
The Chronic Care Model and Relationships to Patient Health Status and Health-Related Quality of Life

Dorothy Y. Hung, PhD, MPH, Russell E. Glasgow, PhD, L. Miriam Dickinson, PhD, Desiree B. Froshaug, MS, Douglas H. Fernald, MA, Bijal A. Balasubramanian, MBBS, PhD, Larry A. Green, MD

Background: The chronic care model (CCM) is a system-level framework used to guide quality improvement efforts in health care. However, little is known about its relationship to patient-level health measures. This study describes the implementation of the CCM as adapted for prevention and health behavior counseling in primary care practices, and examines relationships between the CCM and patient health measures, including general health status and health-related quality of life (HRQOL).

Methods: Baseline data from Round 2 of the Prescription for Health initiative (2005–2007) were used to assess CCM implementation in 57 practices located nationwide. Relationships between the CCM and three separate measures of health among 4735 patients were analyzed in 2007. A hierarchical generalized linear modeling approach to ordinal regression was used to estimate categories of general health status, unhealthy days, and activity-limiting days, adjusting for patient covariates and clustering effects.

Results: Outcome variances were significantly accounted for by differences in practice characteristics ($p < 0.001$). Practices that used individual or group planned visits were more likely to see patients in lower health categories across all measures (OR=0.74–0.81, $p < 0.05$). Practices that used patient registries, health promotion champions, evidence-based guidelines, publicly reported performance measures, and support for behavior change were associated with higher patient health levels (OR=1.28–1.98, $p < 0.05$).

Conclusions: A practice's implementation of the CCM was significantly related to patient health status and HRQOL. Adapting the CCM for prevention may serve to reorient care delivery toward more proactive behavior change and improvements in patient health outcomes.
(Am J Prev Med 2008;35(5S):S398–S406) © 2008 American Journal of Preventive Medicine

Introduction

Efforts to improve the quality of care have brought forth new conceptual frameworks and innovations for redesigning the healthcare setting. The chronic care model (CCM) is a comprehensive framework featuring six major areas for quality improvement: (1) the health system and organization of care, (2) self-management support for patients to participate in managing their own care, (3) a delivery system design that proactively determines and addresses health needs, (4) decision support for clinicians

based on scientific evidence, (5) clinical information systems that provide access to patient population data, and (6) linkages to community resources to facilitate care outside the clinical setting. These elements are conceptualized as fostering productive interactions between patients and healthcare providers, resulting in improved patient outcomes.¹

While most empirical work on the CCM thus far has focused on the management of chronic illnesses such as diabetes, cardiovascular disease, hypertension, and asthma,^{2–10} the model has also been explored preliminarily as a template for prevention and for the delivery of services that address health risk behaviors.^{11,12} This focus on prevention and behavior change is consistent with a growing sense that quality improvement in health care must facilitate a transformation of the healthcare system from its current pattern of reacting to illness and responding mainly when a person is sick to a more proactive focus on promoting health and preventing disease among individuals and populations.^{13,14}

From the Department of Sociomedical Sciences, Columbia University Mailman School of Public Health (Hung), New York, New York; Kaiser Permanente (Glasgow), Denver; the Department of Family Medicine, School of Medicine, University of Colorado Denver (Dickinson, Froshaug, Fernald, Green), Aurora, Colorado; and the Department of Family Medicine, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School (Balasubramanian), Somerset, New Jersey

Address correspondence and reprint requests to: Dorothy Y. Hung, PhD, MPH, 722 W. 168th Street, Suite 548, New York NY 10032. E-mail: dh2237@columbia.edu.

Also, most studies of the CCM to date have focused on improving provider delivery of care processes (e.g., periodic measurement of HbA1c, lipid levels). Yet patient health outcomes are also important indicators of care quality. While prior studies have included such outcomes, these measures have typically been aggregated across patients within a healthcare organization.^{2,4,5} Two exceptions include recent studies^{8,9} that examined disaggregated patient health measures (e.g., asthma-specific quality of life, risk for developing coronary heart disease).

The current research seeks to further this study of the CCM and patient-level outcomes and to extend knowledge of the model specifically as a framework for preventive care and behavior change. Due to the CCM's increasing popularity as a conceptual tool for quality improvement and health-systems redesign, there is need to gather more information on its uses as grounded in the reality of frontline medical practice. This study addresses three main research questions: (1) What was the status of the CCM in a national sample of primary care practices that proactively implemented this model? (2) Were CCM components that were tailored to address preventive care and health risk behaviors associated with patient health measures across practices? and (3) How did varying levels of CCM implementation relate to patient health status and health-related quality of life (HRQOL), adjusting for patient covariates and clustering effects?

Methods

Data Sources

This study used data collected from Round 2 of the national Prescription for Health initiative (2005–2007) sponsored by the Robert Wood Johnson Foundation. This initiative supported interventions for behavior change that were conducted in primary care practice-based research networks (PBRNs) throughout the U.S. Cross-sectional data from three survey instruments were used. Two surveys were collected at the practice level and assessed general practice characteristics, clinical systems/structures, and care delivery processes. Patient-level surveys were administered in each practice to assess patients' sociodemographic characteristics, behavioral risk factors, general health status, and HRQOL. For this study, only practices with corresponding patient data were selected for analysis, yielding a total of 57 practices and 4735 patients.

