

Evaluating Diabetes Education

Are we measuring the most important outcomes?

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This article reviews the published literature on diabetes education evaluations and makes recommendations for outcome measures to be used in future research. We conclude that program evaluations to date have focused too narrowly on assessing knowledge and GHb outcomes to the exclusion of other important variables. To reflect the changing emphasis and conceptual basis of diabetes education, we recommend that future evaluations do the following: 1) report on the program's target population, recruitment methods, and representativeness of participants; 2) collect measures of self-efficacy and patient-provider interaction; 3) include quality of life and patient-functioning outcomes; and 4) use more standardized and objective measures of diabetes management behaviors. We close by providing practical examples of feasible collection measures for most settings and references to studies that have done so.

More than 100 evaluations of diabetes education have been published, and there are probably more than twice that number of dissertations, masters theses, and unpublished reports on this topic. Provocative debates on the efficacy and cost-effectiveness of diabetes education have appeared (1,2). These issues are especially important, given the current crisis in health care reimbursement and financing, and increasing national emphasis on medical outcomes research. Useful meta-analyses of the results of diabetes education programs have been published (3,4), and

these reviewers have concluded, as does Peyrot (5), that, in general, diabetes education is effective. Even these much needed reviews have not been able to provide conclusive answers to several important questions about diabetes education, such as the classic outcome research issue: "What treatment, by whom, is most effective for this individual with that specific problem, under which set of circumstances, and how does it occur (6)" . . . to which we might add: and how cost-effective is it?

A major reason for the lack of consensus on the value of diabetes edu-

cation is that data relevant to many key issues typically are not available. The thesis of this article is that evaluations of diabetes education have been too narrowly focused and have not assessed the most important outcomes. To our knowledge, no thorough review of measures for use in evaluating diabetes self-management programs has been conducted since the classic report by the Rand Corporation in 1979 (7). This article attempts to fill this void and to substantiate the above thesis.

Using the published studies reviewed in Brown's recent meta-analysis as a basis (3), we discuss the frequency of use and quality of the measures that have been collected within each of six conceptual categories: 1) environmental and social context of a program, 2) characteristics of participants, 3) process and mediating variables, 4) diabetes management, 5) short-term health outcomes, and 6) long-term health outcomes. We then discuss what these studies have measured thoroughly, and what they have not, and provide examples of model studies within each of the above categories. Evaluations of diabetes education range from tightly controlled, and often highly selective clinical research trials to broad scale, often uncontrolled program evaluations of ongoing programs. This article and the Brown review include both types of evaluations. It is acknowledged that most of the measures recommended come from the research end of this continuum. Part of the purpose of this article is to identify measures that are feasible to use in both settings. In conclusion, we note the complexity of the challenges inherent in evaluating diabetes education and make recommendations for future research.

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RECEIVED FOR PUBLICATION 26 AUGUST 1991 AND ACCEPTED IN REVISED FORM 20 APRIL 1992.

DCCT, DIABETES CONTROL AND COMPLICATIONS TRIAL.

THIS ARTICLE IS ONE OF A SERIES PRESENTED AT THE MEETING ON THE BEHAVIORAL ASPECTS OF DIABETES MELLITUS.

REVIEW OF THE RESEARCH

Outcome measures for a diabetes education program can be conceptualized along a temporal continuum, ranging from those associated with initial contact with potential participants

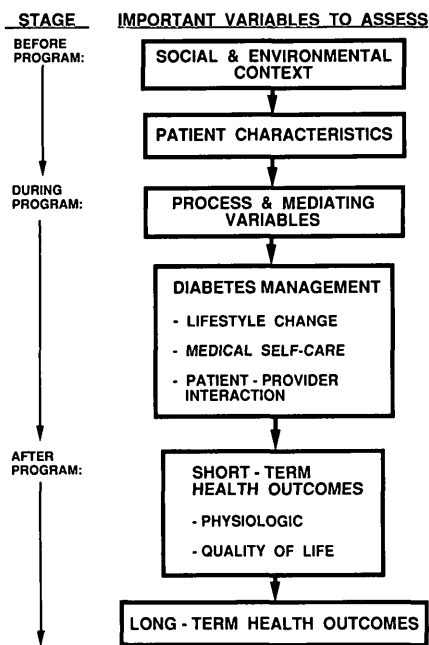


Figure 1—Temporal sequence of program results.

