

Evaluation of pharmacist-managed diabetes mellitus under a collaborative drug therapy agreement

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The role of a pharmacist as part of the health care team is expanding and includes more direct patient care and clinical activities.^{1,2} For example, pharmacist-managed anticoagulation clinics have provided evidence on outpatient services and improved outcomes compared to patients who were managed by usual care.³⁻⁸ The responsibilities of the pharmacists and nurses working under treatment protocols with physicians in these anticoagulation clinics included a variety of roles, such as patient education, medication review, monitoring for hemorrhagic and thromboembolic complications, and adjusting warfarin sodium dosages to maintain therapeutic prothrombin times and International Normalized Ratios. This type of patient care model produced other models of pharmacist-managed clinics operating under protocols, such as congestive heart failure clinics.^{9,10}

Collaborative drug therapy management by pharmacists is defined as “a collaborative practice agreement between one or more physicians and pharmacists wherein qualified pharmacists working within the context

Purpose. The effect of a pharmacist-managed collaborative drug therapy agreement (CDTA) on diabetes mellitus (DM) management in an outpatient setting is evaluated.

Methods. Patients with DM were referred by physicians to the pharmacist for either education or clinical management of DM under the CDTA. A retrospective chart review was conducted between September 2001 and December 2005 and included patients who had laboratory values of interest within one year before and after the initial visit and who had more than two documented visits with the pharmacist. After the pharmacist's intervention in the DM management, glycosylated hemoglobin (HbA_{1c}) and low-density lipoprotein cholesterol were compared using a paired sample *t* test. Average costs for inpatient hospitalization and emergency department (ED) admission were also compared.

Results. A total of 110 patients had a mean \pm S.D. of 5.7 \pm 3.9 visits with the pharmacist. A mean reduction in HbA_{1c} of 0.7% ($p \leq 0.001$, $n = 93$) from 8.9% to 8.2% and

a mean reduction in blood glucose of 26.4 mg/dL ($p \leq 0.001$, $n = 99$) were achieved. Average costs for inpatient hospitalization and ED admissions were significantly higher in the preintervention period than in the postintervention period for patients with DM as the primary or secondary diagnosis (\$2434 versus \$636, respectively; $p = 0.015$). For patients with a primary diagnosis of diabetes, preintervention costs were higher than postintervention costs, but this difference was not significant (\$3082 versus \$696, respectively; $p = 0.100$).

Conclusion. Pharmacist interventions under a CDTA resulted in significant improvements in glucose and HbA_{1c} levels in patients with DM. Postintervention costs for inpatient hospitalization and ED services were significantly less than preintervention costs when DM was a primary or secondary diagnosis for the admission.

Index terms: Ambulatory care; Diabetes mellitus; Economics; Interventions; Pharmaceutical services; Pharmacists

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of a defined protocol are permitted to assume professional responsibility for performing patient assessments, ordering drug therapy-related

laboratory tests, administering drugs; and selecting, initiating, monitoring, continuing, and adjusting drug regimens.¹¹ The ability of a phar-

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macist to provide direct patient care services has grown. Results from a 2003 survey that included 48 participating states showed that 32 states (66%) had existing pharmacist-collaborative practice laws and 23 states (48%) allowed pharmacists to initiate and modify therapy.¹² In 2006, Thomas et al. conducted a survey of pharmacist collaborative drug therapy management in U.S. hospitals and found that 49% of respondents ($n = 327$) reported that pharmacists in their institutions were engaged in some type of collaborative drug therapy management.¹³ Clinical settings in which pharmacists manage patients who are diagnosed with chronic diseases have included community pharmacies, family medicine, primary care clinics, and others.¹⁴ Pharmacists are also providing medication therapy management services under the Medicare Prescription Drug, Improvement, and Modernization Act of 2003.¹⁵ Services provided by pharmacists in various settings range from education and counseling to managing the pharmacotherapy of a patient's chronic disease state.¹⁶⁻¹⁸

With the ability to incorporate in-depth knowledge of medications and disease management, services for asthma, diabetes mellitus (DM), hypertension, and hyperlipidemia have been targeted for management by pharmacists. Disease State Management certification examinations, provided by the National Institute for Standards in Pharmacists Credentialing (NISPC)¹⁹ for these chronic disease states, are aimed at establishing uniform credentials or baseline knowledge needed by the pharmacist to assure positive patient outcomes. Regardless of the disease state, agreements between pharmacists and physicians must be established and formalized.

