**Performance Improvement**

# Are Elements of the Chronic Care Model Associated with Cardiovascular Risk Factor Control in Type 2 Diabetes?

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Control of glucose, blood pressure (BP), and lipids is crucial to reduce the risk of cardiovascular (CV) disease, especially among people with Type 2 diabetes.[1] However, a wide gap still exists between established evidence for control of these risk factors and what is actually achieved in care settings. Recent evidence shows that there has been little improvement in glycosolated hemoglobin (A1C) and blood pressure control, and only small improvements in lipid control among people with Type 2 diabetes over the past decade.[2] The discrepancy between evidence and practice has persisted despite of the wide dissemination of evidence-based guidelines and the availability of new therapeutic classes of medications. Some have suggested that this is partly due to patient characteristics such as age, race/ethnicity, gender, and self-care behaviors.[3-6] Others have attributed this variation to the clinic where the patients receive their care.[7,8] We sought to better understand these relationships by assessing the impact of patient characteristics and clinic characteristics on control of CV risk factors among patients with Type 2 diabetes in primary care clinics.

The Chronic Care Model (CCM) was developed to improve care of patients with a chronic illness. It describes six characteristics of a clinic: organizational support, self-management support, delivery system design, decision support, clinical information systems, and community linkages. If present in a clinic, these characteristics should result in improved outcomes for chronic illness care in general and for diabetes care in particular.[9] Such primary care clinics are said to have strong and prepared, proactive primary care practice teams who interact with informed, activated patients, resulting in optimal outcomes.[10,11] In a previous study, we showed that the presence of these characteristics is associated with process quality of care measures, such as the frequency of measuring A1C or blood pressure and referrals for eye examinations.[12] We have also shown that the degree to which the CCM has been fully implemented in the primary care setting is associated with A1C control.[13] Additional studies have examined the relationship between CCM components and control of CV risk factors.

## Article-at-a-Glance

**Background:** Control of modifiable risk factors for cardiovascular (CV) disease, the most common cause of morbidity and mortality among people with Type 2 diabetes is dependent on both patient self-care behaviors and the characteristics of the clinic in which care is delivered. The relationship between control of CV risk factors, patient self-care behaviors, and the presence of CCM (Chronic Care Model) components across multiple primary care clinic settings was examined.

**Methods:** Thirty consecutive patients presenting with Type 2 diabetes were enrolled from each of 20 primary care clinics from across South Texas. Patients were asked about their stage of change for four self-care behaviors: diet, exercise, glucose monitoring, and medication adherence. CV risk factors included the most recent values of glycosolated hemoglobin (A1C), blood pressure, and (low-density lipoprotein) cholesterol. Clinicians in each clinic completed the Assessment of Chronic Illness Care (ACIC) survey, a validated measure of the CCM components. Hierarchical logistic regression models were used.

**Results:** Only 25 (13%) of the 618 patients had good control of all three CV risk factors. Good control of these risk factors was positively associated with community linkages and delivery system design but was inversely associated with clinical information systems. Patients who were in the maintenance stage of change for all four self-care behaviors were more likely to have all three risk factors well controlled.

**Discussion:** Risk factors for CV disease among patients with diabetes are associated with the structure and design of the clinical microsystem where care is delivered. In addition to focusing on clinician knowledge, future interventions should address the clinical microsystem's structure and design to reduce the burden of CV disease among patients with Type 2 diabetes.

Nutting and colleagues demonstrated a relationship between how care is consistent with the CCM and control of A1C and lipids,[14] whereas Feifer and colleagues found a positive association between the presence of the CCM and a composite score for quality of care that included control of risk factors for diabetes.[15] Finally, in an intervention designed to improve the delivery of the CCM, investigators in Minnesota found a significant improvement in the percentage of patients with A1C and low-density lipoprotein (LDL) cholesterol at guideline-recommended levels, but this improvement was not associated with a measure of change in the CCM.[16] The current study adds to this growing body of knowledge by examining the role of patient-specific measures of self-management behaviors, an important factor that is often missing in prior studies, as well as individual elements of the CCM rather than the overall implementation of the CCM in primary care settings. Because 97% of adults with Type 2 diabetes receive the majority of their diabetes care in primary care settings,[17] we focused on primary care clinics.

## Methods

### Recruitment of Primary Care Clinics

Twenty primary care clinics were consecutively recruited from March 2003 to September 2004 across South Texas in a "snowball" method in an attempt to reach primary care settings where people with Type 2 diabetes were mostly likely to seek care. Each successfully recruited clinic recommended others for the study. Only one clinic that we approached declined to participate. The first four clinics were contacted because they had participated in previous studies.