to follow-up status many years after the program (Fig. 1). The first two categories of social-environmental context in which a program occurs and characteristics of participants usually are not considered outcomes. However, these factors provide important information about the public health impact of an education program and provide a context within which to interpret other program results. During a program, participants presumably change through improvement in underlying process or mediating variables, such as knowledge or self-efficacy. These changes are then (imperfectly) translated into improvements in one or more areas of diabetes management behavior, as listed in Fig. 1. Finally, the program produces both short- and long-term health outcomes. A comprehensive evaluation would assess results at each of these stages. Given real-world time and budgetary constraints, one might expect studies to focus assessment efforts on the results most central to the particular type of education program being studied.

Studies often include, however, only a single measure in each of two categories: a measure of patient knowledge in the process/mediating variable category and a measure of GHb in the short-term health outcomes category. We recommend that greater attention be focused on assessing outcomes in all results categories, especially characteristics of participants and long-term health outcomes; and collecting objective, standardized, specific, and, if possible, multiple measures within each category.

Table 1 expands the six categories outlined above by listing the types of variables within each of them. Asterisks indicate variables that have been under-researched. The following sections

briefly review the status of research within each of these categories.

Social and environmental context

Diabetes education does not occur in a vacuum. We hypothesize that much of the variance in the outcomes of diabetes education programs eventually can be understood by careful analyses of social-environmental factors (8,9). In Table 1, most of the measures listed in this category have asterisks, indicating that they have been underresearched.

Substantial literature on the relationship of social support (especially from family members) to diabetes adherence, psychosocial adjustment, and glycemic control is available (10,11). But

Table 1—Relevant variables within each assessment category

ENVIRONMENTAL AND SOCIAL CONTEXT	DEMOGRAPHICS, MEDICAL HISTORY
SOCIAL SUPPORT	COGNITIVE FUNCTIONING/IMPAIRMENT*
LIVING SITUATION	COMORBIDITY*
HEALTH INSURANCE STATUS*	PARTICIPATION RATE**
PRACTICES OF CLINIC OR ORGANIZATION*	REPRESENTATIVENESS OF PARTICIPANTS**
TIME, COST, AND LOCATION OF MEETINGS*	ATTRITION RATE*
COMMUNITY RESOURCES TO SUPPORT DIABETES CARE**	REPRESENTATIVENESS OF FINAL SAMPLE*
PROCESS AND MEDIATING VARIABLES	DIABETES MANAGEMENT
KNOWLEDGE	LIFESTYLE CHANGE
ATTITUDES	DIETARY INTAKE
SELF-EFFICACY OR SENSE OF CONTROL*	EATING BEHAVIOR*
HEALTH BELIEFS	EXERCISE
PERSONAL MODELS*	MEDICAL SELF-CARE
PROBLEM-SOLVING OR COPING SKILLS*	GLUCOSE TESTING
INTENTIONS	MEDICATION ADHERENCE
SOCIAL SUPPORT	INSULIN SELF-REGULATION*
SHORT-TERM HEALTH OUTCOMES	FOOT CARE AND SAFETY
GHb	PATIENT-PROVIDER INTERACTION**
BLOOD GLUCOSE VARIABILITY*	PATIENT ACTIVITY LEVEL*
HYPOLYCEMIC EPISODES*	DEGREE OF PATIENT-PROVIDER CONGRUENCE
CHOLESTEROL LEVEL*	LONG-TERM HEALTH OUTCOMES
BLOOD PRESSURE	COMPLICATIONS*
SMOKING*	RETINOPATHY/IMPAIRED VISION*
WEIGHT	NEUROPATHY*
QUALITY OF LIFE**	RENAL FAILURE
FUNCTIONAL LIMITATIONS*	SEXUAL DYSFUNCTION*
PSYCHOLOGICAL*	STROKE*
PATIENT CHARACTERISTICS	MORTALITY*
TARGET POPULATION	DIABETES-RELATED
	ALL CAUSES
	COST-EFFECTIVENESS**

* Variables that have not been studied sufficiently.

