THE IMPACT OF DEPRESSIVE SYMPTOMS ON HEALTHCARE UTILIZATION AND CHARGES FOR ADOLESCENTS WITH TYPE 1 DIABETES (T1D)

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"In normal life we hardly realize how much more we receive
than we give, and life cannot be rich without such gratitude.
It is so easy to overestimate the importance of our own achievements
compared with what we owe to the help of others."

- Dietrich Bonhoeffer

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Kyle Clayton, 2012

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by

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THE IMPACT OF DEPRESSIVE SYMPTOMS ON HEALTHCARE UTILIZATION AND CHARGES FOR ADOLESCENTS WITH TYPE 1 DIABETES (T1D)

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LIST OF ABBREVIATIONS

CMCD	Children's Medical Center of Dallas
CES-D	Center for Epidemiological Studies Depression Scale
DS	Depressive Symptoms
HbA1c	Glycemic Control
High-dep	CES-D scores above cutoff point
Low-dep	CES-D scores below cutoff point
ER	Emergency Room Visits
H	Hospitalizations
HID	Hospital Inpatient Days
C	Healthcare Charges

Abstract

Background: Poorly managed chronic illness consumes a large share of health resources. Identifying modifiable variables for those at risk for poor management is essential to containing costs. Given the growing economic burden of diabetes (approximately $200 billion annually) and that type 1 diabetes (T1D) contributes a disproportionately large share to these costs, factors associated with higher costs in this population should be examined. The present study examines the impact of adolescent and maternal depressive symptoms on healthcare utilization and charges in adolescents with T1D.

Methods: This retrospective cohort study relied on archival data collected as part of a longitudinal study on treatment adherence among adolescents with diabetes in the Children's Endocrinology Center at Children's Medical Center of Dallas (CMCD). Two hundred and forty six adolescents with T1D (age range: 11-18 years; 57% girls) and their mothers completed the Center for Epidemiological Studies Depression Scale (CES-D) at enrollment and 12 months later. Demographic and disease-related variables, including HbA1c, were also assessed. Healthcare utilization data and charges for diabetes-related care (i.e., endocrinology clinic visits, emergency room visits, hospitalizations, hospital inpatient days) for the period of 12 and 24 months following enrollment were provided by CMCD.

Results: Both adolescent and maternal depressive symptoms predicted healthcare utilization/charges at 12 and 24 month follow-up, after controlling for demographic and disease-related variables. Adolescent depressive symptoms acted indirectly, by decreasing adherence behaviors. Maternal depressive symptoms predicted healthcare utilization and charges even after controlling for disease management (HbA1c) and adolescent depressive symptoms. Adolescents with high depressive symptoms incurred $5,293 more in healthcare charges over a two year period than those with low depressive symptoms. High maternal depressive symptoms resulted in total charges of $11,389 compared to an average of $3,504.25 when maternal depressive symptoms were low. Maternal depressive symptoms accounted for a portion of the variance in total healthcare charges comparable to HbA1c (5% and 7% respectively). Preliminary directional analyses suggested a path from maternal depressive symptoms to adolescent healthcare utilization, rather than the reverse.

Conclusion: Both adolescent and maternal depressive symptoms impact healthcare utilization and charges for adolescents with T1D. Maternal depressive symptoms are even more important than adolescent depressive symptoms in predicting utilization of medical resources and higher costs in this population. Interventions aimed at identifying and treating depressive symptoms in youth with T1D and their mothers would not only enhance the quality of life of the individuals, they may also be economically advantageous for payers and

providers. To the extent that reducing depressive symptoms would be cost-effective, addressing this issue represents additive value to optimizing the clinical care of patients and their families.

CHAPTER ONE

Introduction

STATEMENT OF THE PROBLEM

The cost of diabetes in the United States represents a substantial economic burden as approximately 1 in 10 health care dollars is currently attributed to diabetes (American Diabetes Association (ADA), 2008). This burden has increased dramatically over the past decade as diabetes related costs have risen from approximately $132 to $218 billion annually (Dall et al., 2010). The majority of these costs are attributable to disease-related complications which typically result in additional clinic visits or hospitalizations. For example, in 2007 approximately 50% of all medical expenditures for diabetes were attributed to inpatient hospitalizations resulting from complications (ADA, 2008). As medical costs rise from these complications, insurance premiums for all policyholders typically increase, thus impacting society at large. Specifically, recent estimates have suggested that diabetes costs each American, regardless of diabetes status, approximately $700 per year (Dall et al., 2010).

Although less prevalent than type 2 diabetes, T1D incurs a disproportionate share of the total costs of diabetes, some of which can be minimized by reducing acute and long-term complications through good self-

management and glycemic control (Tao et al. 2010). T1D is a common chronic disorder of childhood and adolescence, and its incidence is increasing world-wide. The illness is associated with serious long-term microvascular complications that can be minimized or delayed by maintaining good glycemic control (Diabetes Control and Complications Trial Research Group (DCCT), 1993). Individuals with T1D are required to adhere to a complex regimen involving the coordination of frequent blood glucose monitoring, multiple daily insulin injections or continuous subcutaneous insulin infusions, diet, and exercise. Adherence to this regimen is difficult at all ages, but especially so during adolescence when rapid biological and psychosocial developments alter illness management.

Psychological health plays a vital role in T1D diabetes management. According to the International Society for Pediatric and Adolescent Diabetes (ISPAD), "Psychological factors are the most important influences affecting the care and management of diabetes" (ISPAD, 2000). This statement is supported by research over the past four decades which has demonstrated the significant role of psychological functioning in child/adolescent T1D management (Laron, 1977; Laron & Galatzer, 1982; Delamater, 2003; Winkeley, Landau, Eisler, Ismail, 2006). Children and adolescents with T1D are at risk for experiencing difficulties initially adjusting to their diagnosis (Kovacs et al., 1985; Grey, Cameron, Lipman, Thurber, 1995), and these early difficulties are often compounded by the additional demands of their treatment regimen. The emotional demands of T1D

management are often pervasive and persistent, and the task of coping with such circumstances can greatly extend or even overwhelm the psychological resources of most youth. Given such intense pressure, it is not surprising that children and adolescents with T1D are at a heightened risk for psychiatric disorders (Blanz, Rensch-Rieman, Fritz-Sigmund, Schmidt, 1993; Kovacs, Goldston, Obrosky, & Bonar, 1997; Liss, et al., 1998).

Depression is frequently comorbid in pediatric patients with T1D. The rate of depressive symptoms is typically two to three times that of peers without diabetes (Grey, Whittemore, Tamborlane, 2002; Hood et al., 2006) and clinical depression is the most prevalent psychiatric disorder among this population (Kovacs, Goldston, Obrosky, Bonar, 1997). Not only are rates of depression increased in adolescents following diagnosis, but there is evidence that depressive symptoms may increase significantly as illness duration increases (Kovacs, 1997; Whittemore et al., 2002). Some degree of context-related fluctuation in depressive symptoms is common in adolescents (Gutman & Sameroff, 2004); however, those who experience persistent periods of difficulties may be more vulnerable to developing depression.

The mechanism by which depressive symptoms impact diabetes management remains somewhat unclear. One possibility is that the patient becomes less adherent in their treatment regimen. Other possibilities include shared underlying mechanisms such as cortisol reactivity (Adam, 2010; Rao,

Hammen, Poland, 2010) which might explain the high comorbidity between depression and T1D. Regardless of the etiology, the impact of depression in this population appears significant. Depressive symptoms in pediatric and adolescent T1D have been linked to poor metabolic control and disease complications (Helgeson et. al., 2009; Whittemore et al., 2002; Garrison, Katon, Richardson, 2005; Pearson et al., 2010) as well as increased inpatient hospitalizations (Stewart, et al., 2005).

Similar to youths with T1D, mothers of children/adolescents with diabetes also experience depressive symptoms at a higher rate than mothers of medically well youth, with approximately one third developing clinical depression (Delamater, 2009). Maternal depression is a risk factor for offspring psychiatric difficulties, and in particular for depression (Thompson et al., 2010). Consistent with this idea, maternal depression has been associated with a higher incidence of pediatric depression in T1D (Kovacs, Goldston, Obrosky, & Bonar, 1997; Delamater, 1986). Additionally, the psychological health of caregivers seems particularly relevant given that family functioning is often viewed as a significant contributor to T1D management. Cohesive and nurturing family environments offering open communication, shared responsibility, and diabetes-specific support have been associated with better treatment adherence and metabolic control (Whittemore et al., 2002). Mothers struggling with significant depressive symptoms may lack the emotional resources required to provide this level of

support and stability. Therefore, maternal depression could hinder environmental stability related to disease management thus indirectly increasing the probability of complications. When both the patient and his or her mother show depressive symptoms, the impact on management could be even greater.

In summary, the economic burden of diabetes in the United States is significant. The majority of medical costs associated with diabetes have been attributed to excess medical expenditures related to disease complications. Given the higher prevalence of adolescent and maternal depression in T1D, and the influence of psychological factors and family functioning on disease management, examining the impact of depressive symptoms on utilization/charges appears warranted. The present study is the first to examine the increase in diabetes-related healthcare utilization/charges among adolescents when depressive symptoms are present in the patient or a parent. Unlike many factors contributing to disease complications in adolescents with T1D, depression is often amenable to treatment. Identifying an influential factor amenable to treatment could assist in efforts aimed at reducing disease complications and limiting excess medical expenditures. The present study seeks to illuminate the economic burden of depressive symptoms in this population and to examine whether any effects found are mediated through adolescent adherence and magnified when both the youth and his or her mother have a high level of depressive symptoms.

CHAPTER TWO

Literature Review

OVERVIEW OF TYPE 1 DIABETES

Type 1 Diabetes (T1D) is a chronic autoimmune disease resulting in a lack of insulin (Cihakova, 2001). Glucose is the main source of energy for all cells, and insulin is required for the transfer of glucose from the bloodstream into cells. In individuals with T1D, insulin producing beta-cells in the pancreas are destroyed from autoimmune inflammation. The loss of beta cells and subsequent insulin deficiency leads to increased levels of glucose in the blood. As glucose levels rise, cells lack the energy necessary for metabolism, and chronic elevations in blood glucose have been associated with significant health problems including retinopathy, nephropathy, neuropathy, and hypertension (ADA, 2010).

T1D is characterized by persistent or recurring hyperglycemia and diagnosed via plasma glucose levels (ADA, 2010). T1D is often easily recognized as otherwise healthy individuals present with acute symptoms including frequent urination, excessive thirst, fatigue, and weight loss (Cooke & Plotnick, 2008). Although the majority of T1D acute symptoms are less severe, significant complications such as diabetic ketoacidosis (DKA) may also occur. DKA is life-threatening complication requiring hospitalization for intravenous hydration and insulin infusion (Kitabchi et al. 2006). DKA occurs more

frequently in T1D than other types of diabetes and approximately 30% of children with T1D receive their initial diagnosis following an episode of DKA (Silverstein et al., 2005).

In 2007, approximately 23 million people in the United States had diabetes (ADA, 2008). Incidence rates increased substantially over the past decade as over 1 million new cases per year were added. In 2000, approximately 170 million people worldwide had diabetes, and recent projections have suggested that this number will likely double by 2030 (Wild et al., 2004). T1D accounts for 5% to 10% of diabetes cases in adults (CDC, 2007). This proportion increases significantly in children and adolescents as T1D occurs approximately five times more often than type 2 diabetes (T2D) in individuals under age 20 (CDC, 2007). About 75% of all new cases of T1D occur in individuals under age of 18, and each year approximately 13, 000 youth are diagnosed (ADA, 2010). Overall, approximately 1 in 400 to 600 American children/adolescents have T1D.

Individuals with T1D are required to adhere to a complex regimen involving the coordination of frequent blood glucose monitoring, multiple daily insulin injections or infusions, diet, and exercise. Adherence to this regimen is difficult at all ages, but especially so during adolescence when rapid biological and psychosocial developments alter illness management. Proper disease management in children and adolescents typically includes the implementation of a diabetes management plan. Recommended management plans stress

collaboration between patient, family, physicians, and other health care team members and emphasize ongoing disease self-management education (DSME) along with the development of problem-solving skills (ADA, 2010).

The goal for diabetes treatment is to maintain adequate metabolic control. Blood glucose is monitored daily, and target ranges for blood glucose are approximately 90 to 180 for children and 90 to 130 for adolescents prior to meals (ADA, 2007). Metabolic control is also monitored via glycosylated hemoglobin (HbA1c). HbA1c is a form of hemoglobin used to identify the average plasma glucose concentration over prolonged periods of time. Increased HbA1c levels reflect higher glucose in the bloodstream, and HbA1c level is routinely identified as a predictor of health outcomes in patients with diabetes (ADA, 2010; Rewers, et al., 2002; Stewart et al., 2005). The American Diabetes Association (ADA, 2010) recommends monitoring HbA1c levels at least twice a year for individuals who are meeting treatment goals and have stable glycemic control. For patients with poor glycemic control or whose therapy has changed quarterly HbA1c assessment is suggested. Recommended adequate HbA1c levels are <8% for school age children and <7.5% for adolescents (ADA, 2010).

The consequences of poor metabolic control are significant. Chronic hyperglycemia can lead to long-term complications including retinopathy, nephropathy, and neuropathy. Additionally, diabetes dramatically increases your risk of various cardiovascular problems, including coronary artery disease, heart

attack, stroke, atherosclerosis, and hypertension. Adherence to a diabetes management plan is vital in maintaining metabolic control, and reducing the potential for negative long-term complications. Several factors have been shown to impact treatment adherence and metabolic control in children and adolescents with T1D including family functioning and social support (Wiebe et al., 2005; Delamater, 2009). Additionally, issues related to psychological health and emotional adjustment including self-efficacy, stress, anxiety, and depression have also been found to impact metabolic control (Stewart et al., 2000; Whittemore et al., 2002; Stewart, 2006; Shomaker, 2009).

DEPRESSION

Depression in Adolescents

Adolescence is a high-risk period for depression (Kessler, Avenevoli, Merikangas, 2001). By age 18, approximately 25% of all youth in the United States will have experienced major depressive disorder (Kessler, Avenevoli, Merikangas, 2001; Zalsman, Brent, Weersing, 2006). Depression in adolescents has high comorbidity with a number of psychiatric disorders including conduct disorder and anxiety disorders, and significantly increases the risk for substance dependence (Marmorstein, Iacono, Malone, 2010) and suicide (Fergusson &Woodward, 2002). Relapse rates for adolescents with depression are substantial

and have been estimated at 30% to 40% within one to two years from acute treatment (Kennard, Stewart, Hughes, Jarrett, Emslie, 2008). Depressive episodes during adolescence often persist into adulthood (Lewinsohn, Rhode, Klein, Seeley, 1999; Kessler, Avenevoli, Merikangas, 2001), and are linked with significant socioeconomic consequences later in life including early pregnancy, poor occupational functioning, and unemployment (Rao & Chen, 2009).

Fluctuation in depressive symptoms is common among both adolescents and adults. Multiple variables including situational stress, personal characteristics, and cognitive vulnerability impact the occurrence and course of symptoms (Abela & Hankin, 2007; Hammen, 2005). Additionally, ecological factors such as peer relationships, social support, and family functioning significantly influence the incidence and recurrence of depressive symptoms (Anthony & Petronis, 1991; Gutman & Sameroff, 2004). In adolescents, general health, school suspension, family relationships, and healthcare utilization have been identified as factors associated with persistent depressive symptoms (Rushton, Forcier, Schectman, 2002).

Depression and Chronic Illness

Depression is common among individuals with chronic medical illness. Adjustment to illness including coping with ongoing symptoms and managing treatment demands can increase stress and trigger emotional difficulties.

Approximately one-third of individuals with chronic illness such as cardiovascular disease, chronic obstructive pulmonary disease (COPD), and diabetes experience depressive symptoms, and depressive disorders occur at significantly higher rates in these populations (Katon & Ciechanowski, 2002).

Depression is associated with increased chronic disease complications, enhanced symptom burden, and heightened healthcare costs. A recent review of 31 studies on depression in chronic illness found that patients with comorbid depression reported significantly higher numbers of medical symptoms when controlling for severity of medical disorder (Katon, Lin, & Kroenke, 2007). Specifically, somatic symptoms were as strongly associated with depression as objective physiological measures, and treatment for depression reduced somatic symptoms independent of improvement in physiological measures. In addition to an increase in the number of symptoms reported, comorbid depression in chronic illness is associated with amplified symptom severity as well as additional non disease-related physical problems (Dwight et al., 2000; Sullivan et al., 2000; Katon & Ciechanowski, 2002).

Depression in chronic illness has been linked to increased healthcare utilization and heightened costs (Callahan et al., 1994; Unutzer et al., 1996; Katon & Ciechanowski, 2002). Depressed patients are at greater risk for complications typically resulting in additional medical visits and supplemental costs. Additionally, patients with comorbid depression have significantly longer hospital

stays than non-depressed controls (Mayou, Hawton, & Feldman, 1988; Levenson, Hamer, & Rossister, 1990). Overall, it is estimated that depression doubles costs for adults with chronic illness (Simon, Von Korff, & Barlow, 1995; Katon & Ciechanowski, 2002).

Depression and Diabetes

Depression occurs frequently in individuals with diabetes (Egede & Ellis, 2010). Controlled studies in adults report 9-27% of patients with diabetes suffer from major depressive disorder at some point in time (Gavard, Lustman, & Clouse, 1993, Anderson, Freedland, Clouse, & Lustman, 2001; Dantzer et al., 2003). A recent meta-analysis of 42 adult studies (n=21, 531) found the prevalence of major depressive disorder among individuals with diabetes was 11%, while the prevalence of "clinically significant depression" was 31% (Anderson et al., 2001). The prevalence of undiagnosed depression in individuals with diabetes is also significant and has been estimated as high as 41% (Li et al., 2009). Overall, individuals with diabetes are more likely to have depression than those without diabetes and the rate of depressive disorders among individuals with diabetes is significant.

Although the majority of studies examining depression in individuals with diabetes have been conducted with adults, there is evidence that similar patterns are present in youth. The prevalence of depressive symptoms in children and

adolescents has been estimated at 20% in youth with diabetes compared to 7% in youth without diabetes (Grey, Whittemore, & Tamborlane, 2002). Additionally, approximately 28% of children and adolescents with diabetes experience at least one episode of major depressive disorder (Kovacs, Obrosky, Goldston, & Bonar, 1997). Intuitively the impact of depression on self-care activities including treatment adherence would account for changes in glycemic control, and there is evidence to support such a theory (Ciechanowski, Katon, & Russo, 2000; Egede & Ellis, 2010; Gonzalez et al. 2008). However, there is also evidence suggesting that the relationship between depressive symptoms and HbA1c levels is not fully accounted for by changes in diabetes self-care (Wagner et al., 2009).

The causal pathway between depression and diabetes is unclear however two major hypotheses are prominent (Egede & Ellis, 2010). The first theory asserts that depression increases the risk of developing diabetes through physiological alterations including increased hormonal regulation, changes in glucose transport function, and increased inflammatory activation. These physiological changes supposedly contribute to insulin resistance thus leading to the development of type 2 diabetes (T2D) (Musselman et al., 2003). The second theory posits that depression in both T1D & T2D patients results from persistent psychosocial stressors associated with chronic illness (Talbot & Nouwen, 2000; Egede & Ellis, 2010). Supporters of this theory question that depression has a

causal role in diabetes, and point to research suggesting otherwise. Saydah et al. (2003) found that those with moderate to severe depressive symptoms as baseline did not have higher rates of diabetes at follow-up. Additionally, Palinkas, Barrett-Connor, & Wingard (1991) demonstrated poor correlations among depressive measure scores and incidence diabetes. Instead, individuals with a prior diagnosis of diabetes were at a significantly greater risk for depression. Finally, there is evidence for a bi-directional relationship between depression and diabetes (Knol et al. 2006; Egede & Ellis, 2010). A review of adult studies from 1950 to 2007 found that depression was associated with a 60% increase in risk of T2D, while T2D was associated with a 15% risk of depression. Recent studies have offered additional evidence for a bi-directional relationship, and Golden et al. (2008) found that among non-depressed individuals, those treated for diabetes had higher odds of developing depressive symptoms.

Depression not only affects the quality of life for individuals with diabetes but also significantly impacts disease management. A recent meta-analysis of 24 studies by Lustman et al. (2002) found that depression was significantly associated with poor glycemic control. Longitudinal effects of depression on glycemic control have been noted as well. Richardson et al. (2008) demonstrated a significant relationship between depression and HbA1c levels over a four year period.

Diabetes complications are more prevalent among those with comorbid depression (Ciechanowski, Katon, Russo, & Hirsch, 2003; Edge & Ellis, 2010). Adult studies consistently demonstrate that depression is significantly correlated with complications such as retinopathy, nephropathy, neuropathy, and microvascular complications (de Groot et al., 2001). Additionally, Forest et al. (2000) found that depression was an independent predictor of coronary heart disease in adults with diabetes. Finally, depression has been shown to be one of the best predictors of hospitalization for both adult and adolescents individuals with diabetes (Rosenthal, 1998; Stewart et al., 2005).

Depression is associated with significantly higher healthcare costs for adults with diabetes (Ciechanowski, Katon, & Russo , 2000; Egede, Zheng, Simpson, 2002; Simon et al., 2007). In adult studies, individuals with diabetes with depression routinely utilize healthcare services such as clinic visits, ambulatory care, and prescriptions significantly more often than non-depressed patients (Finkelstein, et al., 2003; Egede, Zheng, Simpson, 2002). It is estimated that adults with comorbid diabetes and depression incur total healthcare costs approximately two to four times greater than non-depressed patients, and for patients with severe depressive symptoms costs can increase as much as 86% (Ciechanowski, Katon, & Russo , 2000; Egede, Zheng, & Simpson, 2002). Although the cost of depression in adults with diabetes has been reasonably estimated, additional research in the area of children and adolescents is warranted.

Diabetes-related complications and increased costs are not only associated with depressive disorders, but are impacted by subthreshold symptoms. Multiple studies have demonstrated a significant association between depressive symptoms and glycemic control (Van Tilburg et al., 2001; Lustman et al., 2002; Ciechanowski, Katon, Russo, & Hirsch, 2003; Eckshtain, Ellis, Kolmodin, & Naar-King, 2010). Depressive symptoms have also been associated with functional impairment and increased symptom reporting (Ciechanowski, Katon, Russo, & Hirsch, 2003). Additionally, depressive symptom severity has been linked to treatment non-adherence and increased health care costs in diabetic patients (Ciechanowski, Katon, & Russo, 2000; Ciechanowski, Katon, Russo, & Hirsch, 2003).

Unlike many factors contributing to disease complications and increased costs, depression is often amenable to treatment. Clinical trials utilizing pharmacological interventions, cognitive behavioral therapy (CBT), or combination treatments have consistently resulted in improvements in mood (Lustman et al., 1998; Lustman, Freedland, Griffith, & Clouse, 2000; Snoek et al. (2008). Additionally, a recent review of treatment of depression in diabetes by Petrak & Herpertz (2009) concluded that depression can be treated in individuals with diabetes with success comparable to those without diabetes.

Adult studies suggest that the treatment of depression in individuals with diabetes is cost effective. Katon et al. (2008) found that depression treatment

reduced total healthcare costs by $3,907 per patient over five years. A recent randomized control trial of 329 adult patients with comorbid diabetes and depression found that over the course of two years depression treatment resulted in an economic benefit of $952 per patient (Simon et al., 2007). Simon et al. (2007) ultimately opined that depression treatment has a "significant economic benefit from the health plan perspective," and recommended that depression screening and treatment should be a routine part of diabetes care in the future.

MATERNAL DEPRESSION

Maternal Depression and Children/ Adolescents

Maternal depression adversely impacts cognitive, emotional, and behavioral development in children (Hay et al., 2001; Murray and Cooper, 2003; Halligan, Murray, Martins, & Cooper, 2006). Maternal depression has been associated with inattentiveness, unresponsiveness, and negative perceptions of children (Gelfand & Geti, 1990) and depressed mothers often exhibit critical, hostile, and unsupportive behavior (Burbach & Borduin, 1986; Kaslow, Deering, & Racusin, 1994). Depressed mothers typically struggle with managing their children's behavior (Cummings & Davies, 1994; Kaslow, Deering, & Racusin, 1994), and often utilize parenting strategies requiring minimal cognitive and emotional resources (Kochanska, Kuczynski, Radke-Yarrow, & Welsh, 1987).

