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Evidence-Based Behavioral Interventions to Promote Diabetes Management in Children, Adolescents, and Families

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As members of multidisciplinary diabetes care teams, psychologists are well-suited to support self-management among youth with Type 1 diabetes (T1D) and Type 2 diabetes (T2D) and their families. Psychological and behavioral interventions can promote adherence to the complex and demanding diabetes care regimen, with the goals of promoting high quality of life, achieving optimal glycemic control, and ultimately preventing disease-related complications. This article reviews well-researched contemporary behavioral interventions to promote optimal diabetes family- and self-management and health outcomes in youth with T1D, in the context of key behavioral theories. The article summarizes the evidence base for established diabetes skills training programs, family interventions, and multisystemic interventions, and introduces emerging evidence for technology and mobile health interventions and health care delivery system interventions. Next steps in behavioral T1D intervention research include tailoring interventions to meet individuals' and families' unique needs and strengths, and systematically evaluating cost-effectiveness to advocate for dissemination of well-developed interventions. Although in its infancy, this article reviews observational and intervention research for youth with T2D and their families and discusses lessons for future research with this population. Interventions for youth with T2D will need to incorporate family members, consider cultural and family issues related to health behaviors, and take into account competing priorities for resources. As psychologists and behavioral scientists, we must advocate for the integration of behavioral health into routine pediatric diabetes care in order to effectively promote meaningful change in the behavioral and medical well-being of youth and families living with T1D and T2D.

Keywords: pediatric diabetes, behavioral interventions, diabetes self-management, glycemic control

Adherence to recommended health behaviors required by complex diabetes care regimens is central to diabetes management, as described previously (Hunter, 2016). However, suboptimal diabetes family- and self-management is common and has a substantial impact on health outcomes among youth with Type 1 diabetes (T1D) and Type 2 diabetes (T2D; Adeyemi, Rascati, Lawson, & Strassels, 2012; Hood, Peterson, Rohan, & Drotar, 2009). Given their training to understand behavior in multiple contexts (e.g., home, school, peers, health care setting), psychologists are well-suited to support youth with T1D and T2D and their families to promote adherence to the complex and demanding diabetes care regimen (Kichler, Harris, & Weissberg-Benchell, 2015; Marrero et al., 2013). National and international diabetes organizations (American Diabetes Association, 2015; Delamater et al., 2014) call for routine psychological screening and referral to evidence-based mental health therapies as a component of clinical care for youth with diabetes. However, the gap between these guidelines and psychosocial integration into standard clinical practice the United States (Ducat, Philipson, & Anderson, 2014) calls for (a) increased awareness of empirically supported diabetes-specific behavioral interventions among psychologists, medical providers, and administrators, and (b) systematic efforts to translate efficacious programs for delivery in routine

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diabetes care and other health and mental health care settings. This article provides an overview of foundational theories in behavioral intervention research in pediatric diabetes and reviews the efficacy data for well-studied contemporary behavioral interventions targeting optimal diabetes family- and self-management and diabetes outcomes (most frequently, glycemic control, or how close blood glucose values are to a healthy range) in youth with T1D. Finally, the article discusses what is known about behavioral interventions to promote optimal outcomes in youth with T2D and their families.

Theories of Behavioral Interventions

An understanding of the theoretical principles guiding their design is necessary to evaluate the impact of behavioral interventions on diabetes outcomes in youth. The most frequently employed theories—social cognitive theory (SCT; Bandura, 1998), family systems theory (FST; Kazak, Simms, & Rourke, 2002), and social ecological models (SEMs; Bronfenbrenner, 1979)—are summarized in the following sections. Table 1 lists example behavioral strategies and multicomponent behavioral interventions that align with each theory. This is not intended to be an exhaustive history of behavioral theories, but rather an opportunity to highlight three foundational theories that underlie many of the best-supported contemporary approaches to behavioral diabetes intervention. Moreover, these theories are acknowledged to not be mutually exclusive; indeed, influences from all three theories and others are evident in the components of most of the interventions described in the following sections.

