# Integrating Systematic Chronic Care for Diabetes into an Academic General Internal Medicine Resident-Faculty Practice

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***BACKGROUND:*** The quality of care for diabetes continues to fall short of recommended guidelines and results. Models for improving the care of chronic illnesses advocate a multidisciplinary team approach. Yet little is known about the effectiveness of such models in an academic setting with a diverse patient population and resident physicians participating in clinical care.

***OBJECTIVE:*** To implement a chronic illness management (CIM) practice within an academic setting with part-time providers, and evaluate its impact on the completion of diabetes-specific care processes and on the achievement of recommended outcomes for patients with diabetes mellitus.

***DESIGN:*** Retrospective cohort study.

***SUBJECTS:*** Patients with the diagnosis of diabetes mellitus who receive their primary care in an academic general internal medicine resident-faculty practice.

***MEASUREMENTS:*** Process and outcomes measures in patients exposed to the CIM practice were compared with non-exposed patients receiving usual care.

***MAIN RESULTS:*** Five hundred and sixty-five patients met inclusion criteria. Patients in the CIM practice experienced a significant increase in completion of care processes compared to control patients for measurement of annual low-density lipoprotein (LDL) cholesterol (OR 3.1, 95% CI 1.7–5.7), urine microalbumin (OR 3.3, 95% CI 2.1–5.5), blood pressure (OR 1.8, 95% CI 1.1–2.8), retinal examination (OR 1.9, 95% CI 1.3–2.7), foot monofilament examination (OR 4.2, 95% CI 3.0–6.1) and administration of pneumococcal vaccination (OR 5.2, 95% CI 3.0–9.3). CIM-exposed patients were also more likely to achieve improvements in clinical outcomes of glycemic and blood pressure control reflected by hemoglobin A1c less than 7.0% (OR 1.7, 95% CI 1.02–3) and blood pressure less than 130/80 (OR 2.8, 95% CI 2.1–4.5) compared to controls.

***CONCLUSIONS:*** A systematic chronic care model can be successfully integrated into an academic general internal medicine practice and may result in improved processes of care and some clinical outcomes for diabetic patients. This study provides a model for further hypothesis generation and more rigorous testing of the quality benefits of structured chronic illness care in diverse outpatient practices.

*KEY WORDS:* diabetes; systematic chronic care; resident-faculty practice; chronic care model.
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## BACKGROUND AND SIGNIFICANCE

Over 112 million people in the United States (US) suffer from chronic illnesses, and this figure will grow by 500% over the next 5 decades.[1] Diabetes ranks among the most common chronic conditions affecting 18.2 million people.[2] The incidence of diabetes in the US has increased by 40% in the last decade.[3] When measured by treatment expenditures, hospital bed days, days of work lost or activity impairments, diabetes is also among the most costly of conditions.[4] And this problem will only get worse, since the number of people with diabetes is projected to increase by 225% between now and 2050.[5]

Despite this rise in incidence, diabetes care remains less than optimal when judged by the percent of patients receiving recommended care or achieving certain results. For example, although widely disseminated evidence-based recommendations support achieving a hemoglobin A1c (HbA1c) level of less than 7%, only 42% of diabetics in the US achieved this goal in a national population-based survey.[6] However, certain practice environments such as the Veterans Health Administration appear to achieve superior results in diabetes care. The exact reasons for the discrepancies in care remain uncertain.[7]

Primary care practices face several challenges when attempting to close the gap between recommended care and actual practice for patients with chronic conditions. For example, intensive focus on a complex condition made up of multiple co-morbidities is difficult to maintain in a primary care practice where attention to acute, urgent problems predominates over care of chronic conditions.[8] Furthermore

the processes known to improve outcomes, such as team structure and the presence of case management [9] represent a significant change for traditional primary care practices.

Academic practices face additional challenges, including faculty physicians with part-time practices, lack of care coordination across an open-model health system, care teams that include medical students and residents with widely varying clinical experience in ambulatory settings, and a higher prevalence of underinsured patients with fewer resources for care optimization.

