The Intersection of Adolescent Development and Intensive Intervention: Age-Related Psychosocial Correlates of Treatment Regimens in the Diabetes Control and Complication Trial

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Objective: To provide evidence relevant to developmentally sensitive intervention and prevention of adolescents’ psychosocial distress associated with treatment of type 1 diabetes.

Methods: We used self-reports on the Diabetes Quality of Life and SCL-90-R inventories administered at baseline, 1, and 3 years following adolescents’ (n = 224) entry into the Diabetes Control and Complications Trial.

Results: Initiation of intensive treatment in early adolescence was associated with increasing school dissatisfaction; initiation in later adolescence resulted in marginal elevations in psychological distress.

Conclusions: Age at entry moderates impact of intensive treatment on reported psychosocial distress. Intervention and prevention efforts sensitive to the interaction of developmental tasks with health treatment goals may optimize the well-being of adolescents with type 1 diabetes.

Key words: adolescence; type 1 diabetes; intervention; psychosocial effects.

Adolescence has captured the attention of health care professionals as a period presenting problems, as well as great promise, for the successful treatment of patients with chronic illnesses. Although the rapid biological, social, and cognitive changes of adolescence can pose difficulties, the window between childhood and adulthood is thought to be an important time for establishing lifelong health habits, rendering adolescence a key period in which to substantially influence future health trajectories (Millstein, 1989).

The challenges of managing adolescent health pertain especially to the work of health professionals treating adolescents with type 1 diabetes. Managing this lifelong disease and minimizing its undesirable physiological sequelae require regular blood glucose monitoring, administering insulin at the appropriate dose, exercise, and attention to diet. Poor adherence to this regimen results in diminished glycemic control, which has been linked to a shortened life span.

The biological, social, and cognitive changes of adolescence pose special challenges to the successful management of type 1 diabetes. Biological changes, such as the introduction of pubertal hormones, heighten the risk for poor glycemic control, making the disease more challenging to manage.
Furthermore, self-management of type 1 diabetes often declines during adolescence (Johnson et al., 1992). Because of increased desires to fit in with peers coupled with a growing need for autonomy over one’s actions and body, adolescents often alter their treatment regimens without consulting a health care provider (Susman-Stillman, Hyson, Anderson, & Collins, 1997). In addition, developing cognitive abilities, although potentially enhancing understanding of the complexities of the disease and its treatment, also leave adolescents vulnerable to greater worries about their disease and concern that its successful treatment may be beyond their reach (Allen, Affleck, Tennen, McGrade, & Ratzen, 1984; Skinner & Hampson, 1998).

Developmental changes within adolescence also may moderate the effectiveness of treatments aimed at adolescents, with age-linked changes playing a key role in the success of treatments. Biological changes, for example, may disrupt optimal management, especially near the onset of puberty when glycemic levels first become more difficult to control. Developing cognitive skills in middle to late adolescence such as abstract thinking allows adolescents to consider more fully the potential long-term impact of type 1 diabetes, but increased adolescent egocentrism may create barriers between adolescents and their health care providers. Age-graded social changes such as high school entry, increased extrafamilial activities, and the initiation of dating relationships often result in older adolescents’ diminished adherence. Thus, as a moderator, age provides one avenue for broadly considering the role of development in treating adolescents with type 1 diabetes.

If intervention and prevention strategies are to address some of the developmentally linked barriers to the effective treatment of adolescents with type 1 diabetes, they must be sensitive to developmental as well as physiological considerations (Holmbeck et al., 2000; Varni, La Greca, & Spirito, 2000). To support the design of more effective interventions, we have examined how adolescents are affected by the intersection of diabetes-specific, intervention-specific, and age-related developmental issues. Such an analysis may provide increased understanding of the barriers to treating adolescents with type 1 diabetes and other chronic illnesses, providing the basis for more effective treatments.

The Diabetes Control and Complications Trial (DCCT) is an ideal point of departure for exploring the need for developmentally sensitive approaches to adolescent treatment. Its dual goals were prevention of complications associated with type 1 diabetes in individuals not yet experiencing them and intervention with those whose disease had progressed. The DCCT intervention/prevention effort was large-scale and longitudinal, including 1,441 13- to 39-year-olds who were followed for an average of 6.5 years (DCCT Research Group, 1986, 1987, 1988). Reports from the full sample (ages 13–39) indicate that the intervention significantly and meaningfully reduced the risk of onset and progression of retinopathy and neuropathy (DCCT Research Group, 1993).

