

Impact of Clinical Complexity on the Quality of Diabetes Care

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Objectives: To assess the impact of clinical complexity on 3 dimensions of diabetes care.

Study Design: We identified 35,872 diabetic patients receiving care at 7 Veterans Affairs facilities between July 2007 and June 2008 using administrative and clinical data. We examined control at index and appropriate care (among uncontrolled patients) within 90 days, for blood pressure (<130/80 mm Hg), glycated hemoglobin (<7%), and low-density lipoprotein cholesterol (<100 mg/dL). We used ordered logistic regression to examine the impact of complexity, defined by comorbidities count and illness burden, on control at index and a combined measure of quality (control at index or appropriate follow-up care) for all 3 measures.

Results: There were 6260 (17.5%) patients controlled at index for all 3 quality indicators. Patients with ≥ 3 comorbidities (odds ratio [OR], 1.94; 95% confidence interval [CI], 1.67-2.26) and illness burden ≥ 2.00 (OR, 1.22; 95% CI, 1.13-1.32) were more likely than the least complex patients to be controlled for all 3 measures. Patients with ≥ 3 comorbidities (OR, 2.30; 95% CI, 2.07-2.54) and illness burden ≥ 2.00 (OR, 1.25; 95% CI, 1.18-1.33) were also more likely than the least complex patients to meet the combined quality indicator for all 3 measures.

Conclusions: Patients with greatest complexity received higher quality diabetes care compared with less complex patients, regardless of the definition of complexity chosen. Although providers may appropriately target complex patients for aggressive control, deficits in guideline achievement among all diabetic patients highlight the challenges of caring for chronically ill patients and the importance of structuring primary care to promote higher-quality, patient-centered care.

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The influence of clinical complexity on guideline adherence among chronically ill patients is an important consideration for quality-of-care assessments. This is particularly relevant for patients with diabetes, as approximately 80% of diabetic patients have at least 1 comorbid illness and 40% have 3 or more.^{1,2} The importance of comprehensive diabetes care, including glycemic, blood pressure (BP), and lipid control is widely acknowledged for most diabetic patients.³⁻⁷ Although improving decision support, clinical information systems, and self-management support has led to improvements in diabetes outcomes, studies consistently report suboptimal control across these dimensions.⁶⁻¹¹ Because achieving guideline-recommended treatment goals may have the greatest benefit in preventing diabetes-related complications among the most complex and thus highest risk patients, assessing the magnitude of deficits in care for these patients is critical.

Recent studies examining the relationship between clinical complexity and quality of chronic illness care have generally found that greater complexity is associated with higher levels of quality.¹²⁻¹⁵ In our prior work, we found that patients with higher complexity, defined as having both diabetes concordant and discordant conditions, were more likely to receive guideline-recommended diabetes care.¹² However, among diabetic patients, studies suggest that increasing the number, severity, and type of certain comorbidities predicts poorer self-management skills^{2,16} which may, in turn, result in poorer risk factor control. With the increasing number and complexity of comorbid conditions, both patients and healthcare providers may find risk factor control challenging. For example, compliance with clinical practice guidelines often requires that patients with multiple chronic conditions take numerous medications and make frequent visits for which adherence may be difficult.¹⁷ Further, healthcare providers are faced with time constraints and competing demands during office visits that may limit their ability to thoroughly address all clinical guidelines that pertain to an individual patient. Given these barriers, we sought to examine the relationship between 2 definitions of clinical complexity and quality of care for glycemic, BP, and lipid control among patients with diabetes.

