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Psychiatric disorders in emerging adults with diabetes transitioning to adult care: a retrospective cohort study

Short title: Psychiatric disorders in youth with diabetes

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- What's Known on This Subject: During the transition to adult care, adolescents and emerging adults with diabetes have an increased risk of psychiatric disorders and suicide attempts, compared to those without diabetes.

- What This Study Adds: Prolonged delays in establishing adult care may be associated with higher rates of mood disorders. Older age at transfer, recent birth year and higher frequency of emergency department visits are associated with the risk of mood disorders after transfer.

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ABSTRACT

Background and objectives: During transition from paediatric to adult diabetes care, adolescents with diabetes are at increased risk of psychiatric disorders compared to those without diabetes. Prolonged gaps between the last paediatric and first adult diabetes care visit are associated with higher perceived stress and lower life satisfaction. We assessed the effect of a gap (> 180 days) in establishing adult diabetes care on the risk of psychiatric disorders and determined other risk factors associated with psychiatric disorders during the transfer to adult care.
Methods: Using provincial health administrative databases, we conducted a retrospective cohort study of individuals from Québec, Canada, diagnosed with diabetes between ages 1 to 15 years in 1997-2015. These individuals were followed from six months after their last paediatric visit until age 25 years. We used multivariable Cox proportional hazard models to determine the association of gap in care with psychiatric disorders risk.
Results: Among 1772 youth with diabetes, 740 (42%) had a gap in care. There was a non-statistically significant association between gap in care and mood disorders diagnosed in the emergency department or hospital (hazard ratio, HR 1.38, 95% confidence interval (CI): 0.92, 2.07). Older age at transfer, recent birth year and higher number of all-cause emergency department visits in the year before transfer increased the risks of psychiatric disorders.
Conclusions: Prolonged gaps in care during transfer to adult care are common and may be associated with increased psychiatric disorder risk. Developmental factors associated with adolescence and emerging adulthood may further amplify this risk.

Keywords: Psychiatric disorders; mood disorders; diabetes, transition to adult care; emerging adults; adolescent

INTRODUCTION

Emerging adulthood (ages 18 to 25 years) is a developmental stage wherein an individual is exploring his/her autonomy, personal identity and making vocational and educational choices [1]. For emerging adults with diabetes (type 1 and type 2 diabetes), this stage is complicated by the daily demands of a chronic disease, and the challenge of transitioning from paediatric to adult diabetes care [2]. While the transfer to adult care is an event, transition care is the "planned, purposeful movement of young adults from child-centred to adult-oriented health-care systems"[3].

For emerging adults with diabetes, the transfer to adult care occurs at a point in life that coincides with decreased adherence to diabetes-related management tasks, decreased clinic attendance and increased risk-taking behaviours [4-7]. We previously documented that compared to adolescents and emerging adults without diabetes, those with diabetes have an increased risk of psychiatric disorders and suicide attempts [8]. In those with type 1 diabetes, mood disorders are associated with an increased risk of hypoglycaemia, diabetic ketoacidosis (DKA) and suboptimal glycaemic control (Haemoglobin A1c; HbA1c) [9]. As such, the American Diabetes Association (ADA) recommends that emerging adults regularly be evaluated for mood disorders and that each diabetes care provider ‘‘have a mental health referral source"[10].

As ongoing regular medical follow-up is essential in addressing the adverse clinical issues and high-risk behaviours associated with emerging adulthood, the ADA recommends that emerging adults have their first adult care visit within three to four months after their last paediatric visit[10]. However, descriptive studies from across North America have found that 28-34% of emerging adults with type 1 diabetes have delays in establishing adult care [11, 12]; which are associated

with higher perceived stress, lower life satisfaction and higher levels of depressive symptoms [13] [14]. Data on gaps in care in emerging adults with type 2 diabetes is limited. The association of gaps in establishing adult care on psychiatric disorder risk has not been previously studied. As such and based on literature suggesting increased frequency of depressive symptoms in those with gaps in care, we hypothesize that gaps in care may exacerbate mental health needs and risk. We aimed to determine if > 180-day gap in establishing adult diabetes care (gap in care) was associated with an increased risk of psychiatric disorders and to also identify other potential risk factors.