This study is a preevaluation and postevaluation of written collaborative drug therapy agreements (CDTAs) in a clinic's diabetic population. The objective of this study was

to compare baseline clinical and financial outcomes to postintervention values in patients being managed by a pharmacist in an ambulatory diabetes clinic via written CDTAs.

Methods

This retrospective evaluation was conducted at an outpatient clinic in a county hospital in El Paso, Texas. A CDTA was developed for the clinic site by pharmacists with physician input and then distributed for review and approval. The CDTA included DM, hypertension, and hyperlipidemia because all three of these separate, but often coexisting, disease states should be addressed in the diabetic patient. This CDTA was based closely on the American Diabetes Association recommendations at the time and was adjusted as the recommendations were updated annually.²⁰ The CDTA was also updated annually with new medications, as appropriate, and captured physician-requested changes from the previous year. The CDTA was approved by the Texas State Board of Pharmacy.

The signatures of participating physicians were obtained, and patient referrals were accepted from these physicians only. The participating clinical pharmacist obtained the disease-state management certification from NISPC and was allowed to shadow a physician before seeing patients under the CDTA. All patients were first seen by a physician, and then, at the discretion of the physician, subsequent referrals to the pharmacist were made. Patients were then seen by the pharmacist, who was responsible for diabetes education; initiating, changing, and monitoring medications; ordering all appropriate laboratory tests; scheduling and rescheduling patient visits with the pharmacist; and making referrals to other health care providers as needed (e.g., ophthalmology, nephrology) in conjunction with the patient's primary physician. The pharmacist also performed limited

or focused physical assessments, such as foot examinations (including monofilament tests), with physicians available for consultation regarding any abnormal findings. Patients were referred to the pharmacist for one of two reasons: education only or education and continued medical management of their diabetes. Education included basic definitions associated with DM (e.g., definitions of DM types 1 and 2), complications of diabetes, review and explanation of medications used for diabetes, and diet and exercise recommendations. This analysis includes those patients who were managed (defined as having three or more documented visits) by the pharmacist. Patients with only one or two documented visits with the pharmacist were considered education-only patients and were not included in the analysis.

The analysis included patients referred by participating physicians to a pharmacist for drug therapy management between September 2001 and December 2005. The primary endpoints for the analysis were changes from baseline (preintervention) in glycosylated hemoglobin (HbA_{1c}), low-density lipoprotein (LDL) cholesterol, microalbuminuria, and fasting plasma glucose levels. Microalbuminuria was measured using a spot-urine sample. Only patients who had data available for one year before and one year after the initial pharmacist visit were evaluated. Baseline values were analyzed in two ways: using the most recent value before the initial pharmacist visit or using the mean of the values in the year before the initial pharmacist visit. The data were analyzed using these two values as baseline because they provide a more precise measure of preintervention values for comparison to postintervention values, which were defined as the mean of all available values within the year after the initial pharmacist visit. Once the pharmacist was managing the patients, laboratory tests of interest

were ordered as appropriate (e.g., every three months for HbA_{1c}, annually for LDL). A paired group's *t* test was used to examine differences between preintervention and postintervention values in the primary outcome variables.

There was no compensation or billing for the services provided by the pharmacist. The combined cost for inpatient hospitalization and emergency department (ED) services during the study period was the secondary outcome variable and was obtained from the hospital management information systems. For each patient, these costs were totaled for the preintervention and postintervention periods separately. Because costs were measured over multiple years, the Consumer Price Index for Medical Care was used to adjust all costs to January 2005 values.²¹ A non-parametric Wilcoxon signed rank test was used to compare preintervention and postintervention costs because the cost data were not normally distributed. For a sensitivity analysis, this comparison was made in two situations: where DM was listed as the primary diagnosis on the inpatient or ED medical record and where DM was listed as either the primary or secondary diagnosis (i.e., listed in either the first or second position) on the inpatient or ED medical record.

