

## Diabetes and Behavioral Medicine: The Second Decade

Linda A. Gonder-Frederick, Daniel J. Cox, and Lee M. Ritterband  
University of Virginia Health System

Diabetes management depends almost entirely on behavioral self-regulation. Behavioral scientists have continued a collaboration with other health systems researchers to develop a holistic approach to this disease. The authors summarized the literature in 4 major areas: self-management of diabetes, psychosocial adjustment and quality of life, neuropsychological impact, and psychobehavioral intervention development. Progress made in each of these areas over the past decade is highlighted, as are important issues that have not yet received sufficient scientific attention. Emerging areas likely to become central in behavioral research, such as diabetes prevention, are introduced. The future of behavioral medicine in diabetes is also discussed, including topics such as the changing role of psychologists in diabetes care, the urgent need for more and better intervention research, the growing importance of incorporating a health system–public health perspective, and obstacles to the integration of psychobehavioral approaches into routine health care delivery.

A profound event in diabetes management during the past decade was the release of the 1993 report of the National Institutes of Health (NIH) funded Diabetes Control and Complications Trial (DCCT; DCCT Research Group, 1993), which radically altered both the goals and the philosophy of treatment of this disease. The DCCT was a controlled, prospective trial following more than 1,400 adults and adolescents with Type 1 diabetes (T1DM) over an average of 6.5 years. The results provided strong evidence that the use of intensive treatment regimens to maintain tighter glucose control can delay or prevent the development of at least some of the devastating long-term complications of diabetes, including retinopathy and nephropathy. Subsequent studies replicated these findings and demonstrated the benefits of maintaining tighter metabolic control for patients with Type 2 diabetes (T2DM; Ohkubo et al., 1995; Reichard, Nilsson, & Rosenqvist, 1993; Turner, Cull, & Holman, 1996).

It is almost impossible to overestimate the impact of the DCCT on diabetes treatment and research. Seemingly overnight, large numbers of patients were expected to follow a demanding, intensive treatment regimen that previously had been recommended only for those who were most highly motivated and diligent in their diabetes self-management. Health care practitioners were also expected to know how to help patients achieve these lofty treatment goals. In addition to problems in implementing intensive

treatment, questions arose concerning the effects of these regimens on quality of life (QOL) for patients. Intensive regimens also posed new dilemmas for health care practitioners and patients, not the least of which was the dramatic increase in risk for episodes of severe hypoglycemia when patients attempted to lower blood glucose (BG) levels. It quickly became clear that the greatest challenge to contemporary diabetes treatment was overcoming the many psychobehavioral and social–environmental barriers to optimal self-management. Not surprisingly, the medical establishment turned to behavioral scientists for assistance, and new and stronger partnerships emerged between psychology and diabetes health care.

Following the DCCT, there was an enormous effort to summarize and disseminate relevant findings from psychobehavioral research to assist health care practitioners and patients in adapting to these new treatment goals. In 1994, *The Handbook of Psychology and Diabetes* (Bradley, 1994b) described diabetes-specific psychological instruments, with demonstrated reliability and validity, that are available for clinical and research use. In 1996, the American Diabetes Association (ADA) published *Practical Psychology for Diabetes Clinicians* (B. J. Anderson & Rubin, 1996), an attempt to translate knowledge about psychosocial and behavioral factors in diabetes into concrete, specific recommendations for primary care providers. A subsequent volume, *Psychology in Diabetes Care* (Snoek & Skinner, 2000), described psychobehavioral interventions with demonstrated or potential efficacy for improving diabetes outcome. The growing recognition of the need to incorporate psychological perspectives into treatment and prevention efforts led to a 1999 NIH-sponsored conference on behavioral science and diabetes, which invited prominent researchers to summarize the status of the field and make recommendations for future directions of scientific pursuit (Marrero, Peyrot, & Garfield, 2001). As we enter the new century, the impact of behavioral medicine can be seen in almost every area of diabetes education and treatment, and the effort to integrate psychology into mainstream diabetes management shows no sign of diminishing.

This review provides an overview of psychological and behavioral research over the past decade that has had a significant

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Linda A. Gonder-Frederick, Daniel J. Cox, and Lee M. Ritterband,  
Behavioral Medicine Center, University of Virginia Health System.

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Correspondence concerning this article should be addressed to Linda A. Gonder-Frederick, Behavioral Medicine Center, Box 800223, University of Virginia Health System, Charlottesville, Virginia 22908. E-mail: lag3g@hscmail.mcc.virginia.edu

influence on the understanding and management of diabetes. Findings with clinical implications are highlighted, as is the research into clinical interventions based on psychological and behavioral theories. Topics deserving of more scientific attention in the future are also reviewed. However, to place behavioral medicine research in perspective, it is necessary first to provide an overview of this illness and its treatment.

### Epidemiology, Pathophysiology, and Treatment of Diabetes

Diabetes mellitus is a chronic endocrinological disorder characterized by abnormalities in glucose metabolism due to abnormalities in the production and/or utilization of the hormone insulin. Insulin, which is produced by the pancreatic beta cells, is essential for the utilization and storage of nutrients by the body. The diagnosis of diabetes is defined by the presence of abnormally high glucose levels in the bloodstream, or hyperglycemia. Diabetes is one of the largest health care problems in the United States in terms of prevalence, cost, and burden placed on individuals living with the illness. Its prevalence has increased dramatically over the past few decades, with more than 10 million diagnosed cases in the United States, and these numbers are expected to continue to grow, in large part because of worldwide increases in obesity, sedentary lifestyles, and life expectancy (Clark, 1998). The vast majority of patients (90%) have T2DM, also known as non-insulin-dependent diabetes, which is strongly associated with obesity and age (Haffner, 1998). In the United States, 11% of people age 65 years or older have T2DM (Harris, 1998). Although not nearly as prevalent, T1DM, also known as insulin-dependent diabetes, remains the most common chronic disease of childhood, with more than 13,000 new cases each year (National Diabetes Data Group, 1995). Overall, diabetes is equally prevalent in men and women; however, the risk for T2DM is much higher in minority groups, whereas T1DM occurs more often in Caucasians (Haffner, 1998).

The onset of both T1DM and T2DM is determined by both genetic and environmental factors. For example, more than two thirds of T2DM patients have a first- or second-degree relative with the disease, and 80% are obese (Haffner, 1998). Historically, T2DM has been considered a disease of the elderly. However, a recent and disturbing trend has been the rapid increase in the prevalence of this disorder in overweight children and adolescents (American Diabetes Association, 2000). T2DM can be caused by either insulin resistance or defective insulin secretion or by a combination of these processes. When body cells become insulin resistant, there is an attempt to compensate by increasing insulin production, resulting in hyperinsulinemia and eventual damage to the pancreatic beta cells due to overwork. Treatment can involve diet and exercise, oral medications to combat hyperglycemia, insulin injections, or a combination of these therapies. Because of the strong association between T2DM and obesity, weight loss is often a major treatment goal. For this reason, the vast body of literature in behavioral medicine demonstrating the extreme difficulty of maintaining reduced weight is relevant to the management of this disease (for a review, see Jeffery et al., 2000). Fewer than 10% of patients are able to control T2DM through diet and exercise alone, and there is a growing tendency to use insulin to achieve tighter BG control in this population.