Maternal depression is also associated with higher levels of negative and unproductive communication as well as social withdrawal (Gelfand & Geti, 1990). Overall, youth of depressed mothers are increasingly exposed to negative cognitions, affect, and behavior as well as maladaptive parenting practices (Goodman & Gotlib, 1999). This type of an environment limits emotional and social development and places children at risk for impaired functioning.

Children and adolescents of depressed mothers experience an array of difficulties. These youth exhibit higher levels of negative cognitions including lower self-esteem, poor self-concept, and frequent self-criticism (Hirsch, Moos, & Rieschl 1985; Garber & Robinson, 1997). Offspring of depressed mothers are often less socially competent, and demonstrate poorer peer relationships and decreased interpersonal skills (Beardslee et al., 1998; Goodman & Gotlib, 1999). Decreased cognitive function and academic performance have also been noted in this population (Brennan et al., 2000; Sharp, 2005). Additionally,

Children of depressed mothers display significantly more negative affect and behavioral problems when compared to controls (Goodman & Gotlib, 1999). These youth are at greater risk for anxiety and affective disorders as well as aggression and hyperactivity (Halligan et al., 2007; Low & Stocker, 2005). A recent longitudinal study of 710 youth, reported that adolescents of depressed mothers at age 15 were at significantly greater risk for aggressive behavior by age 20 (Kennan-Miller, Hammen, Brennan, 2010). Allen, Manning, and Meyer

(2010) demonstrated that maternal depressive symptoms predicted increases in teen externalizing behavior over time. Allen, Manning, and Meyer (2010) also found that teen externalizing behavior predicted future increases in maternal depressive symptoms. It was noted that increased reports of adolescent externalizing behaviors in depressed mothers was not simply the result of maternal reporting biases, but rather attributable in part to heightened sensitivity to observable teen behavior. Overall, a reciprocal relationship between maternal depressive symptoms and adolescent externalizing behavior was suggested (Allen, Manning, Meyer, 2010).

Depression is particularly prominent in this population of youth, and numerous studies have demonstrated the association between parental and offspring depression (Hammen, C., Brennan, P., & Keenan-Miller, D., 2008; LaRoche, 1989; Beck, 1999; Racusin & Kaslow, 2004; Thompson et al., 2010). Although a number of factors may contribute to this association, decreased parental warmth, high levels of criticism, intrusion, and rejection in particular have been linked to depressive symptoms in youth (Barber, Stolz, & Olsen, 2005; Gray & Steinberg, 1999). Recent evidence suggests that a history of depression may account for the increase in behavior problems in offspring of depressed mothers. Specifically, Kennan-Miller, Hammen, and Brennan (2010) found that the association between maternal depression and youth aggression was fully mediated by youth history of depression by mid-adolescence.

Maternal Depression and Pediatric Chronic Illness

Maternal depression occurs frequently in pediatric chronic illness, and significantly impacts disease management. In youth with chronic illness, maternal depressive symptoms are associated with adjustment difficulties, health complications, and lower quality of life. (Cameron, Young, & Wiebe, 2007; Jaser et al., 2008; Stewart et al., 2005). In pediatric asthma, maternal depressive symptoms have been linked to symptom severity and higher morbidity (Otsuki et al., 2010; Shalowitz, Berry, Quinn, & Wolf, 2001). Similarly, in children and adolescents with diabetes, maternal depression is associated with higher disease related complications including poor metabolic control (Eckshtain, Ellis, Kolmodin, & Naar-King, 2010; Jaser & Grey, 2010).

Maternal depression impacts the perceptions of children and their symptoms. Children and adolescents of depressed mothers are frequently viewed as less responsible, and incapable of managing their own treatment. Butler et al. (2009) found that maternal negative affect was associated with poorer perceived offspring efficacy, and Bartlett et al. (2004) demonstrated that maternal depressive symptoms contributed to both poorer perceived adherence and decreased treatment efficacy. Youth of depressed mothers are also perceived as more unruly and difficult to control as maternal depression is associated with

more complaints of offspring behavioral problems (Walker, Ortiz-Valdes, Newbrough, 1989).

Finally, there is evidence that maternal depressive symptoms impacts health care utilization. Bartlett et al. (2001) found that mothers with high levels of depressive symptoms were 30% more likely to report taking their children to the emergency department for asthma care after adjusting for other factors. This appears consistent with numerous studies demonstrating higher levels of child and adolescent healthcare use associated with maternal depression (Flynn, Davis, Marcus, Cunningham, & Blow, 2004; McCarthy et al., 2000; Sills et al., 2007).

Maternal Depression and Diabetes

Mothers of children/adolescents with diabetes experience depressive symptoms at a high rate with approximately one third developing clinical depression (Delamater, 2009). This is particularly relevant given that family functioning is often viewed as a significant contributor to diabetes management. Cohesive and nurturing family environments offering open communication, shared responsibility, and support increase treatment adherence and enhance metabolic control (Whittemore et al., 2002). Specifically, higher levels of parental warmth and appraised collaboration are associated with better outcomes (Berg et al., 2008; Jaser & Grey, 2010; Liss et al., 1998; Wiebe et al., 2005). In contrast, maternal depression is associated with maladaptive parenting including

hostility and social withdrawal (Gelfand & Teti, 1990; Goodman & Gotlib, 1999). Such parenting styles are linked to poor diabetes management and higher rates of depression in adolescents with diabetes (Berg et al., 2008; Jaser & Grey, 2010; Wiebe et al., 2005).

Youth with T1D are required to adhere to a complex regimen involving the coordination of frequent blood glucose monitoring, multiple daily insulin injections or continuous subcutaneous insulin infusions, diet, and exercise. Diabetes management is particularly difficulty during adolescence. Along with rapid biological changes, psychosocial development significantly alters illness management. Adolescence is a period of increased need for control and autonomy, and negotiating the transition from parent to adolescent disease management is a difficult undertaking. Adherence and health outcomes often decline during this period (Anderson, Ho, Brackett, & Laffel, 1997; Wyscocki et al., 1996), and evidence suggests that maternal depression likely exacerbates this task.

Given cognitive and emotional difficulties associated with maternal depression (Gelfand & Teti, 1990; Goodman & Gotlib, 1999), depressed mothers are inclined to eschew shared decision making and negotiated solutions (Kochanksa, Kuczynski, Radke-Yarrow, & Welsh, 1987). Rather than engaging in the complex task of collaborative care, more intrusive or avoidant disease management approaches may be employed. Such changes in maternal

involvement can adversely impact diabetes management for adolescents. Recent studies have found that maternal depression is associated with decreased diabetes involvement as well as poor metabolic control (Eckshtain, Ellis, Kolmodin, & Naar-King, 2010; Jaser & Grey, 2010). Specifically, Eckshtain, Ellis, Kolmodin, & Naar-King (2010) reported that parental depressive symptoms influenced metabolic control through decreased disease monitoring. Decreased involvement also impacts treatment adherence and quality of life for these youth. Wiebe et al. (2005) found that low maternal involvement was associated with poor adherence and decreased quality or life, while maternal collaboration was linked to higher adherence and better metabolic control.

Maternal depression may also adversely affect diabetes management related to increased involvement. For children with diabetes, higher levels of maternal involvement are generally associated with better health outcomes (Palmer et al., 2004; Wysocki et al., 1996). Maternal involvement in disease management typically declines during adolescence as youth seek increased autonomy. However, a recent study found that higher levels of depressive symptoms were linked to higher maternal involvement regardless of age (Wiebe et al., 2011). More specifically, this study demonstrated that maternal depressive symptoms moderated the association between maternal involvement and age of adolescent. In terms of possible explanations for this phenomenon, Wiebe et al. (2011) posits that depressed mothers may increase involvement as a means of

simplifying disease management responsibilities. This is conceivable given fewer cognitive and emotional resources common in depressed mothers (Gelfand & Teti, 1990; Goodman & Gotlib, 1999). Additionally, considering that depressed mothers often experience anxiety and view their children as incapable of managing their disease (Berg et al., 2008; Butler et al., 2009), higher levels of involvement are more likely to be viewed as necessary.

In summary, maternal depression significantly impacts adolescents with diabetes. Depressive symptoms in maternal caregivers are associated with higher rates of adolescent depression as well as poor metabolic control. The mechanism of this effect appear to be at least partly attributable to maladaptive parenting techniques as well as avoidant or intrusive diabetes management strategies employed by depressed mothers. The data indicate that adolescent diabetes is best managed in a warm and collaborative family environment, and because maternal depression adversely impacts environmental stability and parental involvement, it increases the risk of poor outcomes.

CATEGORICAL VERSUS DIMENSIONAL APPROACH TO DEPRESSION

Depressive symptoms can be conceptualized as either a categorical (i.e., depressed vs. non-depressed) or continuous (also sometimes called dimensional) variable. A categorical approach utilizes a phenomenological perspective and emphasizes the differences between those who either exhibit or don't exhibit depression (as defined by diagnostic criteria). A dimensional approach views depressive symptoms as falling on a continuum and examines the impact of symptoms at each point. The dimensional approach argues that symptoms severity is relevant regardless of whether symptoms rise to the level of clinical diagnosis, and that distinctions between those with or without a diagnosis can be somewhat misleading. For example, a categorical approach would view someone who exhibits one to four depressive symptoms (including one of the required symptoms) as "non-depressed" as compared to someone reporting five symptoms (the DSM-IV requires five depressive symptoms including one of the two required symptoms, for the diagnosis of a major depressive episode); however, a dimensional approach suggests that distinctions are more relevant at extremes and that there may be little difference in presentation or outcomes for those meeting four versus five of the criteria.

The majority of studies employ one of the two aforementioned approaches (i.e. categorical or continuous/dimensional). A third method is sometimes

utilized which involves using a cutoff point on a depressive measure to distinguish high vs. low symptoms. In this instance, the cutoff point serves as a rough proxy for diagnosis. This method typically captures those who have a high likelihood of obtaining a diagnosis of depression, and in some studies this has been shown to be a more predictive measure (Stewart et al., 2005). Very few studies employ both a categorical and dimensional approach. The present study will utilize both methods because it would be helpful to know whether a certain threshold is important, or whether every increase in point (i.e. a dimensional approach) is predictive.

HEALTHCARE COSTS

Types of Costs

The types of costs associated with illness are divided into three categories: direct, indirect, and intangible costs (Woo & Cockram, 2000). Direct costs reflect expenditures associated with treatment such as clinic visits, hospitalization, drug costs, etc. The responsibility for direct costs is often shared by a number of entities including government, insurance companies, and individuals. Direct costs are typically measured via national surveys and reported as point prevalence data. To calculate the direct cost of a disease at a given point in time the average total healthcare costs per patient is multiplied by the total number of patients with that

disease. Specific healthcare costs for each patient are often easily acquired via clinic, insurance, and/or patient records. In situations where data are more difficult to obtain, values such as average length of hospital stay and average number of clinic visits have been utilized to estimate costs (Woo & Cockram, 2000). In addition to measuring costs at a particular point in time, it is also possible to calculate lifetime direct costs associated with a disease. Incidence-based approaches utilize data regarding incidence, survival, and recurrence/relapse while adjusting for changes in monetary value to estimate lifetime disease costs (Taylor, 1997).

Direct costs often account for the majority of disease related costs, and are heightened significantly in those with chronic illness. For example, direct costs associated with diabetes account for approximately 70% of total disease related costs. Although not generally included in costs studies, recent researchers have advocated that non-medical costs (i.e., transportation to and from medical visits and childcare costs) should also be included in measuring direct costs (Gold et al., 1996; Ettaro et al., 2004). Those advocating this position suggest that current direct cost data is most likely an underestimate of the true direct cost of illness.

Indirect costs refer to the economic value of decreased workforce productivity related to disease. Individuals who are absent from work (absenteeism) or who continue to work but experience a decrease in their level of productivity (presenteeism) diminish their financial contribution to society.

Additionally, caregivers often experience similar decreases in productivity as a result of their responsibilities thus compounding employment costs. Overall, the reduction in workforce productivity resulting from the effects of illness represents a significant economic burden to society.

Intangible costs are more controversial and refer to the economic value of pain, suffering and overall reductions in quality of life associated with a disease. Intangible costs can be difficult to measure and most cost analysis studies do not include them. However, cost utility studies using quality-adjusted life years (QALYs) as their outcome measure will often include intangible costs in their calculation (Teutsch, 2003).

Diabetes Related Costs

The cost of diabetes is increasing at an alarming rate. Largely credited to increases in diabetes prevalence and general medical costs, diabetes related costs have risen substantially over the past decade. In 2002, the total cost of diabetes was estimated at $132 billion annually (ADA, 2002). In 2007, these costs increased significantly to approximately $174 billion, with over $116 billion credited to excess medical expenditures (ADA, 2008). More recently, a comprehensive study including both pre-diabetes and diabetes-related costs increased the total estimate to $218 billion annually with $153 billion in increased medical costs (Dall et al., 2010).

The primary contributor to the high cost of diabetes is excess medical expenditures. Individuals diagnosed with diabetes incur direct medical costs (ex: hospital stay, drug costs, clinic visits, etc.) more than twice that of those without diabetes (ADA, 2008). These costs increase with age and vary significantly according to diabetes type. The estimated annual direct medical cost per case for T1D is $10, 495 as compared to $6,414 for those with T2D, $3514 for gestational diabetes, and $1744 for undiagnosed diabetes. (Dall et al., 2010). Overall, increased medical expenditures account for approximately 70% of the total cost of diabetes.

The majority of diabetes related medical costs are the result of disease complications. Approximately 50% of medical expenditures are attributed to complications as compared to 23% for standard diabetes treatment and 27% in excess general medical costs (ADA, 2008). The largest specific contributor to overall costs is inpatient hospitalization which accounts for approximately 50% of all medical expenditures. Hospitalization inpatient stays are typically the result of difficulties such as endocrine complications, renal complications, neurological symptoms, etc. Additional medical cost components include funds for diabetes medication and supplies (12%), retail prescriptions to treat complications of diabetes (11%), and physician office visits (9%) (ADA, 2008).

The average cost per case for individuals diagnosed with diabetes is $9,975 per year. This estimate is increased to approximately $12,839 per year

when including individuals with undiagnosed diabetes. These expenditures represent an annual economic burden of approximately $700 for each American (Dall et al., 2010). In terms of the typical American household, approximately 3% to 4% of annual household income is spent on diabetes (U.S. Census Bureau, 2009). Given the trend in costs over the past decade and projections of increased prevalence, it is expected that the national economic burden associated with diabetes will continue to increase significantly.

CHAPTER THREE

Rationale, Aims, & Hypotheses

RATIONALE

Recent findings have demonstrated the substantial national economic burden associated with diabetes. The majority of these costs are associated with disease related complications and excess medical expenditures. Depressive symptoms are common among adolescents with type-1 diabetes (T1D), and have been associated with increased disease-related complications. Parents play a key role in pediatric chronic illness, and the relationship between maternal depressive symptoms and adolescent disease management is well documented. Given the increased prevalence of depressive symptoms in mothers of adolescents with T1D, maternal depressive symptoms serve as a possible contributor to increased disease complications and subsequent medical expenditures.

Although adult studies have examined the impact of depressive symptoms on healthcare costs for individual with diabetes, no such study to date has been conducted with adolescents. Similarly, maternal depressive symptoms has been linked to higher rates of healthcare utilization in other areas of pediatric chronic illness, but has not been fully examined in adolescents with T1D. The primary purpose of this study is to illustrate the economic impact of depressive symptoms within this population as assessed by healthcare costs over a period of 12 and 24

months following the assessment of the adolescent. Adolescent depressive symptoms were examined as a potential predictor of healthcare costs. Additionally, the role of maternal depressive symptoms as either an independent predictor of costs or as a moderator of adolescent depressive symptoms was examined. Given the literature demonstrating the impact of adherence and HbA1c level on outcomes in this population, these two variables were examined as potential mediators of the relationship between depressive symptoms and costs. Finally, considering the tendency of depressive symptoms to fluctuate in individuals over time, the impact of persistent depressive symptoms was examined in secondary analyses.

AIMS & HYPOTHESES

For all Aims listed below, utilization/charges were assessed over a period of 12 and 24 months following measurement of depressive symptoms.

Primary Aims

Aim I: To determine whether adolescent depressive symptoms have a significant impact on healthcare utilization and/or direct costs for adolescents with T1D

Hypothesis 1: Adolescents with high levels of depressive symptoms will have higher healthcare utilization and incur higher charges.

Aim II: To determine whether maternal depressive symptoms have a significant impact on healthcare utilization and/or direct costs for adolescents with T1D.

Hypothesis 2: Adolescent offspring of mothers with high levels depressive symptoms will have higher healthcare utilization and incur higher charges.

Aim III*:* To investigate whether differences in healthcare utilization and/or costs related to adolescent depressive symptoms are mediated through adolescents' report of adherence or HbA_{1c} level.

Hypothesis 3: Treatment adherence and HbA_{1c} level will act as mediators of the relationship (if any) between adolescent depressive symptoms and healthcare utilization/charges.

Aim IV: To investigate whether differences in healthcare utilization and/or direct costs related to adolescent depressive symptoms are moderated by maternal depressive symptoms.

Hypothesis 4: Adolescent depressive symptoms will result in greater healthcare utilization/charges when maternal depressive symptoms are higher.

Secondary Aims

Aim V: To determine whether persistent adolescent depressive symptoms have a significant impact on healthcare utilization and/or costs for adolescents with T1D.

Hypothesis 5: Adolescents with elevated depressive symptoms at two time points over a 12 month period will have higher healthcare utilization and incur higher charges.

Aim VI: To determine whether persistent maternal depressive symptoms have a significant impact on healthcare utilization and/or costs for adolescents with T1D.

Hypothesis 6: Adolescent offspring of mothers with elevated depressive symptoms at two time points over a 12 month period will have higher healthcare utilization and incur higher charges.

Aim VII: To determine whether the combination of persistent adolescent and maternal depressive symptoms has a significant impact on healthcare utilization and/or costs for adolescents with T1D.

Hypothesis 7: The combination of persistent depressive symptoms in adolescents and their mothers will result in higher healthcare charges.

CHAPTER FOUR

Methodology

This study received approval from the institutional review board of both the University of Texas Southwestern Medical Center and Children's Medical Center of Dallas.

Participants and Procedure

Participants in this study included 246 adolescents and their mothers. Data regarding adolescent and maternal depressive symptoms, adolescent adherence, glycemic control, and demographic information were obtained from an existing database of adolescent patients treated at Children's Medical Center of Dallas (CMCD). Additional data, specifically: Healthcare utilization data and direct charges associated with endocrine clinic visits, emergency room visits, and hospitalizations were provided by the CMCD. Archival data were collected as part of a longitudinal study on treatment adherence among adolescents with diabetes in the Children's Endocrinology Center at CMCD. The original study was approved by the Institutional Review Board of the University of Texas Southwestern Medical Center at Dallas.

In the archival data, inclusion criteria for adolescents were age of 11 through 18 years, diagnosis of type 1diabetes, and availability of an English-

speaking primary caretaker (typically the mother). Exclusion criteria were coexisting primary medical diseases (e.g., chronic active hepatitis or severe cardiac, renal, or hematologic disease.).

Recruitment was conducted during clinic visits over a period of 18 months. The participation rate among those who met the criteria was 90%. The primary reason stated for nonparticipation was inconvenience because of the time required to administer the study measures; no other characteristics of refusers could be recorded without informed consent. Participation was voluntary, and confidentiality of information (even from the treatment team) was ensured. Written informed consent was obtained from the parent and assent was obtained from the adolescent. The first subject was enrolled in December 2001 and the last in May 2003.

Measures

Demographic Measures

The participant's age at diagnosis was obtained from the medical records. Parents' reports of paternal occupation were analyzed as an approximate measure of socioeconomic status, according to the following categories: unemployed, blue-collar worker (unskilled or manual labor, e.g., construction, domestic help, or landscape crew), white-collar worker (e.g., clerical staff or sales), and professional (e.g., physician, university professor, or lawyer).

Depressive Symptoms

Adolescents and mothers individually completed the Center for Epidemiological Studies Depression Scale (CES-D), a 20-item, self-report, rating scale developed to measure current levels of depressive symptoms in community samples (Radloff, 1977). This widely used scale discriminates between psychiatric and nonpatient samples, and has repeatedly demonstrated high internal consistency across studies (e.g. Cronbach's alpha coefficients ranging from .85 to .90) along with substantial evidence for both concurrent and construct validity (Radloff, 1977). Participants received the self-administered questionnaire from a research assistant during a clinic visit. Each participant was asked to indicate on a Likert scale (0, rarely to none of the time, to 3, most or all of the time) the extent to which each item was true of him or her in the past week. Examples of items are "I felt sad," "I had trouble keeping my mind on what I was doing," and "I thought my life had been a failure." Summed scores on the 20 items ranged from 0 to 60, with higher scores indicating more depressive symptoms. Participants completed the CES-D at baseline and again at 12 months.

Although the CES-D was originally developed for adults, it has been validated with children and younger and older adolescents (Dierker et al., 2001; Garrison et al., 1991). In the validating study, which included youths ≥11 years of age, (Garrison et al., 1991) the self-report scale was followed by a diagnostic interview, to obtain information about the relationship between the scale scores

and diagnoses of MDD. Optimal cutoff points (i.e., scores at or above which the likelihood of false-negative and false-positive results is lowest) were reported as 12 for boys and 22 for girls. With these cutoff points, sensitivity and specificity from receiver operating characteristic curves were 0.85 and 0.49 for boys and 0.83 and 0.77 for girls, respectively (Garrison et al., 1991). As a categorical variable, CES-D scores were grouped relative to these cutoff points, as low (i.e., <12 for boys and <22 for girls) or high (i.e., ≥12 for boys and ≥22 for girls). In adults, a score of 16 or higher signifies the optimal cut-off point for elevated depressive symptoms (Radloff, 1977). Therefore, mother's CES-D scores were grouped relative to this cutoff point as low (<16) or high (≥16). CES-D scores were also analyzed as a continuous variable.

Given normal fluctuation in depressive symptoms, repeated measures of symptom severity over time may be utilized to clarify potential risk. Specifically, multiple high scores over time may be an indicator of persistent depressive symptoms and serve as a better predictor of outcomes than a single measurement. CES-D scores were also examined to determine whether symptoms are persistently high in adolescents or mothers. For the purpose of this study "persistently high depressive symptoms" was defined as having a CES-D score which falls above the cutoff point both at baseline and again at 12 months.

Glycemic Control

Hemoglobin A1c (HbA1c) (the main form of glycosylated hemoglobin) levels are routinely measured at clinic visits. The level measured at the visit at which participants were enrolled in the study and completed the CES-D was obtained from the patients' medical records.

Adherence

A multidimensional measure covering various aspects of the diabetes regimen was utilized (Littlefield, et al., 1992). Regimen components assessed included regular blood glucose testing, taking insulin shots as scheduled, following a dietary plan, exercising, treating a reaction, and remembering to complete all treatment requirements every day. Adolescent patients rated their adherence to these different aspects of the diabetes regimen by giving themselves grades on each care behavior from 0 to 100. The average was computed across the seven areas and used a measure of adherence.

Healthcare Utilization & Charges

Healthcare utilization data including endocrine clinic visits, emergency room visits, and inpatient hospitalizations secondary to diabetes-related complications were obtained from the hospital database for the study participants. Hospital charges for endocrine clinic visits, emergency room visits, and inpatient

hospitalizations secondary to diabetes-related complications during study participation were provided by CMCD. These charges were inflation adjusted to fiscal year 2011 and represent an estimate of direct costs. Healthcare utilization and charges accumulated at one and two years from enrollment were considered.

Analysis

SPSS software (version 19; SPSS, Chicago, IL) was used to analyze data. Descriptive information was compiled for demographic measures (e.g., gender, ethnicity, and age) and the variables in the study. Healthcare utilization and charges were compared with respect to demographic variables to determine significant associations.