This study was conducted with full internal review board approval. Because of the retrospective nature of the data collection, patient consent forms were not obtained or used.

Results

A total of 579 patients were referred to the clinical pharmacist during the study period. The pharmacist managed 110 patients while the rest (*n* = 469) were provided with education only. Of the 110 patients managed by the pharmacist, 107 (97.3%) patients had a diagnosis of type 2 DM, and 3 (2.7%) patients had type 1 DM upon referral to the pharmacist. Sixty-two patients (56.4%)

were women. The mean ± S.D. age of the pharmacist-managed group was 59.8 ± 13.1 years (range, 22–85 years). The mean ± S.D. number of visits with the pharmacist was 5.9 ± 3.7.

A significant reduction of 0.7% (*p* ≤ 0.001, *n* = 93) was seen in mean ± S.D. HbA_{1c} values (preintervention = 8.9 ± 2.0 versus postintervention = 8.2 ± 1.8). There was a significant reduction of 26.4 mg/dL (*p* ≤ 0.001, *n* = 99) in mean ± S.D. fasting plasma glucose values (preintervention mean = 194.6 ± 198.9 mg/dL versus postintervention = 168.2 ± 69.3 mg/dL). Although not significant, LDL cholesterol decreased by 4.3 mg/dL in the 82 patients managed by the pharmacist (112.6 mg/dL versus 108.3 mg/dL), and microalbumin increased by a mean of 51.3 mg/L (152.6 and 203.9 mg/L). Using the most recent value available before the initial pharmacist visit, a mean ± S.D. reduction in HbA_{1c} was 0.6% ± 1.8% (8.8% versus 8.2%, *p* = 0.0013, *n* = 93). The mean ± S.D. reduction in fasting plasma glucose was 22.3 ± 82.2 mg/dL (190.5 mg/dL versus 168.2 mg/dL, *p* = 0.0083, *n* = 99). The preintervention and postintervention values for LDL cholesterol were 112.1 and 108.3 mg/dL, respectively. The premicroalbumin and postmicroalbumin values were 170 and 203 mg/L, respectively.

For the patients who had diabetes as the primary diagnosis (*n* = 15) and who were admitted as inpatients or to the ED in either the preintervention or postintervention period, there was no statistically significant difference in the mean ± S.D. costs between preintervention (\$3,082 ± \$6,648 [median = \$765]) and postintervention (\$696 ± \$2,041 [median = \$0]) (*p* = 0.100). When diabetes was either the primary or secondary diagnosis (*n* = 35), the mean ± S.D. costs were significantly higher during the preintervention (\$2,434 ± \$4,612 [median = \$833]) than postintervention period (\$636 ± \$1,438 [median = \$0],

p = 0.015). For patients with diabetes as the primary diagnosis, total costs for inpatient hospitalization and ED services for those who had these costs were \$35,798 lower during the postintervention period (\$10,435) compared with the preintervention period (\$46,233). For patients with diabetes as the primary or secondary diagnosis, total costs were \$62,925 lower during the postintervention period (\$22,259) compared to the preintervention period (\$85,184).

Discussion

In this study, patients with DM managed by a clinical pharmacist had significantly lower blood glucose and HbA_{1c} levels compared to baseline. Also, LDL cholesterol levels were slightly reduced after pharmacist interventions. Microalbumin levels increased for reasons that are not clear.

In a similar study, Coast-Senior et al.²² evaluated 23 patients with type 2 DM who required insulin therapy and were managed by a pharmacist under a preestablished protocol. These researchers compared preintervention and postintervention variables and found statistically significant improvements as evidenced by decreased fasting blood glucose (FBG), random blood glucose, and HbA_{1c}. In a randomized trial, Jaber et al.²³ compared 22 control patients to 17 pharmacist-managed diabetic patients over a four-month period. They also found statistically significant reductions in FBG and HbA_{1c}.