RESEARCH DESIGN AND METHODS

Methodology

Study design and data sources

We conducted a retrospective cohort study of Canadian children from the Province of Quebec, ages < 18 years diagnosed with diabetes and followed until age 25 years. We used data between 1996-2015 from the Québec Integrated Chronic Disease Surveillance System's Database (QICDSS), maintained at the Institut National de Santé Publique du Québec (INSPQ). Quebec has a universal health insurance coverage plan, through which all residents are insured for hospital services, inpatient and outpatient services. The QICDSS was constructed by the INSPQ using linked provincial administrative databases. The Régie de l'assurance maladie du Québec (RAMQ) database includes patient demographics and physician billing records (International Classification of Diseases, 9th revision). The Quebec hospital discharge database (MED-ECHO) includes the primary and secondary diagnoses (Before April 2006 ICD-9; ICD-10 after) as well as admission and discharge dates. The vital statistics database maintained by the Institut de la Statistique du

Québec (ISQ) includes both causes and dates of death (ICD-9 before 2000; ICD-10 after)[15]. Ethics approval was obtained from The McGill University Health Centre Research Ethic Board.

Study cohort

We included individuals born between April 1, 1982, and December 31, 1998, and diagnosed with diabetes between ages 1 to 15 years, between April 1, 1997, and December 31, 2013. To identify children with diabetes, we used a validated definition of diabetes (specificity 99.9%, sensitivity 98%)[16]. This definition requires 1 hospitalization or 2 physician visit claims with a diabetes code, within a 2-year period. The definition does not differentiate between type 1 and type 2 diabetes; however, 95% of Canadian children with diabetes ages 18 years or less have type 1 diabetes. The diabetes diagnosis date was the date of the first diabetes diagnosis code (outpatient or inpatient). The cohort entry date was the transfer date defined as 6 months (i.e., the 180^{th} day) following the last paediatric diabetes care visit. The first adult diabetes visit was defined as an outpatient visit with a family physician, internist or adult endocrinologist with an outpatient diabetes code. Individuals without an adult diabetes visit (114 individuals) following their last paediatric diabetes visit were excluded. We excluded 257 individuals because they had a code for a psychiatric condition (other than attention deficit hyperactivity disorder (ADHD) or autism spectrum disorder ASD)), in the two years before the transfer date.

Exposed and unexposed individuals

We defined a gap in care as gap > 180 days between the last paediatric and the first adult care visit for diabetes (exposed group). We used a gap >180 days based on the ADA recommendations that

the first adult care visit be within three to four months after their last paediatric visit and that diabetes visits occur every 6-months for those $\geq$ 18 years and treated with insulin [10, 11].

Follow-up

Follow-up was from the transfer date until March 31st, 2015, age 25 years, death or migration out of the province.

Outcomes

Primary outcomes

Primary outcomes were: 1) mood disorders diagnosed in the emergency department (ED) or during a hospital admission (ICD-9: 296, 300, 311; ICD-10: F30-F48, F68); 2) hospital admission for suicide attempts (ICD-9: 950.0-959.9; ICD-10: X60-X84) and 3) death by suicide (ICD-10: X60 to X84 and Y87).

Secondary outcomes

Secondary outcomes were: 1) mood disorders diagnosed exclusively in an outpatient clinic; 2) having at least one visit to a psychiatrist; 3) diagnosis of schizophrenia (ICD-9: 295; ICD-10: F20, F21, F23.2, F25) and 4) combined outcome of any psychiatric disorders (ICD-9: 290-319; ICD-10: F00-F99; inpatient or outpatient), excluding ADHD (314 and F91) and ASD (299 and F84). We differentiated the location of diagnosis as those diagnosed in the ED or requiring admission likely represent more severe pathology.

The aforementioned ICD-9 and 10 codes are used by the INSPQ to conduct population-based surveillance of mental health disorders and have been demonstrated to be reliable and feasible to ascertain mental health disorders within Canadian administrative data [17-20].

Baseline characteristics

The following characteristics were identified at the transfer date: socioeconomic status (SES), sex, year of birth, rural residency, age as well as number of ED-visits, hospitalizations and outpatient clinic visits (i.e., diabetes and non-diabetes-related) in the year before the transfer date. We determined physician specialty at the first adult care visit for diabetes. SES was measured using neighbourhood-level material and social deprivation indices developed by the INSPQ [21, 22]. Material deprivation is based on education level, employment and income. Social deprivation is based on the proportion of individuals living alone, of those who are separated, divorced or widowed, and those who are part of single-parent households[22]. Material and social deprivation are categorized into quintiles (1 = least deprived, 5 = most deprived) [21]. Rural residency was defined using the Census Metropolitan Area and Census Agglomeration Influenced Zones, developed by Statistics Canada[23, 24]. Rural residency was divided in two categories: urban (population >10,000) or rural (population <10,000).

