Relationship Between Diabetes Knowledge, Glycemic Control, and Associated Health Conditions

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■ ABSTRACT

Objective. The purpose of this study was to identify any existing relationship between diabetes knowledge and glycemic control, as well as possible associations with patient health, among patients with type 2 diabetes.

Design and Methods. This qualitative study used a validated multiple-choice test (the Michigan Diabetes Knowledge Test) to assess diabetes knowledge among 17 hospital patients between the ages of 18 and 75 years with type 2 diabetes and a recent (within 3 months) A1C laboratory value. Participants also provided information about their diabetes self-care habits, previous diabetes education, and diabetes-related secondary health conditions.

Results. The average diabetes knowledge score was 8.4 of 14 (60%), and the average A1C was 9.3%. Thirteen participants had previously received diabetes education, whereas four participants had never received diabetes education. The participants who had not received education scored 15.3% lower on the diabetes knowledge test and had an average A1C 0.89% higher than those who had received previous education. Although this difference was not statistically significant, it is clinically relevant. There was a significant association between diabetes knowledge and presence of retinopathy (P = 0.03).

Conclusion. Diabetes self-management education and support is a crucial component of diabetes care. There is a considerable need for diabetes education strategies to improve self-management of diabetes and thereby improve outcomes and decrease the costs of diabetes-related care. There is also a need for efforts to ensure regular vision screenings for individuals with type 2 diabetes.

According to the Centers for Disease Control and Prevention (CDC), 30.3 million Americans (9.4% of the population) had diabetes in 2017; the estimated direct and indirect costs of diabetes in 2012 totaled $245 billion dollars (1). The major contributors to these costs include hospital inpatient care, prescription medications to treat the complications of diabetes, antidiabetic agents, physician office visits, and nursing/residential facility stays. More than one in five health care dollars in the United States go toward individuals with diagnosed diabetes (1). Type 2 diabetes accounts for 90–95% of diagnosed diabetes cases (2). Overweight status is the single largest contributing cause of type 2 diabetes (3). Type 2 diabetes is preventable (3) by means of weight control, physical activity, and a healthy diet and may be delayed or prevented through significant weight loss (4).

Patient education is a crucial and often overlooked component of the diabetes care process. Diabetes is a multifactorial condition that can often be overwhelming and difficult to manage. Individuals diagnosed with diabetes must learn to man-

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age not only their blood glucose, diet, and physical activity, but also medications, foot care, treatment of related conditions such as hypertension, and preventive measures for secondary conditions such as renal failure, neuropathy, and heart disease. A joint position statement from the American Diabetes Association, American Association of Diabetes Educators, and Academy of Nutrition and Dietetics states that there are four critical times to provide diabetes self-management education and support (DSMES): at diagnosis of diabetes; annually to assess education, nutrition, and emotional needs; when there are diabetes-related complications and other factors influencing self-management; and during transitions in care or changes in health status. At least one instructor responsible for planning and designing DSMES must be a nurse, dietitian, pharmacist, certified diabetes educator, or other credentialed health professional (5).

Design and Methods

This descriptive study was reviewed and approved by the institutional review boards of St. Louis University and the Midwest hospital where the study was conducted.

Study Population

Patients aged 18–75 years with a documented diagnosis of type 2 diabetes were recruited from the hospital's dietitian consultations for diabetes. Per hospital protocol, when individuals with diabetes are admitted to the hospital, physicians or nurses order a dietitian consultation. During the consultation, the dietitian evaluates diabetes education needs, provides diabetes-related nutrition education, and establishes a nutrition care plan. Inclusion criteria for this study were new-admission consultations for type 2 diabetes screened for existing recent (within the past 3 months) A1C test results in their medical chart. Patients with recent A1C levels ≥7.0% were invited to participate in the study. A normal A1C level for an

individual without diabetes is ≤5.7%. Prediabetes is indicated by an A1C of 5.7–6.4%. Diabetes is typically diagnosed with an A1C ≥6.5% (6).

