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Journal

Journal of Diabetes and its Complications, 29(2)

ISSN

1056-8727

Authors

Magnan, Elizabeth M
Palta, Mari
Johnson, Heather M
et al.

Publication Date

2015-03-01

DOI

10.1016/j.jdiacomp.2014.10.003

Peer reviewed

Published in final edited form as:
J Diabetes Complications. 2015 March ; 29(2): 288–294. doi:10.1016/j.jdiacomp.2014.10.003.

The Impact of a Patient's Concordant and Discordant Chronic Conditions on Diabetes Care Quality Measures

Elizabeth M. Magnan, MD, PhD[1,2], **Mari Palta, PhD**[2,3], **Heather M. Johnson, MD, MS**[1,4], **Christie M. Bartels, MD, MS**[1,4], **Jessica R. Schumacher, PhD**[1,5], and **Maureen A. Smith, MD, PhD, MPH**[1,2,5,6]

[1] Health Innovation Program, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

[2] Department of Family and Community Medicine, University of California, Davis, Sacramento, CA, USA

[3] Department of Biostatistics and Medical Informatics, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

[4] Department of Medicine, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

[5] Department of Surgery, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

[6] Department of Family Medicine, University of Wisconsin School of Medicine and Public Health, Madison, Wisconsin, USA

Abstract

Aims—Most patients with diabetes have comorbid chronic conditions that could support (concordant) or compete with (discordant) diabetes care. We sought to determine the impact of the number of concordant and discordant chronic conditions on diabetes care quality.

Methods—Logistic regression analysis of electronic health record data from 7 health systems on 24,430 patients with diabetes aged 18-75 years. Diabetes testing and control quality care goals were the outcome variables. The number of diabetes-concordant and the number of diabetes-discordant conditions were the main explanatory variables. Analysis was adjusted for health care utilization, health system and patient demographics.

Corresponding Author Information and Requests for Reprints: Elizabeth M Magnan, MD, PhD, Department of Family and Community Medicine, University of California, Davis, 4860 Y Street, Suite 2320, Sacramento, CA, 95817, USA. Phone: 001-916-734-2827, Fax 001-916-734-5641, elizabeth.magnan@ucdmc.ucdavis.edu.

Conflict of Interest: No conflicts of interest were declared.

Results—A higher number of concordant conditions were associated with higher odds of achieving testing and control goals for all outcomes except blood pressure control. There was no to minimal positive association between the number of discordant conditions and outcomes, except for cholesterol testing which was less likely with 4+ discordant conditions.

Conclusions—Having more concordant conditions makes diabetes care goal achievement more likely. The number of discordant conditions has a smaller, inconsistently significant impact on diabetes goal achievement. Interventions to improve diabetes care need to align with a patient's comorbidities, including the absence of comorbidities, especially concordant comorbidities.

Keywords

diabetes; comorbidity; multimorbidity; multiple chronic conditions; quality; outcomes

1. Introduction

Over 21 million people in the US have diabetes and at least one other chronic condition, and the majority have suboptimal care, which has critical implications for the health outcomes of this growing population (Centers for Disease Control and Prevention, 2011; National Committee for Quality Assurance, 2012). Less than two thirds of patients achieve glycemic control and less than half achieve goal blood pressure control (National Committee for Quality Assurance, 2012). Diabetes is progressive, and suboptimal treatment leads to severe complications (American Diabetes Association, 2014). Comorbid conditions, and the challenges of managing multiple competing demands from multiple conditions, could lead to worse diabetes care by distracting from diabetes care goals (Boyd and Fortin, 2010; Piette and Kerr, 2006). Providers face time constraints during office visits when managing patients with diabetes and comorbidities, as guidelines suggest providers spend 11 hours/day on chronic condition management (Yarnall et al., 2009). Patients face time and financial constraints as well, as guidelines recommend 143 minutes/day on diabetes self-care and 19 medications for diabetes plus four co-morbid conditions (Boyd et al., 2005; Russell et al., 2005; Yarnall et al., 2009). Guidelines do not support providers and patients in integrating multiple care needs of diabetes and co-morbid chronic conditions (Boyd et al., 2005; Zulman et al., 2014). The combined impact of multiple care needs and lack of integration of these needs could mean that patients with a high number of comorbidities are less likely to receive adequate care. We are unable to improve and tailor guidelines and interventions for patients with diabetes without better understanding how multimorbidity impacts diabetes care quality.

The impact of multimorbidity is often measured as the total count of comorbid conditions but this approach ignores a potentially important consideration: if the comorbidity has similar or dissimilar management to diabetes ((Huntley et al., 2012; Kerr et al., 2007). Piette and Kerr's conceptual framework of Concordance and Discordance suggests that diabetes co-morbidities can be either concordant (similar) or discordant (dissimilar) with respect to diabetes management and can either support or compete with diabetes care (Piette and Kerr, 2006). Patients with more concordant conditions will receive better diabetes care due to provider cuing and synergistic care, while patients with more discordant conditions will receive worse diabetes care due to distraction and competition for limited resources (Jaen et

al., 1994; Piette and Kerr, 2006). There is no neutral category in this framework as any condition that is not concordant is by definition discordant and competes with diabetes for health care resources. This framework suggests that past studies that have shown improved outcomes in patients with more chronic conditions (Higashi et al., 2007; Min et al., 2007) were likely showing the beneficial effect of having more concordant conditions.