Recognizing the distinctive treatment-related characteristics of adolescents, DCCT researchers separately examined the effectiveness of the intervention in the adolescent cohort (ages 13 to 17 at entry; DCCT Research Group, 1994). As in the full sample, both the risk of the onset and progression of diabetic complications were significantly reduced in the adolescent intensive intervention group, compared to the conventional treatment group. Still, even after becoming adults, intensively treated adolescents’ mean Hemoglobin A1c levels remained higher than corresponding levels in adult participants. Achieving near-normal glycemic levels proved to be difficult and also heightened the risk for hypoglycemia. Nonetheless, DCCT researchers concluded that intensive treatment is currently the best option for adolescents with type 1 diabetes, the short-term increase in hypoglycemia being offset by the demonstrated long-term health benefits of intensive treatment (DCCT Research Group, 1994).

Despite evidence that intensive interventions are advantageous to long-term health status, clinical decisions to adjust treatment are often made in response to patients’ perceptions of well-being (DCCT Research Group, 1996). In the DCCT, intensively treated patients’ reports of quality of life and psychiatric symptoms at the end of the trial generally were not significantly worse or better than their baseline levels. Effects of the DCCT intervention on the psychosocial well-being of the adolescent subset have not yet been examined separately, however, perhaps because adolescents were not anticipated to differ from adults in this domain. Given that type 1 diabetes has been demonstrated to place adolescents at an increased risk for psychological difficulties, it is reasonable to suspect that the demands of an intensive intervention might exacerbate this vulnerability (Gilbert, 1992; Varni, Babani, Wallander,
Method

Participants

This study relies on the longitudinal data available from the Diabetes Control and Complications Trial (DCCT), a 29-center prospective clinical trial evaluating the effectiveness of intensive diabetes treatment on long-term health outcomes. Of the 1,441 volunteers with type 1 diabetes, 224 were adolescents, ages 13 to 18 years at baseline (pretreatment). One hundred and six (47%) of these adolescents were male and 118 (53%) were female. Ninety-six percent of the adolescent subsample was Caucasian, and most were in the middle to upper socioeconomic classes.

In follow-up analyses for this study, adolescent participants were further divided into two groups: (1) younger adolescents, ages 13 to 15 years at entry \( n=131 \), and (2) older adolescents, ages 16 to 18 years at entry \( n=93 \). Participants were selected for the DCCT based partly on their likelihood to complete the trial. Accordingly, the retention rate was extremely high (DCCT Research Group, 1994). Finally, note that numbers vary slightly across analyses to maximize data available from each assessment.

Patients were randomly assigned to an intervention (intensive treatment) or control (conventional treatment) condition, producing two groups with remarkably similar characteristics at baseline (see DCCT Research Group, 1994, for details). The intervention itself was considered intense, with the ambitious goal of achieving near-normal glycemic levels. This task carried extensive demands, requiring at least three daily insulin injections in combination with frequent blood glucose monitoring, weekly 3 a.m. blood glucose checks, vigilant attention to the effects of diet and exercise on blood glucose levels, monthly clinic visits, and frequent telephone contacts for treatment adjustment to lower blood glucose levels. A control group received the best current standard treatment of type 1 diabetes then recommended. This conventional treatment typically included one or two daily insulin injections, once daily monitoring of blood glucose levels, attention to diet and exercise, and quarterly clinic visits. Although conventional regimens were adjusted to alleviate symptoms when necessary, treatment was not further intensified to lower blood glucose levels. The medical trial monitored the psychosocial well-being of all participants so that it...
might track potential psychological as well as biological impacts of the intervention. More detailed accounts of the DCCT design and methods are widely available (DCCT Research Group, 1986, 1987, 1988).