The clinics were initially contacted by phone. We then made a recruitment and enrollment visit to each clinic to explain the purpose of the study and to obtain the lead physician's agreement to participate. We returned for a "welcome visit," where we explained the study to all clinic personnel, answered their questions, obtained informed consent, and asked them to complete our survey.

Of the 20 practices/clinics that participated in the study, 12 were solo or two-physician practices, 2 were single specialty practices with three or more physicians, 3 were city-county health clinics, 1 was a federally qualified community health center, and 2 were outpatient clinics in a local Veterans Affairs health system.

### Patient Characteristics

Thirty consecutive patients presenting with Type 2 diabetes were enrolled from each clinic. The 618 patients completed an exit survey and were asked about their stage of change for each of four self-care behaviors: diet, exercise, self-monitoring of blood glucose, and medication adherence. The stages of change were adopted from the transtheoretical model: pre-contemplation, contemplation, preparation, action, and maintenance.[3,18,19] In the analysis, a stage of change variable was constructed as a dichotomous outcome: yes, the patient is in the maintenance stage of change, or no, the patient is not in the maintenance stage of change, for all four self-care behaviors. Patients in the maintenance stage of change reported that they have been adherent to these behaviors for at least the past six months. Additional patient characteristics included in the analysis were age, sex, and race/ethnicity, and self-reported health status (excellent, very good, good, fair, poor).

### CCM Components

We used the Assessment of Chronic Illness Care survey (ACIC) to determine the degree to which care in each clinic was consistent with the CCM.[20] This 25-item survey, which measures the presence of the elements of the CCM, was completed by all clinicians in each clinic: physicians, nurse practitioners, and physician assistants. Each item is scored on a 0 to 11 scale and provides subscale scores for each of the six CCM components (Appendix 1, page 137). Several studies support the validity of this instrument. For example, all six subscales were responsive to process of care improvement in a study of an intervention for diabetes and congestive heart failure,[20] whereas ratings by an external team on the depth of implementation of the elements of the CCM were significantly associated with the overall ACIC score for 5 of the 6 elements, in a collaborative intervention study overseen by the Institute for Healthcare Improvement.[21]

### CV Risk Factors

Medical records were abstracted for CV risk factors by recording the most recent values of A1C, BP, and LDL-cholesterol. Current clinical practice guidelines recommend the following target levels for potentially modifiable risk factors: A1C $\leq$ 7.0mg%; BP $\leq$ 130/80mmHg; and LDL-cholesterol $\leq$ 100mg/dl.[22] The outcome variable included in the analysis was whether all three of these risk factors were well controlled (yes/no).

### Analyses

Hierarchical logistic regression models were used to account for clustering of patients within clinics. Three separate models were constructed: a "random coefficient model," with patient

Table 1. Characteristics of the 618 Patient at the 20 Clinics*

| Characteristics | Mean (S.D.)/Percentage | Range |
|---|---|---|
| Age | 58.6 (12.93) | 20–94 |
| Female | 51% | 3.0%–80.6% (across clinics) |
| Hispanic | 57% | 19.4%–97.1% (across clinics) |
| Maintenance stage of change for all 4 self-care behaviors | 25% | 46.9%–93.8% (across clinics) |
| A1C < 7.0% | 43% | 20%–69.7% |
| BP < 130/80 mm/hg | 49% | 0%–72.7% |
| LDL < 100 mg.dL | 50% | 0%–73.3% |
| All 3 well controlled | 13% | 0%–31.3% |
| Organizational Leadership | 6.5 (2.3) | 2.5–10.0† |
| Community Linkage | 7.1 (1.7) | 4.3–10.7† |
| Self-Care Support | 6.9 (1.9) | 2.8–10.3† |
| Decision Support | 6.0 (1.8) | 2.7–9.0† |
| Delivery System Design | 6.7 (2.2) | 3.4–11.0† |
| Clinical Information System | 5.2 (2.4) | 0.6–10.2† |

* S.D., standard deviation; A1C, glycosolated hemoglobin; BP, blood pressure; LDL, low-density lipoprotein.
† Potential range of each subscale, 0 to 11.

characteristics as predictors and clinic as a fixed effect; a "means-as-outcomes" model, with mean values for each subscale score on the ACIC entered as predictors without patient characteristics; and a final "intercepts- and slopes-as-outcomes" model, with both patient and clinic predictors. We used SPSS version 12.0 (SPSS, Inc., Chicago) and HLM (version 6.0; Scientific Software International, Lincolnwood, Illinois). The study was reviewed and approved by the Institutional Review Board at the University of Texas Health Science Center, San Antonio, Texas.