METHODS

Study Population

We identified patients with diabetes who had a primary care visit

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between July 2007 and June 2008 at 7 midwestern Veterans Affairs (VA) facilities located in 3 states. We used the VA National Patient Care Database, VA fee-basis files, VA Decision Support System, and a VA network data warehouse which contains clinical and demographic information from patient medical records at the 7 facilities, to classify patients as having diabetes. We classified patients as having diabetes if they had the following: diagnoses codes indicating diabetes (2 outpatient codes or 1 inpatient code), filled prescriptions for diabetes medications (oral hypoglycemic agents or insulin), or at least 2 outpatient blood glucose readings ≥ 200 mg/dL recorded at least 1 day apart. Consistent with VA quality indicators,¹⁸ we excluded patients with documented limited life expectancy, including those receiving hospice care and those with metastatic cancer. To allow for equal opportunity for follow-up care, we also excluded patients who died during the study interval or follow-up period. We assigned each patient index dates based on the most recent reading for each measure (eg, the date of the last recorded BP reading for the hypertension measure). We also assessed each patient's past engagement with the VA healthcare system, by identifying the number of primary care and specialty care visits in the prior year, anchored from the patient's last primary care visit during the study interval. We included those specialty care clinics most likely to treat the comorbidities we studied and required the patient to have the coexisting condition appropriate to the clinic's treating specialty (eg, depression and psychiatry).

Clinical Complexity Definitions

We defined clinical complexity using 2 different approaches. First, we used a count of 6 common comorbidities to define complexity: hypertension, ischemic heart disease, hyperlipidemia, depression, arthritis, and chronic obstructive pulmonary disease. Patients were categorized as having 0, 1, 2, or ≥ 3 of these coexisting conditions. Second, we used the Diagnostic Cost Group Relative Risk Score (DCG RRS), a measure of patient illness burden, to define clinical complexity.¹⁹ The DCG RRS is a ratio of the patient's predicted cost to the average actual cost of the VA population. A score of 1.00 represents the cost of an "average" patient whereas a DCG RRS of <1.00 represents a lower-than-average cost (and illness burden), and a score of >1.00 represents a higher-than-average illness burden. We categorized patients into 4 categories of increasing illness severity: DCG RRS <0.50 , 0.50-0.99, 1.00-1.99, and ≥ 2.00 .

Take-Away Points

Studies have shown that greater clinical complexity is associated with higher quality; however, it is unknown if these findings persist when using different complexity definitions.

- We found that the most complex patients were more likely to meet blood pressure, glycemic, and lipid quality indicators than the least complex patients, regardless of complexity definitions chosen.
- While providers may appropriately target complex patients for aggressive risk factor control, there is room for improvement for all diabetic patients.
- These findings highlight the challenges of caring for chronically ill patients and the importance of implementing patient-centered approaches to chronic illness care.

Study Outcomes

We assessed the quality of diabetes care using the American Diabetes Association's³ recommendations for BP ($<130/80$ mm Hg), glycemic (glycated hemoglobin [A1C] $<7\%$), and low-density lipoprotein cholesterol (LDL-C <100 mg/dL) control using laboratory and vital sign readings obtained from the network data warehouse. Among those not meeting goals at the index visit or who did not have an index reading recorded, we examined a 90-day follow-up period from index to determine the receipt of appropriate follow-up care (ie, medication treatment intensification or controlled follow-up reading).¹²

Statistical Analyses

We determined the proportion of patients that were controlled at index and at the conclusion of a 90-day follow-up period for each of the 3 diabetes quality indicators. We used χ^2 analyses to assess the difference in the proportions of patients controlled at each timepoint. To allow ample time for follow-up in response to uncontrolled readings, we also assessed the proportion of patients uncontrolled at index that received appropriate follow-up care (ie, medication treatment intensification or controlled reading) within 90 days of index for each quality indicator. Next, to examine a single longitudinal measure of quality, we combined patients who were controlled at index and those who received appropriate follow-up care. We then performed separate generalized ordered logistic regression analyses to examine the impact of each definition of clinical complexity on achieving control at index and the combined measure of quality. The models included a variable with 4 level-ordered values (0 = patient did not meet any of the quality indicators [ie, control at index or combined measure of quality]; 1 = patient met only 1 of the indicators; 2 = only 2 of the indicators; and 3 = all of the indicators). We adjusted all models for age, number of VA primary and specialty care visits in the prior year, and clustering of patients by facility. We controlled for visits to ensure that the study findings were not due solely to differences in healthcare utilization between the complexity groups.²⁰ Also,