Recent models for improving the care of chronic illnesses advocate a multidisciplinary team dedicated to proactively managing a population of patients. The most detailed of these models is the Chronic Care Model (CCM).[8–11] The CCM is a conceptual framework focused on prevention with four main elements, whose presence appears to improve clinical results: [12] self-management support, delivery system redesign, decision support and clinical information systems. Published studies demonstrating the effectiveness of the CCM usually involve integrated delivery systems, such as group-model health maintenance organizations, staffed by fulltime clinicians, and care for a predominantly homogenous, commercially insured population.[8,10,11]

In order to test the CCM in an alternative setting—an academic practice with part-time providers, residents, and underinsured patients—we implemented components of the model in our resident-faculty practice. This quality improvement study reports on the design and implementation of a Chronic Illness Management (CIM) practice dedicated to improving clinical processes and outcomes for patients with diabetes.

# METHODS

## Setting

Twenty-five faculty and forty-six internal medicine residents provided primary care to a population of about 11,000 adults in a hospital-based, academic general internal medicine resident-faculty practice (GIM practice) serving predominately publicly insured, female, Caucasian patients (see Table 1); 3.2% were uninsured. Only one faculty member was a full-time clinician, defined as eight four-hour clinic sessions per week. The remaining faculty members were employed part-time in clinical practice. The 46 internal medicine residents included first-year, second-year and third-year residents.

In 2000, as part of a quality improvement initiative, the academic health center created a population registry for patients with diabetes mellitus that was separate from the existing electronic medical record.

All patients seen in the GIM practice with a diagnosis of diabetes (ICD-9 250.xx) were flagged and placed into the registry. The patient registry was populated on an ongoing basis, but at that time no systematic approach was implemented for using the registry.

The registry collected and maintained the following variables: hemoglobin A1c level (HbA1c, %); low-density lipoprotein cholesterol level (LDL in mg/dL, either calculated as part of a lipid panel or measured directly); blood pressure level (BP, mmHg); date of administration of influenza and pneumococcal vaccines; assessment of neuropathy by foot monofilament exam (date and results); date of dilated eye exam; and date of documentation of self-management goals.

Laboratory values (HbA1c, LDL, microalbumin) were automatically populated into the registry as the tests were performed. All other data were keyed into the registry at completion of the patient's visit.

## Study Design

This study retrospectively analyzed the effect of quality improvement and educational initiatives on the care of diabetic patients within a diverse GIM practice. Study variables described below were analyzed using a retrospective cohort design where patients exposed to the CIM practice were compared to the non-exposed patients who had received usual care from their primary care providers.

## Comparison Groups

***Intervention Practice Setting- The Chronic Illness Management Practice.*** In 2003, the GIM practice leadership initiated a quality improvement and educational program by creating the Chronic Illness Management (CIM) practice as a referral practice within the larger GIM practice. The GIM leadership also launched a four-week block rotation within the practice for teaching residents about chronic care. The CIM practice mission was to improve the quality of care by fulfilling the evidence-based practice guidelines from the American Diabetes Association (ADA)[13] for diabetic patients receiving their primary care in the GIM practice, while also teaching resident physicians the chronic care model.

***The CIM Practice Consisted of the Following Key Elements:. Team.*** Creation of a CIM diabetes care team included two faculty physicians providing care or supervising residents' care delivery,

**Table 1. Demographics of Participants**

| Characteristic | CIM | Control | p value |
|---|---|---|---|
| Subjects (N) | 288 | 277 | |
| Gender | | | |
| % female | 176 (61%) | 154 (56%) | 0.23 |
| Race | | | |
| % non-white | 74 (26%) | 59 (21%) | 0.23 |
| Insurance | | | |
| % Medicaid | 48 (17%) | 33 (12%) | 0.12 |
| % Medicare | 164 (57%) | 150 (54%) | 0.61 |
| Age | 58.9±12.3 | 58.3±13.1 | 0.53 |
| Comorbidities | | | |
| Average comorbidity score | 3.3±2.2 | 2.6±1.7 | <0.001 |
| % with depression | 79 (27%) | 54 (20%) | 0.03 |
| % with CHF | 31(11%) | 27 (10%) | 0.78 |
| % with renal failure | 13 (5%) | 15 (5%) | 0.56 |
| % with PVD | 31 (11%) | 13 (5%) | 0.01 |
| Glycemic control | | | |
| mean HbA1c | 7.3% | 7.0% | 0.04 |
| Outpatient visits | | | |
| Baseline visits per year | 4.7±3.5 | 2.8±2.0 | <0.001 |
| Primary care provider status | | | |
| Faculty primary care provider | 204 (71%) | 196 (71%) | 0.98 |
| Resident primary care provider | 84 (29%) | 81 (29%) | |

*Characteristics of patients with diabetes exposed to chronic illness management (CIM) practice or usual care (control)*

a registered nurse, a social worker, and medical assistants. Residents assigned to this rotation participated as team members in delivering focused care to patients with diabetes using components of the chronic care model including as described below, team-delivered planned visits,[9,10,14] the patient registry, delegation of care tasks to other team members, and discussing self-management with patients.