Gestational diabetes is another type of this disorder that typically onsets during the third trimester of pregnancy because of the inability of the pancreas to meet increased insulin needs (Coustan, 1995). Although gestational diabetes typically resolves postpartum, these women are at greatly increased risk for the later development of T2DM. Gestational diabetes also introduces unique challenges from a behavioral perspective because mothers must quickly learn and adapt to a demanding treatment regimen to avoid fetal complications.

The onset of T1DM usually, but not always, occurs before middle age and appears to be caused by a susceptibility gene that renders an individual vulnerable to the autoimmune-mediated destruction of the pancreatic beta cells. With T1DM, the pancreas produces little to no insulin, allowing glucose to accumulate in the bloodstream, causing hyperglycemia. The body's inability to utilize glucose causes the breakdown of fat for use as metabolic fuel, which, in turn, leads to a buildup of ketone acids and can cause diabetic ketoacidosis (DKA). The only way to promote sufficient glucose utilization and reduce hyperglycemia in T1DM is by delivering insulin through subcutaneous injections or an insulin pump. Without exogenous insulin treatment, T1DM is fatal. Both T1DM and T2DM are associated with serious long-term health complications, including retinopathy, nephropathy, neuropathy, and cardiovascular disease. In fact, diabetes is the leading cause of blindness, nontraumatic lower limb amputation, physiological erectile dysfunction, and end-stage renal disease in the United States (Harris et al., 1998).

The goal of contemporary diabetes treatment is to keep BG levels in as close to a normal range as possible through the use of medication, BG monitoring (BGM), diet therapy, and exercise to reduce the long-term complications of chronic hyperglycemia. Although it is technologically possible to normalize diabetic BG levels, in reality only a small minority of patients achieve this goal. Even in the DCCT, where a multidisciplinary team provided consistent supervision and support, only 5% of patients were able to maintain normal BG levels (DCCT Research Group, 1995). Intensive insulin therapy requires three or more injections per day (before each meal and often at bedtime) or the use of an insulin infusion pump that is worn continuously and programmed to deliver changing doses throughout the day. Unfortunately, such intensive regimens are also associated with an increased frequency in hypoglycemia, or abnormally low BG, which occurs when insulin levels are too high relative to food intake and physical activity. To monitor glucose control and hypoglycemic episodes, patients on intensive therapy need to test their BG four or more times per day and adjust their insulin dose, food intake, and activity accordingly. The ADA no longer recommends a specific diabetes diet, but rather recommends a healthy low-fat meal plan that is individually tailored to patient lifestyle, culture, and ethnicity (ADA, 1996). However, food must still be monitored closely, and patients typically quantify their intake by some method, such as counting calories or fat for weight loss or counting carbohydrate content to determine insulin requirements.

Because of the close relationship between the risk of cardiovascular complications and BG control, contemporary diabetes management is placing increasing emphasis on the reduction of cardiovascular risk factors, including hypertension and hyperlipidemia. Aggressive treatment of hypertension, for example, significantly decreases diabetes-related deaths, strokes, microvascular

complications, and visual loss (United Kingdom Prospective Diabetes Study Group, 1998). Research also has shown that the combination of diabetes and smoking is a lethal one, resulting in increased risk for micro- and macrovascular complications, and there is a renewed effort to address the need for smoking cessation interventions (Haire-Joshu, Glasgow, & Tibbs, 1999).

In addition to the self-treatment behaviors noted above, patients must maintain constant vigilance for symptoms that signal hypo- or hyperglycemia, follow a daily foot-care regimen, engage in regular aerobic exercise, and attend frequent medical appointments. Thus, patients with diabetes must perform multiple self-treatment behaviors on a daily basis for the remainder of their life spans after diagnosis. From a psychobehavioral perspective, it is difficult to imagine any other illness that places the same level of demand on patients to self-monitor and self-regulate their own health status.

### Self-Management of Diabetes

Because diabetes management depends largely on a complex process of behavioral self-regulation, patients' abilities to comply with or adhere to regimens have long been of prominent interest to both researchers and clinicians. However, studies have repeatedly demonstrated that diabetes self-treatment is poorly explained by simplistic, compliance-based models (Glasgow & Eakin, 1998). A global construct of adherence is also misleading because there is considerable variability in the individual level of self-care across both the different aspects of the regimen and time. In addition, some aspects of diabetes treatment (e.g., changing habits in eating and physical activity) are more difficult for patients to follow than others (e.g., taking medication or insulin on a recommended schedule). Active ongoing decision making is also an integral part of diabetes management, and patients frequently confront situations with multiple response options and no single right solution. For these reasons, current models of diabetes management, education, and counseling are based on a "patient empowerment" perspective (R. M. Anderson et al., 2000; Feste & Anderson, 1995). In contrast with more traditional compliance models that rely on exerting pressure to follow recommendations, the goals of patient empowerment are to provide individuals with the skills and resources they need to make and execute informed personal choices about self-care.

To provide patients with these critical skills and resources, however, caregivers must first understand the factors that enhance or interfere with self-treatment. Over the past decade, psychobehavioral research has continued to confirm that diabetes self-management is an enormously complex, multifactorial process influenced by a broad range of reciprocally interacting individual, social, and environmental variables (see Figure 1).

### Individual Variables

Early research on the individual characteristics that mediate diabetes management were guided by health belief models and social-cognitive theories. A number of studies demonstrated that both personal health beliefs and self-efficacy predicted self-care across a wide range of behaviors in both adolescents and adults (Brownlee-Duffeck et al., 1987; McCaul, Glasgow, & Schafer, 1987). A recent meta-analysis concluded that research findings

have continued to show that these cognitive and attitudinal processes have direct effects on self-management and, thus, significant indirect effects on clinical outcome (Robiner & Keel, 1997). Self-efficacy, for example, has a significant influence even after controlling for the strong predictive effect of past levels of self-care (Kavanagh, Gooley, & Wilson, 1993). However, the impact of health beliefs may vary as a function of developmental stage. Adolescent beliefs about long-term consequences (e.g., future complications) of treatment have much less influence than their beliefs about short-term (e.g., daily BG levels) consequences (Skinner & Hampson, 1999). Recent research also has indicated there is an even stronger relationship between highly individual health beliefs, called *personal models of illness*, and self-management (Hampson, Glasgow, & Strycker, 2000). Irrational health beliefs, characterized by cognitive distortions (e.g., minimization of personal risk), also appear to be associated with poorer long-term metabolic control (Christenson, Moran, & Wiebe, 1999).