■ **Table 1.** Cohort Characteristics by Definition of Clinical Complexity

Patient Characteristics	No. of Comorbid Conditions ^a (n = 35,872)				Illness Burden by DCG RRS (n = 35,872)			
	0 (n = 2082)	1 (n = 5883)	2 (13,473)	≥3 (n = 14,434)	<0.50 (n = 14,126)	0.50-0.99 (n = 6207)	1.00-1.99 (n = 6316)	>2.00 (n = 9223)
Age, mean (SD)	58.7 (10.6)	60.9 (9.4)	63.0 (8.3)	63.6 (7.7)	63.7 (8.4)	62.9 (8.5)	62.3 (8.5)	61.1 (8.3)
DCG RRS, mean (SD)	1.04 (1.75)	1.27 (1.92)	1.33 (2.03)	2.39 (3.26)	0.29 (0.10)	0.72 (0.14)	1.46 (0.28)	4.82 (3.64)
No. comorbidities, mean (SD)	0	1	2	3.4 (0.6)	2.0 (1.0)	2.3 (1.1)	2.4 (1.1)	2.7 (1.2)
No. VA primary care visits in 1 year prior, mean (SD) ^b	2.6 (2.3)	4.1 (3.2)	4.6 (3.4)	5.8 (4.5)	3.5 (2.3)	4.5 (3.1)	5.3 (3.8)	7.1 (5.2)
No. VA specialty care visits in 1 year prior, mean (SD) ^c	0.3 (0.9)	0.8 (3.2)	1.4 (5.0)	4.0 (8.7)	0.5 (1.6)	1.5 (3.3)	2.4 (4.7)	5.4 (11.3)

DCG RRS indicates Diagnostic Cost Group Relative Risk Score; VA, Veterans Affairs; SD, standard deviation.

^aNo. of comorbid conditions are among the 6 study conditions evaluated.

^bNo. of primary care visits to VA in 1 year prior to the patient's last primary care visit during the study interval.

^cNo. of specialty care visits to VA in 1 year prior to the patient's last primary care visit during the study interval. Visits designated as specialty care if the patient had a study condition relevant to the clinic from which he received care (eg, depression and psychiatry).

because this analysis consisted of patients who received care in 7 different facilities, we adjusted for clustering to remove any potential facility-level variations.²¹ We conducted sensitivity analyses to determine the impact of a shorter (45 days) and longer (180 days) follow-up interval on the combined measure of quality (ie, control at index or appropriate follow-up care). We conducted the analyses using SAS v 9.2 (SAS Institute Inc, Cary, North Carolina) and Stata 10 (StataCorp LP, College Station, Texas). Institutional review boards at the Michael E. DeBakey VA Medical Center and Baylor College of Medicine, both in Houston, Texas, approved this study.

RESULTS

Of the 190,156 patients receiving care at the 7 VA facilities during the study period, 35,872 (18.9%) had diabetes and met the study inclusion criteria. Patient characteristics according to each clinical complexity definition are presented in **Table 1**. Mean age was lowest among those with no comorbid conditions (58.7 years). Patients with 3 or more comorbid conditions had higher levels of measured illness burden than patients with fewer conditions. The most complex patients, defined by DCG

RRS ≥ 2.00 , utilized VA primary and specialty care in the 1 year prior most often (7.1 and 5.4 visits, respectively).

