristics in the study are summarized using descriptive statistics. Sociodemographic characteristics were compared by using χ^2 test for categorical variables and the *t* test for continuous variable for each diabetes type. We used two age categories: 13–18 years (youth) and 19–25 years (young adults). All analyses were performed separately for T1D and T2D, with a significance level of $P < 0.05$.

RESULTS

We identified and analyzed 38,053 hospital admission encounters in both youth and young adults with DKA or SH in California between years 2014 and 2018. There were 34,749 encounters for T1D and 3,304 for T2D. Mean ages were 17.3 ± 4.6 years in T1D and 17.9 ± 4.6 years in T2D. Males made up a larger percentage of those hospitalized with T2D than females (56.1%), whereas those with admitted with T1D were a slightly more likely to be female (53.1%). Youth and young adults admitted with T2D were disproportionately of Hispanic ethnicity compared with those with T1D (57.5% vs. 39.3%). A larger share of admitted youths and young adults (74.3%) with T2D resided in lower-income ZIP codes compared with ∼40% in T1D.

The diabetes-related hospitalization rates increased steadily with age, with a significant rise during the transition to adulthood, from 70/100,000 California population at age 17, increasing to 132/100,000 at age 19 in T1D (Fig. 1). Based on the age-specific diabetes population, the rates of hospital admission were 22.9/100 at age 17 and almost doubled to 43/100 at age 19 (Fig. 2). In contrast, the diabetes-related hospitalization rates by age for the T2D population remained similar during the transition period, ∼11/100,000 California population at age 17 to 10/100,000 at age 19, and rose slightly to 13/100,000 at age 23.

For both types of diabetes, we demonstrated higher hospitalization rates in young adults than in youth. Although the White population predominated in our cohort, there were disproportionately higher hospital admission rates in non-White minorities in both youth and young adults with T1D. Among the T1D population in California, there were 23.9 Black young adults and 3.4 White young adults per 100 hospital admissions admitted over the study years. This pattern was similar among the youth group (12.0 Black vs. 1.8 White per 100 hospital admissions). We observed that the rates of hospital admission were significantly higher in Black young adults than in Black youth (23.0 and 12.0 per 100 hospital admissions, respectively) among the age- and race-adjusted population with diabetes ($P < 0.0001$). More young adults were on public insurance, 65.0 young adults versus 45.1 youth per 100 hospital admissions in T1D. A similar trend was seen in T2D, with 50.4 youth rising to 68.0 young adults per 100 hospital admissions ($P < 0.0001$). The percentage of young adults without insurance was five times higher than youth in T2D. Diabetes-related hospitalizations were more frequent in lower-income ZIP codes and ∼41.6 and 48.8 cases per 100 hospital admissions were from the lowest income quartile in T1D and T2D, respectively (Table 1).

Individuals with diabetes-related hospitalization did have worse outcomes and higher financial burdens. We observed that more young adults were admitted for moderate or severe conditions with coma than youth in both T1D and T2D. In T1D, there were 78.8 moderate or severe cases per 100 hospital admissions among young adults and 71.0 cases among youth. On the other hand, we observed 79.0 moderate or severe cases per 100 hospital admissions among young adults, which was double the number among youth in T2D (30.7 cases per 100 hospital admission). The hospitalization rates of severe DKA increased with age in T1D and significantly increased from 3 in 100,000 at age 17 to 12 in 100,000 population at age 19 ($P < 0.0001$). However, no difference was observed in the population with T2D. Only a small number of cases were admitted for severe hypoglycemia in T1D in our cohort. Mean hospital length of stay was similar between both types of diabetes; however, the hospital charges per visit were significantly higher among young adults in both T1D ($41,370 in young adults vs. $36,160 in youth) and T2D ($37,218 in young adults vs. $30,991 in youth, $P <$ 0.0001).

CONCLUSIONS

Diabetes-related hospitalization rates increased with age during emerging adulthood in the state of California. Particularly, the rates of hospitalization were higher among transitioning young adults of color, who were more likely to be publicly insured and reside in low-income ZIP codes in both T1D and T2D populations. The disparity widened after age 18, implicating socioeconomic factors as important contributors to the rising trend.

