

ORIGINAL ARTICLES

Beyond Comorbidity Counts: How Do Comorbidity Type and Severity Influence Diabetes Patients' Treatment Priorities and Self-Management?

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BACKGROUND: The majority of older adults have 2 or more chronic conditions and among patients with diabetes, 40% have at least three.

OBJECTIVE: We sought to understand how the number, type, and severity of comorbidities influence diabetes patients' self-management and treatment priorities.

DESIGN: Cross-sectional observation study.

PATIENTS: A total of 1,901 diabetes patients who responded to the 2003 Health and Retirement Study (HRS) diabetes survey.

MEASUREMENTS: We constructed multivariate models to assess the association between presence of comorbidities and each of 2 self-reported outcomes, diabetes prioritization and self-management ability, controlling for patient demographics. Comorbidity was characterized first by a count of all comorbid conditions, then by the presence of specific comorbidity subtypes (microvascular, macrovascular, and non-diabetes related), and finally by severity of 1 serious comorbidity: heart failure (HF).

RESULTS: 40% of respondents had at least 1 microvascular comorbidity, 79% at least 1 macrovascular comorbidity, and 61% at least 1 non-diabetes-related comorbidity. Patients with a greater overall number of comorbidities placed lower priority on diabetes and had worse diabetes self-management ability scores. However, only macrovascular and non-diabetes-related comorbidities, but not microvascular comorbidities, were associated with lower diabetes prioritization, whereas higher numbers of microvascular, macrovascular, and non-diabetes-related conditions were all associated with lower diabetes self-management ability scores. Severe, but not mild, HF was associated with lower diabetes prioritization and self-management scores.

CONCLUSIONS: The type and severity of comorbid conditions, and not just the comorbidity count, influence diabetes patients' self-management. Patients with

severely symptomatic comorbidities and those with conditions they consider to be unrelated to diabetes may need additional support in making decisions about care priorities and self-management activities.

KEY WORDS: comorbidity; discordant conditions; diabetes mellitus; self-management.

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The vast majority of older adults live with 1 chronic condition and at least 65% have 2 or more.¹ Whereas providers can prescribe medications, recommend exercise and nutrition plans, and support patients in their self-care efforts, most of the burden of chronic disease management falls upon patients and their families. For example, diabetes self-management often necessitates multiple, daily self-care tasks or activities such as glucose monitoring, exercise, taking medications, following a diet, and checking one's feet.² To make matters more complex, most adults with diabetes have at least 1 comorbid chronic disease,³ and 40% have 3 or more.¹ Nonetheless, most diabetes disease management programs and guidelines are entirely focused on diabetes itself and do not address the challenges to patients and providers of managing concomitant conditions.^{4, 5} A variety of patient and provider factors impact patients' success in diabetes self-management.^{6–9} However, we know little about how the presence of comorbid conditions affects either patients' focus on diabetes as a dominant medical problem or their ability to complete self-care tasks.^{10, 11} Both the priority given to diabetes treatment and diabetes self-management are key factors in patients' health outcomes and in the costs of care.^{9, 12–15} To effectively organize care in ways that support self-management among the ever growing population of patients who have diabetes and other conditions, we must understand how the number, type, and severity of comorbidities influence these patients' diabetes self-management.

Comorbid conditions may shift priority away from diabetes and complicate patients' self-management. We know, for example, that conditions such as heart failure (HF), depression, and chronic pain can have a more debilitating impact on patients' functional and health status than diabetes per se.¹⁶ Similarly, people with both diabetes and chronic pain are more

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likely to experience difficulty following their recommended exercise plan, even when controlling for concurrent depression.^{17, 18} Comorbid conditions may also serve as competing demands on patients' self-management resources,^{19, 20} potentially reducing the amount of time and energy left for diabetes self-care. Conversely, to the extent that some self-care activities necessary for other conditions are consistent with diabetes self-care goals (for example, diet and exercise in mild-moderate HF), having a comorbidity may not detract from diabetes self-care. The impact of comorbid chronic conditions on diabetes self-management may depend largely on the severity of the comorbidity. A severely symptomatic condition, such as class IV HF, may become dominant and eclipse both patients' and providers' attention to diabetes self-management. However, the types or combinations of comorbidities that are most likely to interfere with diabetes self-management are poorly understood.

