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The Impact of Comorbidity Type on Measures of Quality for Diabetes Care

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Abstract

Objective—Studies provide conflicting results about the impact of comorbid conditions on the quality of chronic illness care. We assessed the effect of comorbidity type (concordant, discordant, or both) on the receipt of guideline-recommended care among patients with diabetes.

Research Design—Patients were assigned to 1 of 4 condition groups: diabetes-concordant (hypertension, ischemic heart disease, hyperlipidemia), and/or -discordant (arthritis, depression, chronic obstructive pulmonary disease) conditions, or neither. We evaluated hemoglobin (Hb) A1c, blood pressure, and low-density lipoprotein cholesterol (LDL-C) readings at index and measured overall good quality of diabetes care, including a 6-month follow-up interval. We assessed the effect of condition group on overall good quality of care with logistic regression and generalized ordered logistic regression.

Results—We assigned 35,872 patients to the diabetes comorbid condition groups, ranging from 2.0% in the discordant-only group to 58.0% in the concordant-only group. Patients with both types of conditions were more likely **than those with no comorbidities** to receive overall good quality for glycemic [odds ratio (OR), 2.13; 95% confidence interval (CI), 1.86-2.41], blood pressure (**OR, 1.62; 95% CI, 1.40-1.84**) and LDL-C (**OR, 3.57; 95% CI, 3.08-4.05**) control within 6 months of an index visit. **They were also more likely** to receive overall good quality for all 3 quality measures combined (**OR, 2.17; 95% CI, 1.96-2.39**).

Conclusions—Patients with the greatest clinical complexity were more likely than less complex patients to receive high quality diabetes care, suggesting that increased complexity does not necessarily predispose chronically ill patients to receiving poorer care. However, caution should be used in treating certain patient groups, such as the elderly, for whom adherence to multiple condition-specific guidelines may lack benefit or cause harm.

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Keywords

diabetes mellitus; quality of health care; comorbidity

Introduction

Although treatment of chronically ill patients consumes more than three-fourths of U.S. healthcare expenditures, evidence suggests that these patients receive just over half of the appropriate recommended care.^{1,2} This has implications particularly for patients with diabetes, as approximately 40% suffer from 3 or more comorbidities.¹ Studies assessing **the impact of comorbidities on quality of chronic illness care** provide mixed results. **One study** found that discussion of unrelated conditions during a clinical encounter decreased the likelihood **of addressing** elevated blood pressure in diabetic patients.³ Similarly, patients with uncontrolled hypertension were less likely to receive antihypertensive therapy intensification if they had greater numbers of unrelated conditions.⁴ Conversely, emerging evidence **suggests** that the presence of multiple comorbidities may **actually** enhance quality for chronically ill patients. **We recently** reported that **hypertensive** patients with greater complexity were more likely to receive high quality care than those with **fewer** comorbidities.⁵ **This and other studies**^{6,7} highlight the need for **additional** research to elucidate the impact of comorbid conditions on **the** quality of **chronic illness** care.

Using a framework employed in prior research,^{5,8} we identified comorbidities that were concordant and discordant with diabetes. Diabetes-concordant comorbidities have similar pathogenesis and treatment strategies, while diabetes-discordant comorbidities are not related to diabetes development or management. We examined the impact of comorbidity type (concordant, discordant, or both) on 3 diabetes quality-of-care measures: glycemic, blood pressure, and lipid control. We also assessed the relationship between comorbidity type and likelihood of receiving overall good quality for all 3 measures.

Methods

Study population

We identified Veterans with diabetes receiving primary care at 7 Veterans Affairs (VA) **facilities** from July 2007 through June 2008. We classified patients as having diabetes if, **in the** study interval or 2 years prior, **they had:** 2 outpatient or 1 inpatient diagnosis code indicating diabetes;⁹ a filled prescription for diabetes medication; or at least 2 glucose readings ≥ 200 mg/dL. We excluded patients with limited life expectancy (diagnosis of metastatic cancer or hospice/palliative care use) and who died during the study or follow-up period.

