A 3-Year Prospective Study of Parent–Child Communication in Early Adolescents With Type 1 Diabetes: Relationship to Adherence and Glycemic Control

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Objective To examine changes in parent–child communication patterns and their relation to glycemic control and treatment adherence using observational data in a 3-year prospective multisite study of youth with type 1 diabetes aged 9–11 years at baseline and their families (n = 217). Methods Adolescents and caregivers participated in a diabetes problem-solving discussion. Families were rated on negative and positive communication and interactions using the Interaction Behavior Code. Results Maternal and paternal negative communication decreased over time, whereas adolescent and maternal positive communication and positive reciprocity increased. Baseline preadolescent youth and maternal positive communication predicted adherence 3 years later. Changes in family communication did not predict changes in glycemic control or adherence. Conclusions During the transition to adolescence, family communication changed in unexpected and positive ways. Additionally, the relationship of baseline family communication to subsequent adherence suggests the need to assess family communication concerning diabetes-related management during preadolescence.

Key words glycemic control; observational data; parent–adolescent communication; treatment adherence; type 1 diabetes.

The quality of parent–child relationships and family interactions plays an essential role in illness management among adolescents with type 1 diabetes (Tsioili et al., 2013) and may have an important role in the disruption of adherence and glycemic control that is observed during this developmental period (Anderson, Miller, Auslander, & Santiago, 1981; Drotar et al., 2013; Duke et al., 2008; Geffken et al., 2008; Jacobson et al., 1994; Lewin et al., 2006; Miller-Johnson et al., 1994). Lewin and colleagues (2006) examined the moderating effect of adolescents’ age on the relationship between their perceptions of diabetes management related to parental negativity and criticism, and glycemic control in a sample of adolescents between the ages of 8 and 18 years. Younger children’s (aged 8–12 years) reports of parental negativity and criticism did not predict metabolic control, whereas older adolescents (aged 13–18 years) who reported that their parents were more unsupportive, critical, and negative had worse glycemic control. Similarly, Duke et al. (2008) found that youth self-reports of critical parenting were related to worse glycemic control in a sample of children and adolescents aged 8–18 years. In a cross-sectional design, Miller-Johnson and colleagues’ (1994) examination of youth (aged 8–18 years) and parent reports of parental discipline, warmth,
behavioral support, and family conflict revealed that reports of parent–child conflict were consistently correlated with worse adherence and glycemic control. Geffken and colleagues (2008) also found that adolescents (aged 7–18 years) who perceived their parents as high in negativity and low in warmth had a greater probability of experiencing episodes of diabetic ketoacidosis (DKA).

In a prospective study, Jacobson et al. (1994) examined the influence of baseline levels of parent- and adolescent-reported family expressiveness, cohesion, and conflict on glycemic control 4 years later with adolescents between the ages of 9 and 16 years. Families who were perceived as the least expressive had the worst glycemic control 4 years later. Anderson et al. (1981) also found that adolescents who were in good metabolic control reported more family cohesion and less family conflict than adolescents who had fair or poor metabolic control. Pereira Berg-Cross, Almeida, and Machado (2008) revealed that family members’ reports of support were associated with better adherence in adolescents (aged 10–18 years). Finally, Drotar et al. (2013) noted that baseline levels of perceived mother and youth family conflict predicted less adequate glycemic control 1 year later.

Several observational studies have also identified consistent patterns of findings between positive family interaction and better glycemic control and between negative family interactions and problematic adherence to treatment. For example, Martin, Miller-Johnson, Kitzmann, and Emery (1998) found that warmth, emotional support, and effective conflict resolution were all associated with better glycemic control in a sample of adolescents between the ages of 8 and 18 years. Jaser and Grey (2010) noted that maternal positive reinforcement of adolescent behavior was associated with better metabolic control in adolescents (aged 10–16 years). Furthermore, Bobrow, AvRuskin, and Siller (1985) reported that poor adherence to diabetes treatment was associated with emotionally charged and confrontational interactions between adolescent girls (aged 12–17 years) and their mothers.