Table 2 reports the number and proportion of patients that were controlled at index and 90 days following the patient's last primary care visit for each quality indicator. We found that the proportion of patients controlled was significantly higher at 90 days compared with index for A1C and LDL-C ($P < .001$ for both comparisons). Similarly, when examining control for all 3 quality indicators, we found that 6260 patients (17.5%) were controlled at index and 6974 (19.4%) were controlled at 90 days ($P < .001$). We also examined the number and proportion of patients that were uncontrolled at index and that received appropriate follow-up care within 90 days for each clinical complexity group (**Table 3**). The proportion of patients that received appropriate follow-up care was different across groups for each quality indicator when measuring complexity by number of comorbidities ($P < .001$ for each comparison) and for BP and LDL-C when measuring complexity by DCG RRS ($P < .001$ for both comparisons).

In the ordered logistic regression analysis evaluating clinical complexity using number of comorbidities, patients with the highest number of comorbid conditions (≥ 3 conditions)

were more likely than those with no comorbid conditions to be controlled at index (odds ratio [OR] 1.94; 95% confidence interval [CI], 1.67-2.26) or to meet the combined measure of control at index or receipt of appropriate follow-up care for all 3

■ **Table 2.** Number and Proportion of Patients Controlled at Index and at 90 Days Following Last Primary Care Visit (n = 35,872)

Quality Indicator	Time Interval		P
	Index N (%)	90 days N (%)	
BP <130/80 mm Hg	17,013 (47.4)	17,263 (48.1)	.06
A1C <7%	16,444 (45.8)	17,763 (49.5)	<.001
LDL-C <100 mg/dL	24,630 (68.7)	25,714 (71.7)	<.001
All 3 controlled	6260 (17.5)	6974 (19.4)	<.001

A1C indicates glycated hemoglobin; BP, blood pressure; LDL-C, low-density lipoprotein cholesterol.

Table 3. Number and Proportion of Patients in Each Complexity Group That Were Uncontrolled at Index and Received Appropriate Follow-Up Care Within 90 Days

Quality indicator	Clinical Complexity Definition				P	Illness Burden by DCG RRS (n = 35,872)				P	
	No. of Comorbid Conditions ^a (n = 35,872)					P	<0.50 (n = 14,126) (%)	0.50-0.99 (n = 6207) (%)	1.00-1.99 (n = 6316) (%)		≥2.00 (n = 9223) (%)
	0 (n = 2082) (%)	1 (n = 5883) (%)	2 (n = 13,473) (%)	≥3 (n = 14,434) (%)							
BP <130/80 mm Hg											
Uncontrolled at index	1126	3137	7355	7241		7715	3204	3276	4664		
Appropriate follow-up care ^b	449 (39.9)	1438 (45.8)	3913 (53.2)	4341 (60.0)	<.001	3594 (46.6)	1710 (53.4)	1850 (56.5)	2987 (64.0)	<.001	
A1C <7%											
Uncontrolled at index	1453	3267	7267	7441		7613	3392	3472	4951		
Appropriate follow-up care	604 (41.6)	1545 (47.3)	3570 (49.1)	3696 (49.7)	<.001	3681 (48.4)	1636 (48.2)	1692 (48.7)	2406 (48.6)	.97	
LDL-C <100 mg/dL											
Uncontrolled at index	1179	2207	4193	3663		4776	1854	1932	2680		
Appropriate follow-up care	319 (27.1)	810 (36.7)	1933 (46.1)	2065 (56.4)	<.001	2025 (42.4)	856 (46.2)	926 (47.9)	1320 (49.3)	<.001	

A1C indicates glycated hemoglobin; BP, blood pressure; DCG RRS, Diagnostic Cost Group Relative Risk Score; LDL-C, low-density lipoprotein cholesterol.

^aNo. of comorbid conditions are among the 6 study conditions evaluated.