There is conflicting evidence that the presence of concordant and discordant conditions leads to differences in the receipt of recommended diabetes care (Desai et al., 2002; Kerr et al., 2007; Krein et al., 2009; Pentakota et al., 2012; Redelmeier et al., 1998; Sales et al., 2009; Thorpe et al., 2012; Vitry et al., 2010; Voorham et al., 2012). For example, concordant conditions have been associated with a higher likelihood of HbA1c and cholesterol control in one study (Woodard et al., 2011) but only with cholesterol control in another (Pentakota et al., 2012). Discordant conditions were associated with both better and worse diabetes care (Dixon et al., 2004; Pentakota et al., 2012; Woodard et al., 2011). However, these studies used limited lists of chronic conditions (the majority under 10), and none assessed the role of both the number of concordant and the number of discordant chronic conditions on diabetes care goal achievement.

The purpose of our study was to improve understanding of the impact of the number of concordant and discordant chronic conditions on diabetes care goal achievement (care quality) for patients with diabetes. We hypothesized that patients with more concordant conditions would have better diabetes care quality than those with fewer concordant conditions, and that patients with more discordant conditions would have worse diabetes care quality than those with fewer discordant conditions.

2. Methods

2.1. Sample

Adult patients (aged 18-75) with diabetes (type 1 or type 2) who were medically homed in ambulatory practices within 7 health systems that participate in a Midwestern quality reporting collaborative, the Wisconsin Collaborative for Healthcare Quality (WCHQ). The age limit reflects the standard age range for public reporting of quality metrics, based on diabetes care guidelines, as children and the very elderly have different care needs (National Committee for Quality Assurance, 2011; Wisconsin Collaborative for Healthcare Quality, 2011). The participating health systems include academic and community systems in rural, suburban, and urban settings and all used the same approach to identify eligible patients (Wisconsin Collaborative for Healthcare Quality, 2011). Two years of electronic health record data were used, a baseline year, 2010, and a quality metrics reporting year, 2011. The presence of diabetes (type 1 or type 2) was defined by patients having at least two face-to-face ambulatory visits (using CPT-4 outpatient evaluation and management or E&M codes) with any provider (MD, DO, PA, NP) on different dates of service with an ICD-9 diagnosis code of 250.XX, 357.2, 362.XX, 366.41, or 648.XX over the two years of data (Wisconsin Collaborative for Healthcare Quality, 2011). A patient has a current medical home at the provider group if they had at least two E&M office visits on different dates of service in the past two years to a primary care provider (or one E&M visit to a primary care provider and one to an endocrinologist), regardless of diagnostic codes. Patients were eligible for the

study if they were seen at least once for an ambulatory care visit in the reporting year, 2011(Wisconsin Collaborative for Healthcare Quality, 2011). The Minimal Risk Health Sciences Institutional Review Board at the University of Wisconsin determined the project was exempt from IRB oversight.

2.2. Outcome Variables

We used American Diabetes Association guideline-recommended diabetes testing and control care goals, for adult patients aged 18-75 with type 1 or type 2 diabetes, that are shown to be associated with macrovascular and microvascular outcomes as our outcome variables, using 2011 goal levels (reporting year) (American Diabetes Association, 2011; Wisconsin Collaborative for Healthcare Quality, 2011). These included : HbA1c testing two or more times/year; HbA1c control <7% (or <8% if 65-75 years old or having guideline-specified comorbidities); LDL cholesterol testing in the past year; LDL cholesterol control <100 mg/dL; kidney function testing (urine microalbumin test in past year or documented evidence of active nephropathy); blood pressure control at <130/80 mmHg (American Diabetes Association, 2011; Wisconsin Collaborative for Healthcare Quality, 2011). We also used two overall measures of diabetes control, “all testing” (all three testing goals achieved) and “all control” (all three control goals achieved). Variables were binary (goal achieved or not).

2.3. Explanatory Variables

Patient comorbidity profiles expressed as the number of concordant conditions and the number of discordant conditions were the main explanatory variables. We chose to use the number of conditions (a count) as this is a common approach to measuring comorbidity in comorbidity indices (Higashi et al., 2007; Huntley et al., 2012). We used a comprehensive set of 62 chronic condition indicators (excluding diabetes) covering 1,412 ICD-9 codes based on an established list of outpatient-relevant chronic conditions developed from the AHRQ Clinical Classification Software (CCS) categories (Hwang et al., 2001; Naessens et al., 2011). Chronic conditions were assessed in the baseline year, 2010, to ensure they were active and present before the quality reporting time frame.

Patient chronic conditions were categorized as concordant or discordant to diabetes, as per Piette and Kerr’s conceptual framework (Piette and Kerr, 2006), based on primary care expert opinion using Delphi methodology. Primary care providers were asked which conditions shared care goals with diabetes (concordant) for the care goals included in this study, and which conditions did not (discordant). Of 62 conditions, 12 were considered concordant and 50 were considered discordant (Supplementary Table).