Based on the statewide data, we found the difference in diabetes prevalence was less likely to explain the differences in diabetes-related hospitalization we observed. In 2016, the prevalence of adults diagnosed with T1D was 0.55% and that of T2D was 8.6%. Approximately 0.25% of Americans younger than age 20 are estimated to have a diagnosis of diabetes of either type (12–15). The peak incidence of new-onset T1D usually occurred in children between 4 and 7 years and in youth ages 10–14 years. In our cohort, we observed a rapid increase during the transitioning period, which then became steady in the mid-20s, a pattern that

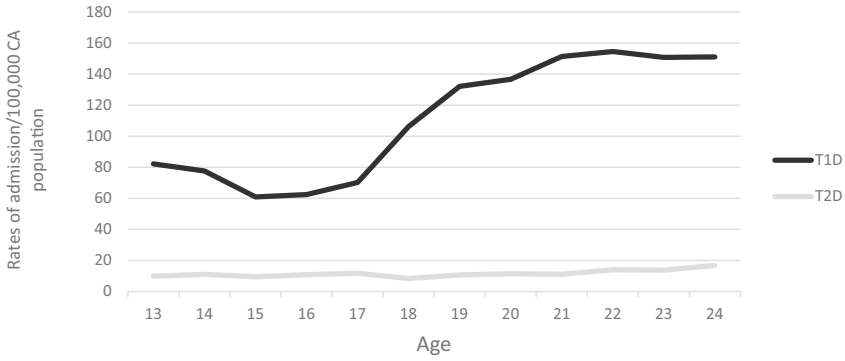

Figure 1—Diabetes-related hospitalization rates by age among the California population.

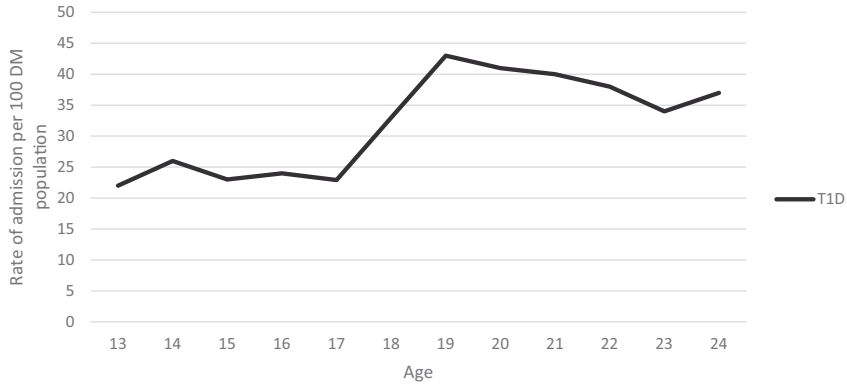

Figure 2—Diabetes-related hospitalization rates by age among the T1D population. DM, diabetes mellitus.

could not be explained by the incidence of new-onset diabetes diagnoses.

One possible reason for the rising hospitalization during the transitioning period was that emerging adults in California lacked effective transition from pediatric to adult diabetes care and frequently underwent health insurance changes, resulting in changes of care providers (pediatric vs. adult), decreased frequency of clinical follow-up, or even loss of insurance after transitioning into adulthood (16). Studies demonstrated that a large proportion of youth and young adults with T1D experienced substantial barriers (e.g., access to care, not having a regular provider, and not receiving contextual care [care that takes into account personal and family context]) (17,18). Youth and young adults often age out from their parental insurances and CCS coverage, which might contribute to the sharp rise in diabetes-related hospitalization. Underinsurance reduces the use of diabetic specialty care, and underinsured patients are more likely to visit the emergency department for diabetes-related complications. In addition, high prescription drugs costs may reduce insulin adherence and even lead to discontinuation of insulin therapy. An increasing number of studies have shown that use of technology devices, such as pump and CGM, are significantly impacted by the insurance types (19,20).