^bAppropriate follow-up care includes medication treatment intensification or a controlled reading during the 90-day follow-up period.

quality indicators (OR, 2.30; 95% CI, 2.07-2.54), adjusting for age, VA primary and specialty care visits, and clustering of patients at facilities. In addition, patients with the highest illness burden (DCG RRS ≥2.00) were more likely than those with the lowest illness burden (DCG RRS <0.50) to be controlled at index (OR, 1.22; 95% CI, 1.13-1.32) or to meet the combined measure of quality for all 3 quality indicators (OR, 1.25; 95% CI, 1.18-1.33) (Table 4). Our findings that patients with greater clinical complexity were more likely to receive high quality care across all 3 indicators persisted when we assessed a shorter (45 days) and longer (180 days) follow-up period.

DISCUSSION

We examined the influence of patient complexity, defined by the number of coexisting conditions and patient illness burden, on achievement of glycemic, BP, and lipid control at index. We also assessed a combined measure of quality, which included control at index and a 90-day follow-up period to account for treatment intensification or repeat testing provided to patients in response to poorly controlled levels at index. This type of linked quality measure has been shown to more accurately reflect the longitudinal nature of patient care.²²⁻²⁵ Our finding that more complex patients, ir-

respective of how complex is defined, receive higher quality of diabetes care is consistent with prior work in this area, including our own.¹²⁻¹⁵ Building on these prior studies, we found that the relationship between clinical complexity and quality persists even across multiple domains of care. In addition, compared with their respective reference groups, patients with the highest complexity as defined by comorbidity count had greater odds of meeting the combined quality measure for all 3 quality indicators than those with the greatest complexity as measured by DCG RRS. Because information regarding the number of comorbidities is readily accessible to healthcare providers at the time of an encounter, this finding suggests that for certain conditions, a simple comorbidity count may be the most practical way for providers to categorize patient risk when faced with the high demand of an office visit.

In addition, we found that the least complex patients utilized primary care less frequently and received poorer quality care compared with more complex patients. Although it is not surprising that patients with fewer or less complex comorbidities seek care less often, our results indicated that more complex patients received better care, even after adjusting for numbers of VA primary and specialty care visits. Lower exposure to the healthcare system may be appropriate for less complex patients; however, it may limit opportuni-

■ **Table 4.** Odds of Being Controlled at Index and Odds of Being Controlled at Index or Receiving Appropriate Follow-Up Care Within 90 For at Least 1, at Least 2, or All 3 Quality Indicators^a For Each Definition of Clinical Complexity

Clinical Complexity Definition	Odds Ratio (95% CI) ^b					
	Controlled at Index			Controlled at Index or Received Appropriate Follow-Up Care ^c		
	For at Least 1 Quality Indicator vs 0	For at Least 2 Quality Indicators vs 0 or 1	For All 3 Quality Indicators vs 0, 1, or 2	For at Least 1 Quality Indicator vs 0	For at Least 2 Quality Indicators vs 0 or 1	For All 3 Quality Indicators vs 0, 1, or 2
No. comorbidities						
0	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
1	1.97 (1.74-2.23)	1.72 (1.55-1.91)	1.53 (1.30-1.79)	2.31 (1.90-2.80)	1.81 (1.62-2.03)	1.53 (1.37-1.70)
2	2.16 (1.93-2.43)	1.84 (1.67-2.03)	1.56 (1.34-1.81)	3.49 (2.90-4.19)	2.44 (2.20-2.71)	1.81 (1.63-2.00)
>3	2.71 (2.40-3.06)	2.27 (2.05-2.50)	1.94 (1.67-2.26)	6.73 (5.38-8.41)	3.49 (3.12-3.90)	2.30 (2.07-2.54)
Illness severity (DCG RRS)						
<0.50	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
0.50-0.99	1.16 (1.06-1.28)	1.13 (1.06-1.20)	1.12 (1.04-1.22)	1.30 (1.08-1.57)	1.20 (1.11-1.31)	1.10 (1.04-1.17)
1.00-1.99	1.11 (1.01-1.22)	1.09 (1.03-1.16)	1.11 (1.02-1.20)	1.36 (1.12-1.65)	1.20 (1.10-1.31)	1.12 (1.05-1.19)
≥2.00	1.13 (1.03-1.25)	1.19 (1.12-1.26)	1.22 (1.13-1.32)	1.38 (1.14-1.67)	1.22 (1.12-1.33)	1.25 (1.18-1.33)

CI indicates confidence interval; DCG RRS, Diagnostic Cost Group Relative Risk Score.