2.4. Covariates

All models were adjusted for several patient socio-demographic and health care utilization factors that are associated with health care quality. Socio-demographic factors included age, gender, race (white or other), insurance (non-commercial Medicare, Medicaid, commercial (including commercial Medicare), or self-pay/unreported), and patient ever on Medicaid. To account for potential diabetes care contextual effects, we developed a variable for the prevalence of self-reported diabetes in each patient’s county of residence, and a variable for

the percent of all Medicare patients in the county who have had HbA1c testing, from patient zip codes linked to the University of Wisconsin Population Health Institute-Robert Wood Johnson County Health Rankings (University of Wisconsin Department of Population Health, 2006-2014). We determined two additional measures of socioeconomic status by linking patient zip codes to census tract data for the percent of the population in the patient's zip code below the poverty line and without a high school education. We included rural-urban commuting area codes based on the patient's zip code (RUCA, 4 level) (WWAMI RUCA Rural Health Research Center, 2011). Health care utilization was measured as number of face-to-face E&M office visits (in baseline year, 4 level categorical variable) (Pham et al., 2007; Wisconsin Collaborative for Healthcare Quality, 2011). We also included an indicator for health system.

2.5. Statistical Analysis

All analyses were conducted using Stata 13.0 (Stata-Corp, College Station, TX). For descriptive analyses, categorical variables were summarized using percentages and continuous variables were summarized using means (with standard deviations). Logistic regression models were fit to obtain odds ratios and 95% confidence intervals (CIs) for the relationship between the number of concordant and the number of discordant conditions, in the same model, and the receipt of each diabetes testing and control goal. Models were first fit unadjusted, then adjusted for the covariates described above. The potential for there being a non-linear relationship between the chronic condition count variables and study outcomes was assessed in models where chronic condition counts were entered as ordinal or categorical variables, using different groupings of counts. (*e.g.*: 0,1,2,3,4,5,6+ conditions, 0-1,2-3,4-5, 6+ conditions, 0-1, 2-3, 4+ conditions). Model fit was assessed with a Wald test between models, BIC, c-statistic, and by visual inspection of plotted results (conditions counts vs. goal achievement). Due to evidence of non-linearity, categorical variables were chosen. There was little difference in goal achievement for 1 condition compared to 0 conditions, and for 4+ conditions compared to 4-5 and 6+.

To test the effect of using variables for the number of concordant and the number of discordant conditions in our models, versus using a variable for the total number of conditions, we compared the coefficients of the concordant conditions variable to those of discordant conditions variable, for each of the 8 outcomes, using Wald tests. We found that the concordance and discordance variables were significantly different. Hence, we concluded that the number of concordant and discordant conditions should be used in our models rather than the total number of comorbid conditions.

An interaction term between the number of concordant and the number of discordant conditions variables was tested to determine if the impact of the number of concordant conditions was different depending on the number of discordant conditions, or vice versa. This was found not to improve prediction by BIC or c-statistic. The interaction term was dropped from our models.

Our final models had the number of concordant conditions and the number of discordant conditions as categorical variables with 0-1 conditions (reference), 2-3 conditions, and 4+ conditions as the categories.

3. Results

Our sample had 23,430 patients with diabetes, between the ages of 18-75 (Table 1). The sample was 58 years old on average, 48% female, and 70% white. The majority had health care coverage, with 12% uninsured or with unreported coverage. The majority (85%) had 10 or fewer face-to-face provider visits in the baseline year. The mean total active chronic conditions (in addition to diabetes) was 3.8 (SD=2.5), and 92% had at least one co-morbid condition (multimorbidity). Patients had a mean of 2.2 (SD=1.3) diabetes concordant conditions and 1.7 (SD=1.7) discordant conditions.

Patient diabetes care goal achievement varied widely between measures. Table 2 shows descriptive frequencies of diabetes care goal achievement. Cholesterol testing was the care goal with the highest achievement at 87% and blood pressure control had the lowest achievement of non-composite goals at 51%.

We found significantly higher diabetes testing goal achievement with a higher number of concordant conditions, adjusted for patient socio-demographics and health care utilization (Table 3). Patients with 2 or more concordant conditions had greater odds of diabetes testing goal achievement (HbA1c, cholesterol, kidney, and all testing) than patients with 0-1 concordant conditions, regardless of the number of discordant conditions, although the greatest difference was demonstrated for patients with 4+ concordant conditions.

The number of discordant conditions had an inconsistently significant impact on testing goal achievement (Table 3). Patients with 4+ discordant conditions were significantly less likely to receive cholesterol testing than patients with 0-1 discordant conditions (OR=0.86; [95% CI=0.75-0.99]). The number of discordant conditions had no significant effect on kidney or all testing goal achievement. Having more than 2 discordant conditions was associated with a statistically significant increase in the likelihood of achieving HbA1c testing (OR for 2-3 conditions= 1.1 [1.1-1.2]; OR for 4+ conditions= 1.3 [CI=1.1-1.4]).

Patients were also significantly more likely to achieve control goals, except blood pressure control, if they had 2+ concordant conditions as compared to 0-1 concordant conditions (Table 4). In general, there were few significant improvements in goal achievement with 4+ conditions over goal achievement with 2-3 conditions. Blood pressure control was less likely to be achieved by patients with 2-3 and 4+ concordant conditions than with 0-1 concordant conditions (OR for 2-3 conditions 0.80 [0.76-0.87];

OR for 4+ conditions 0.9 [0.82-0.99]).

A higher number of discordant conditions was associated with a statistically significant higher likelihood of achieving HbA1c control, and a small but statistically significant higher likelihood of achieving blood pressure and all control (Table 4). The number of discordant conditions had no impact on cholesterol control.

