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Evaluation of the transition program at the University Hospital of Reims from 2015 to 2020

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ABSTRACT

The transition of young type 1 diabetic (T1D) patients from pediatric to adult healthcare is a high-risk period of loss to follow-up. Since 2015, we have implemented a transition program, involving both pediatric and adult clinicians. The main objective was to evaluate the number of patients who had succeeded this transition program at 1 year. We found that 86% of patients underwent the complete transition program. However, adverse outcomes occurred in 19.1% of patients at 1 year but decreased to 2.9% after 3 years. In 63% of patients their HbA1c level had deteriorated 1 year after the transition day and this level stabilized at around 8% in the following 2 and 3 years. In patients who had improved HbA1c levels the body mass index was lower ($P = 0.03$) and they lived alone ($P = 0.04$). Although our program seemed to allow a better follow-up than previously described, this study highlights the importance of further supporting this transition period.

INTRODUCTION

Type 1 diabetes (T1D) is the main form of diabetes in children and adolescents with an increasing incidence as recently shown in our center¹. In 2022, ISPAD reedited the recommendations for the transition of type 1 diabetes patients because the transition period from pediatric to adult healthcare is a period of risk for loss of follow-up, HbA1c level deterioration, and acute and microvascular complications². The DCCT study³ showed an existence of glycemic memory, responsible for long-term complications. Different transition programs have been implemented to help young adults to better control the disease and to avoid loss to follow-up during this high risk period^{4–8}.

In our center, the adult and pediatric diabetes departments have developed a transition program and our main objective was to evaluate the number of patients lost to follow-up. The secondary objective was to evaluate the evolution of HbA1c levels and the occurrence of serious events at 1, 2, and 3 years after a completed transition program.

PATIENTS AND METHOD

This is a descriptive, retrospective, and monocentric study on a population of type 1 diabetic patients followed at the University Hospital of Reims in the pediatrics unit, from April

2015 to December 2020. The inclusion criteria were young type 1 diabetes patients, who underwent the transition program, involving a transition day, with a consultation between patients and both pediatric and adult clinicians, and a therapeutic education workshop between patients, parents, and adult and pediatric practitioners. This day was followed by the year after with at least two scheduled appointments in the adult department, generally 6 months apart (Figure 1). The patients who were directly followed in the adult diabetes care service, those who underwent a transition to simple consultations, and those with diabetes other than type 1 diabetes were excluded.

The investigation plan was established from the data of the Champagne-Ardennes Diabetes Network (CARÉDIAB) and the software used at the University Hospital of Reims. All patients signed a consent form at the time of inclusion in the CARÉDIAB database¹.

The data collected included the date of transition day, social data: level of education, employment, live alone, duration of diabetes, treatment modalities, and psychological follow-up before the transition. The HbA1c levels were collected before, after the transition day, at 1, 2, and 3 years \pm 3 months during follow-up consultations at the hospital. HbA1c levels were measured using either a standardized method (DCA 2000[®]) or high-pressure liquid chromatography. We retrieved the latest biological news, hospitalization reports, and serious events from

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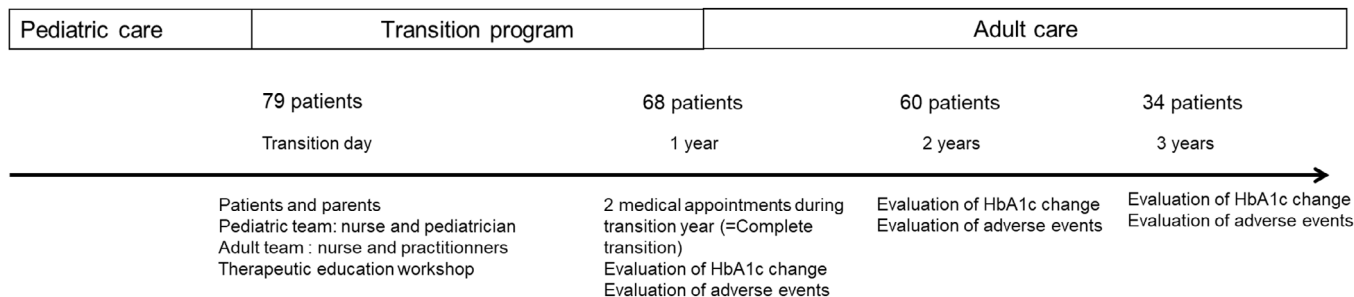