** Variables that have been studied even less often—and that are particularly important to assess.

such measures seldom have been used in evaluations of diabetes education. Social support measures seem particularly appropriate for older persons, many of whom may be isolated socially or may live alone.

It is likely that health insurance status has a large impact on diabetes education. The extent to which third parties will reimburse education activities has a major influence on whether patients will participate in a given program.

We posit that organizational attributes, program logistics, and level of support resources in the surrounding community also will have major effects on whether patients will participate in a diabetes education program and, if so, on how much they will benefit from it. To consider an extreme example, on one end of the scale would be a program conducted at a state of the art clinic in a community that offers several diabetes support groups, many smoke-free restaurants and public meeting places, abundant senior citizens' activities, free community recreation facilities and well-maintained walking/jogging paths, and ongoing low-cost nutrition education opportunities. On the other end of the scale would be a program conducted in a poor, isolated rural community served by an understaffed clinic. Even if it were possible to control for program content and quality, long-term patient outcomes are likely to be quite different in these two settings because of the different levels of socioeconomic status and environmental support for life-style change.

In particular, diabetes research could benefit from increased attention to the organizational practices of the clinic in which diabetes education takes place (8). Issues that could be addressed include: 1) average amount of time patients spend in the waiting room; 2) quality of nonprogram staff communication with patients regarding diabetes education; 3) whether the patient's individual goals and achievements in the program are included in his or her medical record; 4) degree of staff follow-up with patients

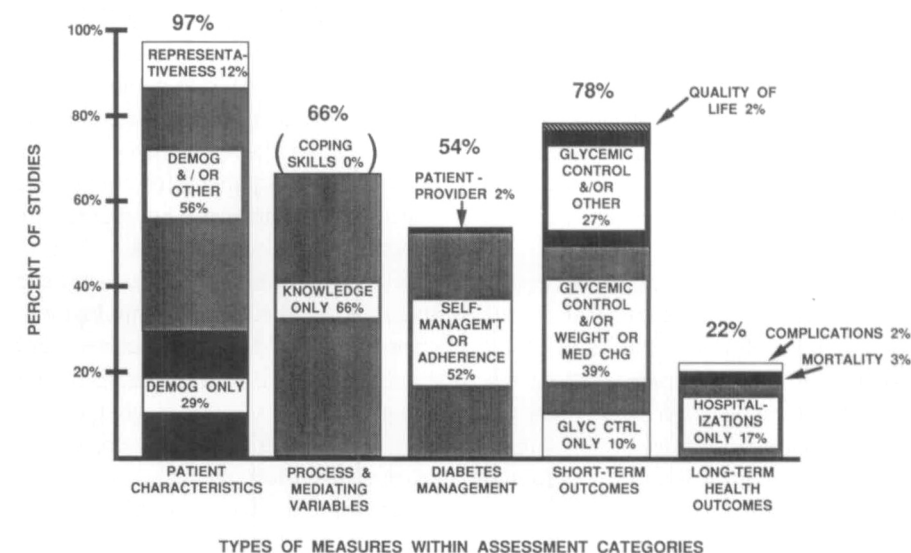


Figure 2—Percentage of studies in Brown's (3) meta-analysis reporting on different variables.

after program completion; and 5) level of liaison between the education program and physician offices, the local American Diabetes Association, and area hospitals.

Patient characteristics: who are we talking about?

Six of the eight types of measures under the patient characteristics category in Table 1 have asterisks, indicating that they have seldom been reported. The bar chart in Figure 2 summarizes visually the percentage of published studies included in Brown's 1990 meta-analytic review (3) that reported various types of outcome measures.

The only patient characteristics reported with any regularity were demographic and medical characteristics of the final sample (90% of studies) (Fig. 2). The target population from which these individuals were selected was described much less frequently (22%). One key medical/psychological patient characteristic that has not been reported often enough is cognitive functioning. Level of cognitive functioning or impairment can impact strongly the extent to which patients are able to process information and benefit from education. Such measures are particularly important in

working with insulin-dependent patients who have had diabetes for some time and older patients who may be suffering from mild dementia.

