Physician-Pharmacist Collaboration in the Management of Patients With Diabetes Resistant to Usual Care

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Diabetes affects 20.8 million Americans and accounts for $132 billion in direct and indirect health care costs per year.[1] It is associated with numerous complications including heart disease, stroke, retinopathy, neuropathy, and nephropathy.

The Diabetes Control and Complications Trial and the U.K. Prospective Diabetes Study demonstrated the effectiveness of intensive glycemic control in the reduction of microvascular complications in patients with type 1 and type 2 diabetes, respectively.[2,3] The American Diabetes Association (ADA) publishes annual clinical practice guidelines that recommend a general hemoglobin A_{1c} (A1C) goal of < 7%, a total cholesterol goal of < 200 mg/dl, an HDL cholesterol goal of > 40 mg/dl for men and > 50 mg/dl for women, a triglyceride goal of < 150 mg/dl, an LDL cholesterol goal of < 100 mg/dl, a systolic blood pressure goal of < 130 mmHg, and a diastolic blood pressure goal of < 80 mmHg.[4]

Despite the publication and wide distribution of these recommendations, many patients with diabetes still do not meet recommended treatment goals.[5] Numerous barriers to care exist in the primary care setting. These barriers can be related to patients, providers, organizations, and public policy.[6–9] Subsequently, patients with diabetes and other chronic diseases often receive suboptimal care in the outpatient setting.

When patients do not meet treatment goals, ADA recommends several interventions. Some of these include intensifying the treatment regimen, identifying barriers to adherence, and increasing frequency of patient contact.[4] Multifaceted interventions targeting providers, patients, and organizations have been shown to improve the chronic care of patients with diabetes.[8,10] Efforts should ultimately be focused on increasing patients' knowledge, skills, and confidence in managing their disease.[11]

Several studies have reported improvements in glycemic control through pharmacist intervention within collaborative practices,[12–15] case management,[16] and interdisciplinary teams.[17] Pharmacists have been involved in diabetes care for many years within the Regional Medical Center in Memphis, Tenn., through a referral-based diabetes management clinic and an ADA-certified group diabetes self-management education (DSME) program.

Despite the availability of these services, an evaluation of diabetes management within the internal medicine clinic revealed the presence of a finite population of patients with poorly controlled diabetes. The failure of these patients to respond to traditional care measures led to the development of the Diabetes Initiative Program. The purpose of this program is to improve the care of patients with poorly controlled diabetes through physician-pharmacist collaboration. The goals of the program are to improve glycemic, lipid, and blood pressure measurements in patients with poorly controlled diabetes.

Patients and Methods

A retrospective review of the Diabetes Initiative Program was conducted to evaluate patients enrolled between August 2005 and January 2007. The study was approved by the University of Tennessee Health Science Center Institutional Review Board. The requirement for informed consent was waived because patient confidentiality was maintained and all measurements from this observational study were performed as part of routine clinical care. To target patients resistant to usual care, program inclusion criteria were diagnosis of diabetes for at least 1 year and an A1C ≥ 9%.

Patients were identified through direct physician referrals or through use of an electronic report. The report listed patients scheduled to attend the internal medicine clinic with their most recent A1C, cholesterol panel, and urine microalbumin values. Pharmacists performed a comprehensive interview with each identified patient. Pharmacists reviewed patients' medical history, baseline laboratory values, medication compliance, blood glucose monitoring routine, psychosocial concerns, and nutrition and exercise habits. Patient-specific behavioral goals were set, and education was provided during the initial interview.

The interviewer subjectively identified potential barriers to obtaining medications, attending appointments, and meeting treatment goals. Targeted barriers included lack of financial or insurance resources, lack of knowledge about diabetes care, transportation limitations, cognitive deficits, clinical inertia, and psychological barriers. Psychological barriers included mental illness, substance abuse, and social stressors that hindered patients' ability to perform self-care. Individualized

education and referrals to an outpatient medication assistance program, DSME program, and mental health providers were provided in response to identified barriers as appropriate.

Patients were managed through telephone interviews, joint physician-pharmacist office visits, and pharmacists' specialty clinics every 1–6 weeks depending on their level of glycemic control. Individualized diabetes education was provided throughout enrollment in the program at a patient-specific pace. Other interventions included adding or adjusting medications, ordering indicated laboratory tests and vaccinations, and referring patients to medical nutrition therapy and ophthalmology. Medication adjustments included addition or titration of medications for diabetes, hypertension, and hyperlipidemia and the addition of aspirin. All interventions were recorded in an electronic database.