Social Cognitive Theory (SCT)

SCT posits that an individual's self-efficacy, or confidence in one's ability to complete particular behaviors, and outcome expectancies, or the positive or negative consequences of each behavior one anticipates, influence health behaviors (Bandura, 1998). Among youth with T1D, more

Table 1
Applications of Key Health Behavior Theories to Diabetes Family and Self-Management in Youth With Diabetes

Behavioral strategies	Example intervention components
Social cognitive theory	
Mastery experiences: teaching management tasks with receding adult assistance	Coping skills training (Grey et al., 2000): group role-plays diabetes management in social settings; feedback from peers and coach; problem-solving skills training
Social learning: observational learning of skills and care tasks from parents or other youth	Internet-based self-management program (Mulvaney et al., 2010): anticipating personal barriers to self-management; training in coping and problem-solving skills; social networking forum
Outcome expectancies: education plus cognitive restructuring of maladaptive beliefs	
Family systems theory	
Collaborative involvement: parent role in care shifts from completing tasks to partnering with child to monitoring and providing support	Family teamwork (Anderson et al., 1999): education about developmentally appropriate self-management; develop plan for sharing responsibility; communication skills training
Family communication: calm, nonjudgmental conversational style among family members on diabetes-related topics	Behavioral family systems therapy for diabetes (Wysocki et al., 2007): training in family communication, problem solving, conflict resolution, cognitive restructuring
Social ecological model	
Targeted interventions: tailor intervention content and format to match emotional, cognitive, socioeconomic, or health needs of individual, family, social context, etc.	Multisystemic therapy (Ellis et al., 2008); novel interventions in children's healthcare (Harris et al., 2014): intervention occurs in multiple settings (e.g., home, community, school) and tailored to individual and family needs; incorporate case management as needed
Healthcare system interventions: medical team integrates proactive or preventive behavioral strategies to enhance care of all youth and families	Quality of life monitoring and feedback (de Wit et al., 2010); motivational interviewing (Miller & Rollnick, 2013): healthcare team uses behaviorally informed communications as part of routine care; tailored to individual and family



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self-efficacy and positive outcome expectancies predict better adherence and glycemic control (Berg et al., 2011). Greater self-efficacy helps youth exert sufficient effort to master and maintain diabetes care behaviors. Moreover, higher self-efficacy mediates the relation between having more diabetes responsibility and demonstrating better treatment adherence (Ott, Greening, Palardy, Holderby, & DeBell, 2000), and between an organized, supportive family environment and in-range glycemic control (Herge et al., 2012).

Family Systems Theory (FST)

In FST, youth behavior is understood in the context of family interactions. Family factors have been demonstrated to be powerful predictors of child health outcomes across pediatric chronic conditions (Brown, 2002; Wiebe, Helgeson, & Berg, 2016), and FST focuses on both adaptive and maladaptive family interactions related to the child's disease management (Kazak et al., 2002). Family interaction characteristics associated with T1D outcomes include diabetes-related family conflict and communication, parental involvement and monitoring, and parental support, making these family processes important targets of FST-based intervention approaches (Jaser, 2011).

Social Ecological Model (SEM)

According to SEM, dynamic, reciprocal interactions among factors at multiple levels, including child, family, community, and society, influence health behaviors (Bronfenbrenner, 1979). Derived from SEM, the *model of social ecological risk factors for special health care needs* (Newacheck, Rising, & Kim, 2006), the *pediatric self-management model* (Modi et al., 2012), and the *diabetes resilience model* (Hilliard, Harris, & Weissberg-Benchell, 2012) outline how multiple systems influence children's disease self-management behaviors and health outcomes, and identify potential intervention points at each level. Data supporting an SEM framework for youth with T1D reported by Naar-King, Podolski, Ellis, Frey, and Templin (2006) indicated that individual (i.e., externalizing behaviors, older age), family (i.e., diabetes conflict), and systems (i.e., dissatisfaction with the health care provider) factors were all associated with treatment adherence among minority adolescents with poorly controlled T1D.

State of the Science Review

Several interventions target psychological and behavioral influences on glycemic outcomes for youth with T1D. The key medical target of such interventions is typically glycosylated hemoglobin, a biomarker representing average blood glucose levels over the past 2 to 3 months. Although there is not a one-to-one correspondence between psychosocial or behavioral factors and glycemic control, they are related and are considered key mechanisms of glycemic change (Hood et al., 2009, 2014). Typically, behavioral interventions aim to impact psychosocial and behavioral processes that will ultimately slow, pause, or even reverse trajectories of deteriorating glycemic control, as the landmark Diabetes Control and Complications Trial (DCCT; Diabetes Control and Complications Trial Research Group, 1994) demonstrated that tighter glycemic control can substantially reduce risk for microvascular complications (White et al., 2001).