Diabetes-concordant and -discordant conditions

Using diagnosis and procedure codes **in the VA National Patient Care Database¹⁰ and Fee Basis files,¹¹** we identified patients with diabetes-concordant (hypertension, ischemic heart disease, and hyperlipidemia) and diabetes-discordant [arthritis, chronic obstructive pulmonary disease (COPD), and depression] conditions within 2 years prior to their most recent primary care encounter during the study interval. We categorized patients into mutually exclusive **diabetes condition** groups: 1) no comorbid conditions; 2) **discordant-only**; 3) **concordant-only**; 4) both concordant and discordant conditions.⁵

Study outcomes

We used American Diabetes Association recommendations¹² to **assess hemoglobin A1c** (HbA1c) (<7%), blood pressure (<130/80 mm Hg), and low-density lipoprotein cholesterol (LDL-C) (<100 mg/dL) control at index. **Among uncontrolled patients**, we examined a 6-month follow-up period to determine whether appropriate medication adjustments were made or the patient's most recent follow-up reading was at goal (Figure 1).

We obtained HbA1c, blood pressure, and LDL-C values from the VA Network data warehouse, which includes data from each hospital's electronic medical records. We assessed control at index using the patient's most recent readings. We used VA Decision Support System pharmacy data to identify current medications (prescriptions filled within 100 days prior to index)¹³ and those received during follow-up. We used the data warehouse to identify prescriptions filled outside the VA. We computed average daily medication dosages using the formula: (quantity of medication/days supplied) × numeric dosage. We calculated overall **good** quality for each measure by **adding** the number of patients controlled at index and **those receiving** appropriate **follow-up** care. We refer to attainment of either of these criteria as "overall good quality"

Statistical analyses

We assessed the proportion of patients that were controlled at index; received appropriate follow-up care; and received overall good quality by chronic condition group for the 3 measures. We used logistic regression to determine the impact of coexisting conditions on the likelihood of being controlled at index; receiving appropriate follow-up care; and **receiving** overall good quality. Additionally, we compared the likelihood of receiving overall good quality for 1 or more of the measures, using generalized ordered logistic regression. **Models** were adjusted for age, illness burden defined by Diagnostic Cost Group (DCG) Relative Risk Scores,¹⁴ and accounted for clustering of patients by facility (Table 1). Analyses were conducted using SAS v9.2 (SAS Institute Inc., Cary, North Carolina) and Stata 10 (StataCorp LP, College Station, TX).

Sensitivity analyses

We assessed the impact of a shorter follow-up interval (3 months); exclusion of patients with limited life expectancy; use of VA quality indicators [HbA1c (<9%) and blood pressure (<140/90 mm Hg)]; and effect of VA primary and specialty care utilization, on the study outcomes. We identified 25 relevant specialty care clinics for the study conditions, and designated an encounter as specialty care if the patient had a condition and a visit to the relevant clinic (e.g., patient with COPD and a visit to pulmonary clinic) during the prior year. Additionally, because diabetes and depression commonly co-occur, we conducted univariate analyses to evaluate the influence of depression on study outcomes.

The Institutional Review Board at Baylor College of Medicine and the Michael E. DeBakey VA Research and Development Committee approved this study. The funding sources played no role in the **study** conduct or interpretation.

Results

We identified 35,872 diabetic patients meeting inclusion criteria. Of **these**, 5.8% had no **comorbidities**, 58.0% had concordant-only, 2.0% had discordant-only, and 34.2% had both (Table 2). We excluded 2,337 patients who had limited life expectancy or died during follow-up.