Outcome measures included A1C, lipid, and blood pressure measurements. Laboratory tests were performed throughout enrollment in the program as indicated by medication titration. Blood pressure was assessed at each clinic visit. Patients were defined as successfully completing the program once their A1C decreased to < 9% and identified barriers were resolved. Patients could be referred back to the program if new barriers surfaced, previous barriers returned, or there was deterioration in glycemic control. Patients were defined as lost to follow-up if they failed to attend three or more successive office visits, or if they could not be contacted by telephone after three or more consecutive attempts.

The intention-to-treat analysis includes all patients with pre- and post-intervention A1C measurements. This includes patients who completed the program by achieving an A1C < 9%, patients who remain active in the program with an A1C ≥ 9%, and patients lost to follow-up. A subgroup analysis of patients completing the program was also performed.

Continuous data were expressed as mean ± SD. All data analysis was conducted using Statview for Windows, version 5.0.1 (SAS Institute Inc., Cary, N.C.). Patients' baseline data were compared to follow-up information for both actual values (A1C; LDL, HDL, triglyceride, total cholesterol levels; and systolic and diastolic blood pressure) and number of patients at goal (LDL, HDL, triglyceride, total cholesterol levels, and systolic and diastolic blood pressure). Comparison of continuous data for the entire study group and for the subset of patients who completed the program was performed using Student's *t* test for paired variables. Nominal data were compared using x^2 or Fisher's exact test as appropriate. A *P* value of

Table 1. Baseline Patient Characteristics

n = 81	Number	Percentage (%)
Race		
Black	77	95.1
White	3	3.7
Hispanic	1	1.2
Sex		
Female	57	70.4
Male	24	29.6
Average age (years)	56.5 ± 11.6; range: 30–80	
Average education (years)	10.4 ± 2.2; range: 4–16	
Payer		
Medicare	29	35.8
Medicaid	25	30.9
Self pay	25	30.9
Insurance	2	2.4
Type 2 diabetes	79	97.5
Insulin therapy	47	59.5
Type 1 diabetes	2	2.5
Insulin therapy	2	100.0
Duration of diabetes		
1–3 years	11	13.6
4–7 years	12	14.8
> 8 years	58	71.6
Average BMI (kg/m²)	35.0 ± 9.1	
Completed DSME class	44	54.3
Hypertension (systolic > 130, diastolic > 80 mmHg)	72	88.9
Hyperlipidemia (LDL > 100 mg/dl)	57	70.4
Cardiovascular disease	18	22.2
Hypertension and hyperlipidemia	55	67.9
Hypertension, hyperlipidemia, and cardiovascular disease	11	13.6
Depression	12	14.8

Table 2. Pre- and Post-Intervention Clinical Indicators for All Patients

Number of Patients	Clinical Indicator	Pre-Intervention	Post-Intervention	Change
81	A1C (%)	11.1 ± 1.7	8.9 ± 1.8	–2.4 ± 2.2 *P* < 0.001
81	Systolic blood pressure (mmHg)	135.0 ± 24.4	133.5 ± 22.7	–1.5 ± 27.5 *P* = 0.63
81	Diastolic blood pressure (mmHg)	79.1 ± 13.8	76.1 ± 12.3	–3.0 ± 15.0 *P* = 0.07
67	Total cholesterol (mg/dl)	179.6 ± 48.2	158.6 ± 39.8	–21.6 ± 46.0 *P* < 0.01
67	HDL cholesterol (mg/dl)	47.4 ± 16.0	50.8 ± 14.2	+3.4 ± 13.6 *P* = 0.04
67	Triglycerides (mg/dl)	150.7 ± 88.3	107.5 ± 66.1	–43.2 ± 67.3 *P* < 0.0001
66	LDL cholesterol (mg/dl)	103.3 ± 42.7	87.1 ± 34.2	–16.2 ± 38.7 *P* < 0.01

Table 3. Pre- and Post-Intervention Clinical Indicators for Patients Who Completed the Program