Data analysis

Baseline characteristics were summarized using descriptive statistics (mean ± standard deviation (SD), range [min-max], median (quartile 1, quartile 3) or n(%) by exposure status). We used t-tests and Pearson's chi-square tests for comparisons of continuous and categorical variables as appropriate. Incidence rates were calculated per 100 person-years for the primary and secondary outcomes. The 95% confidence intervals (CI) for the incidence rates were calculated based on the Poisson distribution. Univariable and multivariable Cox proportional hazard models were used to compare time to psychiatric disorders between exposed and unexposed individuals. The models

were adjusted for the following variables: SES, rural residency, birth year, sex, age, adult physician specialty; and number of ED-visits, outpatient visits and hospitalizations in the year before transfer. These variables were included because of their clinical relevance and their possible association with psychiatric disorders [8, 25]. Crude and adjusted hazard ratios (aHR) with 95% CI were reported. The proportional hazards assumption was confirmed graphically and using the log-log test of proportionality [26].

Sensitivity analysis

We conducted a sensitivity analysis for all outcomes with longer durations of gaps in care (≥ 365 days). Individuals who did not have diabetes care visits with an adult physician after their last paediatric visit were included.

We performed statistical analyses with SAS software, version 9.4 (SAS Institute). The statistical tests were 2-sided with significance at $p < 0.05$.

RESULTS

Study cohort

Our cohort included 1,772 individuals with diabetes (Table 1). Among these, 740 (42%) had a > 180-day gap in care (median duration 367 days; Q1= 251 days and Q3=639 days; exposed, versus (vs.) 92 days; Q1=56 days and Q3=127 days; unexposed; Table 1).

Outcomes

Primary outcomes

The incidence rate of mood disorders diagnosed in the ED or hospital was higher in those with a gap in care compared to those without (1.67 [CI 1.29, 2.12] vs. 1.12 [CI 0.86, 1.48] per 100 person-

years; Table 2). Less than five individuals attempted suicide or died by suicide. There was no difference in the rates of hospitalizations for suicide attempts and death by suicide between the two groups. Although it did not achieve statistical significance, there was a possible association between having a mood disorder diagnosed in the ED or during a hospitalization and a gap in care (1.38, 0.92, 2.07) (Table 3). Because of the small number of attempted and completed suicides, we could not run regression models. In the adjusted models, older age at transfer, recent birth year; and higher number of ED-visits and outpatient visits in the year before, were associated with an increased risk of mood disorders diagnosed in the ED or hospital (Table 4).

Secondary outcomes

Compared to those without a gap in a care, the incidence rate of visiting a psychiatrist at least once was higher in those with a gap in care, while the incidence rate of mood disorders diagnosed in the clinic was lower in those with a gap in care (Table 2). There was no difference in the incidence rate of schizophrenia between the groups. None of the above findings reached statistical significance.

Gaps in care were not associated with an increase in the risk of mood disorders diagnosed in clinic, schizophrenia or visit to a psychiatrist (Table 3). In multivariable Cox regression models, women, recent birth year, older age at transfer, referral to an internist (compared to adult endocrinologist) and the number of outpatient visits in the year before transfer was associated with an increased risk of mood disorders diagnosed in clinic. Recent birth year, older age at transfer, increased social deprivation and number of ED visits before transfer increased the risk of have at least one visit to a psychiatrist. Schizophrenia was not associated with any of the baseline variables (Table 4).

Combined outcomes

There was no significant difference in the risk of the combined outcomes, any psychiatric disorder, between the groups (Tables 2-3). Recent birth year, older age and the number of ED-visits in the year before transfer were associated with an increased the risk of any psychiatric disorder (Table 4).

Sensitivity analysis

We included 1,886 individuals in the sensitivity analysis, of which 584 (31%) had a gap in care ≥ 365 days; including 114 that did not have an adult diabetes care visit. Results of the sensitivity analyses were similar to those of the main analyses (Appendix, Table 1).

DISCUSSION

In this population-based cohort study, 42% of emerging adults had a > 180-day gap between their last paediatric and first adult diabetes care visit. Gaps (> 180 or ≥ 365 days) were not associated with an increased risk of psychiatric disorders, but a trend towards an increasing risk of mood disorders was observed with these gaps.