For all measures, the proportion of patients controlled at index was lowest among those with no comorbidities (Table 3). The **group** with both concordant and discordant comorbidities had the highest proportion receiving appropriate follow-up care for glycemic (61.2%), blood pressure (66.5%), and LDL-C (55.8%) control. **The no comorbidities group had the lowest proportion receiving appropriate follow-up care for glycemic and LDL-C control (50.0% and 25.8%, respectively) while the discordant-only group had the lowest proportion receiving appropriate follow-up for blood pressure control (44.0%).** The total proportion of patients receiving overall good quality was 77.8% for glycemic, 80.4% for blood pressure, and 85.5% for LDL-C control. **Similar to findings for control at index, patients with both types of conditions had the highest proportion of patients receiving overall good quality for each measure, while the no comorbidities group had the lowest.**

Adjusting for age and illness burden, patients with both types of **comorbidities** were more likely **than patients with no comorbidities to achieve** glycemic and LDL-C control at index [odds ratio (OR), 2.15; 95% confidence interval (CI), 1.88-2.43; and 2.22; 1.94-2.49, respectively)], (Table 3). Patients with **concordant-only comorbidities** and those with **both types were more** likely than those with **no comorbidities** to receive appropriate follow-up care **and overall good quality** for each measure. **Patients with discordant-only comorbidities** were more likely than those with **no comorbidities** to receive overall good quality for glycemic (**OR, 1.48; 95% CI, 1.13-1.83**) and LDL-C (**OR, 1.30; 95% CI, 1.06-1.59**) control. **When assessing attainment of guideline-recommended levels across the 3 quality-of-care measures simultaneously, patients with concordant-only and both types of comorbidities were more likely than those with no comorbidities to receive overall good quality (OR, 2.00; 95% CI, 1.82-2.20 and OR, 2.17; 95% CI, 1.96-2.39, respectively)** (Table 4).

We found similar results for overall good quality using a 3-month follow-up period and when assessing less stringent glycemic (HbA1c $\leq 9\%$) and blood pressure ($<140/90$ mm Hg) thresholds. Our findings that the most complex patients received higher levels of overall good quality for each measure persisted after adjusting for primary and specialty care visits. Although a higher proportion of patients excluded for limited life expectancy or death were in the both condition group, study outcomes were similar when including these patients in our analyses. Finally, univariate analyses showed that depression was not associated with decreased levels of overall good quality for any of the measures (data not shown).

Discussion

We assessed quality for 3 dimensions of diabetes care: glycemic, blood pressure, and LDL-C control, and determined how **this varied by condition group**. We found that patients with both concordant and discordant conditions as well as those with concordant-only were more likely than those with no comorbidities to receive overall good quality for each dimension examined. These findings did not change when we controlled for prior visits, assessed a shorter follow-up period, or evaluated care using VA performance indicators for glycemic and blood pressure control. Patients with both types of comorbidities were also more likely than those with no comorbidities to receive overall good quality for all 3 dimensions of diabetes care combined.

This work extends prior studies by examining the correlation between different types of conditions and quality **for 3 dimensions of diabetes care**.^{15,16} As assessed by current standards, provision of high quality, comprehensive care in this population necessitates adherence to numerous clinical practice guidelines. Although our results show high levels of guideline-recommended care among the most complex diabetic patients, studies indicate that such care may not be equally beneficial across all chronically ill patients.^{17,18} For example,

elderly patients with multiple comorbidities receiving care in accordance with multiple guidelines may have worse outcomes. This highlights the intricacies of managing such patients and the need to adapt current methods of quality assessment and provider reimbursement to address the challenges unique to this patient population.

Several factors may contribute to the higher quality found among more complex **diabetic** patients. First, providers may be more likely to treat coexisting conditions in **complex** patients to reduce the risk of adverse consequences. **For example, they** may aggressively target blood pressure and lipid control because their benefit in preventing or slowing the progression of coronary artery disease has been well documented.¹² Additionally, **these findings may result in part from** system-level processes aimed at increasing evidence-based care within the VA.¹⁹

Medication adherence and healthcare utilization may also **influence** the relationship between **diabetes** complexity and quality of care. Patients with both **types of comorbidities** had more frequent primary and specialty care visits than **other** patients. This increased **healthcare** exposure may lead to stronger provider/patient relationships, which may increase adherence to treatment plans, including recommended visits and prescribed medications.^{20,21} More complex patients may also utilize ancillary services, such as case management, more often which may improve their overall health and increase adherence.²⁰ However, we **found** that controlling for patient visits **did not impact** our findings.

