



Let's Empower and Prepare (LEAP): Evaluation of a Structured Transition Program for Young Adults With Type 1 Diabetes

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OBJECTIVE

To evaluate the efficacy of a structured transition program compared with usual care in improving routine follow-up, clinical, and psychosocial outcomes among young adults with type 1 diabetes.

RESEARCH DESIGN AND METHODS

Eighty-one young adults in their last year of pediatric care were recruited from three clinics. Intervention group (IG) participants ($n = 51$) received a structured transition program incorporating tailored diabetes education, case management, group education classes, and access to a newly developed young adult diabetes clinic and transition website. Control group (CG) participants ($n = 30$) received usual care. The primary outcome was the number of routine clinic visits. Secondary outcomes included glycemic control, hypoglycemia, health care use, and psychosocial well-being. Assessments were conducted at baseline, and 6 and 12 months.

RESULTS

Limitations in CG follow-up prevented direct comparisons of adult care visits; however, at the 12-month follow-up among IG participants discharged from pediatric care ($n = 32$), 78% had one or more adult visits. Among IG participants, the total number of clinic visits did not differ between those who transitioned and those who remained in pediatric care (3.0 ± 1.24 vs. 3.11 ± 0.94 , $P = 0.74$). IG compared with CG participants had improved glycemic control ($-0.40 \pm 1.16\%$ vs. $0.42 \pm 1.51\%$ [4.4 ± 12.7 mmol/mol vs. 4.6 ± 16.5 mmol/mol], $P = 0.01$), incidence of severe hypoglycemia (0.0% vs. 16%, $P = 0.02$), and global well-being ($P = 0.02$) at 12 months.

CONCLUSIONS

A structured transition program was successful in facilitating transition to adult care without a decrease in clinical follow-up. Compared with usual care, the transition program facilitated improvements in glycemic control, hypoglycemia, and psychosocial well-being.

Transition from pediatric to adult health care usually occurs during a critical period for young adults (YAs) with type 1 diabetes. YAs who have inadequate transition from pediatric to adult care often are lost to follow-up (1). There is conflicting evidence regarding the effect of the transition on glycemic control, with some

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studies showing improved glycemic control in adult care compared with pediatric care (2,3), whereas others have shown no change or a deterioration in glycemic control (4–6). A consistent finding, however, is a decline in the frequency of clinic attendance among YAs after transition to adult care (2–4).

YAs with type 1 diabetes are at risk for disruptions in care for a variety of reasons: difficulty finding adult providers who can address their medical and developmental needs; challenges in transitioning between insurance programs and health systems; and disengagement from care due to competing priorities during the relatively chaotic period of young adulthood (7,8). These issues contribute to a lack of continuity of care during transition, with one study finding that 34% of YAs had a gap of >6 months in establishing adult care (9). Such disruptions in care put YAs at an increased risk for medical and psychosocial complications of diabetes (10).

With rates of diabetes in children increasing, the challenges of transition are likely to worsen over time (11). Many health care providers are aware of the challenges in transition but are unclear about how to ameliorate these problems given the lack of resources to facilitate the transition process. Although to date strong observational data indicate the need for improved transition care for YAs with diabetes, few studies have evaluated structured transition programs, particularly in the U.S. health care context (7,12,13). The first randomized controlled trial of a structured transition program for diabetes, done in Australia, demonstrated that such studies are exceedingly difficult to conduct (14). Although the study provided important feasibility data, it did not meet recruitment goals and, therefore, its main outcomes could not be evaluated. To explore whether a structured transition program could improve clinical and psychosocial outcomes among a largely underserved population of Los Angeles, California, we undertook a prospective, nonrandomized, two-group experimental study evaluating such a program for YAs with type 1 diabetes.