The rate of participation among eligible patients often is not reported (27%), and characteristics of those electing versus declining to participate are seldom available (3% of studies). Without such data, it is difficult to draw inferences about the generalizability of results (12). When studying relatively intensive programs that are time consuming or expensive, data on participation rate, representativeness of those who participate, and recruitment methods are particularly critical. Without such information, diabetes education programs are vulnerable to the criticism leveled against many health promotion activities that those who participate are those who need it the least.

Bradley (13) has offered the provocative argument that randomized clinical trials produce a resulting patient sample that is unrepresentative. Her basic contention is that, because of informed consent procedures, only patients who are interested in receiving a new experimental treatment will participate in randomized controlled trials.

When combined with a failure to report on representativeness (or even the recruitment methods used to reach participants), this argument offers a compelling indictment of the generalizability of much diabetes education and clinical trials research in most other areas of medicine.

The last two types of patient characteristic measures are attrition rates (reported in 54% of studies) and characteristics of drop-outs versus those who completed the program (8%). These data are especially important in evaluation of long-term results. It is dangerous to draw conclusions when either attrition rates or characteristics of patients differ between intervention and control conditions.

In addition, program results would be better understood if greater attention were given to barriers to participation experienced by nonparticipants and barriers to follow-through on educational recommendations experienced by participants (14), and characteristics of patients who do well in a program versus those who do not.

Overall, measures of social-environmental context and representativeness have been reported infrequently. We must better understand both the social context and the characteristics of our samples, because these variables provide the perspective from which to interpret other results.

Process/mediating variables: too much ado about knowledge

Diabetes education researchers often collect process measures. The range and focus of these measures, however, have been relatively restricted. Many studies have adopted a knowledge-attitude-behavior measurement framework. This model of imparting knowledge and expecting to see corresponding changes in attitudes and overt behavior is incomplete at best. Numerous studies have found that knowledge either is not or is only weakly associated with other outcomes (15–17). Although studies of how knowledge and beliefs relate to di-

abetes self-management have some benefits, this information has been gained at the expense of excluding other potentially important mechanisms of change. Currently, we do not know if the skills being taught to patients in current diabetes self-management programs contribute to their health status.

As indicated in Table 1 and conspicuous by their absence in Figure 2, changes in self-efficacy/perceived sense of control (18,19) or problem-solving/coping skills (20,21) associated with diabetes outcomes have received little research attention. It is important to differentiate between problem-solving skills and mechanical skills, such as glucose testing and insulin injecting techniques, weighing food portions, and clipping toe nails. Mechanical skill outcomes were reported in 22% of the studies. Although ~66% of the published studies reviewed by Brown (3) reported on improvements in knowledge (Fig. 2), none reported on coping skills or self-efficacy—variables currently assumed by many theoreticians (22,23) to be critical mediators of behavior change. Like Johnson et al. (20), we recommend that patient-knowledge measures assess practical, applied skills, such as making appropriate food choices or adjusting insulin dosage, rather than knowledge of abstract concepts, such as pancreatic function, which are far removed from what patients need to do to take care of their diabetes.

With the current shift to considering empowerment as a framework for diabetes education (24,25), measurement of this construct and related variables, such as self-efficacy or perceived control, becomes correspondingly more important. Similarly, social learning-oriented education programs emphasize training patients in problem-solving, coping skills, and relapse prevention techniques, but seldom measure change in these presumed mediating variables. To better understand how diabetes education works (or why it does not work), we need more and better measurement

of such hypothesized mechanisms (26). Table 1 lists some of the most frequently discussed explanatory variables in the diabetes education literature. The particular process measure(s) collected in a given study need to reflect the putative theoretical mechanism(s) of change behind a program.