^aDiabetes quality indicators assessed included: blood pressure <130/80 mm Hg, A1C <7.0%, and low-density lipoprotein cholesterol <100 mg/dL.

^bEach model is adjusted for age, number of primary and specialty care visits to the VA in the prior year, and clustering of patients at facilities.

^cAppropriate follow-up care includes medication treatment intensification or a controlled reading during the 90-day follow-up period.

ties to address risk factor control. Further, patients with less clinical complexity may more frequently use their visits to address conditions unrelated to their diabetes, which may also contribute to poorer risk factor management. Previous work suggests that the patient’s primary concern often dictates the provider’s focus during a visit.¹⁶ This may result in limited or no time to discuss diabetes-related issues. Evidence has also shown that patients with diabetes who had fewer visits, accessed healthcare more frequently for conditions deemed to be of lower priority, or patients who discussed conditions unrelated to diabetes during their visits were at risk for delayed receipt of guideline-recommended diabetes care.²⁶⁻²⁸

Importantly, although it is reassuring that more complex patients received higher quality care, our findings identified significant deficits in BP, glycemic, and lipid control for all patients with diabetes. Several factors may limit a primary care clinician’s ability to achieve these standards, including prioritizing competing demands, coordinating care with other members of the healthcare team, lack of belief that guideline adherence will improve patient outcomes, and accounting for patient preferences within the time constraints of a single office visit.²⁹⁻³³ In addition, these time restrictions may limit shared decision making between patients and providers,²⁹ a practice that has been shown to improve patient outcomes.³⁴ To address some of these issues, previous studies have recom-

mended individualizing treatment plans for patients with multimorbidity.^{35,36}

One approach to providing more individualized primary care is through initiatives such as the patient-centered medical home (PCMH).³¹ This model of care delivery focuses on coordinated care teams that aim to provide integrated, comprehensive primary care by promoting partnerships between patients, their providers, and their community. This approach may be particularly relevant to patients with multimorbidity, who have identified individualized, coordinated care and global health outcomes (eg, preservation of physical functioning) as important to them.^{36,37} The VA has transitioned to a similar model that emphasizes team-based, patient-centered care.³⁸ Further, results of a PCMH national demonstration project examining patient outcomes before and after PCMH implementation demonstrated modest improvements in chronic illness care after PCMH implementation.³⁹ Metrics used to assess quality must be amended to reflect the value of this patient-centered approach to care.

Our study has limitations that should be considered when interpreting the results. First, the study was conducted in the primarily male VA population. Also, studies have shown that the VA population has a higher prevalence of diabetes and more comorbidities than the general population,^{40,41} thus, generalizability may be limited. In addition, we assessed only a select number of common comorbidities which may not reflect

all of a patient's coexisting conditions. Of these, 3 conditions were unrelated to diabetes, limiting conclusions about the impact of other unrelated conditions on receipt of quality of care for diabetes. However, our study has significant strengths including our use of VA clinical and administrative data, which allowed for an assessment of a large cohort of patients with diabetes. In addition, we incorporated a follow-up period in our assessment of quality and examined multiple dimensions of diabetes care simultaneously. Finally, because diabetes management requires attention to multiple guideline-recommended standards of care, diabetes was an ideal condition in which to examine our study question.

In summary, we found that patients with the greatest levels of clinical complexity received higher quality care for diabetes compared with less complex patients, regardless of complexity definition chosen. While providers may appropriately target the most complex patients for aggressive diabetes management, there is significant room for improvement for risk factor control among all patients with diabetes. These findings highlight the challenges of caring for chronically ill patients and the importance of implementing more patient-centered approaches to chronic illness care.

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