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Predictors of Deteriorations in Diabetes Management and Control in Adolescents With Type 1 Diabetes

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ABSTRACT

Purpose: Deteriorating type 1 diabetes management and control are common among adolescents; however, clinical evidence suggests that individual trajectories can vary. The aim of this study was to examine patterns and predictors of blood glucose monitoring (BGM) frequency and glycemic control (hemoglobin A1c).

Methods: Prospective data analysis spanning 18–24 months was conducted with 150 adolescent–parent pairs. Latent group-based trajectory modeling identified subgroups and determined medical, demographic, psychological, and family predictors of subgroup membership.

Results: Three subgroups emerged, representing diabetes management and control that are "meeting treatment targets" (40%; A1c at baseline = 7.4%, BGM frequency at baseline = 4.8 checks/day) and two levels "not meeting targets":"normatively similar" youth (40%; A1c = 9.2%, BGM frequency = 2.8 checks/day), and "high-risk" youth (20%; A1c = 11.2%, BGM frequency = 2.9 checks/day). Subgroup membership was maintained over 18–24 months. There was minimal change across time, although only one-third of adolescents met treatment targets. Older age, longer diabetes duration, ethnic minority status, unmarried caregiver status, insulin delivery via injections versus continuous subcutaneous insulin infusion, greater depressive symptoms, negative affect about BGM, and diabetes-specific family conflict each predicted membership in a subgroup with poorer diabetes management and control.

Conclusions: Among the nearly two-thirds of adolescents with management and control that do not meet treatment targets, modifiable and nonmodifiable factors may signal the need for prevention or intervention. Demographic and medical factors may call for proactive efforts to prevent deterioration, and psychological symptoms and family conflict signal opportunities for clinical intervention to promote improved diabetes management and control in adolescence.

IMPLICATIONS AND CONTRIBUTION

Many adolescents with type 1 diabetes meet treatment goals; however, nearly two-thirds engage in suboptimal diabetes management and have an out-of-range glycemic control. Depressive symptoms, diabetes-related distress, and family conflict raise some teens' risk for poorer diabetes management and control, and these issues may be important targets of intervention.

The treatment regimen for type 1 diabetes is complex and demanding [1]. Data from large-scale clinical and epidemiological studies show that deteriorations in diabetes management and control are common during adolescence [2–8]. These deteriorations raise the risk for complications and contribute to rising health care costs [9]. However, clinical observations and study

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data reveal substantial individual differences in diabetes management and control [7,10,11].

Researchers have begun to delineate subgroups of pediatric patients with distinct patterns of diabetes management and control. Rohan et al [10] detected three distinct patterns of diabetes management behaviors in early adolescence. Studies by Helgeson et al [11] and Luyckx and Sieffge-Krenke and colleagues [7] identified similar subgroups of adolescents and young adults characterized by optimal, moderate, or poor/deteriorating glycemic control over 5 and 10 years, respectively. Classifying the patient population into subgroups is valuable for estimating individuals' relative risk for particular outcomes over time and determining the appropriate type, level, and timing of treatment strategies. Using these data, clinicians can tailor treatment plans and appropriately allocate clinical resources for prevention and intervention (i.e., personalized care planning) [12].

To our knowledge, patient subgroups based on longitudinal trajectories of both diabetes management behaviors and glycemic control have not been identified. However, clinicians routinely make treatment decisions based on both pieces of data. Despite this and the established associations between management and glycemic outcomes [13], the manner in which management behaviors and glycemic control change together over time remains unclear. Thus, the aims of the current study were twofold. First, we aimed to characterize subgroups of adolescents with type 1 diabetes based on 18- to 24-month trajectories of both diabetes management and control. Based on previous work [7,10], we hypothesized that individuals would cluster into three subgroups. Given growth, hormonal changes, and developmental demands across social, academic, family, and interpersonal domains that are linked with declining glycemic control [2,11,14], we expected deterioration over time in all subgroups. The second aim was to identify predictors of membership in each trajectory subgroup. Based on previous findings indicating associations of demographic, medical, and potentially modifiable behavioral, emotional, and family characteristics with diabetes outcomes [3–5,7,8,10,11,15–18], we anticipated that variables in each of these classes would predict subgroup membership.