Recent systematic reviews and meta-analyses concluded that behavioral interventions can have modest but meaningful impact on quality of life, regimen adherence, and glycemic control, with average effect sizes in the small to medium range (Hampson et al., 2000; Hood, Rohan, Peterson, & Drotar, 2010; Savage, Farrell, McManus, & Grey, 2010). Effects of this magnitude (equating to absolute reductions in glycosylated hemoglobin up to 0.5%) have been linked with significantly reduced risk for complications (White et al., 2001). Larger effect sizes have been demonstrated among interventions that were behavioral or multicomponent versus strictly educational, that addressed modifiable diabetes-related emotional or family processes compared with those that targeted a specific self-management behavior, that were delivered sooner versus later postdiagnosis, and that included training in problem-solving skills (Hood et al., 2010; Savage et al., 2010). Although behavioral interventions driven by an explicit theory have shown stronger effects than those without, few named a theoretical framework (Hampson et al., 2000; Savage et al., 2010). Finally, effects on psychosocial and



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behavioral outcomes have tended to be larger than glycemic outcomes (Hampson et al., 2000).

What follows is an overview of the most promising and well-researched behavioral intervention approaches for improving diabetes self-management and glycemic outcomes in youth with T1D, including skills training programs, family-based interventions, multisystemic therapies, mobile (mHealth) tools, and interventions delivered at the level of the health care system. Although a full review is beyond the scope of this article, the article synthesizes the key components of several approaches to behavioral interventions in the context of the behavioral theories that drive the interventions. Given the radical change in pediatric T1D care following the release of the DCCT (Diabetes Control and Complications Trial Research Group, 1994), making intensive insulin regimens the standard of care (Anderson, Svoren, & Laffel, 2007), this review will focus on post-DCCT behavioral interventions to ensure greatest relevance to contemporary approaches to diabetes care.

Skills Training Programs

Interventions that teach youth skills related to successful T1D self-management are among the most common behavioral approaches. This broad category encompasses programs that teach coping, problem-solving, and stress management skills, which are delivered to individuals or groups of youth with T1D. Skills training programs typically intensively teach a targeted set of skills for coping with challenging situations related to diabetes self-management. The most researched is coping skills training (CST), which focuses on managing diabetes in stressful social situations (Grey, Boland, Davidson, Li, & Tamborlane, 2000).

Based in SCT, CST was designed to enhance mastery and competence in diabetes self-management by replacing maladaptive coping styles with more constructive strategies directly related to diabetes care behaviors (Grey et al., 2000). Across its various evaluations, the intervention has been delivered in four to six small group sessions and used role-plays with group and coach feedback to teach social problem-solving strategies. Among adolescents, CST has resulted in improved quality of life, coping skills, and glycemic control up to 1 year postintervention compared with a control group receiving comparable intensive diabetes management without CST (Grey et al., 2000). Similar improvements were reported for younger children receiving CST, although these improvements were also observed in children in an educational intervention (Ambrosino et al., 2008). Recent CST adaptations for parents (Grey, Jaser, Whittemore, Jeon, & Lindemann, 2011) and for delivery via the Internet (Grey et al., 2013) showed improvements in coping and quality of life, but no differences in glycemic control compared with an educational intervention. Youth with T1D may benefit from education in both general diabetes knowledge and in behavioral coping strategies for managing diabetes-related stressors.

Family Interventions

Ideally, youths' self-management of T1D is a collaboration with parents and family members (Jaser, 2011), and thus many behavioral interventions based primarily in FST target family partnership, communication, and collaboration, and often include skills training components. Two behavioral family interventions have reported the most consistent, lasting impact on key diabetes outcomes: family teamwork (Anderson, Brackett, Ho, & Laffel, 1999) and behavioral family systems therapy (BFST) for diabetes (Wysocki et al., 2008).