4. Discussion

We found that having 2 or more concordant conditions is associated with better diabetes care quality for testing and control goals, except blood pressure control. The patients with the fewest concordant conditions had the lowest likelihood of achieving diabetes care goals. The impact of the number of concordant conditions was strongest for testing goals. We found an inconsistently significant no effect or minimal supportive effect of having more discordant conditions. In general, the impact of the number of concordant conditions on diabetes care goal achievement of greater magnitude than the impact of discordant conditions, with the exception of HbA1c control. Our results support the concordant aspect of the Concordance and Discordance framework as we found that patients with more concordant conditions received better diabetes care. Our results did not support the discordant aspect of the framework as we did not find that the number of discordance conditions was associated with substantially worse diabetes care.

Our concordant condition results are consistent with literature showing that concordant conditions are associated with better diabetes management in the setting of multiple chronic conditions (Aung et al., 2013; Lagu et al., 2008; Pentakota et al., 2012; Thorpe et al., 2012). In a study of patients with diabetes, grouped by comorbidity type, those with concordant-only comorbidities had better cholesterol control goal achievement than those with no comorbid conditions (Pentakota et al., 2012). Our previous work showed that patients with diabetes and dementia have higher rates of HbA1c tests, cholesterol tests, and eye examinations if they also have diabetes-concordant ischemic heart disease and peripheral vascular disease (Thorpe et al., 2012). The increased likelihood of diabetes goal achievement with more concordant comorbidities fits theories of cueing and synergy for congruent care that suggest, for example, that kidney disease in a patient with diabetes might cue for blood pressure control, or providers and patients might preferentially attempt to achieve synergistic care goals (Kerr et al., 2007; Pentakota et al., 2012; Piette and Kerr, 2006). It is reasonable that for a higher number of concordant conditions, the potential for cuing is higher as well.

Another potential reason for our concordance findings is that patients with more concordant conditions might receive better diabetes care due to a greater sense of urgency in providers and patients to optimize diabetes care for patients who already have diabetic complications and have a greater need for diabetes care goal achievement (American Diabetes Association, 2011; Kerr et al., 2007; Laiteerapong et al., 2011; Voorham et al., 2012). Past studies support this rationale. In one study, providers only intensified blood sugar treatment in uncontrolled diabetes for patients who had a new-onset complication (Voorham et al., 2012). In another study, patients with microvascular-concordant conditions expressed higher self-care priority for diabetes care goals than did patients without these concordant conditions (Kerr et al., 2007).

Contrary to what we expected from the conceptual model, discordant conditions were not associated with worse care in our study, with the exception of less cholesterol testing. Piette and Kerr's framework suggests that discordant conditions divert resources from diabetes care (Piette and Kerr, 2006). A previous test of this framework showed that patients with

discordant conditions only were less likely to achieve HbA1c and cholesterol management goals than patients with no comorbid conditions (Pentakota et al., 2012). However, this study grouped all patients with any number of discordant conditions together and did not consider the number of discordant conditions. This approach, in contrast to our approach, does not differentiate between having 1 and having more than 1 discordant condition which we found to matter in our study. The small but statistically significant beneficial effect that we found from having 2 or more discordant conditions for 4 outcomes, even after controlling for number of visits, could be due to a beneficial effect of having a greater number of conditions in general, as has been seen previously (Higashi et al., 2007). It might be that patients who are sicker receive better care or do better self-care than patients with fewer conditions. Also, medication and lifestyle changes done for discordant conditions could inadvertently benefit diabetes control goals.

Additionally, Pentakota's previous study removed patients with serious or terminal discordant conditions when determining the impact of discordance (*e.g.* cancers, end stage renal disease) (Pentakota et al., 2012). Our approach allowed examination of the impact of the number of discordant conditions, including serious conditions that might have a greater impact on diabetes care. We chose to include serious and terminal conditions in our counts or concordance and discordance to measure the full impact of concordant and discordant conditions experienced by each patient. We recognize that including a large number of heterogeneous conditions could reduce the measurable impact from any individual condition, and this could partially explain the limited impact seen from the number of discordant conditions.

The model of Competing Demands suggests that discordance should distract providers from ordering tests (Jaen et al., 1994; Piette and Kerr, 2006), however it is plausible that test ordering is robust to distraction as providers can order lab tests easily. We found that having more discordant conditions did not lead to fewer HbA1c and kidney tests. However, we also found that 4+ discordant conditions reduced the likelihood that the cholesterol testing was completed. The LDL cholesterol test requires fasting and often a return visit, compared to HbA1c and kidney tests that patients can complete the day of a clinic visit. This suggests that discordance can be detrimental when the task is complex enough, as when it requires a return visit or fasting, or when the number of discordant conditions is great enough. Despite these challenges, cholesterol testing was the most achieved testing or control goal, with an increased odds of completion in patients with more concordance.

Blood pressure control was the least achieved single goal in our study. It was the only goal less likely to be achieved with 2+ concordant conditions, compared to 0-1, and was slightly more likely to be achieved with 2+ discordant conditions. Although blood pressure control is a top priority in diabetes care (American Diabetes Association, 2011), it is multifactorial and extremely challenging. Blood pressure often remains uncontrolled despite clinical and self-care efforts, as the average patient needs 2-3 antihypertensive medications to achieve control, requiring appropriate medication titration and timely follow-up (James et al., 2014). Another reason patients with more diabetes concordant conditions might be less likely to have controlled blood pressure is that these patients could also have more advanced pathophysiologic changes that contribute to lack of blood pressure control (Calhoun et al.,

2008). In contrast, discordant conditions might be less likely to have a pathophysiologic impact on blood pressure and these conditions could contribute to a sense of urgency for more intense care for a patient with more comorbidities.