Number of Patients	Clinical Indicator	Pre-Intervention	Post-Intervention	Change
48	A1C (%)	10.9 ± 1.8	7.8 ± 0.8	–3.2 ± 2.0 *P* < 0.0001
48	Systolic blood pressure (mmHg)	135.2 ± 24.9	135.5 ± 22.7	–0.3 ± 29.8 *P* = 0.95
48	Diastolic blood pressure (mmHg)	80.9 ± 13.4	76.0 ± 12.1	–4.8 ± 13.2 *P* = 0.02
38	Total cholesterol (mg/dl)	176.9 ± 52.4	151.2 ± 36.2	–25.6 ± 46.9 *P* < 0.01
38	HDL cholesterol (mg/dl)	48.3 ± 19.1	51.9 ± 13.1	+2.6 ± 15.7 *P* =.03
38	Triglycerides (mg/dl)	158.8 ± 105.1	100.2 ± 67.7	–58.6 ± 73.1 *P* < 0.0001
37	LDL cholesterol (mg/dl)	98.4 ± 43.8	82.4 ± 32.4	–16.1 ± 39.5 *P* < 0.01

≤ 0.05 was established as statistically significant.

Results

One hundred thirty-one patients were enrolled in the program. Fifty patients were either lost to follow-up or were not enrolled in the program long enough to have pre- and post-intervention data. Pre- and post-intervention data was available for 81 patients. Forty-eight (59%) patients completed the program. Twenty-one (26%) patients are receiving active treatment in the program. Twelve (15%) patients were lost to follow-up.

Patients were enrolled in the program a mean of 200.7 ± 114.0 days. The mean number of interactions between a pharmacist and a patient was 7.4 ± 5.0 with a range of 1 to 24 encounters. Baseline patient characteristics are shown in Table 1. The majority of patients were African American, female, between the ages of 45 and 64, years and had a diagnosis of diabetes for > 8 years. The most frequent comorbitities were obesity, hypertension, and hyperlipidemia.

The percentage of patients facing various barriers to achieving ADA treatment goals are as follows: knowledge deficits, 100%; financial constraints, 47%; psychological problems, 47%; cognitive deficits, 12%; transportation difficulties, 11%; and clinical inertia, 3%. The mean number of barriers identified per patient was 2.2 ± 0.9 with a range of 1 to 5.

A total of 201 medication changes were implemented. Seventy-three percent of patients required a medication change. The most common medication changes involved the addition or adjustment of metformin (20%), insulin therapy (16%), thiazolidinediones (10%), sulfonylureas (6%), angiotensin-converting enzyme inhibitors (25%), hyperlipidemia therapy (17%), aspirin (16%), and vaccinations (15%). The most common nonpharmacological interventions were performing individualized diabetes education (100%), referring to the DSME program (46%), referring to a medication assistance program (18%), and ordering indicated laboratory tests (A1C [53%], microalbumin [50%], lipid profile [43%], and serum chemistries [35%]).

The mean pre- and post-program clinical indicators and the change in pre- and post-program clinical indicators for all patients are shown in Table 2. The mean A1C reduction was 2.4 ± 2.2% (*P* < 0.0001). An A1C reduction of at least one