## Results

Descriptive statistics were calculated for patient characteristics, clinic characteristics, and CV risk factors (Table 1, above). Mean patient age was 57 years, with 51% females and 57% of Hispanic race/ethnicity. Only 25% of the patients reported being at the maintenance stage of change for all four self-care behaviors. The proportions of patients with good control of A1C, BP, and LDL were 43%, 49%, and 50% respectively. Only 13% had good control of all three. Overall, the clinics ranked higher on community linkages and self-care support and lower on clinical information system and decision support.

Results of the 2-level hierarchical logistic models are shown in Table 2 (right), Table 3 (right), and Table 4 (right). The likelihood that all three risk factors were in good control increased as age increased, with female gender, and with maintenance stage of change for all four self-management behaviors (Table 2). In a similar fashion, good control of all three risk factors was associated with community linkages (Odds Ratio [O.R.], .1.65; 95% confidence interval [C.I.], 1.31, 2.09) and delivery

Table 2. Random Coefficient Model for Patient Characteristics*

| Patient Characteristic | Odds Ratio | 95% C.I. |
|---|---|---|
| Age | 1.01 | 1.00, 1.02 |
| Female | 0.66† | 0.48, 0.92 |
| Hispanic | 0.86 | 0.62, 1.19 |
| All Maintenance | 1.55† | 1.09, 2.21 |

* C.I., confidence interval.
† Indicates statistical significance at < .05.

Table 3. Means-as-Outcomes Model for ACIC Subscales*

| CCM Component | Odds Ratio | 95% C.I. |
|---|---|---|
| Organizational Leadership | 0.89 | 0.72, 1.11 |
| Community Linkage | 1.65† | 1.31, 2.09 |
| Self-Care Support | 0.97 | 0.78, 1.21 |
| Decision Support | 1.10 | 0.75, 1.63 |
| Delivery System Design | 1.38† | 1.40, 1.67 |
| Clinical Information System | 0.58† | 0.42, 0.81 |

* ACIC, Assessment of Chronic Illness Care; CCM, Chronic Care Model; C.I., confidence interval.
† Indicates statistical significance at < .05.

Table 4. Final Model

| Predictor | Odds Ratio | 95% C.I. |
|---|---|---|
| Female | 0.59† | 0.36, 0.98 |
| All Maintenance | 1.82† | 1.08, 4.07 |
| Community Linkages | 1.56† | 1.23, 1.98 |
| Delivery System Design | 1.47† | 1.17, 1.86 |
| Clinical Information System | 0.58† | 0.44, 0.73 |

* C.I., confidence interval.
† Indicates statistical significance at < .05.

system design (O.R., 1.38; 95% C.I., 1.40, 1.67) but was inversely associated with clinical information systems (O.R., 0.58; 95% C.I., 0.42, 0.81). The relationships between these three CCM element scores and control of all three risk factors persisted after controlling for patient self-care behaviors and gender, as shown in the final model in Table 3.

## Discussion

Control of risk factors for CV disease among patients with Type 2 diabetes is associated with structural characteristics of the primary care clinic, as viewed through the lens of the CCM, specifically the strength of the community linkages and the design of the delivery system within the clinic. This remains true after controlling for patient characteristics and self-care behaviors. In the ACIC survey, community linkage refers to the extent to which primary care clinicians are linked to diabetes specialists and educators, educational resources are available to patients, and coordination of diabetes care guidelines is taking place at the clinic. This finding suggests that clinics with better access to educational resources and the latest evidence-based knowledge have incorporated this knowledge into patient care activities in a manner that results in better control of patients' A1C, BP, and LDL-cholesterol.