Consistent with both studies, we documented short-term improvements in glycemic control. The long-term clinical benefits of glycemic control include reducing risk of microvascular complications in type 1 and type 2 DM as demonstrated by the Diabetes Control and Complications Trial²⁴ and the United Kingdom Prospective Diabetes Study.²⁵ In the latter study, the risk of complications was reduced by 35% for each percentage point reduction in HbA_{1c}.

In a prospective population study of 4662 men, Khaw et al.²⁶ demonstrated that HbA_{1c} significantly predicted mortality. The lowest mortality rates were seen with HbA_{1c} of <5%, and for each 1% increase, mortality increased by 28% ($p < 0.002$).

Studies have also documented cost benefits, improved symptoms, and an improved quality of life for diabetic patients by reducing HbA_{1c} values.²⁷⁻²⁹ In a study using computer simulation of a hypothetical patient cohorts model developed by the National Institutes of Health, De Lissoy et al.³⁰ concluded that maintaining long-term glycemic control reduces complication rates and costs for medical care. They also stated that greater benefits may be obtained by targeting Hispanics and younger, newly diagnosed patients. Our study population was 97% Hispanic; therefore, our results are concurrent with the model of De Lissoy et al.

For patients with diabetes as the primary or secondary diagnosis who were managed by a clinical pharmacist, the postintervention costs for inpatient hospitalization and ED admissions were significantly lower than preintervention costs. Patients with diabetes as the primary diagnosis had lower postintervention costs than preintervention costs, although this difference was not statistically significant, probably because of the relatively small sample size ($n = 15$). The lower total postintervention costs (\$35,798) observed for this group seem meaningful.

Similar results have been reported for other studies. In the study of pharmaceutical care services provided to patients with diabetes, Cranor et al.²⁸ also reported a decrease in costs for physician office visits, hospitalizations, ED visits, and laboratory tests combined between baseline (mean = \$6,096, S.D. = \$11,479) and the first-year follow-up period (mean = \$3,596, S.D. = \$6,308); however, this difference was not statistically significant. Wagner et al.²⁶ found

lower mean total health care costs in diabetic patients who had improved HbA_{1c} values compared with those with unimproved HbA_{1c}; however, these differences were not consistently statistically significant.

It is important to recognize that several factors must be in place for a CDTA approach to work. These factors include the participation of appropriately trained pharmacists, collaboration between physicians and pharmacists, and use of well-defined protocols with approval by the state board of pharmacy, the given institution, and other regulatory agencies.

There were several limitations to this study. First, we evaluated only short-term outcomes in patients and were unable to determine if these benefits would persist over longer periods of time. Second, we did not assess cost differences between physician- and pharmacist-managed groups. Also, we did not formally assess patient adherence. Lastly, our patients were not randomly assigned to either a pharmacist-managed group or a control group because random assignment was not feasible in this clinical setting. With no control group, it is likely that patients who were referred were more difficult-to-treat patients and may have tended to have higher preintervention values; however, this situation reflects the reality of practice. Additionally, patients who are difficult to treat are the ones who need the most help in controlling their conditions and are likely target patients for this type of intervention. Some of the cost reduction may have occurred because the patients with relatively high preintervention values were the ones referred to the intervention and smaller cost reductions are likely for patients with lower preintervention costs. The results of this study represent the effects of the intervention on these patients. Additionally, we recognize that the primary diagnosis may have affected the cost results in the analy-

sis with diabetes as the secondary diagnosis.

Future research in this clinic will evaluate long-term outcomes of pharmacist-managed DM patients. Additional endpoints of future studies will include a comparison to a similar cohort not managed by the pharmacist, patient satisfaction, and cost-benefit evaluations. Further study is needed to determine if the costs of providing this service are outweighed by the cost savings associated with improved glycemic control of the patients.

Conclusion

Pharmacist interventions under a CDTA resulted in significant improvements in glucose and HbA_{1c} levels in patients with DM. Postintervention costs for inpatient hospitalization and ED services were significantly less than preintervention costs when DM was a primary or secondary diagnosis for the admission.

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