Data from the adult and pediatric populations show that CGM use has been associated with a reduction in HbA_{1c} levels and a significant reduction in time spent in hypoglycemia. The availability of real-time CGM data allows the individual or caregiver to be aware of dangerously high or low blood glucose levels and adjust diet and medications to avert adverse hyperglycemic or hypoglycemic events (21). The ADA stated the CGM are essential tools to assess therapy and detect incipient hypoglycemia and modified its recommended age range from prescribing CGM from 25 years of age to starting at age 18 years in 2018 (22). Studies revealed a CGM dose-dependent improvement in HbA_{1c} across all age groups, including adolescents and emerging adults, demonstrating the effectiveness of this technology in those who use it consistently (23–25). In addition, CGM nearly eliminates the need for finger sticks and has been shown to be superior to self-monitoring of blood glucoses. As part of the CCS program, children and young adults with T1D are eligible for technology devices. However, young adults are at risk for losing coverage once they age out of CCS coverage. Those devices are not covered under Medi-Cal and only some under Medicaid after the Affordable Care Act. Last year, the bill to add CGM and related supplies to the schedule of Medi-Cal benefits for diabetes treatment was vetoed by Governor Gavin Newsom due to costs to the General Fund (26). Other studies have shown that individuals with lower socioeconomic status and lack of insurance coverage consistently demonstrated lower rates of CGM use than those of higher socioeconomic status (8). Furthermore, studies reported that the use of technology among Caucasians is higher than its use in other racial and ethnic groups, particularly African Americans (20,27–29,). We speculate the low CGM coverage for all people with diabetes under public insurance is related to the potential high cost purchasing all of the supplies. However, it may not be actually cost-effective, because the cost of diabetes supplies, such as CGMs, account for only 1.1% of the total cost of diabetes, while the costs of treating complications and lost productivity accounts for 73.1% of total diabetes costs (30). Both expenses can actually be reduced with widespread CGM use. Thus, CGMs should not be the focus of cost-cutting efforts.

To our knowledge, this is the first study with a large sample size looking at diabetes-related hospitalization rates in youth and young adults in California. There were a few limitations of the study. We based the type of diabetes classification on the reported ICD codes, which might have the possibility of

Table 1—Characteristics of youth and young adults in T1D and T2D

	T1D			T2D		
Characteristics	Youth	Young adults	*P* value	Youth	Young adults	*P* value
Age, years	15.8	21.6		15.6	21.8	
Sex, % female	54.1	53.0	0.1018	47.7	41.0	0.0003
Ethnicity and race, %						
Hispanic	40.1	47.0	<0.0001	64.1	52.6	<0.0001
Non-Hispanic, White	36.0	37.6		12.7	21.3	
Non-Hispanic, Black	14.2	15.6		11.9	18.2	
Income quartile, %						
<25th	40.0	41.6	<0.0001	47.1	48.8	<0.0001
25–50th	25.1	26.4		25.5	26.8	
50–75th	20.5	18.5		18.0	15.3	
>75th	13.8	10.1		9.2	6.1	
Insurance types, %						
Public	45.1	64.0	<0.0001	50.4	68.4	<0.0001
Commercial	35.7	29.0		22.5	22.5	
Self-pay	1.6	2.4		0.8	4.1	
Others	17.6	4.6		26.3	5.0	

inaccurate or miscoding. In addition, we only captured the numbers of hospital encounters rather than the numbers of patients, which meant that one patient might have multiple admissions. Thus, we might overestimate the rates of diabetes-related hospitalizations. However, we believed that given such a large sample size, the differences would be less significant.

Second, we were not able to exclude admission for a new-onset diagnosis due to the limitation of the diagnostic codes. Thus, it might also overestimate the hospitalization rates because new-onset T1D often presents in DKA. However, national data demonstrated that the peak incidence of new-onset T1D usually occurred in children and youth ages 4–14 years (10,31). Our study demonstrated the highest diabetes-related hospitalization during the transition period to young adulthood, which most likely represented hospital admission for known diabetes other than a new diagnosis.

Third, individual information, such as glycemic control/HbA_{1c}, use of pumps or CGM, was not available in our cohort. We were unable to evaluate the association between glycemic control, use of technology devices, and hospital admission or to determine numbers of CGM use with and without CCS coverage. Further studies thus are warranted to specifically look at the impact on CGM use after loss of CCS. We did have large sample size for T1D; however, the sample was relatively small for T2D. It was not surprising because T2D patients had lower risk for DKA or severe hypoglycemia that required hospital admission. Further studies with larger T2D sample size are warranted. Although CCS is a California-specific public health service, there are similar public health services across the U.S. that may fail many emerging adults with diabetes in a similar way (32). Our study provided important information to support the need for improved medical transition for emerging adults with diabetes.