Another health belief that mediates self-treatment is locus of control; that is, beliefs about whether diabetes management and outcome are determined by internal (personal) or external (situational, medical, chance) factors. In both T1DM and T2DM, health locus of control is related to numerous outcome variables, including metabolic status, body weight, frequency of DKA, emotional well-being, and treatment satisfaction (Bradley, 1994a). However, recent research has highlighted the complexity of the health locus-of-control construct. Although a sense of healthy autonomy over outcome is associated with positive medical and psychological outcomes, self-blame is associated with negative outcomes, including less frequent BGM and insulin adjustment (Peyrot & Rubin, 1994). The relevance of self-determination theory (G. C. Williams, Freedman, & Deci, 1998), which proposes a construct of autonomous self-regulation in health care, has also recently been tested. Although both autonomous self-regulation and self-efficacy were predictive of dietary behavior, self-efficacy was a stronger predictor of adherence, whereas perceived autonomy was more closely associated with life satisfaction (Senecal, Nouwen, & White, 2000).

Psychopathology and psychological distress are individual characteristics that also play a critical role in diabetes management. The presence of clinical depression, which occurs in 15%–20% of patients with either T1DM or T2DM, interferes with adequate self-treatment and glycemic control in both youths and adults (Christenson et al., 1999; Kovacs et al., 1985; La Greca, Swales, Klemp, Madigan, & Skyler, 1995; Lustman, Freedland, Carney, Hong, & Clouse, 1992; Peyrot & Rubin, 1997). Although the strong association between hyperglycemia and depression was confirmed in a recent meta-analysis, the causal mechanisms remain unclear (Lustman et al., 2000). Depressive symptoms, such as reduced energy and motivation, can clearly have a negative impact on self-treatment, but the presence of chronic hyperglycemia and the threat of complications could also easily lead to feelings of helplessness, self-blame, and hopelessness. There is also evidence that depression may tend to precede the onset of diabetes. Regardless of causal link, treatment with either pharmacotherapy or psychotherapy improves both depressive symptoms and diabetes control (Lustman, Freedland, Griffith, & Clouse, 2000; Lustman, Griffith, Freedland, Kissel, & Clouse, 1998).

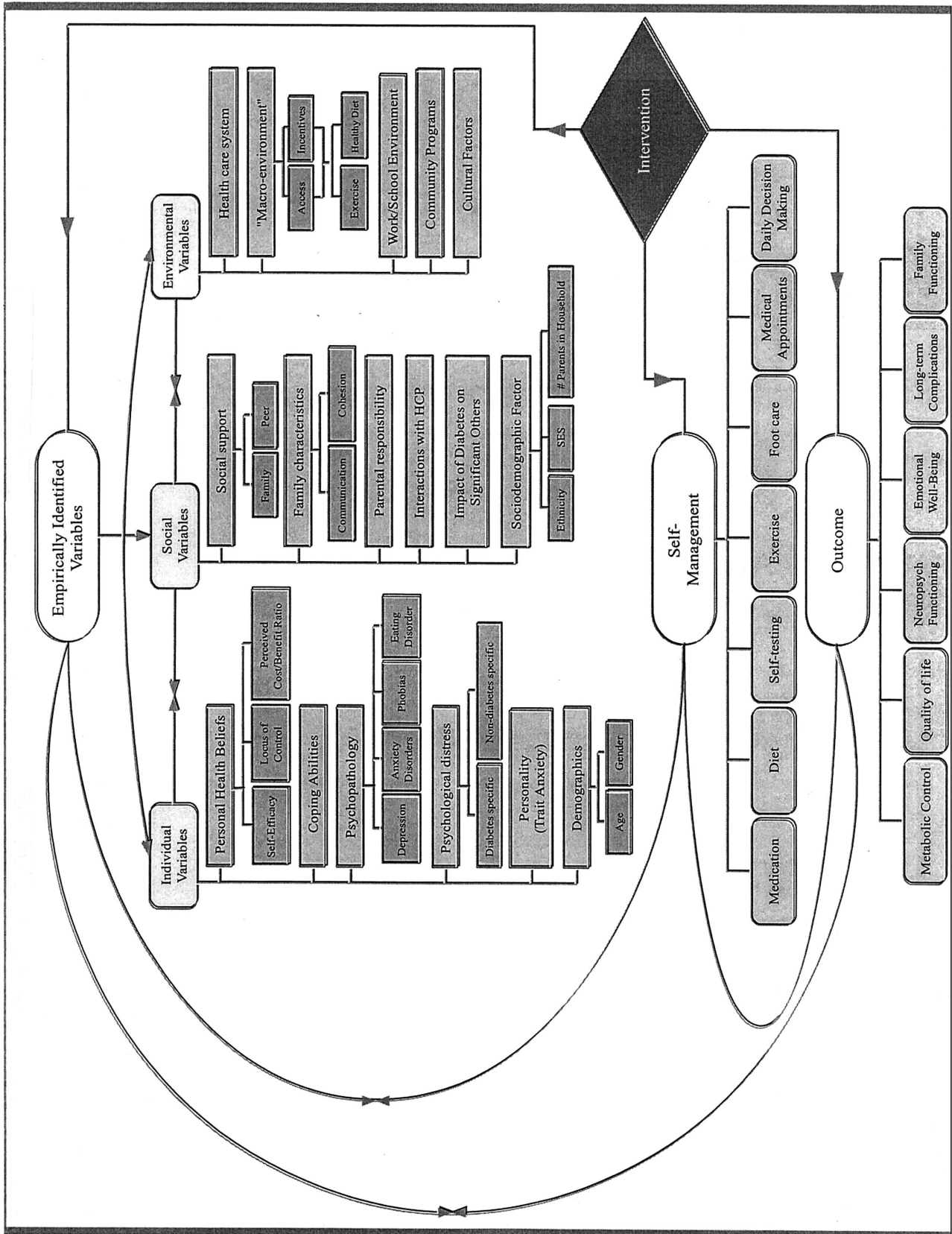


Figure 1. A psychobehavioral model of variables influencing self-management and clinical outcome in diabetes. HCP = health care practitioner; SES = socioeconomic status.

Another problem of special concern in diabetes management is the presence of eating disorders, which are far more prevalent in adolescent and young adult females with T1DM (Jones, Lawson, Daneman, Olmsted, & Rodin, 2000; Rodin, Johnson, Garfinkel, Daneman, & Kenshole, 1986) than in other groups and are also associated with a greatly increased risk of poor metabolic control, retinopathy, and other health complications (Daneman, Olmsted, Rydall, Maharaj, & Rodin, 1998; Rydall, Rodin, Olmsted, Devenyi, & Daneman, 1997). This increased vulnerability to eating disorders may reflect the degree of attention focused on food intake in diabetes, as well as concerns about weight gain secondary to insulin use. One type of eating disorder unique to diabetes is the manipulation of insulin dose to control weight (i.e., to compensate for binge eating with insulin underdosing, which induces hyperglycemia and worsens diabetes control; Polonsky et al., 1994).