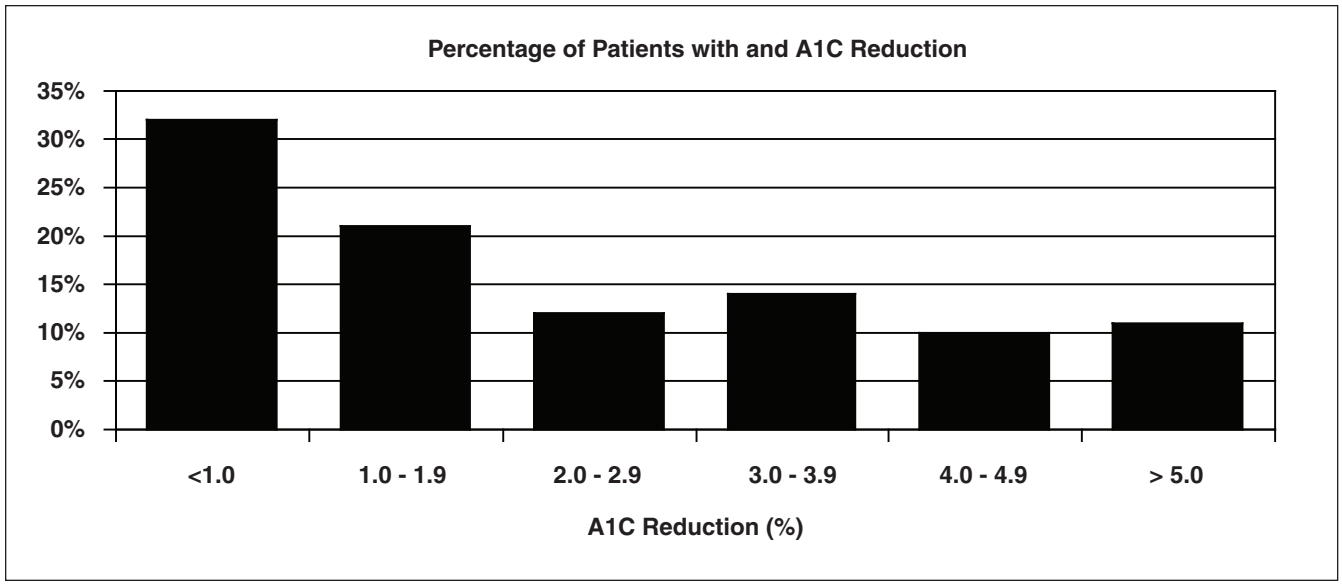

Figure 1. The percentage of patients with an A1C reduction pre- and post-intervention stratified into A1C reduction levels.

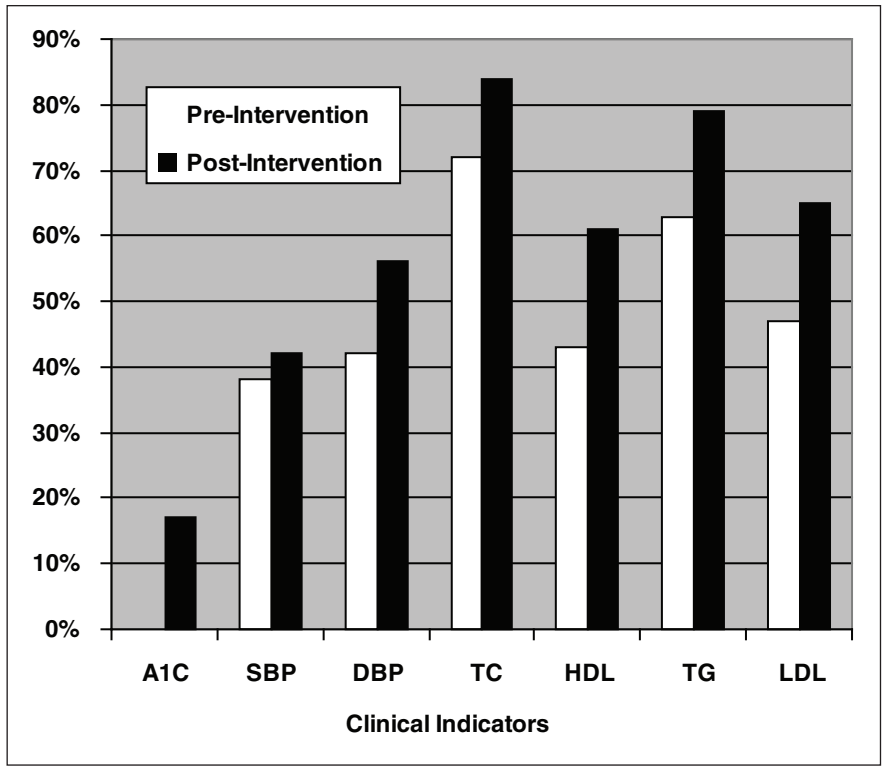

Figure 2. Percentage of patients achieving ADA treatment goals. ADA has established the following treatment goals for diabetes: A1C < 7%; LDL < 100 mg/dl or < 70 mg/dl for very-high-risk patients; SBP < 130 mmHg; and DBP < 80 mmHg. The percentage of patients who achieved the ADA treatment goals pre- and post- intervention are shown. TC goal achieved P < 0.01. HDL goal achieved P < 0.01. TG goal achieved P < 0.0001. LDL goal achieved P < 0.01. DBP goal achieved P < 0.01.
DBP, diastolic blood pressure; SBP, systolic blood pressure; TC, total cholesterol; TG, triglycerides.

percentage point was achieved in 55 (68%) patients, and an A1C reduction of at least four percentage points was achieved in 17 (21%) patients (Figure 1).