Conclusion

We demonstrated a significant rise in diabetes-related hospitalization rates during the transition to adulthood in individuals with T1D. Among hospitalizations in both types of diabetes, there were significantly more Black young adults who were on public insurance and had lower socioeconomic status. This population group had poorer health outcomes with a higher incidence for moderate and severe complications, and they accumulated more hospital charges than the youth population with both types of diabetes. Our findings suggest that the U.S. health care system fails many emerging adults with diabetes, particularly for people of color, and that improving the medical transition is crucial. More resources should be focused on this at-risk population from a healthcare system perspective.

Duality of Interest. No potential conflicts of interest relevant to this article were reported.
Author Contributions. A.S.Y.N. and M.L. wrote the manuscript, researched data, contributed to the discussion, and reviewed the manuscript. A.S.Y.N. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Prior Presentation. Parts of this study were presented in abstract form at the Endocrine Society ENDO 2021 virtual meeting, 20–23 March 2021.

References

1. Miller KM, Foster NC, Beck RW, et al.; T1D Exchange Clinic Network. Current state of type 1 diabetes treatment in the U.S.: updated date from the T1D Exchange Clinic Registry. Diabetes Care 2015;38:971–978
2. Realsen J, Goettle H, Chase HP. Morbidity and mortality of diabetic ketoacidosis with and without insulin pump care. Diabetes Technol Ther 2012;14:1149–1154
3. Benoit SR, Zhang Y, Geiss LS, Gregg EW, Albright A. Trends in diabetic ketoacidosis hospitalizations and in-hospital mortality – United States, 2000–2014. MMWR Morb Mortal Wkly Rep 2018;67:362–365
4. Rogers MAM, Rogers BS, Basu T. Prevalence of type 1 diabetes among people ages 19 and younger in the United States. Prev Chronic Dis 2018;15:E143
5. Dabelea D, Mayer-Davis EJ, Saydah S, et al.; SEARCH for Diabetes in Youth Study. Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. JAMA 2014;311:1778–1786
6. Neu A, Lösch-Binder M, Ehehalt S, Schweizer R, Hub R, Serra E. Follow-up of adolescents with diabetes after transition from paediatric to adult care: results of a 10-year prospective study. Exp Clin Endocrinol Diabetes 2010;118:353–355
7. Buschur EO, Glick B, Kamboj MK. Transition of care for patients with type 1 diabetes mellitus from pediatric to adult health care systems. Transl Pediatr 2017;6:373–382
8. Prahalad P, Addala A, Buckingham BA, Wilson DM, Maahs DM. Sustained continuous glucose monitor use in low-income youth with type 1 diabetes following insurance coverage supports expansion of continuous glucose monitor coverage for all. Diabetes Technol Ther 2018;20:632–634
9. United States Census Bureau. American Community Survey. American Community Survey Tables for Health Insurance Coverage. Table HIC5_ACS. Health insurance coverage status and type of coverage by state. Accessed 11 March 2021. Available from https://www.census.gov/library/publications/2020/demo/p60-271.html
10. Maahs DM, West NA, Lawrence JM, Mayer-Davis EJ. Epidemiology of type 1 diabetes. Endocrinol Metab Clin North Am 2010;39:481–497
11. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2020. Accessed 11 March 2021. Available from https://www.cdc.gov/diabetes/data/statistics-report/index.html
12. Centers for Disease Control and PRevention. National Center for Health Statistics. 2016 National Health Interview Survey (NHIS) public use date release. Atlanta, GA, US Department of Health and Human Services, CDC, National Center for Health Statistics, 2017
13. Geiss LS, Wang J, Cheng YJ, et al. Prevalence and incidence trends for diagnosed diabetes among adults aged 20 to 79 years, United States, 1980-2012. JAMA 2014;312:1218–1226
14. Dall TM, Yang W, Halder P, et al. Type 2 diabetes detection and management among insured adults. Popul Health Metr 2016;14:43
15. Klompas M, Eggleston E, McVetta J, Lazarus R, Li L, Platt R. Automated detection and classification of type 1 versus type 2 diabetes using electronic health record data. Diabetes Care 2013;36:914–921
16. Peters A; American Diabetes Association Transitions Working Group. Diabetes care for emerging adults: recommendations for transition from pediatric to adult diabetes care systems: a position statement of the American Diabetes Association, with representation by the American College of Osteopathic Family Physicians, the American Academy of Pediatrics, the American Association of Clinical Endocrinologists, the American Osteopathic Association, the Centers for Disease Control and Prevention, Children with Diabetes, The Endocrine Society, the International Society for Pediatric and Adolescent Diabetes, Juvenile Diabetes Research Foundation International, the National Diabetes Education Program, and the Pediatric Endocrine Society (formerly Lawson Wilkins Pediatric Endocrine Society). Diabetes Care 2011;34:2477–2485
17. Valenzuela JM, Seid M, Waitzfelder B, et al.; SEARCH for Diabetes in Youth Study Group. Prevalence of and disparities in barriers to care experienced by youth with type 1 diabetes. J Pediatr 2014;164:1369–75.e1
18. Pyatak EA, Sequeira PA, Whittemore R, Vigen CP, Peters AL, Weigensberg MJ. Challenges contributing to disrupted transition from paediatric to adult diabetes care in young adults with type 1 diabetes. Diabet Med 2014;31:1615–1624
19. Rogers MAM, Lee JM, Tipirneni R, Banerjee T, Kim C. Interruptions in private health insurance and outcomes in adults with type 1 diabetes: a longitudinal study. Health Aff (Millwood) 2018;37:1024–1032
20. Lai CW, Lipman TH, Willi SM, Hawkes CP. Racial and ethnic disparities in rates of continuous glucose monitor initiation and continued use in children with type 1 diabetes. Diabetes Care 2021;44:255–257