Because of the crucial role that parents play in managing their child’s illness, changes in the parent–child relationship and patterns of communication during the transition to early adolescence may affect the quality of treatment adherence and glycemic control. During adolescence, deteriorations in treatment adherence and glycemic control become most evident. Factors such as hormonal changes during puberty (Silverstein et al., 2005), changes in treatment responsibilities, and the parent–child relationship (Schwartz, Cline, Hansen, Axelrad, & Anderson, 2010) that occur during adolescence may be influential. Changes in communication patterns between parents and children during the transition to adolescence may also affect glycemic control and treatment adherence. As children transition to adolescence and undergo puberty, their attempt to individuate from their parents and develop an independent identity leads to challenges in their relationship with their parents (Laursen & Collins, 2004). Evolutionary theory also suggests that changes in the parent–child relationship that occur during the transition to adolescence can result in increased conflict and decreased warmth (Hill, 1988; Steinberg, 1989). Reciprocal influences between parents and children are evident as children make the transition to adolescence, especially when youth display high levels of negativity. Some studies have found that when a parent or adolescent displayed high levels of negative behaviors, this often leads to the other individual displaying higher levels of negativity (Rueter & Conger, 1998). With respect to positive communication patterns, attachment theory and interdependence models suggest that the parent–child relationship will remain stable over time in relationships with a history of responsiveness, warmth, and strong emotional bonds (Laursen & Collins, 2004).

Information concerning changes in family communication and relationship patterns during adolescence is largely lacking for adolescents with type 1 diabetes. However, individual differences in family communication patterns during adolescence may have important effects on health. For families with children with type 1 diabetes, poor communication patterns (i.e., high levels of negative communication and low levels of positive communication) may negatively impact the family’s ability to follow the treatment regimen and may negatively affect glycemic control (Anderson, 2004). On the other hand, positive patterns of family communication may promote an environment in which family members actively strive to follow the treatment regimen and strive toward good glycemic control (Anderson et al., 2009).

Previous research has established a link between family interactions and communication patterns and relevant behavioral and health outcomes among adolescents with type 1 diabetes. However, a number of methodological issues limit the conclusions that can be drawn from previous research. For example, the cross-sectional design of the majority of previous studies makes it impossible to ascertain the direction of influence. Additionally, when longitudinal studies have been used, they have relied on adolescent and maternal self-report of family communication (Jacobson et al., 1994). Moreover, developmental changes in parent–child communication are not well understood. In particular, little is known about developmental changes in patterns of parent–child communication...
and interactions with youth with type 1 diabetes during the transition to adolescence. The transition to adolescence is particularly important given the deterioration of adherence to treatment and glycemic control that often occurs during adolescence (Danne et al., 2001). In addition, previous research examining family relationships of children and adolescents with type 1 diabetes has relied on mother and/or child reports (Drotar, 1997; Jaser, 2011). Direct observation of family communication assesses behaviors of family members independent of self-appraisals (Kerig, 2001) and may relate to treatment adherence and glycemic control as children with type 1 diabetes transition to adolescence. Finally, most previous research has studied groups of adolescents with type 1 diabetes in samples with heterogeneous ages (Bobrow et al., 1985; Hanson, Henggeler, & Burghen, 1987; Hauser et al., 1986; Martin et al., 1998), which makes it difficult to ascertain the specific impact of the transition to adolescence.

The current study was designed to address some of the limitations of previous research by using a 3-year prospective follow-up study of parent–child communication during the developmental transition to adolescence in type 1 diabetes with a relatively large sample collected from three university-affiliated medical centers based on an observational method that has been shown to be reliable and valid in previous research on adolescents with type 1 diabetes (Wysocki et al., 2000, 2008). Our study had two aims: (1) to describe changes in parent–child communication during this transition and (2) to document the relationship of parent–child communication to treatment adherence (e.g., blood glucose monitoring frequency [BGMF]) and glycemic control at 3-year follow-up.

Given the scarcity of prospective and observational studies of family communication in adolescents with type 1 diabetes, we hypothesized that changes in parent–child communication involving youth with type 1 diabetes would follow similar trends as communication involving healthy adolescents from early to mid-adolescence. We expected the following changes: (a) negative communication and negative reciprocity would increase from preadolescence to early adolescence (Laursen, Coy, & Collins, 1998; Rueter & Conger, 1998) and (b) levels of positive communication and positive reciprocity would remain stable (Kim, Conger, Lorenz, & Elder, 2001; Laursen & Collins, 2004).