Multiple regression analyses were utilized to determine significant predictors of healthcare utilization/charges. Prior to conducting the regression analyses, variable distributions were examined for normality and outliers. Natural logarithmic transformations were applied to IV (CES-D scores) and DV (emergency room visits, hospitalizations, hospital inpatient days, charges) to account for significant positive skew. Demographic and disease-related variables associated with utilization/charges were entered as covariates. The overall strength of the relationship between the each predictor variable and the criterion (healthcare utilization/charges) as well as the results of the overall significance test were reported.

CHAPTER FIVE

Results

A *p* value <.05 will be described as significant. Values between .05 and .10 will be referred to as "marginally" significant for all analyses. Depressive symptoms were examined as both a continuous (CES-D score) and categorical (Low-dep, High-dep by gender specific CES-D cutoff point, i.e., 12 for boys and 22 for girls) variable (see introduction for significance of the two different measurement strategies). Please see Figure 1 in Appendix B for consort diagram.

Descriptive Statistics

Descriptive statistics for study participants are detailed in Table 1.

Depressive Score Patterns

CES-D scores at enrollment and follow-up are provided in Table 2. As a continuous variable, depressive symptoms (i.e., CES-D scores) declined over time for both adolescents, $t(156) = 5.06$, $p < .001$, and mothers, $t(143) = 6.28$, $p < .001$. As a categorical variable (by CES-D cutoff point), depressive symptoms also declined for both groups. The percentage of CES-D scores above the cutoff point was significantly lower at 12 months for both adolescents, $\chi^2(1, N = 157) = 49.18$, $p<.001$ and mothers, $\chi^2(1, N = 144) = 23.64$, $p<.001$. Adolescent and maternal

depressive symptoms (i.e., CES-D scores) were directly related at baseline (r =.25, p<.01) and at 12 month follow-up (r =.21, p<.05).

Depressive Scores: Associations with Demographic and Disease-Related Variables

The correlational matrix in Table 3 shows the bivariate correlations between CES-D scores, demographic information, and disease-related variables. As a continuous variable, adolescent depressive symptoms were higher in girls [$t(238)$= -2.00, p<.05] and older adolescents. Maternal depressive symptoms were higher the more recent their child's diabetes diagnosis. Tables 4 and 5 provide group comparisons for adolescents and mothers above versus below the CES-D cutoff point, respectively. As a categorical variable, adolescents above the CES-D cutoff point had higher Hba1c levels and mothers with higher CES-D scores. Adolescent depressive groups also differed by gender as more boys than girls had scores above the CES-D cutoff point. Mothers falling above the CES-D cutoff point had children with higher CES-D scores and marginally higher HbA1c levels. Also, lower SES mothers were more likely to have CES-D scores above the cutoff point.

Healthcare Utilization/Charges

Healthcare utilization rates and charges for the total sample are presented in Table 6. Hospitalizations accounted for the largest percentage of mean total charges over 24 months (62%), compared to endocrinology clinic visits and emergency room visits (both at 19%).

Table 3 included bivariate associations between utilization rates and charges and demographic variables. Healthcare utilization/charges were directly related to higher HbA1c. Younger adolescents had more endocrinology clinic visits at 12 and 24 months. However, age was not associated with healthcare visits that are related to significant complications (i.e., emergency room visits, hospitalizations, or hospital inpatients days) or total healthcare charges. Utilization/charges did not differ by gender or SES. Hospitalizations were higher for African American (M=.31, *SD*=.46) than Caucasian (M=.11, SD=.32) and Hispanic (M=.04, SD=.19) adolescents. Thus, as expected given more hospitalizations, total charges were higher for African American (M=8.75, SD=1.57) than Caucasian (M=7.72 SD=1.72) and Hispanic (M=7.63, SD=1.07) adolescents. HbA1c levels were also higher for African American (M=10.34, SD=2.35) than Caucasian (M=8.19, SD=1.43) and Hispanic (M=8.84, SD=1.32) adolescents. After controlling for HbA1c, African American adolescents did not have higher hospitalizations, β = -.01, $t(243)$ = -.18, p=.85, or incur higher

charges, $\beta = .09$, $t(243) = 1.41$, $p=.16$. Thus, higher hospitalizations and charges in African American adolescents were fully explained by higher Hba1c levels.

Analyses related to Study Aims

For the following aims, cross-sectional associations will be reported followed by multivariate longitudinal analyses. Demographic and disease-related variables associated with utilization/charges (i.e., HbA1c, age) were included as covariates in regression analyses. Although not correlated with utilization or expenditures in our sample, time since diagnosis and gender have been associated with diabetes-related complications and hospitalization in earlier prospective studies of youth with diabetes (Charron-Prochownik, Kovacs, Obrosky, Stiffler, 1994; La Greca, Swales, Klemp, Madigan, Skyler, 1995 ; Kovacs, Charron-Prochownik, Obrosky, 1995; Rewers et al., 2002; Stewart et al., 2005). Therefore, in order to generalize findings to the population of interest, these variables were also included as covariates of healthcare utilization and charges in regression analyses. It is notable that analyses were conducted both with and without the aforementioned covariates (i.e. gender, time since diagnosis) and it did not alter the outcome of our findings.

Primary Aims

Adolescent depressive symptoms and healthcare utilization/charges

Aim I: The study's first aim was to determine whether adolescent depressive symptoms at baseline predict healthcare utilization and/or charges at 12 months and 24 months from enrollment.

Hypothesis 1: Adolescents with high levels of depressive symptoms will have higher healthcare utilization and incur higher charges.

As a continuous variable, adolescent depressive symptoms were not related to utilization/charges in bivariate analyses (Table 3). The exception was a marginal bivariate relationship with hospital inpatient days at 12 months. In multivariate, longitudinal analyses adolescent depressive symptoms did not predict utilization/charges at 12 or 24 months, after controlling for age, time since diagnosis, gender, and HbA1c, (p>.10 for all analyses).

As a categorical variable (by CES-D cutoff point), adolescent depressive symptoms were related to utilization/charges. Table 7 presents the means and differences on healthcare utilization and charges between adolescents whose depressive scores were below versus above the cutoff. As hypothesized, adolescents in the high-dep category utilized services more and incurred higher charges. The exception was for endocrine clinic visits where the two groups were equivalent, which would be expected given that these are routine visits.

Table 8 presents the results of the multivariate linear regression analyses examining the prediction offered by high/low adolescent depressive symptoms at baseline to healthcare service utilization and charges, controlling for age, time since diagnosis, gender, and HbA1c. High/low adolescent depressive symptoms at enrollment predicted healthcare charges and marginally predicted hospital inpatient days at 12 months. High/low adolescent depressive symptoms predicted emergency room visits, hospital inpatient days, and charges and marginally predicted hospitalizations at 24 months.

In total, results suggest that adolescent depressive symptoms were not linearly related to healthcare utilization or charges. Only group comparisons were meaningful, such that High-dep group membership predicted higher utilization and expenditures.

Maternal depressive symptoms and healthcare utilization/charges

Aim II*:* The study's second aim was to determine whether maternal depressive symptoms predict healthcare utilization and/or direct charges for adolescents with T1D.

Hypothesis 2: Adolescent offspring of mothers with high levels of depressive symptoms will have higher healthcare utilization and incur higher charges.

As a continuous variable, maternal depressive symptoms were associated with utilization/charges at 12 and 24 months in bivariate analyses (Table 3). The

exception was for endocrine clinic visits and emergency room visits at 12 months. In multivariate, longitudinal analyses, maternal depressive symptoms predicted healthcare charges and marginally predicted hospitalizations and hospital inpatient days at 12 months after controlling for age, time since diagnosis, gender, and HbA1c. Maternal depressive symptoms predicted hospitalizations, hospital inpatient days, and charges and marginally predicted emergency room visits at 24 months (Table 9).

As a categorical variable, maternal depressive symptoms were related to utilization/charges in cross-sectional analyses. Table 10 presents the means and differences on healthcare utilization and charges between adolescents whose mothers' depressive scores were below versus above the cutoff. As hypothesized, adolescents whose mothers fell in the high-dep category utilized services more and incurred higher charges than those whose mothers fell in the low depressive category. The exception once again was for endocrine clinic visits.

In multivariate, longitudinal analyses maternal depressive symptoms at enrollment predicted healthcare charges and marginally predicted emergency room visits at 12 months after controlling for age, time since diagnosis, gender, and HbA1c. Maternal depressive symptoms predicted emergency room visits, hospitalizations, hospital inpatient days, and charges at 24 months (Table 11).

In total, as hypothesized, higher maternal depressive symptoms predicted higher adolescent healthcare utilization and expenditures. Apart from marginal

prediction of emergency room visits, hospitalization, and hospital inpatient days at 12 months, outcomes did not differ as a function of CES-D scores being treated as a continuous or categorical variable.

Adherence and HbA1c level as mediators of the relationship between depressive symptoms and healthcare utilization/charges.

Aim III*:* The study's third aim was to investigate whether differences in healthcare utilization and/or charges related to adolescent depressive symptoms are mediated through adolescents' report of adherence or HbA_{1c} level.

Hypothesis 3: Treatment adherence and HbA_{1c} level will act as mediators of the relationship (if any) between adolescent depressive symptoms and healthcare utilization/charges.

Mediation is established in four steps: 1) Predictor is correlated with the outcome 2) Predictor is correlated with the mediator 3) Mediator is related to the outcome, independent of the predictor 4) The relationship between the predictor and the outcome is weakened when controlling for the mediator. Essentially, a variable functions as a mediator if it accounts, at least in part, for the relationship between a predictor and criterion variable. If this relationship is fully explained by the mediator variable, then complete mediation has occurred. If the predictor is associated with an outcome through a mediator, then this is described as an indirect effect.

Mediation was tested using the bootstrapping technique recommended by (Preacher & Hayes, 2004). This method of mediation is appropriate for smaller sample sizes and does not rely on the assumption of normality within the path that constitute the indirect effect or within the sampling distributions of the total and specific indirect effects (Preacher & Hayes, 2004; 2008). In the bootstrap analysis, multiple samples are randomly drawn from the larger dataset and statistics are computed on each of those sets of data, providing a distribution of the statistic across the random samples. The estimates presented in the current study are based on 5,000 bootstrap samples. Initially, covariates (i.e., age, gender, time since diagnosis) were included in all bootstrap methods. HbA1c level was included as a covariate when testing adherence as a mediator. Bootstrapping techniques were then utilized to determine if depressive symptoms at baseline were indirectly linked to healthcare utilization /charges at follow-up (24 months) through either of the two potential mediators: adherence (by adolescent self-report) or HbA1c. Tests were conducted separately for the three domains of the dependent variable (i.e., emergency room visits, hospital inpatient days, total charges). Significant mediation is concluded if the confidence interval for the indirect effect (IV to DV after controlling for the mediator) does not cross zero.

Adolescent depressive symptoms, as a continuous variable, were not related to utilization/charges, therefore mediation was not tested. As a categorical variable, cross-sectional analyses revealed that worse adherence and HbA1C were

related to higher adolescent depressive symptoms and higher healthcare utilization/charges (Table 4). In addition, high adolescent depressive symptoms predicted higher utilization (i.e., emergency room visits, hospital inpatient days) and expenditures in longitudinal analyses (see Table 8). Thus, both self-reported adherence and HbA1c were potential candidates for mediation of the relationship between high/low adolescent depressive symptoms and healthcare utilization/charges.

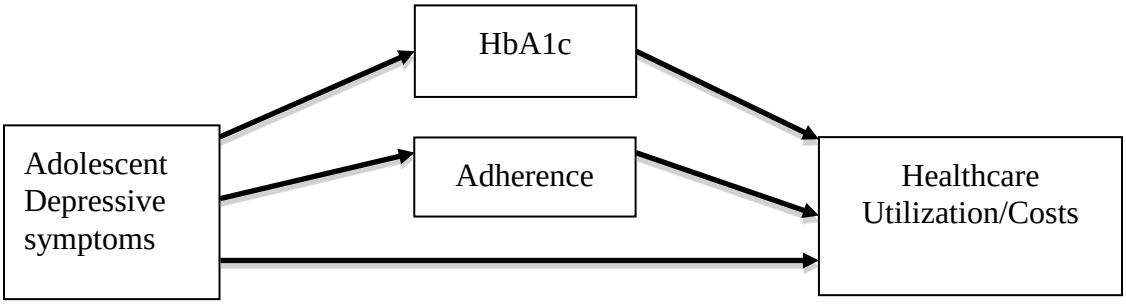


Figure 2. HbA1c and/or Adherence as potential mediators between adolescent depressive symptoms and healthcare utilization/charges

First, the relationship between high/low depressive symptoms (IV) and healthcare utilization/charges (DV) was examined with HbA1c as the mediator. Results suggested that when controlling for age, gender, and time since diagnosis, HbA1c did not mediate the relationship between high/low adolescent depressive symptoms and healthcare utilization or charges (Table 12).

Next, the relationship between high/low adolescent depressive symptoms (IV) and healthcare utilization/charges (DV) was examined with adherence as the mediator. When controlling for age, gender, time since diagnosis, and HbA1c,

results suggested that adherence may account at least partially for the relationship between high/low adolescent depressive symptoms and emergency room visits and hospital inpatient days, but not charges (Table 13).

Follow-up regression analyses found that the relationship between high/low adolescent depressive symptoms and emergency room visits was fully mediated by adherence (see Figure 3), while adherence only partially mediated the relationship between high/low adolescent depressive symptoms and hospital inpatient days.

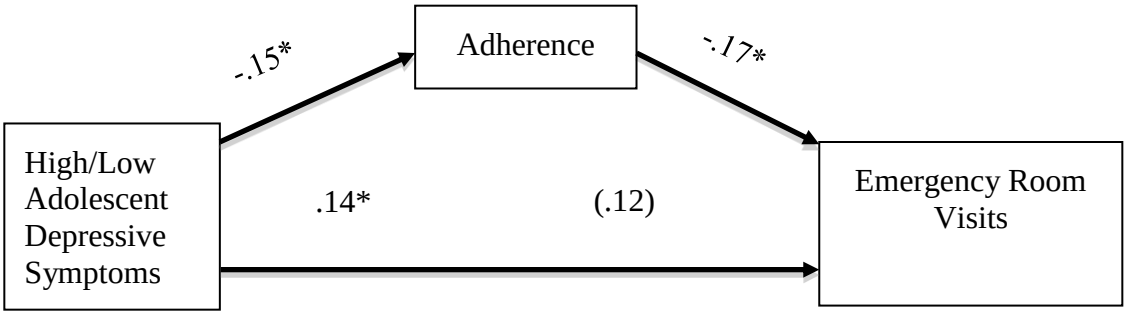


Figure 3. Standard regression coefficients for the relationship between adolescent depressive symptoms and emergency room visits as mediated by adherence. The standard regression coefficient between adolescent depressive symptoms and emergency room visits controlling for adherence is in parentheses. Age, gender, time since diagnosis, and HbA1c were entered as covariates.
*$p < .05$

Do maternal depressive symptoms moderate the relationship between adolescent depressive symptoms and healthcare utilization/charges?

Aim IV: To investigate whether differences in healthcare utilization and/or direct charges related to adolescent depressive symptoms are moderated by maternal depressive symptoms.

Hypothesis 4: Adolescent depressive symptoms will result in greater healthcare utilization/charges overall when maternal depressive symptoms are also high.

High/low maternal depressive symptoms were examined as a potential moderator of the relationship between high/low adolescent depressive symptoms and healthcare utilization or expenditures. HbA1c and demographic variables were entered as covariates. Regression equation was entered as follows:

DV: Emergency room visits, hospital inpatient days, hospitalizations, and total charges at 24 months (tested separately)

Predictors: Gender, HbA1c, age, time since diagnosis, adolescent depressive symptoms, maternal depressive symptoms (moderator), maternal depressive symptoms x adolescent's depressive symptoms (interaction term)

The interaction term was significant for hospitalizations ($\beta = 1.255$, $t(222) = 2.263$, $p<.05$) and hospital inpatient days ($\beta = 1.244$, $t(222) = 2.260$, $p<.05$), thus maternal depressive symptoms moderated the relationship between high/low adolescent depressive symptoms and these two outcomes (Figure 4 and Figure 5,

respectively). High/low maternal depressive symptoms did not moderate the relationship between high/low adolescent depressive symptoms and emergency room visits or total expenditures.

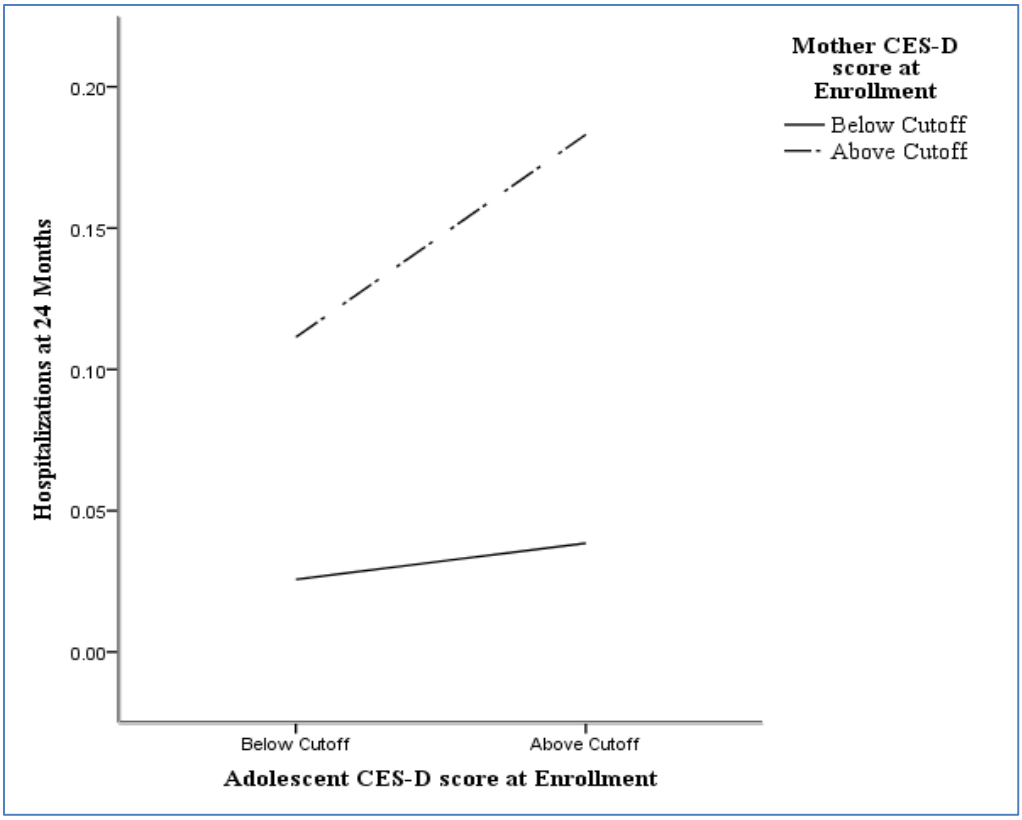


Figure 4. The effect of adolescent depressive symptoms on hospitalizations at 24 months moderated by maternal depressive symptoms

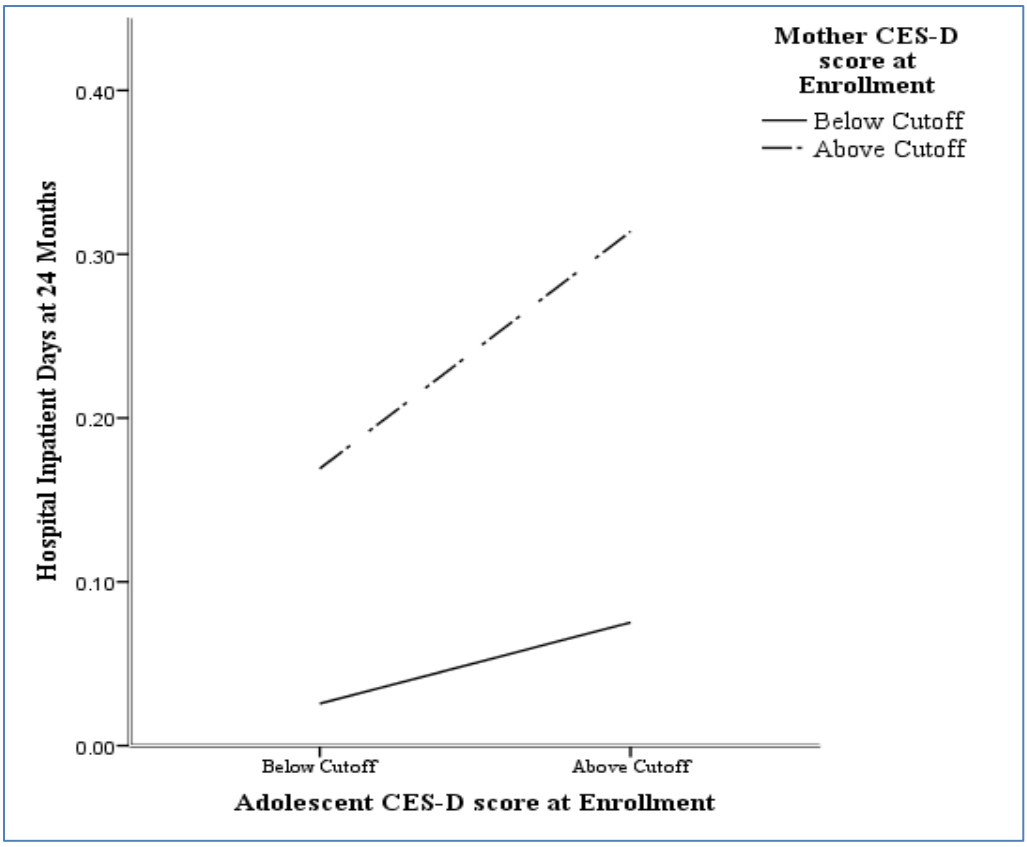


Figure 5. The effect of adolescent depressive symptoms on hospital inpatient days at 24 months moderated by maternal depressive symptoms

Secondary Aims

The impact of persistent depressive symptoms (adolescent, maternal, and/or both) on healthcare expenditures

Aims V, VI, and VII focused on the issue of persistent depressive symptoms and their impact on healthcare expenditures. For the purpose of this study "persistently high depressive symptoms" was defined as having a CES-D

score which falls above the cutoff point both at baseline and again at 12 months. It was hypothesized that adolescent healthcare charges at 24 months would be significantly higher if either adolescents (Hypothesis 5) or their mothers (Hypothesis 6) displayed depressive symptoms. Finally, charges were expected to be greater when persistent depressive symptoms were present in both adolescent and mothers (Hypothesis 7) as opposed to only one family member.

For Aims V and VI, adolescents and their mothers were each separated into two groups (i.e., non-persistent depressive symptoms or persistent depressive symptoms) based on their CES-D scores at enrollment and 12 month follow-up. Those demonstrating scores above the CES-D cutoff point and both time points were placed in the persistent group while those displaying significant symptoms at only one time point (i.e., enrollment or follow-up) were placed in the non-persistent group. Thus, two IVs (i.e., adolescent depressive symptoms, maternal depressive symptoms) each having two levels: non-persistent and persistent resulted in four total groups: Non-persistent Adolescents (N=83), Persistent Adolescents (N=74), Non-persistent Mothers (N=73), and Persistent Mothers (N=71). The relationships between each IV and the DV (i.e., healthcare expenditures at 24 months) when controlling for age, gender, time since diagnosis, HbA1c, were examined using a factorial analysis of covariance (ANCOVA).

Hypothesis 5: Adolescents with elevated depressive symptoms at two time points over a 12 month period will incur higher healthcare charges.

When controlling for age, gender, HbA1c, and time since diagnosis, the effect of persistent versus non-persistent adolescent depressive symptoms on adolescent healthcare expenditures was non-significant, $F(1, 124) = .801$, $p > .10$.

Hypothesis 6: Adolescent offspring of mothers with elevated depressive symptoms at two time points over a 12 month period will incur higher healthcare charges.

When controlling for age, gender, HbA1c, and time since diagnosis, the main effect of maternal persistent versus non-persistent depressive symptoms on expenditures at 24 months was significant, $F(1, 143) = 5.31$, $p < .05$. Thus, charges were significantly higher when mothers exhibited persistent depressive symptoms than when mothers had high depressive symptoms at only one time point.