Our results show a difference in the impact of the number of concordant conditions versus the number of discordant conditions for all outcomes except HbA1c control. The number of concordant conditions was associated with a statistically significant increase in the achievement of all care goals except blood pressure control which was significantly less likely to be achieved. The number of discordant conditions, however, had an inconsistently significant impact on care goal achievement. When the number of discordant conditions was related to a statistically significant increase in the likelihood of care goal achievement, the effect size was typically smaller than seen with concordance. One exception was HbA1c management. The number of concordant and the number of discordant conditions had the same impact on HbA1c control and similar impacts on HbA1c testing. HbA1c management (testing and control) could be robust to distraction from discordant conditions as glycemic management has long been central to diabetes care and diabetes public reporting (American Diabetes Association, 2011; National Committee for Quality Assurance, 2012; Wisconsin Collaborative for Healthcare Quality, 2011). Therefore, these care goals are likely to be achieved in patients with any mix of concordant or discordant conditions, and especially in patients with more than 1 comorbid condition who might be perceived as sicker and more in need of tight control.

This study has several strengths that help it build on what has been done previously in the field. We assessed the impact of the number of concordant and discordant conditions to determine the impact of concordance and discordance on diabetes care goal achievement, rather than using the any versus none approach that has been used previously (Aung et al., 2013; Pentakota et al., 2012). We identified 62 different concordant and discordant chronic conditions to use in our condition counts. We used active co-morbid conditions as those had the opportunity to support or distract from current diabetes care, rather than including historic conditions that might not be currently managed. The concordance or discordance of these conditions was defined by consensus primary care provider opinion, a difference from concordance-discordance determination in previous studies, with similar categorizations of condition concordance and discordance as used previously (Aung et al., 2013; Kerr et al., 2007; Pentakota et al., 2012). The sample of patients with diabetes was large (n=24,430) and from 7 health systems with standardized diabetes metrics reporting algorithms (Wisconsin Collaborative for Healthcare Quality, 2011). Finally, we chose to control for number of office visits in the baseline year. While the number of office visits might be in the causal pathway between the number of comorbid conditions and quality of care, the goal of this study was to focus on the impact of the number of concordant and discordant conditions, above and beyond any effect from health care utilization. In a previous study, the detrimental effect of discordance disappeared when a patient had more than 24 office visits in a year (Pentakota et al., 2012). After controlling for office visits, we found minimal change in our results, suggesting much of the impact of the number of concordant and discordant conditions on diabetes care is not due to increased face-to-face encounters with providers.

Some limitations of this work include that the data is from a Midwest population that is not as racially diverse as the general US population and the data is from health systems that choose to participate in public quality reporting (Wisconsin Collaborative for Healthcare Quality, 2011). However, diabetes quality achievement in our study was similar to achievement found in a national public reporting sample, with less HbA1c testing and more blood pressure and cholesterol control achievement (National Committee for Quality Assurance, 2012). While we were able to account for some socio-demographic factors, we were also limited in our ability to account for socioeconomic or other contextual effects (Bayliss et al., 2014). Additionally, although used frequently in public reporting, our outcomes are markers of condition management rather than patient-centered end outcomes such as increased morbidity. While we controlled for health care utilization with the number of E&M visits in the baseline year, we were unable to control for phone calls and non-E&M visits (Pham et al., 2007; Wisconsin Collaborative for Healthcare Quality, 2011) that might influence care goal achievement. Due to lack of data, we were also unable to control for or test mediating effects of the duration of diabetes or of the comorbid conditions, the different specialties seen by the patients or the use of medications during the study period. Finally, we did not test the effect of specific individual chronic conditions or severity of those conditions. The goal of this paper was to assess the role of the number of concordant and discordant conditions in diabetes care and we recognize that there are many other factors that influence diabetes care goal achievement. Future work should examine the impact of individual concordant and discordant conditions. It is possible that certain concordant or discordant conditions have a greater impact on care than other conditions. Additionally, it is possible that certain discordant conditions could still have some overlap in care with diabetes that could enhance diabetes care. For instance, rheumatoid arthritis and lupus were classified by primary care providers as diabetes discordant, but overlap with diabetes for the importance of cardiovascular risk reduction (Bartels et al., 2012).We recognize that the impact on care goal achievement we found was relatively small for some goals, and could be specific to our population. Future work should confirm our findings in other populations with additional covariates.

5. Conclusions

As the prevalence of diabetes and diabetes with multimorbidity increases, we need adequate approaches to treat these patients and prevent future complications in our time-constrained environment. Our findings suggest that the patients most at risk for suboptimal diabetes care are the patients with the fewest comorbidities, especially the fewest concordant comorbidities. These patients are likely earlier in their disease progression, and represent important targets for interventions to prevent additional complications. If our results bear out in future work, it could be beneficial to place additional focus in guidelines and interventions on achieving optimal care in patients with fewer comorbidities, especially fewer concordant comorbidities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Funding/Financial Support: This project was funded by grant R21 HS021899 from the Agency for Healthcare Research and Quality. Additional support was provided by the Health Innovation Program, the UW School of Medicine and Public Health from The Wisconsin Partnership Program, and the Community-Academic Partnerships core of the University of Wisconsin Institute for Clinical and Translational Research (UW ICTR) through the National Center for Advancing Translational Sciences (NCATS), grant UL1TR000427. The work presented here was carried out while Dr. Magnan was a Primary Care Research Fellow supported by a National Research Service Award (T32HP10010) from the Health Resources and Services Administration to the University of Wisconsin Department of Family Medicine. Christie Bartels is supported by the National Institute of Arthritis and Musculoskeletal and Skin Diseases, part of the National Institutes of Health (NIH), under award K23AR062381. Heather Johnson is supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under award number K23HL112907, and also by the University of Wisconsin Centennial Scholars Program of the University of Wisconsin School of Medicine and Public Health. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH or AHRQ.