Diabetes management: semantics, subjectivity, and specificity

Many measures have been collected in this area, but the global, retrospective, unvalidated self-report instruments often used have not been particularly helpful in understanding patient outcomes. The term diabetes management is used to refer to a broad class of patient behaviors involved in controlling one's diabetes. As listed in Table 1, this includes lifestyle behaviors, such as diet and exercise patterns; medical self-care activities, such as glucose testing and insulin self-regulation; and patient-health care provider interaction, such as making requests of and clarifying information provided by physicians and educators. The first two categories frequently are lumped together and variously have been referred to as compliance (27), adherence (15,28), diabetes self-care (29), self-management (30), and self-regulation (31). Choosing which of these conceptualizations to adopt and related decisions concerning patient education goals and evaluation measures can have major philosophical and practical implications (32).

Space limitations preclude discussion of the rationale behind, and sometimes subtle distinctions among, these concepts. Johnson (33) reviews issues of diabetes adherence more thoroughly, but key issues in the assessment of diabetes self-care include the need to: 1) use multiple measures and/or assess adherence at multiple points in time (because of the limited reliability of any one measure); 2) use more objective and unobtrusive measures of adherence (31) to alleviate problems of self-report data; and 3) develop and use standardized, validated measures of self-care (28) to

make comparisons across studies more feasible. The current state of the art is at variance with these recommendations. Only 54% of the studies reviewed by Brown (3) reported on any measure of diabetes management. Twenty-five percent of the studies used retrospective self-report measures and 32% included self-monitoring or behavioral self-observation diary measures. Only 20% included an objective measure of adherence/self-care, and only 17% included multiple measures.

One important point that bears directly on assessment of diabetes education programs is the consistent finding that diabetes adherence or self-care is a multidimensional construct. Most studies, and especially those using more objective measures of adherence, find that a patient's level of self-care in one area of the regimen often is associated only loosely with or is unrelated to their degree of adherence to other regimen areas (34–37). This has been demonstrated most recently by Rubin et al. (38), who reported differential effects of diabetes education on lifestyle (e.g., diet and exercise) and medical self-care (e.g., glucose testing, insulin regulation) aspects of the regimen.

A final, underrepresented area of diabetes management behavior is patient-provider interactions (39–41). As indicated in Figure 2, only 1 of 59 studies included a measure of such interactions. Greenfield et al. (42) demonstrated that even a very brief intervention focused on training patients to be more active and assertive in interactions with their physician produced significant improvements in glucose control and quality of life. These issues are discussed in greater detail by Kaplan (43). Two points to consider are that objective measures of patient-provider interaction, such as audio recordings, can be collected with little or no additional cost to patients or providers; and diabetes patients may have interactions with a variety of health care providers (e.g., diabetes educators, dietitians, social workers, psychologists,

nurses) in addition to physicians, and these interactions are also important to assess.

Short-term health outcomes: what's important?

Diabetes education researchers have evaluated some short-term health outcomes systematically, notably glycemic control, but excluded other, arguably even more important, health outcomes, such as patient functioning and quality of life. Almost all of the short-term health outcomes listed in Table 1, with the exception of GHb and weight, have asterisks indicating that they have been assessed infrequently.

Several important physiological outcomes in addition to GHb should be noted; however, only GHb (53% of all studies and 67% of reports since 1985), mean blood glucose levels (50%), and weight (59%) have been reported in $\geq 50\%$ of diabetes education studies. In terms of metabolic control, reduction in the variability in blood glucose levels or number of hypoglycemic episodes (reported in 37% of studies) may be critically important outcomes in addition to mean level of blood glucose, as indexed by GHb or fructosamine (44). For example, a clinically significant reduction in insulin reactions or episodes of diabetic ketoacidosis could occur, even in the absence of change in mean level of GHb. This is especially true of patients on multiple or high doses of insulin.

Given the increased risk of persons with diabetes to develop cardiovascular disease, it is surprising that few studies (27%) report outcomes on coronary heart disease risk factors, such as cholesterol, blood pressure, or smoking status. These measures are collected routinely in many medical offices. We recommend that they be reported routinely in diabetes education studies to better evaluate patients' overall medical status rather than just their GHb levels. In our experience, clinical decisions often are based on these other risk factors rather than GHb in isolation. It is particularly

curious, given the wealth of information on behavioral management of smoking in medical settings (45), that smoking status is seldom reported or an intervention target in diabetes education studies.