Delivery system design, on the other hand, is more of an internal dimension that relates to the actual delivery of care during the patient's visit at the clinic and the subsequent follow-up. Clinics with teams that have well-defined leadership and effective teamwork, where the appointments and visits' systems are well structured and where follow-up and coordination of care after the visit are well planned, seem to have an advantage in terms of controlling CV risk factors for their diabetic patients. This finding supports work by others who found that high-functioning health care teams have patients with better outcomes.[23-25] Prior studies also support the importance of coordination and continuity of care in improving diabetes outcomes.[26,27]

The finding that the clinical information system subscore is inversely associated with CV risk factor control is puzzling and will require more study. This score reflects the use of disease registries, reminders to providers, audit and feedback, and standardized patient treatment plans and algorithms. It is important to note that the mere presence of these systems does not necessarily reflect appropriate use. One possible explanation is that these systems are used primarily to improve performance on process of care measures and not intermediate clinical outcomes such as A1C, BP, or lipids. In a separate analysis of these data, in visits where all diabetes process of care measures are done, the likelihood that medications are intensified for an elevated A1C was significantly lower.[28] Thus, a fully implemented clinical information system may inadvertently increase the phenomenon of clinical inertia: failure to intensify therapy for poor control of a chronic disease when indicated, resulting in worse control of A1C, BP, or lipids.[29] It also is important to note that we observed similar findings in other studies that we have conducted.[30]

Another possible explanation is that use of clinical information systems in the medical encounter may compete with time devoted to addressing patient needs and concerns. For example, use of a computer by a physician in an exam room is associated with shorter responses to patients, less eye contact, failure to hear patient concerns, and frustration on the part of the patient in trying to judge when to talk based on the physician's interaction with the computer.[31,32]

Not surprisingly, patients who reported that they have been adherent to all four self-care behaviors (diet, exercise, self-monitoring of blood glucose, and medication adherence) for at least the past six months—that is, maintenance stage of change—had better control of all three CV risk factors, which is in agreement with previous studies.[15,33,34] One strength of this study is that these patient self-care behaviors were accounted for in the analysis. Failure to adjust for patient self-care behaviors may explain why earlier studies were unable to find a relationship between implementation of the CCM and control of these three CV risk factors.[16]

The limitations of the study include the small number of primary care clinics from a limited geographic region of the country, limitations imposed by the cross-sectional nature of data, as well as selection bias of consecutive patients. The recruitment of consecutive patients presenting for care in each clinic may have resulted in selection bias in that subjects who enrolled had worse control of their diabetes, BP, or lipids and had worse overall health status or a greater number and severity of comorbidities. However, control of A1C, BP, and lipids in this sample were little different than that of nationally representative samples.[2] Another concern reflects the ability of clinicians to self-rate themselves and their settings on each element of the CCM using the ACIC survey. Even so, results of this study and other studies suggest that these self-rated scores are associated with chronic disease outcomes in a manner that supports the CCM overall.[12,13,20,29,30]

### Implications

Although prior studies have suggested that elements of the CCM are associated with process quality of care indicators, this

## Appendix 1. Assessment of Chronic Illness Care Components

**I. Organization of the Practice/Clinic**
1. Organizational commitment for diabetes management
2. Improving strategies for diabetes management
3. Incentives and regulations for diabetes management
4. Senior leaders

**II. Community Linkages**
5. Linking primary care clinicians to diabetes specialists and educators
6. Patients' diabetes education resources
7. Coordination of diabetes care guidelines

**III. Self-management Support**
8. Assessment and documentation of self-management needs and activities
9. Self-management support
10. Addressing concerns of diabetes patients and families
11. Effective behavior change interventions and peer support

**IV. Decision Support**
12. Evidence-based guidelines for diabetes
13. Involvement of diabetes specialists in improving primary care
14. Provider education for diabetes care

**V. Delivery System Design**
15. Practice team functioning
16. Practice team leadership
17. Appointment system
18. Follow-up
19. Planned visits for diabetes management
20. Continuity and coordination of care

**VI. Clinical Information Systems**
21. A registry (list of patients with diabetes)
22. Reminders to providers
23. Feedback available to team
24. Information about relevant subgroups of patients needing services
25. Patient treatment plans

**Source:** Bonomi A.E., et al.: Assessment of chronic illness care (ACIC): A practical tool to measure quality improvement. *Health Serv Res* 37:791–820, Jun. 2002.

study suggests that control of risk factors for the most common cause of morbidity and mortality among patients with diabetes, CV disease, is associated with specific elements of the structure and design of the clinical microsystem where care is delivered, specifically, linkages to community resources and the design of the delivery system within the primary care setting. In addition to focusing on clinician knowledge, future interventions may need to address these elements if we are to reduce the burden of CV disease among patients with Type 2 diabetes. Studies are currently underway to evaluate this approach and should go a long way toward informing us about the structure and design of the primary care clinic of the future.[35]

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