RESEARCH DESIGN AND METHODS

Study Design

The Helmsley T1D Transition Let's Empower and Prepare (LEAP) Program

investigated the efficacy of a structured transition program on improving clinic attendance, glycemic control, and psychosocial outcomes among YAs transitioning from pediatric to adult care. The prospective, nonrandomized trial compared outcomes between 1) an intervention group (IG) receiving tailored diabetes education, transition support, and access to a newly developed YA clinic in a large urban public hospital system ($n = 51$) and 2) a control group (CG) that did not receive tailored diabetes education or transition support ($n = 30$). Results from a small subgroup ($n = 12$) of the IG participating in the development and piloting of an innovative support group process are included in the IG findings for the purposes of this report because their exclusion did not alter the main outcomes (clinic visits and A1C) (15). The study procedures were approved by the University of Southern California Institutional Review Board, and all participants completed an informed consent at study enrollment.

Recruitment and Enrollment

Participants were recruited in person by onsite study coordinators during visits at three pediatric diabetes clinics. Potentially eligible participants were referred by their pediatric providers or identified through study coordinator review of weekly clinic schedules. IG participants were recruited from a major urban children's hospital and a large urban public hospital in Los Angeles. CG participants were recruited from a major children's hospital serving a neighboring county. Eligibility requirements at all sites were the following: 1) age 19–25 years at the time of study enrollment, 2) diagnosis of type 1 diabetes according to American Diabetes Association criteria for at least 2 years, 3) receiving routine diabetes care by an assigned provider, and 4) in the last year of pediatric care, defined as anticipating transition to adult care within the next year. An exclusion criterion was pregnancy, or plans to become pregnant, within 12 months.

Intervention

Both IG and CG received routine diabetes care at quarterly visits. The LEAP program provided to the IG had five major components. First, participants received diabetes education tailored to their developmental stage at each

quarterly visit. The educational modules discussed diabetes basics, sick day management, use of alcohol and recreational drugs, contraception and family planning, and accessing care in the adult health care system. Participants who missed clinic visits received the missed modules at their next visit. The materials were also provided as hard copies in a binder as well as on a transition resource website. Second, case managers facilitated program delivery, coordinated transfer from the pediatrics clinic to the adult clinic, and encouraged adherence to scheduled clinic visits. Third, participants had the option to transfer to a newly formed YA clinic at the same hospital as one of the IG recruitment sites that was overseen by an internal medicine-pediatrics-trained physician who had completed a fellowship in adult endocrinology. The YA clinic was staffed by a multidisciplinary care team, including a certified diabetes educator and dietitian, to provide ongoing diabetes education and behavioral support. Fourth, participants had access to carbohydrate counting classes offered by a registered dietitian. Fifth, participants were invited to join a private social networking website to facilitate social support. CG participants did not receive any of these program components but did receive routine care. In addition, after their 12-month study visit, CG participants received a binder containing the developmentally tailored diabetes education.

The LEAP transition program was developed based on existing literature regarding best practices for transition of YAs with diabetes (1,4,7,10,16,17) as well as qualitative assessment (by P.A.S.) among multidisciplinary pediatric providers, focus groups of YAs with type 1 diabetes pre- and posttransfer from pediatric to adult care, and parents. The curriculum was modeled after the *Sweet* transition program (Milton, QLD, Australia). Development of the YA clinic was based on our findings from pediatric providers' concerns about a lack of adult care providers and loss of insurance.

Transition Procedures

Case managers at the pediatric clinic monitored IG participants' anticipated dates for transfer of care to facilitate transition to adult clinics. IG participants

who did not transfer to the newly formed YA clinic received a condensed overview of the remaining educational materials before discharge from pediatric care, with emphasis on preparing them to transfer to adult care. LEAP case managers researched and identified local adult care providers who accepted the participants' insurance. Pediatric and YA case managers scheduled IG participants' initial YA clinic appointment before the participants' last pediatric visit. The YA site case managers assisted IG participants with paperwork and logistics and were present at the participants' first clinic visit to verify attendance and address questions related to transfer of care and insurance enrollment. In contrast, CG participants transferring from pediatric to adult care during the study period were discharged with a reminder to follow up with adult care providers and no coordinated case management.

Data Collection

The primary study end point, assessed through a review of medical records at each facility and supplemented by patient self-report, was the number of routine diabetes clinic visits during the study period (including both pediatric and adult visits). Secondary end points, including A1C, incidence of hypoglycemia, health care utilization, and psychosocial outcomes, were evaluated through an assessment battery at baseline and 6 and 12 months after enrollment. A1C values were measured using the DCA 2000 analyzer (Bayer HealthCare AG, Tarrytown, NY). Incidence of severe hypoglycemia (defined as requiring assistance and/or change in mental status within the past 3 months) and health care utilization (instances of diabetes-related use of paramedics, emergency department visits, and hospitalizations within the past 3 months) were assessed through a brief computerized survey.