Probably the most serious deficit of diabetes education research to date has been the failure to assess the impact on patient functioning and quality of life. Few studies have assessed quality of life outcomes (42,46,47). Only 1 of the 59 published studies included in Brown's (3) meta-analysis reported on a quality of life-related outcome. Although quality of life is admittedly a complex (D.A. Revicki and C. Underwood, unpublished observations) and partially subjective construct (48), practical and well-validated measures of patient functioning and quality of life exist that easily could be included in diabetes education studies. One possibility would be to include both a general measure, such as the Medical Outcome Study general health survey (49) or the Bush/Kaplan "Well Years of Life" assessment interview (50), and a diabetes-specific measure, such as the scale developed by the DCCT (46).

In a thought-provoking article, Kaplan (51) carried the quality-of-life-versus-metabolic-outcome-measures argument a step further. He makes a strong case that biological variables are important only to the extent that they predict (or are associated with) impact on key patient behaviors and long-term outcomes such as physical and social functioning, hospitalization, and mortality. Related to this point, Davis et al. (52) reported data showing that, in a prospective epidemiological study, GHb levels were less predictive of survival than were variables such as social impact of diabetes, complexity of diet regimen, and smoking status.

Long-term health outcomes: the bottom line

The final category of measures is long-term health outcomes. For understand-

able reasons, only 22% of the studies reviewed included any such measures (Fig. 2). The majority of these studies have been conducted in Europe—American researchers have seldom reported any measures of long-term outcomes—and the most commonly reported long-term outcome has been frequency of hospitalizations. As Kaplan and Davis (1) have argued, to defend the value of diabetes education in view of the current health care funding crisis, and in this era of limited resources and medical outcomes research, we need stronger data than are currently available.

One set of important long-term measures is indexes of diabetes complications, such as those listed in Table 1. D.A. Revicki and C. Underwood (unpublished observations) have documented the effects of such complications on patient quality of life convincingly. The ultimate bottom line is, of course, mortality rate. We might learn from our colleagues in cardiovascular research to distinguish between and assess both diabetes-related mortality and all-cause mortality rates.

Assessment of complications and mortality, although conceptually important, is beyond the scope of most diabetes education studies. To definitively answer such questions, large sample sizes and/or years of long-term follow-ups are necessary. With the exception of the DCCT (53), such studies seldom have been funded in the diabetes area.

An important bottom-line outcome that can be collected in most programs, however, is cost-effectiveness. The effectiveness index will vary across studies, but will be based on the study's most important and longest term outcome measures. Only one study in the Brown review (3) reported a true cost-effectiveness measure, and two others (3%) reported the dollar costs of their program. Admittedly, it can be difficult to calculate costs accurately; and it usually is preferable to do so both from various perspectives, such as program development, replication, and societal perspectives (54,55). Sensitivity analyses

can be performed to evaluate the impact of different assumptions on the resulting cost-effectiveness ratios (55). Use of consistent procedures across studies to estimate costs could provide a useful way of comparing different educational programs, because cost often is a real-world determinant of whether a given program will be adopted.

DISCUSSION — The bar chart in Figure 2 provides a concise way to represent the current state of the art. Although slightly dated, because it includes only published studies available to Brown for her 1990 review, it probably overestimates the comprehensiveness of outcome measures. This is because we limited our review to published studies, which generally are of higher methodological quality than unpublished articles.

As seen in Fig. 2, diabetes education research has consistently reported on three outcomes: 1) demographic characteristics of the final sample participating in our studies, 2) changes in knowledge, and 3) GHb or mean levels of blood glucose. Less apparent in Figure 2 are the measures missing from most published reports, including 1) representativeness of participants (only 12% of studies); 2) coping skills and problem-solving abilities; 3) objective, multiple measures of adherence to specific aspects of the regimen (although just over 50% of the studies reported a self-management measure, the majority of these were idiosyncratic, unvalidated, global self-report measures); 4) patient-provider interaction outcomes; and 5) a broader range of health outcomes, such as variability in glucose levels, cardiovascular risk factors, cost-effectiveness, number of hospitalizations, and diabetes complications. Of particular concern is that only a single study in the sample reported a measure related to quality of life.