Hypothesis 7: The combination of persistent depressive symptoms in adolescents and their mothers will result in higher healthcare charges.

For Aim VII, adolescents and their mothers were separated into four groups: Non-persistent Adolescents/ Non-persistent mothers, Persistent Adolescents/Non-persistent Mothers, Persistent Mothers/Non-persistent adolescents, and Persistent Adolescents/ Persistent Mothers. The relationship between IV (persistent groups) and the DV (i.e., healthcare charges at 24 months)

controlling for age, gender, time since diagnosis, HbA1c, was examined using a one-way ANCOVA. When controlling for age, gender, HbA1c, and time since diagnosis, group differences in healthcare expenditures at 24 months were non-significant, (Table 14)

Exploratory Analyses

Maternal depressive symptoms predict adolescent healthcare utilization/charges when controlling for adolescent depressive symptoms

Given that high/low adolescent depressive symptoms were predictive of healthcare utilization and charges (see Aim 1), we tested whether maternal depressive symptoms would remain predictive of healthcare utilization/charges when controlling for high/low adolescent depressive symptoms. As in previous analyses age, gender, time since diagnosis, and HbA1c were also entered as covariates. Maternal depressive symptoms were marginally predictive of hospitalizations at 12 months and predicted hospitalizations, hospital inpatient days, and charges at 24 months. More specifically, only HbA1c and maternal depressive symptoms contributed unique variance to utilization/charges (Table 15).

Do maternal depressive symptoms predict healthcare utilization/charges when controlling for previous healthcare utilization/charges?

Since depressive scores and utilization/charges were measured at two time points, it was examined whether maternal depressive symptoms would remain predictive of outcomes when controlling for previous utilization/charges. After controlling for demographic variables and HbA1c level along with utilization/charges incurred from enrollment to 12 months, maternal depressive symptoms at 12 months predicted adolescent emergency room visits, hospitalizations, hospital inpatient days, and total expenditures at 24 months. (Table 16)

This finding provides information regarding directionality of the relationship between maternal depressive symptoms and healthcare utilization/charges. In all previous analyses we are not accounting for the fact that mothers might have higher depressive symptoms because of previous poorly controlled diabetes and charges. Although we do not have reliable data for the years prior to baseline in this dataset, we are able to address this issue at least over a single year. This finding provides a more definitive demonstration that regardless of previous utilization, a mother's depression score, at any point in time, predicts whether utilization and charges are likely to increase.

Testing for Bidirectional Effects between Maternal Depressive Symptoms and Healthcare Utilization/Charges

Although it is evident that maternal depressive symptoms predict adolescent healthcare utilization and charges, it is also possible that there are bidirectional effects. Therefore, we tested whether healthcare utilization/charges predicted maternal depressive symptoms. Healthcare utilization (i.e., emergency room visits, hospitalizations, and hospital inpatients days) and charges were examined as predictors of maternal depressive symptoms at 12 months. Mother's CES-D score at enrollment was entered as a covariate. Regression equation was entered as follows:

DV: Mother's CES-D score (tested separately as continuous and categorical variable)

Predictors: Mother's CES-D score at enrollment, Emergency room visits, hospital inpatient days, hospitalizations, and total charges at 12 months (tested separately)

After controlling for maternal depressive symptoms at baseline, healthcare utilization/charges did not predict maternal depressive symptoms, as a continuous variable, at 12 months ($p>.10$). The exception was for emergency room visits, β

= .13, $t(141) = 1.86$, p=.07. Utilization/charges were not predictive of maternal depressive symptoms as a categorical variable.

Group Differences in Healthcare Utilization/Charges by Adolescent and Maternal CES-D scores (by cutoff point)

Given that high/low maternal depressive symptoms moderated the relationship between high/low adolescent depressive symptoms and healthcare utilization, i.e. hospitalizations, hospital inpatient days, (Aim IV), we further investigated the effect of high/low depressive groups. Specifically, group comparisons for each DV (emergency room visits, hospitalizations, hospital inpatient days, and total expenditures) were tested, and all group combinations were examined in post-hoc analyses.

Participants were separated into four groups by CES-D cutoff point: 1) Mom Low-dep & Adolescent Low-dep, 2) Mom Low-dep & Adolescent High-dep, 3) Mom High-dep & Adolescent Low-dep, 4) Mom High-dep & Adolescent High-dep. It was hypothesized that utilization rates and expenditures would differ by group membership and that utilization rates and expenditures would be highest when both adolescents and their mothers had high depressive symptoms (i.e., Mom High-dep and Adolescent High-dep).

Total groups were compared separately for each DV (emergency room visits, hospitalizations, hospital inpatient days, and total expenditures) using one-way analysis of variance (ANOVA). Significant total group differences were found for all outcomes (Table 17). Post hoc multiple comparisons were performed using the Games-Howell method to account for unequal group sizes and group variance. As hypothesized, utilization rates and expenditures were highest when both adolescents and their mothers had high depressive symptoms (Group 4). Specifically, Group 4 (Both high-dep) had higher emergency room visits, hospitalizations, hospital inpatient days, and expenditures than Group 1(Both Low-dep). Group 4 also had more hospital inpatient days than Group 2 (Mom Low-dep, Adolescent High-dep) and Group 3 (Mom High-dep & Adolescent Low-dep) had more emergency room visits than Group 1. Group 2 and 3 did not differ on any outcomes. Please see Table 18 for group comparisons.

Predictors for Increasing the Odds and Risk of Hospitalization and Emergency Room Visits

In order to further investigate the relationship between healthcare utilization and study variables, we examined depressive symptoms and demographic and disease-related variables to identify factors that increased the odds/risk of a single hospitalization or emergency room visit. Logistic regression was utilized to test the predictive value of high versus low depressive symptoms

as well as demographic (i.e., gender, age, time since diagnosis) and disease-related variables (i.e., adherence behaviors, HbA1c) on the odds of hospitalization (yes/no) and emergency room visit (yes/no) over 24 months. The following predictor variables were categorized by mean split: age (<=13.8, >13.8 years), time since diagnosis (<=4.3, >4.3 years), self-reported treatment adherence score (<=81.5, >81.5). HbA1c was categorized based on recommended optimal level for adolescents (i.e., <7.5, >7.5). Depressive symptoms were categorized by CES-D cutoff point (12 for boys, 22 for girls, 16 for moms).

Higher HbA1c or high maternal depressive symptoms significantly increased the odds of a hospitalization (Table 19). Only high maternal depressive symptoms increased the odds of an emergency room visit (Table 20). When compared to those whose mothers had low depressive symptoms, adolescents of mothers with high depressive symptoms were three times as likely to have an emergency room visit and four times as likely to have a hospitalization over the course of one year (Table 21 & Table 22, respectively). This risk estimate remained at two years (Table 23 & Table 24, respectively).

Factors related to maternal depressive symptoms

Given that maternal depressive symptoms were such a strong predictor of utilization/charges, it would be helpful to know what the risk factors might be for depressive symptoms in mothers in this population. Identification of such risk

factors could allow for early identification and support aimed at derailing the onset of maternal depressive symptoms. To this end we examined demographic and disease-related variables in this study.

In cross-sectional analyses, maternal depressive symptoms, as a continuous variable, were higher the more recent their child's diabetes diagnosis. As a categorical variable, high depressive symptoms were related to socioeconomic status (SES). Specifically, 73% of mothers reporting low depressive symptoms were from higher SES categories (see Table 5).

In multivariate regression analyses, time since diagnosis and SES were related to maternal depressive symptoms at enrollment, after controlling for adolescent depressive symptoms (Table 25). Time since diagnosis and SES each accounted for approximately 4% (p <.01) of the variance in mother's CES-D scores at enrollment. In longitudinal analyses, SES predicted maternal depressive symptoms at 12 months, after controlling for illness duration, adolescent depressive symptoms, and maternal depressive symptoms at enrollment (Table 26). After controlling for the aforementioned variables, SES accounted for 3% of the variance in mother's CES-D scores at 12 months, $\Delta F(1, 124) = 4.85$, $p = .03$.

Factors potentially impacting the relationship between maternal depressive symptoms and adolescent healthcare utilization/charges

Time Since Diagnosis

Time since diagnosis related to maternal depressive symptoms in bivariate (Table 3) and multivariate (Table 25) analyses. Given the wide range in our sample (<1 to 15 years), we examined whether time since diagnosis would moderate the relationship between maternal depressive symptoms and utilization/charges. If these relationships are stronger at certain points in illness duration, then this might inform time-targeted interventions for reducing utilization/charges.

We examined whether time since diagnosis would moderate the relationship between maternal depressive symptoms and utilization/charges. Time since diagnosis was tested as a continuous and categorical variable. As a categorical variable, time since diagnosis was tested by a mean split (M=4.3 yrs.) as well as by lowest and highest quartile (lowest 25% <=2 yrs., highest 25% >=6 yrs.). Regression equation was entered as follows:

DV: Emergency room visits, hospital inpatient days, hospitalizations, and total charges at 24 months (tested separately)

Predictors: Gender, HbA1c, age, time since diagnosis, Mother's CES-D score, Moderator (time since diagnosis), Mother's CES-D score x Moderator (interaction term)

The interaction term was non-significant in all analyses. Therefore, time since diagnosis did not moderate the relationship between maternal depressive symptoms and healthcare utilization or charges.

SES

Previous analyses demonstrated a significant relationship between SES and maternal depressive symptoms (Table 25, 26). Specifically, lower SES participants were more likely to report high maternal depressive symptoms. Given this finding, we posited that the relationship between maternal depressive symptoms and utilization/charges might be influenced by SES. If lower SES mothers were more likely to report high depressive symptoms, then perhaps they were also more likely engage in maladaptive parenting styles associated with poor diabetes management (Berg et al., 2008; Jaser & Grey, 2010; Wiebe et al., 2005) leading to higher disease-related complications. Secondly, higher depressive symptoms seen in lower SES groups might be reflective of increased general distress related to environmental (i.e., financial) stressors. If this were the case, then we might expect for lower SES mothers to seek assistance in managing their children's diabetes more readily. Thirdly, lower SES families are more likely to receive subsidized healthcare (i.e., Medicaid), and incur less out-of-pocket expense for healthcare utilization. Perhaps this discrepancy in out-of pocket expenses attenuates healthcare utilization for depressed mothers in higher SES families. As such, we tested SES as potential moderator of the relationship between maternal depressive symptoms and healthcare utilization/charges. Regression equation was entered as follows:

DV: Emergency room visits, hospital inpatient days, hospitalizations, and total charges at 24 months (tested separately)

Predictors: Gender, HbA1c, age, time since diagnosis, Mother's CES-D score, Moderator (SES),

Mother's CES-D score x Moderator (SES)

The interaction term was non-significant in all analyses. Therefore, SES did not moderate the relationship between maternal depressive symptoms and adolescent healthcare utilization or charges.

CHAPTER SIX

Discussion

Project Overview and Summary of Findings

Adolescent and maternal depressive symptoms were examined as predictors of adolescent healthcare utilization and charges. Depressive symptoms along with demographic and disease-related variables were measured at enrollment at 12 month follow-up. Healthcare utilization (i.e., endocrine clinic visits, emergency room visits, hospitalizations, and hospital inpatient days) and charges were assessed at 12 months and 24 months.

Both adolescent and maternal depressive symptoms were predictive of adolescent healthcare utilization and expenditures over 24 months; however there were notable differences between the two. For adolescents, it was the presence of depressive symptoms at a high level that impacted utilization/charges, while maternal depressive symptoms were predictive across the spectrum of symptoms. Adolescent depressive symptoms impacted utilization/charges through a decrease in adherence behaviors, while maternal depressive symptoms had a direct and unique effect, not fully explained by diabetes-related complications.

Depressive Symptoms as a Continuous versus Categorical variable

For adolescents, only when comparing those with high versus low depressive symptoms (i.e., categorical approach) did we find a significant difference in utilization/charges. Maternal depressive symptoms were associated with utilization/costs whether a categorical or dimensional approach was employed. In sum, in prediction of utilization/charges it was informative to know whether adolescent depressive symptoms met a certain threshold (i.e., above CED-D cutoff point), while for mothers all CES-D scores, even scores in the lower range, provided valuable information relevant to discrimination in the outcomes.

Patterns of Depressive Symptoms in Adolescents with T1D

A significant portion of adolescents and mothers in our sample had scores above the CES-D cutoff point, 65% and 73% respectively. Mean CES-D scores at enrollment were 20.14 for adolescents and 21.58 for mothers. The number of studies utilizing the CES-D with adolescents in this population are limited, however, of those studies that exist, lower CES-D mean scores have been reported. For example, in a study of individuals with diabetes (88% Type-1) ages 10-21 (N=2672), Lawrence et al. (2006) reported a mean CES-D score of 10.7. In mothers of children/adolescents with type 1 diabetes, scores above the CES-D cutoff point have been reported at 22% (Jaser et al., 2008; Hood et al., 2009) and

14% (de Witt et al., 2007). Thus, our sample may reflect higher depressive symptoms in adolescents and their mothers than is typical in the type 1 diabetes population.

A significantly higher number of boys than girls fell above the CES-D cutoff point. This disparity might further suggest that our sample, particularly as it related to boys, was abnormally high with regards to depressive symptoms. However, it could also suggest that boys with type 1diabetes may be particularly prone to depressive symptoms or that the current CES-D cutoff point for boys is too low, capturing too many false negatives. The CES-D cutoff points utilized in this study (22 for girls, 12 for boys) were those recommended by the original validating study with adolescents (Garrison et al., 1991). Using the gender non-specific cutoff point of 16 recommended for adults, 67% of boys and 73% of girls were above the cutoff point. We acknowledge that the CES-D is a screen measure and cutoff points are purposely skewed to higher sensitivity; however, future studies might explore the extent to which current cutoff points, especially for boys, are adequate for discriminating groups in this particular population.

Adolescent depressive symptoms and healthcare utilization/charges

High adolescent depressive symptoms at study enrollment predicted higher healthcare utilization (i.e., emergency room visits, hospital inpatient days) and expenditures at 24 months, when controlling for age, gender, time since

diagnosis, and HbA1c level. Adolescents with high depressive symptoms incurred $5,293 more in healthcare charges over a two year period than those with low depressive symptoms.

Adolescent depressive symptoms impacted healthcare utilization/charges indirectly through adherence. In other words, adolescents with high depressive symptoms reported more difficulty with meeting the demands of the treatment regimen, which in turn led to more complications and increased healthcare utilization/charges.

Maternal depressive symptoms and healthcare utilization/charges

Maternal depressive symptoms, whether conceptualized as a continuous or a categorical variable, impacted healthcare utilization and expenditures. High maternal depressive symptoms at enrollment resulted in charges of $11,389 at 24 months compared to an average of $3504.25 when maternal depressive symptoms were low. Charges increased 62% ($3,512) at 24 months when symptoms persisted.

Higher maternal depressive symptoms at enrollment predicted higher adolescent healthcare utilization (emergency room visits, hospitalizations, hospital inpatient days) and charges at 12 months and 24 months, when controlling for age, gender, time since diagnosis, and HbA1c level. Maternal

depressive symptoms remained predictive of utilization/charges, even when controlling for adolescent depressive symptoms and prior healthcare utilization. Furthermore, maternal depressive symptoms accounted for a portion of the variance in total healthcare charges comparable to HbA1c, 5% and 7% respectively.

The extent which maternal depressive symptoms affected adolescent utilization and charges was somewhat unexpected. Maternal depressive symptoms are typically thought to impact diabetes-related outcomes indirectly (e.g., parenting style, monitoring, etc.). This is more likely during adolescence given the increase in autonomy and control during this period. This thinking drove our initial hypotheses. We posited that both adolescent and maternal depressive symptoms would predict adolescent healthcare utilizations/charges; however, maternal depressive symptoms would likely act through their impact on adolescent depressive symptoms. As hypothesized, maternal depressive symptoms moderated the relationship between adolescent depressive symptoms and healthcare utilization (i.e., hospitalizations, hospital inpatient days). However, to our surprise, maternal depressive symptoms, not adolescent depressive symptoms, was the stronger predictor of adolescent utilization/charges.

Maternal depressive symptoms represented a unique risk factor for higher adolescent healthcare utilization and expenditures. Higher utilization occurred, at

least in part, independent of their children's depressive symptoms, adherence behaviors, or metabolic control. Thus, increased charges were incurred over and above diabetes related complications. In addition, persistent depressive symptoms in mothers, not adolescents, resulted in higher healthcare charges. While lower SES, a more recent diabetes diagnosis, and adolescent depressive symptoms were associated with higher maternal depressive symptoms, these factors did not account for the increase in utilization/charges. Finally, preliminary directional analyses suggested a path from maternal depressive symptoms to adolescent healthcare utilization, rather than the reverse.

The mechanism by which maternal depressive symptoms relate to higher utilization/charges was not evident from this study. One hypothesis is that as mothers felt more depressed they perceived their children as being in worse health. In a study of pediatric asthma patients, mother's depressive symptoms predicted emergency room visits after controlling for disease morbidity (Bartlett et al., 2001). Bartlett et al. (2001) posited that this may have been related to a decline in perceived treatment adherence and efficacy. For example, mothers with higher maternal depressive symptoms rated their children's adherence as worse and perceived their children's medications as less effective. Similarly, McCarthy et al. (2000) found that in acute illness, maternal depressive symptoms were associated with poor mother-child interaction and higher perception of illness severity.

Another possible explanation for this phenomenon is that mothers seek services for their children as an attempt to signal their own distress. This idea was posited by Bartlett et al. (2001) in their study of maternal depressive symptoms and emergency department use in pediatric asthma. They referred to Mandl et al (1999) which found that mothers find it less threatening or stigmatizing to contact the medical community on behalf of their children than for themselves.

Higher maternal depressive symptoms may also have been reflective of a lack of perceived social support. Collaborative and nurturing family environments optimize diabetes disease management (Berg et al., 2008; Jaser & Grey, 2010; Liss et al., 1998; Whittemore et al., 2002; Wiebe et al., 2005). In contrast, family environments with less shared responsibility and diabetes-specific support increase the risk for health complications and caregiver distress. Mothers experiencing significant stress and without adequate support may have felt overwhelmed and if perceiving themselves as less capable of managing their children's health, sought assistance more quickly.

Finally, higher maternal depressive symptoms may have impacted utilization/charges through their influence on medical providers. McCarthy et al. 2000 noted that maternal depressive symptoms and poor mother-child interactions contributed to poor decision making on the part of providers. Pediatricians exercised worse clinical judgment (i.e., higher perception of illness severity) and

over utilization of medical resources (i.e., ordering more tests) when higher maternal depressive symptoms and poorer mother-child interactions were present. Influenced by increased caregiver/familial distress, providers may have been inclined to provide additional services.

Limitations

All of our utilization/charge data was derived from a single site (CMCD). An advantage of this particular site is that children are provided services regardless of their ability to pay. As a result, we capture a larger cross-section of the population than is typical at a single center. However, there may be regional differences in patterns that a single center cannot adequately represent. Furthermore, CMCD was the primary service provider for our participants and likely accounted for the majority of their diabetes-related healthcare services; however, participants may have utilized healthcare services elsewhere and incurred additional charges. We only had utilization/charges at two time points. Additional time points would have allowed for further analyses including describing trajectories over time.

Only hospital charges, and not actual direct costs, were available. While charge figures were inflated to reflect current dollars, an updated cost/charge ratio was unavailable. Therefore, hospital "cost" data which includes a number of additional factors (i.e., institutional overhead) was not reported. We recognize

that the difference between charges and costs, even within a non-profit organization, can be significant (Finkler, 1982). Collection of information on resource consumption and direct costs would be required to properly measure economic efficiency. Finally, there are significant direct costs incurred by the patient but not reflected in hospital charges and so not included in the present study (e.g., medical supplies, prescription medications).

Future Research

The reasons why maternal depressive symptoms independently predicted increased adolescent healthcare utilization/charges remain unclear. Maternal depressive symptoms have been shown to predict offspring healthcare utilization in pediatric chronic illness such as asthma (Bartlett et al., 2001) as well as in the medically well population (Sills et al., 2007). However, this relationship has not been extensively studied in the diabetes population, and as previously noted, the mechanism by which this occurred was not evident from the present study. Further research examining factors that might account for or impact the relationship between maternal depression and healthcare utilization including the role of social support is warranted. In addition, family-related factors, such as family conflict, the role of fathers, and/or family systems would also be beneficial to explore. For example, Ying et al. (2011) recently found that marital status of the primary caregiver impacts risk for hospitalization and direct healthcare

charges. Identifying additional family factors that might relate, either directly or indirectly, to increased utilization and expenditures would be informative.

Although our findings suggest that decreasing depressive symptoms would have an impact on healthcare utilization and expenditures, future studies would be required to test such a hypothesis. The fact that these two variables are related does not guarantee that manipulation of one variable, in this case decreasing depressive symptoms, would necessarily result in a meaningful decline in utilization/charges. For example, maternal depressive symptoms could be reflective of another factor (e.g., social support) that is more directly associated with higher utilization/charges. In this scenario, decreasing depressive symptoms would only impact utilization/charges to the extent that it affected social support. If the impact of decreased depressive symptoms on social support were negligible, then there would likely be little reduction in utilization/charges. In other words, if mothers were motivated primarily to seek services as a result of a lack of social support, then they would likely continue to seek such services, even if their depressive symptoms decreased.

If indeed it can be demonstrated that decreasing depressive symptoms can lower healthcare utilization/charges in this population, then the next step would be to explore whether interventions aimed at lowering depressive symptoms would be cost effective. Cost effectiveness studies examining the current standard of

care against the implementation of empirically supported treatments for decreasing depression (e.g., pharmacotherapy, cognitive behavioral therapy), supportive measures to support family functioning and caregiver support (e.g., support groups), and or a combination of the two would be warranted.

Intervention to alleviate maternal depressive symptoms would not only improve the quality of life for these mothers (Trivedi et al., 2006) but might also conserve what are becoming more and more costly and limited medical resources (i.e., emergency room and hospital inpatient beds). Thus, the impact would go beyond the single patient, and provide the right care at the right place for all patients by improving access to those who need that level of care.

Clinical Implications

Practitioners should be aware that depressive symptoms may be high not only in the adolescent patient, but also in his or her mother. It may be important to treat both patients and their mothers' depressive symptoms to optimize disease management. Assessment/intervention with mothers could be of chief importance, particularly with regard to identifying subclinical symptoms. While ongoing assessment of depressive symptoms would provide additional and rich information, even a one-time measure can provide valuable information for the two years that follow.

Ideally, assessment of adolescent and maternal depressive symptoms would be implemented early as part of a family-focused treatment program. At diagnosis, providers could educate patients and their mothers about the role of psychological health and family functioning in diabetes management. Along with general information on type one diabetes management, families could be provided educational material on psychological /family factors (e.g., stress, depression, communication, etc.) related to diabetes outcomes. Both patients and their mothers could then be encouraged to complete a brief measure of depressive symptoms (i.e., CES-D), and provided available resources when appropriate. Given the nature of the treatment setting where the adolescent is considered the "patient", mothers could view questions about their psychological health as intrusive. Furthermore, mothers might reject assessment or treatment due to the stigma associated with such symptoms. Thus, emphasizing the role of caregiver psychological health/ family functioning within the context of pediatric chronic illness in general could be helpful. Normalizing increased stress or depressive symptoms for caregivers could help lessen opposition to assessment/intervention.

Policy Implications

Assuming that reduction of depressive symptoms was shown to be cost effective in this population, there are a number of potential implications for payers. Third-party payers might offer incentives, in the form of credits or

reduced premiums, to those willing to undergo initial screenings and/or participate in subsequent interventions. This could include preventive interventions (e.g., resiliency training, relaxation training, skill building, family communication, etc.) which can be provided at very low cost in universal and group formats before symptoms arise, as well as depression treatment (e.g., antidepressant medication, cognitive-behavioral therapy, etc.). Financial incentives might be particularly helpful in encouraging caregivers, both in terms of their own participation as well as in supporting their child's involvement. Payers might also incentivize medical providers to make additional non-emergency services available. Given the expense of emergency vs. non-emergency care reimbursement, incentives could be offered to encourage medical facilities provide adjunct psychological services to families (e.g., satellite clinic services, support hotline, etc.).