There has been far less research into the impact of anxiety disorders on self-management, although these appear to be more prevalent in people with diabetes and are associated with poor metabolic control (DeGroot, Jacobson, & Samson, 1994; Peyrot & Rubin, 1997). A recent survey of over 600 adults found that patients with both T1DM and T2DM reported symptoms of anxiety and depression at an equivalent rate (Peyrot & Rubin, 1997), suggesting that the impact of anxiety disorders on clinical outcome may be deserving of more scientific attention. The possibility that neurohormonal responses to anxiety, primarily sympathetic activation, may have a direct effect on diabetes control is supported by a study that showed (Lustman et al., 1995) that anxiolytic medication leads to improved glycosylated hemoglobin, both in patients with and without anxiety disorders. Anxiety may also have more subtle effects on specific aspects of diabetes management. Individuals with T1DM who are high in trait anxiety show a tendency to misattribute bodily symptoms to hypoglycemia, which can lead to unnecessary treatment and hyperglycemia (Wiebe et al., 1994). In addition, needle phobias and fear of self-injecting/testing, which have an obvious potential impact on diabetes management, persist undetected in some patients long after diagnosis (Snoek, Mollema, Heine, Bouter, & van der Ploeg, 1997).

Subclinical levels of psychological stress and distress also appear to influence self-care, but the precise nature of these effects remains elusive. Although both daily stressors and major stressful life events are related to diabetes control in both children and adults, individuals differ greatly in the extent to which they are glycemic stress sensitive (Aikens, Wallander, Bell, & Cole, 1992; Gonder-Frederick, Carter, Cox, & Clarke, 1990; Lloyd et al., 1999; Stenstrom, Wikby, Hornquist, & Andersson, 1993). The degree to which stress affects BG control through neuroendocrine mechanisms (e.g., epinephrine levels) or by disrupting self-management behavior is unclear, and the assumption that diabetes management deteriorates under increased stress has received only sporadic support.

### *Social and Environmental Variables*

Social influences, such as family factors, peer relations, and social support, that may enhance or interfere with self-management and clinical outcome have not received the scientific attention they merit over the past decade, especially in adult populations. In children with T1DM, research has continued to support the importance of familial characteristics, including the

level of family conflict and stress, cohesion and organization, and communication skills (Hanson, De Guire, Schinkel, & Kolterman, 1995; Jacobson et al., 1994; Miller-Johnson et al., 1994). Family environment appears to have a persistent impact, and children whose families show less conflict and more cohesion at the time of diagnosis experience fewer episodes of DKA and severe hypoglycemia, as well as less deterioration in metabolic control later (Herskowitz et al., 1995). Another critical family variable receiving increased attention is the division of responsibility between parents and children for diabetes care, and there is consensus that premature independence in self-management leads to negative clinical outcomes (B. J. Anderson, Auslander, Jung, Miller, & Santiago, 1990; B. J. Anderson & Brackett, 2000; Wysocki, Hough, Ward, & Green, 1992). Pediatric patients who are given too much responsibility make more mistakes in self-treatment, are less adherent, and are in poorer metabolic control compared with those whose parents remain more involved. Future research is needed to determine whether these family characteristics and processes have an equivalent impact on treatment and outcome in populations with pediatric T2DM.

Unfortunately, the role of family factors in adult diabetes management has been virtually ignored in the literature during the past decade, even though earlier studies suggested that family and spouse support have a significant impact in both T1DM and T2DM (Glasgow & Toobert, 1988; Mercado & Vargas, 1989; Schafer, McCaul, & Glasgow, 1986). Although it is likely that peer relationships also have important influences on diabetes management, especially in adolescents, these too have failed to receive the empirical attention they merit (Glasgow & Anderson, 1995).

There is, however, growing appreciation of the role of sociodemographic variables as important risk factors for poor diabetes management and metabolic control, although most of the research has focused on pediatric populations. For example, African American youths are in poorer glycemic control than Caucasian youths (Auslander, Thompson, Dreitzer, White, & Santiago, 1997; Delamater et al., 1999), perhaps in part because of the increased number of single-parent homes where one parent bears the burden of being entirely responsible for the child's diabetes treatment (Overstreet et al., 1995). Limited financial resources are also a risk factor, and lower socioeconomic status (SES) is associated with both poor metabolic control and recurrent hospitalization (Auslander, Bubb, Rogge, & Santiago, 1993; Kovacs, Mukerji, Drash, & Iyengar, 1995). Lower SES is also associated with an increased prevalence of obesity and T2DM (Wing et al., 2001). These findings suggest that the broader sociocultural, economic, and environmental context needs to be considered in models of diabetes management and prevention.

There is also an urgent need for more research into health care provider and health care delivery factors that enhance self-treatment behavior (Glasgow et al., 2001). Studies in diabetes and other chronic illnesses have suggested that numerous variables can increase patient satisfaction with provider treatment and the likelihood of successful behavior change. These include a patient-centered approach that emphasizes addressing and listening to patient concerns, frequent contact, support and reminders, and consistent follow-up. Unfortunately, our current health care system is not designed to provide the continuum of treatment that is optimal for chronic disease management, and this remains a major obstacle to adequate self-management of diabetes.

## Neuropsychology and Diabetes

In addition to metabolic control and avoidance of long-term complications, another important clinical outcome of diabetes is the neurobehavioral impact of the extreme BG fluctuations associated with diabetes (see Figure 1). In the 1980s, neuropsychological research demonstrated convincingly that frequent episodes of severe hypoglycemia can have a detrimental effect on cognitive-motor abilities, especially in the developing brain (Ryan, 1997). Children with early onset of T1DM (< 5 years of age), in whom severe hypoglycemia is more common, appear to have fundamental decrements in information processing, especially in visuospatial, psychomotor, and attentional skills (Rovet, Ehrlich, & Hoppe, 1988; Ryan, Vega, & Drash, 1985). Because of these findings, current treatment recommendations *discourage* intensive therapy aimed at very tight metabolic control in young children. There is also evidence that severe hypoglycemia can cause neurological damage in later onset and older children, including EEG abnormalities. However, some of the observed performance deficits, especially in verbal skills and achievement scores, appear to be related to more frequent school absences in diabetic youth (Kovacs, Goldston, & Morrow, 1992; Ryan et al., 1985).

Although the effect of severe hypoglycemia on the adult brain is more controversial, the data are increasingly convincing that it can cause deficits in visuospatial and psychomotor skills similar to those found in youth (Deary, Langan, & Graham, 1992; Deary et al., 1993). To date, only a few studies have directly addressed the question of whether placing patients on intensive insulin regimens, which greatly increases the risk of episodes of severe hypoglycemia, also increases the risk of hypoglycemia-induced neurological damage. These studies have yielded mixed results, which may be a result of age effects. Although assessments of adults participating in large-scale trials have found no increase in cognitive-motor deficits due to intensive therapy (DCCT Research Group, 1996), a recent prospective study of children showed more impairments in spatial and pattern recognition in those on intensive therapy compared with conventional regimens (Hershey, Bhargava, Sadler, White, & Craft, 1999).