***Delegation of Duties.*** Medical assistants were trained to perform monofilament foot exams on all patients on an annual basis and brief foot inspections at all other visits, obtain height, weight, and blood pressure for each patient, identify specific patient concerns for the visit, and print a summary record of capillary blood glucose readings. The registered nurse provided patient-specific diabetes education (e.g., basic nutrition, medication review, insulin injection teaching) as determined by the team's care plan and followed up as necessary. The social worker provided assessment of social and financial barriers to obtaining care and arranged financial assistance as appropriate. The faculty and residents assessed patients' understanding of diabetes, self-care processes (e.g., frequency and timing of capillary blood glucose testing, diet, exercise), symptom review relevant to diabetes and early detection of coronary artery disease, and conducted a directed physical exam pertinent to diabetes (e.g., vitals, skin, mouth, feet, and cardiovascular and peripheral nervous systems).

***Self-management.*** Utilizing information gathered from other team members, the physicians then created a collaborative treatment plan with patients including negotiation of self-management plans (e.g., specific actions patients chose to take to improve their health). Most patients were referred to diabetes education, an organized set of classes and individualized appointments taught by certified diabetes nurse educators and dieticians.

***Clinical Information Systems.*** The CIM team used the registry for systematic, ongoing population management. The CIM team regularly performed ongoing review of the registry for accuracy of assigned patients. Patients were removed from the registry if their primary care physicians were not part of the GIM practice, if they did not meet criteria for the diagnosis of diabetes, or if they received their diabetes care exclusively from other physicians.

A registry summary sheet was printed and used at each patient visit to the CIM practice. This sheet reported longitudinally the last several values for blood pressure, weight, BMI, hemoglobin HbA1c, LDL, urine microalbumin, dilated eye exam dates, monofilament and brief foot exams (normal or abnormal), smoking status, influenza and pneumococcal vaccine dates, and dates self-management goals were set. These variables were selected based on the ADA Standards of Medical Care in Diabetes.[13] The summary sheet guided patient care decisions and collection of data to maintain the registry. For example, by revealing the date of the last eye exam or foot exam, the summary sheet served as a ready reminder of when to perform such preventive interventions.

Finally, the CIM practice implemented population reports that were produced on a monthly basis from the registry. The CIM practice used these to monitor the progress of the overall GIM practice with regards to the percent of diabetic patients obtaining recommended care and achieving control of HbA1c, BP and LDL. The CIM practice also used the reports to identify patients with key metrics not at target and called these patients and invited them to come in for a visit.

The registry was the source of the data used in this study for determining the differences in care between CIM-exposed and control patients.

## CIM Patient Recruitment

All patients with the diagnosis of diabetes mellitus in the GIM resident-faculty practice were eligible for referral to the CIM practice. Patients were recruited through several methods: 1) the CIM practice used the registry to proactively identify patients who were not up to date with preventive measures or were not achieving control of HbA1c, BP, or LDL and, following review and approval from the patient's primary provider, the CIM team invited the patient to the CIM practice; or 2) the patient was referred to the CIM practice by any provider in the practice during any visit with the patient. The CIM practice served as a referral practice for diabetes patients receiving their primary care within the GIM practice. Patients seen in the CIM practice continued to see their primary provider in the GIM practice.