In the family teamwork intervention, families of young adolescents with T1D met with an interventionist at four consecutive diabetes clinic appointments. Consistent with FST, the family teamwork intervention provided education on diabetes management and outcomes in the context of normative developmental processes, the importance of family involvement, skills training for communication, conflict prevention and resolution. This intervention was delivered in the diabetes clinic setting by a trained research assistant, before or after a routine medical follow-up visit. Key outcomes included decreased family conflict, increased parent involvement in diabetes management, and improved glycemic control up to 2 years postintervention compared with attention control and standard care (Anderson et al., 1999; Laffel et al., 2003). The care ambassador model is an adaptation of the family teamwork intervention. Svoren, Butler, Levine, Anderson, and Laffel (2003) demonstrated the efficacy of training research staff to deliver a psychoeducational intervention similar to family teamwork and also to provide logistical support (e.g., assistance with

clinic appointment) at routine diabetes clinic visits. This approach resulted in higher clinic attendance, fewer hospitalizations and acute medical events, and prevented deterioration of glycemic control, especially among the youth at highest risk for poor outcomes (Katz, Volkening, Butler, Anderson, & Laffel, 2014; Svoren et al., 2003). Employing research staff rather than trained medical professionals or case managers to be care ambassadors may be a more resource-efficient approach that can facilitate broader translation to practice settings (Anderson et al., 2007).

Recently, other research groups have integrated SCT and FST by adapting the family teamwork intervention with components of CST, in a multifamily group format (Murphy et al., 2012) or in individual family sessions (Holmes, Chen, Mackey, Grey, & Streisand, 2014). Although both adaptations reported improvements in behavioral and psychological outcomes, and prevented deteriorations in glycemic control, differences compared with control groups were not replicated. These mixed results have implications for dissemination and implementation into clinical practice: In addition to the core behavioral components of the original family teamwork intervention protocol, high-quality educational interventions providing tips for diabetes self-management during extracurricular and peer activities, travel, and in school settings may also be effective for many families during challenging periods in diabetes management (e.g., transition to adolescence).

BFST is an FST-based family therapy intervention in which a trained family therapist taught individual families skills related to communication, problem solving, and conflict resolution over 10 sessions. Early applications of BFST for youth with T1D demonstrated encouraging improvements in parent–child communication and problem-solving skills, but changes in treatment adherence were inconsistent and glycemic control did not improve compared with standard care or educational and support control conditions (Harris & Mertlich, 2003). To address this, BFST was adapted to specifically target family interactions around T1D management tasks. BFST for diabetes (BFST-D) also increased the intervention dose and included a parent simulation of diabetes self-management, resulting in significant improvements in treatment adherence and glycemic control up to 18 months postintervention compared with controls (Wysocki et al., 2007, 2008). To enhance accessibility and cost-effectiveness, recent evolutions of BFST-D have translated the intervention for delivery via web-based video chat, with promising results (Freeman, Duke, & Harris, 2013).

Multisystemic Interventions

Contributors to suboptimal adherence and glycemic control are multifaceted, and for many, the challenges extend beyond individual coping and self-management skills and the parent–child relationship. Derived from both FST and SEM, multisystemic therapy (MST) targets adherence barriers on various levels, including individual, family, community, and access to resources. MST for youth with T1D in chronically poor glycemic control has been delivered by a trained family therapist to individual families over several months in various settings (e.g., home, school, health care system). The intervention content and format varied based on individual needs and barriers to T1D management, and drew from other empirically supported approaches such as behavioral contingencies, cognitive–behavioral therapy, and case management. MST for diabetes has demonstrated increased adherence to diabetes management tasks, fewer hospitalizations, lower health care costs, and improved glycemic control up to 24 months postintervention compared with standard care or a telephone support intervention (Ellis et al., 2012; Ellis et al., 2008).

Others have begun to replicate and adapt a multisystemic approach to behavioral interventions. Harris and colleagues (2014) have developed Novel Interventions in Children's Healthcare (NICH) for youth with various chronic conditions, including T1D, who are in chronic suboptimal disease control. NICH emphasizes family interactions by delivering tailored behavioral intervention, care coordination between medical providers and family, and intensive case management to address adherence barriers related to school, housing, and insurance. Pilot data with 25 youth with T1D suggested improvements in diabetes outcomes and decreased health care costs (Harris et al., 2014). MST-like interventions consistently demonstrate positive outcomes, yet require many resources (e.g., financial support, time, health care system that supports flexible health care delivery during atypical hours and in community settings) to effectively intervene at multiple levels for high-risk youth and their families. Thus, implementation and cost-effectiveness analyses will be critical to determine translatability to everyday practice settings.