Some widely used risk-adjustment models weight comorbid conditions differentially rather than simply counting them.^{21, 22} However, most studies examining the influence of comorbidities on self-care or treatment quality have focused on 1 of 2 approaches: (1) assessing the role of a specific condition such as depression, under the assumption that the condition's impact is caused by its unique pathophysiology, symptoms, and treatment; or (2) treating all comorbidities as "the same" by using counts to characterize their effect on patients' health status and service receipt. Neither of these approaches is adequate to fully understand the interplay between specific dimensions of comorbidities, such as their type and severity, and diabetes self-management.

To address this issue, we suggested a framework for examining the ways in which comorbid conditions may influence a diabetes patient's care and medical management.¹¹ Based on prior research,²³ we classified chronic conditions as "concordant" and "discordant" with diabetes. Diabetes concordant conditions, such as hypertension, retinopathy, and heart disease, represent parts of the same overall pathophysiologic risk profile and are more likely to be the focus of diabetes disease management programs. Concordant conditions may be either microvascular complications (e.g., retinopathy, neuropathy, nephropathy) or macrovascular complications (e.g., cardiovascular and cerebrovascular disease, HF, hypertension) of diabetes. In contrast, unrelated or "discordant" conditions are not directly related in either their pathogenesis or management to diabetes and do not share an underlying predisposing factor (e.g., arthritis).¹¹ Within each category, we posited that the number, type, and severity of the condition(s) may be important influences on patients' prioritization to diabetes care and their ability to execute diabetes self-management activities.

In the current study, we used this framework for understanding the interplay of diabetes and comorbidities to assess the role of the number, type, and severity of comorbid conditions in diabetes prioritization and self-management. Using data from a sample of nearly 2,000 patients with diabetes in the Health and Retirement Study (HRS), we examined 3 hypotheses: 1) that patients with discordant conditions would place lower priority on diabetes and report higher diabetes self-management ability; 2) that patients with concordant conditions would place higher priority on diabetes and report better diabetes self-management; and 3) that diabetes prioritization and self-management would be negatively affected by comorbid conditions that are severely symp-

tomatic (e.g., classes III-IV CHF), regardless of whether the condition is discordant or concordant.

METHODS

The HRS is a nationally representative, biennial longitudinal study, sponsored by the National Institute on Aging.²⁴ As of 2002, the HRS combined 5 different study cohorts that were enrolled at different times since 1992. Combining these 5 cohorts, the HRS represents the entire US population born before 1948 (55 years of age and above in 2002) with a national sample of more than 30,000 individuals (including over 5,000 who have died after their entry into the sample).

Interviews are conducted with HRS respondents every 2 years, either by telephone or in person. Data are available on all respondents from earlier survey waves, and most specifically for this study from the survey conducted in 2002 (for more information, see <http://hrsonline.isr.umich.edu>).

In October of 2003, a supplemental survey was sent in 2 mailings to 2,350 HRS respondents who reported having diabetes in the 2002 wave of the HRS. The subsamples drawn for this diabetes survey included all racial and ethnic groups. A Spanish translation of the instrument was provided to Spanish-speaking respondents. The diabetes survey included questions assessing the main components of current behavioral models for factors influencing diabetes self-management behaviors and attitudes.^{6, 7, 25-27} Questions asked in the 2002 HRS wave were not repeated. Respondents received a compensation of \$40 with the first survey mailing. A total of 1,901 HRS participants completed the diabetes survey (80% response rate). Approval for the study was obtained from the University of Michigan Institutional Review Board.