The following self-reported well-being measures were also administered: the Diabetes Empowerment Scale-Short Form, an 8-item measure evaluating diabetes self-efficacy (18); an adapted Diabetes Knowledge Test, a 14-item measure assessing general diabetes knowledge (19); the adapted Perceived Stress Scale, a 17-item measure assessing an individual's perception of life as

stressful within the past month (20) and revised to increase comprehension among urban Latino adolescents (21); the Patient Health Questionnaire-9, a 9-item depressive symptom severity measure (22); the Satisfaction With Life Scale, a 5-item global life satisfaction measure (23); and the Arizona Integrative Outcomes Scales (24), single-item visual analog scales measuring a person's global state of physical, emotional, and spiritual well-being in the preceding 24 h and 30 days.

Data Analysis

All data were analyzed using SAS for Windows version 9.2 software (SAS Institute, Cary, NC). All *P* values are two-sided. Baseline characteristics of the IG and CG were compared using independent-sample *t* tests or Fisher exact tests as appropriate. Because the IG and CG differed by race/ethnicity, parent education level, and health insurance status, subsequent analyses adjusted for these variables. Ethnicity was categorized as Hispanic/non-Hispanic because >50% of the study population was Hispanic; therefore, we were unable to make statistical comparisons among non-Hispanic subpopulations.

For the study's primary end point, the number of routine diabetes clinic visits, we were unable to make direct comparisons between the IG and CG due to incomplete data in the CG. IG participants primarily transferred to a single health system, whereas CG participants transferred to a wide variety of providers out of county, out of state, or unknown. Because of this outcome limitation, we are presenting within-group descriptive data.

Health care utilization measures over the 12-month period were compared using negative binomial regression. Other secondary end points (i.e., A1C, psychosocial outcomes) were compared by changes in values from baseline to 6 months, 6–12 months, and a linear trend from baseline to 12 months. Change values were analyzed using ANOVA. Linear trends were compared using mixed-effects regression models, with statistical significance of the interaction term (treatment group * time) indicating a difference in trends over time in the two groups. For the A1C comparisons, we performed confirmatory analyses imputing missing 6- and

12-month values using multiple imputation methods with group, sex, age, race/ethnicity, participant education level, parent education level, health insurance status, and baseline values for A1C and each psychosocial measure as predictors.

RESULTS

Baseline Characteristics

Fifty-one participants enrolled in the IG and 30 in the CG. Loss to follow-up did not differ between groups, with 84.3% of IG participants (*n* = 43) and 83.3% of CG participants (*n* = 25) completing the 12-month study visit (*P* = 0.91). CG participants were more likely to be white, have parents with a high education level, and have private health insurance than IG participants (Table 1). Across both groups, Hispanics/Latinos had a lower education level (*P* = 0.01) and lower parent education level (*P* < 0.0001) than other racial/ethnic groups (data not shown).

Routine Clinic Visits

Table 2 summarizes the within-group analyses regarding routine clinic visits for the IG and CG. Within the IG, 62.7% of participants (*n* = 32) were discharged from pediatric care during the study period, 35.3% (*n* = 18) remained in pediatric care, and the transition status of one participant was unknown. Of those discharged from pediatric care, 78% (*n* = 25) successfully transitioned, which was defined as having at least one routine clinic visit in adult care during the study period (average 1.4 adult visits within the study period, range 1–4 visits); the remaining 22% (*n* = 7) had no routine adult care clinic visits.