21. Bailey TS, Zisser HC, Garg SK. Reduction in hemoglobin A1C with real-time continuous glucose monitoring: results from a 12-week observational study. Diabetes Technol Ther 2007;9:203–210
22. American Diabetes Association. Professional Practice Committee: *Standards of Medical Care in Diabetes—2018*. Diabetes Care 2018;41(Suppl 1):S3–S3
23. Los E, Ulrich J, Guttmann-Bauman I. Technology use in transition-age patients with type 1 diabetes. J Diabetes Sci Technol 2016;10:662–668
24. Hinshaw L, Basu A. Technology use for problem solving in adolescent type 1 diabetes: reality and promises. Diabetes Technol Ther 2015;17:443–444
25. El Youssef J, Ward WK. Treatment challenges for the young patient with type 1 diabetes. Diabetes Technol Ther 2015;17:367–369
26. Legislative bill chart. Improving the Health of All California, October 2019. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB848
27. Sherr JL, Hermann JM, Campbell F, et al.; T1D Exchange Clinic Network, the DPV Initiative, and the National Pediatric Diabetes Audit and the Royal College of Pediatrics and Child Health registries. Use of insulin pump therapy in children and adolescents with type 1 diabetes and its impact on metabolic control: comparison of results from three large, transatlantic paediatric registries. Diabetologia 2016;59:87–91
28. Wirunsawanya K, Rizo I, Fantasia K. OR30-03 Racial differences in technology use among type 1 diabetes in a safety-net hospital. J Endocr Soc 2020;4(Suppl 1):OR30-03
29. Agarwal S, Schechter Clyde, Gonzalez J, Long JA. Racial-ethnic disparities in diabetes technology use among young adults with type 1 diabetes. Diabetes Technol Ther 2021;23:306–313
30. Anderson JE, Gavin JR, Kruger DF. Current eligibility requirements for CGM coverage are harmful, costly, and unjustified. Diabetes Technol Ther 2020;22:169–173
31. Kahn HS, Morgan TM, Case LD, et al.; SEARCH for Diabetes in Youth Study Group. Association of type 1 diabetes with month of birth among U.S. youth: The SEARCH for Diabetes in Youth Study. Diabetes Care 2009;32:2010–2015
32. Davidson MB. How our current medical care system fails people with diabetes: lack of timely, appropriate clinical decisions. Diabetes Care 2009;32:370–372