A power analysis was performed for multiple linear regression with five predictor variables and one deviant. A sample of ~43 participants was needed to obtain statistical power at the recommended 0.80 level, with an α of 0.05 (7).

Instruments

The study used a subset of the Michigan Diabetes Knowledge Test (MDKT), a validated questionnaire developed by the University of Michigan Diabetes Research and Training Center (8). The original MDKT is a 23-question multiple-choice questionnaire; only the 14 questions that apply to noninsulin-dependent type 2 diabetes were used for this study. Participants also provided information regarding their height, usual weight, and frequency of blood glucose measurement; whether they had ever received diabetes education from a health care professional (HCP) and the discipline of the HCP providing the education; and known presence of any diabetes-related complications such as hypertension, cardiovascular disease, neuropathy, and skin problems. These additional questions were reviewed by a panel of HCPs for content validity before use.

Statistical Analysis

Analyses were performed to determine a possible correlation between MDKT score and A1C level. In addition, possible associations between diabetes knowledge (as measured by the MDKT) and health conditions and complications related to diabetes were also explored using χ^2 correlation and linear regression tests. Data were analyzed using SAS 9.3 (SAS Institute, Cary, N.C.).

Results

A total of 17 participants qualified for and completed the study. Participants reported checking their blood glucose an average of 2.25 times per day, with an average usual blood glucose level of 185 mg/dL. Participants had a mean BMI of 35.4 kg/m², which is classified as class II obesity per CDC guidelines (9). All but one participant reported having secondary health complications related to diabetes. The average MDKT score was 8.4 of 14 (60%), and the average A1C was 9.3% (Table 1). Participants had been diagnosed with type 2 diabetes for an average of 15.1 years, with 13 participants reporting having received previous diabetes education. Of these, eight had received education from an registered dietitian (RD) and five had received education from a registered nurse (RN). Four of the 17 participants had received no previous diabetes education.

The most frequently missed question was question 8 (64.7%), which asked, "Which of four food items (3

TABLE 1. Demographic Characteristics of Participants (*n* = 17)

Sex, *n*	
Female	7
Male	10
Mean weight, lb	239.1
Mean BMI, kg/m²	35.4
Mean blood glucose, mg/dL	185
Mean duration of diabetes, years	15
Mean frequency of blood glucose monitoring, times/day	2.25
Mean A1C, %	9.3
Mean MDKT score, number correct of 14 (%)	8.4 (60)

TABLE 2. Average MDKT Score and A1C Among Participants With and Without Previous Diabetes Education

	Mean MDKT Score, number correct of 14 (%)	Mean A1C, %
Previous diabetes education (n = 13)	8.9 (63.5)	9.09
No previous diabetes education (n = 4)	6.75 (48.2)	9.95

hard candies, ½ cup orange juice, 1 cup diet soft drink, or 1 cup skim milk) should not be used to treat a low blood glucose?" Question 9, which asked, "For a person in good control, what effect does exercise have on blood glucose? (lowers it, raises it, or has no effect)," was the least frequently missed item, with 94.2% of participants correctly answering the question.

Among the participants who had received previous education, the average MDKT score was 8.9 of 14 (63.5%), and the average A1C was 9.09% (Table 2). The average MDKT score of the participants with no previous diabetes education was 6.75 of 14 (48.2%), with an average A1C of 9.95%. There were too few participants with no previous diabetes education to perform statistical analyses.

There was a significant relationship between the occurrence of retinopathy and diabetes knowledge score as measured by the MDKT (P = 0.03). There were no other significant associations between diabetes knowledge score and reported existing secondary conditions. There were no statistical differences in MDKT scores or A1C between participants who received previous diabetes education from an RD and those who received previous diabetes education from an RN.