Within the IG, the total number of routine clinic visits, including both pediatric and adult visits, did not differ between those who were discharged from pediatric care versus those who remained in pediatric care (3.0 vs. 3.11 visits, *P* = 0.72). Among participants who were discharged from pediatric care, we differentiated between those who transitioned successfully to adult care, defined as having at least one routine adult care provider visit, and those who were unsuccessful in transitioning, defined as having no routine visits with an adult care provider. This comparison revealed a *t* difference in the total number of clinic visits (both pediatric and adult) among those who successfully

Table 1—Baseline demographics

Variable	Intervention (n = 51)	Control (n = 30)	P value*
Age (years)	19.61 ± 1.02	19.70 ± 0.65	0.62
Sex			0.36
Female	25 (49.0)	11 (36.7)	
Male	26 (51.0)	19 (63.3)	
Race/ethnicity			0.01
Hispanic	33 (64.7)	10 (33.3)	
Non-Hispanic	18 (35.3)	20 (66.7)	
White	5 (9.8)	15 (50.0)	
Black	5 (9.8)	1 (3.3)	
Other	8 (15.7)	4 (13.3)	
Education			0.07
Less than high school	8 (15.7)	3 (10.0)	
High school diploma or GED	27 (52.9)	10 (33.3)	
Some college	14 (27.5)	15 (50.0)	
Trade school	2 (3.9)	0 (0.0)	
Associate's degree	0 (0.0)	1 (3.3)	
Bachelor's degree	0 (0.0)	1 (3.3)	
Parent education level			0.01
Less than high school	20 (39.2)	7 (23.3)	
High school diploma or GED	15 (29.4)	3 (10.0)	
Some college/trade school/associate's degree	10 (19.6)	8 (26.7)	
Bachelor's/advanced degree	4 (7.8)	11 (36.7)	
Unknown	2 (3.9)	1 (3.3)	
Health insurance status			<0.001
Private insurance†	1 (2.0)	16 (53.3)	
Publicly funded health care‡	43 (84.3)	11 (36.7)	
Unknown	7 (13.7)	3 (10.0)	

Data are mean ± SD or n (%). GED, General Education Development. *t test for age, Fisher exact test for all others. †Any private insurance alone or in combination with public programs. ‡Public programs only (e.g., MediCal, California's Medicaid program; California Children's Services, state-sponsored insurance for children with chronic health problems) or uninsured.

transitioned versus those who were unsuccessful (3.48 vs. 1.0 visits, $P < 0.001$). No difference in the number of clinic visits was found between those who transitioned successfully and those who were not discharged from pediatric

care (3.48 vs. 3.11 visits, $P = 0.18$). Thus, participants who transitioned successfully maintained a similar number of clinic visits to those who did not transition.

Within the CG, 67% of participants ($n = 20$) transitioned from pediatric to

adult care within the study period; 23% ($n = 7$) remained in pediatric care. Transition status was unknown for 10% ($n = 3$). Although lacking reliable data on the number of adult clinic visits among CG participants, case managers and study coordinators did collect information, when possible, on where CG participants sought adult care. Among participants who provided information about their adult care status, the majority were attending free or safety net clinics (25%), had no current source of routine care due to financial barriers (20%), or were receiving care at their college or university (15%) (data not shown).

Clinical Outcomes

Using mixed-effects regression models, we compared the rate of change in A1C over the study period in the IG versus the CG. As shown in Table 3, over the 12-month study period, A1C declined by 0.40% (4.4 mmol/mol) in the IG and increased by 0.42% (4.6 mmol/mol) in the CG for an overall between-group difference of 0.82% (9.0 mmol/mol) ($P = 0.01$). After adjusting for between-group differences in ethnicity, parent education, and insurance status, both the 12-month A1C (9.05% vs. 9.39% [75 vs. 79 mmol/mol]) and the change in A1C from baseline to 12 months (−0.40% vs. 0.42% [−4.4 vs. 4.6 mmol/mol]) were improved in the IG compared with the CG ($P = 0.03$ for both). Furthermore, the monthly rate of change in A1C remained statistically significant when the statistics were

Table 2—Within-group analysis of transition status/number of routine care visits

Group	n (%)	No. clinic visits	Between-group comparisons (negative binomial regression)	
			P value	No transition* vs. successful transition P value
Intervention (n = 51)				
Did not transition*	18 (35.3)	3.11 ± 0.96	0.72	0.18
Transitioned**	32 (62.7)	3.0 ± 1.26	—	—
Successful (≥1 routine adult care visit within study period)	25 (78.1)	3.48 ± 0.77	<0.001	—
Unsuccessful (no routine adult care visits within study period)	7 (21.9)	1.0 ± 0.89	—	—
Unable to determine	1 (2.0)	—	—	—
Control (n = 30)				
Did not transition	7 (23.3)	—	—	—
Transitioned	20 (67.8)	—	—	—
Unable to determine	3 (10.0)	—	—	—

Data are mean ± SD unless otherwise indicated. *Did not transition: followed continuously in pediatric care for the duration of 12-month study period. **Transitioned: discharged from pediatric care within 12-month study period (regardless of adult care status).