In addition to chronic effects, studies have continued to investigate the impact of acute hypoglycemia on cognitive-motor function. Whereas early research documented clear deficits when BG levels were very low (< 45 mg/dl), more recent work has demonstrated that even mild hypoglycemia (< 65 mg/dl) can cause performance deficits on a variety of tasks, although these effects tend to be idiosyncratic (Driesen, Cox, Gonder-Frederick, & Clarke, 1995; Gonder-Frederick, Cox, Driesen, Ryan, & Clarke, 1994; Ryan et al., 1990). Laboratory research using a sophisticated driving simulator has also shown that both mild and more severe hypoglycemia disrupt driving performance, resulting in more driving across the midline, speeding, and inappropriate braking (Cox, Gonder-Frederick, Kovatchev, Julian, & Clarke, 2000). Furthermore, many of these subjects remained unaware of their impairment and inability to operate a vehicle safely. The extent to which hypoglycemia and driving represent a safety hazard is an extremely controversial topic, and diabetes advocacy groups have expressed concern that research in this area may lead to unfair restrictions in driving privileges. However, a recent field study suggested that patient judgment regarding hypoglycemia and driving can be problematic, finding that subjects indicated a willing-

ness to drive 43% of the time when BG was believed to be between 60 and 70 mg/dl (Clarke, Cox, Gonder-Frederick, & Kovatchev, 1999).

More attention is also being given to the potential effects of chronic or severe hyperglycemia on neuropsychological function. In earlier research, some studies found a relationship between metabolic control in adults and deficits in learning and memory (Lichy & Connell, 1988; Perlmutter et al., 1984), and others did not (Mooradian, Perryman, & Fitten, 1988). More recent research has documented MRI abnormalities in adults with T1DM (Araki et al., 1994; Jacobson et al., 2000), although the clinical significance of these is unknown. Because one of the best predictors of cognitive-motor impairments in adults appears to be the presence of peripheral neuropathy, Ryan and colleagues (Ryan & Geckle, 2000; Ryan, Williams, Orchard, & Finegold, 1992) have suggested that another long-term complication of chronic hyperglycemia may be a "central neuropathy," or damage to neural structures in the central nervous system. However, some neuropsychological decrements associated with hyperglycemia may be reversible because improving diabetes control appears to enhance learning and memory performance (Gradman, Laws, Thompson, & Reaven, 1993).

## Psychosocial Adjustment and QOL

Although it is generally accepted that psychosocial and behavioral adaptation to diabetes is an ongoing, lifelong process for patients and their families, there have been surprisingly few longitudinal studies of coping and adjustment. One exception to this is the work of Marie Kovacs and her colleagues, who prospectively followed children with T1DM and their parents for an average of approximately 9 years after diagnosis. Initial findings indicated that most children experienced some psychological symptoms (e.g., anxiety, depression, social withdrawal), with more than one third meeting criteria for clinical diagnosis (Kovacs et al., 1985). Similar symptoms occurred in parents, with mothers experiencing significantly more distress than fathers (Kovacs, Brent, Steinberg, Paulauskas, & Reid, 1986). This study, as well as others, subsequently found that by 1 year after diagnosis, symptoms resolved in the majority of children as well as their parents, suggesting that successful psychosocial adjustment occurs relatively quickly in most families (Jacobson et al., 1986; Kovacs et al., 1986). These positive findings were somewhat tempered by subsequent research that showed that psychosocial problems often re-emerge in youths several years after diagnosis and that difficulty in coping with diabetes can increase over time (Grey, Cameron, Lipman, & Thurber, 1995), especially in those patients who exhibit poor initial adjustment (Kovacs et al., 1986). Unfortunately, there have been no such longitudinal studies of psychosocial adjustment in adults, even though clinicians are frequently faced with the problem of "diabetes burnout," which is common in patients who have been dealing with the disease for a number of years (Polonsky, 1999).

Although the causal mechanisms are unclear, there is now ample evidence that diabetes is a significant risk factor for the development of psychiatric problems in all age groups. In the Kovacs project, almost half of the subjects experienced at least one episode of a psychiatric disorder by young adulthood, with major depression occurring in approximately 28% (Kovacs, Mukerji, Iyengar,

& Drash, 1996; Kovacs, Obrosky, Goldston, & Drash, 1997). As noted earlier, the high prevalence rate of depression in people with diabetes compared with the general population has been well-documented (Lustman, Clouse, & Alrakawi, 1997; Lustman, Anderson, et al., 2000). Studies also repeatedly have found that the course of depression is more severe in diabetes, with high relapse rates following initial episodes and a protracted period of recovery in both children and adults (Kovacs, Obrosky, et al., 1997; Kovacs, Goldston, Obrosky, & Bonar, 1997; Lustman, Griffith, & Clouse, 1997; Lustman, Clouse, & Alrakawi, 1997). The problem of underdiagnosis of depression in patients with diabetes is significant, with as many as 2 of 3 cases remaining undetected, primarily because many symptoms of depression (e.g., fatigue) are also symptoms of diabetes (Lustman, Griffith, & Clouse, 1997). Depression is associated with many health behaviors that have a negative impact on diabetes management and metabolic control such as smoking, alcohol and other drug abuse, and dysregulation in appetite and eating. In addition to its association with poorer self-management and metabolic control, depression also strongly correlates with other negative outcomes in both children and adults, including complications and decreased QOL (Jacobson et al., 1997; La Greca et al., 1995; Lustman, Anderson, et al., 2000). However, the reciprocal relationships between these outcome variables are highly complex and in need of further investigation.

Even when patients do not meet criteria for clinical diagnosis of a psychiatric disorder, they are likely to experience some form of diabetes-related psychological distress. Several researchers in the United States and Europe have developed questionnaires to measure diabetes-specific stress and distress, and questionnaire findings confirm that significant problems are not uncommon (Welch, Dunn, & Beeney, 1994; Polonsky, 2000). Some of the most frequently reported sources of distress include worries about long-term complications, guilt and/or anxiety when problems in self-management occur, and fear about other potential negative effects of the disease (Polonsky et al., 1995). Other questionnaires have been developed to assess feelings and attitudes about diabetes (e.g., the extent to which it interferes with reaching life goals) and the degree to which diabetes has been integrated into self-concept in a healthy manner (Carey et al., 1991; Welch, Dunn, & Beeney, 1994).

More discrete sources of diabetes-related distress also exist, such as the fear of hypoglycemia and its negative consequences (Irvine, Cox, & Gonder-Frederick, 1994). Even mild hypoglycemia is typically aversive, with unpleasant symptoms (trembling, sweating, anxiety, slowed thinking) and the potential for social embarrassment. More severe episodes resulting in mental stupor, unconsciousness, or seizure can place patients in danger of injury and even death (Gonder-Frederick, Clarke, & Cox, 1997). Both personality and experience appear to contribute to fear of hypoglycemia, as it is greater in patients with high levels of trait anxiety as well as those with histories of traumatic episodes (Polonsky, Davis, Jacobson, & Anderson, 1992). After episodes resulting in physical injury, fear of hypoglycemia can increase dramatically, leading to efforts to maintain BG levels in a higher, safer range, which subsequently leads to worse metabolic control (Cox, Gonder-Frederick, Antoun, Clarke, & Cryer, 1990). Fear of hypoglycemia can also be inappropriately low, reflecting a type of psychological denial, in patients who are at high risk for severe episodes (Irvine, Cox, & Gonder-Frederick, 1992).