Almost half of emerging adults in our cohort experienced a >180-day gap in care, among whom the median duration of a gap in care was high. We report a higher percentage of emerging adults with gaps in care > 180 days than previously reported in older Canadian studies [12, 27], but comparable to more recent findings from Canada (47%) [25] and the United States (34%) [11]. Further, the median (367 days) duration of a gap in care was similar to durations in gaps in care reported in another Canadian study by Shulman et. al., that reported a mean duration of 267 ± 55 days[25]. The lack of improvement in establishing adult care suggests that barriers to a timely

diabetes care transition continue to exist. Our findings are concerning, as >90-day gaps in care are associated with greater perceived stress, decreased life satisfaction, higher HbA1c and increased ED use, [13] while >365-day gaps in care are associated with increased risk of DKA and death [25].

Emerging adults with diabetes are at increased risk of psychiatric disorders during the transition to adulthood and adult diabetes care [8]. Prolonged gaps in care may be associated with psychiatric outcomes; however, our results suggest that other factors may also play a role.

Recent birth year

Recent birth year was associated with an increased risk of mood disorders, visit to a psychiatrist and diagnosis of any psychiatric disorder. Increased mental health awareness among diabetes care providers may explain some of the results, although this has not been studied. Further, the increasing complexity and intensity of diabetes management in more recent years might have heightened the mental health burden among older adolescents and emerging adults with diabetes born in more recent years [28].

Age at transfer

Emerging adults who are older at the time of transfer were more likely to experience mood disorders, visit a psychiatrist at least once or be diagnosed with any psychiatric disorder. Age at transfer is independent from recent birth year, as one individual born in 1982 and another in 1997, may have both been transferred to adult care at age 18 years in 2000 and 2015, respectively. The underlying mechanisms of our findings requires further investigation. Arguably, adolescents without a formal diagnosis of a psychiatric disorder could have been voluntarily retained in paediatric care as they either had subclinical symptoms and were waiting to see a psychiatrist or the adolescent had identified needs that were not yet diagnosed. As such, paediatric providers may

have been reluctant to transfer their patients because of a perceived lack of mental health resources within adult care [29-31]. However, if at-risk adolescents were retained in paediatric care this could have biased our results and may partly explain the non-significant association we found between gaps in care and mental health disorders. Despite the possibility that a small group of at-risk individuals may have been retained in paediatric care, the mean age at transfer of all individuals experiencing a gap in care was slightly lower than that of individuals who did not experience a gap.

ED-visits and outpatient visits

Individuals visiting the ED more frequently before transfer were more likely to be diagnosed with a mood disorder in the ED or hospital, visit a psychiatrist or be diagnosed with any psychiatric disorder. A previous study demonstrated that individuals with psychiatric disorders are more likely to visit the ED for any reason compared to individuals without psychiatric disorders [32]. As higher HbA1c is associated with an increased risk of psychiatric comorbidities [33], individuals with worsening diabetes control might present to the ED more frequently with subclinical mental health symptoms before being formally diagnosed. Increasing frequency of outpatient visits preceding transfer was associated with increased risk of a mood disorder diagnosis. Emerging adults with early psychiatric symptoms or who are struggling with the challenges of transition and the burden of diabetes management may also be seeking more help in the ED or outpatient clinics before their eventual transfer.

Adult physician specialty

Transfer to an internist compared to an adult endocrinologist was associated with a higher risk of being diagnosed with a mood disorder in clinic. Internists may be more likely to inquire about mood disorders or explore psychiatric disorders as part of their practice. Adult endocrinologists

have identified a lack of accessible mental health professionals as a barrier to diabetes management among emerging adults with psychiatric disorders[31]. Further research should investigate whether psychosocial wellbeing or the mental health of emerging adults are being appropriately assessed by adult endocrinologists.