## Control Practice

In this study, the comparison group consisted of patients with diabetes mellitus in the GIM practice that never received care in the CIM practice. These patients were identified retrospectively as control patients who received usual care. Usual care consisted of patient-initiated visits to a primary care provider and physician-directed decisions regarding diabetes management. Follow-up of patients relied on physicians receiving test results and making ongoing decisions with patients either in person or by telephone. Physicians were free to consult endocrinology, the diabetes education program, or refer patients to the CIM practice, at which point they would then become part of the intervention group. Both faculty physicians and residents were aware of the CIM practice goals. As part of the CIM care initiatives, all providers in the GIM practice began receiving the point-of-care diabetes summary sheet when a patient with diabetes showed up for a usual care primary care visit. However, only the CIM practice trained its team members in the use of these summary sheets for updating processes of care and monitoring outcomes. Other than the two faculty physicians working in the CIM practice, only 1 of 25 faculty members had been trained in the CCM through a local diabetes collaborative. This physician cared for approximately 80 diabetic patients that were considered part of the usual care group in this study. Residents who had previously rotated through the CIM practice and had a continuity clinic within the GIM practice were free to utilize the diabetes summary sheet to direct care decisions and continue to apply the learnings from their rotation to their primary care diabetic patients.

## Baseline and Study Periods

Because of the rolling nature of potential exposure in the natural setting of the clinical practice, each intervention patient ("CIM-exposed") or control patient had his or her own

unique baseline period, start date, and study period duration. The baseline period was defined as the 6-month period prior to the patient's start date. The start date was defined as the first visit in either the CIM practice or the control practice during the eligibility period, which ran from 01 July 2003 to 01 June 2005. The study period was defined as the time elapsed between the patient's start date and the end of the study period, December 1, 2005. Exposure to the CIM practice was defined as any two visits to the practice from 01 July 2003 to 01 June 2005 (the eligibility period), with the initial visit being the start date for exposure. To control for visit frequency bias, control patients (those in the registry not seen in the CIM practice) were included only if they had two regular visits during the study period, with the first visit being the control start date. Follow-up time, which began accruing after the individually defined start date, ranged from 6 to 24 months.

## Study Variables

***Process Measures.*** Diabetic care processes measured in this study included fulfillment of the recommended preventive interventions[13] for measurement of HbA1c% (every six months), LDL levels (yearly), and blood pressure (yearly); administration of influenza (yearly) and pneumococcal (at least once) vaccines; assessment of neuropathy by foot monofilament exam (yearly); dilated eye exam (yearly); documentation of any self-management goals.

Retrospective analysis was carried out for each individual to determine whether the care process measures were current or overdue at baseline and at the end of the study period. Patients were overdue for testing if 7 months (for HbA1c) or 13 months (for LDL, BP, eye and foot exam) had elapsed since the last test. Documentation of any self-management goal during the study period on the structured registry form met the requirements for goal setting. These care process variables were each considered independently and classified as either current or overdue at the time of measurement during the baseline period and the study period. Out of date or never performed processes were recorded as overdue.

***Outcomes Measures.*** Outcome measures were defined as achieving glycemic, blood pressure and lipid control, based on the ADA guidelines.[13] The desired outcomes targets were HbA1c<7.0% for glycemic control, LDL<100 mg/dL for lipid control, and BP<130/80 mmHg for blood pressure control. A retrospective analysis was carried out to determine whether observed test values fell above or below these desired targets at baseline and at the end of the study period for each individual.

## Statistical Analysis

Univariate analysis for sex and process and outcomes measures at baseline and after the study period was completed using Fisher's exact test to compare differences in CIM-exposed and control patients. Chi-square test was used to test for the association between the patient's intervention status (CIM or control) and the patient's primary care provider status (resident or faculty).

Students' t-test was used to test for significant differences between the average comorbidity score and age of patients at baseline. A series of multivariable logistic regression was generated with achievement of each process and outcome measure as the dependent variable and exposure group (CIM-exposed or control) as the primary independent variable. Confounders (age, sex, comorbidity score, and baseline individual adherence to the measure of interest) were adjusted for in the models. The comorbidity index was calculated based on the work by Deyo, Cherkin, and Ciol.[15] In their approach, the co-existing diseases in a single patient during the baseline period (represented by ICD-9-CM codes from outpatient visit billing) are weighted and summed, with a maximum score of 14 (weighted) comorbidities. The Hosmer–Lemeshow test was used to assess goodness of fit for the models, and the c statistic was used for model discrimination: that is, the ability to predict whether the individual is in the adherent or non-adherent group.