For providers, over-utilization of healthcare resources is significant from a cost-effectiveness standpoint. Given the movement to diagnosis-related group (DRG) based reimbursement systems in pediatric hospitals, additional unplanned visits can be economically disadvantageous. Higher depressive symptoms in adolescents, mothers, or both are likely to lead to over -utilization of services. This may occur through increased complications or indirectly through worse perception of illness severity by parents or providers. In total, to the extent that reducing depressive symptoms would be cost-effective for providers, addressing

this issue represents additive value to optimizing the clinical care of patients and their families.

APPENDICES

APPENDIX A
Tables

Table 1

Descriptive Data for Study Participants (Total Sample, N=246)

	N (%)		
Gender			
Female	141(57)		
Male	105(43)		
Ethnicity			
Caucasian	183(74)		
African American	32(13)		
Hispanic	17(7)		
Other	14(6)		
Socioeconomic status*			
Unemployed	9(4)		
Blue collar	84(39)		
White collar	95(44)		
Professional	14(13)		
	Mean	SD	Range
Age	13.80	1.79	11-18
Time since T1D diagnosis, (years)	4.30	3.52	<1-15
HbA_{1c} level**	8.53	1.72	5.10-14
Treatment Adherence score†	81.54	13.48	30-100

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.
**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).
†self-reported measure of various treatment regimen components (score range 1-100). Cronbach's α value adherence measure = .86

Table 2

CES-D scores for study participants

	Mean	SD	Range	Above CES-D Cutoff Point‡
Enrollment				
Adolescents	20.14	7.02	7-43	65%
Boys	19.03	6.59	9-37	91%
Girls	20.94	7.23	7-43	46%
Mothers	21.58	8.44	8-51	73%
Follow-up (12 Months)				
Adolescents	17.70	6.42	4-43	52%
Boys	16.37	4.22	9-30	87%
Girls	18.78	7.62	4-43	24%
Mothers	17.20	5.55	8-41	58%

‡CES-D cutoff point: boys=12, girls=22, adults=16

Cronbach's α values: Adolescent CES-D at Enrollment = .74, Adolescent CES-D at 12 Month Follow-up = .73, Mother's CES-D at Enrollment = .86, Mother's CES-D at 12 Month Follow-up = .74

Table 3: *Pearson Correlations Among Selected Study Variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age																
2. Gender	-.01															
3. HbA1c	.10	-.05														
4. TSD	.31**	-.10	.11′													
5. ADH	-.32**	-.12′	-.37**	-.23**												
6. A-dep	.14*	.13*	.07	-.04	-.23**											
7. M-dep	-.10	.05	.05	-.19**	-.03	.25**										
8. EC 12	-.29**	-.05	-.01	-.10	-.27**	-.02	.08									
9. EC 24	-.30**	-.08	-.02	-.05	.19**	.01	.06	.81**								
10. H 12	.02	.01	.36**	-.01	-.19*	.10	.15*	.03	.08							
11. H 24	-.03	.05	.33**	-.01	-.21**	.09	.21**	.02	.11	.81**						
12. HID 12	.01	.03	.34**	.02	-.21**	.11′	.14*	-.01	.04	.94**	.76**					
13. HID 24	-.03	.05	.34**	.01	-.23**	.11	.20**	-.01	.07	.83**	.95**	.87**				
14. ER 12	-.01	-.01	.25**	-.04	-.20**	.05	.10	.03	.07	.66**	.54**	.63**	.56**			
15. ER 24	-.02	-.02	.26**	-.02	-.21**	.07	.13*	.02	.09	.61**	.74**	.61**	.72**	.84**		
16. C 12	-.11′	-.01	.22**	-.12′	.05	.09	.21*	.53**	.40**	.56**	.48**	.53**	.48**	.57**	.53**	
17. C 24	-.06	-.03	.26**	-.03	-.12′	.08	.23**	.37**	.50**	.55**	.73**	.52**	.66**	.53**	.70**	.73**

TSD = time since diagnosis, ADH = adherence by adolescent self-report, A-Dep = adolescent CES-D score, M-Dep = mother CES-D score, EC = endocrine clinic visits, H = hospitalizations, HID = hospital inpatient days, ER = emergency room visits, C = healthcare charges, 12=12 months, 24 = 24 months

′p<.10, *p<.05, **p<.01

Table 4

Differences between participants at enrollment by Adolescent CES-D score

	Below Cutoff Point (N=84)	Above Cutoff Point (N=156)	*P* for Difference Between Groups
Gender, $\chi^2(1, N = 240) = 52.17$			<.001
Male, N(%)	9(11)	92(59)	
Female, N(%)	75(89)	64(41)	
Ethnicity, $\chi^2(3, N = 240) = 3.24$			NS
Caucasian, N (%)	68(81)	113(72)	
African American, N (%)	6(7)	23(15)	
Hispanic, N (%)	5(6)	11(7)	
Other, N (%)	5(6)	9(6)	
Ethnicity, $\chi^2(1, N = 240) = 2.14$			NS
Caucasian, N (%)	68(81)	113(72)	
Minority, N (%)	16(19)	43(28)	
SES*, $\chi^2(3, N = 211) = 5.02$			NS
Unemployed, N (%)	1(1)	8(6)	
Blue collar, N (%)	34(45)	48(35)	
White collar, N (%)	29(39)	65(48)	
Professional, N (%)	11(15)	15(11)	
	M ± SD	M ± SD	
Age	13.58 ± 1.82	13.97 ± 1.76	NS
Time since diagnosis, (years)	4.21 ± 3.16	4.31 ± 3.64	NS
HbA_{1c} level**	8.25 ± 1.30	8.67 ± 1.89	.047
Treatment Adherence score†	83.64 ± 12.73	80.61 ± 13.60	.09
Adolescent CES-D score	14.93 ± 3.91	22.94 ± 6.72	NA
Mother CES-D score	19.98 ± 7.50	22.53 ± 8.97	.029

CES-D cutoff scores: boys=12, girls=22. NS indicates not significant. Continuous variables compared by independent-sample *t* test. Categorical variables compared by chi-squared test for independence.

*Socioeconomic status (SES) assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self- reported measure of various treatment regimen components (score range 1-100).

Table 5

Differences between participants at enrollment by Mother CES-D score

	Below Cutoff Point (N=63)	Above Cutoff Point (N=173)	*P* for Difference Between Groups
Gender, $\chi^2(1, N = 236) = .052$			NS
Male, N(%)	28(44)	74(43)	
Female, N(%)	35(56)	99(57)	
Ethnicity, $\chi^2(3, N = 236) = 1.92$			NS
Caucasian, N (%)	47(75)	131(76)	
African American, N (%)	6(9.5)	23(13)	
Hispanic, N (%)	6(9.5)	9(5)	
Other, N (%)	4(6)	10(6)	
Ethnicity, $\chi^2(1, N = 236) = .031$			NS
Caucasian, N (%)	47(75)	131(76)	
Minority, N (%)	16(25)	42(24)	
SES*, $\chi^2(3, N = 208) = 9.21$			.03
Unemployed, N (%)	1(2)	7(4)	
Blue collar, N (%)	14(25)	66(44)	
White collar, N (%)	31(54)	63(42)	
Professional, N (%)	11(19)	15(10)	
	M ± SD	M ± SD	
Age	13.84 ± 1.67	13.77 ± 1.84	NS
Time since diagnosis, years	4.83 ± 3.71	4.08 ± 3.45	NS
HbA_{1c} level**	8.18 ± 1.37	8.61 ± 1.75	.05
Treatment Adherence score†	83.93 ± 11.93	81.54 ± 13.09	NS
Adolescent CES-D score	17.75 ± 6.10	20.71 ± 7.07	.004
Mother CES-D score	12.94 ± 1.70	24.73 ± 7.68	NA

CES-D cutoff score for adults = 16. NS indicates not significant. Continuous variables compared by independent-sample *t* test. Categorical variables compared by chi-squared test for independence.

*Socioeconomic status (SES) assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self- reported measure of various treatment regimen components (score range 1-100).

Table 6

Healthcare Utilization Rates and Charges, Total Sample (N=246)

	M	SD	Range
12 months			
Endocrine Clinic Visits	3.35	1.62	0-9
Emergency Room Visits	.24	.71	0-6
Hospitalizations	.12	.47	0-5
Hospital Inpatient Days	.54	3.39	0-42
Endocrine Clinic Charges	$1019.51	$492.96	$0-2,736
Emergency Room Charges	$920.74	$2,740.49	$0-23,034
Hospitalization Charges	$3,025.61	$12,070.67	$0-128,150
Total Charges	$5,065.86	$13,858.30	$0-136,740
24 Months			
Endocrine Clinic Visits	5.85	2.62	0-14
Emergency Room Visits	.45	1.70	0-10
Hospitalizations	.23	.66	0-5
Hospital Inpatient Days	.76	3.59	0-42
Endocrine Clinic Charges	$1,778.28	$797.35	$0-4,256
Emergency Room Charges	$1,732.24	$4,501.89	$0-38,390
Hospitalization Charges	$5,834.47	$16,798.90	$0-128,150
Total Charges	$9,344.98	$20,236.20	$0-137,956

Note. Charges have been inflation adjusted to fiscal year 2011

Charges include all utilization on the patient's encounter during visit (e.g., labs, radiology, room, etc.).

Table 7

Differences in Healthcare Utilization and Charges by Adolescent Depressive Symptoms, Mean (SD)

	Adolescent Low-dep (N=84)		Adolescent High-dep (N=156)		
	M(SD)	Range	M(SD)	Range	*P* for Difference Between Groups
12 months					
Endocrine Clinic Visits	3.25(1.66)	0-7	3.37(1.62)	0-9	NS
Emergency Room Visits	.12(.36)	0-2	.29(.83)	0-6	.05
Hospitalizations	.05(.21)	0-1	.15(.56)	0-5	.04
Hospital Inpatient Days	.13(.62)	0-4	.78(4.22)	0-42	.04
Total Charges	$2,665.50 ($6,482.09)	$0-34,220	$6,100.12 ($16,326.82)	$0-136,740	.04
24 months					
Endocrine Clinic Visits	5.6(2.70)	0-11	5.88 (2.58)	0-14	NS
Emergency Room Visits	.24(.63)	0-4	.55 (1.37)	0-10	.02
Hospitalizations	.12(.33)	0-1	.28 (.767)	0-5	.08
Hospital Inpatient Days	.23(.70)	0-4	1.04(4.44)	0-42	.04
Total Charges	$5,677.05 ($10,333.04)	$0-43,114	$10,969.97 ($23,559.50)	$0-137,956	.02

Low-dep/High-dep = below/above CES-D cutoff point (boys=12, girls=22). NS indicates not significant.

Table 8

Regression Analyses for Adolescent Depressive Symptoms as a Categorical Variable (by CES-D cutoff point) Predicting Healthcare Utilization and Charges at 12 and 24 months controlling for demographic variables and HbA1c

A-dep → ER12		**A-dep → H12**		**A-dep → HID12**		**A-dep → C12**	
R^2=.07, F(5,234) = 4.21**		R^2=.14, F(5,234) = 7.38***		R^2=.13, F(5,234) = 7.07***		R^2=.09, F(5,234) = 4.61***	
	β		β		β		β
HbA1c	.24***	HbA1c	.35***	HbA1c	.34***	HbA1c	.23***
A-dep	.11	A-dep	.11	A-dep	.13†	A-dep	.16*
A-dep → ER24		**A-dep → H24**		**A-dep → HID24**		**A-dep → C24**	
R^2=.09, F(5,234)= 4.73***		R^2=.13, F(5,234)= 7.04***		R^2=.15, F(5,234) = 8.05***		R^2=.09, F(5,234) = 4.57***	
	β		β		β		β
HbA1c	.27***	HbA1c	.33***	HbA1c	.35***	HbA1c	.25***
A-dep	.14*	A-dep	.13†	A-dep	.15*	A-dep	.16*

Note. All analyses control for age, gender, and time since diagnosis. With the exception of gender predicting H24 (β=.14, p=.044), all demographic variables were non-significant. Utilization/Charges were transformed to natural log for regression analysis. CES-D cutoff point (boys=12, girls=22)

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-dep = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment
†p<.10, *p< .05, **p <.01, ***p<.001

Table 9

Regression Analyses for Maternal Depressive Symptoms as a Continuous Variable (i.e., CES-D score) Predicting Healthcare Utilization and Charges at 12 and 24 months controlling for demographic variables and HbA1c

M-dep → ER12		**M-dep → H12**		**M-dep → HID12**		**M-dep → C12**	
R^2=.08, F(5,229) = 4.21***		R^2=.17, F(5,229) = 9.12***		R^2=.15, F(5,229) = 8.36***		R^2=.14, F(5,229) = 7.62***	
	β		β		β		β
HbA1c	.28***	HbA1c	.38***	HbA1c	.37***	HbA1c	.29***
M-dep	.07	M-dep	.12†	M-dep	.12†	M-dep	.16**

M-dep → ER24		**M-dep → H24**		**M-dep → HID24**		**M-dep → C24**	
R^2=.09, F(5,229) = 4.30***		R^2=.17, F(5,229) = 9.19***		R^2=.17, F(5,229) = 9.45***		R^2=.13, F(5,229) = 6.53***	
	β		β		β		β
HbA1c	.26***	HbA1c	.35***	HbA1c	.36***	HbA1c	.26***
M-dep	.11†	M-dep	.19**	M-dep	.18**	M-dep	.21**

Note. Age, gender, and time since diagnosis entered as covariates. Demographic variables were non-significant in all analyses. Utilization/Charges were transformed to natural log for regression analysis.

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-dep = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment

†p<.10, *p< .05, **p <.01, ***p<.001

Table 10

Differences in Healthcare Utilization and Charges by Maternal Depressive Symptoms, Mean (SD)

	Mother Low-dep (N=63)		Mother High-dep (N=173		
	M(SD)	Range	M(SD)	Range	*P* for Difference Between Groups
12 months					
Endocrine Clinic Visits	3.14(1.64)	0-7	3.46(1.62)	0-9	NS
Emergency Room Visits	.10(.39)	0-2	.31(.81)	0-6	.01
Hospitalizations	.03(.18)	0-1	.16(.55)	0-5	.005
Hospital Inpatient Days	.10(.56)	0-4	.74(4.02)	0-42	.01
Charges	$2,134.70 ($5,679.67)	$0-34,524	$6,376.90 ($16,000.51)	$0-136,740	<.001
24 months					
Endocrine Clinic Visits	5.51(2.49)	0-10	6.02(2.65)	1-14	NS
Emergency Room Visits	.16(.52)	0-3	.56(1.34)	0-10	.001
Hospitalizations	.05(.22)	0-1	.29(.75)	0-5	<.001
Hospital Inpatient Days	.11(.57)	0-4	1.00(4.23)	0-42	<.001
Charges	$3,504.25 ($6,851.33)	$0-35,740	$11,389.29 ($22,981.12)	$0-137,956	<.001

Low-dep/High-dep = below/above CES-D cutoff point (adults=16). NS indicates not significant.

Table 11

Regression Analyses for Maternal Depressive Symptoms as a Categorical Variable (by CES-D cutoff point) Predicting Healthcare Utilization and Charges at 12 and 24 months controlling for demographic variables and HbA1c

M-dep → ER12		**M-dep → H12**		**M-dep → HID12**		**M-dep → C12**	
R^2=.08, F(5,229) = 4.58***		R^2=.16, F(5,229) = 8.69***		R^2=.15, F(5,229) = 7.85***		R^2=.16, F(5,229) = 8.38***	
	β		β		β		β
HbA1c	.27***	HbA1c	.38***	HbA1c	.37***	HbA1c	.28***
M-dep	.11†	M-dep	.09	M-dep	.08	M-dep	.20**

M-dep → ER24		**M-dep → H24**		**M-dep → HID24**		**M-dep → C24**	
R^2=.10, F(5,229) = 4.81***		R^2=.15, F(5,229) = 8.13***		R^2=.16, F(5,229) = 8.41***		R^2=.14, F(5,229) = 7.22***	
	β		β		β		β
HbA1c	.25***	HbA1c	.35***	HbA1c	.36***	HbA1c	.25***
M-dep	.15*	M-dep	.13*	M-dep	.12*	M-dep	.23***

Note. Age, gender, and time since diagnosis entered as covariates. Demographic variables were non-significant in all analyses. With the exception of time since diagnosis predicting charges at 12 months (β= -.15, p<.05), demographic variables were non-significant. Utilization/Charges were transformed to natural log for regression analysis.

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-dep = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment
†p<.10, *p< .05, **p <.01, ***p<.001

Table 12

Bootstrap Analyses for HbA1c as Mediator of the relationship between Adolescent Depressive Symptoms and Healthcare Utilization/Charges (N=238)

Independent Variables (IV)	Mediating Variable (M)	Dependent Variable (DV)	Effect of IV on M (a)	Effect of M on DV (b)	Direct Effect of IV on DV (c′)	Total Effects (c)	Indirect Effect IV on DV through M 95% CI†
A-dep	HbA1c	ER 24	.3646	.0700**	.1347*	.1602*	-.0055 to .0715
A-dep	HbA1c	HID 24	.3646	.1170**	.1810*	.2236*	-.0081 to .1244
A-dep	HbA1c	C 24	.3646	.2446**	.5419*	.6311*	-.0190 to .2616

Note. Age, gender, and time since diagnosis were entered as covariates. None were significant.
A-dep = adolescent depressive symptoms (by CES-D cutoff point; boys=12, girls=22), ER = emergency room visits, HID = hospital inpatient days, C = healthcare charges, 24 = 24 months from enrollment

†Mediation is concluded if the confidence interval (CI) does not cross zero [Bootstrap samples = 5000]
*p<.05, **p<.01

Table 13

Bootstrap Analyses for Adherence as Mediator of the relationship between Adolescent Depressive Symptoms and Healthcare Utilization/Charges (N=238)

Independent Variables (IV)	Mediating Variable (M)	Dependent Variable (DV)	Effect of IV on M (a)	Effect of M on DV (b)	Direct Effect of IV on DV (c′)	Total Effects (c)	Indirect Effect IV on DV through M 95% CI†
A-dep	ADH	ER 24	-4.080*	-.0056*	.1132	.1360*	.0007 to .0773
A-dep	ADH	HID 24	-4.080*	-.0063*	.1679*	.1935*	.0007 to .0899
A-dep	ADH	C 24	-4.080*	-.0061	.5209*	.5459*	-.0447 to .1396

Note. Age, gender, time since diagnosis, and HbA1c were entered as covariates. Only HbA1c was significant. ADH= adherence by adolescent self-report, A-dep = adolescent depressive symptoms (by CES-D cutoff point; boys=12, girls=22), ER = emergency room visits, HID = hospital inpatient days, C = healthcare charges, 24 = 24 months.

†Mediation is concluded if the confidence interval (CI) does not cross zero [Bootstrap samples = 5000]
*p<.05, **p<.01

Table 14

Group Differences in Healthcare Charges at 24 months by Persistent Depressive Symptoms

Groups:
1) Adolescents & Mothers Non-persistent (N=43)
2) Persistent Adolescents/Non-persistent Mothers (N=27)
3) Persistent Mothers/Non-persistent adolescents (N=31)
4) Adolescents & Mothers Persistent (N=31)

	Group 1 M(SD)	Group 2 M(SD)	Group 3 M(SD)	Group 4 M(SD)	F(3,124)	Sig.
Healthcare Charges at 24 months	.03(.13)	.15(.35)	.19(.39)	.31(.53)	2.02	.114

Note. Persistent depressive symptoms defined as having CES-D score above the cutoff point at enrollment and 12-month follow-up. CES-D cutoff point (adults=16, boys=12, girls=22).

DVs tested separately by one-way ANCOVA. Age, gender, time since diagnosis, and HbA1c entered as covariates. Charges were transformed to natural log

Table 15

Maternal Depressive Symptoms as a Continuous Variable (i.e., CES-D score) predict Healthcare Utilization and Charges at 12 and 24 months controlling for demographic variables, HbA1c, and Adolescent Depressive Symptoms

M-dep → ER12		**M-dep → H12**		**M-dep → HID12**		**M-dep → C12**	
R^2=.08, F(6,223) = 3.27**		R^2=.17, F(6,223) = 7.41***		R^2=.16, F(6,223) = 7.00***		R^2=.14, F(6,223) = 6.06***	
	β		β		β		β
HbA1c	.27***	HbA1c	.37***	HbA1c	.36***	HbA1c	.36***
M-dep	.06	M-dep	.11†	M-dep	.10	M-dep	.10
M-dep → ER24		**M-dep → H24**		**M-dep → HID24**		**M-dep → C24**	
R^2=.09, F(6,223) = 3.60***		R^2=.17, F(6,223) = 7.39***		R^2=.18, F(6,223) = 7.91***		R^2=.12, F(6,223) = 5.15***	
	β		β		β		β
HbA1c	.27***	HbA1c	.35***	HbA1c	.36**	HbA1c	.26**
M-dep	.10	M-dep	.18**	M-dep	.16*	M-dep	.21**

Note. Age, gender, time since diagnosis, and adolescent depressive symptoms (CES-D score) entered as covariates. Demographic variables and adolescent depressive symptoms were non-significant in all analyses. Utilization/Charges were transformed to natural log for regression analysis.

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-dep = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment

†p<.10, *p< .05, **p <.01, ***p<.001

Table 16

Prediction by Maternal Depressive Symptoms to Healthcare Utilization and Charges in the following 12 months, after controlling for demographic variables, HbA1c, and Healthcare Utilization/Charges for the previous 12 months

M-dep → ER24		**M-dep → H24**		**M-dep → HID24**		**M-dep → C24**	
R^2=.64, F(6,141) = 41.70***		R^2=.49, F(6,141) = 22.94***		R^2=.68, F(6,141) = 50.76***		R^2=.42, F(6,141) = 16.97***	
	β		β		β		β
HbA1c	.21***	HbA1c	.30***	HbA1c	.26***	HbA1c	.26***
ER12	.78***	H12	.61***	HID12	.77***	C12	.59***
M-dep12	.11*	M-dep12	.12*	M-dep12	.11*	M-dep12	.16*

Note. Only utilization/charges relevant to each DV (i.e., covariate ER12 for DV: ER24) included in each model. Age, gender, and time since diagnosis also entered as covariates. Gender marginally predicted ER24 (β= -.09, p=.09) and age marginally predicted H24 (β= -.12, p=.09), and HID24 (β= -.09, p=.09). All other demographic variables were non-significant. Utilization/Charges were transformed to natural log for regression analysis.