Technology and mHealth Interventions

Adapting behavioral interventions for web delivery is increasingly common, and initial studies have suggested no threat to efficacy (BFST-D: Freeman et al., 2013; CST: Grey et al., 2013). Mulvaney, Rothman, Wallston, Lybarger, and Dietrich (2010) expanded upon web delivery of traditional behavioral interventions by developing a web-based, self-guided behavioral intervention aligned with SCT, which included multimedia vignettes, training and guided practice in coping and problem-solving skills, and social networking for adolescents. Among participants who engaged with the website, improved problem-solving skills, self-management behaviors, and no deterioration in glycemic control were reported (Mulvaney et al., 2010).

A new wave of interventions that integrate electronic health (eHealth) and mHealth technologies has begun to emerge for youth with T1D. Examples (many in the pilot stage) include text-message reminders for diabetes tasks or delivery of educational or motivational text messages (Herbert, Collier, Stern,

Monaghan, & Streisand, 2015; Markowitz et al., 2014), smartphone applications to monitor diabetes tasks (Carroll, DiMeglio, Stein, & Marrero, 2011), and motivational electronic games (Klingensmith et al., 2013). At this early point, glycemic improvements are not consistently evident, yet initial findings have suggested many youth enjoy using technology-based interventions, and there may be benefits for motivation, self-efficacy, and adherence (Herbert et al., 2015; Klingensmith et al., 2013).

Delivery of behavioral interventions via technology may increase their reach and integration into youths' daily activities, yet access to, and interest in, interacting with eHealth or mHealth interventions may be a limiting factor for some (Herbert, Owen, Pascarella, & Streisand, 2013; Whittemore et al., 2013). As the science of dissemination and implementation research grows (Glasgow et al., 2012) and investigators publish results from the next generation of behavioral interventions, rigorous evaluations of their efficacy will be needed (Herbert et al., 2013; Ritterband et al., 2003). In a review of initial eHealth and mHealth behavioral interventions for diabetes, Mulvaney, Ritterband, and Bosslet (2011) recommended that interventions integrate technology as a tool in combination with human contact for clinical support, and motivational and behavioral components such as goal setting and problem solving are emphasized.

Health Care Delivery System Interventions

Many T1D behavioral interventions are delivered in the clinical care setting, typically by members of either the psychology team or research staff (Anderson et al., 1999; Holmes et al., 2014). Recent studies with foundations in SEM have evaluated behavioral interventions delivered by medical providers and allied health professionals in the context of health care. For example, de Wit and colleagues (2010) trained diabetes care providers to assess and discuss their adolescent patients' diabetes-related quality of life during routine diabetes visits. This brief, clinic-integrated intervention demonstrated improvements in psychological functioning and health care satisfaction, and prevented deterioration in glycemic control compared with controls (de Wit et al., 2010). Monaghan and colleagues (2015) trained diabetes care providers to provide scripted psychoeducation around the importance of collaborative parent involvement in blood glucose management. This FST- and SEM-inspired pilot intervention reported reduced family conflict and a trend toward improved adherence and glycemic control for a subset of participants (Monaghan et al., 2015). Although preliminary, these studies show the promise of implementing brief, theory-based behavioral interventions as part of medical care.

Also designed to be delivered by health care providers (consistent with SEM), motivational interviewing (MI) is a communication and interaction style that aims to elicit individuals' intrinsic motivation and strengthen commitment to behavior change goals (Miller & Rollnick, 2013). Studies of MI to promote adherence among youth with T1D are emerging, and preliminary outcomes have suggested potential to improve glycemic control and quality of life, and to decrease disease burden (Christie & Channon, 2014; Powell, Hilliard, & Anderson, 2014). Data from a nonrandomized study incorporating MI pointed to benefits for youth with suboptimal glycemic control (Stanger et al., 2013), suggesting MI may be particularly useful in combination with, or as an introductory approach to, deliver other evidence-based behavioral strategies targeting specific adherence behaviors in alignment with individual goals and preferences. Differences compared with control groups are rare, possibly because of variability in study design and implementation fidelity. Despite its intent as a provider-delivered intervention, most T1D MI studies have used research staff or psychologists. Recent attempts to train health care providers in MI have not yet translated to improvements in adherence or glycemic control (Robling et al., 2012).