Dependent Variables

Diabetes prioritization was assessed by asking patients the extent to which they agreed (on a scale of 1 to 5) with 3 questions: (1) "Taking care of my diabetes is a top priority right now"; (2) "I have other health problems that are more important than diabetes"; (3) "I have many more important things in my life than diabetes to take care of right now". After reverse coding questions 2 and 3, the responses were summed and the score was transformed into a scale ranging from 0 to 100, with higher scores indicating greater prioritization to diabetes. The scale had a reliability of 0.58 (Cronbach's alpha), median of 59, (interquartile range: 46, 75). Sixty-four respondents (3.3%) did not answer all items in this scale and are not included in the analysis.

Diabetes self-management ability was assessed using a validated scale previously determined to correlate with glycemic control.⁹ Respondents were asked to indicate their ability to execute each area of diabetes self-management according to their health providers' recommendations: (1) taking diabetes medication; (2) exercising regularly; (3) following a recommended eating plan; (4) checking their blood glucose level; and (5) checking their feet for wounds or sores. Respondents rated their level of difficulty with each activity on a scale ranging from 1 ("so difficult that I couldn't do it at all") to 5 ("not difficult, I got it exactly right"). Following the original scaling method,⁹ unweighted item responses were summed and the score was transformed into a scale ranging from 0 to

100, with higher scores indicating greater self-management ability. The scale had a reliability of 0.70 (Cronbach's alpha), median of 75 (interquartile range: 69, 90). Ninety respondents (4.7%) did not answer all items in this scale and are not included in the analysis.

Independent Variables

Respondents indicated the presence or absence of specific comorbidities in both the diabetes survey as well as in the 2002 HRS wave. In addition, the presence of diabetes-related renal disease, neuropathy symptoms, hypertension, and eye disease was assessed from the diabetes survey. Presence of coronary disease, cerebrovascular disease, and HF was defined by an affirmative response in either the diabetes survey or the 2002 HRS wave. Presence of lung disease, cancer (except skin cancer), and arthritis was assessed in the 2002 HRS wave only.

To investigate the influence of comorbidity number and type on diabetes prioritization and self-management ability, we first created a count of all comorbid conditions (with a maximum of 10 possible comorbid conditions). We then grouped conditions using separate counts as concordant/microvascular (renal disease, neuropathy, diabetic eye disease); concordant/macrovascular (coronary disease, cerebrovascular disease, hypertension, HF); and discordant (lung disease, cancer, arthritis). To test whether the severity of a comorbid condition, rather than just its presence, was specifically associated with diabetes prioritization and self-management ability, we further classified HF by its severity based on responses in the diabetes survey. HF was classified as severely symptomatic when respondents with HF reported shortness of breath most or all of the time with sitting and resting, walking less than 1 block, and climbing 1 flight of stairs; and mildly or moderately symptomatic when respondents with HF reported shortness of breath with the same activities some or none of the time.

Covariates

Diabetes-specific covariates (duration of diabetes, diabetes medication treatment, and diabetes-related visits) were assessed from responses in the diabetes survey, and other patient covariates were obtained from the 2002 HRS wave. Demographic covariates were categorized according to standard HRS conventions and included age (<65, 65–74, >74), gender, race (African American, White, other), education (0–11 years, 12 years, >12 years), and net worth (< \$29,000, \$29,001–105,900; \$105,901–277,000; >\$277,000).

Analysis

We constructed separate multivariable linear regression models to examine the association between comorbidity and our 2 dependent variables: diabetes prioritization and self-management ability. The first set of models examined the associations between the overall comorbidity count and each dependent variable. The second set of models examined the association between specific comorbidity subtypes (i.e., concordant-microvascular, concordant-macrovascular, and discordant conditions) and each dependent variable. The last set of models focused on the role of HF severity while simultaneously examining the independent effect of microvascular-concordant conditions, macrovascular-concordant conditions (minus HF),

and discordant conditions. Persons without the comorbidity in each category were considered the referent group. All models were adjusted for age, gender, race, education, and net worth.