Statements of Assistance: We thank the WCHQ and its participating health systems for providing the data for this study. The authors gratefully acknowledge Katie Ronk and Dave Beam, University of Wisconsin-Madison, Health Innovation Program, for data preparation, and Jamie LaMantia, University of Wisconsin-Madison, Department of Medicine, and Colleen Brown, University of Wisconsin-Madison, Health Innovation Program, for manuscript preparation. We also thank Mindy Smith, MD, MS, Michigan State University, Department of Family Medicine, for scientific writing and editing assistance.

Guarantor: Elizabeth Magnan

References

American Diabetes Association. Standards of medical care in diabetes--2011. Diabetes Care. 2011; 34(Suppl 1):S11–61. [PubMed: 21193625]

American Diabetes Association. Standards of medical care in diabetes--2014. Diabetes Care. 2014; 37(Suppl 1):S14–80. [PubMed: 24357209]

Aung E, Donald M, Coll J, Dower J, Doi SA. The impact of concordant and discordant comorbidities on patient-assessed quality of diabetes care. Health Expectations. 2013 M. W. G.

Bartels CM, Saucier JM, Thorpe CT, Kind AJ, Pandhi N, Hansen KE, Smith MA. Monitoring diabetes in patients with and without rheumatoid arthritis: a Medicare study. Arthritis Research and Therapy. 2012; 14:R166. [PubMed: 22809064]

Bayliss EA, Bonds DE, Boyd CM, Davis MM, Finke B, Fox MH, Glasgow RE, Goodman RA, Heurtin-Roberts S, Lachenmayr S, Lind C, Madigan EA, Meyers DS, Mintz S, Nilsen WJ, Okun S, Ruiz S, Salive ME, Stange KC. Understanding the context of health for persons with multiple chronic conditions: moving from what is the matter to what matters. Annals of Family Medicine. 2014; 12:260–9. [PubMed: 24821898]

Boyd CM, Darer J, Boult C, Fried LP, Boult L, Wu AW. Clinical practice guidelines and quality of care for older patients with multiple comorbid diseases - Implications for pay for performance. JAMA. 2005; 294:716–724. [PubMed: 16091574]

Boyd CM, Fortin M. Future of Multimorbidity Research: How Should Understanding of Multimorbidity Inform Health System Design? Public Health Reviews. 2010; 32:451–474.

Calhoun DA, Jones D, Textor S, Goff DC, Murphy TP, Toto RD, White A, Cushman WC, White W, Sica D, Ferdinand K, Giles TD, Falkner B, Carey RM. Resistant hypertension: diagnosis, evaluation, and treatment. A scientific statement from the American Heart Association Professional Education Committee of the Council for High Blood Pressure Research. Hypertension. 2008; 51:1403–19. [PubMed: 18391085]

Centers for Disease Control and Prevention. National Diabetes Fact Sheet: National Estimates and General Information on Diabetes and Prediabetes in the United States. US Department of Health and Human Services, Centers for Disease Control and Prevention; Atlanta (GA): 2011. 2011

Desai MM, Rosenheck RA, Druss BG, Perlin JB. Mental disorders and quality of diabetes care in the veterans health administration. Am J Psychiatry. 2002; 159:1584–90. [PubMed: 12202281]

Dixon LB, Kreyenbuhl JA, Dickerson FB, Donner TW, Brown CH, Wohlheiter K, Postrado L, Goldberg RW, Fang L, Marano C, Messias E. A comparison of type 2 diabetes outcomes among

persons with and without severe mental illnesses. Psychiatr Serv. 2004; 55:892–900. [PubMed: 15292539]

Higashi T, Wenger NS, Adams JL, Fung C, Roland M, McGlynn EA, Reeves D, Asch SM, Kerr EA, Shekelle PG. Relationship between number of medical conditions and quality of care. New England Journal of Medicine. 2007; 356:2496–504. [PubMed: 17568030]

Huntley AL, Johnson R, Purdy S, Valderas JM, Salisbury C. Measures of multimorbidity and morbidity burden for use in primary care and community settings: a systematic review and guide. Annals of Family Medicine. 2012; 10:134–41. [PubMed: 22412005]

Hwang W, Weller W, Ireys H, Anderson G. Out-of-pocket medical spending for care of chronic conditions. Health Affairs (Project Hope). 2001; 20:267–78. [PubMed: 11816667]

Jaen CR, Stange KC, Nutting PA. Competing demands of primary care: A model for the delivery of clinical preventive services. Journal of Family Practice. 1994; 38:166–171. [PubMed: 8308509]

James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, Lackland DT, LeFevre ML, MacKenzie TD, Ogedegbe O, Smith SC Jr. Svetkey LP, Taler SJ, Townsend RR, Wright JT Jr. Narva AS, Ortiz E. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014; 311:507–20. [PubMed: 24352797]

Kerr EA, Heisler M, Krein SL, Kabeto M, Langa KM, Weir D, Piette JD. Beyond comorbidity counts: how do comorbidity type and severity influence diabetes patients' treatment priorities and self-management? J Gen Intern Med. 2007; 22:1635–40. [PubMed: 17647065]