Measures

Dependent variables. Patient outcomes included three separate measures of general health status and HRQOL. All questions were based on the CDC's Healthy Days core measures, which included four items.¹⁵ The first item assessed general health status according to five categories: excellent, very good, good, fair, or poor, and was analyzed as a five-level ordinal outcome.

The following two survey items assessed the number of days that respondents felt that they had physically or mentally

unhealthy days.^{16,17} The first question was *Thinking about your physical health (e.g., physical illness, injury), for how many days during the past 30 days was your physical health not good?* The second question was *Now thinking about your mental health (e.g., stress, depression, problems with emotions), for how many days during the past 30 days was your mental health not good?* An overall HRQOL measure of unhealthy days experienced in the past month was calculated according to the CDC's scoring protocol of summing responses and truncating at 30 days.¹⁷ Due to this variable's bimodal distribution, it was analyzed as a three-level ordinal outcome: 0 unhealthy days, 1–13 unhealthy days, and 14–30 unhealthy days.¹⁷

Another measure assessing HRQOL was the number of activity-limiting days: *During the past 30 days, for how many days did poor physical or mental health keep you from doing your usual activities (e.g., self-care, work, recreation)?*¹⁵ The same ordinal categories for unhealthy days were used: 0 limiting days, 1–13 limiting days, and 14–30 limiting days. All items used to measure general health status and HRQOL were shown to be valid, reliable, and responsive to change in conditions related to chronic diseases (e.g., nutritional risk).^{16,18}

Independent variables. Prescription for Health grantees proactively designed interventions that incorporated the CCM, and specific features were operationalized based on conceptual and empirical examples from the literature. The CCM element of health system/organization of care was characterized by two practice features. The first was whether the practice was owned by a larger health system, such as a hospital or university health system, versus a clinician, public sponsor, or other entity.^{3,7,19,20} The second feature was whether the practice publicly reported performance information (e.g., patient satisfaction, chronic care/disease management, preventive service delivery) to payers, health plans, or large employers.^{2,6,7,19}

The self-management support element of the CCM was characterized by a practice's use of patient reminder cards and support for patients ready to engage in behavior change.^{2,6,7,19,20} Questions measuring support for behavior change were adapted from the Assessment of Chronic Illness Care (ACIC) survey^{6,7} in consultation with experts and collaborators on the Prescription for Health initiative. A practice's support for behavior change included (1) the distribution of information (pamphlets, booklets); (2) referral to behavior-change classes or health educators; (3) support from behavior-change specialists who were affiliated with the practice and who saw patients on referral; or (4) support from behavior-change specialists affiliated with the practice, who saw patients on referral, and were trained in patient empowerment and problem-solving methodologies. Each approach was assessed separately for tobacco use, unhealthy diet, physical inactivity, and risky alcohol use. Responses were summed across behaviors and standardized to range from 0, indicating minimum support, to 1, representing maximum support for all four behaviors.

Indicators of delivery system design included whether practices had either a multispecialty or single-specialty physician staff and whether practices used planned visits in the form of group or individual meetings for preventive care.^{2,6,7,19,20} Practices reporting that planned visits were either an option, actively promoted, or used for most patients were considered to have implemented this into their delivery

Table 1. Practice characteristics and implementation of CCM elements (N=57)

CCM elements	n	% or M (SD)
Health system and organization of care		
Practice ownership		
Hospital health system	22	38.6
University health system	11	19.3
Clinician wholly or partially	17	29.8
Public sponsor	4	7.0
Other	3	5.3
Public reporting of practice performance	26	45.6
Self-management support		
Support for behavior change (range 0.25–1)	57	0.45 (0.19)
Patient reminder cards	22	38.6
Delivery system design		
Specialty type		
Single specialty	41	71.9
Multispecialty	16	28.1
Group or individual planned visits for prevention	29	50.9
Practice champions or leaders who promote health	39	68.4
Decision support		
Evidence-based guidelines for treating risk behaviors (range 0–1)	57	0.47 (0.46)
Personal digital assistant	25	43.9
Clinical information systems		
Patient registry	35	61.4
EMRs	30	52.6
Electronic patient records	28	49.1
E-prescribing	20	35.1
Electronic lab orders	19	33.3
Electronic interface with hospital records	20	35.1
Number of EMR functions (range 0–4)	57	1.53 (1.67)
Community resources		
Linkages to resources for behavior change (range 0–1)	57	0.59 (0.42)

CCM, chronic care model; EMR, electronic medical record

system design. The presence of practice champions or leaders who mobilized others to make and sustain improvements to health promotion was also included as a part of the delivery system design.^{2,7} This item was measured on a 5-point Likert scale, and responses of *agree* or *strongly agree* were considered affirmative.

Decision support consisted of a practice's integration and support of evidence-based guidelines for treating risk behaviors.^{2,6,7,19–21} Responses to these ACIC-adapted questions on evidence-based guidelines included (1) *not available*; (2) *available but not integrated into care delivery*; (3) *available and supported by clinician education*; or (4) *available, supported by clinician education, and integrated into care through reminders and other clinician behavior-change methods*. Practices that integrated guidelines into care delivery and/or supported guidelines through clinician education were considered to have implemented decision support. These responses were assessed for each risk behavior, summed, and standardized across the four behaviors. Computerized decision support for clinicians in the form of personal digital assistants (PDAs) was

also included.¹⁹ Typical uses for PDAs included reference to medication, diagnostic, and therapeutic information.