Depression and diabetes frequently co-occur, yet differ in pathogenesis and treatment, **so** we felt this was an ideal discordant condition.⁸ While some studies have shown that depression is associated with poorer quality of diabetes care,^{22,23} others report that patients with comorbid mental illness, including depression, received similar quality of diabetes care to those without mental disorders.^{24,25} We examined the influence of depression on our models and did not find a significant impact.

Our study's strengths **include** a large study population, evaluation of multiple dimensions of diabetes care, inclusion of a follow-up period, and **use of** a novel **multinomial logistic** approach to **assess** the impact of comorbidities on **comprehensive** diabetes care. We ascertained data from VA administrative sources which provide extensive inpatient and outpatient VA utilization data¹⁰ and obtained clinical variables from the data warehouse which includes data directly from VA electronic medical records. Nonetheless, there are limitations that should be considered when interpreting our findings. First, we conducted this study in the VA, which **serves** a predominantly male, elderly patient population; thus generalizability may be limited. Also, we identified common chronic conditions to classify patients into **condition** groups, but the conditions **chosen** may not reflect all **existing** comorbidities. **Finally, although the patient distribution** across the 4 condition groups is not balanced, each group is large enough for appropriate statistical modeling.

We found that **diabetic** patients with the highest level of complexity did not have lower levels of overall **good** quality compared with less complex patients. **Further**, complex patients were more likely to receive overall **good** quality of care across all 3 dimensions of care. **This** suggests that increased complexity does not necessarily predispose patients with diabetes to receiving poorer quality of care.

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Figure 1. Algorithm to Assess Appropriate Care for Patients with Diabetes

*Maximal therapy for hypertension defined as 4 antihypertensive medications prescribed at index; LDL-C maximal therapy defined as patient prescribed maximum dosage of lipid-lowering agent or > 1 agent at index.

ADA indicates American Diabetes Association; BP, blood pressure; HbA1c, hemoglobin A1c; LDL-C, low-density lipoprotein cholesterol.

Table 1
Definitions of study variables

Study variable	Definition
Age	Age in years at the beginning of the study interval [*]
DCG RRS	Ratio of patient's predicted health care costs to the average observed health care costs of an individual in the VA based on diagnoses; RRS of 1.00 reflects the average illness burden of the national VA population
HbA1c level LDL-C level	Patient's most recent reading documented in the study interval or within the prior 12 months of the patient's last primary care visit in the study interval
BP level	Patient's most recent qualifying BP reading in the study interval

DCG RRS indicates Diagnostic Cost Group Relative Risk Score; VA, Veterans Administration; HbA1c, hemoglobin A1c; and LDL-C, low-density lipoprotein cholesterol; BP, blood pressure

^{*} Study interval is July 1, 2007 – June 30, 2008.