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-dep = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment

*p< .05, **p <.01, ***p<.001

Table 17

Group Differences in Healthcare Utilization and Charges at 24 months by Adolescent and Maternal CES-D score

Groups:
1) Mom Low-dep, Adolescent Low-dep (N=27)
2) Mom Low-dep, Adolescent High-dep (N=36)
3) Mom High-dep, Adolescent Low-dep (N=56)
4) Mom High-dep, Adolescent High-dep (N=111)

	Group 1 M(SD)	Group 2 M(SD)	Group 3 M(SD)	Group 4 M(SD)	F(3,226)	Sig.
24 months						
Emergency Room Visits	.03(.13)	.15(.35)	.19(.39)	.31(.53)	3.51	.016
Hospitalizations	.03(.13)	.04(.16)	.11(.26)	.18(.41)	2.96	.033
Hospital Inpatient Days	.03(.13)	.08(.32)	.17(.41)	.31(.75)	2.88	.037
Charges	6.57(2.50)	7.57(1.56)	7.98 (1.24)	8.17(1.48)	7.81	<.001

DV tested separately by one-way ANOVA

Low-dep/High-dep = below/above CES-D cutoff point (adults=16, boys=12, girls=22), Utilization/Charges were transformed to natural log

Table 18

Post Hoc Comparisons of Healthcare Utilization and Charges at 24 months by CES-D score groups

Group 1	Mom Low-dep, Adolescent Low-dep (N=27)
Group 2	Mom Low-dep, Adolescent High-dep (N=36)
Group 3	Mom High-dep, Adolescent Low-dep (N=56)
Group 4	Mom High-dep, Adolescent High-dep (N=111)

24 months	Group 1 M(SD)	Group 2 M(SD)	Group 3 M(SD)	Group 4 M(SD)
Emergency Room Visits	.03(.13)	.15(.35)	.19(.39)	.31(.53)
Hospitalizations	.03(.13)	.04(.16)	.11(.26)	.18(.41)
Hospital Inpatient Days	.03(.13)	.08(.32)	.17(.41)	.31(.75)
Charges	6.57(2.50)	7.57(1.56)	7.98 (1.24)	8.17(1.48)

	Group Comparisons	Sig.
Emergency Room Visits	Group 4 > Group 1	<.001
	Group 3 > Group 1	.019
Hospitalizations	Group 4 > Group 1	.001
	Group 4 > Group 2	.014
Hospital Inpatient Days	Group 4 > Group 1	.001
	Group 4 > Group 2	.04
Charges	Group 4 > Group 1	.016

Post hoc comparisons were performed using the Games-Howell method to account for unequal group sizes and group variance. Low-dep/High-dep = below/above CES-D cutoff point (adults=16, boys=12, girls=22), Utilization/Charges were transformed to natural log

Table 19

Significant Predictors for Increasing the Odds of Hospitalization over 24 Months

Predictors	Odds Ratio (OR)	*p*-value
HbA1c (<7.5, >7.5)	.23	.018
Mom CES-D (above vs. below cutoff point)	.25	.029

Note. Age, gender, time since diagnosis, and treatment adherence score were non-significant predictors

CES-D cutoff point for adults = 16

Table 20

Significant Predictors for Increasing the Odds of an Emergency Room Visit over 24 Months

Predictors	Odds Ratio (OR)	*p*-value
Mom CES-D (above vs. below cutoff point)	.29	.007

Note. Age, gender, time since diagnosis, treatment adherence score, and HbA1c were non-significant predictors

CES-D cutoff point for adults = 16

Table 21

Relative Risk for Emergency Room Visit over 12 Months

Risk Factor	Risk Estimate Value	95% CI
HbA1c	2.47	1.00 – 6.10
Mom High-dep	3.00	1.11 – 8.14

High-dep = CES-D score above the cutoff point (i.e, CES-D >16)

Table 22

Relative Risk for Hospitalization over 12 Months

Risk Factor	Risk Estimate Value	95% CI
HbA1c	8.78	1.21 – 63.84
Mom High-dep	3.82	.92 – 15.84

High-dep = CES-D score above the cutoff point (i.e, CES-D >16)

Table 23

Relative Risk for Emergency Room Visit over 24 Months

Risk Factor	Risk Estimate Value	95% CI
HbA1c	1.70	.94 – 3.09
Mom High-dep	2.60	1.25 – 5.43

High-dep = CES-D score above the cutoff point (i.e, CES-D >16)

Table 24

Relative Risk for Hospitalization over 24 Months

Risk Factor	Risk Estimate Value	95% CI
HbA1c	4.39	1.39 – 13.84
Mom High-dep	3.88	1.23 – 12.24

High-dep = CES-D score above the cutoff point (i.e, CES-D >16)

Table 25

SES and Time Since Diagnosis Associated with Maternal Depressive Symptoms controlling for Adolescent Depressive Symptoms

Model
R^2=.14, F(3,200)= 11.06, p<.001

Predictors	β	*t*	Sig.
A-dep	.24	3.61	<.001
TSD	-.20	-2.98	.003
SES	.20	3.09	.002

DV: Mother's CES-D score at enrollment

TSD = time since diagnosis, M-dep = maternal depressive symptoms (CES-D score) at enrollment, A-dep = adolescent depressive symptoms (CES-D score) at enrollment

Table 26

SES Predicts Maternal Depressive Symptoms at 12 Months controlling for Adolescent Depressive Symptoms, Time Since Diagnosis, and Maternal Depressive Symptoms at Enrollment

Model
R^2=.28, F(4,124)= 12.20, p<.001

Predictors	β	*t*	Sig.
M-dep	.46	5.58	<.001
SES	.17	2.20	.03

DV: M-dep12 (mother's CES-D score at 12 months from enrollment). Time since diagnosis and adolescent depressive symptoms (CES-D score) were non-significant covariates.

TSD = time since diagnosis, A-dep = Adolescent depressive symptoms at enrollment (CES-D score), M-dep = maternal depressive symptoms at enrollment (CES-D score)

Table 27

Descriptive Data for Adolescents who did not complete CES-D at Enrollment (N=6)

	N (%)		
Gender			
Female	2(33)		
Male	4(67)		
Ethnicity			
Caucasian	2(33)		
African American	3(50)		
Hispanic	1(17)		
Other	0(0)		
Socioeconomic status*			
Unemployed	0(0)		
Blue collar	2(50)		
White collar	1(25)		
Professional	1(25)		
	Mean	SD	Range
Age	12.67	1.51	11-14
Time since T1D diagnosis, years	5.40	5.90	0-13
HbA_{1c} level**	8.90	1.90	6.6-11.7
Treatment Adherence score†	75.95	18.45	40-93

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self-reported measure of various treatment regimen components (score range 1-100)

Table 28

Descriptive Data for Moms who did not complete CES-D at Enrollment (N=10)

	N (%)		
Gender			
Female	7(70)		
Male	3(30)		
Ethnicity			
Caucasian	5(50)		
African American	3(30)		
Hispanic	2(20)		
Other	0(0)		
Socioeconomic status*			
Unemployed	1(14.3)		
Blue collar	4(57)		
White collar	1(14.3)		
Professional	1(14.3)		
	Mean	SD	Range
Age	14.20	1.55	11-16
Time since T1D diagnosis, years	4.70	3.50	0-10
HbA_{1c} level**	9.38	2.58	5.1-14
Treatment Adherence score†	66.29	19.73	30-96

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self-reported measure of various treatment regimen components (score range 1-100)

Table 29

Descriptive Data for Adolescents who did not complete CES-D at 12 Month Follow-Up (N=87)

	N (%)		
Gender			
Female	53(61)		
Male	34(39)		
Ethnicity			
Caucasian	64(73)		
African American	12(14)		
Hispanic	5(6)		
Other	6(7)		
Socioeconomic status*			
Unemployed	5(7)		
Blue collar	33(45)		
White collar	27(37)		
Professional	8(11)		
	Mean	SD	Range
Age	13.92	1.95	11-18
Time since T1D diagnosis, years	4.29	3.51	0-13
HbA_{1c} level**	8.77	1.77	5.1-14
Treatment Adherence score†	79.52	15.03	30-100

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self-reported measure of various treatment regimen components (score range 1-100)

Table 30

Descriptive Data for Moms who did not complete CES-D at 12 Month Follow-up (N=95)

	N (%)		
Gender			
Female	54(57)		
Male	41(43)		
Ethnicity			
Caucasian	71(75)		
African American	12(13)		
Hispanic	6(6)		
Other	6(6)		
Socioeconomic status*			
Unemployed	5(7)		
Blue collar	33(42)		
White collar	33(42)		
Professional	7(9)		
	Mean	SD	Range
Age	14.04	1.91	11-18
Time since T1D diagnosis, years	4.21	3.70	0-15
HbA_{1c} level**	8.72	1.92	5.10-14
Treatment Adherence score†	80.52	14.39	30-100

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self-reported measure of various treatment regimen components (score range 1-100)

Table 31

Descriptive Data for Adolescents with no Healthcare Utilization/Charge Data at 12 months (N=11)

	N (%)		
Gender			
Female	6(55)		
Male	5(45)		
Ethnicity			
Caucasian	10(91)		
African American	1(9)		
Hispanic	0(0)		
Other	0(0)		
Socioeconomic status*			
Unemployed	0(0)		
Blue collar	2(22)		
White collar	7(78)		
Professional	0(0)		
	Mean	SD	Range
Age	14.64	2.29	11-18
Time since T1D diagnosis, years	6.64	4.86	0-13
HbA_{1c} level**	8.35	1.46	6.7-12
Treatment Adherence score†	70.45	18.16	30-97

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self-reported measure of various treatment regimen components (score range 1-100)

Table 32

Descriptive Data for Adolescents with no Healthcare Utilization/Charge Data at 24 months (N=39)

	N (%)		
Gender			
Female	24(62)		
Male	15(38)		
Ethnicity			
Caucasian	31(79)		
African American	3(8)		
Hispanic	3(8)		
Other	2(5)		
Socioeconomic status*			
Unemployed	3(9)		
Blue collar	13(37)		
White collar	19(54)		
Professional	0(0)		
	Mean	SD	Range
Age	14.15	1.99	11-18
Time since T1D diagnosis, years	3.69	3.37	0-12
HbA_{1c} level**	8.36	1.81	5.9-14
Treatment Adherence score†	81.87	14.07	40-100

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.

**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).

†self-reported measure of various treatment regimen components (score range 1-100)

Figure 1

APPENDIX B
Figures

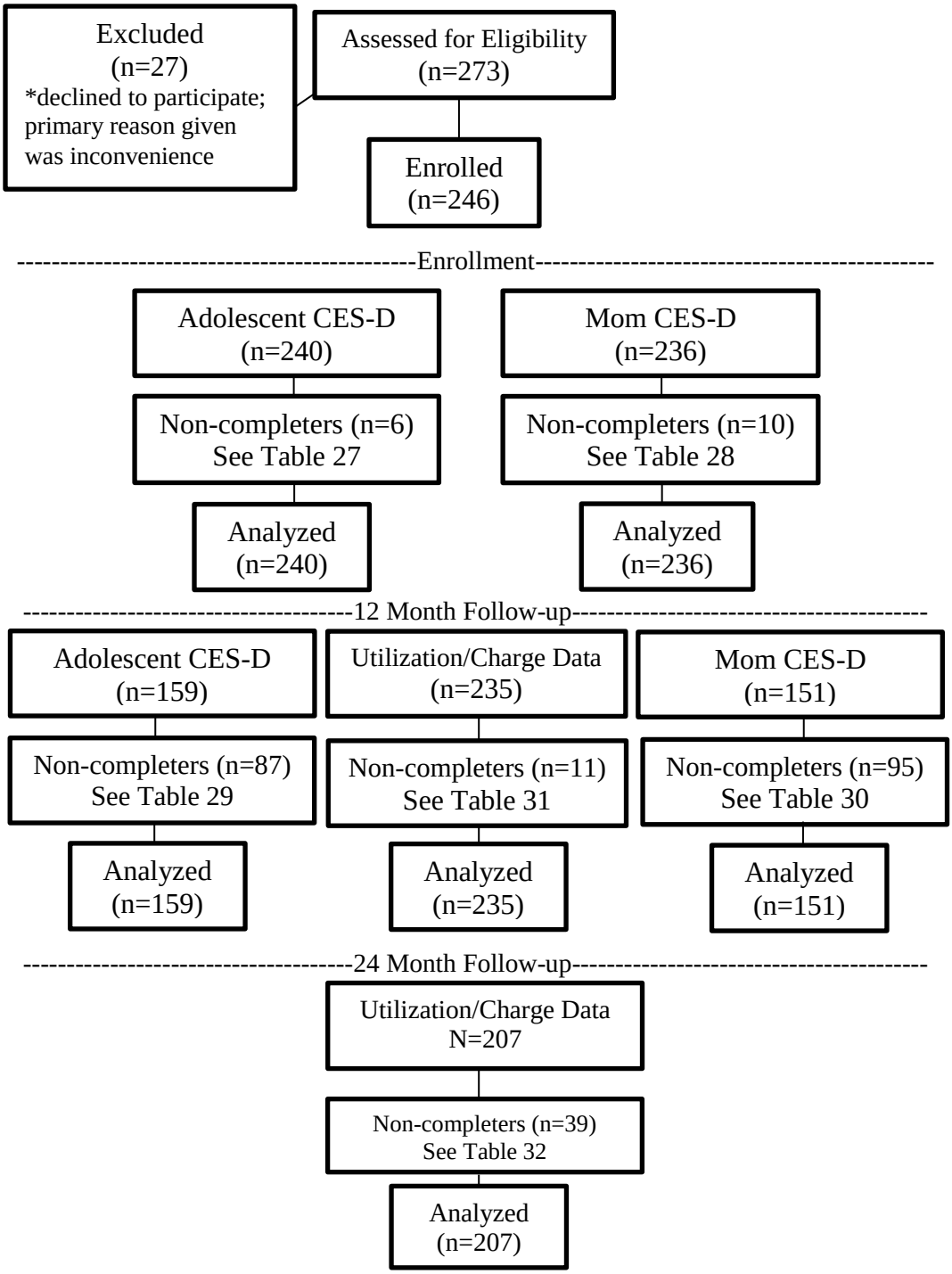
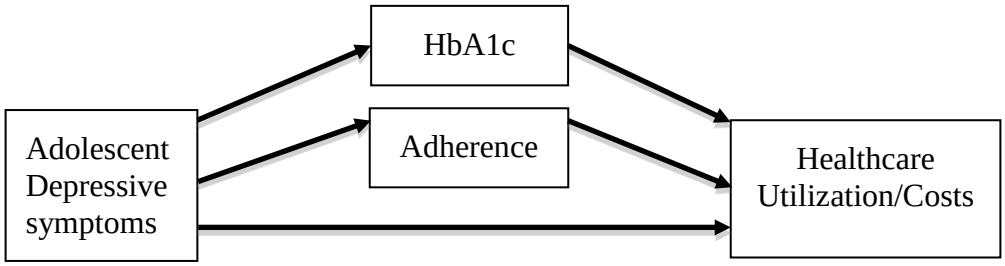
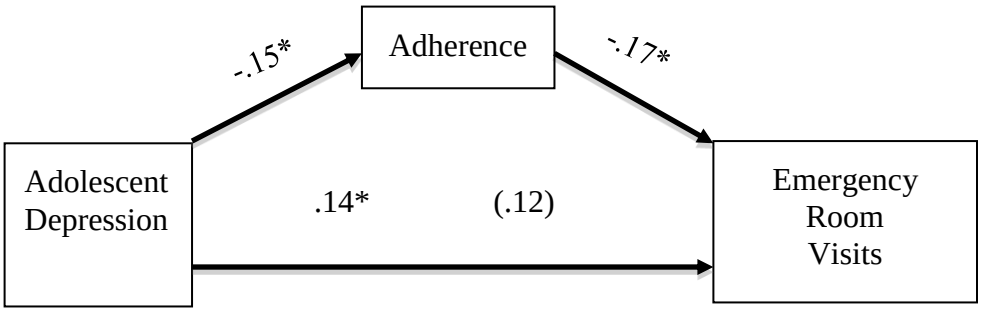


Figure 2



HbA1c and/or Adherence as potential mediators between adolescent depressive symptoms and healthcare utilization/costs.

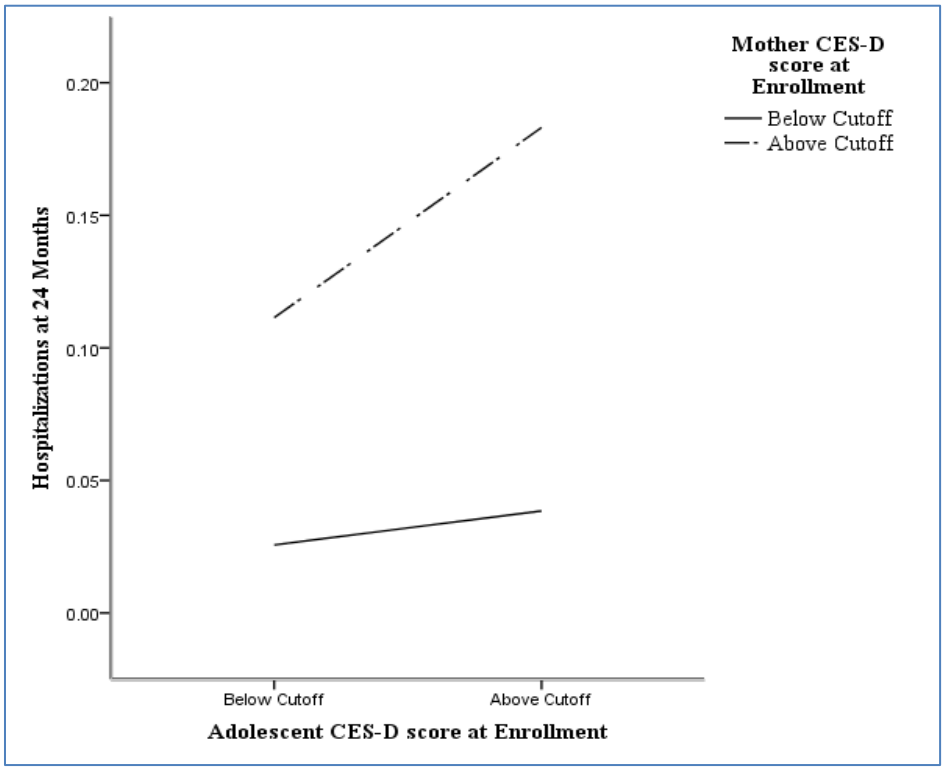
Figure 3



Standard regression coefficients for the relationship between adolescent depressive symptoms and emergency room visits as mediated by adherence. The standard regression coefficient between adolescent depressive symptoms and emergency room visits controlling for adherence is in parentheses. Age, gender, time since diagnosis, and HbA1c were entered as covariates.

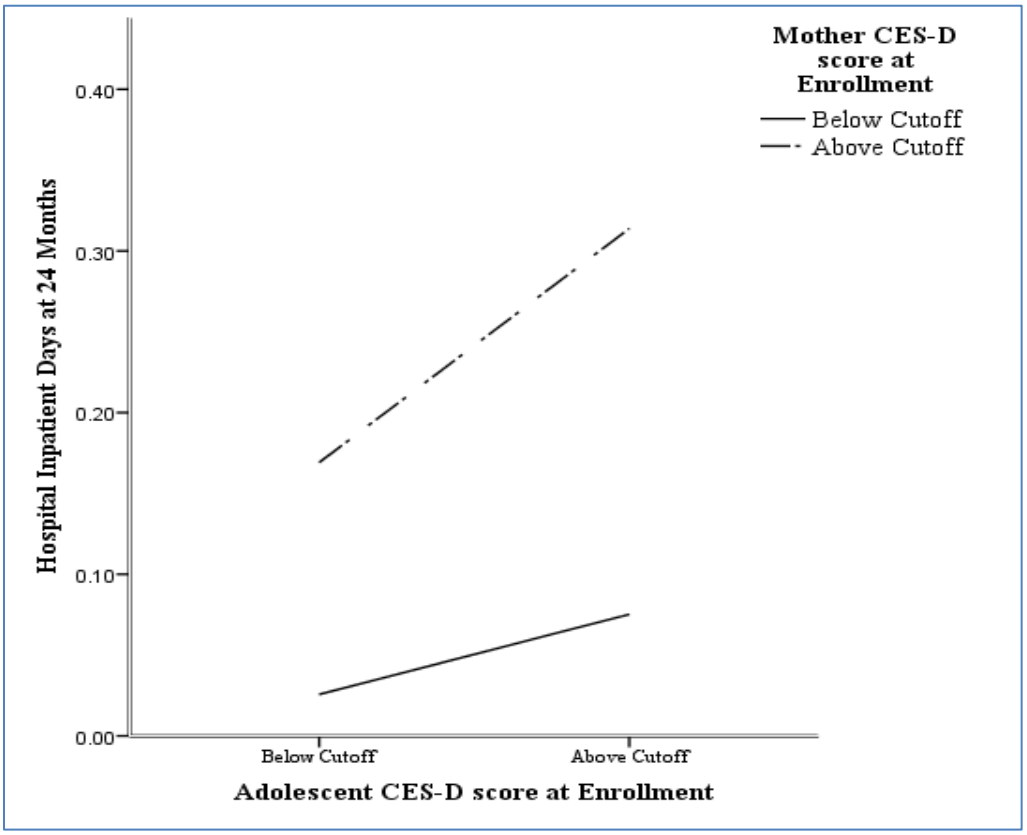
*$p < .05$

Figure 4



The effect of adolescent depressive symptoms on hospitalizations at 24 month moderated by maternal depressive symptoms

Figure 5



The effect of adolescent depressive symptoms on hospital inpatient days at 24 month moderated by maternal depressive symptoms

APPENDIX C
Study Measures

Center for Epidemiological Studies Depression Scale (CES-D)

Below is a list of some of the ways you may have felt or behaved. Please indicate how often you have felt this way during the past week: (circle one number on each line)

During the past week….	**Rarely or none of the time** (< 1 day)	**Some or a little of the time** (1-2 days)	**Occasionally or a moderate amount of time** (3-4 days)	**All of the time** (5-7 days)
1. I was bothered by things that usually don't bother me	0	1	2	3
2. I did not feel like eating; my appetite was poor	0	1	2	3
3. I felt that I could not shake off the blues even with help from my family	0	1	2	3
4. I felt that I was just as good as other people	0	1	2	3
5. I had trouble keeping my mind on what I was doing	0	1	2	3

During the past week….	**Rarely or none of the time** (less than 1 day)	**Some or a little of the time** (1-2 days)	**Occasionally or a moderate amount of time** (3-4 days)	**All of the time** (5-7 days)
6. I felt depressed	0	1	2	3
7. I felt that everything I did was an effort	0	1	2	3
8. I felt hopeful about the future	0	1	2	3
9. I thought my life had been a failure	0	1	2	3
10. I felt fearful	0	1	2	3
11. My sleep was restless	0	1	2	3
12. I was happy	0	1	2	3
13. I talked less than usual	0	1	2	3
14. I felt lonely	0	1	2	3
15. People were unfriendly	0	1	2	3
16. I enjoyed life	0	1	2	3
17. I had crying spells	0	1	2	3

During the past week….	**Rarely or none of the time** (less than 1 day)	**Some or a little of the time** (1-2 days)	**Occasionally or a moderate amount of time** (3-4 days)	**All of the time** (5-7 days)
18. I felt sad	0	1	2	3
19. I felt that people disliked me	0	1	2	3
20. I could not "get going"	0	1	2	3

Scoring

Item Weights	**Rarely or none of the time** (less than 1 day)	**Some of a little of the time** (1-2 days)	**Occasionally or a moderate amount of the time** (3-4 days)	**All of the time** (5-7 days)
Items 4, 8, 12, & 16	3	2	1	0
All other items:	0	1	2	3

Adherence Measure

ADHERENCE

Instructions: *No one* is perfect, and *everyone* has some trouble sometimes taking care of their diabetes. We would like you to grade yourself! How well do you manage your own diabetes? Give yourself a letter grade to show how well you do each task listed below most of the time. Give yourself A+ if you could not be better, A if you are excellent,....and all the way to F if you are a disaster. *Remember:* your answers will be kept confidential - even from your doctors and nurses.

1. Testing your blood for glucose regularly.

100 90 80 70 60 50 40 30 20

2. Taking your insulin on schedule.

100 90 80 70 60 50 40 30 20

3. Following your food plan.

100 90 80 70 60 50 40 30 20

4. Keeping your blood glucose at the right level.

100 90 80 70 60 50 40 30 20

5. Fitting exercise into your treatment plan.

100 90 80 70 60 50 40 30 20

6. Treating a reaction.

100 90 80 70 60 50 40 30 20

7. Remembering to do everything every day.

100 90 80 70 60 50 40 30 20

SELF EFFICACY

Instruction: Now grade yourself on how well you could do each of these same tasks if you could get yourself as organized as you could be. Use the same letter grades.

PERCEIVED BENEFIT

Instruction: How important are each of these tasks to your health?

9	8	7	6	5	4	3	2	1
supremely important								not important at all

APPENDIX D
IRB Approval Letter

UT SOUTHWESTERN MEDICAL CENTER eIRB System

From:	George Buchanan Institutional Review Board Chairperson IRB - 8843
To:	Sunita Stewart , Kyle Clayton , Taryn Mayes
Date:	August 24, 2011
Re:	Study Approval
IRB Number:	STU 062011-073
Title:	THE IMPACT OF DEPRESSIVE SYMPTOMS ON HEALTHCARE UTILIZATION AND CHARGES FOR ADOLESCENTS WITH TYPE 1 DIABETES (TID)
Documents:	Protocol

The UT Southwestern Institutional Review Board (IRB) reviewed the above-referenced research study via an expedited review procedure on August 12, 2011 in accordance with 45 CFR 46.110(a)-(b)(1). Having met all applicable requirements, the research study is approved. The approval period for this research study begins on August 24, 2011 and lasts until August 11, 2012.