The implementation of clinical information systems was assessed by whether practices used registries to track patients with specific conditions.^{2,6,7,19,20} These conditions included chronic illnesses such as diabetes, high cholesterol, hypertension, coronary artery disease, asthma, and cancer, as well as behavioral risk factors including tobacco use, unhealthy diet, physical inactivity, and risky alcohol use. Additionally, the extent of a practice's use of electronic medical records (EMRs) was indicated by the sum of four EMR capabilities: patient records, e-prescribing, lab orders, and electronic interface with hospital records.^{2,20,22}

Finally, the community resources element was assessed according to what approach practices used to link patients to

Table 2. Patient characteristics (N=4735)

Health measures and patient covariates	n	% or M (SD)
General health status		
Excellent	188	4.0
Very good	978	21.2
Good	1784	38.6
Fair	1238	26.8
Poor	434	9.4
Unhealthy days		
Number of physical/mental unhealthy days in past month (range 0–30)	3945	11.4 (11.9)
0	1041	26.4
1–13	1465	37.1
≥14	1439	36.5
Activity-limiting days		
Days kept from doing usual activities (e.g., self-care, work, recreation, in past month; range 0–30)	3502	5.4 (9.2)
0	1876	53.6
1–13	1030	29.4
≥14	596	17.0
Age (years)		
18–39	1348	28.9
40–54	1476	31.6
55–64	925	19.8
≥65	921	19.7
Gender		
Male	1319	27.9
Female	3377	71.3
Race		
Non-Hispanic white	2652	58.1
Non-Hispanic black	775	17.0
Hispanic	915	20.0
Other	226	4.9
Education		
<High school	748	16.7
High school graduate	3736	83.3
Income (\$)		
<25,000	1963	48.7
25,000–50,000	1035	25.7
>50,000	1029	25.6
Overweight/obese		
Yes	3470	76.5
No	1064	23.5
Smoker		
Yes	1206	26.2
No	3390	73.8

Table 3. Bivariate results: CCM elements, patient characteristics, and patient health measures across practices