Complexity

It is a considerable challenge to evaluate diabetes education programs thoroughly. To meet this challenge, we must move

beyond the incomplete model of patient education represented by the diagram below. Not many present day educators would endorse such a simplistic conceptual model. Current programs have shifted to self-management skills training (30,31) or patient-empowerment (24, 25) approaches. Unfortunately, the schematic below accurately represents the measurement approach still used by many studies—one that fails to reflect current educational content:

Impart knowledge ---> Change beliefs (and behavior) --> Improvement in GHb

Instead, we must examine the many other social, environmental, and process factors, and their interrelationships involved in determining the outcomes of diabetes education. Recent theories, such as Green's PRECEDE model (56) and Ewart's social action theory (9), include such factors in their general framework. Figure 3, which is still an oversimplified representation, outlines such a model specific to diabetes education. It presents the six categories of measures discussed in this paper and their interrelationships. It also introduces an additional category of program characteristics. As indicated, program characteristics often have a major influence on process variables. For example, a program that includes family members, a large amount of group interaction, and shared exercise sessions will more likely produce improvements in social support measures. Other important features of Figure 3 are that it visually represents the centrality of diabetes management behaviors (including patient-provider interactions), presents quality of life and long-term health outcomes (rather than short-term changes in GHb) as the ultimate criteria of program success, and indicates primary (solid arrows), secondary (dashed arrows), and reciprocal (bidirectional) relationships among the different sets of variables.

This model is presented as a heuristic device to guide thinking about measurement of diabetes-education out-

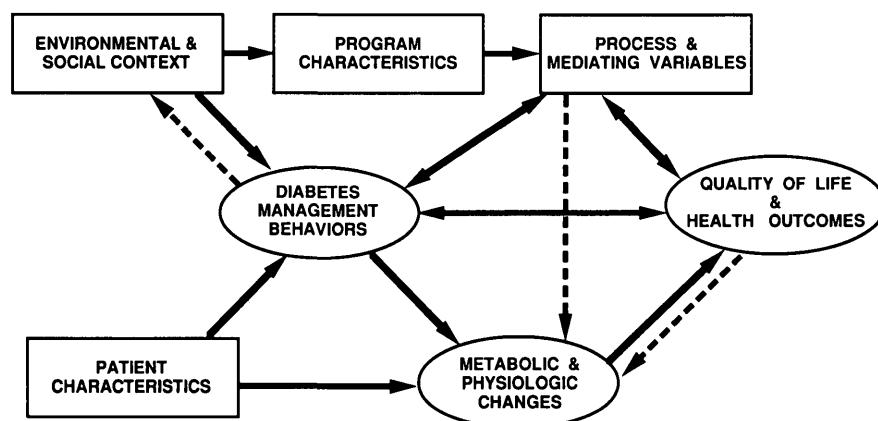


Figure 3—More complete (but still oversimplified) model of diabetes education.

comes, rather than as a definitive structural model. Several additional factors probably could be added, and certainly many additional relationships and pathways could be represented. However, we believe that this figure summarizes the key factors that should be addressed in program evaluations (57).

Feasible recommendations and good examples

Although it is impossible for any one study to assess all of the variables discussed in this article, many of these measures can be incorporated into most settings and would improve the quality of diabetes education research. Table 2 summarizes our recommendations for studies with limited resources. These recommendations are our impressions based on considerations of what is known already and what has been underresearched; and on cost and time factors. At the risk of offending some in the education and biomedical communities, we suggest that if only a few measures can be collected, it would be preferable, given the current state of the literature, to assess the outcomes presented in Table 2 instead of knowledge and GHb outcomes. The particular measures should be tied to the goals, educational content, and presumed underly-

ing intervention processes in a given study.