Discussion

The purpose of this study was to identify any existing relationship between diabetes self-management knowledge and glycemic control and secondary health conditions in hospitalized patients with type 2 diabetes. Nearly one-fourth of the study participants (23.5%) had never received diabetes education. Although this proportion was not as high as the finding that half of individuals with diabetes overall do not receive any structured diabetes education or nutrition therapy (10), it still represents a substantial number, especially considering that participants had a mean duration of diabetes of 15.1 years. Participants with no previous diabetes education scored an average of 15.3% lower on the MDKT than those who had received previous diabetes education and had a mean A1C 0.86% higher than those who had received previous diabetes education.

An Institute of Medicine study found that medical nutrition therapy improves clinical outcomes and has the potential to significantly decrease costs associated with the management of diabetes (10). Similarly, a study of 76 adults with type 2 diabetes found that diabetes self-management education (DSME) improved A1C and body weight, two major factors associated with improved outcomes (11). A 2015 systematic review of DSME and glycemic control found that patient engagement in DSME resulted in a statistically significant decrease in A1C (12). The current study sought to investigate the relationship between diabetes knowledge and glycemic control and possible associations with patient health among hospitalized patients with type 2 diabetes.

It has been shown that providing diabetes education can lead to improved A1C (13), which is associated with reduced onset or advancement of diabetes-related complications, improved quality of life, and decreased presence of diabetes-related distress and depression (5). The only significant relationship found in the present study between a diabetes-related condition and MDKT score was for retinopathy. This is likely because retinopathy and eye health are monitored less than other diabetes-related conditions such as hypertension, kidney disease, and cardiovascular disease. This is consistent with findings from a recent study (14) that only 79% of 4,340 adults with diabetes had ever received an eye examination for diabetic eye disease, and 23% had not received an eye examination within the past year. Furthermore, 65% of ophthalmologists surveyed reported that most patients presented after visual problems had already occurred (14).

We found no significant differences in knowledge scores or A1C levels between participants who had received previous diabetes education from an RD and those who had received such education from an RN. This finding is similar to a meta-analysis that found a significant decrease in A1C when education was delivered by either nurses or dietitians, but no change when physicians delivered the intervention (15).

The continuing rise in type 2 diabetes will increase health care costs and secondary conditions. There is a great need for interventions to improve outcomes associated with type 2 diabetes. A 2015 literature review of DSME for adults with diabetes found that 86% of DSME interventions in 120 studies achieved significant improvements in A1C. Additionally, 61.9% of those interventions attained significant and clinically relevant improvements in A1C in participants who received DSME compared to those who did not (12). A 2017 study in *Medical Care* (16) found that Medicare beneficiaries who had participated in diabetes self-management training had a 14% decrease in risk of any

hospitalizations and $830 lower Medicare expenditures over 1 year compared to those who had not participated in the training program.

Limitations

Limitations to this pilot study include its small sample size. However, despite the small sample size, the study's findings were clinically relevant. There is also the possibility of error due to self-reported variables, including height, weight, and presence of diabetes-related conditions, which were not verified through review of participants' medical charts. Because participants were hospital inpatients, A1C levels may have been increased because of the presence of illness; this possibility was not controlled for in the study.

Conclusion

There is a great need for DSMES services for people with type 2 diabetes to aid in improving health outcomes and decreasing diabetes-related health care costs. The lack of diabetes education and knowledge among many people with type 2 diabetes indicates a need for improved patient education efforts. A 2015 study estimated that 7% of newly diagnosed patients with private insurance and <5% of newly diagnosed patients covered by Medicare participate in DSME (17). Patients who have received diabetes education have a greater chance of improving their blood glucose levels, which in turn could decrease health care costs related to diabetes, as well as the development of diabetes-related complications and secondary conditions such as cardiovascular disease. There is also a need for regular vision screenings to monitor the eye health of people with type 2 diabetes. Greater control of type 2 diabetes can lead to a decrease in medication requirements and hospital visits and improvement in quality of life for patients.

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