Summary and Recommendations for T1D Behavioral Interventions

The studies reviewed here must be interpreted in the context of common methodological limitations that influence the scope and reach of behavioral interventions. Small sample sizes and restricted characteristics (e.g., lack of racial/ethnic or socioeconomic diversity) raise questions about generalizability and relevance across demographic groups. Varied intervention targets (e.g., psychological functioning, adherence behaviors, glycemic outcomes) and assessment methods (e.g., self-report, electronic monitoring) make it difficult to compare results to draw cross-cutting conclusions. Many behavioral interventions are time and resource intensive, few have been replicated and refined to the point of readiness for widespread dissemination, and cost-effectiveness data are infrequently reported, all of which must be addressed to translate the behavioral T1D intervention research to clinical practice.

The evidence base for behavioral intervention research in T1D emphasizes middle childhood and adolescence, with notably fewer interventions targeting adherence and glycemic control in the extreme pediatric age ranges of early childhood (Streisand & Monaghan, 2014) and emerging adulthood (Monaghan, Helgeson, & Wiebe, 2015). Initial findings suggest that family-oriented support programs for parents of young children may improve parental well-being (Monaghan, Hilliard, Cogen, & Streisand, 2011; Sullivan-Bolyai, Bova, Lee, & Gruppuso, 2011), and research is underway to extend the impact to diabetes management and glycemic outcomes. At the other end of the pediatric age range, health-services-

based transition programs, such as structured diabetes clinics for young adults and transition coordinator programs, have demonstrated improvements in clinic attendance, reductions in loss to follow-up in adult care, and improvements psychological support. Some improvements in glycemic control have been reported, yet consistent and enduring impact remains elusive (Holmes-Walker, Llewellyn, & Farrell, 2007; Sequeira et al., 2015; Van Walleghem, MacDonald, & Dean, 2011).

In sum, the growing body of behavioral intervention literature for youth with T1D points toward a few well-developed, theory-based behavioral strategies (see Table 1) with strong potential to effectively promote well-being, adherence, and optimal glycemic control. Efforts to adapt these approaches for young children and emerging adults and for other types of diabetes are needed to maximize health and behavioral outcomes.

Unique Challenges in Type 2 Diabetes (T2D)

Until two decades ago, diabetes diagnosed in youth was almost exclusively T1D (Nadeau & Dabelea, 2008). However rates of T2D have grown, especially in adolescents from families of minority racial/ethnic groups. Youth with T2D are often overweight or obese, have a first-degree relative with T2D, and are of low socioeconomic status (American Diabetes Association, 2000). Because the rise in T2D has been linked causally to the obesity epidemic, most youth struggle with two chronic conditions: T2D and obesity (Nadeau & Dabelea, 2008). Because of the lack of behavioral and medical research focused on youth with T2D (Tamborlane and Klingensmith, 2013), in the last decade, the National Institutes of Health and the Centers for Disease Control and Prevention have funded two large empirical studies that have provided new and important information about T2D in youth. This section will describe these two landmark studies, review the literature on barriers to treatment adherence, and discuss lessons for future research with youth with T2D.

Landmark Research in T2D in Youth

The SEARCH for Diabetes in Youth Study (hereafter, "SEARCH") was initiated in 2000 to address questions about the prevalence, incidence, and clinical and psychosocial course of T1D and T2D in youth under 20 years of age. This active surveillance registry is currently taking place at five sites across the United States. SEARCH also follows a longitudinal cohort to assess the natural history and risk factors for acute and chronic diabetes-related complications. SEARCH is the largest and most racially and geographically diverse study focused on youth with diabetes; it has provided the first ascertainment data about youth with T2D and the first characterization of the sociodemographic factors of youth with T2D in the United States (SEARCH for Diabetes in Youth Study Group, 2006). Recent SEARCH data have shown that between 2000 and 2009, the prevalence of T2D grew more than 30% and T2D now accounts for up to 50% of new-onset diabetes diagnoses in youth, varying across regions of the country, and disproportionately affects minority racial/ethnic groups (Dabelea et al., 2014).