No variable had greater than 5% missing data except for diabetic eye disease (6% missing). We conducted 2 sensitivity analyses. First, we repeated regression analyses also controlling for diabetes duration, frequency of visits to diabetes care providers, and diabetes treatment (medication type). Next, we repeated the analyses using dependent variables that had been transformed to approximate a normal distribution. There was no effect on the directionality, statistical significance, or relative magnitude of the main results, and we thus present the original models described above.

RESULTS

Respondent sociodemographic and diabetes characteristics are presented in Table 1. Only 8% of respondents had no comorbid conditions, 40% had at least 1 microvascular comorbidity, 79% had at least 1 macrovascular comorbidity, and 61% had at least 1 discordant comorbidity (Table 2).

Patients with a greater overall number of comorbidities had lower diabetes prioritization and diabetes self-management ability scores (Table 3). However, when we examined the role of specific comorbidity subtypes (Table 4), the presence of microvascular-concordant conditions had no effect on prioritization. In contrast, having more macrovascular-concordant comorbidities and more discordant comorbidities was associated with lower diabetes prioritization. Additionally, higher numbers of macrovascular concordant, microvascular concordant, and discordant conditions were all associated with lower diabetes self-management ability.

In the models examining the association between HF severity and the 2 outcomes (Table 5), severe HF was associated with lower diabetes prioritization and self-management

Table 1. Characteristics of Respondents (N=1,901)

	% (N)
Age	
% <65 years	30 (581)
% 65–74	40 (753)
% >74	30 (567)
% Female	53 (1002)
Race	
% White	76 (1442)
% African American	19 (368)
% Other	5 (87)
Education completed	
% 0–11 years	35 (660)
% 12 years	33 (630)
% >12 years	32 (607)
Net worth (quartiles)	
\$<29,000	25 (475)
\$29,001–105,900	25 (476)
\$105,901–277,000	25 (477)
\$>277,000	25 (473)
Diabetes medication treatment	
% none	14 (262)
% only oral	61 (1164)
% insulin ± oral	25 (475)
Mean duration of diabetes, years (SE)	11.9 (.24)

Table 2. Diabetes Comorbidities (N=1,901)

Comorbidity	% (N)
Concordant, microvascular	
Renal disease	18 (337)
Neuropathy	21 (391)
Diabetic eye disease	15 (267)
Microvascular combined score	
% 0	61 (1163)
% 1	28 (522)
% 2-3	11 (216)
Concordant, macrovascular	
Coronary disease	28 (509)
Cerebrovascular disease	16 (310)
Hypertension	76 (1404)
Heart failure	13 (256)
Mild symptoms	43 (109)
Severe symptoms	57 (142)
Macrovascular combined score	
% 0	19 (364)
% 1	48 (914)
% 2	19 (368)
% 3-4	14 (255)
Discordant conditions	
% Lung disease	10 (195)
% Cancer	14 (272)
% Arthritis	55 (1041)
Combined discordant conditions	
% 0	37 (706)
% 1	48 (910)
% 2-3	15 (285)
Overall count	
% 0	8 (140)
% 1	20 (385)
% 2	25 (483)
% 3	20 (386)
% 4	13 (246)
% 5-8	14 (261)

ability. In contrast, mild HF did not significantly affect diabetes prioritization or self-management. Relationships between the other comorbidity categories and the dependent variables did not change significantly when HF was removed from the macrovascular score and severity was taken into account.

Table 3. Adjusted Association Between Overall Number of Comorbid Conditions and Diabetes Prioritization and Self-Management Ability*

Overall number comorbid conditions (reference is none)	Diabetes Prioritization (N=1,832)		Self-Management Ability (N=1,793)	
	Coeff	P	Coeff	P
1	-4.6	.02	-1.5	.37
2	-6.2	.001	-4.3	.01
3	-8.1	<.001	-5.9	.001
4	-12.1	<.001	-8.1	<.001
5-8	-14.7	<.001	-8.1	<.001

*Higher scores represent greater prioritization to diabetes and higher self-management ability. Comorbid conditions comprise renal disease, neuropathy, diabetic eye disease, coronary disease, cerebrovascular disease, hypertension, heart failure, lung disease, cancer, and arthritis. Model is adjusted for age, gender, race, education, and net worth. $R^2=.07$ for the Diabetes Prioritization model and 0.05 for the Self-Management Ability model.