	General health status <i>n</i> (%)					χ^2 or <i>F</i>	HRQOL <i>M</i> (SD) or Pearson <i>r</i>	
	Excellent	Very good	Good	Fair	Poor		Unhealthy days	Activity-limiting days
Health system and organization of care								
Practice ownership						79.3***	<i>t</i> = -2.40*	<i>t</i> = -1.44
Hospital or university health system	109 (3.9)	494 (17.9)	1036 (37.4)	827 (29.9)	301 (10.9)		11.8 (12.1)	5.6 (8.9)
Other	79 (4.3)	484 (26.1)	748 (40.3)	411 (22.2)	133 (7.2)		10.9 (11.5)	5.2 (9.4)
Public reporting of performance						169.3***	<i>t</i> = 8.93***	<i>t</i> = 8.57***
Yes	118 (5.2)	594 (26.4)	918 (40.8)	458 (20.4)	160 (7.1)		9.7 (11.1)	4.1 (8.1)
No	70 (2.9)	384 (16.2)	866 (36.5)	780 (32.9)	274 (11.5)		13.1 (12.3)	6.7 (10.0)
Self-management support								
Support for behavior change <i>M</i> (SD)	0.41 (0.17)	0.41 (0.16)	0.44 (0.18)	0.50 (0.20)	0.52 (0.20)	<i>F</i> = 56.1***	<i>r</i> = 0.14***	<i>r</i> = 0.09***
Patient reminder cards						16.2**	<i>t</i> = -1.08	<i>t</i> = 1.58
Yes	77 (4.5)	322 (19.0)	702 (41.4)	427 (25.2)	168 (9.9)		11.7 (12.0)	5.1 (9.0)
No	111 (3.8)	656 (22.4)	1082 (37.0)	811 (27.7)	266 (9.1)		11.3 (11.8)	5.6 (9.3)
Delivery system design								
Multispecialty staff						130.8***	<i>t</i> = -4.93***	<i>t</i> = -2.01*
Yes	44 (3.8)	152 (13.1)	396 (34.3)	395 (34.2)	169 (14.6)		13.1 (12.2)	6.0 (9.6)
No	144 (4.2)	826 (23.8)	1388 (40.0)	843 (24.3)	265 (7.6)		10.9 (11.7)	5.3 (9.0)
Group/individual planned visits for prevention						17.0**	<i>t</i> = 2.71**	<i>t</i> = 1.46
Yes	97 (3.9)	543 (21.9)	896 (36.1)	709 (28.5)	239 (9.6)		10.9 (11.7)	5.2 (9.2)
No	91 (4.3)	435 (20.3)	888 (41.5)	529 (24.7)	195 (9.1)		12.0 (12.0)	5.7 (9.3)
Practice champions who promote health						38.1***	<i>t</i> = 5.90***	<i>t</i> = 6.98***
Yes	178 (4.4)	895 (21.9)	1594 (39.0)	1060 (25.9)	362 (8.9)		11.1 (11.7)	5.1 (8.9)
No	10 (1.9)	83 (15.6)	190 (35.6)	178 (33.4)	72 (13.5)		14.7 (12.3)	8.9 (11.1)
Decision support								
Evidence-based guidelines for risk behaviors <i>M</i> (SD)	0.55 (0.48)	0.56 (0.48)	0.55 (0.46)	0.48 (0.44)	0.49 (0.43)	<i>F</i> = 6.20***	<i>r</i> = -0.05**	<i>r</i> = -0.02
Personal digital assistant						213.9***	<i>t</i> = -9.54***	<i>t</i> = -6.06***
Yes	63 (2.9)	318 (14.5)	813 (37.0)	725 (33.0)	278 (12.7)		13.3 (12.3)	6.4 (9.8)
No	125 (5.2)	660 (27.2)	971 (40.0)	513 (21.2)	156 (6.4)		9.8 (11.2)	4.5 (8.6)
Clinical information systems								
Patient registry						112.3***	<i>t</i> = 9.64***	<i>t</i> = 9.94***
Yes	140 (5.0)	659 (23.7)	1138 (40.9)	632 (22.7)	213 (7.7)		10.0 (11.3)	4.2 (8.3)
No	48 (2.6)	319 (17.3)	646 (35.1)	606 (32.9)	221 (12.0)		13.7 (12.4)	7.3 (10.2)
Number of EMR functions	1.65 (1.54)	1.83 (1.54)	1.91 (1.54)	1.92 (1.55)	1.99 (1.55)	<i>F</i> = 2.10*	<i>r</i> = -0.04*	<i>r</i> = 0.04*
Community resources								
Linkages to community resources <i>M</i> (SD)	0.70 (0.41)	0.67 (0.43)	0.64 (0.44)	0.55 (0.46)	0.56 (0.46)	<i>F</i> = 14.7***	<i>r</i> = 0.07***	<i>r</i> = 0.07**
Patient age (years)								
18-39	67 (5.1)	286 (21.7)	525 (39.8)	341 (25.8)	101 (7.7)	37.2***	<i>F</i> = 20.6***	<i>F</i> = 4.83**
40-54	49 (3.4)	262 (18.0)	560 (38.6)	412 (28.4)	169 (11.6)		12.1 (11.5)	5.0 (8.3)
55-64	35 (3.9)	201 (22.2)	331 (36.6)	245 (27.1)	93 (10.3)		12.6 (12.2)	6.2 (9.7)
≥65	36 (4.1)	213 (24.0)	351 (39.6)	222 (25.0)	65 (7.3)		11.2 (12.1)	5.5 (9.5)
Gender								
Male	128 (3.9)	696 (21.1)	1267 (38.4)	904 (27.4)	306 (9.3)	3.84	8.3 (11.1)	4.8 (9.4)
Female	60 (4.7)	275 (21.4)	506 (39.3)	321 (25.0)	125 (9.6)		<i>t</i> = 4.87***	<i>t</i> = -0.70
							12.0 (11.8)	5.4 (9.0)
							10.0 (11.8)	5.6 (9.8)
Race								
White	112 (4.3)	662 (25.5)	1038 (39.9)	581 (22.3)	207 (8.0)	192.9***	<i>F</i> = 8.74***	<i>F</i> = 7.91***
Black	28 (3.7)	135 (17.8)	312 (41.1)	224 (29.5)	61 (8.0)		11.0 (11.7)	5.2 (9.0)
Hispanic	31 (3.4)	90 (10.0)	303 (33.6)	346 (38.4)	132 (14.6)		11.0 (11.6)	4.7 (8.7)
Other	11 (5.1)	52 (24.3)	80 (37.4)	50 (23.4)	21 (9.8)		13.5 (12.5)	6.9 (10.2)
							10.7 (11.9)	5.9 (10.0)

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Table 3. Bivariate results: CCM elements, patient characteristics, and patient health measures across practices (continued)

	General health status n (%)					HRQOL M (SD) or Pearson r		
	Excellent	Very good	Good	Fair	Poor	χ^2 or F	Unhealthy days	Activity-limiting days
Education						133.4***	t = -4.98***	t = -4.88***
<High school graduate	23 (3.1)	80 (10.9)	237 (32.4)	885 (38.5)	301 (15.0)		13.8 (12.7)	10.6 (7.3)
≥High school graduate	159 (4.3)	853 (23.2)	1472 (40.1)	282 (24.1)	110 (8.2)		11.1 (11.7)	8.9 (5.1)
Income (\$)						574.3***	F = 139.3***	F = 113.3***
<25,000	35 (1.8)	208 (10.8)	665 (34.5)	723 (37.5)	295 (15.3)		15.2 (12.2)	8.3 (10.8)
25,000–50,000	43 (4.2)	268 (26.1)	457 (44.6)	203 (19.8)	54 (5.3)		9.9 (11.1)	3.5 (7.2)
>50,000	65 (6.4)	365 (36.0)	414 (40.8)	144 (14.2)	26 (2.6)		7.7 (10.0)	3.0 (6.6)
Overweight/obese						148.9***	t = -3.98***	t = -3.20***
Yes	108 (3.2)	624 (18.4)	1327 (39.0)	996 (29.3)	345 (10.1)		11.9 (12.0)	5.7 (9.4)
No	76 (7.3)	329 (31.6)	380 (36.5)	188 (18.1)	67 (6.4)		10.1 (11.2)	4.5 (8.5)
Smoker						123.2***	t = -10.3***	t = -9.06***
Yes	23 (2.0)	263 (13.8)	443 (37.8)	377 (32.1)	168 (14.3)		14.6 (12.2)	7.6 (10.4)
No	162 (4.9)	806 (24.2)	1303 (39.1)	809 (24.3)	255 (7.6)		10.2 (11.5)	4.5 (8.5)

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

CCM, chronic care model; EMR, electronic medical record; HRQOL, health-related quality of life

outside community resources.^{2,6,7,23} Responses to these ACIC-adapted questions included (1) *no systematic approach*; (2) *list of identified community resources*; (3) *designated staff person responsible for ensuring that providers and patients make maximum use of community resources*; or (4) *coordination and feedback between the practice, community service agencies, and patients*. Practices with no systematic approach were considered not to have implemented this CCM component. Responses for each of the four behaviors were summed and standardized across practices.