Despite the increased prevalence of T2D in youth, there had been no clinical trials focused on the relative effectiveness of different treatment approaches in youth with T2D. Therefore, the Treatment Options for Type 2 Diabetes in Adolescents and Youth (TODAY) Study was undertaken to test the efficacy of different treatments on glycemic control in youth with recent-onset T2D. In a randomized controlled trial that followed 699 youth (ages 10–17 years with T2D duration <2 years) over 2 to 6 years, the TODAY study compared metformin mono-therapy with two alternative approaches: metformin plus a second pharmacologic agent (rosiglitazone) or metformin plus an intensive lifestyle behavioral intervention delivered individually to youth and parents by trained research assistants in their home or a convenient community setting. The lifestyle intervention focused on self-monitoring and promoting healthy eating and physical activity and decreasing sedentary behaviors. Results revealed that metformin alone was effective in maintaining glycemic control in only half the study participants, and complications including hypertension, microalbuminuria, retinopathy, and risk for myocardial infarction increased; the addition of rosiglitazone was superior to metformin alone, suggesting that the majority of youth with T2D may require combination treatment or insulin therapy within a few years after diagnosis to prevent glycemic decompensation. For the lifestyle plus metformin intervention group, results were intermediate but not statistically different from metformin alone or metformin plus rosiglitazone (TODAY Study Group, 2012). As emphasized by Narasimhan and Weinstock (2014), the fact that metformin provided durable glycemic control in only half of the participants indicated that T2D is more aggressive and rapidly progressive when onset is early in life. Thus, an aggressive, multifaceted approach will be needed to prevent or forestall the complications of T2D in high-risk, vulnerable youth diagnosed with T2D.

Adherence Barriers in T2D

Given the need for aggressive and protective therapies early in the course of T2D, the study of adherence to treatment in adolescents with T2D is especially important (Anderson & McKay, 2011). Treatment of T2D requires that adolescents make multiple behavior changes, including eating and physical activity, taking medications, and monitoring blood glucose (American Diabetes Association,

2000). To date, most research on treatment adherence among youth with T2D has focused on identifying barriers to adherence (Auslander, Sterzing, Zayas, & White, 2010), which can inform the design of future behavioral interventions for youth with T2D.

Multilevel barriers to T2D adherence are in line with SEM, including physiologic, individual, family, socioeconomic, health care systems, and cultural factors (Anderson & McKay, 2011). At a physiologic level, T2D in youth is diagnosed most often during the period of pubertal growth. Obesity causes youth with T2D to go through puberty early, which accelerates insulin resistance in genetically vulnerable youth (Nadeau & Dabelea, 2008). This often necessitates initiating additional oral antidiabetic agents and/or supplemental insulin therapy, which can increase stigma and treatment burden. At the individual level, youth with T2D are at elevated risk for poor psychological functioning (Hood et al., 2014; Lawrence et al., 2006). Elevated psychological distress has been linked with decreased adherence behavior among adults with T2D (Gonzalez et al., 2008), and may similarly impact adherence among youth with T2D. At the family level, most youth with T2D have at least one first-degree relative with T2D (Pinhas-Hamiel et al., 1999). Thus, there is an intergenerational burden of T2D and its complications, and the adult relatives with T2D of youth with T2D also struggle with many barriers to adherence (Rothman et al., 2008). Finally, the most significant barrier to adherence in youth with T2D relates to socioeconomic and cultural issues at the societal level. Cultural differences in nutrition, parenting practices, and health beliefs may impact diabetes management and health outcomes, and disparities in education and income that introduce practical socioeconomic barriers to adherence (e.g., limited access to safe outdoor areas for physical activity or grocery stores selling fresh produce) are not under the direct control of individuals with T2D or their families (Naranjo, Schwartz, & Delamater, 2015).