**Measures**

The following measures were administered annually, beginning at baseline:

*Diabetes Quality of Life (DQOL).* The DQOL is a self-report 60-question instrument that assesses satisfaction and functioning in school, at home, and at work. This instrument was designed for the DCCT and is intended to capture patients’ perceptions of how aspects of diabetes management affect their lives and life satisfaction (DCCT Research Group, 1988; Jacobson, 1994). The DQOL has demonstrated adequate reliability within adult samples. Items specifically aimed at assessing salient aspects of adolescents’ lives (e.g., parent-adolescent relationships, school achievement, and peer relationships) are included in the DQOL, resulting in four adolescent-specific scales: school dissatisfaction, school impact, parent impact, and school worry. Parent impact is composed of four items, whereas each of the other scales contains three items. Responses on these scales range from 1 (highest quality of life) to 5 (lowest quality of life). The adolescent subsample examined here produced reliability alphas that ranged from .48 to .67 on these scales. Though these reliabilities are marginal, we have nonetheless used these variables in analyses as they are the only quality of life indicators available in the DCCT.

*Symptom Checklist 90-Revised (SCL-90-R).* The SCL-90-R is a widely used measure of psychiatric symptoms in adults and adolescents as young as 13 years old (see Derogatis, 1994, for adolescent norm group). Patients self-administer this measure by indicating the degree to which they have been distressed by each of 90 symptoms in the past week. Items correspond to nine symptom distress dimensions: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The scoring system also allows for global measures of psychiatric distress, including the Global Severity Index (GSI), which was used in analyses here due to the relatively large intercorrelations among subscales. The GSI is calculated by summing the symptom distress dimension scores and seven additional items not subsumed under any of the dimensions and then dividing this sum by the total number of responses. It is considered to be the best single indicator of current level of distress in the SCL-90-R (Derogatis & Lazarus, 1994). Raw scores for the GSI were converted into standardized T scores. Based on the adolescent norm group, 10% of older adolescents and 4% of the younger adolescents in the trial had clinically significant elevations on the SCL-90-R at baseline (GSI ≥ T score of 63). Eight percent of adolescents in both the intensive and conventional treatment conditions had clinically significant GSI elevations at baseline. Finally, note that reliabilities generated from the responses of the adolescent subsample examined in this article are comparable to those published by Derogatis (1994), with alphas on SCL-90-R scales ranging from .77 to .90.

**Results**

**Overview**

For the DQOL variables, the significance of the three-way interaction between time (e.g., baseline, 1 year, and 3 years), treatment (intensive vs. conventional), and age (measured continuously) was tested using a mixed-design repeated measures multivariate analysis of variance (MANOVA), with treatment and age as between-subjects variables, and time as the within-subjects variable. While this initial conservative approach was used initially to minimize Type I error, given that time × treatment × age effects were not necessarily presumed a priori to be homogeneous across outcomes, exploratory univariate analyses using repeated measures analyses of variance (ANOVAs) were also examined for each of the DQOL global scales. In a complementary fashion, the time × treatment × age interaction was tested for the GSI of the SCL-90-R using a repeated measure ANOVA. Means and standard deviations of all outcome scales (DQOL global measures and the GSI from the SCL-90-R) are presented by age group at each assessment year in Tables I and II.

**Diabetes Quality of Life**

In accord with the conclusions of previous research with the full DCCT sample (DCCT Research Group, 1996), a repeated measures MANOVA revealed no significant multivariate effects for the time × treatment or time × treatment × age interactions across
group that entered the DCCT in early adolescence, \(F(2, 108) = 2.33, p = .10\), and a nonsignificant effect for the later entry group, \(F(2, 53) = .78, p = .46\).

Symptom Checklist 90-Revised

A repeated measure ANOVA revealed a marginally significant time \(\times\) treatment \(\times\) age effect for the GSI, \(F(10, 406) = 1.68, p = .08\). Importantly, in accord with our prediction, adolescents in the intensively treated group reported greater distress on the GSI across time than their conventionally treated peers. Moreover, the marginally significant three-way interaction of time \(\times\) treatment \(\times\) age suggested that, as hypothesized, intensively treated older adolescents experienced the largest increases in psychological distress relative to their conventionally treated counterparts.