Table 2
Characteristics of the Diabetes Cohort by Chronic Condition Group

Characteristics	All (n=35,872)	None (n=2,082)	Concordant Only* (n=20,797)	Discordant Only [†] (n=726)	Both (n=12,267)	P Value
Comorbidities, mean, (SD)	2.3 (1.1)	NA	2.0 (0.7)	1.2 (0.4)	3.2 (0.9)	<0.001
Type of comorbidity, No. (%)						
Arthritis	5,784 (16.1)	NA	NA	260 (35.8)	5,524 (45.0)	
Chronic obstructive pulmonary disorder	3,560 (9.9)	NA	NA	143 (19.7)	3,417 (27.9)	
Depression	6,569 (18.3)	NA	NA	443 (61.0)	6,126 (49.9)	
Hypertension	28,431 (79.3)	NA	17,837 (85.8)	NA	10,594 (86.4)	
Hyperlipidemia	26,979 (75.2)	NA	16,950 (81.5)	NA	10,029 (81.8)	
Ischemic heart disease	10,270 (28.6)	NA	6,125 (29.5)	NA	4,145 (33.8)	
Age, mean (SD), y	62.7 (8.5)	58.7 (10.6)	63.7 (8.1)	56.3 (9.9)	61.9 (8.1)	<0.001
Age group, mean (SD), y						
<55	5,259 (14.7)	579 (27.8)	2,426 (11.7)	287 (39.5)	1,967 (16.0)	
55-64	15,363 (42.8)	919 (44.1)	8,386 (40.3)	309 (42.6)	5,749 (46.9)	
65-75	15,250 (42.5)	584 (28.1)	9,985 (48.0)	130 (17.9)	4,551 (37.1)	
Diagnostic Cost Group Relative Risk Score, mean (SD)	1.73 (2.63)	1.04 (1.75)	1.29 (2.01)	2.09 (2.49)	2.58 (3.36)	<0.001
Diagnostic Cost Group Relative Risk Score group, No. (%)						
<0.50	14,126 (39.4)	1,178 (56.6)	10,001 (48.1)	182 (25.1)	2,765 (22.5)	
0.50-0.99	6,207 (17.3)	328 (15.8)	3,660 (17.6)	126 (17.4)	2,093 (17.1)	
1.00-1.99	6,316 (17.6)	271 (13.0)	3,372 (16.2)	147 (20.3)	2,526 (20.6)	
2.00	9,223 (25.7)	305 (14.7)	3,764 (18.1)	271 (37.3)	4,883 (39.8)	
Outpatient specialty care visits to VA in 1 year prior, No. (%)	2.3 (6.6)	0.3 (0.9)	0.8 (1.9)	4.5 (9.9)	5.0 (10.2)	<0.001
Outpatient primary care visits to VA in 1 year prior, No. (%)	4.9 (3.9)	2.6 (2.3)	4.5 (3.3)	4.9 (4.2)	6.1 (4.6)	<.0001
Indicator of diabetes, No. (%)						
ICD-9-CM diagnosis code [‡]	35,223 (98.2)	2,016 (96.8)	20,462 (98.4)	697 (96.0)	12,048 (98.2)	
Filled prescription of diabetes medications	28,481 (79.4)	1,305 (62.7)	16,979 (81.6)	468 (64.5)	9,729 (79.3)	
2 blood glucose readings 200 mg/dL	8,800 (24.5)	290 (13.9)	4,789 (23.0)	153 (21.1)	3,568 (29.1)	

ICD-9-CM indicates International Classification of Disease, 9th Revision, Clinical Modification; VA, Veterans Administration.

* Concordant only conditions include hypertension, ischemic heart disease, and hyperlipidemia.

[†]Discordant only conditions include arthritis (rheumatoid and osteoarthritis), chronic obstructive pulmonary disease, and depression.

[‡]2 outpatient diagnosis codes or 1 inpatient diagnosis code (250.xx).

Table 3
Glycemic, Blood Pressure, and LDL-C Control at Index, Appropriate Follow-up, and Overall Good Quality of Diabetes Care by Chronic Condition Group, Proportions and Adjusted ORs