Strengths and limitations

This is the first population-based study to examine the association of gaps in establishing diabetes care and psychiatric disorder risk; however, our study has some limitations. It is observational in nature, and therefore no causation links can be established between gaps in care and risk of psychiatric disorders. Using administrative data, we could not distinguish between type 1 and type 2 diabetes within our cohort and although the vast majority of youth with diabetes have type 1 diabetes; the transition care needs of those with type 2 diabetes may differ and require further study. We did not include HbA1c in our analysis as lab data is not available in our administrative databases. We could not capture whether the gaps in care occurred as a result of patient-related factors (i.e., non-adherence to visits) or health-system related factors (i.e., access to adult provider). However, in general, in Quebec, patients are retained in paediatric care until they have a booked appointment with their adult care provider. Research suggests that case ascertainment of psychiatric illness can take time; therefore, there can be long delays in a formal diagnosis, including for depressive disorders in some individuals[34]. As such, we were not able to determine if the difference between whether a youth who received a psychiatric diagnosis after transfer to adult care actually developed that condition post-transfer, versus whether it existed but was simply unidentified before transfer. However, these delays in diagnosis are non-differential between those with gaps and those without and therefore would have biased our results towards the null. Our observed lower incidence rates of mood disorders diagnosed in clinic in individuals with a gap in

care may be due to decreased outpatient clinic attendance rather than a true decreased risk, resulting in decreased opportunities to be diagnosed with a mood disorder.

In summary, gaps in establishing adult diabetes care in emerging adults with diabetes may be associated with an increased risk of psychiatric disorders. Risk factors identifiable during the transition period should be ascertained to provide appropriate mental health screening and support for the emerging adult. Future research should examine the association of psychiatric disorders with HbA1c, diabetes technology use or DKA rates during the transition period.

REFERENCES:

1. Arnett, J.J., Emerging adulthood. A theory of development from the late teens through the twenties. Am Psychol, 2000. 55(5): p. 469-80.
2. Weissberg-Benchell, J., H. Wolpert, and B.J. Anderson, Transitioning from pediatric to adult care: a new approach to the post-adolescent young person with type 1 diabetes. Diabetes Care, 2007. 30(10): p. 2441-6.
3. Blum, R.W., et al., Transition from child-centered to adult health-care systems for adolescents with chronic conditions. A position paper of the Society for Adolescent Medicine. J Adolesc Health, 1993. 14(7): p. 570-6.
4. Wills, C.J., et al., Retrospective review of care and outcomes in young adults with type 1 diabetes. Bmj, 2003. 327(7409): p. 260-1.
5. Lotstein, D.S., et al., Transition from pediatric to adult care for youth diagnosed with type 1 diabetes in adolescence. Pediatrics, 2013. 131(4): p. e1062-70.
6. Bryden, K.S., et al., Poor prognosis of young adults with type 1 diabetes: a longitudinal study. Diabetes Care, 2003. 26(4): p. 1052-7.
7. Nakhla, M., et al., Transition to adult care for youths with diabetes mellitus: findings from a universal health care system. Pediatrics, 2009. 124(6): p. e1134-41.
8. Robinson, M.E., et al., Risk of Psychiatric Disorders and Suicide Attempts in Emerging Adults With Diabetes. Diabetes Care, 2020. 43(2): p. 484-486.
9. Plener, P.L., et al., Depression, metabolic control, and antidepressant medication in young patients with type 1 diabetes. Pediatr Diabetes, 2015. 16(1): p. 58-66.
10. Peters, A. and L. Laffel, 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(11): p. 2477-85.
11. Garvey, K.C., et al., Health care transition in patients with type 1 diabetes: young adult experiences and relationship to glycemic control. Diabetes Care, 2012. 35(8): p. 1716-22.
12. Pacaud, D., McConnell, B., Huot, C., Aebi, C. & Yale, J. , Transition from pediatric care to adult care for insulin-dependent diabetes patients. Can. J. Diabetes, 1996.
13. Pyatak, E.A., et al., Challenges contributing to disrupted transition from paediatric to adult diabetes care in young adults with type 1 diabetes. Diabet Med, 2014. 31(12): p. 1615-24.
14. Pyatak, E.A., et al., Clinical and Psychosocial Outcomes of a Structured Transition Program Among Young Adults With Type 1 Diabetes. J Adolesc Health, 2017. 60(2): p. 212-218.
15. Blais, C., et al., Quebec Integrated Chronic Disease Surveillance System (QICDSS), an innovative approach. Chronic Dis Inj Can, 2014. 34(4): p. 226-35.