Follow-up Analyses

As a check, mean baseline levels of dependent variables for which there was a significant or marginally significant time \(\times\) treatment or time \(\times\) treatment \(\times\) age effect were compared by treatment group across and within the earlier and later entry adolescent groups. It is notable that \(t\) tests revealed no significant differences in mean levels for school dissatisfaction by treatment group at baseline either across or within the adolescent groupings. Group means for the GSI also did not differ significantly by treatment group across or within the adolescent groups.

**Table II.** Means of Conventionally and Intensively Treated Adolescents on SCL-90-R Global Symptom Index by Age Group

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Global Severity Index</th>
<th>School dissat.</th>
<th>School Impact</th>
<th>Parent impact</th>
<th>School worry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>1</td>
<td>3</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>Younger (13–15)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>42.9</td>
<td>41.1</td>
<td>44.7</td>
<td>(.77)</td>
<td>(.64)</td>
</tr>
<tr>
<td>Intensive</td>
<td>43.6</td>
<td>40.0</td>
<td>44.8</td>
<td>(.90)</td>
<td>(.57)</td>
</tr>
<tr>
<td>Older (16–18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional</td>
<td>47.2</td>
<td>48.7</td>
<td>49.2</td>
<td>(.143)</td>
<td>(.119)</td>
</tr>
<tr>
<td>Intensive</td>
<td>43.4</td>
<td>46.3</td>
<td>50.3</td>
<td>(.95)</td>
<td>(.86)</td>
</tr>
</tbody>
</table>

SCL-90-R scores are average T values where larger values indicate greater distress. B = baseline; 1 = 1 year after baseline; 3 = 3 years after baseline.
at baseline. Finally, none of the time × treatment × sex interactions proved significant in follow-up analyses.

**Discussion**

The Diabetes Control and Complication Trial drew from the best medical knowledge on type 1 diabetes management; applied this knowledge in a long-term, large-scale, and comprehensive trial; and achieved unprecedented success in improving the health outcomes of hundreds of type 1 diabetes patients. Although these results warrant cautious interpretation, the data presented herein imply that age at treatment entry moderates the impact of intensive interventions on adolescents’ psychosocial well-being. Young adolescents (ages 13–15) assigned to the intensive intervention group reported greater increases in school dissatisfaction over time than their conventionally treated peers. In contrast, patients entering the trial in later adolescence (ages 16–18) reported marginal elevations in distress from psychiatric symptoms over time when assigned to the intensive intervention group.

The treatment plan advocated by the DCCT is already being implemented with adolescents in some treatment centers (Brink, 1997). The findings from our analyses of the psychosocial correlates of intensive diabetes-related intervention raise the possibility that treatment protocols in these centers, as well as those in centers offering other types of interventions, should attend to how developmental issues interact with health-related goals. Younger adolescents’ participation in the intensive treatment group was associated with rises in dissatisfaction over time with their conventionally treated peers. In contrast, patients entering the trial in later adolescence (ages 16–18) reported marginal elevations in distress from psychiatric symptoms over time when assigned to the intensive intervention group.

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The implications for younger adolescents contrast with those for older adolescents, according to our findings. Patients who began intensive treatment in later adolescence reported marginally increased general distress from psychiatric symptoms over time. More research is needed to specify the nature of this increased distress and to determine whether and how distress may be linked to specific features of treatment regimens. Perhaps the relatively intrusive character of the intensive treatment protocol disturbed aspects of close friendships and romantic relationships in later adolescence, heightening adolescents’ normatively increasing sensitivity toward establishing intimate relationships. If so, by being alert to the impact of treatment on outside relationships, health care providers may be able to give distressed adolescents tools for integrating their treatment with their social lives.

One alternative possibility deserves special attention, namely the possibility that unique demands of the intensive treatment regimen may have led to feelings of depression among older adolescents. Adolescents in the intensive intervention were given the ambitious goal of achieving near-normal levels of blood glucose, despite the fact that blood glucose levels are difficult to control during adolescence. This scenario parallels studies of learned helplessness in which individuals attempt to master a situation they cannot control. Over time, feelings of despair and even depression develop (Burns & Seligman, 1991; Delamater, 1992, 1993; Nolen-Hoeksema, Grigus, & Seligman, 1992). If specific evidence is found for this pathway to older adolescents’ distress, health care providers could monitor patients for signs of depression and social isolation and help them to appropriately attribute gains and setbacks in their treatment.