First, several important variables can be assessed behind the scenes and do not require much, if any, additional time or effort on the part of patients or program-delivery staff. These variables include data on the representativeness of participants (characteristics of participants versus nonparticipants and of drop-outs versus those completing a program); the cost of various components of the program; and patient-provider interac-

tions (which can be audiotaped and coded at a later time by trained coders). Unobtrusive data on both frequency of testing and variability in blood glucose levels are now available from several models of memory glucose analyzers.

It is also feasible to assess several other variables without greatly increasing the time or resources devoted to evaluation. In particular, some measures of self-efficacy and quality of life can be collected in a few minutes. As listed in the right column of Table 2, it is more difficult, but worth the effort, to collect good measures of diabetes self-management (35), cardiovascular risk factors (58,59), predictors of treatment outcome, and cost-effectiveness (17).

The studies cited in the preceding paragraph provide good examples of how to incorporate these measures into a given study. In addition, reports such as those by Anderson et al. (60), Glasgow et al. (61), Kaplan et al. (47), and Wing et al. (59) illustrate how it is possible to assess many of the variables advocated above in a single study. The DCCT study (53) provides an example of what can be done with the additional resources of a multicenter collaborative trial with long-term follow-up. Appendix 1 contains a bibliography of recent articles that discuss key issues, provide examples of practical mea-

Table 2—Feasible variables to measure future research

ASSESSMENT CATEGORY	MEASURES	
	MOST STRONGLY RECOMMENDED	OTHER RECOMMENDATIONS
PATIENT CHARACTERISTICS	REPRESENTATIVENESS OF SAMPLE	VARIABLES PREDICTIVE OF OUTCOME (E.G., COMORBIDITY, SOCIAL SUPPORT)
PROCESS	COPING SKILLS OR SELF-EFFICACY	
DIABETES MANAGEMENT	PATIENT-PROVIDER INTERACTION	INSULIN SELF-ADJUSTMENT
SHORT-TERM HEALTH OUTCOMES	QUALITY OF LIFE	CHOLESTEROL, BLOOD PRESSURE, SMOKING STATUS
LONG-TERM HEALTH OUTCOMES		COST-EFFECTIVENESS

tures, and present good methodological models within each of the six conceptual areas discussed in this paper. Readers are referred to these articles for a more detailed discussion than is possible here.

CONCLUSION — We conclude by echoing the sentiments of other reviewers. Dunn (16) told us that “the simple model of knowledge transfer is inadequate and inconsistent with observed human behavior” and that diabetes education must move beyond knowledge improvement and metabolic control (17). Padgett et al. (4) concluded that the diabetes studies they reviewed had serious limitations, including inadequate descriptions of sample characteristics, neglect of cost-related outcomes, and poor assessment of behavior change. Brown (3) reported in her meta-analysis that “many researchers and clinicians develop their own instruments without determining reliability and validity, particularly when measuring knowledge and self-care.” The consensus seems to be that future studies must broaden the range of outcomes assessed. At the same time, however, the hodgepodge of measures collected within a given category must be limited to a more standard set of efficient, validated instruments.

In summary, we may be on the verge of a modest paradigm shift represented by Kaplan's (51) thesis that behavior, not physiology, should be the primary outcome end point for health education. The past decade also has witnessed a dramatic shift from knowledge-attitude-belief models of diabetes education to a focus on patient-centered perspectives (62), self-efficacy, self-management, and empowerment issues (25). To address this shift, we need to modify our assessment approaches to measure outcomes such as program reach and appeal to different patient populations, patient-provider interactions, quality of life, and cost-effectiveness.

Acknowledgments — This research was supported by Grant DK-35524 from the National Institute of Diabetes, Digestive and Kidney Diseases.

Appreciation is expressed to Drs. Sarah Hampson, Ed Lichtenstein, Kevin McCaul, and Matt Riddle, who provided helpful comments on an earlier draft of this manuscript.

An abbreviated version of this paper was presented at the Satellite Symposium on “Behavioral Aspects of Diabetes Mellitus” as part of the 14th International Diabetes Federation Congress in Williamsburg, Virginia, June 1991.

APPENDIX I — Illustrative studies providing examples of useful and feasible outcome measures for diabetes education

Social and environmental context

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