The baseline level for glycemic, BP, and lipid control was used as a classifier for final outcomes, per the methods of Dorr, et al.[16] such that individual patients were classified as either in control, out of control, or unknown control at baseline with respect to HbA1c, BP and LDL targets. The intent with inclusion of patients with unknown control was to avoid double counting missing process measures and outcome measures at baseline. In all, 90 patients (16%) had one or more unknown outcome measures at baseline

Odds ratios were also adjusted for propensity scores. To derive propensity scores, bivariate analyses comparing values for the intervention versus baseline group for a total of 20 variables—including race, age, baseline outpatient visits, baseline process and outcome measures, and comorbidities—were performed. Then, the probability, or propensity, of being referred to the intervention group was modeled with the significant variables in the initial analysis using stepwise logistic regression. The quartile of propensity score was then added to the multivariable analyses as an additional variable.

# RESULTS

The study population consisted of 565 patients with diabetes mellitus. We studied the results of 288 persons exposed to the CIM practice and compared them with 277 controls who received usual care. At baseline, the two groups were not significantly different in age, gender, insurance coverage, LDL cholesterol and blood pressure (Table 1). There was no significant association between patient intervention group and the primary care physician status (p-value=0.98). However, the CIM-exposed group did have a significantly higher mean hemoglobin HbA1c, baseline outpatient visits, and comorbidity score than the control group. These variables were included in the propensity score to account for the differences. The higher comorbidity score is from a greater frequency of diagnoses of depression and peripheral vascular disease in the CIM-exposed group.

## Intervention Effect

During the study period (after baseline), patients from both groups had an increase in visits from baseline (control group increased by 1.9 visits per year greater than baseline for a total of 4.7±3.5 visits per year. The CIM-exposed group increased by 1.7 visits greater per year than baseline for a total of 6.4±3.9

visits per year). The difference in the increase was not significant (p=0.52). Baseline differences are accounted for in the multivariate models.

## Process Measures

This analysis measured the likelihood of the patients fulfilling diabetes care processes before and after exposure to the CIM practice compared to patients receiving usual care. Patients in the CIM practice experienced a significant increase in completing seven recommended diabetes care processes.

The likelihood of obtaining an LDL, microalbumin, and BP test and retinal eye examination was significantly greater for the CIM group than for the usual care group. Figure 1a shows the percent of patients in each group before and after the study period completing these interventions, along with the adjusted odds ratios and the 95% confidence intervals for the odds of patients in the CIM practice achieving the recommend care compared to the control patients.

