This study explored the impact of an intensive educational intervention to patients on their knowledge and understanding of diabetes. This study was a hypothesis-testing, prospective study, with an experimental two-by-two factorial design. The educational programs were offered to physicians only, patients only, or both patients and their physicians. In the fourth arm, neither patients nor their physicians received any education. Patients with uncontrolled diabetes were enrolled in the study. The outcome was the changes in the score of patients on the diabetes knowledge test. The knowledge test was administered at the time of enrollment and every six months thereafter.

The study showed that a total of 622 (75%) patients took the diabetes knowledge test. The mean diabetes knowledge test score increased over time for both insulin and non-insulin users. The mean diabetes knowledge score in patients with patient education only was 11 points higher compared to those in the group of patients and their physicians without education (P=.0104).

The study indicated that patients who are exposed to the educational program end up with better knowledge on all counts, than patients who just go through the health care system in the course of usual care for diabetes. (Ethn Dis. 2011;21(4):485–489)

Key Words: Diabetes, Interventions, Diabetes Knowledge

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INTRODUCTION

Approximately 24 million Americans have diabetes.[1] The Centers for Disease Control and Prevention reports that about 1.6 million new cases of diabetes were diagnosed in people aged ≥20 years in 2007.[1] The burden of diabetes is very high; it is one of the leading causes of death and disability in the United States, including blindness, end-stage kidney disease, and lower limb amputations,[1] and is an independent risk factor for heart disease and stroke. In the absence of a cure for diabetes, the key to good health is control, keeping blood sugar levels along with blood pressure and cholesterol, as close to normal as possible. Good control in the long run may reduce diabetes complications that include damage to blood vessels, eyes, kidneys, and nerves.[1] Most notably, good control of blood sugar levels is largely contingent on proper diet, exercise and physical activity, adherence to medication regimens and regular monitoring.[1] In spite of the high prevalence of diabetes, public awareness of the disease is consistently very low, particularly among at-risk minority populations such as African Americans and Hispanics, even as those populations have the highest prevalence and rate of complications. Lack of awareness together with poor knowledge of diabetes presents a missed opportunity to empower the patients thus precluding an active role for the patient in his/her own diet, physical activity and adherence to medical regimen and clinical monitoring.[1–3] One of the goals of *Healthy People 2010* was to increase the number of people reached with diabetes education from 40% in 1998 to 60% by 2010.[4] Proper management of diabetes is largely predicated on day-to-day decisions made

The education of both the health care professional and the patient is a major element in the successful management of diabetes.[2,5]

by individuals, and unless those individuals have proper knowledge, they cannot make the complex daily medically-related decisions required for good health, quality of life and survival. The results of the landmark Diabetes Control and Complications Trial[3] proved that intensive management of diabetes can significantly improve diabetes outcomes. Specifically, the education of both the health care professional and the patient is a major element in the successful management of diabetes.[2,5]

As in any educational intervention, an important question for diabetes education is whether patients are retaining knowledge. Although knowledge alone does not ensure behavior changes or effective self-management,[6,7] it is a necessary first step. The evaluation of diabetes-related knowledge provides a critical template on which to build customized diabetes education programs and evaluate them.[6,7] This study evaluates the knowledge of diabetes patients in the Baltimore Cardiovascular Partnership Program during a 2-year time-period. We hypothesized that patient's knowledge and understanding of diabetes increased over time with education.

METHODS

We conducted this study within the scope of the Baltimore Cardiovascular

Partnership, a community-university partnership generally aimed at improving communication between research institutions and community. The aim of this study was to improve the management of diabetes, through an enhanced understanding of that disease. Specifically, we examined the impact of an intensive educational intervention to patients on their knowledge and understanding of diabetes.

The general study was designed as a four-arm randomized clinical trial, where the educational programs were offered to physicians only, patients only, both patients and their physicians, or neither. It was conducted at all clinics within the Bon Secours Baltimore Health System; patients were randomly assigned to one of the four arms. The physician intervention was an in-depth series of 90-minute interactive lecture sessions presented every two months. All patients in the study had uncontrolled HbA1c at enrollment. The study was approved by the Ethics Committee at the Bon Secours Hospital and the Bon Secours Baltimore Health System.

This study was a hypothesis-testing, prospective study, with an experimental two-by-two factorial design. Patients were not made aware of whether or not their physicians were receiving the educational intervention, and vice versa.

We enrolled primary care physicians and their patients. Patients were randomized to the patient education group or to the control group, retaining their physician of record. Enrollment was on a rolling basis, over a period of 2.5 years, starting on April 1, 2005. Inclusion criteria included uncontrolled diabetes (HbA1c ≥ 6.5) and the absence of medical conditions or treatments that would preclude standard diabetes drug therapies.

The patient education intervention consisted of up to 30 minutes of personal counseling by the study nurse, at each patient visit, at three months intervals. Topics included weight reduc-

tion, the DASH eating plan, sodium and alcohol reduction, physical activity, and adherence to visits and to medication regimens. Given the naturalistic setting, the counseling sessions were interactive and customized to the patient.