16. Dart, A.B., et al., Validation of a pediatric diabetes case definition using administrative health data in manitoba, Canada. Diabetes Care, 2011. 34(4): p. 898-903.
17. Steele, L.S., et al., Using administrative data to measure ambulatory mental health service provision in primary care. Med Care, 2004. 42(10): p. 960-5.
18. Toulany, A., et al., Association of Primary Care Continuity With Outcomes Following Transition to Adult Care for Adolescents With Severe Mental Illness. JAMA Netw Open, 2019. 2(8): p. e198415.
19. Kisely, S., et al., Use of administrative data for the surveillance of mental disorders in 5 provinces. Can J Psychiatry, 2009. 54(8): p. 571-5.
20. Surveillance of Mental Disorders in Québec: Prevalence, Mortality and Service Utilization Profile. 2013, Institut National De Santé Publique Du Quebec: Quebec City.
21. Pampalon, R., et al., An area-based material and social deprivation index for public health in Quebec and Canada. Can J Public Health, 2012. 103(8 Suppl 2): p. S17-22.
22. Pampalon, R., et al., A deprivation index for health planning in Canada. Chronic Dis Can, 2009. 29(4): p. 178-91.
23. Pampalon, R., J. Martinez, and D. Hamel, Does living in rural areas make a difference for health in Quebec? Health Place, 2006. 12(4): p. 421-35.
24. Statistical Area Classification (SAC). 2015; Available from: https://www150.statcan.gc.ca/n1/pub/92-195-x/2011001/other-autre/saccss/sac-css-eng.htm.
25. Shulman, R., et al., Diabetes transition care and adverse events: a population-based cohort study in Ontario, Canada. Diabet Med, 2018. 35(11): p. 1515-1522.
26. Hosmer, H.D., S. Lemeshow, and S. May, Applied Survival Analysis: Regression Modeling of Time-to-Event Data, Second Edition. 2011: Wiley-Blackwell.
27. Pacaud, D., et al., Problems in transition from pediatric care to adult care for individuals with diabetes. Can J Diabetes., 2005. 29(1): p. 13-18.
28. Madsen, S.D., G.I. Roisman, and W.A. Collins, The intersection of adolescent development and intensive intervention: age-related psychosocial correlates of treatment regimens in the diabetes control and complication trial. J Pediatr Psychol, 2002. 27(5): p. 451-9.
29. Nakhla, M., et al., Improving the transition from pediatric to adult diabetes care: the pediatric care provider's perspective in Quebec, Canada. BMJ Open Diabetes Res Care, 2017. 5(1): p. e000390.
30. Michaud, S., et al., Adult care providers' perspectives on the transition to adult care for emerging adults with Type 1 diabetes: a cross-sectional survey. Diabet Med, 2018. 35(7): p. 846-854.
31. Garvey, K.C., et al., Health Care Transition in Young Adults With Type 1 Diabetes: Perspectives of Adult Endocrinologists in the U.S. Diabetes Care, 2016. 39(2): p. 190-7.
32. Baillargeon, J., et al., Medical emergency department utilization patterns among uninsured patients with psychiatric disorders. Psychiatr Serv, 2008. 59(7): p. 808-11.
33. Bryden, K.S., et al., Clinical and psychological course of diabetes from adolescence to young adulthood: a longitudinal cohort study. Diabetes Care, 2001. 24(9): p. 1536-40.
34. Wang, P.S., et al., Failure and delay in initial treatment contact after first onset of mental disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry, 2005. 62(6): p. 603-13.

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TABLES

Table 1. Characteristics of the study population at the time of transfer from paediatric to adult diabetes care

	Gap in care > 180 days N= 740	Gap in care ≤ 180 days N=1,032	P-value
Age at diabetes diagnosis in years	10.9 ± 3.3	10.8 ± 3.2	0.30
1-4 years	36 (4.9)	49 (4.8)	
5-9 years	189 (26)	269 (26)	
10-15 years	515 (70)	714 (69)	0.97
Age at transfer (years)	17.9 ± 1.1 [15.5, 23.5]	18.5 ± 1.1 [15.5, 24.4]	<0.0001
Duration of follow-up after transfer (years)	5.1 ± 2.3 [0.0, 9.0]	4.4 ± 2.4 [0.0, 9.0]	<0.0001
Duration of the gap in care (days)	367 (251, 639) [182, 3,012]	92 (56, 127) [1, 180]	<0.0001
Men	423 (57)	546 (53)	0.08
Social deprivation quintile			
Missing	25 (3.4)	28 (2.7)	
1 (Least deprived)	156 (21)	277 (27)	0.17
2	156 (21)	206 (20)	
3	144 (19)	190 (18)	
4	145 (20)	189 (18)	
5 (Most deprived)	113 (15)	142 (14)	
Material deprivation quintile			
Missing	4 (0.6)	6 (0.6)	
1 (Least deprived)	149 (21)	247 (25)	
2	163 (23)	221 (22)	0.11