Table 4. Adjusted Association Between the Number of Concordant-Microvascular, Concordant-Macrovascular and Discordant Comorbidities and Diabetes Prioritization and Self-Management Ability*

Comorbidity type and number (reference is no comorbidity)	Diabetes Prioritization (N=1,832)		Self-Management Ability (N=1,793)	
	Coeff	P	Coeff	P
1 Concordant-microvascular	0.90	.38	-3.1	.001
2-3 Concordant-microvascular	0.49	.74	-3.7	.005
1 Concordant-macrovascular	-3.6	.003	-2.4	.03
2 Concordant-macrovascular	-8.6	<.001	-4.3	.001
3-4 Concordant-macrovascular	-12.4	<.001	-4.9	.001
1 Discordant	-1.8	.062	-2.8	.001
2-3 Discordant	-6.4	<.001	-1.3	.26

*Higher scores represent greater prioritization to diabetes and higher self-management ability. Concordant microvascular comprise renal disease, neuropathy and diabetic eye disease; concordant macrovascular conditions comprise coronary disease, cerebrovascular disease, hypertension, and congestive heart failure; and discordant conditions comprise lung disease, cancer, and arthritis. The model is adjusted for age, gender, race, education, and net worth. $R^2=.09$ for the Diabetes Prioritization model and 0.06 for the Self-Management Ability model.

DISCUSSION

To our knowledge, this is the first study to go beyond simple counts of comorbidities to examine how the type and severity of comorbidities may influence diabetes patients' treatment priorities and self-management ability. In this sample of middle-aged and older adults, only 8% of respondents reported having no comorbid conditions, whereas over 70% reported 2 or more. Whereas previous studies have stressed the importance of singular conditions^{17, 28, 29} or of overall comorbidity

Table 5. Adjusted Association Between Heart Failure Severity as Well as the Number of Microvascular, Macrovascular, and Discordant Comorbidities, and Diabetes Prioritization and Self-Management Ability*

Heart failure severity (reference is no heart failure)	Diabetes Prioritization (N=1,828)		Self-Management Ability (N=1,791)	
	Coeff	P	Coeff	P
Mild heart failure	-2.3	.24	1.9	.27
Severe heart failure	-6.2	.001	-4.6	.003

*Higher scores represent greater prioritization to diabetes and higher self-management ability. The model is adjusted for concordant microvascular conditions, concordant macrovascular conditions, discordant conditions, age, gender, race, education, and net worth concordant microvascular conditions comprise renal disease, neuropathy and diabetic eye disease; concordant macrovascular conditions comprise coronary disease, cerebrovascular disease, and hypertension; and discordant conditions comprise lung disease, cancer, and arthritis. $R^2=.09$ for the Diabetes Prioritization model and 0.06 for the Self-Management Ability model.

counts,³⁰ our results suggest that some conditions typically included in overall counts may have little impact on diabetes prioritization and self-management ability, whereas other conditions differentially affect these 2 outcomes. When we combined all comorbidities into a single score, we found the expected relationship: the greater the number of comorbidities, the lower the scores for diabetes prioritization and self-management ability. Although we hypothesized that the presence of concordant conditions would increase diabetes prioritization and self-management scores, we found the presence of microvascular-concordant conditions was associated with lower self-management, but not lower prioritization, scores. It is plausible that when persons develop diabetic microvascular complications they have more difficulty with self-management tasks (i.e., retinopathy may make checking blood sugar difficult and neuropathy may impede exercise), but they keenly realize how important diabetes is to their overall health. It is also possible that patients who had more difficulty with self-management were more likely to develop microvascular complications.