Patient covariates included age, gender, race/ethnicity, education, and income. Clinical covariates included obesity/overweight (BMI ≥ 25 kg/m²) and smoking status. Respondents were identified as smokers if they reported having smoked 100 cigarettes in their lifetime and had smoked at least part of a cigarette in the last 30 days.

Statistical Analysis

Practice and patient characteristics were described, followed by the analysis of unadjusted bivariate relationships between each CCM component and patient health measure. Because patient data were nested within practice data, hierarchical generalized linear modeling (HGLM) was used.²⁴ Unconditional models produced significantly large intraclass correlation coefficients, indicating that a large portion of outcome variances were accounted for by practice differences ($p < 0.001$). Thus, patient outcomes were modeled at two levels, using restricted maximum likelihood estimation. Beginning with all conceptually relevant variables, a backward elimination of CCM components was used to avoid problems of overfitting and to produce models that were stable. An HGLM cumulative probability approach to ordinal logistic regression was used to estimate categories of general health status, unhealthy days, and activity-limiting days. All analyses were conducted in 2007, and multilevel models were analyzed using HLM version 6.02.

Results

Table 1 describes practices in the study and their implementation of CCM components. Approximately 58% of the practices belonged to a hospital or university health system, and reported moderate support for patients' behavior change, as assessed on a spectrum ranging from limited approaches (e.g., pamphlet distribution) to comprehensive involvement by behavior-change specialists. Approximately 28.1% had a multi-specialty physician staff, 50.9% reported using group or individual planned visits for preventive care, and 68.4% had champions or leaders for health promotion. There was moderate integration of evidence-based guidelines for treating risk behaviors, and 43.9% reported using computerized forms of decision support such as PDAs. Approximately two thirds of practices used a patient registry and linked patients to community resources for behavior change.

Table 2 describes the characteristics of patients included in the study sample. Approximately 65% re-

ported being in good or fair health. The average number of physical or mental unhealthy days experienced in the past month was 11.4, and the average number of days in which poor health kept patients from doing usual activities was 5.4. Most patients were female (71.3%); aged <55 years (60.5%); non-Hispanic white (58.1%); and high school educated (83.3%). Slightly more than half (51.3%) reported an annual income of at least \$25,000. Approximately three quarters of the sample were overweight/obese and reported being nonsmokers.

Table 3 presents unadjusted bivariate associations among practices' implementation of the CCM, patients' characteristics and health measures. Across practices, general health status varied significantly according to CCM elements such as the health system and organization of care, self-management support for behavior change, delivery system design, integration of decision support, use of clinical information systems, and community resources ($p<0.01$). There were also significant relationships among almost all CCM components and both unhealthy and activity-

limiting days ($p<0.05$). Patients' ages, race/ethnicity, education, income, and behavioral risk factors were significantly related to all health measures across practices ($p<0.01$).

Adjusting for patient covariates and clustering in Table 4, patients seen in hospital/university health system–owned practices (OR=0.73, $p<0.01$) and multispecialty practices (OR=0.67, $p<0.01$) were likely to be in a lower health category. Similarly, patients in practices that used group/individual planned visits for prevention (OR=0.81, $p<0.05$) and PDAs for clinician-decision support (OR=0.61, $p<0.01$) reported lower health status. In contrast, patients in practices that supported behavior change (OR=1.98, $p<0.05$); had health promotion champions onsite (OR=1.47, $p<0.001$); and used patient registries (OR=1.33, $p<0.01$) had better general health status. Within-practice modeling found that patients with less than a high school education (OR=0.67, $p<0.001$) and lower incomes (OR=0.31, $p<0.001$) had lower health status, as did overweight/obese patients (OR=0.50, $p<0.001$) and smokers (OR=0.64, $p<0.001$).

Table 4. HGLM results: CCM and patient correlates of better general health status