3	130 (18)	191 (19)	
4	133 (19)	195 (19)	
5 (Most deprived)	141 (20)	149 (15)	
Rural residency	127 (17)	161 (16)	0.38
Birth year			
1982	<10	<10	0.56
1983	13 (1.8)	24 (2.3)	
1984	29 (3.9)	36 (3.5)	
1985	33 (4.5)	43 (4.2)	
1986	37 (5.0)	45 (4.4)	
1987	43 (5.8)	59 (5.7)	
1988	51 (6.9)	72 (7.0)	
1989	65 (8.8)	80 (7.8)	
1990	67 (9.0)	83 (8.0)	
1991	74 (10)	97 (9.4)	
1992	65 (8.8)	109 (11)	
1993	78 (11)	96 (9.3)	
1994	78 (11)	99 (9.6)	
1995	61 (8.2)	91 (8.8)	
1996	30 (4.1)	61 (5.9)	
1997	<10	16	
1998	<10	<10	
Number of ED visits in prior year	0.74 ± 1.26 [0, 12] 0 (0, 1)	0.66 ± 1.22 [0, 11] 0 (0, 1)	0.17
Number of diabetes-related ED visits in the prior year	0.28 ± 0.63 [0, 5] 0 (0, 0)	0.21 ± 0.58 [0, 5] 0 (0, 0)	0.014

Number of hospitalizations in prior year	0.19 ± 0.65 [0, 7] 0 (0, 0)	0.18 ± 0.61 [0, 6] 0 (0, 0)	0.65
Number of outpatient clinic visits in prior year	4.67 ± 4.48 [1,68] 4 (2, 6)	6.68 ± 5.14 [0,50] 5 (4, 8)	<0.0001
Specialty of Adult Physician Being transferred to			
Adult endocrinologist	401 (54)	697 (68)	<0.0001
Internist	89 (12)	118 (12)	
Family physician	247 (34)	209 (20)	
Missing	<10	<10	

Data are presented as mean ± SD, range [min-max], median (quartile 1, quartile 3) or n (%).

The p-value was obtained using t-tests for continuous variables and chi square tests for categorical variables.

Abbreviations: ED: Emergency Department
Rural population refers to population < 10,000. Urban population refers to population > 10,000.

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Table 2. Incidence rates of psychiatric outcomes occurring between the date of transfer and age 25 years among emerging adults with diabetes with and without gaps in care

	Gap in care > 180 days N= 740	Gap in care ≤ 180 days N=1,032	p-values
Primary Outcomes			
Mood disorders diagnosed in the ED or hospital	63 (1.67) [1.29, 2.12]	51 (1.12) [0.86, 1.48]	0.04
Hospitalization for suicide attempts	≤5 (0.03) [0.002, 0.12]	≤5 (0.02) [0.001, 0.11]	0.99
Completed suicides	≤5 (0.00)	≤5 (0.02) [0.001, 0.11]	0.99
Secondary Outcomes			
Mood disorders diagnosed in the clinic only	74 (1.96) [1.55, 2.45]	117 (2.58) [2.14, 3.08]	0.08
Visits to a psychiatrist	95 (2.50) [2.05, 3.06]	92 (2.03) [1.64, 2.47]	0.16
Schizophrenia	≤5 (0.05) [0.01, 0.17]	≤5 (0.07) [0.02-0.18]	0.99
Combined Outcome			
Any psychiatric disorder	148 (3.92) [3.33, 4.59]	170 (3.74) [3.21, 4.34]	0.72

Data are presented as n (incidence rates per 100 person-year), [CI]
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Abbreviations: ED: emergency department; CI; 95% confidence interval

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Table 3. Univariate and Multivariable Cox proportional hazard models of psychiatric outcomes in individuals with gaps in care versus those without

	Univariate model	Full Model***
Primary Outcomes		
Mood disorders diagnosed in the ED or hospital	1.22 (0.83, 1.77)	1.38 (0.92, 2.07)
Secondary Outcomes		
Mood disorders diagnosed in the clinic only	0.73 (0.55, 0.98)	0.84 (0.61, 1.15)
Visit to a psychiatrist	1.13 (0.85, 1.51)	1.18 (0.86, 1.61)
Schizophrenia	0.82 (0.14, 4.93)	0.32 (0.02, 4.62)
Combined Outcome		
Any psychiatric disorder	0.92 (0.74, 1.15)	0.96 (0.76, 1.23)