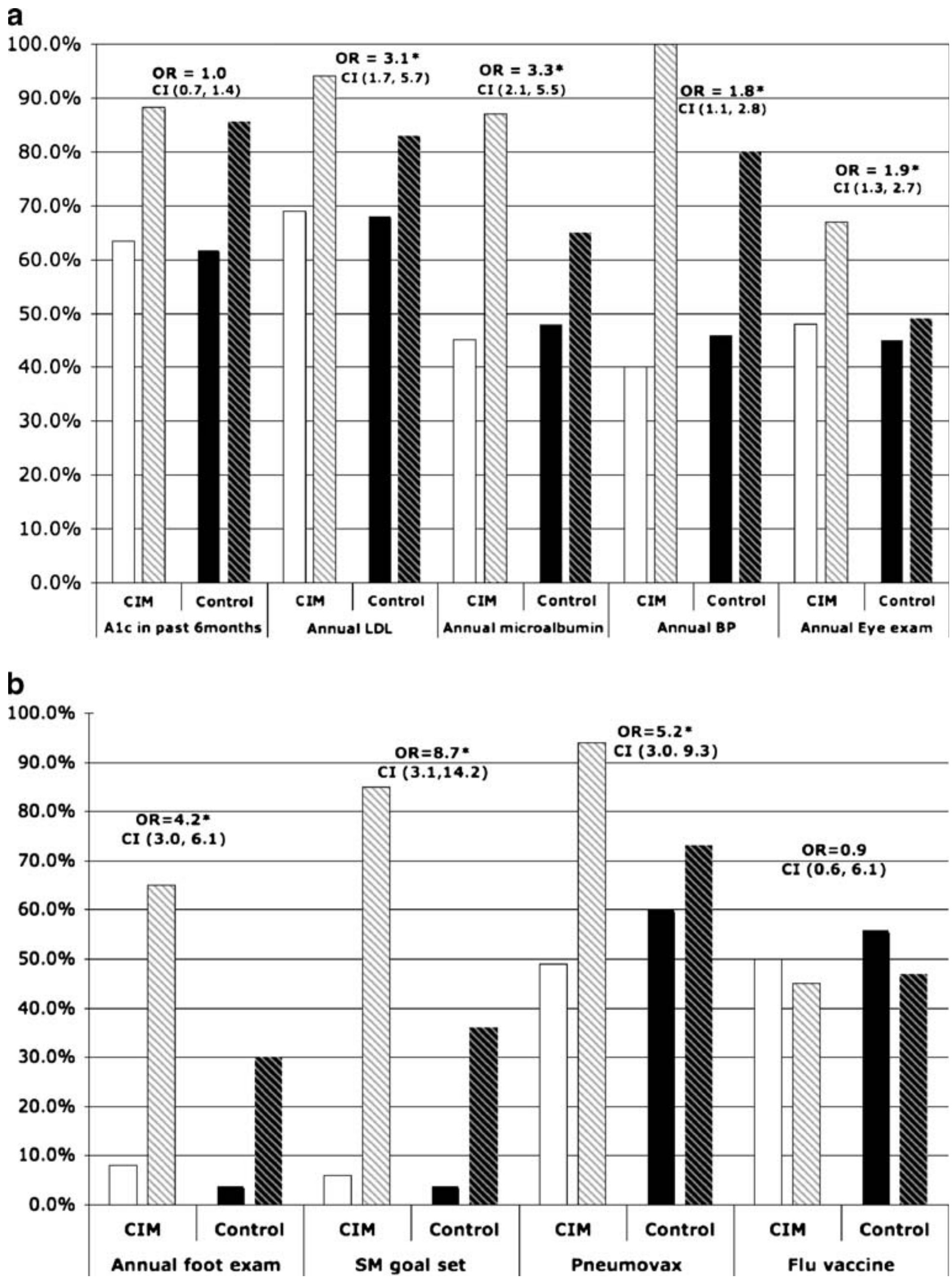


**Figure 1.** (a) Process measures. Percent of population achieving adherence to process measures before and after exposure to chronic illness management (CIM) or usual care (control) in patients with diabetes. Odds ratios represent the multivariate adjusted odds of achieving the recommended process measure in CIM versus control populations. (A1c=hemoglobin A1c; LDL=low density lipoprotein; BP=blood pressure; *p<0.05). (b). Percent of population achieving adherence to process measures before and after exposure to chronic illness management (CIM) or usual care (control) in patients with diabetes. Odds ratios represent the multivariate adjusted odds of achieving the recommended process measure in CIM versus control populations. (SM=self-management goal; *p<0.05).

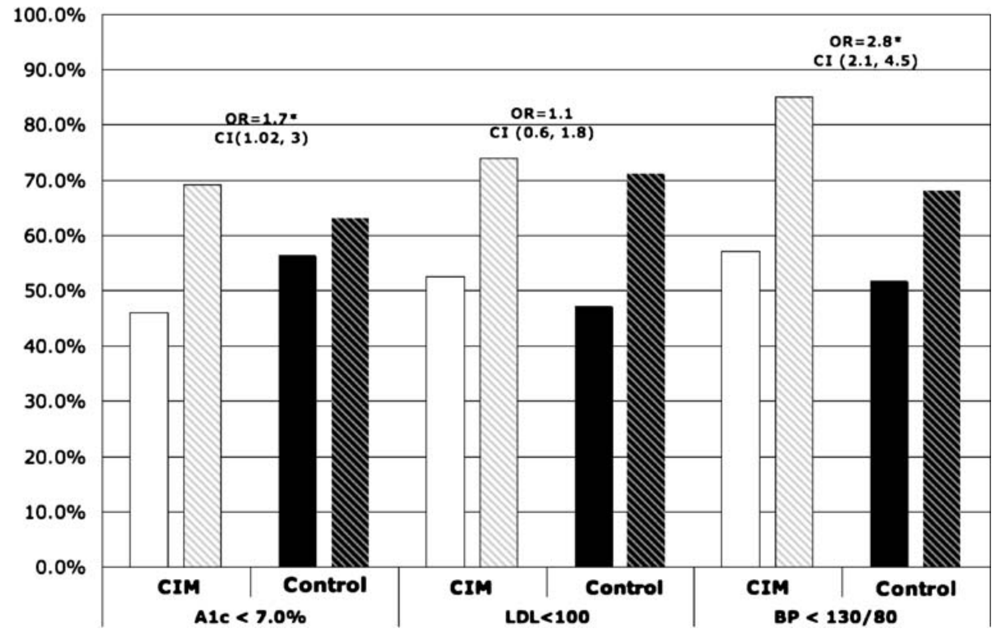


**Figure 2. Outcomes measures. Percent of population achieving recommended outcome targets before and after exposure to chronic illness management (CIM) practice or usual care (control) in patients with diabetes. Odds ratios represent the multivariate adjusted odds of achieving the recommended outcome measure in CIM versus control populations. (A1c=hemoglobin A1c; LDL=low density lipoprotein; BP= blood pressure; *p<0.05).**