Figure 1 | Transition program description. The inclusion criteria were young type 1 diabetes patients, who underwent the transition program, involving a transition day, involved patient and both pediatric and adult clinicians and a therapeutic education workshop between patients, parents, and adult and pediatric practitioners. This day was followed the year after with at least two scheduled appointments in the adult department.

all patients from their medical records. Serious events were defined as keto-acidosis, severe hyperglycemia requiring unscheduled hospitalization, severe hypoglycemia, and diabetes imbalance with HbA1c >10%.

Statistics data were described using mean ± SD for continuous variables and ± standard error of the mean (SEM) for figures, frequency, and percentage for qualitative variables. The results were obtained through univariate analysis (Student's

t-tests, Wilcoxon tests, Chi-square tests, or Fisher's exact test) depending on the application conditions. The significance threshold was set at 0.05 with R studio.

RESULTS

Seventy-nine young adults underwent the transition day, 86% of the patients underwent a complete transition program, and 14% had no regular follow up (Figure 2b).

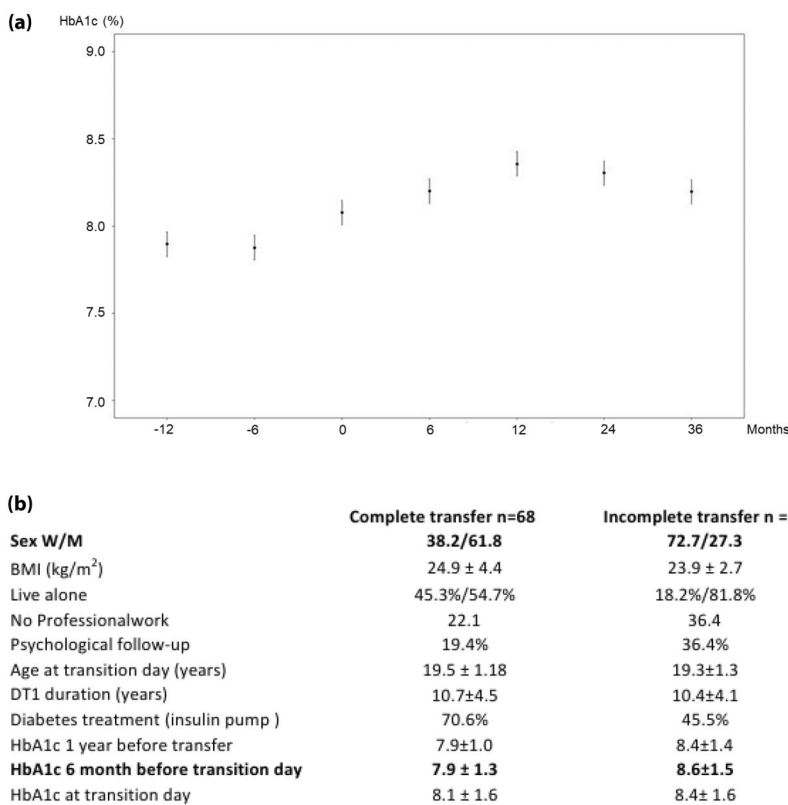


Figure 2 | (a) HbA1c evolution during follow up in patients with completed transfer during follow up (mean ± SEM), NA, not available. Mean of HbA1c at 12 months before transition 7.9 ± 0.12. Mean of HbA1c at 6 months before transition 7.9 ± 0.13. Mean of HbA1c at transition 8.1 ± 0.16. Mean of HbA1c at 12 months after transition 8.4 ± 0.19. Mean of HbA1c at 2 years after transition 8.3 ± 0.25 (NA: 8). Mean of HbA1c at 3 years after transition 8.2 ± 0.25 (NA: 34). (b) Characteristics of patients who underwent complete and incomplete transition can be described as follows: BMI, body mass index; DT1, diabetes type 1.