Because of the negative impact diabetes can have on both psychosocial and health status, more recent research has focused on QOL in people living with this illness. In fact, current research has viewed QOL as being just as important an outcome variable as metabolic control and one which may be more important to patients than health status (Delamater, 2000; Rubin, 2000). The need to consider QOL and diabetes control as separate outcome measures is underscored by the fact that there is not a linear relationship between these variables, with some studies finding a weak or moderate relationship and others finding none (Delamater, 2000). Even though QOL appears to be lower in people with diabetes compared with the general population, its prevalence compared with other groups with chronic illnesses is unclear (Jacobson, 1997; Rubin, 2000). There are also questions about whether perceived well-being is negatively affected in healthy patients with diabetes, as poor QOL is strongly associated with the presence of comorbid disorders, whether psychiatric or physical (Wikblad, Leksell, & Wibell, 1996). In addition, little is known about QOL in pediatric populations (Delamater, 2000), although the available data have shown that poorer QOL is related to depression, lower family SES, and single-parent family status (Auslander et al., 1997; Delamater, Tercyk, Applegate, Eidson, & Nemery, 1999; Grey, Boland, Yu, Sullivan-Bolyai, & Tamborlane, 1998). Studies have examined the effects of following intensive regimens on QOL and have yielded mixed findings, with some showing no change in QOL and others showing a deterioration (Jacobson, Cleary, & Baker, 1996; Wikblad, Montin, & Wibell, 1991). However, these mixed findings are not surprising given the complex relationships between self-management, diabetes control, and QOL, as well as the failure in many studies to assess important mediating factors such as coping skills and social support (Snoek, 2000).

Even though diabetes can clearly have a significant psychosocial impact on family members, little attention has been given to adjustment and coping in the significant others of patients. Our research has shown that fear of hypoglycemia is high in both parents of children with T1DM and spouses of diabetic partners, especially in families where the patient has experienced episodes of severe hypoglycemia associated with seizure and/or unconsciousness (Clarke, Gonder-Frederick, Snyder, & Cox, 1998; Gonder-Frederick, Cox, Kovatchev, Julian, & Clarke, 1997). In fact, family members exhibited even higher levels of fear than those reported by adults living with T1DM, possibly because parents, spouses, and other family members have a perceived lack of control over these traumatic events, yet, at the same time, have a perceived sense of responsibility because they often must provide emergency treatment. Spouses of patients who experience recurrent episodes of severe hypoglycemia also have reported increased levels of worry and distress, diabetes-related marital conflict, and sleep disruptions secondary to concerns about nocturnal episodes (Stahl, Berger, Schaechinger, & Cox, 1998; Gonder-Frederick, Cox, Kovatchev, et al., 1997).

### Clinical Applications and Interventions

Over the past decade, behavioral scientists have tested a variety of different treatment approaches to reducing individual, social-familial, and environmental barriers that interfere with optimal self-management, clinical outcome, and QOL (see Figure 1). Many

of these have been shown to be effective, and there is now substantive evidence that psychobehavioral interventions can have a positive impact on physical and emotional well-being for people living with diabetes. Furthermore, a recent review of the efficacy of behavioral interventions in adolescents with T1DM demonstrated that treatments derived from a sound psychological theoretical base were more beneficial (Hampson et al., 2000). This section summarizes studies of a number of diverse therapies designed to intervene at either the individual or the family level to improve adjustment, coping, treatment behaviors, and diabetes control. It also examines efforts to develop more user-friendly and cost-effective psychobehavioral approaches to intervention and explores the need for a public health approach as well as for changes in health delivery systems to optimize diabetes management and prevention.

### *Individual Characteristics*

Several interventions appear to be effective in improving individual patients' coping, psychosocial status, and self-treatment in both pediatric and adult populations. In adolescents, coping-skills training and stress management programs can decrease diabetes-related stress, enhance social interactions and QOL, and improve metabolic control (Boardway, Delamater, Tomakowsky, & Gutai, 1993; Grey, Boland, Davidson, et al., 1998; Mendez & Belendez, 1997). Similarly, coping-skills training in adults decreases diabetes-related anxiety and avoidance behaviors, enhances coping ability and emotional well-being, and improves self-care and glycemic control (Rubin, Peyrot, & Saudek, 1989; Zettler, Duran, Waadt, Herschbach, & Strian, 1995). However, it should also be noted that, although many of these benefits are maintained over time, the long-term impact of coping-skills training on lifestyle factors, such as diet and exercise, appears to be minimal (Rubin, Peyrot, & Saudek, 1991). Interventions aimed at enhancing patients' sense of empowerment and diabetes-management skills also benefit adults with T1DM, resulting in improved QOL, self-efficacy, self-care, and metabolic control (R. M. Anderson et al., 1995; Pieber et al., 1995). Similar benefits have been demonstrated in minority and older patients with T2DM (R. M. Anderson, Funnell, Barr, Dedrick, & Davis, 1991; Glasgow et al., 1992).

Behavioral therapies that include goal setting, contracting, reinforcement, and a focus on specific self-care behaviors, such as BG self-testing or foot care, are also associated with improvements in diabetes management and long-term control (B. J. Anderson, Wolf, Burkhart, Cornell, & Bacon, 1989; Delamater et al., 1991; Litzelman et al., 1993). More recent studies have focused on adapting cognitive-behavioral therapies (CBT) for diabetic populations. For example, CBT offers an effective treatment modality for depression in adults with diabetes (Lustman et al., 1998). Currently, researchers in the Netherlands are assessing a brief, group-based CBT intervention that targets diabetes-specific issues (e.g., anxiety about complications and relationship problems) and beliefs about diabetes that present barriers to self-care and QOL (van der Ven, Chatrou, & Snoek, 2000). Preliminary data have shown a decrease in diabetes-related distress, as well as improvements in emotional well-being and metabolic control. In addition, cognitive-analytic therapy addressing psychosocial difficulties that contribute to problems in self-management has been tested in adults with T1DM in poor control, with reported long-term im-

provements in interpersonal relationships and glycemic status (Fosbury, Bosley, Ryle, Sonksen, & Judd, 1997).

One frequent criticism of intervention research is that, even though studies tend to be well-controlled, most have been efficacy trials utilizing small samples tested at single sites (Delamater et al., 2001). One exception to this is blood glucose awareness training (BGAT; Cox et al., 1989), an intervention that incorporates both behavioral and cognitive strategies to improve self-treatment and decision making in adults with T1DM (Gonder-Frederick, Cox, Clarke, & Julian, 2000). BGAT targets specific self-regulatory behaviors, such as recognizing symptoms of extreme glucose levels and identifying treatment decisions that contribute to glucose dysregulation, and its efficacy has been demonstrated in a series of studies conducted at multiple sites in the United States and Europe. BGAT's benefits, which are long lasting, include improved psychosocial status, better ability to recognize BG symptoms, a reduction of hypo- and hyperglycemia, and fewer motor vehicle violations and accidents (Cox et al., 2000, 2001).