With respect to the second aim, previous cross-sectional studies have suggested that negative communication patterns between parents and adolescents with type 1 diabetes have a negative relationship to and potential impact on treatment adherence and glycemic control (Duke et al., 2008; Geffken et al., 2008; Lewin et al., 2006; Tsiouli et al., 2013). Our prospective data set allowed us to test alternative predictions concerning the relationship between family communication, treatment adherence, and glycemic control. One prediction was that increases in negative maternal, paternal, and child communication would be associated with deterioration in adherence and glycemic control as children with type 1 diabetes transitioned to adolescence. An alternative prediction was that baseline levels of family negative communication before the onset of adolescence would be the most powerful predictor of glycemic control and adherence 3 years later.

Cross-sectional research suggests that positive parent–child communication has a beneficial impact on adherence and control (Anderson et al., 1981; Martin et al., 1998; Pereira et al., 2008; Tsiouli et al., 2013). As with negative communication, one prediction was that increases in adolescent, maternal, and paternal positive communication as children transition to adolescence would be associated with positive changes in glycemic control and adherence. An alternative prediction was that positive communication before the onset of adolescence would predict better adherence and glycemic control 3 years later. These alternative predictions have different implications. For example, prediction of treatment adherence and glycemic control from baseline parent–child communication patterns would underscore the importance of ongoing family communication established during preadolescence for treatment adherence and glycemic control. Alternatively, findings concerning the predictive power of changes in family communication would suggest that the quality of family communication during the transition to adolescence is most relevant for treatment adherence and glycemic control.

**Method**

**Participants and Procedure**

Participants were youth with type 1 diabetes and their maternal and paternal caregivers who were followed at pediatric diabetes clinics at three university-affiliated medical centers in the United States. Institutional review boards at each site approved the study. Data were collected as part of a 3-year ongoing longitudinal study. This is the first article from this data set with a primary focus on family communication using observational data and 3-year outcomes. Three previous studies have been published using the 3-year outcomes from this data set (Hilliard et al., 2014; Rohan et al., 2014; Wu et al., 2014). However, the focus of these studies is different than that of the present study.

Children and their caregivers were recruited as part of a larger prospective study examining predictors of glycemic control.
control and treatment adherence during a routine outpatient clinic visit. Clinic staff identified potentially eligible participants who were then approached by research staff who provided families with information about the study. Inclusion criteria included a diagnosis of type 1 diabetes for at least 1 year, aged 9–11 years at the time of recruitment, English speaking, absence of potential secondary causes of their type 1 diabetes diagnosis (e.g., cystic fibrosis, glucocorticoid treatment), and no plans to move out of the area within the following 3 years. Families were excluded based on the following criteria: Current involvement in foster care at baseline, presence of severe psychiatric disorders, diagnosis of mental retardation, or comorbid chronic conditions (e.g., renal disease) that required intensive ongoing treatment.

Of the 361 families who were approached for the study, 240 (66.5%) provided consent and participated at baseline. Reasons cited for not participating included being too busy (n = 54), no transportation (n = 3), and other (n = 64; not interested in research, did not return recruitment phone calls, did not attend clinic regularly, etc.). A parent or legal guardian provided signed informed consent for each child, written assent was gathered from children who were 11 years old, and verbal assent was obtained from children <11 years old according to the guidelines established at the local institutional review board. After enrollment, one child was diagnosed with monogenic diabetes of the young, was no longer treated with insulin, and was thus dropped from the study and analysis.

This analysis included a subsample of adolescents and their families (N = 217) who completed at least three of the observational videos to allow a valid application of growth curve analysis (Singer & Willet, 2003). Families were contacted by researchers via phone calls and were approached during routine clinic visits. In addition, families were provided small monetary incentives for their participation. Families also received quarterly newsletters regarding the progress of the study and references to manuscripts that were published based on the study, thank-you cards for their participation, as well as birthday and holiday cards. Overall attrition from baseline to 3 years was 4.2% (n = 10). Reasons for attrition included: Child and/or family no longer interested in research, family moving out of the area, changed endocrinologists and the doctor was not affiliated with the hospital, or family would not schedule research visits. Twelve other families were not included in the analyses because they did not have at least three observations. There were no significant differences between baseline age, duration of type 1 diabetes, baseline HbA1c levels, primary caregiver education, race, baseline income, baseline household composition (one- vs. two-parent families), child’s gender, or 6-month HbA1c values between those who participated in three or four observational video follow-ups (n = 217) and those who did not (n = 22).