	Coefficient (SE)	OR (95% CI)
CCM ELEMENTS		
Intercept	-2.38 (0.22)***	0.09 (0.05, 0.14)
Health system and organization of care		
Hospital or university health system	-0.30 (0.08)**	0.73 (0.61, 0.87)
Self-management support		
Support for behavior change	0.68 (0.27)*	1.98 (1.14, 3.44)
Delivery system design		
Multispecialty practice	-0.38 (0.11)**	0.67 (0.54, 0.85)
Group/individual planned visits for preventive care	-0.19 (0.09)*	0.81 (0.68, 0.98)
Practice champions who promote health	0.38 (0.09)***	1.47 (1.20, 1.79)
Decision support		
Personal digital assistant	-0.49 (0.10)**	0.61 (0.49, 0.75)
Clinical information systems		
Patient registry	0.28 (0.08)**	1.33 (1.12, 1.57)
PATIENT CHARACTERISTICS		
Age (years) (ref: 18–39)		
40–54	-0.16 (0.08)	0.85 (0.72, 1.00)
55–64	-0.09 (0.10)	0.90 (0.73, 1.12)
≥65	-0.11 (0.13)	0.88 (0.67, 1.16)
Gender (ref: female)		
Male	0.04 (0.07)	1.05 (0.91, 1.21)
Race (ref: non-Hispanic white)		
Non-Hispanic black	-0.06 (0.09)	0.93 (0.77, 1.12)
Hispanic	-0.11 (0.10)	0.89 (0.72, 1.10)
Other	-0.08 (0.13)	0.91 (0.70, 1.20)
Education (ref: high school graduate)		
<High school	-0.38 (0.08)***	0.67 (0.57, 0.80)
Income (\$) (ref: >50,000)		
<25,000	-1.15 (0.10)***	0.31 (0.25, 0.38)
25,000–50,000	-0.41 (0.10)***	0.66 (0.53, 0.81)
Risk factors		
Overweight/obese	-0.68 (0.11)***	0.50 (0.40, 0.63)
Smoker	-0.43 (0.06)***	0.64 (0.57, 0.73)

Note: Better general health status is defined as higher categories measured on the ordinal scale: excellent, very good, good, fair, poor.

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

CCM, chronic care model; HGLM, hierarchical generalized linear model

Table 5. HGLM results: CCM and patient correlates of fewer unhealthy days

	Coefficient (SE)	OR	95% CI
CCM ELEMENTS			
Intercept	-1.48 (0.15)***	0.22	(0.16, 0.30)
Health system and organization of care			
Public reporting of performance	0.25 (0.07)**	1.28	(1.09, 1.51)
Self-management support			
Patient reminder cards	-0.36 (0.08)***	0.69	(0.58, 0.82)
Delivery system design			
Group/individual planned visits for prevention	-0.29 (0.08)**	0.74	(0.62, 0.89)
Practice champions who promote health	0.34 (0.07)***	1.41	(1.22, 1.64)
Decision support			
Evidence-based guidelines for risk behaviors	0.26 (0.07)**	1.30	(1.12, 1.51)
Clinical Information systems			
Patient registry	0.26 (0.08)**	1.29	(1.09, 1.53)
Number of EMR functions	0.07 (0.02)**	1.08	(1.03, 1.13)
PATIENT CHARACTERISTICS			
Age (years) (ref: 18-39)			
40-54	0.03 (0.10)	1.03	(0.84, 1.25)
55-64	0.31 (0.12)**	1.37	(1.07, 1.74)
≥65	0.65 (0.13)***	1.91	(1.45, 2.52)
Gender (ref: female)			
Male	0.38 (0.08)***	1.46	(1.23, 1.73)
Race (ref: non-Hispanic white)			
Non-Hispanic black	0.28 (0.09)**	1.33	(1.11, 1.59)
Hispanic	0.29 (0.11)*	1.34	(1.07, 1.68)
Other	0.20 (0.16)	1.23	(0.89, 1.70)
Education (ref: high school graduate)			
<High school	-0.19 (0.12)	0.82	(0.64, 1.05)
Income (\$) (ref: >50,000)			
<25,000	-0.84 (0.09)***	0.42	(0.35, 0.51)
25,000-50,000	-0.35 (0.11)**	0.70	(0.56, 0.87)
Risk factors			
Overweight/obese	-0.13 (0.07)	0.87	(0.75, 1.02)
Smoker	-0.30 (0.09)**	0.73	(0.61, 0.88)

Note: Fewer unhealthy days is defined as lower categories measured on the ordinal scale: 0, 1-13, 14-30 unhealthy days.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

CCM, chronic care model; EMR, electronic medical record; HGLM, hierarchical generalized linear model

Tables 5 and 6 present estimates of unhealthy days and activity-limiting days that reflected similar trends observed with general health status. Adjusting for patient covariates and clustering, practices that used group/individual planned visits for prevention and patient reminder cards saw patients with more unhealthy (OR=0.69, $p < 0.001$) or activity-limiting days (OR=0.74, $p < 0.05$). In contrast, practices that used patient registries, health promotion champions, and evidence-based guidelines for treating risk behaviors had patients with fewer unhealthy days (OR=1.29-1.41, $p < 0.01$) and fewer activity-limiting days (OR=1.40-1.51, $p < 0.05$). In addition, public reporting of performance measures (OR=1.28, $p < 0.01$) and the number of EMR functions (OR=1.08, $p < 0.01$) were both associated with fewer unhealthy days, while EMR use was associated with more activity-limiting days (OR=0.91, $p < 0.05$). Within these study practices, higher HRQOL was associated with being older, male, more affluent, African American or Hispanic, and without behavioral risk factors ($p < 0.05$).

Discussion

This study found that features consistent with the CCM and adapted for behavior change were implemented to a moderate degree among frontline primary care practices participating in Round 2 of the Prescription for Health initiative. Comparisons with a similar national sample of practices participating in Round 1 suggest an increased adoption of the CCM, with the most dramatic change involving the implementation of clinical information systems.¹² Reported rates of using patient registries doubled from 32% to 61% over the course of approximately 3 years, and rates of using EMR systems more than tripled from 15% to 53%. These increases suggest a much greater awareness and investment in monitoring patient-population data, and transitioning from paper to electronic storage and management of clinical information. Seeking to understand how patients' health may be affected by practice implementation of features outlined by the CCM is important and timely.