We recorded as the outcome, the score of patients on the diabetes knowledge test, and measured the changes in those scores.

We also collected data on patients including: whether they were in the intervention or the control group, demographics (age, sex and race/ethnicity, and clinical data), chronic medical conditions, smoking status, presence of hypertension, weight, height, and body mass index.

We built a Microsoft Access relational database for the data repository, to provide sufficient functionality for security, patient confidentiality, and data integrity. The HIPAA compliant data, without patient names, were exported to SAS V8 for analysis.

This part of the study was conducted with patients participating in the Baltimore Cardiovascular Partnership Study to reduce Health Disparities, on the Diabetes section. All patients enrolled in the study were from an underserved minority population, fully representative of our community and the catchment area of the Bon Secours Baltimore Health System.

During the enrollment process, a knowledge test was given to both intervention and control patients, providing topics for discussion and serving as a basis for an assessment of the patients' knowledge of their disease. This information was specific to patient-reported barriers to care and treatment adherence in terms of diet, exercise, medication, and overall understanding of disease process and management. Although the control patients were given knowledge tests, they received no further education than what would be provided in the course of usual care.

The tool used for testing patients' knowledge was obtained from the Michigan Diabetes Research and Training Center, and was modified by the principal investigator to complement the type of diabetic patients (insulin vs noninsulin users) in the study. The knowledge test was administered at the time of enrollment and every six months thereafter. The test was given to patients by the research nurse or a research assistant via phone, or in person after an educational session, during one-on-one meetings with the nurse. The test emphasized the patients' understanding of their disease process and management, co-morbidities related to diabetes, and new knowledge acquired. The same test was given to patients in both intervention and control groups. As part of the test modification by the principal investigator, patients were tested on questions related to insulin, depending on whether or not they were insulin dependent. The test was graded based on the answers of the particular group and measured the extent of knowledge gained throughout the process in either control or intervention group.

RESULTS

There were a total of 823 patients enrolled in the study (Table 1). Patients were mostly female (64%), Black (91%), with a mean age of 64 years. At baseline, the mean hemoglobin A1c (HbA1c) level was 8.03 mmol/L and about 36% of patients ($n=293$) had HbA1c levels lower than 7 mmol/L. The mean systolic blood pressure (SBP) was 137 mm Hg and mean diastolic blood pressure (DBP), 77 mm Hg.

Among the 823 patients in the diabetes arm of the study, 75% took the diabetes knowledge test (Table 2). The proportion of patients with repeated test scores at 6 months was about 83%; at 12 months 51%; at 18 months 20%; and at 24 months, 1%. Patients

Table 1. General characteristics of the patient population (N=823)

Characteristic	n (%)
Sex	
Male	293 (35.60)
Race/Ethnicity	
White	56 (6.80)
Black	751 (91.23)
Other	15 (1.82)
Mean age (SD)	64 (13.82)
Mean HbA1c (SD)	8.03 (2.13)
HbA1c control*	293 (35.60)
Mean SBP (SD)	137 (16.65)
Mean DBP (SD)	77 (11.57)
BP control†	432 (52.49)
Insulin users	204 (24.79)
Smokers	157 (19.08)

* Control defined as HbA1c value <7.
† BP measurement <130/80.

were mostly female (65%), Black (91%), with a mean age of 64 years. At baseline, about 40% of patients (n=246) were at HbA1c control levels <7 mmol/L. Approximately 54% of patients (n=332) were at BP control with a reading of <130 mm Hg/ 80 mm Hg.

The mean diabetes knowledge test score increased over time for both insulin and non-insulin users (Table 3).

Table 2. Characteristics of patients with diabetes knowledge test scores (N=622)

Characteristic	n (%)
Knowledge test scores*	
-Baseline only	622 (100)
-6 months follow-up	516 (82.99)
-12 months follow-up	321 (51.61)
-18 months follow-up	122 (19.61)
-24 months follow-up	7 (1.13)
Patient education	320 (51.45)
Physician education	339 (54.50)
HbA1c control	246 (39.55)
BP control	332 (53.55)
Insulin user	204 (32.80)
Male	216 (34.73)
Black	563 (90.51)
Smoke	112 (18.01)
Mean age (SD)	64 (13.6)

* Proportion of patients with knowledge test scores by length of follow-up.

Table 3. Mean diabetes knowledge test score (%) by insulin user status over time

Time	Insulin user (n=204)	Non-insulin user (n=416)
Baseline	36.81±18.34	35.39±20.20
6 months	42.75±20.58	45.61±18.62
12 months	46.39±17.23	48.45±19.14
18 months	50.92±19.49	48.21±19.80
24 months	53.62±23.95	65.63±14.88

mean±SD

At baseline, the mean score for insulin users was about 37% and at the end of 18 months about 51%. The baseline mean score for non-insulin users was about 35% and at the end of 18 months about 48%. Mean values were not reported for 24 months because of small sample size (n=7).