Demographic and medical characteristics of our subsample at baseline are shown in Table I. The sample

| Table I. Demographic Characteristics of Sample at Baseline |
|-------------------------------|---------------|-------------------|
|                                |   n (%)       |   Mean (SD); Range |
| Child age (years)              |   –           |   10.53 (0.93); 9.03–12.12 |
| Duration of diabetes (years)   |   –           |   4.33 (2.46); 1–11 |
| Tanner stage                   |               |                   |
| Male                           |   1.39 (0.59); 1.0–3.0 |
| Female                         |   1.94 (1.02); 1.0–5.0 |
| Child gender                   |               |                   |
| Male                           |   100 (46.1)  |   –               |
| Female                         |   117 (53.9)  |   –               |
| Child ethnicity                |               |                   |
| Non-Hispanic, Caucasian        |   165 (76.0)  |   –               |
| Non-Hispanic, other            |   24 (11.0)   |   –               |
| Hispanic                       |   28 (12.9)   |   –               |
| Insulin regimen                |               |                   |
| Conventional/multiple daily injections |   98 (45.2)  |   –               |
| Pump                           |   119 (54.8)  |   –               |
| Maternal caregiver education   |               |                   |
| Did not finish high school     |   6 (2.8)     |   –               |
| Obtained high school diploma/ general educational development (GED) |   61 (28.1)   |   –               |
| Some college/college degree    |   149 (68.7)  |   –               |
| Annual household income        |               |                   |
| <$18,745                       |   15 (6.9)    |   –               |
| $18,745–$32,874                |   15 (6.9)    |   –               |
| $32,874–$48,999                |   28 (12.9)   |   –               |
| $49,000–$72,999                |   45 (20.7)   |   –               |
| $73,000–$126,500               |   71 (32.7)   |   –               |
| >$126,500                      |   40 (18.4)   |   –               |
| Household                      |               |                   |
| Single parent                  |   46 (21.2)   |   –               |
| Two parent                     |   171 (78.8)  |   –               |
| Paternal participation in at least one observational video |   150 (69.1)  |   –               |
| Maternal and paternal participa- |   143 (65.9)  |   –               |
| tion in at least one observa- |               |                   |
| tional video                  |               |                   |

Note. Seven children were recruited at age 11 years but were not seen for baseline visits until after they turned 12 years of age because of study visit cancellations and reschedules.
(mean age 10.53 years) was composed of a comparable percentage of females (53.9%) and males (46.1%), with a majority of non-Hispanic Caucasian youth (76.0%), but higher than typical percentages of Hispanic Caucasian youth (12.9%) in studies of type 1 diabetes. Recent studies of adolescents with type 1 diabetes (Helgeson, Honcharuk, Becker, Escobar, & Siminerio, 2011; Ingerski, Anderson, Dolan, & Hood, 2010) had 0.1% Hispanic youth. Annual household income ranged from <$18,745 to >$126,500 at baseline. The majority of the sample (54.8%) received insulin through subcutaneous insulin infusion (i.e., insulin pump or pod). One hundred and fifty paternal caregivers (69.1%) participated in at least one observational video, and 143 families (65.9%) had both a maternal and paternal caregiver participate in at least one observational video together.

Measures

Family Communication and Reciprocity

The Interaction Behavior Code (IBC) was used to code positive and negative communication behaviors (absent [0]/present [1]) during a videotaped observation of a parent–child diabetes-related problem-solving activity (Wysocki et al., 2000). One unit refers to whether that communication is present or absent. At year 3, the mean level of paternal negative communication was 0.12, which means that fathers tended to have a relatively low level of negative communication at year 3. On the other hand, the mean level of maternal positive communication at year 3 was 0.89 meaning that mothers were closer to displaying a high level of positive communication than a low level of positive communication at year 3. Descriptive statistics for the family communication variables, as well as for BGMF and HbA1c levels, are provided in Table II. Families were given a list of diabetes-related topics and were asked to choose a topic that had been conflictual or difficult for the family. Families were asked to discuss the issue for 10 min to come up with a plan to improve on that part of diabetes care. Positive and negative communications were rated separately for each individual in the family. The positive communication index included behaviors such as asking the other person about their views, making suggestions, and stating the other person’s opinion. Higher scores indicated greater positive communication. The negative communication index included behaviors such as interrupting, making quick negative judgments of the other person’s suggestions, and giving short unhelpful responses. Higher scores indicated greater negative communication. Calculations for the negative and positive communication indices were made by taking the total number of variables that were present on that particular subscale then dividing by the total number of items on that subscale. Negative reciprocity (minimal [1]/some [2]/a lot [3]) was coded for each video and measured mutual and overall levels of negativity for the dyad/triad including active negativity (e.g., criticism, belittlement) and passive negativity (e.g., interrupting, not responding). Positive reciprocity (minimal [1]/some [2]/a lot [3]) was also coded for each video and measured mutual and overall levels of warmth/friendliness, such as saying nice things and keeping the discussion pleasant for everyone.