Among the patients who underwent a complete transition program, 38% were women, while they accounted for 73% of the loss to follow-up group ($P = 0.0481$). Nineteen percent received psychological care vs 36% among those who discontinued care, with no significant difference (Figure 2b). The majority of patients were on insulin pumps, 22% did not work or study, and 45.3% lived alone with no significant difference.

The HbA1c level during the transition day was $8.1 \pm 1.5\%$ in the group who completed the transition program vs $8.4 \pm 1.6\%$ in the group lost to follow-up, with no significant difference. However, 6 months before the transition day, the HbA1c level was higher at $8.6 \pm 1.5\%$ in the group lost to follow-up ($P = 0.043$) (Figure 2b).

Patients who completed the transition program had a slight deterioration of their HbA1c level 1 year after: from $7.9 \pm 1.3\%$ during the last year of pediatrician care and $8.4 \pm 1.6\%$ 1 year after the transition ($P = 0.047$), and respectively $8.3 \pm 1.5\%$ and $8.2 \pm 1.2\%$ after 2 and 3 years, as shown in Figure 2a.

Individually, 63% of patients had worse HbA1c levels at 1 year after the transition day with a great heterogeneity of results as shown in Figure 3; among them 15% experienced a degradation of more than 1% in their HbA1c level.

At transition day, 23.5% of patients had an HbA1c level $<7\%$, and 25% 1 year after (Figure 3).

Patients who had an improved HbA1c level during the transition had a lower body mass index (BMI; $P = 0.03$), a lower HbA1c level at transfer and 1 year after the transition (respectively $P = 0.02$, and $P = 0.001$), and lived alone ($P = 0.04$; Table 1).

Nineteen percent of patients had a serious adverse outcome the first year after transition day: seven patients had diabetic

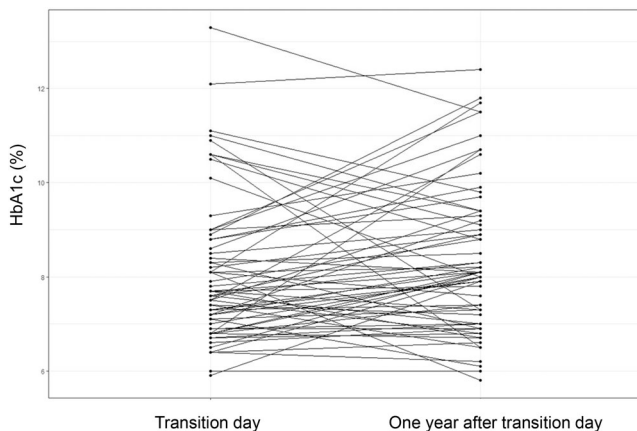


Figure 3 | Evolution of HbA1c 1 year after transition compared with transition day in patients who underwent a complete transition. Data for one patient are missing one year after the transition day. Two patients had the same HbA1c level at transition day and 1 year later. Forty-three patients had worse HbA1c levels but five patients maintained an HbA1c level of $<7\%$. Twenty-two patients had an improved HbA1c level.