The requirement to obtain informed consent is waived in accordance with 45 CFR 46.116(d).

The research study cannot continue beyond the approval period without continuing review and approval by the IRB. In order to avoid a lapse in IRB approval, the Principal Investigator must apply for continuing review of the protocol and related documents before the expiration date. A reminder will be sent to you approximately 90 days prior to expiration of research study approval.

The approved number of subjects to be enrolled is 246. If additional subjects are needed, you first must obtain permission from the IRB to increase the sample size.

If you have any questions related to this approval letter or about IRB policies and procedures, please telephone the IRB Office at 214-648-3060.

APPENDIX E
Journal Manuscript #1

Maternal depressive symptoms: A risk factor for adolescent depressive symptoms in type 1 diabetes?

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[2]Children's Medical Center of Dallas

Abstract

The purpose of this study was to examine the relationship between adolescent and maternal depressive symptoms (DS) in youth with type 1 diabetes. Adolescents (n=175) ages 12-18 with type 1 diabetes and their mothers completed the CES-D at enrollment (baseline) and again 12 months later (follow-up). Demographic and disease-related variables (e.g., metabolic control, illness duration, hospitalization) were also assessed. Higher maternal DS indicated higher adolescent DS at both time points, independent of glycemic control and demographic factors. Maternal and adolescent symptoms remained directly related across time. Causal effects were not apparent, suggesting the relationship may be bidirectional.

Key Words: type 1 diabetes, adolescents, depression

INTRODUCTION

Depressive symptoms (DS) occur frequently among adolescents with type 1 diabetes (Whittemore & Tamborlane, 2002), are associated with poor metabolic control (Whittemore & Tamborlane, 2002; Helgeson, Siminerio, Escobar, & Becker, 2009), and predict time to inpatient hospitalization [reference deleted to maintain the integrity of the review process]. DS often go unidentified in this population (Stewart, Rao, & White, 2005), and specific predictors for risk are limited. Maternal depression is a risk factor for youth DS in the medically well population (Halligan, Murray, Martins, & Cooper, 2006). If maternal DS are a risk factor for DS in youth with type 1 diabetes, this may have implications regarding early identification of youth at risk for developing disease complications.

Mothers of youth with diabetes experience DS at a higher rate than their peers, with approximately one third developing clinical depression (Delamater, 2009). Whereas maternal depression increases the risk of depression in medical well youth (Racusin & Kaslow, 2004; Thompson et al., 2010) and in youth with diabetes (Kovacs, Goldston, Obrosky, & Bonar, 1997;Delamater, 1986), studies examining the impact of subclinical symptoms are limited. This is important as subclinical symptoms are more common, frequently undetected, and often precursors of depressive disorders (Pine, Cohen, Cohen, & Brook, 1999).

Two cross-sectional studies have explored the direct relationship between maternal and youth DS in diabetes. A study of 108 children ages 8-12 years found a significant relationship between maternal and child DS (Jaser, Whittemore, Ambrosino, Lindemann, & Grey, 2008). The only study to date examining this relationship in adolescents reported a similar correlation in 61 youth (Eckshtain, Ellis, Kolmodin, & Naar-King, 2010); however, the scope of these findings was limited given the small sample size, inclusion of patients with both type 1 and type 2 diabetes, and restricted sample (87% African American, all patients in poor metabolic control; mean HbA1c = 11.8). Finally, the cross-sectional nature of these studies precludes information regarding directional effects. It is not known whether the offspring's DS influenced the parent, or vice versa.Distinguishing factors associated with adolescent DS in this population could aid in the identification of youth at greater risk for health complications. Furthermore, an understanding of the nature of the relationship between adolescent and maternal DS, if such a relationship exists, and diabetes management could inform interventions aimed at improving clinical care.

The specific aims of this study were to assess:

1. Cross-sectional and longitudinal associations between adolescent and maternal DS in a large sample reflective of the general clinic population of youth with type 1 diabetes.

2. Associations between DS and indicators of diabetes management (current HbA1c, past hospitalizations, and time to the next hospitalization after baseline).

METHOD

Procedure

Secondary analysis was performed on archival data collected from a longitudinal study on treatment adherence among adolescents with diabetes in a large metropolitan clinic in the Southwest. In the original study, youth with type 1 diabetes between 11 and 18 years of age were recruited during clinic visits over a period of 18 months. Participation was voluntary and confidentiality of information (even from the treatment team) was assured. Written informed assent and consent were obtained from the adolescent and parent, respectively. The participants and mothers completed the forms in the clinic, where a research assistant was present to answer any questions. This study received approval from the institutional review board of [name deleted to maintain the integrity of the review process].

Participants

The original sample consisted of 231 adolescents (90% participation rate). Exclusion criteria were coexisting primary medical diseases (for example, severe

cardiac, renal, or hematologic disease). Given the association between DS and diagnosis of diabetes in youth (Grey & Tamborlane, 2002), only adolescents who received their diagnosis more than one year prior (n = 175) were included in the present analyses. Further descriptive analyses are presented in Table 1.

[Table 1 here]

Measures

Demographic Measures. The participant's age at diagnosis was obtained from the medical records. Parents' reports of paternal employment were analyzed as an approximate measure of socioeconomic status, according to the following categories: employed – full time, employed – part time, unemployed, and other (e.g., homemaker).

Depressive Symptoms. Adolescents and their mothers completed the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977)at enrollment (baseline) and again 12 months later (follow-up). This self-report measure of current DS is widely used with both clinical and community samples. A total score is calculated from 20 items and ranges from 0 to 60. Higher scores indicate more DS. The authors recommend a cutoff point of 16 for adults in screening for major depressive disorder (Radloff, 1977). In the validating study for use with adolescents (Garrison et al., 1991), which included youths ≥11 years of age, optimal CES-D cutoff points (i.e., scores at or above which the likelihood

of false-negative and false-positive results is lowest) were reported as 12 for boys and 22 for girls. For the present study, CES-D scores were grouped according to these pre-established cutoff points (adults=16, boys=12, girls=22).

Metabolic control. Hemoglobin A1c (HbA1c) (the main form of glycosylated hemoglobin) levels are routinely measured at clinic visits. The level measured at the visit at which participants were enrolled in the study and completed the CES-D was obtained from the patients' medical records.

RESULTS

Descriptive Information on adolescent and maternal depressive symptoms provided in Table 2. Cronbach's alpha for the CES-D (range = .72 to .85) indicated acceptable to good internal reliability for adolescents and mothers at both points. CES-D scores were higher for girls than boys at 12 month follow-up; however, more boys than girls had scores above the cutoff point (12 for boys, 22 for girls) at enrollment χ^2 (1, N = 175) = 38.98, p<.001and follow-up, χ^2 (1, N = 175) = 50.03, p<.001. CES-D scores declined over time for both adolescents, t(115) = 4.34, p < .001, and mothers, t(110) = 4.54, p< .001. Furthermore, fewer participants had scores above the cutoff point at follow-up than at enrollment, adolescents χ^2(1, N = 116) = 36.25, p<.001 and mothers, χ^2 (1, N = 111) = 18.32, p<.001.

[Table 2 here]

Maternal DS was associated with adolescent DS at baseline and at follow-up (See Figure 1). The relationship between adolescent and maternal DS remained significant at both time points, after controlling for age, gender, ethnicity, SES, and metabolic control(baseline: $\beta = .40$, $t(174) = 5.81$, $p < .001$; follow-up: $\beta = .22$, $t(101) = 2.21$, $p = .029$). In multivariate longitudinal analyses, participant DS at baseline was a significant predictor of their DS at follow-up after controlling for demographic and disease related variables, maternal DS: $\beta = .51$, $t(115) = 5.36$, $p < .001$; adolescent DS: $\beta = .47$, $t(110) = 5.20$, $p < .001$. We further examined whether maternal DS predicted adolescent DS, and vice versa. Neither predictor was significant (maternal DS: $\beta = .02$, $t(115) = .22$, $p > .10$; adolescent DS: $\beta = -.08$, $t(110) = -.88$, $p > .10$). Maternal DS score above the published cutoff point on the CES-D was associated with a significantly higher number of past hospitalizations for diabetes-related complications, after controlling for glycemic control, duration of illness and child DS ($\beta = .16$, $t(171) = 2.04$, $p < .05$), but not with time to hospitalization examined in a survival analysis. In contrast, as reported in a previous study of an overlapping sample [reference deleted to maintain the integrity of the review process], child DS above the published cut-off was associated with time to next hospitalization, but not with the number of past hospitalizations.

[Figure 1 here]

DISCUSSION

Maternal DS were associated with adolescent DS, and this relationship remained significant at follow-up. Directional effects were not apparent in longitudinal analyses. This may reflect a bidirectional relationship, or biological or environmental shared factors not measured in the current analyses (e.g., genetic predisposition, family financial stress). Finally, influences of one family member on the other may be more apparent in briefer follow-up periods.

Despite the lack of directionality of the relationship, this association remained significant over time and persisted regardless of glycemic control or demographic factors commonly associated with DS (i.e., age, gender, SES, ethnicity). These findings suggest that there is a "trait" aspect to the expression of DS, and those who are at risk for developing higher levels of DS tend to maintain their status relative to their cohort over the period of a year. Finally, whereas adolescent DS predict time to next hospitalization [reference deleted to maintain the integrity of the review process], consistent with other studies (Eckshtain, Ellis, Kolmodin, & Naar-King, 2010; Wiebe et al., 2011), our findings suggest that maternal DS may be associated with other indicators of disease management (i.e., number of prior hospitalizations).

IMPLICATIONS FOR PRACTICE

Higher maternal DS indicated higher adolescent DS. This relationship persisted over time independent of demographic and disease-related factors known to influence youth DS in this population. Given that maternal and adolescent DS remain related over time and that both are linked to negative health outcomes, assessment of mood difficulties in mothers as well as adolescents may identify those at greatest risk for development of diabetes complications. Furthermore, interventions directed at both parties could potentially improve health outcomes more than interventions aimed only at adolescent symptoms.

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TABLES/FIGURES

Table 1

Descriptive Data for Study Participants (n=175)

	N(%)
Gender	
Female	97(55)
Male	78(45)
Ethnicity	
Caucasian	133(76)
African American	21(12)
Hispanic	9(5)
Other	12(7)
Socioeconomic status*	
Employed – Full Time	143(84)
Employed – Part Time	3(2)
Unemployed	10(6)
Other	14(8)

	M	*SD*	Range
Age	14.31	1.55	12-18
Time since diagnosis (years)	5.07	3.35	< 1-15
HbA_{1c} level**	8.69	1.70	5.8-14
Past hospitalizations	.31	1.01	0-10

*Assessed on the basis of the father's employment. If the father was not making a financial contribution to the family or was deceased, then the mother's employment was used.**Recommended optimal HbA1c levels are <7.5% for adolescents with diabetes
†self-reported measure of various treatment regimen components (score range 1-100)

Table 2

Depressive Symptoms in Adolescents and Mothers

	M	*SD*	Range
Enrollment			
Adolescent CES-D (n=175)	20.03	7.08	9-43
Boys (n=78)	18.99	6.80	9-37
Girls (n=97)	20.87	7.21	9-43
Mother CES-D (n=175)	20.69	7.70	9-48
12 Month Follow-up			
Adolescent CES-D (n=116)	17.49	6.15	4-43
Boys (n=54)	16.24	4.37	9-30
Girls (n=62)	18.58	7.22	4-43
Mother CES-D (n=111)	17.23	5.73	8-41

Above CES-D cutoff point†	N(%)
Enrollment	
Adolescents	113(65)
Boys	70(90)
Girls	43(44)
Mothers	124(70)
12 Month Follow-up	
Adolescents	58(50)
Boys	46(85)
Girls	12(19)
Mothers	63(57)

Note. Cronbach's α values: Adolescent CES-D at Enrollment = .76, Adolescent CES-D at 12 Month Follow-up = .72, Mother's CES-D at Enrollment = .85, Mother's CES-D at 12 Month Follow-up = .75

†CES-D cutoff points indicating increased likelihood of a diagnosis of depression: boys=12, girls=22, adults=16

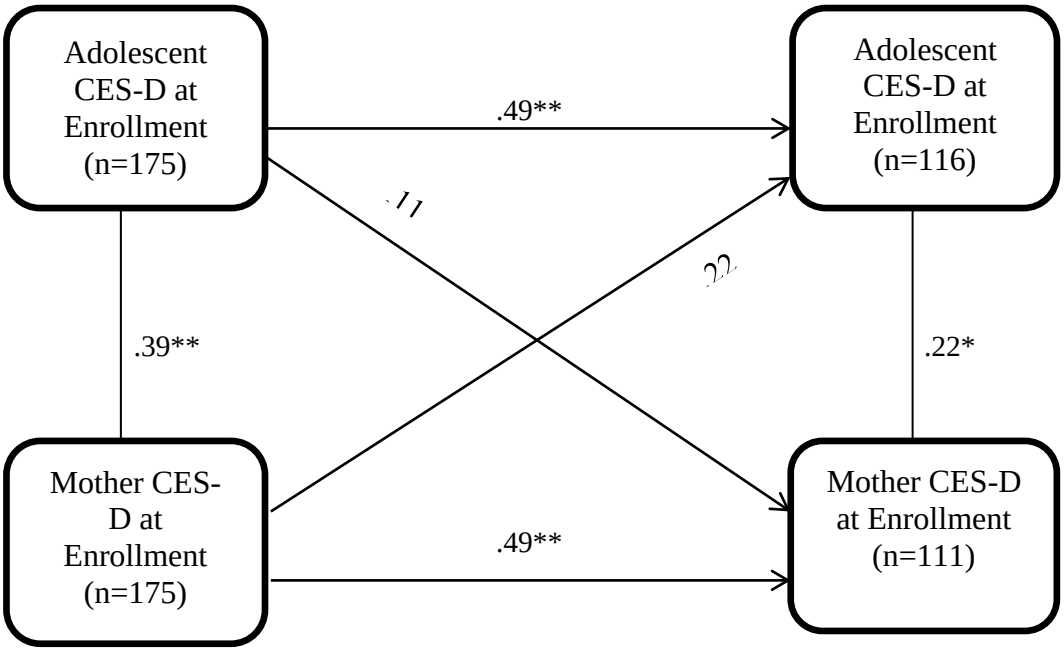

Figure 1 Pearson correlations for Adolescent and Maternal CES-D scores
*p <.05, ** p <.001

APPENDIX F
Journal Manuscript #2

Adolescent and Maternal Depressive Symptoms as Predictors of Healthcare Utilization and Charges in Youth with Type 1 Diabetes

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Abstract

Objective: To examine whether adolescent and/or maternal depressive symptoms (DS) predict diabetes-related healthcare utilization and charges in adolescents with type 1 diabetes. ***Methods:*** Two hundred and twenty-nine adolescents ages 11-18 (58% girls) with type 1 diabetes and their mothers completed the Center for Epidemiological Studies Depression Scale (CES-D). Demographic and disease-related variables, including HbA1c, were also assessed. Healthcare utilization data and charges for diabetes-related care (i.e., endocrine clinic visits, emergency room visits, hospitalizations, hospital inpatient days) for the period of 12 and 24 months following enrollment were assessed. ***Results:*** Adolescent DS were inconsistently associated with healthcare utilization or charges. In contrast, maternal DS predicted utilization/charges at 12 and 24 month follow-up, after controlling for demographic and disease-related variables and past utilization/charges. High maternal DS resulted in $7,832 additional charges over two years. Adolescents of mothers with high DS were twice as likely to have an emergency room visit and three times as likely to have a hospitalization. Directional analyses suggested a path from maternal DS to adolescent healthcare utilization, rather than the reverse. ***Conclusion:*** Maternal DS are an independent predictor of healthcare utilization and charges in this population. Interventions aimed at identifying and treating DS in mothers could not only enhance caregiver quality of life but also be economically advantageous for payers and providers.

Introduction

Diabetes accounts for approximately 10% of all healthcare expenditures in the United States (American Diabetes Association (ADA), 2008). This economic burden has increased dramatically over the past decade as diabetes-related costs have risen from approximately $132 to $218 billion annually (Dall et al., 2010). Although depressive symptoms (DS) in the management of diabetes have been given extensive attention in the literature (see, for example, Stewart, Rao, & White, 2005), there is little information about the impact of adolescents' or their mothers' DS on health care costs. This study investigates the role of these DS in predicting health care utilization and charges over a period of 24 months.

The majority of diabetes costs are attributable to disease-related complications and subsequent increases in healthcare utilization. Recent estimates have suggested that diabetes costs each American, regardless of diabetes status, approximately $700 per year (Dall et al., 2010). The estimated annual direct medical cost per case for type 1 diabetes (T1D) is $10, 495 as compared to $6,414 for those with T2D (Dall et al., 2010). The majority of these costs can be minimized by reducing acute and long-term complications through good self-management and glycemic control (Tao et al. 2010).

According to the International Society for Pediatric and Adolescent Diabetes (ISPAD), "Psychological factors are the most important influences affecting the care and management of diabetes" (ISPAD, 2000). This statement is

supported by research over the past four decades which has demonstrated the significant role of psychological functioning in T1D management (Laron, 1977; Laron & Galatzer, 1982; Delamater, 2003; Winkeley, Landau, Eisler, Ismail, 2006). The rate of major depressive disorder (MDD) in youth with T1D is typically two to three times that of peers without diabetes (Grey, Whittemore, Tamborlane, 2002; Hood et al., 2006). DS in T1D are associated with metabolic control and disease complications (Hood et al., 2006; Lustman et al., 2002; Pearson et al., 2010; Stewart et al. 2005; Whittemore et al., 2002).

Although they are rarely the target of investigation, mothers of youth with diabetes also experience DS at a higher rate, with approximately one third developing clinical depression (Delamater, 2009). Maternal psychological health is particularly relevant as family functioning is a significant contributor to T1D management (Whittemore et al., 2002; Wiebe et al., 2005). In contrast, maternal depression is associated with maladaptive parenting practices (Gelfand & Teti, 1990; Goodman & Gotlib, 1999) as well as increased familial conflict and poor emotional and behavioral outcomes in children (Burke, 2003).

In adults with diabetes, DS are associated with increased healthcare utilization and higher costs (Ciechanowski, Katon, & Russo, 2000; Egede, Zheng, & Simpson, 2002; Finkelstein, et al., 2003; Simon et al., 2007). Specifically, total healthcare costs are approximately two to four times greater in depressed versus non-depressed adult diabetic patients, and for patients with severe DS costs can

increase as much as 86% (Ciechanowski et al., 2000; Egede, et al, 2002). Although not yet tested in diabetes, maternal DS have been associated with healthcare utilization in youth offspring in other samples (McCarthy et al., 2000; Sills et al., 2007) including in chronic illness such as asthma (Bartlett, Kolodner, & Butz, 2001). No prospective longitudinal study on maternal DS and offspring healthcare utilization has explored outcomes past six months or examined a direct relationship with healthcare charges.

In summary, the national economic burden of diabetes is significant and growing. The majority of medical costs associated with diabetes have been attributed to excess medical expenditures related to disease complications. Psychological factors and family functioning are known to influence disease management, and adolescent and maternal DS in T1D are common. No study to date has examined the increase in diabetes-related healthcare utilization/charges among adolescents when DS are present in the patient or a parent. Unlike many factors contributing to disease complications in adolescents with T1D (i.e., age, ethnicity, genetic predisposition), DS can be treated. Identifying an influential factor amenable to treatment could assist in efforts aimed at reducing disease complications and limiting excess medical expenditures. The aim of the present study was to examine whether adolescent and maternal DS predict diabetes-related healthcare utilization and charges in youth with T1D.

Methods

Participants and Procedures

Data regarding adolescent and maternal DS, adolescent adherence, glycemic control, and demographic information were obtained from an existing database of adolescent patients treated at a large metropolitan clinic in the Southwest. In the original study, youth with type 1 diabetes were recruited during clinic visits over a period of 18 months. Inclusion criteria for adolescents were age 11 through 18 years, diagnosis of type 1diabetes, and availability of an English-speaking primary caretaker (typically the mother). Exclusion criteria were coexisting primary medical diseases (e.g., chronic active hepatitis or severe cardiac, renal, or hematologic disease.). Participation was voluntary and confidentiality of information (even from the treatment team) was assured. Written informed assent and consent were obtained from the adolescent and parent, respectively. Participants completed study forms at a clinic visit.

The original study database included 246 pairs, representing 90% of people approached. Data were missing at baseline on CES-D for six adolescents and 10 moms, and they were not included in any analyses, resulting in 240 adolescents and 236 mothers. A further 11 adolescents did not remain in the clinic database after baseline, and were also dropped from the study, resulting in 229 adolescents and 226 mothers (one of the mothers had already been dropped as she had no CES-D at baseline). For analyses beyond 12 months, an additional 36

adolescents and 34 of their mothers had not been previously dropped. Therefore, analyses of data from baseline to 24 and 12 to 24 months are based on 193 adolescents and 192 mothers. Demographic and CES-D scores were compared for adolescents and mothers who were eliminated at baseline (n = 17 and 20 respectively) or 12 months (n = 36 and 34 respectively) versus those who were retained in the entire study, and found to be equivalent. This study received approval from the Institutional Review Board of The University of Texas Southwestern Medical Center and Children's Medical Center of Dallas.

Measures

Demographic measures. The participant's age at diagnosis was obtained from the medical records. Parents' reports of paternal occupation were analyzed as an approximate measure of socioeconomic status, according to the following categories: unemployed, blue-collar worker (unskilled or manual labor, e.g., construction, domestic help, or landscape crew), white-collar worker (e.g., clerical staff or sales), and professional (e.g., physician, university professor, or lawyer). Ethnicity was assessed self-report, using a mixture of racial (African-American/Caucasian) and ethnic (Hispanic/non-Hispanic) categories as these are in our experience most consistent with how individuals identify themselves in this setting.

Depressive symptoms. Adolescents and their mothers completed the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977) at

enrollment (baseline) and again 12 months later (follow-up). This self-report measure of current DS is widely used with both clinical and community samples. A total score was calculated from 20 items and ranges from 0 to 60. Higher scores indicate more DS. CES-D scores were examined as a continuous variable in primary analyses. Cronbach's alpha for the CES-D (range = .72 to .85) indicated good internal reliability for adolescents and mothers at both baseline and 12 month follow-up.

Metabolic control. Hemoglobin A1c (HbA1c) (the main form of glycosylated hemoglobin) levels are routinely measured at clinic visits, and were obtained from the patients' medical records.

Healthcare utilization and charges. Endocrine clinic visits, emergency room visits, and inpatient hospitalizations secondary to diabetes-related complications were obtained from the hospital database for the study participants. Charges were provided by the hospital's financial department. These charges were inflation adjusted to fiscal year 2011. Healthcare utilization and charges accumulated at one and two years from enrollment were assessed.

Analysis

Healthcare utilization and charges were compared with respect to demographic variables to determine significant associations. Natural logarithmic transformations were applied to IV (CES-D scores) and DV (emergency room visits, hospitalizations, hospital inpatient days, charges) to account for significant

positive skew. Multiple regression analyses were utilized to determine significant predictors of healthcare utilization/charges. Demographic and disease-related variables associated with utilization/charges were entered as covariates. In order to further examine the relationship between maternal DS and healthcare utilization/charges, logistic regression was used to estimate odds ratios (OR) and relative risk (RR). In these analyses, maternal CES-D scores (low/high by CES-D cutoff point) as well as emergency room visits and hospitalizations (no/yes) were dichotomized. Logistic regression was also used to derive ORs, after controlling for demographic and disease-related variables.

Results

For all analyses, a *p* value <.05 will be described as significant. Values between .05 and .10 will be referred to as "marginally" significant.