Videos were coded by independent raters who were blind to the purposes and hypotheses of the study. A senior research assistant resolved discrepancies between two coders. Coders were instructed to watch each interaction at least twice while completing the ratings. Interrater reliability in previous studies has ranged from 0.81 to 0.88, and validity has been demonstrated by responsiveness to behavioral family systems intervention (Wysocki et al., 2008). In this study, interrater reliability (intraclass correlation coefficient) for negative communication was 0.87 (p < .05) for youth, 0.67 (p < .05) for maternal caregivers, and 0.89 (p < .05) for paternal caregivers. Interrater reliability for positive communication was 0.70 (p < .05) for youth, 0.72 (p < .05) for maternal caregivers, and 0.28 (p = .21) for paternal caregivers. Finally, interrater reliability for negative reciprocity was 0.82 (p < .05) and 0.83 (p < .05) for positive reciprocity. Descriptive statistics of these variables can be found in Table II.

### Table II. Descriptive Statistics: Family Communication, Adherence, and Glycemic Control (HbA1c)

<table>
<thead>
<tr>
<th></th>
<th>Baseline M (SD)</th>
<th>Year 1 M (SD)</th>
<th>Year 2 M (SD)</th>
<th>Year 3 M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BGMF</td>
<td>5.07 (1.74)</td>
<td>4.69 (2.00)</td>
<td>4.78 (2.02)</td>
<td>4.64 (2.13)</td>
</tr>
<tr>
<td>HbA1c</td>
<td>8.17 (1.33)</td>
<td>8.3 (1.39)</td>
<td>8.51 (1.43)</td>
<td>8.76 (1.59)</td>
</tr>
<tr>
<td>Child negative</td>
<td>0.16 (0.12)</td>
<td>0.25 (0.18)</td>
<td>0.18 (0.16)</td>
<td>0.20 (0.14)</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child positive</td>
<td>0.34 (0.28)</td>
<td>0.54 (0.30)</td>
<td>0.52 (0.30)</td>
<td>0.75 (0.24)</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal negative</td>
<td>0.13 (0.12)</td>
<td>0.15 (0.15)</td>
<td>0.08 (0.10)</td>
<td>0.13 (0.13)</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal positive</td>
<td>0.57 (0.25)</td>
<td>0.72 (0.22)</td>
<td>0.76 (0.20)</td>
<td>0.89 (0.20)</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paternal negative</td>
<td>0.15 (0.11)</td>
<td>0.16 (0.16)</td>
<td>0.11 (0.12)</td>
<td>0.12 (0.13)</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paternal positive</td>
<td>0.48 (0.26)</td>
<td>0.70 (0.19)</td>
<td>0.74 (0.21)</td>
<td>0.79 (0.30)</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>1.30 (0.54)</td>
<td>1.46 (0.70)</td>
<td>1.43 (0.70)</td>
<td>1.31 (0.52)</td>
</tr>
<tr>
<td>reciprocity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>1.69 (0.70)</td>
<td>1.92 (0.67)</td>
<td>2.04 (0.66)</td>
<td>1.9 (0.67)</td>
</tr>
<tr>
<td>reciprocity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tanner Stage

Tanner staging, a measure of pubertal status, was assessed at baseline based on physical examination conducted by physicians or nurse practitioners (Marshall & Tanner, 1969, 1970) as a proxy for insulin resistance that is associated with pubertal changes (Amiel, Sherwin, Simonson, Lauritano, & Tamborlane, 1986). Tanner stage was rated on a scale of 1–5, where 1 indicated prepubertal and 5 indicated full pubertal status. For females, pubertal status was the average of the breast development stage and pubic hair stage, and for males, pubertal status was the average of pubic hair stage and testicular girth.