	Controlled at Index		Appropriate Follow-up within 6 months		Overall Good Quality of Care	
	No. (%)	OR (95% CI)*	No. (%)	OR (95% CI)*	No. (%)	OR (95% CI)*
Glycemic control[†]						
No comorbid conditions	629 (30.2)	1.00 (Reference)	726 (50.0)	1.00 (Reference)	1,355 (65.1)	1.00 (Reference)
Concordant only [‡]	9,392 (45.2)	1.75 (1.53-1.96)	6,742 (59.1)	1.50 (1.29-1.71)	16,134 (77.6)	1.83 (1.61-2.05)
Discordant only [§]	333 (45.9)	2.06 (1.61-2.51)	202 (51.4)	0.99 (0.71-1.27)	535 (73.7)	1.48 (1.13-1.83)
Both	6,090 (49.7)	2.15 (1.88-2.43)	3,783 (61.2)	1.56 (1.33-1.79)	9,873 (80.5)	2.13 (1.86-2.41)
Total	16,444 (45.8)	NA	11,453 (59.0)	NA	27,897 (77.8)	NA
Blood pressure control[†]						
No comorbid conditions	956 (45.9)	1.00 (Reference)	509 (45.2)	1.00 (Reference)	1,465 (70.4)	1.00 (Reference)
Concordant only [‡]	9,728 (46.8)	0.96 (0.85-1.07)	6,949 (62.8)	1.94 (1.63-2.24)	16,677 (80.2)	1.56 (1.36-1.75)
Discordant only [§]	376 (51.8)	1.26 (1.02-1.53)	154 (44.0)	0.78 (0.54-1.02)	530 (73.0)	0.98 (0.74-1.21)
Both	5,953 (48.5)	1.03 (0.91-1.16)	4,201 (66.5)	1.94 (1.62-2.26)	10,154 (82.8)	1.62 (1.40-1.84)
Total	17,013 (47.4)	NA	11,813 (62.6)	NA	28,826 (80.4)	NA
LDL-C control[†]						
No comorbid conditions	1,037 (49.8)	1.00 (Reference)	270 (25.8)	1.00 (Reference)	1,307 (62.8)	1.00 (Reference)
Concordant only [‡]	15,210 (73.1)	2.32 (2.05-2.59)	2,922 (52.3)	3.22 (2.62-3.83)	18,132 (87.2)	3.56 (3.12-4.01)
Discordant only [§]	423 (58.3)	1.48 (1.15-1.80)	79 (26.1)	0.93 (0.59-1.28)	502 (69.2)	1.30 (1.06-1.59)
Both	8,821 (71.9)	2.22 (1.94-2.49)	1,923 (55.8)	3.41 (2.73-4.08)	10,744 (87.6)	3.57 (3.08-4.05)
Total	25,491 (71.1)	NA	5,194 (50.0)	NA	30,685 (85.5)	NA

CI indicates confidence interval; LDL-C, low-density lipoprotein cholesterol; OR, odds ratio

* Adjusted for age and illness burden using Diagnostic Cost Group Relative Risk Scores and accounts for clustering of patients at the facility.

[†] p<0.001 across condition groups for No. (%) for all outcomes.

[‡] Concordant conditions include hypertension, ischemic heart disease, and hyperlipidemia.

§Discordant conditions include arthritis (rheumatoid and osteoarthritis), chronic obstructive pulmonary disease, and depression.

Table 4
Adjusted ORs of Overall Good Quality of Care for at least 1, 2, or 3 Diabetes Quality Indicators by Condition Group*

Condition Group	Odds (95% CI) of Receiving Overall Good Quality for at Least 1 Quality Indicator vs. 0	Odds (95% CI) of Receiving Overall Good Quality for at Least 2 Quality Indicators vs. 0 or 1	Odds (95% CI) of Receiving Overall Good Quality for all 3 Quality Indicators vs. 0, 1, or 2
No comorbid conditions	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
Concordant only [†]	5.13 (4.26-6.19)	3.32 (2.99-3.69)	2.00 (1.82-2.20)
Discordant only [‡]	1.93 (1.30-2.84)	1.41 (1.15-1.72)	1.12 (0.95-1.34)
Both	6.35 (5.04-7.99)	3.74 (3.33-4.21)	2.17 (1.96-2.39)

CI indicates confidence interval; OR, odds ratio.

* All models adjusted for age and illness burden using Diagnostic Cost Group Relative Risk Scores and accounts for clustering of patients at the facility.

[†] Concordant only conditions include hypertension, ischemic heart disease, and hyperlipidemia.

[‡] Discordant only conditions include arthritis (rheumatoid and osteoarthritis), chronic obstructive pulmonary disease, and depression.