These findings indicate that three separate measures of patient health and HRQOL performed similarly in

Table 6. HGLM results: CCM and patient correlates of fewer activity-limiting days

	Coefficient (SE)	OR (95% CI)
CCM ELEMENTS		
Intercept	0.08 (0.27)	1.08 (0.62, 1.90)
Delivery system design		
Group/individual planned visits for prevention	-0.29 (0.12)*	0.74 (0.57, 0.95)
Practice champions who promote health	0.53 (0.19)**	1.71 (1.16, 2.53)
Decision support		
Evidence-based guidelines for risk behaviors	0.33 (0.15)*	1.40 (1.03, 1.91)
Personal digital assistant	-0.21 (0.12)	0.80 (0.62, 1.04)
Clinical information systems		
Patient registry	0.41 (0.13)**	1.51 (1.14, 2.01)
Number of EMR functions	-0.08 (0.04)*	0.91 (0.84, 0.99)
Community resources		
Linkages to community resources	-0.31 (0.16)	0.72 (0.51, 1.01)
PATIENT CHARACTERISTICS		
Age (years) (ref: 18–39)		
40–54	0.14 (0.09)	1.15 (0.96, 1.39)
55–64	0.27 (0.11)*	1.32 (1.04, 1.67)
≥65	0.48 (0.18)**	1.63 (1.14, 2.33)
Gender (ref: female)		
Male	0.17 (0.07)*	1.18 (1.02, 1.37)
Race (ref: non-Hispanic white)		
Non-Hispanic black	0.24 (0.08)**	1.27 (1.08, 1.49)
Hispanic	0.08 (0.11)	1.08 (0.87, 1.35)
Other	-0.09 (0.22)	0.90 (0.58, 1.41)
Education (ref: high school graduate)		
<High school	-0.14 (0.14)	0.86 (0.65, 1.14)
Income (\$) (ref: >50,000)		
<25,000	-0.69 (0.09)***	0.49 (0.41, 0.60)
25,000–50,000	-0.03 (0.09)	0.96 (0.80, 1.15)
Risk factors		
Overweight/obese	-0.23 (0.09)**	0.78 (0.66, 0.94)
Smoker	-0.32 (0.08)***	0.72 (0.60, 0.86)

Note: Fewer activity-limiting days is defined as lower categories measured on the ordinal scale: 0, 1–13, 14–30 days.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

CCM, chronic care model; EMR, electronic medical record; HGLM, hierarchical generalized linear model

relation to the CCM. Certain practice features were highlighted, reinforcing the idea that organizational characteristics can influence patient health outcomes. Specifically, practices' use of patient registries, of champions or leaders to promote health onsite, and the integration of evidence-based guidelines into clinical practice were routinely associated with healthier patients, while group or individual planned visits were routinely associated with sicker patients. The fact that sicker patients are often the recipients of more comprehensive care processes should be considered as one possible explanation for paradoxical relationships between better processes and worse outcomes.²⁵ On one hand, such findings may be encouraging, as they suggest that novel services are being used to proactively address health needs. On the other hand, they reflect the empirical challenge of establishing relationships between improved processes and patient outcomes, particularly in cross-sectional studies.^{4,26,27}

Another finding pertains to this study's simultaneous modeling of both patient and practice characteristics, which suggests significant differences not only among patients but also among care settings. At the practice

level, CCM components with greater effect sizes relative to others were features that have been specifically recommended by the IOM for improving quality. These include proactive support for behavior change, the implementation of clinical information systems, and the integration of specialized health professionals as part of the care delivery team.²⁸

The CCM increasingly is being used as a framework to guide quality improvement efforts in health care. It is not intended to be an explanatory theory but rather a synthesis of evidence-based system changes to improve care processes and, ultimately, patient outcomes.²⁹ These findings explore the relationships between the CCM and patient health measures, and offer preliminary insight into certain interventions with respect to others. For example, practices that staff health educators onsite versus refer patients to other venues may have different degrees of influence on patients' activities, including whether care will be sought beyond the clinical visit, and this is likely to affect health outcomes in the long term. However, providing care beyond the clinical setting is an important health promotion strategy, and its effectiveness may ultimately

depend on how accountability relationships between patients and various care providers are structured. Well-organized interventions may yield health benefits and warrant further, longitudinal study.

Limitations of this study include the cross-sectional data that are insufficient to establish causality. For a variety of reasons, different practices may tend to attract more- or less-healthy patients, although existing practice structures and care systems may also, in turn, lead to favorable health outcomes. While this study is suggestive of the CCM's utility as a framework for health behavior change in primary and secondary prevention, understanding the complexity of the interaction is a work in progress. Follow-up data from practices participating in this initiative are now being collected, offering further opportunities for longitudinal study. Additionally, the list of examined CCM components was not exhaustive as there may have been other related tools and structures that were not captured. Finally, the fact that all sites were part of a PBRN may affect the generalizability of results to other primary care practices.

Study strengths include an opportunistic ability to examine applications of the CCM through the Prescription for Health initiative, which involved a diverse sample of practices and patients across the country. Also, the use of advanced analytic approaches, such as ordinal HGLM, contributes to an improved understanding of possible systems-level effects on patient-level outcomes as conceptualized by the CCM.