Glycemic Control

Glycated hemoglobin (HbA1c) provided an estimate of glycemic control over the previous 2–3 months. Research staff collected blood samples by a finger stick at a clinic visit during the yearly study visits (baseline, 12 months, 24 months, and 36 months). Blood samples from each site were sent to one central laboratory to ensure standardization of results. Samples were analyzed using the TOSOH-G7 method (reference range 4.0–6.0%). In this sample, HbA1c ranged from 5.7 to 16.8% at baseline with a mean of 8.17%.

Treatment Adherence

The BGMF provided a behavioral indicator of treatment adherence. Research staff gathered 2 weeks’ worth of blood glucose meter data at the yearly study visits (baseline, 12 months, 24 months, and 36 months). Averages of the frequency of daily meter readings was calculated based on the number of days collected. In this sample, the daily frequency of BGM ranged from 1.00 to 9.79 with a mean of 5.07 at baseline.

Data Analytic Strategy

Unconditional and conditional growth curve models examined changes in the IBC variables, as well as adherence and glycemic control, from baseline to 3 years. Unconditional growth curve models (level 1 models) measured change over time for the entire sample and summarized growth for the sample as a whole using two terms: Fitted intercept and fitted slope (Singer & Willett, 2003). In the conditional growth curve model (level 2), static and/or dynamic predictors were included to determine whether changes in HbA1c and treatment adherence could be predicted by one or more of the observational variables (Singer & Willett, 2003).

Unconditional and conditional growth curve modeling were performed using SAS PROC Mixed (SAS Institute, 1990). Restricted maximum likelihood estimations were used to avoid biased estimations of the variance components. Unstructured covariance matrices were used to allow variances and covariances to vary across time points rather than to conform to a priori constraints (Singer & Willett, 2003).

Regression analyses examined the relationship of baseline levels of family communication to glycemic control and treatment adherence at 3 years. Data analyses were performed using the Statistical Package for the Social Sciences Version 22.0 (SPSS 22.0). Significance levels were set at $p < .05$.

Results

Description of Change From Baseline to 3 Years: Unconditional Growth Curve Analyses

The results of the unconditional growth curve models for each of the observational variables are presented here. Paternal positive communication was excluded from further analyses because of low interrater reliability. In general, predictions about overall changes in family communication and reciprocity from baseline to 3 years were not confirmed.

In addition, there were higher levels of adolescent, maternal, and paternal positive communication at baseline than negative communication. Fathers generally did not talk as much as adolescents or mothers. However, level of participation for the adolescent and mother varied significantly.

Negative Communication and Reciprocity

Adolescent. Adolescent negative communication did not increase from baseline to 3 years ($p = .20$).

Maternal. Observed maternal negative communication decreased (less negative communication) at a rate of 0.01 units per year from a mean score of 0.15 at baseline to 0.11 at 3 years ($F(1, 596) = 6.96, p < .01, d = 1.66$) (Figure 1).

Paternal. Paternal negative communication was 0.17 at baseline and decreased (less negative communication) at a rate of 0.01 units per year from baseline to 3 years ($F(1, 319) = 7.69, p < .01, d = 1.71$).

Negative Reciprocity. Baseline negative reciprocity did not increase as predicted from baseline to 3 years ($p = .98$).

Positive Communication and Reciprocity

Adolescent. Adolescent positive communication increased at a rate of 0.12 units per year from a mean score of 0.24 at baseline to 0.72 at 3 years ($F(1, 214) = 194.9, p < .0001, d = 1.87$).
Maternal. Maternal positive communication increased at a rate of 0.10 units per year from a mean score of 0.48 at baseline to 0.88 at 3 years (F(1, 207) = 214.99, p < .0001, d = 3.27).

Positive Reciprocity. Positive reciprocity increased at a rate of 0.08 units per year from 1.69 at baseline to 2.01 at 3 years (F(1, 212) = 17.22, p < .0001, d = 3.97) (Figure 2).

Changes in BGMF and Glycemic Control

Blood Glucose Monitoring Frequency. The BGMF did not significantly change from baseline to 3 years (p > .05).

Glycemic Control. Glycemic control as measured by HbA1c increased at a rate of 0.20 units per year from a mean score of 7.94 at baseline to 8.74 at 3 years (F(1, 217) = 27.65, p < .01).