Including both positive and negative indicators of psychosocial well-being is a particular strength of the DCCT study and one to be emulated in future research. Still, our analysis of the impact of the intervention on psychosocial well-being is limited in several ways. First, all measures of psychosocial well-being were self-reported. Although adolescents’ personal perceptions of their well-being are important in their own right, external assessments would have increased confidence in our findings. Second, the study lacks a healthy adolescent control group. We cannot determine whether the demonstrated developmental trajectories in psychosocial well-being are normative for all adolescents, or
whether they stem from diabetes-specific issues that could be addressed in future treatment programs. A related concern is the fact that DCCT participants were relatively well functioning and, indeed, were selected for their likelihood of completing the trial, thus raising questions of representativeness. At the same time, however, these intake characteristics underscore the potential unexpected impact of treatment regimens for even apparently optimum candidates for intervention.

The findings presented here clearly must be interpreted with caution, as conservative statistical tests considering all outcomes did not yield significant time × treatment × age interaction effects. The findings do, however, provide further evidence that treatments motivated by improving physical health also may affect the psychosocial well-being of individuals, sometimes in unintended ways. Optimizing the impact of future prevention and intervention efforts on adolescents’ physical and psychosocial health requires both greater knowledge of, and vigilant attention to, the intersection of treatment tasks and normative developmental patterns. We offer four suggestions for designing developmentally sensitive approaches in future interventions and prevention efforts involving adolescents. Although these suggestions were conceptualized with respect to treatment of adolescents with type 1 diabetes, they are likely to apply to interventions addressing other aspects of adolescent health as well.

First, like other researchers (Holmbeck et al., 2000; Varni et al., 2000), we suggest that interventions involving adolescents consider patients within a developmental perspective. Treating patients in adolescence often may be challenging, because of developmental tasks that conflict with the goals of health care providers. For example, though adolescents with type 1 diabetes may share their doctors’ concern for enhancing their health, a stronger desire to fit in with peers in later adolescence may lead them to alter their eating and sleeping patterns. Looking beyond biological development in adolescence to other social and cognitive factors of influence may result in the development of a treatment plan that is less likely to be undermined by conflicting goals.

Second, interventions should be mindful of the fact that adolescent patients continue to develop during the course of treatment. Longitudinal studies including adolescents are critical for addressing our most important questions about successfully treating chronic illness. They also bring with them the inherent complication of patients who are developing and changing across these longitudinal studies. Although it is theoretically possible that there is one treatment course for the best possible health outcomes, it is unlikely that the most effective approach for a 13-year-old will work equally well with an 18-year-old. The most successful interventions and prevention efforts anticipate and adapt to developmental changes (e.g., the transition to high school or college, the development of romantic relationships).

Third, the rapid developmental changes during adolescence necessitate tracking short-term, intermediate, and long-term impacts of interventions. Adult interventions often consider psychosocial well-being only at the baseline and the end point of the study. When adolescents are included in interventions, however, this approach is unlikely to capture the unique effects of the intervention on their changing lives. This study showed the impact of the intervention on adolescents’ well-being long before they left the study as adults.

Last, developmentally sensitive interventions should attempt to delineate the processes involved in the success or the frustration of intervention goals. We have suggested that adolescent developmental tasks conflicting with intervention tasks may be partly responsible for the unintended psychosocial effects observed herein among adolescents in the DCCT. Whether or not this is so, as well as whether or not these effects affect the health of adolescent patients, cannot be fully determined from the broad markers of development used in this study (i.e., age groups) and well-being. Interventions that include a finer analysis of the processes that facilitate or block treatment goals are not only more likely to succeed but also will provide needed guidance for future prevention and intervention efforts.

Adolescence is likely to continue to be considered by health care professionals as a period fraught with problems and promise. One aim of a developmentally sensitive approach to interventions with adolescents is to improve our understanding of how these problems may be influenced by age-related psychosocial changes (Holmbeck et al., 2000). Understanding and adapting to the unavoidable interaction of developmental issues with interventions enhances the chances of devising treatments that uncover the long-term promise for better health for adolescents.
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