Descriptive statistics for study participants are detailed in Table 1. Approximately two-thirds (69%) of adolescents were ages 12 to 15. The mean ± SD age of diabetes onset was 9.51 ± 3.24, and 87% received their diagnosis more than one year prior to enrollment. 71% of adolescents exhibited poor glycemic control (i.e., HbA1c > 7.5). The majority of participants were either Caucasian or African American and 56% were higher SES families (i.e., father's occupation was defined as "professional" or "white collar"). Most mothers were ages 31-40 (46%) or 41-50 years (47%) and 68% were married.

[Table 1 here]

The correlational matrix in Table 2 shows the bivariate correlations between CES-D scores, demographic information, and disease-related variables. Adolescent DS were higher in older adolescents and those with worse self-reported adherence behaviors and marginally higher in girls, $t(227) = -1.93$, $p = .05$. Maternal DS were higher the more recent their child's diabetes diagnosis. DS did not differ by ethnicity or SES. DS declined over time for adolescents, $t(138) = 4.93$, $p < .001$, and mothers, $t(129) = 6.15$, $p < .001$. Adolescent and maternal DS were associated at enrollment ($r = .24$, $p < .001$) and at 12 month follow-up ($r = .21$, $p = .02$).

[Table 2 here]

Healthcare utilization rates and charges for the total sample are presented in Table 3. Hospitalizations accounted for the largest percentage of mean total charges over 24 months (62%), compared to endocrinology clinic visits (20%) and emergency room visits (18%). Table 2 included bivariate associations between utilization rates and charges and demographic variables. Healthcare utilization/charges were directly related to higher HbA1c. Younger adolescents received more endocrinology clinic visits at 12 and 24 months. However, age was not associated with emergency room visits, hospitalizations, hospital

inpatients days, or total healthcare charges. Utilization/charges did not differ by sex or SES. Hospitalizations were higher for African American (M = .33, *SD* = .47) than Caucasian (M = .13, SD = .33) and Hispanic (M = .05, SD = .19) adolescents. Correspondingly, total charges were higher for African American (M = 8.85, SD = 1.55) than Caucasian (M = 8.12 SD = 1.21) and Hispanic (M = 7.85, SD = 1.05) adolescents. HbA1c levels were also higher for African American (M = 10.28, SD = 2.44) than Caucasian (M = 8.24, SD = 1.46) and Hispanic (M = 8.90, SD = 1.14) adolescents. After controlling for HbA1c, African American adolescents did not have higher hospitalizations, β = -.06, $t(190)$ = -.82, p = .42, or incur higher charges, β = .003, $t(190)$ = .04, p = .97. Thus, higher hospitalizations and charges in African American adolescents were fully explained by higher Hba1c levels.

[Table 3 here]

Analyses Related to Study Aims

Cross-sectional associations are reported followed by multivariate longitudinal analyses. Demographic and disease-related variables associated with utilization/charges (i.e., HbA1c, age) were included as covariates in regression analyses. Time since diagnosis and sex have been associated with diabetes-related complications in earlier prospective studies of youth with diabetes

(Charron-Prochownik, Kovacs, Obrosky, Stiffler, 1994; La Greca, Swales, Klemp, Madigan, Skyler, 1995 ; Kovacs, Charron-Prochownik, Obrosky, 1995; Rewers et al., 2002; Stewart et al., 2005), and were included as covariates in regression analyses.

Adolescent DS as a predictor of healthcare utilization and charges at 12 and 24 months

Adolescent DS were not related to utilization/charges in bivariate analyses (Table 3). In multivariate longitudinal analyses, adolescent DS did not predict utilization/charges at 12 or 24 months, after controlling for age, time since diagnosis, sex, and HbA1c, (Table 4).

Maternal DS as a predictor of healthcare utilization and charges at 12 and 24 months

Maternal DS were associated with utilization/charges at 12 and 24 months in bivariate analyses (Table 3). The exception was for endocrine clinic visits and emergency room visits at 12 months. In multivariate, longitudinal analyses, maternal DS predicted healthcare charges and marginally predicted hospitalizations and hospital inpatient days at 12 months after controlling for age, time since diagnosis, sex, and HbA1c. Maternal DS predicted hospitalizations, hospital inpatient days, and charges at 24 months (Table 4).

In order to further investigate the relationship between maternal DS and healthcare utilization, we examined the odds/risk of a hospitalization or

emergency room visit. Logistic regression was utilized to test the predictive value of high versus low maternal DS (below/above published CES-D cutoff point of 16) on the odds of hospitalization (yes/no) and emergency room visit (yes/no) over 24 months controlling for demographic (i.e., gender, age, time since diagnosis) and disease-related variables (i.e., adherence behaviors, HbA1c).

High maternal DS significantly increased the odds of a hospitalization (OR =.27, p = .04) and an emergency room visit (OR =.38, p = .04). When compared to those whose mothers had low DS, adolescents of mothers with high DS were twice as likely to have an emergency room visit (RR = 1.98, 95% CI = .954 – 4.11) and three times as likely to have a hospitalization (RR = 3.16, 95% CI = 1.00 – 9.91).

Factors potentially impacting the relationship between maternal DS and adolescent healthcare utilization/charges

Time since diagnosis and SES related to maternal DS in bivariate and multivariate cross-sectional analyses. Post-hoc analyses examined whether TSD and/or SES moderated the relationship between maternal DS and utilization/charges. They did not. In addition, controlling for adolescent DS did not change the significance of the relationship between maternal DS and utilization/charges.

[Table 4 here]

Evidence for directionality in the relationship between maternal DS and healthcare utilization and charges

After controlling for demographic variables and HbA1c level along with utilization/charges incurred from enrollment to 12 months, maternal DS at 12 months predicted adolescent emergency room visits, hospitalizations, hospital inpatient days, and total expenditures at 24 months. (Table 5)

Although it is evident that maternal DS predict adolescent healthcare utilization and charges, it is also possible that there are bidirectional effects. Therefore, we tested whether healthcare utilization/charges predicted maternal DS. Healthcare utilization (i.e., emergency room visits, hospitalizations, and hospital inpatients days) and charges were examined as predictors of maternal DS at 12 months. Mother's CES-D score at enrollment was entered as a covariate. After controlling for maternal DS at baseline, healthcare utilization/charges did not predict maternal DS at 12 months.

[Table 5 here]

Discussion

Adolescent DS were not associated with healthcare utilization or charges. In contrast, maternal DS predicted utilization/charges at 12 and 24 month follow-up, after controlling for past utilization and charges. Adolescents with mothers

with high DS were three times as likely to have an emergency room visit, four times as likely to have a hospitalization, and incurred an average of $7,832 additional charges over two years. In addition, controlling for adolescent DS, SES and time since diagnosis did not change the significance of the relationship between maternal DS and utilization/charges.

Adolescent DS and Utilization and Charges

That adolescent DS did not relate to utilization would appear to contradict the literature that has shown that adolescent DS are associated with poor disease management. In an earlier study using an overlapping sample, DS were examined categorically, above and below the published cut-points of 22 for girls and 12 for boys and found to predict hospitalization (Stewart et al., 2005). We therefore repeated our analyses with DS entered as a categorical variable. Now, adolescent DS was associated with higher total charges at 24 months. All analyses repeated with categorical separation for maternal DS scores remained significant. This suggests that adolescent DS are not linearly associated with utilization and healthcare charges; however, after they reach a moderately high level, they do increase utilization and charges. Maternal DS in contrast, have a relationship with utilization and charges across the continuum.

Maternal DS and Utilization and Charges

Most studies of associations between DS and disease management in youth take a cross-sectional perspective, making it difficult to determine

directionality. It is not an unreasonable hypothesis that repeated health crises would cause the parent of a chronically ill child to become overwhelmed and experience depressive symptoms. A contribution to the current literature is made by the demonstration of the directionality of the relationship. Maternal DS at 12 months predicted adolescent emergency room visits, hospitalizations, hospital inpatient days, and total expenditures at 24 months. In contrast, healthcare utilization/charges did not predict maternal DS at 12 months. This finding provides a more definitive demonstration that a mother's depression score predicts whether utilization and charges are likely to increase.

How Do Maternal DS Impact Utilization and Charges?

Maternal DS are typically thought to impact diabetes-related outcomes indirectly (e.g., parenting style, monitoring, etc.). Mothers in this developmental stage step back from the child's daily regimen management, as adolescents take more responsibility for their own care. We posited that both adolescent and maternal DS would predict adolescent healthcare utilizations/charges. To our surprise, only maternal DS predicted adolescent utilization/charges. This finding may be consistent with the concept that mothers who are not debilitated by depressive symptoms may compensate for their children's needs if the child is not managing well. However, a depressed parent either is ineffective at turning over strategies for care to the adolescent, or may not detect his or her need for ongoing monitoring, decreasing control too rapidly. These hypotheses, though logical,

suggest that the mechanism by which maternal and/or adolescent DS act on healthcare utilization is poor disease management. We, in fact, controlled for an indicator of disease management HbA1c, but found the relationship between maternal DS and utilization persisted.

One hypothesis to explain this relationship is that as mothers felt more depressed they perceived their children as being in worse health. In a study of pediatric asthma patients, mother's DS predicted emergency room visits after controlling for disease morbidity (Bartlett et al., 2001). Bartlett et al. (2001) posited that this may have been related to a decline in perceived treatment adherence and efficacy. For example, mothers with higher maternal DS rated their children's adherence as worse and perceived their children's medications as less effective. Similarly, McCarthy et al. (2000) found that in acute illness, maternal DS were associated with poor mother-child interaction and higher perception of illness severity.

Another possible mechanism for the impact of maternal DS on utilization and charges is that mothers seek services for their children as an attempt to signal their own distress. This idea was posited by Bartlett et al. (2001) in their study of maternal DS and emergency department use in pediatric asthma. They referred to a study (Mandl et al,. 1999) that reported that mothers find it less threatening or stigmatizing to contact the medical community on behalf of their children than for themselves.

Finally, higher maternal DS may have impacted utilization/charges through their influence on medical providers. McCarthy et al. (2000) noted that maternal DS and poor mother-child interactions contributed to decision making on the part of providers. Pediatricians exercised worse clinical judgment (i.e., higher perception of illness severity) and over utilization of medical resources (i.e., ordering more tests) when higher maternal DS and worse mother-child interactions were present. Influenced by increased caregiver/familial distress, providers may have been inclined to provide additional services.

Clinical Implications

Practitioners should be aware that DS may be high not only in the adolescent patient, but also in his or her mother. Assessment/intervention with mothers could be important, particularly with regard to identifying those at risk for excess healthcare utilization and expenditures. While ongoing assessment of DS would provide additional and rich information, even a one-time measure can provide valuable information for the two years that follow.

Ideally, assessment of adolescent and maternal DS would be implemented early as part of a family-focused treatment program. During the initial period following diagnosis, providers could educate patients and their mothers about the role of psychological health and family functioning in diabetes management. Along with general information on T1D management, families could be provided educational material on psychological /family factors (e.g., stress, depression,

communication, etc.) related to diabetes outcomes. Both patients and their mothers could then be encouraged to complete a brief measure of DS (e.g., the CES-D), and provided available resources when appropriate. Given the nature of the treatment setting where the adolescent is considered the "patient", mothers could view questions about their psychological health as intrusive. Furthermore, mothers might reject assessment or treatment due to the stigma associated with such symptoms. Thus, emphasizing the role of caregiver psychological health/ family functioning within the context of pediatric chronic illness in general could be helpful. Normalizing increased stress or DS for caregivers could help lessen opposition to assessment/intervention.

Finally, perhaps special attention should be given to the familial environment and in particular the level of social support. Social support is linked to diabetes disease management (Berg et al., 2008; Jaser & Grey, 2010; Liss et al., 1998; Whittemore et al., 2002; Wiebe et al., 2005). Environments with less shared responsibility and diabetes-specific support increase the risk for health complications and caregiver distress. Therefore, surveying social support may be important in assessing vulnerabilities in adolescent youth with T1D, and may also be part of psychoeducation of parents with newly diagnosed children. Support could also be provided to parents preventively, through support groups and social work services during clinic visits.

Policy Implications

Assuming that reduction of DS was shown to be cost effective in this population, there are a number of potential implications for payers. Third-party payers might offer incentives in the form of credits or reduced premiums, to those willing to undergo initial screenings and/or participate in subsequent interventions. This could include preventive interventions (e.g., resiliency training, relaxation training, skill building, family communication, etc.) which can be provided at very low cost in universal and group formats before symptoms arise, as well as depression treatment (e.g., antidepressant medication, cognitive-behavioral therapy, etc.). Payers might also incentivize medical providers to make additional non-emergency services available. Given the expense of emergency vs. non-emergency care costs, incentives could be offered to encourage medical facilities to provide adjunct psychological services to families (e.g., satellite clinic services, support hotline, etc.).

For providers, over-utilization of healthcare resources is significant from a cost-effectiveness standpoint. Given the movement to diagnosis-related group (DRG) based reimbursement systems in pediatric hospitals, additional unplanned visits can be economically disadvantageous. Higher DS in adolescents, mothers, or both are likely to lead to over -utilization of services. This may occur through increased complications or indirectly through worse perception of illness severity by parents or providers. In total, to the extent that reducing DS would be cost-

effective for providers, addressing this issue represents additive value to optimizing the clinical care of patients and their families.

Limitations

All of our utilization/charge data was derived from a single site. An advantage of this particular site is that children are provided services regardless of their ability to pay. As a result, we capture a larger cross-section of the population than is typical at a single center. However, there may be regional differences in patterns that a single center cannot adequately represent. The hospital and clinics in which this study was based was the primary service provider for our participants and likely accounted for the majority of their diabetes-related healthcare services; however, participants may have utilized healthcare services elsewhere and incurred additional charges. We only had utilization/charges at two time points. Standardized and more time points would have allowed for further analyses including describing trajectories over time.

Only hospital charges, and not actual direct costs, were available. While charge figures were inflated to reflect current dollars, an updated cost/charge ratio was unavailable. Therefore, hospital "cost" data which includes a number of additional factors (i.e., institutional overhead) was not reported. We recognize that the difference between charges and costs, even within a non-profit organization, can be significant (Finkler, 1982). Collection of information on resource consumption and direct costs would be required to properly measure

economic efficiency. Finally, there are significant direct costs incurred by the patient but not reflected in hospital in- and outpatient charges and so not included in the present study (e.g., medical supplies, prescription medications).

Future Research

The mediators for maternal DS' prediction of adolescent healthcare utilization/charges remain unclear. Further research examining factors that might account for or impact the relationship between maternal depression and healthcare utilization including the role of social support is warranted. In addition, family-related factors, such as family conflict, the role of fathers, and/or family systems would also be beneficial to explore. For example, Ying et al. (2011) recently found that marital status of the primary caregiver impacts risk for hospitalization and direct healthcare charges. Identifying additional family factors that might relate, either directly or indirectly, to increased utilization and expenditures would be informative.

Although our findings suggest that decreasing DS would have an impact on healthcare utilization and expenditures, future studies would be required to test such a hypothesis. The fact that these two variables are related does not guarantee that manipulation of one variable, in this case decreasing DS, would necessarily result in a meaningful decline in utilization/charges. For example, maternal DS could be reflective of another factor (e.g., social support) that is more directly associated with higher utilization/charges. In this scenario, decreasing DS would

only impact utilization/charges to the extent that it affected social support. If mothers were motivated primarily to seek services as a result of a lack of social support, then they would likely continue to seek such services, even if their DS decreased.

Adult studies suggest that the treatment of depression in individuals with diabetes is cost effective. Katon et al. (2008) found that depression treatment reduced total healthcare costs by $3,907 per patient over five years. In addition, a recent randomized control trial of 329 adult patients with comorbid diabetes and depression found that over the course of two years depression treatment resulted in an economic benefit of $952 per patient (Simon et al., 2007). These studies suggest that reducing depressive symptoms in adolescents would likely result in lower costs; however, cost effectiveness studies such as theses have yet to be implemented with caregivers of those with diabetes.

If indeed it can be demonstrated that decreasing DS can lower healthcare utilization/charges in this population, then the next step would be to explore whether interventions aimed at lowering DS would be cost effective. Cost effectiveness studies examining the current standard of care against the implementation of empirically supported treatments for decreasing depression (e.g., pharmacotherapy, cognitive behavioral therapy), supportive measures to support family functioning and caregiver support (e.g., support groups), and or a combination of the two would be warranted.

Intervention to alleviate maternal DS would not only improve the quality of life for these mothers (Trivedi et al., 2006) but might also conserve what are becoming more and more costly and limited medical resources (i.e., emergency room and hospital inpatient beds). Thus, the impact would go beyond the single patient, and provide the right care at the right place for all patients by improving access to those who need that level of care.

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Tables

Table 1

Descriptive Data for Study Participants (Adolescents N=229; Mothers N=226)

	N (%)
Sex	
Female	133(58)
Male	96(42)
Ethnicity	
Caucasian	171(75)
African American	28(12)
Hispanic	16(7)
Other	14(6)
Socioeconomic status*	
Unemployed	9(4)
Blue collar	80(40)
White collar	87(43)
Professional	26(13)

	Mean	SD	Range
Age, years	13.79	1.75	11-18
Time since T1D diagnosis, years	4.16	3.36	<1-15
HbA_{1c} level**	8.53	1.73	5.1-14
Treatment Adherence score†	82.22	12.88	30-100
Adolescent CES-D (Enrollment)	20.24	7.02	7-43
Mother CES-D(Enrollment)	21.88	8.45	9-51
Adolescent CES-D (12 months)‡	17.82	6.27	4-43
Mother CES-D (12 months)‡	17.40	5.73	8-41

*Assessed on the basis of the father's occupation. If the father was not making a financial contribution to the family or was deceased, then the mother's occupation was used.
**Recommended optimal HbA1c levels are <7.5% for adolescents (ADA, 2010).
†self-reported measure of various treatment regimen components (score range 1-100)
‡n=139 for adolescents; n=130 for mothers

Cronbach's α values: Adolescent CES-D at Enrollment = .74; Adolescent CES-D at 12 Month Follow-up = .73; Mother's CES-D at Enrollment = .86; Mother's CES-D at 12 Month Follow-up = .74; Adherence Measure = .86

Table 2: *Pearson Correlations Among Selected Study Variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age																
2. Sex	.01															
3. HbA1c	.12	-.09														
4. TSD	.30***	-.06	.14*													
5. ADH	-.30***	-.10	-.36***	-.23***												
6. A-DS	.14*	.13′	.06	.01	-.25***											
7. M-DS	-.11	.07	.04	-.19**	-.05	.24***										
8. EC 12	-.28***	-.06	-.04	-.04	-.23***	-.02	-.01									
9. EC 24	-.30***	-.06	-.05	-.10	.17*	.01	.01	.83***								
10. H 12	.03	.01	.36***	.03	-.24***	.10	.14*	-.02	.08							
11. H 24	.07	.04	.37***	.06	-.27***	.04	.20**	-.03	.04	.78***						
12. HID 12	.03	.03	.35***	.04	-.24***	.11	.14*	-.05	.04	.94***	.76**					
13. HID 24	.05	.04	.39***	.07	-.30***	.07	.19**	-.07	-.01	.81***	.95***	.86***				
14. ER 12	.04	-.01	.25***	.01	-.26***	.05	.08	-.01	.07	.64***	.54**	.62***	.56**			
15. ER 24	.05	-.03	.29***	.02	-.27***	.03	.12′	-.04	.02	.57***	.72***	.59***	.70***	.82***		
16. C 12	-.02	-.02	.33***	.01	-.17**	.09	.14*	.32***	.30***	.82***	.48**	.77***	.48**	.80***	.53**	
17. C 24	-.02	.01	.34***	-.01	-.22**	.04	.15*	.17*	.28***	.66***	.88***	.63***	.83***	.61***	.85***	.75***

TSD = time since diagnosis, ADH = adherence by adolescent self-report, A-DS = adolescent CES-D score, M-DS = mother CES-D score, EC = endocrine clinic visits, H = hospitalizations, HID = hospital inpatient days, ER = emergency room visits, C = healthcare charges, 12=12 months, 24 = 24 months; ′p<.10, *p<.05, **p<.01

Table 3

Healthcare Utilization Rates and Charges

	M	SD	Range
12 months (N=229)			
Endocrine Clinic Visits	3.49	1.49	1-9
Emergency Room Visits	.24	.73	0-6
Hospitalizations	.12	.48	0-5
Hospital Inpatient Days	.58	3.51	0-42
Endocrine Clinic Charges	$1060.68	$453.43	$0-2,736
Emergency Room Charges	$938.79	$2,788.65	$0-23,034
Hospitalization Charges	$3,133.80	$12,307.69	$0-128,150
Total Charges	$5,133.28	$14,075.70	$0-136,740
24 Months (N=193)			
Endocrine Clinic Visits	6.58	2.17	2-14
Emergency Room Visits	.49	1.20	0-10
Hospitalizations	.25	.66	0-5
Hospital Inpatient Days	.87	3.95	0-42
Endocrine Clinic Charges	$1,998.84	$658.60	$0-4,256
Emergency Room Charges	$1,869.77	$4,604.61	$0-38,390
Hospitalization Charges	$6,374.30	$16,958.92	$0-128,150
Total Charges	$10,242.91	$20,191.30	$0-137,956

Note. Charges have been inflation adjusted to fiscal year 2011

Charges include all utilization on the patient's encounter during visit (e.g., labs, radiology, room, etc.).

Table 4

Predictors of Adolescent Healthcare Utilization and Charges at 12 and 24 months

DV: ER12		**DV: H12**		**DV: HID12**		**DV: C12**	
Model Fit		*Model Fit*		*Model Fit*		*Model Fit*	
R^2=.08, F(6,213) = 2.98**		R^2=.17, F(6,213) = 7.00***		R^2=.16, F(6,213) = 6.62***		R^2=.14, F(6,213) = 5.59***	
Predictors	β	Predictors	β	Predictors	β	Predictors	β
HbA1c	.27***	HbA1c	.37***	HbA1c	.36***	HbA1c	.36***
		M-DS	.11†				
DV: ER24		**DV: H24**		**DV: HID24**		**DV: C24**	
Model Fit		*Model Fit*		*Model Fit*		*Model Fit*	
R^2=.09, F(6,179) = 2.91**		R^2=.19, F(6,179) = 7.01***		R^2=.20, F(6,179) = 7.36***		R^2=.14, F(6,179) = 4.66***	
Predictors	β	Predictors	β	Predictors	β	Predictors	β
HbA1c	.27***	HbA1c	.38***	HbA1c	.40***	HbA1c	.35***
		M-DS	.20**	M-DS	.18**	M-DS	.13*

Note. Age, sex, time since diagnosis, and adolescent DS (CES-D score) were non-significant covariates. DS and Utilization/Charges were transformed to natural log for regression analyses.

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-DS = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment

†p<.10, *p< .05, **p <.01, ***p<.001

Table 5

Maternal Depressive Symptoms predict Adolescent Healthcare Utilization and Charges in the following 12 months, after controlling for demographic variables, HbA1c, and Healthcare Utilization/Charges for the previous 12 months

DV: ER24		**DV: H24**		**DV: HID24**		**DV: C24**	
Model Fit		*Model Fit*		*Model Fit*		*Model Fit*	
R^2=.71, F(6,118) = 48.75***		R^2=.49, F(6,118) = 26.51***		R^2=.76, F(6,118) = 63.26***		R^2=.62, F(6,118) = 31.51***	
Predictors	β	Predictors	β	Predictors	β	Predictors	β
HbA1c	.25***	HbA1c	.34***	HbA1c	.29***	HbA1c	.33***
ER12	.79***	H12	.67***	HID12	.81***	C12	.70***
Sex	-.12*	Age	-.17*	Age	-.11*	Age	-.17**
M-DS12	.11‡	M-DS12	.13*	M-DS12	.11*	M-DS12	.14*

Note. Only utilization/charges relevant to each DV (i.e., covariate ER12 for DV: ER24) included in each model. Time since diagnosis was a non-significant covariate. DS and Utilization/Charges were transformed to natural log for regression analyses.

ER = emergency room visits, H= hospitalizations, HID = hospital inpatient days, C= healthcare charges, M-DS = Maternal depressive symptoms (CES-D score), 12 = 12 months from enrollment, 24 = 24 months from enrollment

‡p=.05; *p< .05; **p <.01; ***p<.001

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