Prediction of BGMF and Glycemic Control (HbA1c) Based on Changes in Communication and Reciprocity: Conditional Growth Curve Models

Negative Communication and Reciprocity

Adolescent. Changes in observed adolescent negative communication did not predict the rate of change in BGMF or HbA1c (p > .05).

Maternal. There was a significant main effect of maternal negative communication observed at baseline on overall levels of glycemic control (F(1, 603) = 4.51, p = .03). Maternal negative communication was associated with higher HbA1c. However, contrary to prediction, the rate of change in glycemic control did not differ as a function of maternal negative communication from baseline to 3 years (p > .05). Similarly, maternal negative communication did not predict the rate of change in BGMF (p > .05).

Paternal. Paternal negative communication did not predict changes in glycemic control or BGMF (p > .05).

Reciprocity. Contrary to hypotheses, negative reciprocity did not predict rates of change in BGMF or glycemic control (p > .05).

Positive Communication and Reciprocity

Adolescent. Adolescent positive communication did not predict the rate of change in BGMF or glycemic control (p > .05).

Maternal. Maternal positive communication did not predict the rate of change in BGMF or glycemic control (p > .05).

Reciprocity. There was a significant main effect of positive reciprocity measured at baseline on overall levels of glycemic control (F(1, 630) = 4.14, p = .04). Positive reciprocity was associated with lower HbA1c. However, contrary to prediction, the rate of change in glycemic control and BGMF did not differ as a function of observed positive reciprocity (p > .05).
**Prediction of BGMF and Glycemic Control (HbA1c) Based on Baseline Observational Data: Regression Analyses**

The results of the regression analyses are presented here. Baseline Tanner stage was controlled for in these analyses.

**Negative Communication and Reciprocity**

**Adolescent.** Baseline levels of adolescent negative communication did not predict glycemic control of BGMF at 3 years.

**Maternal.** Baseline levels of maternal negative communication did not predict BGMF or glycemic control at 3 years.

**Paternal.** Contrary to predictions, paternal negative communication at baseline did not predict glycemic control or BGMF at 3 years.

**Reciprocity.** Baseline levels of negative reciprocity did not predict BGMF or glycemic control \((p > .05)\) at 3 years.

**Positive Communication and Reciprocity**

**Adolescent.** As predicted, results of a linear regression indicated that observed adolescent positive communication at baseline significantly predicted BGMF at 3 years \((r = .30; \text{intercept } = 4.83; \beta = 1.67; p = .002; \text{adjusted } R^2 = .08)\). Higher levels of positive communication among youth predicted more frequent daily BGM at 3 years.

**Maternal.** Consistent with our hypothesis, results of a linear regression revealed that observed maternal positive communication at baseline significantly predicted BGMF at 3 years \((r = .29; \text{intercept } = 4.27; \beta = 1.73; p = .005; \text{adjusted } R^2 = .07)\). Higher levels of maternal positive communication were associated with a higher frequency of daily blood glucose monitoring at 3 years.

**Reciprocity.** Baseline levels of positive reciprocity did not predict treatment adherence or glycemic control at 3 years \((p > .05)\).

**Discussion**

To our knowledge, this is the first study to examine patterns of adolescent, maternal, and paternal communication over time using observational data and their relation to glycemic control and treatment adherence over 3 years in youth with type 1 diabetes who were in the process of transitioning to adolescence. Our first set of relevant findings involved changes in family communication across the transition to adolescence. Interestingly and contrary to our hypotheses, adolescent and maternal positive communication, as well as positive reciprocity, increased, whereas maternal and paternal negative communication decreased as youth transitioned to adolescence. These findings are somewhat unexpected given the direction of effects (e.g., increases in negative communication and stable patterns of positive communication) found in parent–child communication in healthy adolescents (Kim et al., 2001; Laursen & Collins, 2004; Laursen, Coy, & Collins, 1998; Rueter & Conger, 1998). However, it is important to note that the methods and constructs used in previous research were different than those used in this study. Previous research on healthy adolescents has used measures of patterns of general family communication. The measures used in this study focused on communication during diabetes-related problem-solving tasks that were rated as conflictual. The fact that findings from previous studies of family communication with healthy adolescents did not generalize to youth with type 1 diabetes may have related to the differences in methods and context of observation. One interpretation of our finding is that families in this sample improved their abilities to communicate about challenging diabetes-related management tasks and/or became more comfortable with the task over the course of the study. Given the use of direct observation in this study, it is possible that reactivity may have influenced our participants’ behaviors. For example, families may have communicated in a more socially desirable way (i.e., may have been more positive and less negative during the problem-solving task than in a natural setting) and may have coached one another before follow-up visits to communicate more positively than they did at baseline. It may also be possible that families were inclined to behave more positively given their awareness of publications resulting from the overall study.