The odds of obtaining an annual LDL, microalbumin, BP test and retinal eye examination was significant in both the unadjusted and the multivariate model and the propensity score model. Annual LDL had a significant factor of previous LDL testing in the multivariate model. BP testing had a significant factor of comorbidity score in the multivariate model. Testing of HbA1c in the past six months was not significantly improved after exposure to the CIM practice (adjusted OR 1, 95% CI 0.7 to 1.4, p=0.53).

The likelihood of obtaining an annual monofilament foot exam, of ever setting a self-management goal and of ever receiving a pneumococcal vaccine was significantly greater for the CIM group than for the usual care group. Figure 2a shows the percent of patients in each group before and at the end of the study period achieving completion of these interventions, along with the adjusted odds ratios and the 95% confidence intervals for the odds of patients in the CIM practice achieving the recommend care compared to the control patients.

The odds of obtaining an annual monofilament foot exam, of ever setting a self-management goal and of ever receiving a pneumococcal vaccine were significant in both the unadjusted and the multivariate model and the propensity score model. Annual foot examination had a significant factor of previous foot exam testing in the multivariate model. Setting a self-management goal had a significant factor of comorbidity score in the multivariate model.

Obtaining a flu vaccine in the past year was not significantly improved after exposure to the CIM practice (adjusted OR 0.9, 95% CI 0.6 to 6.1, p=0.35).

## Outcome Measures

Exposure to the CIM practice also resulted in a significant increase in the likelihood of patients achieving recommended outcomes targets for HbA1c (less than 7%) and blood pressure (less than 130/80) compared to control patients (Fig. 2).

Figure 2 shows the percent of patients in each group before and after the study period achieving the recommended outcomes for HbA1c, BP and LDL, along with the adjusted OR and the 95% CIs for the odds of patients in the CIM practice achieving the recommend clinical outcomes compared to the control patients.

The odds of having a HbA1c less than 7% after exposure to the CIM practice was significant in both the unadjusted and the multivariate model, but the propensity score model was no longer significant (OR 1.3, 95% CI 0.8 to 2.3). Achieving a HbA1c level of less than 7% had a significant factor of previous HbA1c level in the multivariate model.

The odds of having a BP less than 130/80 after exposure to the CIM practice was significant in both the unadjusted and the multivariate model (OR 2.8, CI 2.1 to 4.5). Achieving the BP goal had a significant factor of previous BP level in the multivariate model. Exposure to the CIM practice did not improve the achievement of the recommended LDL target compared to control patients (adjusted odds ratio 1.1, 95% confidence interval 0.6 to 1.8, p=0.76). The propensity score model did not change the odds ratios significantly for achievement of the LDL and the BP targets.

## DISCUSSION

In this study, we demonstrate that a Chronic Illness Management (CIM) practice implemented in an academic general internal medicine practice may serve as a model for improving care processes and outcomes in patients with diabetes. Based on studies indicating that practice re-design can improve clinical outcomes,[17] we used quality improvement methods to create a team approach to diabetes care and to educate team members about the chronic care model, and residency pro-

gram support to integrate internal medicine residents into the delivery of care in the new model.

Our study extends the current research in chronic care by showing that the CCM can be implemented successfully within an academic general internal medicine practice, in a population characterized by economic, ethic and social diversity and with a provider population of resident physicians and faculty physicians whose clinical practice is less than fulltime.

Previous research identifies elements of the CCM that improve adherence to process and outcomes measures.[18] Our use of a CIM practice in an academic learning setting provided a set of unique implementation characteristics that may be beneficial for other centers with learners and to any practice with diverse patients and part-time providers.