Conclusion

This study reports on CCM implementation in frontline primary care practices, and finds significant differences between practices and corresponding associations with patient health measures. Increasing adaptation of the CCM for prevention and health behavior counseling may be an important step in proactively addressing health needs anywhere along the spectrum of health maintenance to disease management. Implementing system changes that are consistent with the CCM may serve to reorient care delivery toward more proactive behavior change and, ultimately, toward improvements in patient health outcomes.

This study was funded by grants #047075 and #053221 from the Robert Wood Johnson Foundation, and K02 HS017007 from the Agency for Healthcare Research and Quality.

No financial disclosures were reported by the authors of this paper.

References

1. Improving Chronic Illness Care. The chronic care model. www.improvingchroniccare.org.
2. Wagner EH, Glasgow RE, Davis C, et al. Quality improvement in chronic illness care: a collaborative approach. *Jt Comm J Qual Improv* 2001; 27:63–80.
3. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness: the chronic care model, Part 2. *JAMA* 2002;288:1909–14.
4. Sperl-Hillen JM, Solberg LI, Hroschicki MC, Crain AL, Engebretson KI, O'Connor PJ. Do all components of the chronic care model contribute equally to quality improvement? *Jt Comm J Qual Improv* 2004;30:303–9.
5. Stroebe RJ, Gloor B, Freytag S, et al. Adapting the chronic care model to treat chronic illness at a free medical clinic. *J Health Care Poor Under-served* 2005;16:286–96.
6. Bonomi AE, Wagner EH, Glasgow RE, VonKorff M. Assessment of chronic illness care (ACIC): a practical tool to measure quality improvement. *Health Serv Res* 2002;37:791–820.
7. Pearson ML, Wu SY, Schaefer J, et al. Assessing the implementation of the chronic care model in quality improvement collaboratives. *Health Serv Res* 2005;40:978–96.
8. Mangione-Smith R, Schonlau M, Chan KS, et al. Measuring the effectiveness of a collaborative for quality improvement in pediatric asthma care: does implementing the chronic care model improve processes and outcomes of care? *Ambul Pediatr* 2005;5:75–82.
9. Parchman ML, Zeber JE, Romero RR, Pugh JA. Risk of coronary artery disease in type 2 diabetes and the delivery of care consistent with the chronic care model in primary care settings: a STARNet study. *Med Care* 2007;45:1129–34.
10. Nutting PA, Dickinson WP, Dickinson LM, et al. Use of chronic care model elements in associated with higher-quality care for diabetes. *Ann Fam Med* 2007;5:14–20.
11. Glasgow RE, Orleans CT, Wagner EH, Curry SJ, Solberg LI. Does the chronic care model serve also as a template for improving prevention? *Milbank Q* 2001;79:579–612, iv–v.
12. Hung DY, Rundall TG, Tallia AF, Cohen D, Halpin HA, Crabtree BF. Rethinking prevention in primary care: applying the chronic care model to address health risk behaviors. *Milbank Q* 2007;85:69–91.
13. Wagner EH, Austin BT, Von Korff M. Organizing care for patients with chronic illness. *Milbank Q* 1996;74:511–44.
14. Calkins E, Boulc C, Wagner H, Pacala J. New ways to care for older people: building systems based on evidence. New York: Springer, 1999.
15. CDC. Measuring healthy days: population assessment of health-related quality of life. Washington DC: USDHHS, 2000.
16. Moriarty DG, Kobau R, Zack MM. Tracking health days: a window on the health of older adults. *Prev Chronic Dis* 2005;2:A16.
17. CDC. Health-related quality of life surveillance: U.S., 1993–2002. *MMWR Surveill Summ* 2005;54:1–35.
18. Keller HH, Ostbye T, Goy R. Nutritional risk predicts quality of life in elderly community-living Canadians. *J Gerontol A Biol Sci Med Sci* 2004;59:68–74.
19. Wagner EH, Davis C, Schaefer J, Von Korff M, Austin B. A survey of leading chronic disease management programs: are they consistent with the literature? *Manag Care Q* 1999;7:56–66.
20. Bodenheimer T, Wagner EH, Grumbach K. Improving primary care for patients with chronic illness. *JAMA* 2002;288:1775–9.
21. Woolf SH, Grol R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. *BMJ* 1999;318:527–30.
22. Rundall TG, Shortell SM, Wang MC, et al. As good as it gets? Chronic care management in nine leading U.S. physician organizations. *BMJ* 2002;325: 958–61.
23. Solberg LI. Guideline implementation: what the literature doesn't tell us. *Jt Comm J Qual Improv* 2000;26:525–37.
24. Raudenbush SW, Bryk AS. Hierarchical linear models: applications and data analysis methods. Thousand Oaks CA: Sage Publications, 2002.
25. Kahn KL, Tisnado DM, Adams JL, et al. Does ambulatory process of care predict health-related quality of life outcomes for patients with chronic disease? *Health Serv Res* 2007;42:63–83.
26. Kerr EA, Smith DM, Hogan MM, Hofer TP, Hayward RA. Avoiding pitfalls in chronic disease quality measurement: a case for the next generation of technical quality measurement. *Am J Manag Care* 2001;7:1033–43.
27. Leatherman S, Berwick DM, Iles D, et al. The business case for quality: case studies and an analysis. *Health Aff (Millwood)* 2003;22:17–30.
28. IOM. Crossing the quality chasm: a new health system for the 21st century. Washington DC: The National Academies Press, 2001.
29. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. *Health Aff (Millwood)* 2001;20:64–78.