Our second set of new findings related to the predictive validity of patterns of family communication during a diabetes-related problem solving task for treatment adherence as measured by BGMF and glycemic control as children with type 1 diabetes transitioned to adolescence. Taken together, the findings from both growth curve and regression analyses indicated that the baseline measures of family communication that were assessed during preadolescence, controlling for baseline pubertal status, were more powerful predictors of treatment adherence and glycemic control 3 years later than changes in family communication patterns during the transition to adolescence. We found that baseline levels of youth and maternal positive communication predicted better treatment adherence, as measured by BGMF, 3 years later. These findings are consistent with previous cross-sectional studies of the association between
family communication patterns and relationships, adherence to treatment, and glycemic control (Geffken et al., 2008; Hanson et al., 1987; Martin et al., 1998; Tsiousli et al., 2013).

The current findings extend previous research by using a direct observational method of family communication to predict glycemic control and adherence over 3 years as children with type 1 diabetes transitioned to adolescence. Positive family communication may promote adherence to medical treatment by facilitating effective problem solving concerning diabetes management and treatment adherence. In addition, it is possible that positive and negative communication may have an impact on an adolescent’s mood and overall self-esteem. For example, parents’ more frequent use of positive communication may enhance adolescents’ affect and self-esteem, which may in turn influence their treatment adherence and glycemic control.

However, changes in adolescent, maternal, and paternal communication during a diabetes-related problem-solving task did not predict changes in adherence or glycemic control. These findings suggest that family communication patterns concerning diabetes that have become established during preadolescence may influence subsequent glycemic control and adherence to treatment during adolescence. Baseline levels of family communication about diabetes management that have been established by preadolescence may be especially important and override the influences of changes in family communication that occur during the transition to adolescence.

Several limitations should be considered in the interpretation of our findings. Families who self-selected to participate in the study may have had more positive communication patterns than families who did not participate in the study. Our sample included a majority of Caucasian and highly educated families, which may limit the generalizability of these findings. However, our sample did include a relatively high percentage of Hispanic youth who are often underrepresented in research with type 1 diabetes (Helgeson et al., 2011; Ingerski et al., 2010).

Our findings have several potential clinical implications. It is difficult to ascertain the direct clinical significance of changes in family communication over time. However, the effect sizes of the changes in positive and negative parental communication from baseline to 3 years were large and greater than the clinically significant changes noted in comparable family communication variables associated with behavioral family systems therapy (Wysocki et al., 2008). However, it should be noted that Wysocki et al. (2008) preselected families on the basis of problematic adherence, inadequate glycemic control, and elevated levels of family conflict, whereas we did not selectively enroll families who were candidates for a family-based behavioral intervention. In addition, the relationship of preadolescent family communication to subsequent glycemic control and adherence during adolescence underscores the value of assessing family communication concerning diabetes-related management during the preadolescent period. Providing consistent support to families to promote positive family communication concerning diabetes management during preadolescence may help to enhance glycemic control and adherence as children transition to adolescence (Wysocki et al., 2000, 2008). Our findings also suggest that for a good number of families with children with type 1 diabetes, observed positive communication concerning diabetes management increases, whereas negative communication patterns decrease as children transition to adolescence. For this reason, deviations from this trend (i.e., marked decreases in positive communication or increases in negative communication that are associated with problematic adherence and/or glycemic control) may represent potential targets of intervention.

Future studies are needed to replicate and extend our findings in other populations of adolescents with type 1 diabetes. In particular, it would be useful to determine the extent that family communication patterns concerning diabetes-related management reflect more global patterns of communication concerning other areas of adolescent life. In addition, future work might study self-report and observational methods of family communication to examine similarities and discrepancies between these methods, as well to determine their unique ability to predict glycemic control and treatment adherence during adolescence. Additional studies could be conducted to determine family communication patterns in youth who demonstrate chronic and suboptimal glycemic control. Finally, future research using more diverse samples is needed to determine whether our results generalize to lower socioeconomic status (SES) families and ethnic minorities.

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