Table 3—Comparison of A1C outcomes

	Intervention	Control	χ^2 or <i>t</i> test	P value	
				Adjusted	
				Hispanic ethnicity, parent education, and insurance status	With imputation for missing values
Baseline A1C (<i>n</i> = 81)			0.56	0.29	—
%	9.41 ± 2.06	9.15 ± 1.81			
mmol/mol	79 ± 22.5	76 ± 19.8			
6-month A1C (<i>n</i> = 57)			0.42	0.93	—
%	9.12 ± 1.80	8.65 ± 1.21			
mmol/mol	76 ± 19.7	71 ± 13.2			
12-month A1C (<i>n</i> = 68)			0.48	0.03	—
%	9.05 ± 1.98	9.39 ± 1.67			
mmol/mol	75 ± 21.6	79 ± 18.3			
Change from baseline to 12 months (<i>n</i> = 68 with 12-month data)			0.01	0.03	—
%	−0.395 ± 1.16	0.420 ± 1.51			
mmol/mol	−4.3 ± 12.7	4.6 ± 16.5			
Overall monthly rate of change	−0.03	0.03	0.02	0.02	0.01
Hispanic	−0.05	0.11		0.00	
Non-Hispanic	−0.01	−0.01		0.89	

Data are mean ± SD unless otherwise indicated.

unadjusted ($P = 0.02$); adjusted for ethnicity, parent education, and insurance status ($P = 0.02$); and adjusted for ethnicity, parent education, insurance status, and use of imputed values for those with missing data ($P = 0.01$).

We found no differences in A1C changes according to sex or transition status (unadjusted $P = 0.20$ – 0.98 ; P adjusted for ethnicity, parent education, and insurance status = 0.13 – 0.98) (data not shown). However, a statistically significant interaction was found between race/ethnicity and the intervention effect. Among non-Hispanic participants, no difference was seen in monthly rates of change in A1C in the IG versus the CG ($P = 0.89$). However, among Hispanic participants, there was a difference in A1C change. In the IG, Hispanic participants' A1C decreased by an average of 0.05% (0.5 mmol/mol) monthly, whereas in the CG, Hispanic participants' A1C increased by an average of 0.11% (1.2 mmol/mol) monthly ($P = 0.001$; P for interaction = 0.01).

At baseline, both groups had similar rates of severe hypoglycemia (8.0% vs. 6.7% in IG vs. CG, respectively; $P = 1.00$). However, the proportion of participants reporting severe hypoglycemia decreased among IG participants and increased among CG participants over the study period. At 12 months, IG

participants had a lower incidence of severe hypoglycemia compared with CG participants (0.0% vs. 16%, $P = 0.02$).

Health Care Utilization

No between-group differences were found in rates of emergency department visits, hospitalizations, or paramedic use during the study period (data not shown). Overall rates of emergency health care utilization were low, with six reported emergency department visits, five reported hospitalizations, and one reported use of paramedics across all participants during the study period.

Psychosocial Outcomes

As shown in Table 4, improvements in the IG compared with the CG were seen for changes in 1-month global well-being ($P = 0.01$), 24-h global well-being ($P = 0.02$), and perceived stress ($P = 0.02$). However, after adjusting for baseline differences in ethnicity, parent education, and insurance status, only the improvement in 1-month global well-being remained significant (adjusted $P = 0.02$). No differences were found in the effect of the intervention by sex on any psychosocial outcomes. Compared with Hispanics, monthly global well-being was not different among non-Hispanics. However, among Hispanics, monthly global well-being increased

in the IG compared with the CG (unadjusted $P = 0.01$).