The mean difference in the change of percent knowledge test score comparing insulin and non-insulin users over time (Table 4) was only significant at 6 months of follow-up (P=.0204). The mean difference in the change of knowledge test scores decreased over time from baseline from 5.10 at 6 months to −5.50 at 24 months.

Table 5 shows the adjusted data on the impact of physician and patient education on diabetes knowledge score change at 12 months of followup. Patient education was the only factor statistically significant (P=.0104). Being male, Black, and a smoker had a larger impact on the diabetes knowledge score, than combined physician and patient education, physician education alone, insulin use, BP control and age.

DISCUSSION

Diabetes carries a high mortality and morbidity burden, especially for minorities, people at high risk, and people of low educational and socioeconomic status.[8,9] Given that treatments and management strategies for diabetes have proven to be successful, the missing gap is proper patient empowerment, and the first step is an improvement in knowledge and awareness of the disease and its complications. Indeed one of the barriers to diabetes control is education and awareness,[1–3] in addition to cultural, communication, insurance and other factors.

In this mostly female, African American population, only 40% had controlled diabetes at baseline. Overall, as a result of the education, the knowledge scores improved over the course of the intervention. Interestingly, the baseline knowledge was higher for insulin dependent patients than for those not taking insulin, but the improvement in scores was better for the latter, although both groups did improve. Most of the improvement occurred in the first six

Table 4. Change in percent knowledge test score comparing insulin and non-insulin users by time*

Time	Mean Difference	Std Dev	t	P
6 months – Baseline	5.10	23.27	2.33	.0204
12 months – Baseline	2.71	23.02	1.05	.2971
18 months – Baseline	1.40	22.37	.32	.7520
24 months – Baseline	-5.50	27.60	-.23	.8292

* Total possible score for insulin user is 23 and for non-insulin user is 16. All scores have been normalized by conversion to percent.

Table 5. The impact of patient education on diabetes knowledge score change*

Variable	Parameter	P
Patient and physician education	−5.86	.2751
Patient education	10.67	.0104
Physician education	−1.14	.7564
Insulin user	−2.51	.3711
BP control	−3.82	.1379
Male	2.44	.3907
Age	−.12	.2836
Black	3.63	.4454
Smoker	5.45	.1690

* Change of diabetes knowledge score: 12 month followup score–baseline score. Higher score indicates patients have good diabetes knowledge

months, and although it continued improving beyond six months, it did so at a decreasing rate.

Finally, we tested the independent effect of relevant variables and attributes on score change and found that the single most significant predictor of score improvement was the patient receiving the education program. The additional impact of the physician training sessions did not affect the score change. Similarly, the patients race, age, sex, smoking status, blood pressure or insulin dependency did not independently affect knowledge scores.

We found that patients who were exposed to the educational program finished with better knowledge on all counts than patients who followed usual diabetes care. Education alone can be very effective in improving knowledge, regardless of the patients age, sex, race, smoking, and insulin or hypertension status. This study demonstrates that

We found that patients who were exposed to the educational program finished with better knowledge on all counts than patients who followed usual diabetes care.

patients retain information pertinent to them. This is the first step in an empowerment approach to disease management, putting the patient at the center of hisher care. It is very consistent with national initiatives eg, PCORI, the newly formed Patient Centered Outcomes Research Institute.[10]

The novelty in our approach is that it runs counter to a more patronizing approach to care, typically adopted with patients in underserved populations and those of minority or low socioeconomic and educational status. It shows that patients can be informed consumers, and paves the way for new studies to explore the impact of knowledge on the actual process eg, adherence or clinical outcomes of care such as HbA1c control.

Most importantly, the intervention is very sustainable and can be readily implemented in practice. We suggest securing educators in usual care points of service, thus perpetuating the positive results shown in this study, and possibly enhancing the effectiveness and the costeffectiveness of practice models.

A limitation of the study was that it was based on a naturalistic intervention and accordingly, thus not designed to control for a very precise extent of exposure to education. Indeed, if some patients in the intervention group became very motivated and went on to query some literature about diabetes, or search the internet for more information, we would not have captured that.

In fact it is our hope that our education program stimulated the curiosity of patients and caused them to proactively search for information independently. As a consequence, our estimate of exposure can admittedly be an underestimate. However, we do not see it as a serious limitation, rather just an allowance for natural curiosity to unfold.

Our results may not be generalizable to the general population or to other ethnicracial groups. In addition, there are not enough participants completing the survey at 2 years (1%) to draw any comparisons between groups. What was critical was the compatibility of the patients with the educators. Thus, short of cultural fluency, which we built into our study but did not measure, our results may not be replicable in other racialethnic groups. The education modules have to be delivered in a culturally sensitive and competent manner, otherwise, patient outcomes will be suboptimal.

CONCLUSIONS

Overall, the education program did deliver results with patients who registered significant improvements in their scores, starting with six months postintervention, and through the study end. Further studies should explore the parallel services that derive from the core education and the longer term effects.

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