Historically, intervention research in T2DM has almost exclusively focused on behavioral weight-loss programs. Although great strides have been made in developing programs that produce significant short-term weight loss over the past decade, efforts to maintain these effects continue to be much less successful (see Jeffery et al., 2000, for a review of this literature). One strategy that appears to be helpful in promoting long-term weight loss is the use of periodic very-low-calorie diets (Williams, Mullen, et al., 1998). Programs integrating behavioral and pharmacological interventions may also be useful, although there is a need for much more research in this area (Hollander et al., 1998) and into the critical role of exercise in maintenance of weight loss. There is continued interest in interventions that incorporate additional psychological strategies into behavioral programs; for example, studies have investigated a technique called *motivational interviewing*, which includes multiple sessions to set personal goals and problem solve (Smith, Heckemeyer, Kratt, & Mason, 1997). However, although the addition of motivational interviewing appears to enhance both compliance and BG control compared with a behavioral intervention, it does not necessarily lead to more weight loss.

Research into lifestyle interventions is going to become increasingly important over the next decade because of the nearly unequivocal evidence that the onset of T2DM can be prevented or delayed in high-risk individuals by changing diet and exercise habits. Studies from Europe and Japan have demonstrated that weight loss and exercise can normalize glucose tolerance and BG control in the early stages of T2DM (Eriksson & Lindgärde, 1991) and reduce the overall incidence of the disease (Pan et al., 1997). In the United States, NIH funded a large-scale longitudinal study of over 3,000 subjects to test the hypothesis that intensive lifestyle intervention, along with oral diabetes medication, reduces the incidence of T2DM in individuals with high fasting BG levels and impaired glucose tolerance (Diabetes Prevention Program Research Group, 1999). However, that project has been scheduled to end in the near future because early evidence so clearly demonstrated the effectiveness of these interventions in preventing diabetes.

Relatively few studies have addressed the potential benefits of systematic psychobehavioral interventions on outcome variables other than weight loss in T2DM. One recent article reviewed 74 controlled studies conducted from 1980 to 1999 that tested inter-



ventions designed to improve diabetes management and control in patients with T2DM (Norris, Engelgau, & Narayan, 2001). Descriptions of these studies indicated that the majority involved little to no intervention beyond didactics and minimal interaction, and only a few utilized psychobehavioral techniques in a systematic manner. Nonetheless, there is ample evidence that self-management training can have significant benefits on treatment outcomes beyond dietary changes, including improvements in knowledge, self-testing, and metabolic control. In addition, Norris et al. (2001) found that interventions that included more collaboration and interaction with the patient were more effective, indicating that behavioral science continues to play an important role in the development of educational programs for T2DM.

Another psychobehavioral intervention that appears promising in T2DM is relaxation training, but this area has been virtually ignored by researchers over the past decade. Early studies from the 1980s indicated that progressive muscle relaxation reduced hyperglycemia and improved glucose tolerance (Lammers, Naliboff, & Straatmeyer, 1984; Surwit & Feinglos, 1983) and that this effect occurred only in patients with T2DM and not those with T1DM (Feinglos, Hastedt, & Surwit, 1987). Research on animal models of T2DM has suggested that glucose levels are highly sensitive to the hyperglycemic effects associated with the neurohormonal responses to stress, such as sympathetic activation. These effects may be especially important for a subgroup of patients who are particularly stress responsive, including those with high trait anxiety or anxiety disorders (Lane, McCorkill, Suzanne, Feinglos, & Surwit, 1993). However, there is also evidence that even T2DM patients without increased anxiety show improvements in BG control when treated with anxiolytic medication, suggesting that neurohormonal stress responses have a direct impact on glucose levels (Lustman et al., 1995). Despite this compelling evidence, no large-scale studies have continued investigating the relationship between the regulation of psychological stress and the regulation of diabetes in T2DM (Surwit & Schneider, 1993).

### *Family Interventions*

The use of family interventions in adults with diabetes has received virtually no empirical attention, with the exception of studies including spouses/partners in weight-loss programs (Wing, Marcus, Epstein, & Salata, 1987). In pediatric populations, the majority of studies have focused on family-based interventions for adolescents (Delamater, 2000). For example, family therapies designed to improve communication, problem solving, and conflict resolution skills can reduce parent-adolescent conflict (Wysocki et al., 2000). Intervention that emphasizes the importance of adolescents and parents sharing responsibility for diabetes management appears to enhance continued parental involvement (B. J. Anderson, Brackett, Ho, & Laffel, 1999). Because habits in diabetes care established early tend to persist over time (Jacobson et al., 1990), several researchers have suggested that programs need to be implemented soon after diagnosis (B. J. Anderson & Brackett, 2000; Skinner, John, & Hampson, 2000). There is some evidence that family-based intervention early in the disease course may improve long-term metabolic control in pediatric patients (B. J. Anderson & Brackett, 2000; Delamater et al., 1990). Intervention may also be most efficacious at other junctures when problems in diabetes

management arise, such as several years after diagnosis (Grey et al., 1995; Kovacs, Goldston, Obrosky, & Iyengar, 1992).

In addition, the epidemic increase in T2DM in pediatric populations presents new challenges. Little is known about effective weight-loss interventions for children and adolescents, although some studies have indicated that those targeting overweight parents as well as youth are needed to maximize success (Epstein, Valoski, Wing, & McCurley, 1996). Because pediatric T2DM is typically diagnosed during adolescence, interventions with demonstrated effectiveness in T1DM are likely to prove useful in addressing such problems as family conflict, poor self-management, and maintenance of parental involvement in diabetes care.

### *Health Care Professionals and Health Care Systems*

Targeting the health care professional for intervention is another strategy to provide patients with more social-environmental support, but only a few studies have addressed this approach in diabetes research over the past decade. For example, providing health care practitioners with training in methods to increase patient empowerment has positive effects on attitudes toward patients with diabetes, but it remains unclear whether these attitudinal changes lead to improvements in clinical practice or medical outcome (R. M. Anderson et al., 1991; G. C. Williams et al., 1998). Simulation training techniques, in which health care practitioners attempt to follow diabetes-management regimens, produce similar positive changes in attitudes toward patients (R. M. Anderson et al., 2000). Even if training in a more patient-centered approach does not lead to improvements in diabetes control, patients appear to benefit in terms of their perceived ability to communicate with health care practitioners, treatment satisfaction, and emotional well-being (Kinmonth, Woodcock, Griffin, Spiegel, & Campbell, 1998). Unfortunately, changing health care delivery systems so that they are more conducive to the successful management of chronic illnesses faces many barriers to implementation in real-world clinical settings. Not the least of these barriers is the pressure exerted by managed care to reimburse for briefer patient contacts (Glasgow et al., 2001).

### *The Need for User-Friendly, Easily Accessible, and Cost-Effective Interventions*

Even though individual, group, and family interventions have clearly demonstrated benefits, it is becoming increasingly clear that providing such treatment to all individuals with diabetes is unrealistic. For this reason, recent efforts have focused on developing interventions with greater potential to have an impact on larger numbers of people, with an emphasis on cost-effectiveness, convenience, and accessibility. One approach to addressing this need is the development of medical-office-based interventions that can be integrated into routine clinic visits (Glasgow & Eakin, 2000). An early demonstration of this approach treated parents and adolescents with T1DM in separate groups that focused on problem-solving skills and increasing self-testing. Eighteen months following intervention, adolescents continued to show improved metabolic control as well as more self-testing with exercise (B. J. Anderson et al., 1989). A subsequent study of adolescents demonstrated that targeted improvements in conflict

resolution and sharing of diabetes management responsibilities were maintained over 1 year (B. J. Anderson et al., 1999).