A higher burden of macrovascular conditions was associated with both lower prioritization and self-management ability. Until recently, patients with diabetes were often warned about microvascular complications of diabetes, whereas macrovascular complications (heart disease, stroke) received much less attention. We now know that patients with Type 2 diabetes are at much greater risk of mortality and morbidity from macrovascular disease than from microvascular complications,³¹ yet this message has been slow to reach patients and some providers.^{9, 32} It is possible, therefore, that although we viewed macrovascular conditions as pathophysiologically concordant with diabetes, patients view those diseases as discordant and potentially more burdensome than diabetes.

It is especially important to note that among patients with HF (a particularly serious and often symptomatic macrovascular condition), those with severe HF, but not those with mild HF, had lower diabetes prioritization and self-management scores. This supports our hypothesis that it is not only the presence of a specific type of comorbidity but also its severity that influences patients' ability to focus on diabetes and to perform self-care tasks. In particular, patients with mild HF need to perform similar self-management activities for HF as for diabetes (e.g., diet, exercise), and their disease state does not yet impede their ability to accomplish these tasks. However, severe HF may eclipse the importance of all other conditions, making diabetes a lesser priority and its self-management more difficult.

Finally, as expected, the presence of discordant conditions (in this case, lung disease, cancer, and arthritis) was associated with lower prioritization and lower self-management ability. We had few respondents with 2–3 discordant conditions, however, and generally a small number of discordant condition types. This relationship warrants further examination.

Despite its methodological strengths, several study limitations should be considered. First, our results are cross-sectional, and it is possible that increased numbers and severity of comorbid conditions are the result of, rather than the cause of, poor diabetes self-management. Additionally, conditions were self-reported and it is possible that patients may have under- or overreported the presence of certain conditions, although steps have been taken to improve reliability in the HRS.³³ Both self-management ability and prioritization were self-reported, and the prioritization scale

had only moderate internal consistency reliability, which may have limited our power to detect some associations between our main independent variables and diabetes prioritization. Whereas our study found significant associations of comorbidity number, type, and severity with diabetes prioritization and self-management ability, our models explained only a small percentage of the variance in each dependent variable. The purpose of the current study, however, was not to construct comprehensive models that explain variance in prioritization and self-management, but rather to isolate the association between different specifications of comorbidity and the dependent variables. Models designed to explain a larger proportion of the variance in self-management tend to include variables that assess, for example, specific barriers to self-management, beliefs about the importance of diabetes self-management, and effectiveness of provider communication.^{7,8} Whereas we could hypothesize correlations between those variables and our indicators of the type and severity of comorbidity, those important issues remain largely unexplored. Our current models provide a reasonable best estimate of the magnitude and direction of associations under investigation.

Had we limited our analysis to looking only at simple counts of comorbid conditions, we would have concluded that patients with a greater number of comorbidities are less likely to place priority on diabetes and have more difficulty with diabetes self-management tasks. Examining in more depth the types and severity of the comorbidities, however, reveals a more nuanced picture. Indeed, it appears that certain conditions may have greater influence than others on the ability of diabetes patients to manage their self-care. For example, severe but not mild HF significantly increases difficulty with diabetes self-care. Whereas decreasing diabetes prioritization or a focus on diabetes self-care may be appropriate for many patients with severe comorbid conditions, for most patients those decisions are made without information about the relative impact of their individual conditions on future complications or mortality. Indeed, patients generally get little help from their providers in setting care priorities among their many conditions and we are just beginning to define strategies for addressing the challenges involved in this type of priority setting.³⁴ However, our findings suggest that patients with severely symptomatic comorbidities, and those with conditions they consider to be unrelated to diabetes, may need additional support both in making explicit decisions about care priorities and in managing their day-to-day self-care activities.

Although this study focused on patients with diabetes, it is likely that similar interactions among comorbidities exist for patients with other common chronic conditions. New models of care organization, such as those that focus on a "medical home" for care coordination, may help to address the needs and preferences of patients with multiple conditions.³⁵ It is clear that our aging population is facing significant challenges in managing the demands of multiple chronic conditions. It is time that the health care profession take up the challenge of better understanding how to adapt our care management strategies to balance the benefits and risks of multiple medical recommendations and to incorporate patient preferences.

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