CONCLUSIONS

As one of the first studies to prospectively evaluate the efficacy of a structured transition program compared with usual care, this study provides evidence that such programs are beneficial in improving glycemic control, reducing the incidence of hypoglycemia, and improving overall well-being among YAs with type 1 diabetes. Furthermore, the structured transition program had a high degree of success in transferring participants to adult care, with 78% transitioning successfully and maintaining a similar frequency of routine clinic visits as those who remained in pediatric care during the entire study period. These findings were particularly noteworthy given that the IG as a whole had a lower socioeconomic status than the CG with lower levels of education, fewer participants with private health insurance, and more participants with nonwhite race or ethnicity.

As discussed by Lyons et al. (12), patients lost to follow-up are likely to have a higher A1C than those who remain in care. Similarly, we found that the improvement in A1C in the IG was maintained after adjusting for missing data. The robustness of this finding provides strong evidence of a true

Table 4—Changes in psychosocial variables from baseline to 12 months

Variable	Intervention		Control		P value		
	n	Mean (SD)	n	Mean (SD)	Unadjusted	Adjusted*	Interaction**
Diabetes knowledge							
Baseline	51	10.92 (1.65)	30	11.23 (1.38)	—	—	—
12 months	37	11.62 (1.36)	26	11.81 (1.20)	—	—	—
Change	37	0.62 (1.11)	26	0.50 (1.14)	0.67	0.95	0.65
Diabetes empowerment							
Baseline	51	33.06 (6.07)	30	33.40 (7.11)	—	—	—
12 months	37	34.32 (6.24)	26	33.62 (5.61)	—	—	—
Change	37	0.78 (7.54)	26	−0.27 (8.00)	0.60	0.40	0.70
Global well-being, 24 h							
Baseline	51	72.69 (20.35)	30	73.33 (17.95)	—	—	—
12 months	37	82.43 (18.96)	26	67.08 (26.06)	—	—	—
Change	37	8.32 (24.32)	26	−6.65 (24.27)	0.02	0.12	0.08
Global well-being, month							
Baseline	51	69.88 (22.36)	30	69.00 (16.95)	—	—	—
12 months	37	82.41 (16.97)	26	64.04 (26.30)	—	—	—
Change	37	11.11 (23.04)	26	−6.73 (28.64)	0.01	0.02	0.04
Life satisfaction							
Baseline	51	24.43 (6.54)	30	21.70 (7.22)	—	—	—
12 months	37	26.22 (6.69)	26	21.77 (6.60)	—	—	—
Change	37	1.35 (6.51)	26	0.00 (6.49)	0.42	0.79	0.52
Perceived stress							
Baseline	51	46.08 (8.55)	30	48.07 (7.50)	—	—	—
12 months	37	39.49 (9.32)	26	47.96 (10.86)	—	—	—
Change	37	−5.51 (8.72)	26	0.08 (10.19)	0.02	0.20	0.59
Depression							
Baseline	51	4.31 (3.90)	30	5.43 (4.42)	—	—	—
12 months	37	4.57 (4.66)	26	6.73 (6.21)	—	—	—
Change	37	0.51 (4.34)	26	1.54 (4.97)	0.39	0.61	0.06

*Adjusted for Hispanic/non-Hispanic ethnicity, parent education (less than high school, high school diploma or General Education Development; some college, trade school, or associate's degree; bachelor's degree or advanced degree; unknown), and insurance status (private insurance, publicly funded health care, unknown). **P value for interaction of treatment group with Hispanic/non-Hispanic ethnicity.

improvement in glycemic control in the IG compared with the CG rather than a reflection of selection bias among those for whom complete follow-up data were available.

After adjusting for baseline differences between groups, the IG had improvements in global well-being ($P = 0.02$) at 12 months compared with the CG, but there were no significant changes in diabetes empowerment, diabetes knowledge, perceived stress, or life satisfaction. Although diabetes knowledge scores did not change in the IG, the questionnaire did not assess the specific targeted domains included in the developmentally tailored educational program (e.g., drinking and drug use, family planning, accessing health care); therefore, we are unable to ascertain whether knowledge related to these domains improved as a result of the intervention.