Data are presented as hazard ratio (CI)

Abbreviations: aHR: adjusted hazard ratio; CI: 95% confidence interval; ED: emergency hospital; HR: hazard ratio

***Model was adjusted for the following variables: social deprivation, material deprivation, rural residency, birth year, sex, age at transfer (which is defined as more than 180 days after the last paediatric visit), specialty of adult physician that emerging adult was transferred to, number of ED visits in the year prior to the transition date, number of outpatient visits in the year prior to transition date and number of hospitalizations in the year prior to transition date.

Fully adjusted models could not be performed for hospitalized suicide attempts and deaths by suicide because of insufficient number of events.

Table 4. Multivariable Cox proportional hazard ratios of psychiatric outcomes

	Primary outcomes	Secondary outcomes			Combined outcome
	Mood disorders diagnosed in the ED or hospital	Mood disorders diagnosed in the clinic	Visit to a psychiatrist	Schizophrenia	Any psychiatric disorder
Gap in care (reference: no gap in care)	1.38 (0.92, 2.07)	0.84 (0.61, 1.15)	1.18 (0.86, 1.60)	0.32 (0.02, 4.61)	0.96 (0.76, 1.23)
Social deprivation (most compared to least deprived)	1.19 (0.66, 2.13)	1.12 (0.69, 1.82)	1.82 (1.11, 3.01)	4.00 (0.31, 50.88)	0.96 (0.66, 1.41)
Material deprivation (most compared to least deprived)	1.60 (0.84, 3.06)	0.82 (0.48, 1.39)	1.08 (0.67, 1.73)	1.45 (0.06, 33.84)	1.08 (0.73, 1.61)
Sex (reference: men)	0.75 (0.50, 1.13)	1.57 (1.16, 2.13)	1.04 (0.77, 1.42)	1.39 (0.15, 12.70)	0.98 (0.76, 1.27)
Rural residency* (reference: urban)	1.10 (0.66, 1.85)	0.84 (0.54, 1.30)	0.90 (0.57, 1.40)	1.95 (0.16, 24.24)	0.75 (0.51, 1.10)
Birth year (every one-year increase)	1.13 (1.05, 1.22)	1.07 (1.01, 1.13)	1.13 (1.07, 1.20)	0.79 (0.57, 1.09)	1.15 (1.10, 1.20)
Age at transfer	1.58 (1.31, 1.91)	1.33 (1.14, 1.55)	1.35 (1.15, 1.57)	1.35 (0.45, 3.99)	1.40 (1.22, 1.60)
Physician type post-transfer					
Endocrinologist	1.00	1.00	1.00	1.00	1.00
Internist	1.08 (0.57, 2.05)	1.70 (1.11, 2.60)	1.31 (0.84, 2.05)	3.15 (0.25, 39.43)	1.05 (0.73, 1.51)
Family physician	1.32 (0.85, 2.03)	1.30 (0.91, 1.86)	1.03 (0.72, 1.47)	1.40 (0.12, 17.10)	0.97 (0.74, 1.29)
Number of ED visits in the prior year	1.21 (1.09, 1.35)	1.07 (0.95, 1.20)	1.19 (1.08, 1.30)	1.18 (0.47, 2.97)	1.13 (1.04, 1.23)

Number of outpatient visits in the prior year	1.04 (1.01, 1.07)	1.02 (1.0-1.05)	1.01 (0.98-1.04)	0.94 (0.61-1.45)	1.02 (0.99, 1.04)
Number of hospitalizations in the prior year	1.02 (0.78, 1.32)	0.93 (0.71-1.22)	1.16 (0.97-1.38)	Not estimable from the model	0.87 (0.74, 1.03)

Data are presented as hazard ratio (CI)

Models were adjusted for gap in care social and material deprivation index, sex, rurality, birth year, age at transfer, specialty of the adult physician being transferred to, number of ED-visits in the prior year, number of outpatient visits in the prior year, and number of hospitalizations in the prior year.

Abbreviations: aHR: adjusted hazard ratio; CI: 95% confidence interval; ED: Emergency Department

Fully adjusted models were not done for hospitalized suicide attempts and deaths by suicide because of insufficient number of events.

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