First, the CIM practice consists of a team of health care professionals with specific delegated responsibilities. For example, medical assistants were responsible for performing yearly monofilament foot exams and identifying patients deficient in vaccines. Delegation of responsibility across the team fosters a sense of collective responsibility for success. This mutual responsibility is reinforced at weekly meetings where progress on process and outcomes measures is reviewed.

Second, the CIM practice measures success through a patient population registry from which measures are analyzed and discussed with the entire team at regular intervals. This builds a team culture focused on achieving specified population targets for process and outcome measures, and a place where team members can see the results of their work.

Third, the registry enables production of summary sheets that provide longitudinal data at the individual patient level. These data sheets present trends in process and outcome measures, and serve as visual reminders of clinical deficiencies at the point of care. These sheets reinforce at each visit the difference between actual and desired clinical results.

Fourth, the CIM practice has physician leaders who act as local clinical champions to keep all other clinical personnel up to date in developments and advances in diabetes care. These clinical champions create a culture comfortable with aggressively intensifying therapy to meet specified process guidelines and outcome targets. This is particularly important because other studies show that clinical inertia is a major barrier to achieving desired outcomes.[19,20] In fact, even when providers know evidenced-based recommendations, they fail to implement them unless systematic processes are in place.[21] The CIM practice addresses this deficit by combining clinical expertise with a team structure and culture that facilitates the delivery of recommended care.

Finally, the CIM practice operates in an educationally rich academic environment. As one of the collateral benefits of the educational mission, the entire team becomes critical learners and teachers of chronic care. All the clinical personnel—medical assistants, social worker, registered nurse and physicians—are exposed to the curriculum and learn the chronic care model theory and the CIM methodology, ensuring that providers follow a consistent and systematic approach to care, become comfortable measuring success by examining population results, and tenaciously pursue improvements.

However, even a structured program with a motivated team is not alone sufficient for overcoming barriers to excellent care. One interesting finding of this study is the documentation that foot examinations were preformed in only 65% of patients exposed to the CIM practice. This represents a significant improvement compared to usual care, but remains less than optimal. Several possibilities could explain this result. First, this could be a problem of documentation since the monofilament exam had to be manually keyed into the registry. Second, this could reflect shortfalls in team training and team turnover, especially of the medical assistants. Finally, the value most likely reflects delayed follow-up: patients exposed to the CIM practice may not have been brought back in time to get their yearly foot exams during the study period. Any practice seeking to improve care will have to confront these challenges.

Our study has several limitations. First, it is not a randomized, controlled, blinded trial. Instead the CIM practice emerged from a quality improvement project. Lessons learned from the project were purposely disseminated to the rest of the practice. Residents who had rotated through the CIM clinic brought the techniques to their primary care practice and CIM faculty shared methods with other residents and faculty. This spread of method contaminates the control group results over time. Had we been able to control this contamination (or desired to control it), our differences may have been even greater. Importantly, results presented here were achieved in a real practice environment where learning usually influences clinical care delivery. However, further more rigorous studies will be required to draw definitive conclusions from the CIM model.

There may have been selection bias in sending patients to the CIM practice. As noted, when adjusted for propensity score, the odds of having a HbA1c under control in the CIM group was no longer significant when compared to the usual care group. This suggests that some of the improvement in HbA1c levels may have been due to selection bias. Since the CIM group had higher HbA1c at baseline more positive change was seen in this group. This improvement may be due to regression to the mean. This is a risk with an uncontrolled, retrospective analysis of a quality improvement program.

Other limitations reflect the constraints of the data collection system. Both eye exams and vaccine data were manually entered into the registry and depended in part on patient recall. Where possible the dates of eye exams and vaccinations were verified by chart review and requests of outside records. Blood pressure results, monofilament examination results, and the self-management goals were also manually entered into the registry at the time of the visit. This could lead to errors and omissions. Furthermore, the very nature of the CIM practice, with protocols focused on documenting processes, could create systematic bias in favor of recording these variables. Because of these limitations, this study should, thus, serve as hypothesis generation for future more rigorous controlled studies.

In conclusion, the implementation of a CIM practice to close the gap between what guidelines suggest should be routine care and actual clinical practice translated into improved outcomes for our patients, improved teamwork, and enhanced education. Ours is only one model of re-designed care, but we do show that a systematic chronic care model can be successfully integrated into an academic general internal medicine practice and achieve better results for patients with diabetes.

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***Conflict of Interest:*** *None disclosed.*

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