When adjusting the findings by ethnicity, we found that the beneficial

effects of the intervention on A1C and global well-being were attributable to improvements among the Hispanic participant subset. Given that the Hispanic participants had lower education levels and parent education levels than the non-Hispanic participants, this may indicate that structured transition programs are particularly beneficial for YAs with fewer socioeconomic resources to support their transition process.

Although we lack empirical data on the efficacy of individual intervention components, we found that a critical factor for IG participants' successful transition was the availability of case management at both the discharging pediatric clinic and the accepting adult clinic, which is in line with previous findings (16,17). Before the development of the YA diabetes clinic, low-income YAs with type 1 diabetes followed at the IG pediatric sites had no easily accessible adult diabetes care provider or case managers to communicate between

pediatric and adult clinics. The current study found that among the 78% of IG participants who transitioned successfully, 100% transferred to the new clinic. In contrast, few participants made use of the group carbohydrate counting classes and private social networking website. We believe that these were not critical to the success of the intervention. Qualitative data from IG participants regarding the perceived utility of the various intervention components were collected through surveys following completion of the study, which will be analyzed to further optimize the transition program components.

Limitations

This study is limited by a relatively small sample size ($n = 81$), short duration of follow-up (12 months), and lack of randomization. Therefore, the results should be interpreted with caution until they can be replicated in a larger and more rigorous study. In particular, the

multivariate analyses presented have limited statistical power and should be viewed as highly preliminary. Additionally, changes in the context of health care delivery following the implementation of the Affordable Care Act, particularly the expansion of Medicaid to low-income adults in some states, may have implications for transition programs, limiting the generalizability of the current study, which was undertaken before the Affordable Care Act.

Poor follow-up regarding adult clinic visits among the CG participants was a significant limitation of the study, restricting our ability to make direct comparisons on this outcome. This disparity in data collection between the CG and IG made it impossible to assess the number of adult clinic visits for the CG. However, the secondary outcome of A1C strongly suggests a benefit of the transition program, particularly among Hispanics. In the current study, 70.6% of IG participants and 100% of CG participants transitioned across health systems (i.e., from children's hospitals to adult clinics), which can be more challenging than transitioning within a single health system (as did the 29.4% of IG participants whose pediatric care was colocated with the YA clinic). However, we were able to address the challenge of continuity between pediatric and adult care providers in the IG because most IG participants transferred to a single adult clinic. Future research investigating cross-system transitions may facilitate improved tracking of participants through the use of retention strategies tailored to emerging adults as outlined by Hanna et al. (25).

The small sample size within the CG ($n = 20$ who transitioned, $n = 7$ who remained in pediatric care) limited our ability to compare these participants' clinical and psychosocial outcomes according to transition status as a proxy measure for their transition success. In examining the data qualitatively, the differences in scores seemed somewhat large for global well-being and life satisfaction, both favoring those who transitioned, whereas those who did not transition had greater improvements in diabetes empowerment. However, we are unable to draw firm conclusions regarding the clinical and psychosocial status of these groups due to limited statistical power.

Summary

To our knowledge, this study is the first to report on a prospective evaluation of a structured transition program compared with usual care. Although limited by a lack of randomization and short follow-up period, this study provides evidence that a structured transition program improves glycemic control, incidence of hypoglycemia, and psychosocial well-being among YAs with type 1 diabetes. This program particularly benefited YAs with lower socioeconomic status because the effects of the intervention were greatest among Hispanic participants with lower education and parent education than the overall sample. Structured transition programs in pediatric and adult diabetes clinics, particularly those serving underserved populations, may prevent YAs from being lost to follow-up and experiencing deteriorating health and well-being during this developmentally demanding period of their lives.