Krein SL, Hofer TP, Holleman R, Piette JD, Klamerus ML, Kerr EA. More than a pain in the neck: how discussing chronic pain affects hypertension medication intensification. J Gen Intern Med. 2009; 24:911–6. [PubMed: 19479311]

Lagu T, Weiner MG, Hollenbeak CS, Eachus S, Roberts CS, Schwartz JS, Turner BJ. The impact of concordant and discordant conditions on the quality of care for hyperlipidemia. J Gen Intern Med. 2008; 23:1208–13. [PubMed: 18465174]

Laiteerapong N, Huang ES, Chin MH. Prioritization of care in adults with diabetes and comorbidity. Ann N Y Acad Sci. 2011; 1243:69–87. [PubMed: 22211894]

Min LC, Wenger NS, Fung C, Chang JT, Ganz DA, Higashi T, Kamberg CJ, MacLean CH, Roth CP, Solomon DH, Young RT, Reuben DB. Multimorbidity is associated with better quality of care among vulnerable elders. Med Care. 2007; 45:480–8. [PubMed: 17515774]

Naessens JM, Stroebel RJ, Finnie DM, Shah ND, Wagie AE, Litchy WJ, Killinger PJ, O'Byrne TJ, Wood DL, Nesse RE. Effect of multiple chronic conditions among working-age adults. Am J Manag Care. 2011; 17:118–22. [PubMed: 21473661]

National Committee for Quality Assurance. The State of Health Care Quality 2011: Continuous Improvement and the Expansion of Quality Measurement. The State of Health Care Quality; Washington DC: 2011.

National Committee for Quality Assurance. The State of Health Care Quality 2012: Focus on Obesity and Medicare Plan Improvement. The State of Health Care Quality; Washington, DC, NCQA: 2012. Early Edition

Pentakota SR, Rajan M, Fincke BG, Tseng CL, Miller DR, Christiansen CL, Kerr EA, Pogach LM. Does diabetes care differ by type of chronic comorbidity?: An evaluation of the Piette and Kerr framework. Diabetes Care. 2012; 35:1285–92. [PubMed: 22432109]

Pham HH, Schrag D, O'Malley AS, Wu BN, Bach PB. Care patterns in Medicare and their implications for pay for performance. New England Journal of Medicine. 2007; 356:1130–1139. [PubMed: 17360991]

Piette JD, Kerr EA. The impact of comorbid chronic conditions on diabetes care. Diabetes Care. 2006; 29:725–31. [PubMed: 16505540]

Redelmeier DA, Tan SH, Booth GL. The treatment of unrelated disorders in patients with chronic medical diseases. New England Journal of Medicine. 1998; 338:1516–1542. [PubMed: 9593791]

Russell LB, Suh DC, Safford MA. Time requirements for diabetes self- management: too much for many? Journal of Family Practice. 2005; 54:52–6. [PubMed: 15623407]

Sales AE, Tipton EF, Levine DA, Houston TK, Kim Y, Allison J, Kiefe CI. Are co-morbidities associated with guideline adherence? The MI-Plus Study of Medicare Patients. Journal of General Internal Medicine. 2009; 24:1205–1210. [PubMed: 19727967]

Thorpe CT, Thorpe JM, Kind AJ, Bartels CM, Everett CM, Smith MA. Receipt of monitoring of diabetes mellitus in older adults with comorbid dementia. Journal of the American Geriatrics Society. 2012; 60:644–51. [PubMed: 22428535]

University of Wisconsin Department of Population Health. University of Wisconsin - Madison; Madison, WI: 2006-2014. Wisconsin County Health Rankings

Vitry AI, Roughead EE, Preiss AK, Ryan P, Ramsay EN, Gilbert AL, Caughey GE, Shakib S, Esterman A, Zhang Y, McDermott RA. Influence of comorbidities on therapeutic progression of diabetes treatment in Australian veterans: a cohort study. PLoS One. 2010; 5:e14024. [PubMed: 21103337]

Voorham J, Haaijer-Ruskamp FM, Wolffenbuttel BH, de Zeeuw D, Stolk RP, Denig P. Differential effects of comorbidity on antihypertensive and glucose-regulating treatment in diabetes mellitus--a cohort study. PLoS One. 2012; 7:e38707. [PubMed: 22679516]

Wisconsin Collaborative for Healthcare Quality. WCHQ Ambulatory Measure Specification: Diabetes Care Performance Measures. Wisconsin Collaborative for Healthcare Quality; Middleton, WI: 2011.

Woodard LD, Urech T, Landrum CR, Wang D, Petersen LA. Impact of comorbidity type on measures of quality for diabetes care. Med Care. 2011; 49:605–10. [PubMed: 21422952]

WWAMI RUCA Rural Health Research Center. Rural-Urban Commuting Area Codes (RUCAs). 2011

Yarnall KS, Ostbye T, Krause KM, Pollak KI, Gradison M, Michener JL. Family physicians as team leaders: "time" to share the care. Preventing Chronic Disease. 2009; 6:A59. [PubMed: 19289002]

Zulman DM, Asch SM, Martins SB, Kerr EA, Hoffman BB, Goldstein MK. Quality of Care for Patients with Multiple Chronic Conditions: The Role of Comorbidity Interrelatedness. J Gen Intern Med. 2014; 29:529–37. [PubMed: 24081443]