Lessons for T2D Behavioral Interventions

Although there is, as yet, very little behavioral intervention research for youth with T2D, lessons may be gleaned from what we have learned about demographic characteristics from the SEARCH Study and from intervention research, both the TODAY study and research in youth with T1D (as reviewed in the previous section). Given that T2D disproportionately affects youth from low-income and racial/ethnic minority backgrounds, behavioral interventions designed for and tested with primarily Caucasian, middle-class, two-parent families will be unlikely to generalize to families of low-income, ethnic/racial minority adolescents. It is critical that behavioral interventions are tailored to the cultural background, family composition, and developmental levels of youth most frequently diagnosed with T2D, and take into account the competing priorities for the family's resources. For example, it will be important for family-based interventions for youth with T2D to acknowledge cultural differences in family beliefs about health, nutrition, and parenting practices, and adapt intervention content and format accordingly. Like behavioral interventions in T1D, simply providing education about needed behavior changes will likely be inadequate, and theory-based interventions employing behavioral strategies (e.g., monitoring, goal-setting, and contingency management) across settings will most likely facilitate optimal healthy changes in eating and physical activity behavior.

Conclusions and Future Directions

Three important gaps remain in the study of behavioral interventions to promote management of T1D and T2D in youth and families: the development of individualized interventions, integration of evidence-based interventions in health and mental health care delivery settings, and advocacy initiatives to increase access to effective behavioral and mental health support for people with diabetes. First, despite improvements in diabetes outcomes from several behavioral interventions, effect sizes are modest compared with alternative treatments. Emerging evidence suggests that many people may benefit from lower level interventions, whereas others may require more intensive multicomponent interventions. Echoing the trend toward personalized medicine in health care, more data are needed about how to tailor the most appropriate match between different behavioral intervention strategies and characteristics of the youth and family living with T1D or T2D. An emphasis on positive psychology intervention strategies in T1D (e.g., Jaser, Patel, Linsky, & Whittemore, 2014) may also help extend the impact of behavioral interventions by capitalizing on youth and family strengths to promote diabetes resilience (Hilliard et al., 2012).

Second, there is an urgent need to study how to integrate evidence-based interventions into diabetes care delivery settings and other health and mental health care settings. Although promising new diabetes management technologies such as insulin pumps and continuous glucose monitors currently make the achievement of in-range blood glucose levels more possible, the uptake and sustained use of these modern diabetes technologies is quite low (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, 2009). The growing field of dissemination and implementation science can guide behavioral scientists in adapting research innovations into clinical practice in pediatric diabetes and other care delivery settings (Glasgow et al., 2012). For example, cost-effectiveness research will be important to determine the level of training and resources

needed to effectively and efficiently deliver the behavioral intervention.

As a complement to psychologists' roles in providing behavioral intervention as part of multidisciplinary diabetes care, several recent reviews (Datye, Moore, Russell, & Jaser, 2015; Hood, Hilliard, Piatt, & Ievers-Landis, 2015; Kichler et al., 2015; Powell, Corathers, Raymond, & Streisand, 2015) thoroughly discuss the importance of, and offer practical guidance to enhance, the roles of health and mental health professionals in supporting people with diabetes across a variety of care settings. Johnson and Marrero (2016) also address organizational and policy influences relevant to the integration of behavioral interventions into health care systems. To enhance translation from research to practice, important roles for psychologists will be to adopt and advocate a public health perspective, to investigate how to adapt efficacious interventions for implementation in routine pediatric diabetes care, and to develop strategies to train mental health providers who are not diabetes specialists and lay, nonmedical interventionists (e.g., peer coaches) to competently treat people with diabetes and deliver evidence-based interventions outside of the medical care setting (Datye et al., 2015; Streisand, Herbert, Owen, & Monaghan, 2012). Broader access to effective behavior change promotion interventions and support may help facilitate the uptake and sustained use of modern diabetes management technologies (Gonder-Frederick, Shepard, Grahman, & Ritterband, 2016).

Finally, although national and international diabetes guidelines (American Diabetes Association, 2015; Delamater et al., 2014) recommend that psychological screening and referral to evidence-based therapies are an integrated into routine diabetes care and are adopted as "best practices" for children and their families living with T1D and T2D, this is part of standard clinical practice in very few diabetes care delivery settings in the United States (Ducat et al., 2014). As psychologists and behavioral scientists, we are ideally suited to advocate (Hilliard et al., 2015) more effectively for the integration of behavioral health screening and care into routine pediatric diabetes care and other health and mental health care settings as one critical step toward improving care and outcomes for people with diabetes locally and worldwide.

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