Researchers have also begun to investigate the feasibility and effectiveness of computer-based interventions to address the need for more user-friendly, easily accessible interventions. For example, recent studies have tested a program that incorporates a computerized assessment, completed at the clinic just prior to routine appointments, that generates a list of specific, individually tailored goals and motivational information. Patients review these assessment results with a diabetes educator who helps them develop behavioral strategies for accomplishing goals. This intervention, which targets dietary management in patients with T2DM, has resulted in improved eating behaviors and reduced serum cholesterol levels that are maintained for at least 1 year (Glasgow, Toobert, Hampson, & Noell, 1995; Glasgow et al., 1997).

Another effort in this arena is the adaptation of BGAT into a computerized home-study program, which is currently being tested. With the rapid rise in access to personal computers and the Internet and the expanding use of this technology to provide health information, we expect to see a dramatic increase in the development of computer-based interventions over the next decade. The feasibility of these interventions was recently demonstrated in a study showing that 60% of patients with T2DM were willing to participate in an Internet-based diabetes management program (Fell, Glasgow, Boles & McKay, 2000). Those patients who were willing or not willing to participate did not differ in gender or computer-familiarity; however younger patients and those more recently diagnosed were more often interested in Internet-based intervention.

### *A Public Health Approach to Diabetes Intervention*

The need for brief, pragmatic, and user-friendly strategies to improve outcome in diabetic populations presents challenges for psychologists, who have typically been trained to approach intervention from an individual or small-group perspective (Glasgow et al., 2001). In contrast, the public health approach aims to disseminate interventions that are cost-effective and involve minimal effort to large numbers of patients, often accomplishing this by using health care personnel who are not licensed mental health providers to implement programs. The need to adopt a public health approach has been advocated in the areas of diet and exercise (Wing et al., 2001) to combat the increasing prevalence of both obesity and T2DM that is occurring in both pediatric and adult populations. A public health approach will no doubt be needed in the effort to prevent T2DM in high-risk populations through diet and exercise changes. In our contemporary society, easy access to high-fat large-portion meals (e.g., fast or convenience foods) is far more common than access to healthy food, which is also typically more expensive. As the population spends increased amounts of time engaging in sedentary activities, such as watching television and using computers, the availability of convenient ways to obtain adequate exercise is decreasing. Over the next decade, there will be a growing need to develop creative public and community-oriented interventions that provide increased opportunities and incentives for people to engage in healthier eating and more physical activity.

### Conclusions and Future Directions

To appreciate fully the role of psychology in contemporary models and management of diabetes, one should remember that the *first* effort to bring together experts from behavioral medicine and diabetology occurred just over 20 years ago, when NIH sponsored the Behavioral and Psychosocial Issues in Diabetes conference in 1979 (Hamburg, Lipsett, Inoff, & Drash, 1979). This interdisciplinary gathering concluded that incorporating behavioral science was essential to achieve a more comprehensive understanding of diabetes and called for new sources of federal research funding to facilitate this participation. Clearly, psychologists have “come a long way” in the 2 decades following that first conference. However, researchers and clinicians also remain acutely aware of the enormous gaps that exist between these past accomplishments and the current and future needs in the treatment and prevention of diabetes.

One of the largest of these gaps is the inability to translate our current body of knowledge into practical, beneficial, and cost-effective interventions that improve patients’ ability to cope emotionally and behaviorally with the demands of diabetes. This effort will require not only larger scale and multisite studies to demonstrate the utility of effective interventions in real-world settings but also a significant shift in how psychologists think about behavioral and psychosocial treatment modalities. The role of behavioral medicine is likely to change dramatically over the next decade, with more emphasis on the development of briefer, highly accessible, and more pragmatic interventions, many of which will need to be implemented by nonpsychologists in medical settings. This shift will likely be accompanied by other changes in the role of psychologists, from direct delivery of treatments to providing training and supervision for other health care professionals, such as diabetes educators and nurses, who are responsible for assessment and intervention.

The application of psychobehavioral interventions into routine diabetes treatment has been greatly hindered by the widespread tendency to conduct single, small-sample clinical trials. This has prevented behavioral scientists from answering important questions, such as which interventions (or techniques) are most effective and for which patient groups? Research also needs to take a more specific, less global perspective over the next decade, focusing on discrete problem areas and patient populations. Researchers do not know, for example, whether programs that are effective for reducing emotional distress and establishing positive self-management habits soon after initial diagnosis will have equivalent benefits for patients experiencing burnout after years of coping with the illness. Interventions to help patients cope with and adjust optimally to long-term complications are nonexistent, and little is known about the psychological needs of these populations. The development of such targeted interventions depends on a comprehensive understanding of the coping process and changes in self-care across time in different populations, and this will require large-scale, longitudinal, prospective investigations of patient populations not yet studied in this manner, including adults with T1DM and T2DM, youngsters with T2DM, and the elderly.

Somewhat surprisingly, the past decade has seen little growth in research focusing on the psychosocial and behavioral aspects of T2DM, even though more than 80% of patients have this form of diabetes. Perhaps psychologists and behavioral scientists, like their

medical counterparts, have held the misconception that T2DM is a less serious disease than T1DM and less difficult to manage and that psychobehavioral factors, other than those related to weight loss, are less important for this patient group. Because of the rising prevalence of T2DM in all age groups, and the increasing appreciation for its impact on morbidity, health cost burden, and premature mortality, there is a critical need for interventions that improve outcome for this large population. The need for culturally sensitive interventions is also urgent, given the disproportionate number of minorities affected by T2DM and the growing evidence that minority children with T1DM face significant social and financial barriers to positive medical outcome.

Although it is not possible to predict every development and new direction that will emerge in the partnership between psychology and diabetes management over the next decade, there are clear signs that a broader, more systems-oriented approach will become increasingly important.

Much more effort is needed to find ways to integrate the model of chronic disease management into our health care system, including training health care practitioners in how to implement this model in clinical settings. Psychologists and behavioral scientists are just beginning to play a prominent role in diabetes prevention and genetic risk screening, exciting new areas for research over the next several years (Fisher et al., 2002; Wing et al., 2001). In addition, the ongoing interplay between technological advancements and humanistic factors in diabetes treatment will continue to present future challenges. For example, devices that provide continuous BG monitoring by measuring glucose levels in interstitial tissue will soon become widely available, and although such advances may make diabetes more easily managed from a technological perspective, their psychosocial and behavioral implications are unknown. From a psychobehavioral perspective, it is not difficult to imagine that some patients may not entirely welcome a device that constantly reminds them of their diabetes and is always visible to others. Regardless of future technologies, scientists and practitioners in behavioral medicine will continue to play an integral role as long as successful diabetes management remains dependent on the complex interplay between emotional, cognitive, and social processes that determine human behavior.

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