Table 1

Characteristics of Patients with Diabetes

	n=23,430
Patient Comorbidities	
Total	
Number total comorbid conditions, m (SD)	3.8 (2.5)
None (diabetes only, no other chronic conditions), %	8
Concordant	
Number concordant comorbid conditions, m (SD)	2.2 (1.3)
Number of concordant conditions, by category, %	
0-1	28
2-3	60
4+	12
Discordant	
Number discordant comorbid conditions, m (SD)	1.7 (1.7)
Number of discordant conditions, by category, %	
0-1	56
2-3	31
4+	13
Age, m (SD)	57.6 (1.7)
Sex, female, %	48
Race/ethnicity, white, %	70
Insurance, %	
Commercial	50
Medicare	33
Medicaid	6
Uninsured/unreported	12
Medicaid ever, %	6
Office visits in baseline year, %	
<2	27
3 to 10	58
11 to 29	15
30 or more	1
RUCA, by patient's zip code, %	
Urban core	52
Suburban	16
Large Town	9
Small Town and Rural	23
Percent with self-reported diabetes in patient's county, m (SD)	8 (1)
Percent of Medicare patients in county who had HbA1c testing, m (SD)	89 (2.9)
Percent below poverty line in patient's zip code, m (SD)	12 (8.7)
Percent without HS education in patient's zip code, m (SD)	10 (5.6)

m=mean; SD=standard deviation

Table 2

Diabetes Care Goal Achievement: percentage of patients who achieved each diabetes quality outcome

Diabetes Care Goal	Achieved Outcome, % (n=23,430)
HbA1c Testing *twice in last 12 months*	73
LDL Cholesterol Testing *once in last 12 months*	87
Kidney Testing *microalbuminuria in last 12 months*	80
All Testing *achieved HbA1c, LDL and kidney testing goals*	60
HbA1c Control *<7%, or <8% if 65-75 years old or certain comorbidities*	62
LDL Cholesterol Control *<100 mg/dL*	57
Blood Pressure Control *<130/80 mmHg*	51
All Control *achieved HbA1c, LDL and blood pressure control goals*	22

Diabetes Care Goals are per WCHQ and ADA 2011 guidelines (American Diabetes Association, 2011; Wisconsin Collaborative for Healthcare Quality, 2011)

Table 3

Impact of Concordant and Discordant Conditions on Diabetes Testing Goal Achievement (n=23,430)

	Diabetes Testing Goal Achieved											
	HbA1c Testing			LDL Cholesterol Testing			Kidney Testing			All Testing (HbA1c, LDL, Kidney)		
Number of Comorbid Conditions	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**
Concordant comorbid conditions												
0-1	--			--			--			--		
2-3	1.4	(1.3-1.5)	<0.001*	2.0	(1.8-2.2)	<0.001*	1.4	(1.3-1.5)	<0.001*	1.5	(1.4-1.6)	<0.001*
4+	1.8	(1.6-2.1)	<0.001*	2.4	(2.1-2.8)	<0.001*	3.0	(2.6-3.4)	<0.001*	2.1	(1.9-2.3)	<0.001*
Discordant comorbid conditions												
0-1	--			--			--			--		
2-3	1.1	(1.1-1.2)	0.001*	0.97	(0.88-1.1)	0.519	1.0	(0.95-1.1)	0.539	1.1	(0.99-1.1)	0.082
4+	1.3	(1.1-1.4)	<0.001*	0.86	(0.75-0.99)	0.033*	1.0	(0.88-1.1)	0.911	1.1	(0.96-1.2)	0.272

Adjusted for age, sex, race, insurance, having Medicaid ever, number of face-to-face office visits in the baseline year, patient rural-urban commuting area, percent with diabetes in patient's county, percent with diabetes in patient's county who achieved HbA1c testing, percent below poverty line in patient's zip code, percent without high school education in patient's zip code, health system

* p value < 0.05

Table 4

Impact of Concordant and Discordant Conditions on Diabetes Control Goal Achievement (n=23,430)

	Diabetes Control Goal Achieved											
	HbA1c Control			LDL Cholesterol Control			Blood Pressure Control			All Control (HbA1c, LDL, BP)		
Number of Comorbid Conditions	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**	**OR**	**95% CI**	***P* value**
Concordant comorbid conditions												
0-1	--			--			--			--		
2-3	1.2	(1.1-1.3)	<0.001*	1.5	(1.4-1.6)	<0.001*	0.80	(0.76-0.87)	<0.001*	1.21	(1.1-1.3)	<0.001*
4+	1.4	(1.2-1.6)	<0.001*	1.8	(1.6-2.0)	<0.001*	0.90	(0.82-0.99)	0.037*	1.44	(1.3-1.6)	<0.001*
Discordant comorbid conditions												
0-1				--			--					
2-3	1.2	(1.1-1.3)	<0.001*	1.0	(0.95-1.1)	0.587	1.1	(1.002-1.1)	0.044*	1.1	(0.98-1.14)	0.169
4+	1.4	(1.3-1.6)	<0.001*	0.90	(0.83-1.01)	0.077	1.1	(1.0005-1.2)	0.049*	1.1	(1.003-1.25)	0.045*

Adjusted for age, sex, race, insurance, having Medicaid ever, number of face-to-face office visits in the baseline year, patient rural-urban commuting area, percent with diabetes in patient's county, percent with diabetes in patient's county who achieved HbA1c testing, percent below poverty line in patient's zip code, percent without high school education in patient's zip code, health system

* p value < 0.05