Table 1 | Characteristics of patients who had an improved HbA1c level during 1 year after transition day

	HbA1c level improvement <i>n</i> = 24	HbA1c level degradation <i>n</i> = 43	<i>P</i>
Age at transfer day (years)	19.6 ± 0.97	19.5 ± 1.3	0.72
Diabetes duration (years)	9.8 ± 4.6	11.2 ± 4.4	0.21
BMI (kg/m^2)	23.4 ± 3.5	25.7 ± 4.7	0.030
HbA1c level 1 year before transition day (%)	7.8 ± 1.1	7.9 ± 1.0	0.74
HbA1c level at transition day (%)	7.7 ± 1.1	8.8 ± 1.9	0.018
HbA1c 1 year after transition day (%)	7.6 ± 1.4	8.8 ± 1.5	0.001
Gender (%men)	15/24 (63%)	26/43 (60%)	1.0
Psychological follow up	6/24 (25%)	9/43 (21%)	0.76
Lived alone	15/24 (63%)	15/43 (35%)	0.04
Severe events during 3 years after transfer	8/24 (33%)	19/43 (44%)	0.44
Severe events 1 year after transfer	5/24 (21%)	11/43 (26%)	0.77

BMI, body mass index.

ketoacidosis, two severe hypoglycemia, and four imbalanced diabetes. The number dropped drastically to only 2.9% with imbalanced diabetes 3 years after transfer (missing data for five patients).

DISCUSSION

We evaluated the transition program that has been implemented at the CHU of Reims since 2015. Only 14% of patients were lost to follow-up. Two parameters were statistically different in the group of lost to follow-up: female gender and a higher level of HbA1c before the transition day. In our cohort, girls received more psychological support, possibly linked to the presence of depressive symptoms which are a marker of loss to follow up after transition in other studies⁹. The deteriorating factors for HbA1c are often patients' psychological distress, the beginning of working life, poorly compliant patients with poor glycemic control prior to transition¹⁰.

However, most patients who underwent a complete transition program experienced a degradation of their HbA1c level one year after the transition day at around 8.4% which is lower than the HbA1c levels observed in PASSage or the Canadian study⁸. Twenty-five percent of patients were able to maintain their HbA1c level to less than 7%, as in T1D Exchange registry¹¹ or SAGE study¹². Furthermore, in our study we followed up the patients during 3 years and we showed a stabilization of the HbA1c level around 8% as described in the type 1 diabetes international study¹³ with a high level of pump treatment. Despite the high treatment with technology in our study, no difference in the HbA1c level was found.

We highlighted that the HbA1c level at the time of transition did not predict an optimal HbA1c level 1 year after the transition. But patients who had an improved HbA1c level had a lower BMI and lived alone, whereas, other studies have shown that entry into the workforce was a possible contributor to HbA1c level degradation¹⁰. Another study highlights the differences in follow-up between pediatric and adult care, with less frequent appointments for the adults⁵, with at least two scheduled appointments in the first year in adult care vs at least four appointments in pediatric care, in our study. The adult care follow-up may be improved with the help of specialized or practitioner nurses and various telemonitoring platforms¹⁴. Indeed, Telemedicine allows more frequent and individualized follow-up at home and preliminary studies suggest a possible improvement in the HbA1c level with this new way of care^{15–17}.

The transition period is an emotionally stressful period when HbA1c degradation and diabetes management is more complicated. Studies of patients using closed-loop systems are very promising with an improvement in anxiety, and a decrease in mental burden¹⁸. The use of these systems could improve the transition period. Another study implemented a gradual process transition program starting at the age of 11 to enhance diabetes knowledge and self-management, and to transfer patients in the best conditions to the adult care service¹⁹. The limitation of our study is the use of retrospective data.

Our study highlights the degradation of HbA1c level during the first year following the transition, even in patients with the correct target HbA1c level at the time of the transition day. The transition program implemented was accepted by the patients and allowed a regular follow-up in adult diabetic care. However, it is not sufficient during this critical period. Prospective studies combining new technologies must be completed to improve our results.

DISCLOSURE

All authors fill all criteria of authorship and all declare that they have no conflict of interests.

Approval of the research protocol: N/A.

Informed consent: All patients have signed a consent form at the time of inclusion in the CARÉDIAB database.

Approval date of registry and the registration no. of the study/trial: N/A.

Animal studies: N/A.

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