Methods

Participants

Participants were adolescents aged between 13 and 18 years diagnosed with type 1 diabetes (mean age = 15.5 ± 1.4 years) receiving multidisciplinary care for type 1 diabetes at a tertiary pediatric medical center. We approached 166 families to participate in the study, and enrolled and collected baseline data from 150 (90% recruitment rate). Retention rates were 98% at the second visit, 97% at the third visit, and 89% at the fourth visit. Attrition was generally because of an inability to make contact at follow-up. The sample was 51% female, primarily Caucasian (86%), from two-parent families (75%), and covered by private insurance (85%). Parents who participated were largely mothers (85%), 47% of whom had earned a college or advanced degree. The mean duration of diabetes at baseline was 6.0 ± 3.9 years, and the mean hemoglobin A1c (A1c) was 8.8 ± 1.9%; 63% of participants used continuous subcutaneous insulin infusion (CSII), with the remainder of participants on basal-bolus injections.

Procedure. Potentially eligible diabetes center patients were identified and screened to ensure English language fluency and the absence of a severe psychiatric, neurocognitive, or other serious chronic medical condition that would interfere with the ability to participate. Research staff obtained written informed consent and assent from parents and adolescents, respectively, and administered questionnaires before or after every other quarterly diabetes clinic visit. Because of slightly longer intervals between appointments, the mean time from first to second visit was 7.0 ± 1.7 months, from first to third visit was 13.4 ± 2.3 months, and from first to fourth visit was 19.7 ± 3.0 months. Participants received $10 per visit in appreciation of their time and effort. The hospital's institutional review board approved this study.

Measures.

Outcomes. Hemoglobin A1c, the gold standard measure of diabetes control, was collected at diabetes clinic visits. A1c values obtained at the clinic visit closest to each study visit were abstracted from the medical chart. Participants provided a sample of blood for A1c, which was measured using DCA+ 2000 (reference range = 4.3%–5.7%; Bayer, Inc., Tarrytown, NY).

Diabetes management was quantified using the frequency of blood glucose monitoring (BGM), given data demonstrating the key role of BGM in diabetes management and control [5]. BGM frequency data were downloaded from adolescents' blood glucose meters, which they brought to diabetes clinic visits, and were averaged over the previous 14 days. Downloads were available for 77% of the sample at the first visit. For the remainder, self-report or clinician report based on the review of blood glucose meter data or clinical interactions was used. Neither A1c values ($p = .77$) nor BGM frequency ($p = .19$) at baseline differed by the source of BGM frequency data.

Predictors. Measures assessing each predictor were completed by caregivers or adolescents at the baseline study visit. Caregivers provided demographic data, including adolescent age, gender, and ethnicity; caregiver marital status and education; and family insurance coverage. Medical data including diabetes duration and insulin delivery method (injections vs. CSII) were verified through medical chart review.

As a measure of general emotional distress, adolescents completed the Children's Depression Inventory (CDI) [19], a self-report measure of depressive symptoms. Depressive symptoms including irritability and decreased energy and motivation are known risk factors for poorer diabetes management and control [16,20,21]. Adolescents rated their level of depression on 27 items, with higher scores reflecting more depressive symptoms (possible range: 0–54). Internal consistency in this sample was good ($\alpha = .84$).

To assess diabetes-specific emotional distress, adolescents completed the Blood Glucose Monitoring Communication questionnaire (BGMC) [22]. Diabetes-specific emotional distress uniquely contributes to youths' glycemic control [22]. Adolescents reported how frequently they typically experience 8 negative emotions (e.g., scared, frustrated) relating to blood glucose values on a 3-point Likert scale (almost never to almost always). Higher scores indicate more negative affect related to BGM (range = 0−16). The BGMC has demonstrated strong psychometric properties [22], and this sample's internal consistency was adequate ($\alpha = .76$).

To measure family-level distress related to diabetes, caregivers completed the revised Diabetes Family Conflict Scale (DFCS)