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References

- Pacaud D, Yale JF, Stephure D, Trussell R, Davies HD. Problems in transition from pediatric care to adult care for individuals with diabetes. *Can J Diabetes* 2005;29:13–18
- Johnston P, Bell PM, Tennet H, Carson D. Audit of young people with type 1 diabetes transferring from paediatric to adult diabetic services. *Pract Diabetes Int* 2006;23:106–108
- Sparud-Lundin C, Ohrn I, Danielson E, Forsander G. Glycaemic control and diabetes care utilization in young adults with type 1 diabetes. *Diabet Med* 2008;25:968–973
- Busse FP, Hiermann P, Galler A, et al. Evaluation of patients' opinion and metabolic control after transfer of young adults with type 1 diabetes from a pediatric diabetes clinic to adult care. *Horm Res* 2007;67:132–138
- Lotstein DS, Seid M, Klingensmith G, et al.; SEARCH for Diabetes in Youth Study Group. Transition from pediatric to adult care for youth diagnosed with type 1 diabetes in adolescence. *Pediatrics* 2013;131:e1062–e1070
- Helgeson VS, Reynolds KA, Snyder PR, et al. Characterizing the transition from paediatric to adult care among emerging adults with type 1 diabetes. *Diabet Med* 2013;30:610–615
- Peters A, Laffel L; 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
- Pyatak E. Participation in occupation and diabetes self-management in emerging adulthood. *Am J Occup Ther* 2011;65:462–469
- Garvey KC, Wolpert HA, Rhodes ET, et al. Health care transition in patients with type 1 diabetes: young adult experiences and relationship to glycemic control. *Diabetes Care* 2012;35:1716–1722
- Rapley P, Davidson PM. Enough of the problem: a review of time for health care transition solutions for young adults with a chronic illness. *J Clin Nurs* 2010;19:313–323
- 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
- Lyons SK, Becker DJ, Helgeson VS. Transfer from pediatric to adult health care: effects on diabetes outcomes. *Pediatr Diabetes* 2014;15:10–17
- Spaic T, Mahon JL, Hramiak I, et al.; JDRF Canadian Clinical Trial CCTN1102 Study Group. Multicentre randomized controlled trial of structured transition on diabetes care management compared to standard diabetes care in

adolescents and young adults with type 1 diabetes (Transition Trial). *BMC Pediatr* 2013;13:163

14. Steinbeck KS, Shrewsbury VA, Harvey V, et al. A pilot randomized controlled trial of a post-discharge program to support emerging adults with type 1 diabetes mellitus transition from pediatric to adult care. *Pediatr Diabetes* 2014;4:19–23
15. Weigensberg M, Pyatak E, Florindez D, et al. Diabetes Empowerment Council (DEC): development and pilot testing of an innovative mind-body group intervention for young adults with type 1 diabetes (Abstract). *J Altern Complement Med* 2014;20:A69
16. Van Wallegghem N, MacDonald CA, Dean HJ. Building connections for young adults with type 1 diabetes mellitus in Manitoba: feasibility and acceptability of a transition initiative. *Chronic Dis Can* 2006;27:130–134

17. Van Wallegghem N, Macdonald CA, Dean HJ. Evaluation of a systems navigator model for transition from pediatric to adult care for young adults with type 1 diabetes. *Diabetes Care* 2008; 31:1529–1530

18. Anderson RM, Fitzgerald JT, Gruppen LD, Funnell MM, Oh MS. The Diabetes Empowerment Scale-Short Form (DES-SF). *Diabetes Care* 2003;26:1641–1642
19. Fitzgerald JT, Funnell MM, Hess GE, et al. The reliability and validity of a brief diabetes knowledge test. *Diabetes Care* 1998;21: 706–710
20. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983;24:385–396
21. Weigensberg MJ, Lane CJ, Ávila Q, et al. Imagine HEALTH: results from a randomized

pilot lifestyle intervention for obese Latino adolescents using Interactive Guided ImagerySM. *BMC Complement Altern Med* 2014;14:28

22. Kroenke K, Spitzer RL. The PHQ-9: a new depression diagnostic and severity measure. *Psychiatr Ann* 2002;32:509–515
23. Diener E, Emmons RA, Larsen RJ, Griffin S. The Satisfaction With Life Scale. *J Pers Assess* 1985;49:71–75
24. Bell IR, Cunningham V, Caspi O, Meek P, Ferro L. Development and validation of a new global well-being outcomes rating scale for integrative medicine research. *BMC Complement Altern Med* 2004;4:1
25. Hanna KM, Scott LL, Schmidt KK. Retention strategies in longitudinal studies with emerging adults. *Clin Nurse Spec* 2014;28: 41–45