Pre- and post-intervention lipid data were available for 66 patients. There were significant improvements in total cholesterol, HDL, LDL, and triglyceride levels. The mean reduction in LDL was 16.2 ± 38.7 mg/dl ($P < 0.001$), and the mean percentage reduction in LDL was 7.8%.

A subgroup analysis was performed of the patients completing the program. Forty-eight (59%) patients met qualifications for completing the program by resolving identified barriers and achieving an A1C < 9%. The mean pre- and post-program clinical indicators and the change in pre- and post-program clinical indicators are shown in Table 3. The mean A1C reduction was 3.2 ± 2.0% ($P < 0.0001$). Statistically significant improvements were also seen in diastolic blood pressure, total cholesterol, triglyceride, and LDL cholesterol levels.

The percentage of patients achieving ADA treatment goals is shown in Figure 2. Only patients with an A1C ≥ 9% were enrolled in the program. As a result, there were no patients with an A1C goal of < 7% in the pre-intervention group. There was a significant increase in the percentage

of patients achieving treatment goals for diastolic blood pressure, total cholesterol, HDL cholesterol, triglycerides, and LDL cholesterol.

No correlation was found between change in clinical indicators and the diagnosis of depression or identified barriers. There was also no correlation between change in clinical indicators and the number of days in the study or the frequency of patient-pharmacist contact.

Discussion

The physician-pharmacist collaboration significantly improved glycemic and lipid control in patients with uncontrolled diabetes who did not reach treatment goals with usual medical care. The overall mean reduction in A1C observed in this program is similar to the reductions observed in previously published studies.[12–17] The subset of patients who completed the program achieved a mean reduction in A1C of 3.2 percentage points, which is greater than results reported in previously published studies.[12–17]

Reductions in A1C of as little as 1% are associated with significant decreases in diabetes-related end points and microvascular complications.[3] Thus, sustained reductions in A1C to the extent achieved in the Diabetes Initiative Program would be expected to have a significant impact on diabetes-related end points and microvascular complications. The mean reduction in LDL observed in our program was 7.8%, which is similar to that published in other reports.[14,15] Reductions in LDL of 1% have been associated with a 1% relative risk reduction in major coronary heart disease events.[18]

The Diabetes Initiative Program used several recommendations from the Institute of Medicine and the ADA to improve the care of our patients.[4,6] Patient-centered care was provided by identifying patient-specific barriers to care and addressing them accordingly. Additionally, patients received individualized diabetes education according to need and at an appropriate pace. Implementing the program within a primary care practice in collaboration with physicians facilitated mutual goal setting, decision making, and knowledge dissemination between physicians, pharmacists, and patients.

The Diabetes Initiative Program demonstrates the value of physician-pharmacist collaboration within an academic internal medicine clinic. This model involved pharmacists working side-by-side with physicians in the primary care setting and specifically targeted patients with uncontrolled diabetes who did not respond to usual care. Numerous barriers to care exist in the primary care setting. Pharmacists are uniquely positioned to identify and overcome patient-specific barriers to care, provide individualized diabetes education, and perform medication management in collaboration with physicians in the primary care setting.

There are several limitations to this analysis. It is a retrospective review of a small patient population in which subjects served as their own controls. The majority of the patient population was urban, minority, low-income females; therefore, the results of this program may not generally apply to other patient populations. Completing the Diabetes Initiative Program was defined as resolving identified barriers to achieving treatment goals and achieving an A1C < 9%. It was hypothesized that resolving barriers to care would facilitate further reduction in A1C after patients were discharged from the program. It is unknown whether clinical improvements achieved during the program were sustained once patients returned to usual care.

Conclusion

The Diabetes Initiative Program significantly improved A1C, total cholesterol, HDL cholesterol, triglyceride, and LDL cholesterol levels in patients with poorly controlled diabetes previously unresponsive to usual care. Physician-pharmacist collaboration within an academic internal medicine clinic is another potential model to target patients with uncontrolled diabetes. This collaboration allowed pharmacists to identify and overcome patient-specific barriers to care, provide individualized diabetes education, and perform medication management. Pharmacist involvement in diabetes care through physician collaboration directly affected the percentage of patients achieving glycemic and lipid goals.

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